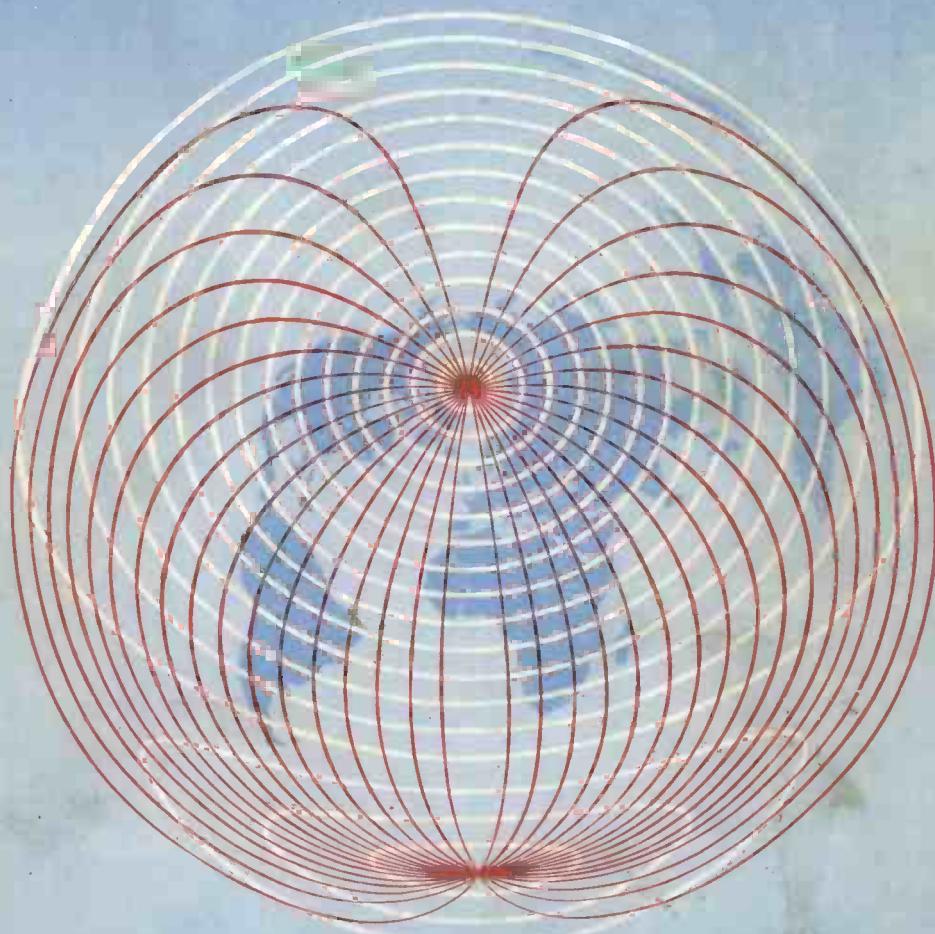


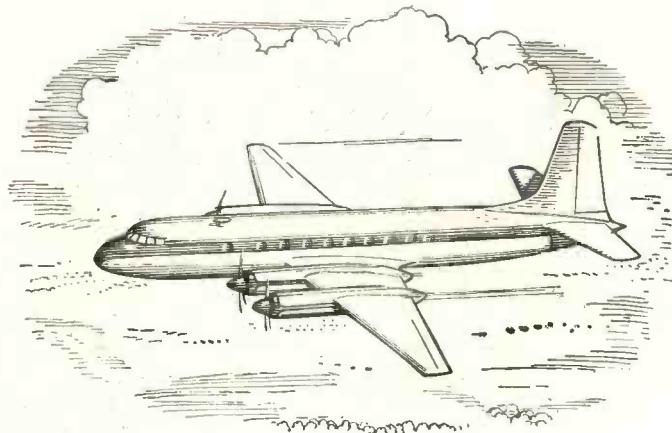
Wireless World

NOVEMBER 1953

TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS



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It is of the utmost importance that valves employed in certain types of airborne electronic and radio equipment, particularly those responsible for the operation of equipment providing vital information, will withstand the rigorous conditions imposed on them and have a lower rate of failure than is normally expected of a commercial type of valve. The Air Registration Board therefore prescribes certain standards with which these valves must comply.

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Wireless World

RADIO, TELEVISION
AND ELECTRONICS

43rd YEAR OF PUBLICATION

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

Editor: H. F. SMITH

NOVEMBER 1953

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NOVEMBER 1953

VOL. 59 No. 11

Speeding Up the Telegrams

WRITING in a rather pessimistic mood just over a year ago, we expressed the view that radio was failing to attune itself to the tempo of modern travel; in other words, we were failing in our task of keeping up with the Comet. These strictures were particularly directed towards radio telegraphy, but, as wire and wireless are now so closely integrated, they might better have been applied to telegraphy as a whole. The inland telegraph service, conducted at a heavy financial loss, is predominantly wire-borne, and so, perhaps, is not quite our concern. At home the telegram has almost acquired an antiquity value, and by its rarity rather than its speed, compels attention where other means of communication fail to do so.

Overseas Commonwealth telegraphic communications are fortunately in a healthier state, but clearly every advantage must be taken of technical developments if the transit time of telegrams is to beat by a sufficiently wide margin the speeds of modern jet aircraft. And speeds of other kinds of transport are going up as well.

The present state of Commonwealth telecommunications was ably surveyed recently by J. A. Smale, Engineer-in-Chief of Cable and Wireless, the new Chairman of the Radio Section of the I.E.E., in his inaugural address. Most of the developments foreshadowed by Mr. Smale were in the direction of faster service. For instance, he envisaged a direct sender-to-addressee service for telegrams, comparable with the existing telephone system. Many of the developments envisaged are those applicable to submarine cables rather than to radio circuits, but the radio man can take heart in the thought that they will be essentially of a radio-like or electronic nature.

Mr. Smale said: "It is a firmly held belief among old telegraphers that the biggest fool in the world sits at the other end of his circuit." In that light-hearted way he introduced a very serious plea for common executive control of all the ends of the Commonwealth circuits. Freedom from errors and delay could, he maintained, best be attained by those means. He expressed the belief that "force of circumstances will eventually produce agreement among the self-governing nations of the Commonwealth to compromise with sovereignty to the extent

necessary to bring their telecommunications systems under unified control of a body possessing the confidence of all."

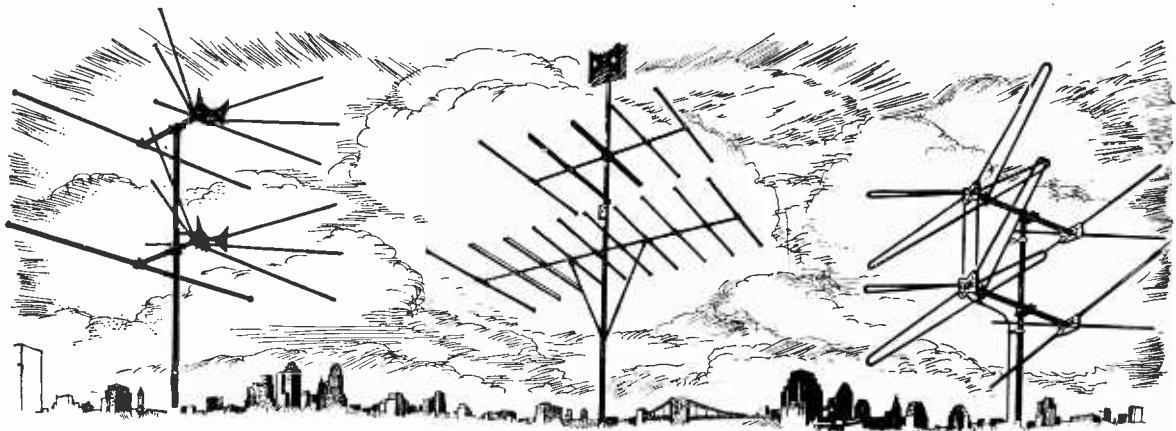
B.B.C. Progress

THE B.B.C. compels our admiration by the way in which it refuses to be shaken by the gusts of political controversy of which it is the storm centre. In spite of long-drawn-out uncertainty as to the way in which the Government will exercise powers of control over its future, the Corporation is calmly going ahead with plans for engineering extensions.

A useful survey of recent developments and of the existing state of broadcasting was recently given by Harold Bishop, director of technical services of the B.B.C., in his inaugural address as President of the Institution of Electrical Engineers. Mr. Bishop then went on to discuss proposed developments, first explaining at some length the present limitations on the medium-wave services. He admitted that reception of the Home programme was difficult or impossible during the hours of darkness for some 5M listeners. The position is deteriorating and such palliatives as can be used could not apparently be expected even to maintain the *status quo*.

Mr. Bishop then briefly outlined the B.B.C.'s plan for providing v.h.f. sound coverage by a system comprising 51 f.m. transmitters at 19 sites. This, presumably, would be the first stage of the Stockholm Plan, described in detail elsewhere in this issue. The first stations to be installed would be in those districts where medium-wave reception is bad. This is all subject to approval by the Government.

Few will quarrel with the general idea of reinforcing our present sound service in this way. We cannot imagine at this stage there will be very much support for the idea that the proposed v.h.f. service will come too late, and, with television growing at the present rate, will be outmoded before it starts. All this takes us into the sphere of prophecy rather than intelligent anticipation, and it would be indeed rash to hazard any guess as to the future position of sound *vis à vis* television.



Television Aerials of the Future

—Not Forgetting V.H.F. Sound Broadcasting

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

ULTIMATELY the outcome of the Television Advisory Committee's first report will take the form of a mixture of politics, economics, and techniques and it is not the purpose of this article to gaze into the crystal ball, but to assume that all five bands internationally allocated to television and v.h.f. sound broadcasting will eventually be used.

To refresh the reader's memory, these bands are split up as follows:—

Band No.	Frequency Range (Mc/s)	Proposed use
1	41-68	Television
2	87.5-100	Sound broadcasting
3	174-216	Television
4	470-585	Television
5	610-960	Television

The United States are operating television in Bands 1, 3 and 4 and v.h.f. sound broadcasting in Band 2. The frequency range is in the ratio of about 10 to 1. Because the stations are not transmitting a common programme, receivers are expected to tune continuously through all channels and the aerial system must therefore be effective over the receiver tuning range. It is not the purpose of this article to deal in detail with the various types of American wide-band aerials excepting to point out that they appear to be inefficient compared with single-channel optimized aerials, and take various forms. The title illustration, which depicts only a few of the dozens of variants, leaves the rest to the reader's imagination.

One significant fact must be observed, namely: that all television and v.h.f. sound transmissions in the

U.S.A. are based on *horizontal polarization*, which at least gives the designer some common basis upon which to engineer his broad-band aerials.

It is with some dismay that one notes that the T.A.C. recommendations for Band 3 television envisage the use of vertical and horizontal polarization, according to the siting of the transmitter. This can only complicate the aerial design and render it more bulky than its U.S.A. counterpart unless some outstanding development is forthcoming.

The use of vertical and horizontal polarization for two television transmitters is confined to the case in which they operate on a common frequency channel (shared-channel operation), and is based upon evidence (so far as Band 1 is concerned) that, during anomalous propagation† a greater freedom from mutual interference results.

This technique may be fully justified on Band 1, where all stations are radiating a common programme, and no one minds a single aerial installation whether vertically or horizontally disposed. But consider the case of a viewer situated so that he is within range of one station in Band 1 and, say, four stations in Band 3, each radiating its own programme. The viewer will naturally require that his receiver be capable of selecting individual programmes and the aerial must be efficient at the frequencies involved.

Providing a common polarization is used, whether vertical or horizontal, it is not difficult to devise the necessary wide-band aerial, but on the present recommendations these four stations in Band 3 can all be vertically polarized, or horizontally polarized, or can be a mixture of both. Clearly, the only solution in this event is a pair of broad-band arrays, one erected vertically and the other horizontally, which just doubles

* Belling and Lee, Ltd.

† *Wireless World*. March 1953.

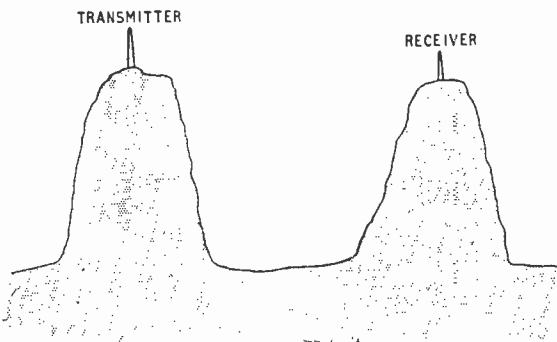


Fig. 1. Example of practical "free space" conditions on the ground.

the total amount of equipment required for any one aerial installation!

Bearing in mind the fact that the frequency of Band 3 is, on the average, four times that of the Band 1, it is suggested that ample experimental evidence must be furnished that mixed polarization on shared-channel operation is an advantage before it is adopted. This is really the crux of the whole matter.

Clearly, it is impossible to enter into a detailed discussion on aerial design until this basic problem is fully resolved, but there are certain fundamental aerial concepts which may be discussed with advantage.

It is usual in theory to refer to "free space" conditions and, mathematically, this is essential in order to get exact solutions for wave-energy equations. But it may be taken that, at the frequencies concerned, a transmitting and receiving site respectively located on the peak of two mountains as shown in Fig. 1, and in direct line of sight, will approximate very closely to ideal "free space" conditions.

Assume that the transmitter is Alexandra Palace on channel 1 (45 Mc/s), and that a conventional "H"-type receiving aerial is used. Now scale the transmitting aerial down by a factor of 10 so that it is a resonant system at 450 Mc/s (which places it in Band 4) and energize it with exactly the same power. The

field strength at the receiving site will be unaffected. Now scale down the receiving aerial by a factor of 10 so that it is again a resonant system at 450 Mc/s. The amount of energy received by the aerial will be only one-hundredth of the original, even though the field strength at the aerial has remained constant. This is because the effective height of the aerial is proportional to the wavelength. Thus if the wavelength is reduced by a factor of 10 the induced e.m.f. in the aerial is reduced by the same factor, so that the energy, which is proportional to the square of the e.m.f., is reduced one-hundredfold.

It is obvious that something must be done to compensate for this very high loss, and it is satisfactory to know that quite a lot of signal may be recovered. If the space originally occupied by the transmitting aerial is filled with 450-Mc/s dipoles, all correctly phased and the same is done in the space previously occupied by the receiving aerial, then there is, theoretically, a net gain.

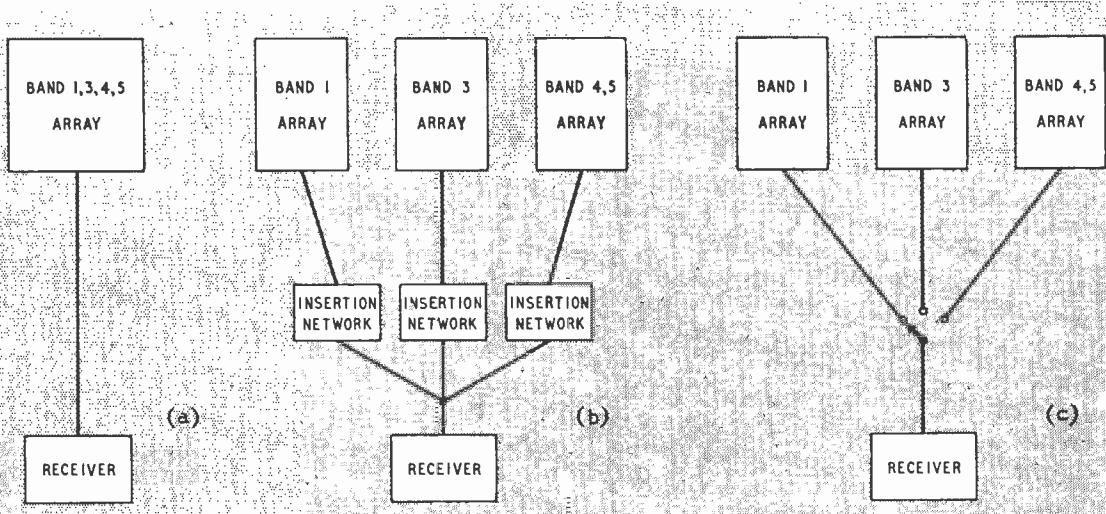
In practice there are certain difficulties on the transmitting side, and there is insufficient space to spare on the receiving side, bearing in mind that Bands 1, 2 and 3 aerials may also be required.

Even in the ideal case of the transmitting and receiving sites being located within line of sight and under "free space" conditions the net result is not likely to be better than that which would have been obtained at 45 Mc/s.

The problem is worsened in practice where the average receiving installation is on the usual type of undulating terrain and is surrounded by other buildings and structures. In these circumstances there are greatly increased propagational losses at 450 Mc/s due to diffraction and ground reflection effects and increased absorption of energy from intervening objects. In addition, there must be included the greater difficulty of exciting the transmitting aerial with anything like the same amount of radio-frequency power, and the higher noise-factor and lower conversion-efficiency of detectors employed in the receiver.

It is difficult to be hard and fast about the overall result of these added problems, but they all add up to a greatly reduced range, and an increased number

Fig. 2. Three basic designs for a multi-band v.h.f. aerial.



of pockets of low field strength within a given area as compared with a service on a lower frequency radiating the same power.

The same remarks apply to Band 3, but here the average frequency is only four times greater than that of Band 1; hence the effects are not so serious. Nevertheless, for a given system the results to be expected, so far as coverage is concerned, will be less than on Band 1.

From all this we may deduce one important point. If we neglect the Band 2 aerial, which is for sound-broadcast reception only, and assume that three separate aerials will be required for Bands 1, 3, 4 and 5 their respective heights should be in the same order—that is, the Band 4 and 5 aerial should be at the top of the mast, with the Bands 3 and 1 aerials progressively lower.

Forgetting the problem of mixed polarization, and assuming that everything is either vertically or horizontally polarized, the design of a suitable all-band aerial may be attacked in three ways.

First, an attempt may be made to devise a single multi-element array which will respond efficiently over all the bands. So far all that has been done has resulted in inefficient systems particularly as regards front-to-back ratio which is very important when "ghosts" are present. It must be remembered that the "ghost" problem is likely to increase as the wavelength is decreased because of the greater reflectivity of surrounding structures.

A second method is to devise a moderately broad-banded array for each channel and feed into a single transmission line via suitable isolating filter networks so that impedance matching may be maintained.

A third method is identical with the second, excepting that the isolating filters are removed and a separate and switchable feeder is used with each aerial.

These arrangements are depicted (in block diagram form) in Fig. 2. Obviously method (a) is ideal if it is capable of achievement. Method (c) would be frowned upon by receiver manufacturers and installers on the grounds of cost, so that the problem resolves itself into either (a) or (b) or some combination of both, but that is a matter which must be left to the ingenuity of the aerial designer and cannot be disposed of prematurely. It is sufficient to note that the U.S.A. has made varied attempts to solve this problem, and the reader is again referred to the title illustrations.

Aerial Feeder

The question of feeders can now be discussed. The popular type at present employed in this country on Band 1 is of coaxial construction and, typically, has a loss when matched of about 3.5 db per 100 ft. The average suburban installation uses about 50 ft of this feeder so the loss (1.75 db) is not serious. It is well known that this loss increases as the square root of the frequency; hence, it is doubled on Band 3 and more than trebled on Bands 4 and 5. Bearing in mind the progressive deterioration of reception with increasing frequency there is a strong suggestion that the existing type of feeder is just about acceptable up to, and including, Band 3 but is completely unacceptable so far as Bands 4 and 5 are concerned.

An examination of data for coaxial feeders shows that a feeder for use at 500 Mc/s (Band 4) will require an outside diameter of nearly 1 in if its loss is not to exceed that at present accepted on Band 1 installations with the conventional feeder. The cost of such a

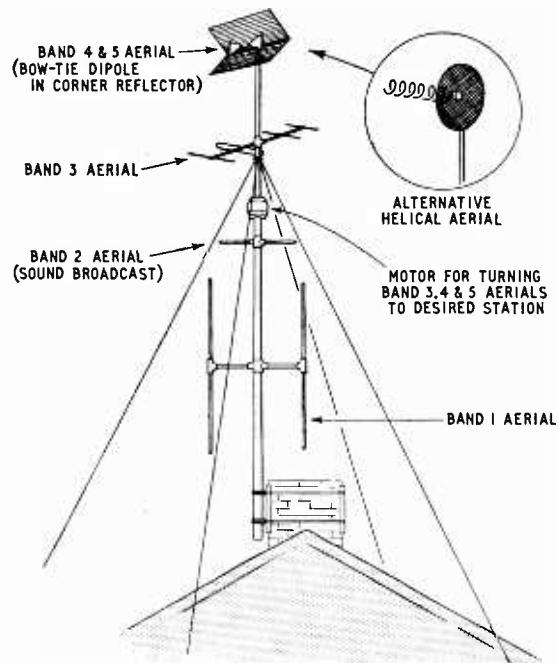


Fig. 3. A multi-band television and v.h.f. broadcasting aerial system might conceivably take this form.

feeder rises alarmingly and can far exceed the cost of the aerial, particularly on Bands 4 and 5 where the material content of the aerial may be fairly small.

Further, the matching of a single wide-band aerial to a feeder is rendered more difficult when the characteristic impedance is low (say 80 ohms), and it is difficult to design a low-loss coaxial feeder of higher impedance—in fact, anything greater than 100 ohms becomes economically impossible.

The Americans have long recognized this fact, and for this reason have almost invariably adopted 300-ohm twin feeders. It is a simple matter to design these for a characteristic impedance up to 400 ohms. They have the advantage of being much cheaper than an 80-ohm coaxial feeder for the same loss and a typical example will consist of a pair of parallel conductors of 7/30 s.w.g. copper wire separated about 0.4 in by a web of low-loss flexible insulating material such as polythene. The characteristic impedance is 300 ohms and the loss at 450 Mc/s (when dry) is about 3 db.

The disadvantage, due to the open construction of this (so-termed) ribbon feeder is that it must be spaced a few inches from walls and other semi-conducting surfaces, or the inherent attenuation loss increases, and the characteristic impedance decreases, thereby causing additional mis-match losses.

Measurements have shown that the installation of 300-ohm ribbon feeder in close proximity to a conductive surface doubles the inherent attenuation loss and reduces the impedance to about 240 ohms. Also, ribbon feeders, on account of their open construction, are very susceptible to nearby interfering fields unless they are electrically balanced; in practice this is difficult, if not impossible, to attain over a wide frequency range.

For a given conductor size the inherent attenuation

is almost inversely proportional to the characteristic impedance. By closing the spacing so that the conductors are separated by about 0.1 in the characteristic impedance will fall to about 150 ohms. This feeder is cheaper because less insulation is used, but the loss will be double. At some increase in cost the conductors may be increased in diameter and the losses reduced somewhat, so, at about the same overall cost, a twin feeder may be converted from 300 to 150 ohms with about 30½% increase in loss.

What is more important, however, is that it is far less influenced by proximity effects. It can be installed without stand-off insulators (these are always used in U.S.A.) and the loss, under the most adverse conditions when routed close to a conductive surface, will increase by only 20% and the impedance will fall by about 10%. This is confirmed by experiment. Additionally, its susceptibility to local interference is reduced and the balancing problem is simplified somewhat. It is hoped that designers of converters, or broad-band receivers, will give these suggestions careful consideration.

Some idea of the shape of things to come may be gleaned from Fig. 3. In accordance with the best technical ethics the Bands 4 and 5 aerial will be at the top of the mast. A typical broad-band aerial may consist of a "bow tie" dipole (already popular in the U.S.A.) located in a wire mesh corner-reflector. Alternatively, a bowl-type reflector may be used, or the helical aerial, with reflector mat, as devised by J. D. Kraus of Ohio State University (see inset). Bearing in mind the increased propagation losses and other sources of inefficiency in the receiver, and the increased "ghosting" problems, it is unlikely that anything so simple as a dipole or even "H" type array will be satisfactory in Bands 4 and 5, excepting line-of-sight conditions. Even then "ghost" elimination may require highly directional arrays, and for wide-band operation the usual parasitically excited rod elements can only work over a fairly restricted frequency band and must be replaced by a surface such as a corner reflector, bowl or mat.

The Band 3 aerial may take the form of a multi-element Yagi with folded dipole to provide the necessary frequency coverage, which is beyond the capabilities of the simple dipole array. The centre impedance of a folded dipole is of the order of 300 ohms, but by the time the parasitic reflector and director elements have been added this will be reduced and is another good reason why a 150-ohm feeder is to be preferred. There will be variants of this aerial (see title illustration) but it cannot be pointed out too strongly that, in the present state of the art, the gain of an aerial is uniquely related to the space it occupies, and that increasing gain without increasing physical size is as impossible as pouring a quart from a pint pot.

The Band 2 aerial is not very ambitious because it is required for sound-broadcast reception and there are no "ghosting" problems, and very little directional effect is likely to be required. At extreme ranges it may need the addition of a reflector and, perhaps, director elements, in which case it will look like a larger version of the Band 3 aerial.

There follows, finally, the conventional (and largest) aerial for Band 1. For reception of the horizontally polarized transmitters (e.g., Belfast) it may be combined with Band 2 and 3 aerials to provide a much more presentable installation occupying far less space. Fig. 3 has, however, been drawn purposely to bring out this point in considering vertical polarization on

Band 1. Bearing in mind that the present plan envisages mixed polarization in Band 3 the earlier remarks on the effect on aerial design may be added (in imagination) to Fig. 3!

Fig. 3 also shows a motor drive located above the Band 2 array so that Band 3, 4 and 5 arrays may be rotated for the purpose of selecting the desired alternative programme, or finding one that is free from "ghosts" (a typical U.S.A. practice, incidentally). This expensive motor drive could be eliminated if the various services had their transmitting aerials on the same site, a point which should not be overlooked in future planning.

The U.S.A., with horizontal polarization throughout and plenty of experience, have achieved nothing by way of compact aerial design beyond what can be seen from the title illustration. In the present circumstances it must be concluded that the British problem is far more difficult. Suggestions for simplifying this may be in conflict with problems relating to transmitter and receiver design and may contain much which lies within the confines of politics—a subject which the author wishes to avoid. For this reason the article must close without drawing any conclusions, but enough has been said to indicate that the problems are not simple, and need weighty considerations from all directions.

Overlapping Television Channels?

NOW that the allocation of television channels is becoming such a problem in the small amount of ether-space available for them, technical people are getting rather worried by the inefficient nature of the television system as a means of conveying information. Measured against Shannon's formula giving the maximum capacity of a communications channel, a television channel consumes far too much bandwidth for the amount of information it conveys.

This subject came up for discussion recently at a Brit. I.R.E. meeting when D. A. Bell gave a lecture on "The Impact of Information Theory on Television." Dr. Bell put some emphasis on the fact that whereas the frequency spectrum of a television transmission was usually represented on paper by the pass-band characteristic of the transmitting and receiving equipment, the actual distribution of sideband energy in the signal tended to fall off quite rapidly away from the carrier frequency in an exponential curve. This suggested that the outer sidebands of two adjacent television channels could be overlapped without serious interference, so that less space would be occupied in the band.

The idea had already been tried out in France and it was also helpful in the N.T.S.C. system of colour television (see page 524) for reducing interference between the two sets of interlaced sidebands. Several speakers were of the opinion, however, that the principle was not very good because the exponential curve of sideband energy was only an average one and in practice the outer sidebands often contained large peaks of energy which could cause mutual interference.

Apart from this, Dr. Bell thought that the shape of the sideband energy curve could be exploited in

another direction. The best way to secure error-free transmission was to distribute the signal over the frequency band in the same way as the interfering noise—that is, more or less evenly. This suggested that some form of "pre-emphasis" should be used at the transmitter to lift the outer, high-frequency sidebands of the signal to the same amplitude as those near the carrier frequency. Then at the receiver "de-emphasis" could be used to restore the energy distribution to its original form.

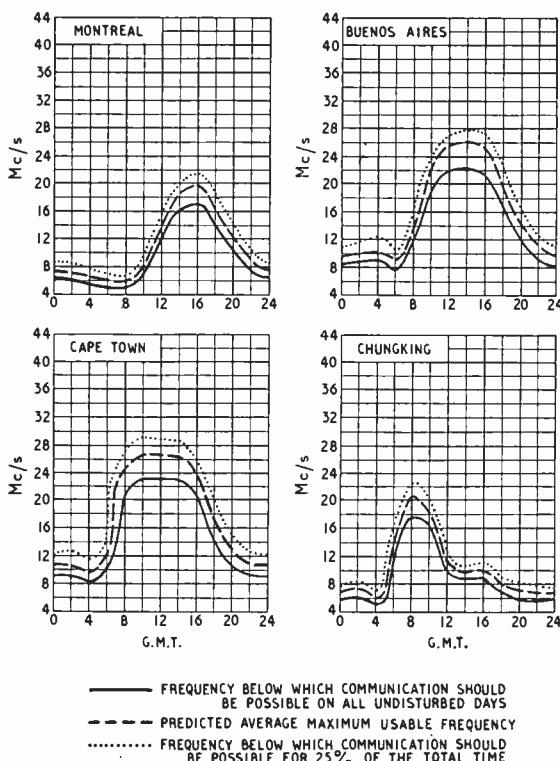
The lecturer considered that synchronizing pulses were a very redundant feature of the television signal because of their repetitive nature. Nevertheless, a large frequency band was required to transmit them properly. All we really needed in principle for synchronizing was a single sideband frequency, with an apparatus at the receiver which would work from a sine wave instead of pulses. In view of the experience that had already been gained with flywheel synchronization this would not be very difficult to arrange.

Short-wave Conditions

Predictions for November

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

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



BOOKS RECEIVED

Fundamentals of Electronic Motion, by Willis W. Harmon. Mathematical treatise on the interaction between electrons and electric and magnetic fields with practical illustrations of their application in electron optics, travelling wave amplifiers, linear accelerators, etc. Pp. 319 + x; Figs. 252. Price in U.K., 46s 6d. McGraw Hill Publishing Company, 95, Farringdon Street, London, E.C.4.

Principles of Electronics, by L. T. Agger, B.E. Elementary textbook on vacuum and gas-filled valves and their associated circuits. Pp. 340; Figs. 307. Price 18s. Macmillan and Company, St. Martin's Street, London, W.C.2.

A First Course in Wireless, by "Decibel." Revised third edition of a collection of articles reprinted from *World Radio*. Pp. 231 + vii; Figs. 93. Price 12s 6d. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2.

Magnetic Amplifiers, by George M. Ettinger. Broad survey of principles and applications with an 82-item bibliography. Pp. 88 + viii; Figs. 48. Price 6s 6d. Methuen and Company, 36, Essex Street, London, W.C.2.

Measurements of Radio Interference in the Frequency Range 0.15 to 30 Mc/s. Technical Report M/T116 "A Portable Measuring Set," by S. F. Pearce and D. C. G. Smith. Pp. 9; Figs. 5. Price 10s 9d by post; and Technical Report M/T117 "A Mains Isolating Unit," by J. Miedzinski and S. F. Pearce. Pp. 7; Figs. 11. Price 12s 10d. Both designs in accordance with performance characteristics prescribed in British Standards Specification BS.727. The Electrical Research Association, Thornton Manor, Dorking Road, Leatherhead, Surrey.

Traité Pratique des Antennes, by E. Rolin. Elementary theory of short-wave aerials (10-100 metres) for reception and transmission, including directional aerials and their orientation for great circle paths. Pp. 216; Figs. 104. Price 1,380 francs. Dunod, 92 rue Bonaparte, Paris VI.

CLUB NEWS

Birmingham.—A demonstrated talk on "Some Experiments in the Application of Cold Cathode Tubes" will be given by A. B. Watt (G2DRG) to members of the Slade Radio Society on November 13th. The annual general meeting of the club will be held on November 27th. Meetings are held at 7.45 on alternate Fridays at the Church House, High Street, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Cleckheaton.—At the meeting of the Spen Valley and District Radio and Television Society on November 18th, E. A. Smith, of the Post Office, will talk on microwave radio links. Meetings are held on alternate Wednesdays at 7.30 in the Temperance Hall, Cleckheaton. Sec.: N. Pride, 100, Raikes Lane, Birstall, Nr. Leeds.

Hounslow.—Meetings of the Hounslow and District Radio Society are held on alternate Thursdays at 7.30 at Grove Road Junior School, Grove Road, Hounslow. The next meeting will be on November 12th. Sec.: R. J. Parsons, 16, Cypress Avenue, Whitton, Twickenham, Middx.

Nottingham.—The Nottingham and District Short Wave Club meets every Monday and Thursday at 7.0 at Woodthorpe House, Sherwood, Nottingham. A basic radio course occupies part of Monday evenings and morse practice is given on Thursdays. Sec.: N. D. Littlewood, 129, Standhill Road, Nottingham.

Two-Call Club.—Membership of the British Two-Call Club, which is restricted to British amateurs having been allocated a call in two or more countries, continues to increase. New members include P. R. Golledge (G3EDW, VQ2W, D2DW), D. R. Wilde (G3EBA, DL2BA), R. D. Raley (G3IDR, DL2SR) and C. W. Liversidge (G3ERF, Y12GQ). The president of the Club is Major D. A. MacDonnell (G8DK), who is in the six-call section. Sec.: G. V. Haylock (G2DHV), 63, Lewisham Hill, London, S.E.13.

Point Contact Germanium Rectifiers

Principles of Operation and Their Relation to Performance and Reliability

By R. T. LOVELOCK,* A.M.I.E.E.

THE point-contact germanium rectifier, consisting of a springy metal wire making end-on contact with a germanium surface, has been available in commercial quantities for several years. During that period some manufacturers have used it very successfully in a variety of electrical equipments, while others have been disappointed in its performance. Failure to obtain satisfactory performance can be attributed either to an imperfectly developed component, which was still suffering from faults not realized by the manufacturer, or to lack of comprehension by the user of the fundamental characteristics of the rectifier, with consequent failure to adopt an optimum circuit design for its inclusion.

In the historical development of the rectifier, the various faults experienced have often led to a better appreciation of the conduction mechanism. However, to obtain a clearer grasp of the faults and limitations of the component, it is better to depart from the historical order and first to outline such principles of operation as will assist understanding of its performance, then to note the electrical characteristics of the rectifier, and finally to examine the major faults of manufacture which may cause premature failure in an equipment. For obvious reasons the treatment must be general, and specific constructions cannot be cited. An appreciation of the possible weaknesses, however, will enable an intending user to devise tests which will discriminate between the good and bad examples of design which may come into his hands.

Electrical Conduction in Solids.—In a solid material the atoms are bonded together by forces resulting from a sharing of electrons in the outermost orbits by two or more atoms. In some materials the arrangement of electrons is such that a large number are free to move at random within the volume occupied by the atomic lattice, and they form an assembly analogous to a gas in a closed container. If an electric field be established within the material, a steady component of drift velocity will be superimposed upon the random thermal movement, and electrical conduction will occur: materials which possess this type of structure are called electrical conductors. There are other forms of material in which all the electrons are bound within the vicinity of their parent nuclei, and no general drift is possible upon application of a potential gradient, but only a certain straining of the system from its passive distribution, which we interpret as a "dielectric constant." Such materials are insulators, and the small leakage current which they do exhibit is due to the drift of a very small number of free electrons which

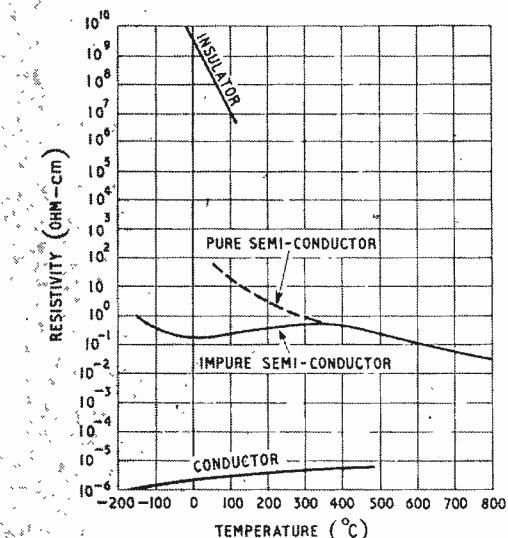
are present as slight imperfections in the material structure.

The behaviour of these two types of material with variation of temperature is radically different. Increase of temperature in a conductor causes an insignificant increase in the number of electrons able to conduct, but the increase in thermal energy reduces the mean free path of an electron within the volume. Resistivity is inversely proportional both to the number of electrons and also to the mean free path, and the decrease of mean free path greatly outweighs the increase of electrons, resulting in an increase of resistivity with increasing temperature. In an insulator however, the very small number of electrons present causes the decrease in mean free path to be insignificant compared with the increase of available electrons, and the resistivity falls with rising temperature.

A semi-conductor, as its name implies, is a material intermediate in type between the two extremes: it has many more mobile charges than an insulator, but several orders less than a conductor. In a pure material in the crystalline form the number of free charges available for conduction increases rapidly with increase of temperature, and resistivity falls; the resulting flow of current is said to be due to "intrinsic conduction."

If, in the crystal lattice of the semi-conductor, a very

Fig. 1. Typical variation of resistivity with temperature.



* Murphy Radio, formerly General Electric Company.

small percentage of the atoms are an impurity material possessing either one less or more electron in the outermost orbit than does the semi-conductor, such impurity atoms will each be capable of contributing one free current-carrying charge to the material; these charges will be liberated by the impurity at a much lower temperature than will those of the semi-conductor, and over the temperature range in which the major component of conduction is provided by the impurity charges, conduction is said to be "extrinsic."

Hence, over the low temperature range in which the number of charges liberated by the impurity is rapidly increasing with rising temperature, the material will exhibit a negative temperature coefficient; when the majority of such charges have been liberated, and those provided by the semi-conductor are still only an insignificant fraction of the total, further increase of temperature, by reducing the mean free path without significant increase of free charges, will result in a positive coefficient; when, once more, the number of charges liberated by the semi-conductor becomes comparable with that from the impurity, the increase in number will once more mask the decrease in free path, and the coefficient again becomes negative. Typical behaviour of all four types of material is illustrated in Fig. 1.

An impurity with one more electron in the outermost orbit is said to be a donor type impurity, since it is capable of donating one extra electron to the assemblage, and the mixture is said to be an "*n*" (negative) type of semi-conductor. An impurity with one less electron is said to be an acceptor impurity, since it results in a space (positive hole) into which an electron can fall (or be accepted): conduction can occur due to the successive falling of bound electrons into these holes, and they behave as though they were free current-carrying agents with a positive charge. Such a material is said to be a "*p*" (positive) type material. By a critical temperature processing of a semi-conductor it is possible to produce a lattice imperfection (cause a small percentage of spaces in the crystal lattice which should be occupied to become vacant) and such imperfections act as if they were a "positive hole" and result in a behaviour similar to that of *p*-type material; such behaviour is not identical with that resulting from the presence of acceptor impurity, but differs from it in several important ways, not perfectly understood as yet. It is probably this possibility of modifying the behaviour of a material by deforming the lattice which makes possible the construction of the high-reverse-voltage type of point-contact germanium rectifier.

The Germanium Rectifier.—During the last few years the germanium rectifier has sprung into prominence as one of the most important applications of the semi-conducting elements. The intrinsic resistivity of pure germanium at 20°C is between 60 and 100 ohm-cm, but in the high-reverse-voltage type of rectifier it is usually employed with sufficient donor impurity to reduce this to 10 ohm-cm. For making the low-impedance type of rectifier it is used with about a thousand times this impurity concentration. The two contents represent 0.1 parts per million, and 100 parts per million respectively.

If a bar of germanium be prepared in which one end consists of high-resistivity *n*-type material, and the other of low-resistivity *p*-type material, and a low-resistance contact be attached to each end of the bar so that current may be caused to flow across the

inter-face where the two types meet, the bar will behave as a rectifier, and this form is known as a *p-n* junction rectifier. It may be shown on theoretical grounds that the static characteristic of the junction, ignoring the bulk resistance of the bar, can be expressed at 20°C by the law :—

$$i = I_0 (1 - e^{39V}) \dots \dots \dots \quad (1)$$

where I_0 is a constant and V is the applied voltage.

Rectifiers have been constructed which exhibit very close agreement with this theoretical law. The junction type of rectifier is being very actively developed in this country, but is not yet available in production quantities.

The point-contact type of rectifier, which has been freely available for some years, consists of a small block of *n*-type germanium, to one side of which is attached a low-resistance contact, and on the other side it is contacted by a pointed springy wire, pressed firmly against it. This device also exhibits a rectification characteristic, but a characteristic which does not agree exactly with that forecast on theoretical grounds for the plain contact between metal and germanium.

Recently, when experiments in connection with the germanium transistor had thrown considerable new light on the mechanism of conduction at a metal-germanium contact, it was realized that the reason for failure to agree with the older theoretical law was because that law had not taken into account the modification to the germanium material which occurs due to the passage of current through the contact. American workers in the Bell Telephone Laboratories have now established that passage of a heavy current pulse through the contact, such as is used to "electro-form" the rectifiers, so modifies the germanium in the immediate vicinity of the contact that it exhibits *p*-type characteristics. It is presumed that this modification occurs partly due to the creation of lattice defects in the material, and although the matter is still controversial Fig 2 shows the most likely form which the point-contact rectifier takes in practice. During manufacture the whisker point is pressed firmly against a specially etched surface of germanium, and a heavy pulse of current passed which serves to form a semi-weld between the metal and germanium, and to produce a small volume of *p*-type germanium between this weld and the bulk *n*-type germanium. Thus a *p-n* junction will be formed at the inter-face, which will be "shunted" by any conducting layer of oxide residues which may be formed on the surface during heating of the contact by the current.

The Rectification Characteristic.—In Fig. 3 are shown typical characteristics of representative rectifiers. Both current and voltage scales are shown proportional to the cube root of the parameter as a convenient means of opening out the scale of small values while still allowing the zero point to be plotted. Experiment has shown that the body life of free charges is not greatly affected by variation of impurity content over the range used for the rectifiers plotted, and it follows from this fact on theoretical grounds that if two rectifiers with different impurity content but identical low-frequency capacitance be chosen, the characteristics of the *p-n* junctions formed will be nearly identical, except for the lower breakdown voltage of the one with higher impurity content. In Fig. 3 the characteristics of two point-contact rectifiers are plotted with equal capacitance, but widely differing impurity content, and also the theoretical

characteristics of the junctions formed under the whisker points.

The forward current is seen to be less than that of the junction, and the reverse current greater: the forward current of the low-resistivity rectifier is nearer to that of the junction than is that of the high-resistivity component, but this relationship is reversed in the case of the inverse currents. Although it is very difficult to devise and control experiments to prove the matter, an obvious explanation of this divergence from the theoretical form is that the rectifier comprises a complex system such as that shown in Fig. 4. Such a system could account for all the departures from the junction characteristic, including the rather puzzling negative resistance slope exhibited by the high-reverse-voltage types. Although it must be emphasized again that this matter is still controversial, this explanation will be adopted for simplicity in the following treatment as a suitable framework on which to erect a picture of rectifier behaviour.

Cyclic Temperature Coefficient.—As the temperature of the germanium block varies, the characteristic undergoes major changes of shape; such variations may or may not be cyclic and reversible. In this section only those which are cyclic will be considered, leaving those which are not to be considered later as faults. When negligible power is being dissipated in the rectifier, the temperature of the contact is that of the ambient conditions, but when appreciable power is dissipated a considerable temperature rise above ambient may occur, due to the small physical size, and should be allowed for. If, therefore, a slow variation with time, which is not related to the variation of ambient temperature, is observed, this effect

duced rate of increase as temperature falls below this limit, while some may even be showing a slight tendency to fall again as temperature falls from -20°C to -40°C . This major variation of resistivity with temperature is a basic feature of germanium material, and it is impossible to make a rectifier using germanium which will not exhibit it: the only solution to the problem of obtaining a more stable rectifier is to utilize another semi-conducting material in which the major transition from extrinsic to intrinsic conduction occurs over a higher temperature range. Such a material is silicon, and considerable effort is being made to develop a high-reverse-voltage silicon rectifier, in which there is a possibility of obtaining an impedance as high at 100°C as is given by the germanium at 20°C .

The attempt to forecast the variation with temperature is fraught with complexity in the case of the point-contact type. It is comparatively easy to forecast the variation of the theoretical junction characteristic but the other two components causing departure from this characteristic are not subject to close control in manufacture, and will be present in varying degrees in commercial rectifiers of a given type. As a result of this, there will be a considerable spread of temperature coefficient among any given batch of components, and the only method of specifying it is for the manufacturers to measure a percentage of each day's production and to supply the user with information concerning the distribution of coefficients for the rectifier type being used.

The variation of junction current is fairly simple. In equation (1) the exponent or index (39 at $+20^{\circ}\text{C}$) will vary inversely with absolute temperature (degrees Kelvin) decreasing to 31 at 100°C . The coefficient I_0

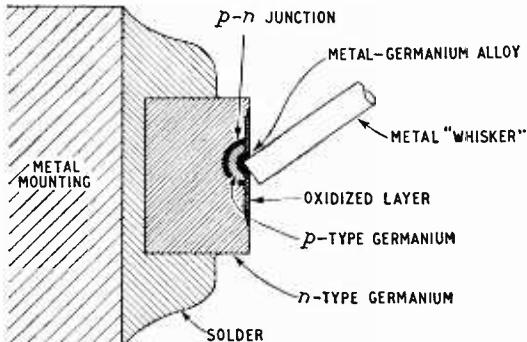


Fig. 2. Diagrammatic representation of point-contact type rectifier.

should be suspected, and when measuring rectifiers care should be taken to avoid it.

Over the temperature range -40°C to $+100^{\circ}\text{C}$ the effect of increasing temperature on the germanium rectifier is to increase both the forward and reverse current at a given potential, and also to decrease the "turn-over" voltage or the breakdown voltage. Germanium at a temperature of $+20^{\circ}\text{C}$ has already released all charges from the impurity centres, and over the range of impurity concentrations used in commercial rectifiers the number of charges released by the germanium itself at that temperature is sufficient to ensure that as temperature increases from $+20^{\circ}\text{C}$ to 100°C the resistivity falls rapidly. Below $+20^{\circ}\text{C}$, however, the behaviour depends to a certain extent on the impurity concentration and the state of the germanium material: all rectifiers will show a greatly re-

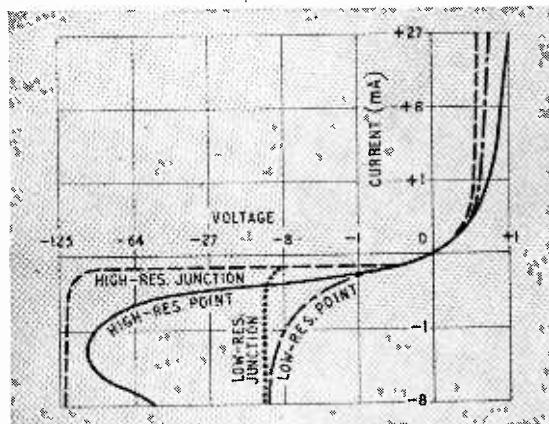


Fig. 3. Typical germanium rectifier characteristics.

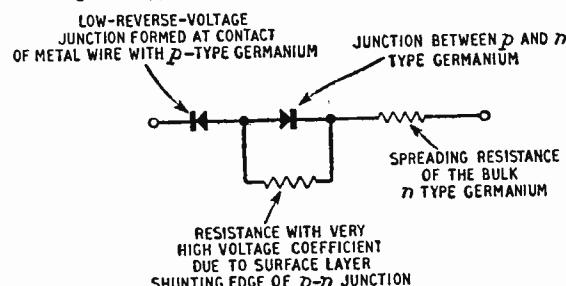


Fig. 4. Suggested equivalent circuit of point-contact germanium rectifier.

has a variation depending mainly on three factors; it is directly proportional to absolute temperature, it is inversely proportional to the overall conductivity of the germanium-impurity alloy, and it is directly proportional to the square of the intrinsic conductivity of pure germanium. The latter term increases so rapidly over the range from 20° C to 100° C that it is the major factor causing the large increase observed, and as a very rough approximation one may consider I_o as increasing a little more rapidly than the conductivity of pure germanium. In the forward direction the current will increase less rapidly than I_o due to the decrease in value of the exponent. In the reverse direction I_o represents a saturation current which will flow at all values of voltage between 0.5 and the breakdown level.

The forward current of the point-contact rectifier is less than that of the junction due to potential drop both in the spreading resistance of the germanium, and also in the reversed rectifier formed by the metal-germanium contact; both these sources will give a smaller fall in potential for a given current as the temperature rises, and in consequence the increase in forward current in the overall rectifier is a little greater than would be that of a junction type. The reverse current will consist of two components, that through the junction, and that through the non-linear leakage shunting the junction. Analysis of practical characteristics indicates that increase of the leakage component

is less rapid than that of the saturation component, and in consequence the overall increase of reverse current is not so great as that of a junction. The leakage component can be analysed into two sub-components, one of which increases linearly with increase of voltage (ohmic) and the other which increases as a power (approximately two) of the voltage. The ohmic component decreases slightly as temperature increases, but the squared component increases and outweighs the ohmic, giving an overall increase of current for increasing voltage. Hence the temperature coefficient of the whole leakage component varies widely between samples due to the variation of ratio between ohmic and non-linear sub-components.

For a given impurity concentration the value of I_o will be directly proportional to the low-frequency capacitance, and as this capacitance varies by as much as four to one over a batch of typical rectifiers, it follows that the value of saturation current will vary by at least as much. An even greater variation of the leakage component is encountered which is not directly related to I_o and it follows that the value of reverse current at any particular voltage is no guide to the value of temperature coefficient. Three general rules may be stated, however, for the guidance of the user:—

(a). The more nearly horizontal the reverse characteristic between -1 and -50 volts, the greater will be the ratio of junction current to leakage current, and the greater will be the overall temperature co-efficient for a given value of reverse current.

(b). For a given value of capacitance, the greater the reverse current at a given voltage the greater will be the leakage component and the smaller the temperature coefficient.

(c). For a given capacitance and a given reverse current at a particular voltage, the greater the concavity of the characteristic the greater will be the ratio of non-linear to linear leakage, and the greater will be the temperature coefficient.

Since the capacitance is controlled within certain limits during manufacture, and the *average* value will remain fairly constant for any large batch, it follows that the *average* value of temperature coefficient for a given batch will be smaller the greater the average value of reverse current; in designing circuits to use these rectifiers it is necessary to design for the average value of coefficients, and allow for the spread of these throughout a representative batch. Typical spread of reverse characteristic for two types is shown in Fig. 5 where it will be seen that the one with highest current has lowest temperature coefficient.

The fall of "turn-over" voltage with rise of temperature is a composite phenomenon, due both to changes in the junction and also in the leakage shunting it. The theory of the negative resistance slope has not been fully evaluated yet, and the only reliable information comes from measurements on production rectifiers. Due to variation of ratio between junction and leakage currents the performance of a rectifier having a given value of "turn-over" voltage at 20° C will vary between the individuals in a batch, and the spread of a typical production batch is shown in Fig. 6. It will be noted that the average fall for a given batch will be less the smaller the average value of "turn-over" voltage, but no rules can be stated for the individual rectifier, and the batch must be considered as having a value which may lie anywhere inside the shaded area in the figure.

(To be concluded)

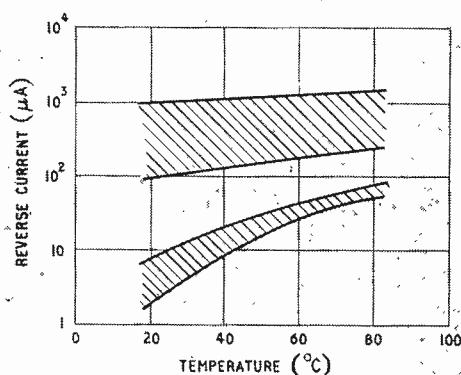


Fig. 5. Typical temperature characteristics of two germanium rectifier types.

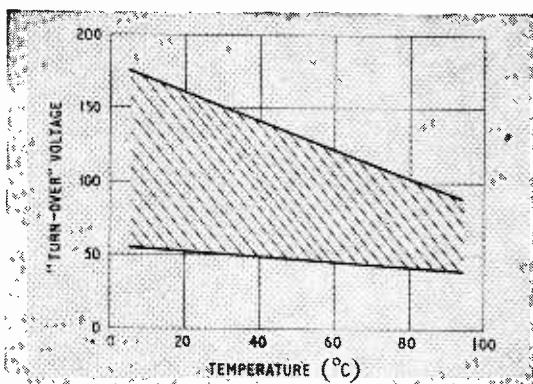


Fig. 6. Variation of "turn-over" voltage with temperature for typical germanium rectifier.

Display showing responses on the 50-mile range from a vessel bound for Liverpool.

Long-Range Marine Radar

Features of the New Kelvin-Hughes Type 2C Equipment

NORMALLY, marine radar sets are provided with a maximum range of 25 miles, which covers all targets within the ship's horizon. On some trade routes it is an advantage in hazy weather to get an early fix from high land which is "visible" to the radar at much greater distances, and to meet this demand Kelvin and Hughes (Marine), 99, Fenchurch Street, London, E.C.3, have produced an equipment with a 50-mile scale in addition to those normally available.

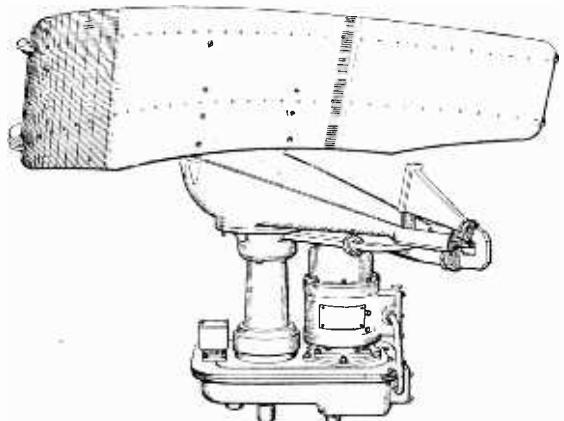
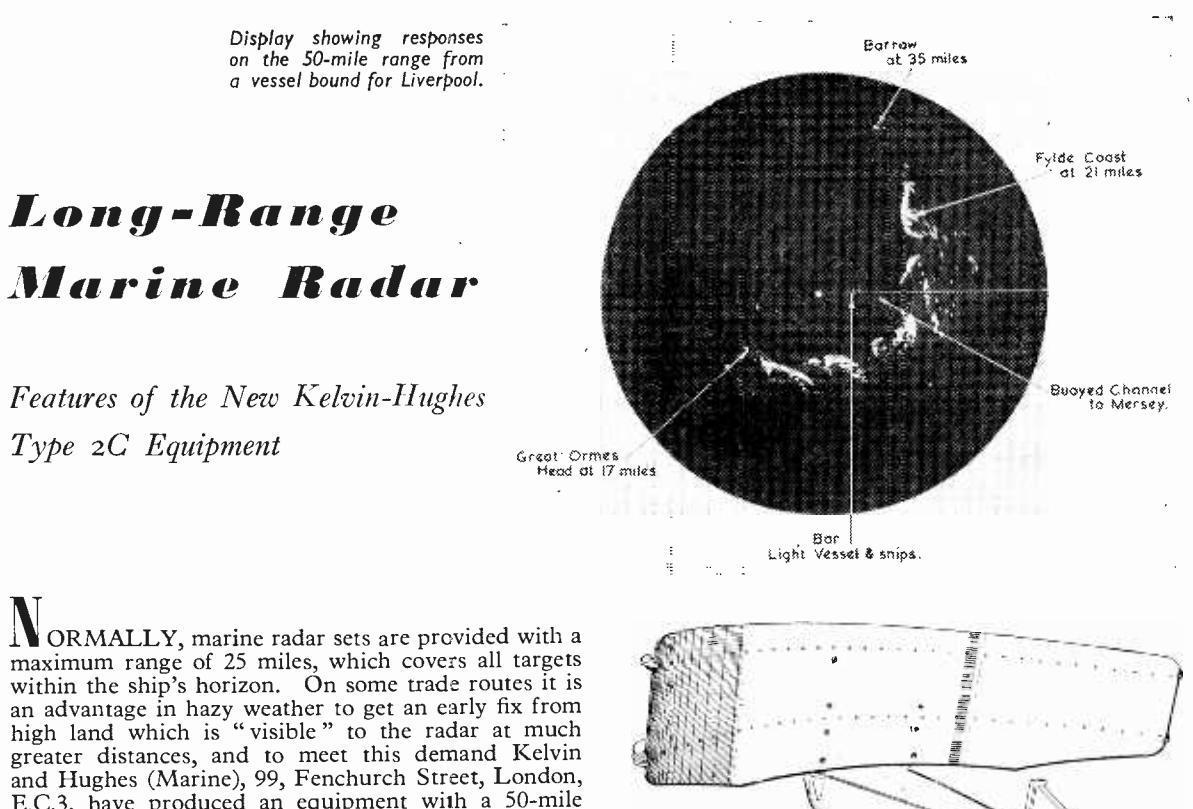
Increased power in the transmitted pulse is necessary, as well as the highest possible receiver sensitivity, in order to make the 50-mile range effective, and in the Type 2C the peak power is 60 kW with a pulse width of 0.2 μ sec. The accompanying photograph shows that the waveguide "plumbing" has been cleaned up and now gives a straight outlet, and the layout has been sectionalized in "book" form giving ready access to components for servicing.

Another feature of this new model is the aerial system, which is of parabolic cylindrical form, and is fed on the focal line from a horn termination on the waveguide.* The reflector is tilted forward so that the horn feed is removed from the main reflected beam, with a consequent reduction of interference and side-lobe generation in the polar diagram of the aerial.

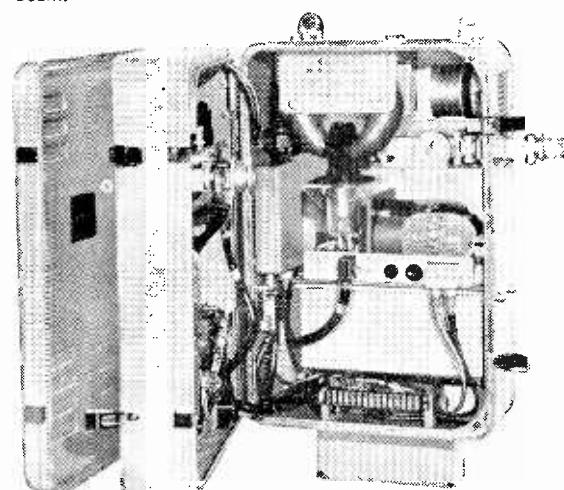
The display unit, which incorporates all the principal controls, uses a 12-in cathode-ray tube. In addition to an adjustable range calibration ring, fixed concentric rings can be superimposed at intervals of 8 miles on the 50-mile range, 4 miles on the 25-mile range, 2 miles on the 10-mile range and $\frac{1}{2}$ -mile on the 1-5 mile range. The last is continuously variable, so that the optimum range can be chosen for piloting in congested waters. Range discrimination and minimum range are 40 yards, while the bearing discrimination claimed is 1.3 degrees.

Monitoring is effected by a cavity-resonator of high-Q, mounted aft in the blind angle formed by the masts and funnels. This resonator "rings" and gives a narrow lobe-like response on the display, the length of which is a measure of the overall efficiency of the equipment, and so gives early warning of any incipient faults.

The price of the new Type 2C long-range equipment is £2,200.



Tilted parabolic cylindrical reflector in the scanner gives an increased gain and reduction of side lobes in the polar diagram by removal of the feed horn from the main axis of the beam.



Transmitter unit opened to show three-leaved "book" construction for ease of inspection and servicing.

A Valve Megohmmeter

*The Measurement of Resistance Up to
More Than a Million Megohms*

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

In a previous article* some of the special precautions necessary when measuring very high resistances were explained, especially the guard-ring technique. Details of an instrument suitable for measuring such resistances will now be given. It is assumed that the desired range of resistance extends from one megohm to one million or perhaps even ten million megohms—a range that opens up a new and fascinating field of study to any one hitherto equipped only with the ordinary type of ohmmeter or bridge. Moreover the instrument is a valve voltmeter with exceptionally high input resistance and therefore suitable for very-low-current or "open-circuit" investigations.

Nearly all ohmmeters are based on the principle of measuring the current flowing through the unknown resistance when a certain voltage is applied. The difficulty with very high resistances is the extreme smallness of the current. With 500 V applied to a million megohms it is one two-thousandth of a microamp. It is possible to buy a galvanometer sensitive enough to measure this, but such an instrument is expensive and delicate—what would happen if the thing being measured accidentally short-circuited does not bear thinking about—and involves a vibrationless mounting and optical accessories for projecting a moving spot of light, to say nothing of a shunt box to control the sensitivity. A cheaper and more convenient alternative is to measure the current as a voltage drop across a known standard resistance. Obviously the voltmeter ought not to shunt this standard resistance sufficiently to affect its value appreciably; in other words, it should pass negligible current compared with that flowing through the unknown. Assuming that d.c. is used, it might be supposed that a valve voltmeter would easily fulfil this requirement, for it is often stated that the d.c. input of a valve provided with suitable grid bias is negligible. And so it may be for most purposes, but not for this one. Supposing for the moment that the grid current is allowed to be 2% of the current used for the test (which is $0.0005 \mu\text{A}$ as suggested above) it would have to be limited to $0.00001 \mu\text{A}$ ($=10^{-11} \text{ A}$). In general the grid current of a valve under working conditions is vastly greater than that.

Fig. 1 shows a simple method of measuring grid current. With S closed, adjust the grid bias to the proposed working point, observed by the anode microammeter; then open S, putting into circuit the high resistance R_g . To exclude any leakage other than via R_g , S is a clip lead and R_g is air mounted. It is also desirable to screen the grid lead and R_g from stray fields. Next, eliminate the resulting change in anode current by adjusting the grid bias; the

amount of adjustment needed is equal to the voltage drop in R_g . Supposing for example, that R_g were $10,000 \text{ M}\Omega$ ($=10^{10} \Omega$) and the change in bias needed to restore the original anode current were -0.2 V , the grid current would be $-0.2/10^{10} = -2 \times 10^{-11} \text{ A}$.

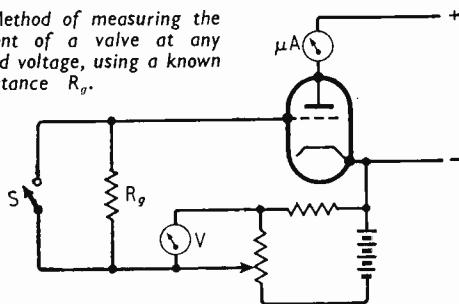
If the space between grid and cathode in the valve behaved as an ordinary ohmic resistance, the value of grid current thus measured and the value of grid bias at which it was measured would indicate the amount of that resistance, which could be allowed for when reckoning the effective value of the standard resistance. Fig. 2 however, which is a typical grid-current/grid-voltage graph, shows that it is nothing like an ohmic resistance (which of course would be represented by a straight line through the origin as shown dotted). This very non-linear characteristic is a combination of several distinct types of current. The peculiarity that a relatively large positive current flows when the voltage is zero is due to some of the electrons emitted from the hot cathode landing on the grid without any positive invitation and flowing back to the cathode via the external circuit. Something between one and two volts negative is needed to suppress this current completely, and the working bias must be not less. If it is more negative, a negative current flows; but instead of increasing with voltage it reaches a maximum not far from the crossover point and then decreases. The reason is that most of this current is due to ions liberated by electrons on their way to the anode, and increasing negative bias reduces anode current and hence ionization. Other causes of negative grid current are internal and external leakage, and grid emission due to heat and light from the cathode and light from outside. In some types of valve, leakage from anode to grid may be serious.

Leakages are minimized by using a suitable type of valve. A top-cap grid connection is obviously a safeguard, but not absolutely essential if the valve is otherwise well insulated. The most important cause of current is then ionization, which can be tackled by reducing anode voltage and current to the lowest practicable. One type of valve in which grid current can be reduced to something like the right extent is the EF37 or EF37A, grid-current data for which have been given by K. D. E. Crawford**. It can be kept down to about 10^{-11} A by restricting anode voltage and current to below 50 V and 0.1 mA respectively, and in these circumstances it is allowable to reduce grid emission by running the heater at 4.5-5 V. Also the valve should be kept in the dark. Not all samples of this type are equally suitable and some selecting may be necessary; or alternatively

* "Measuring High Resistance," *Wireless World*, June 1952, p. 236.

** "H.F. Pentodes in Electrometer Circuits," *Electronic Engineering*, July 1948, p. 227.

Fig. 1. Method of measuring the grid current of a valve at any desired grid voltage, using a known high resistance R_g .



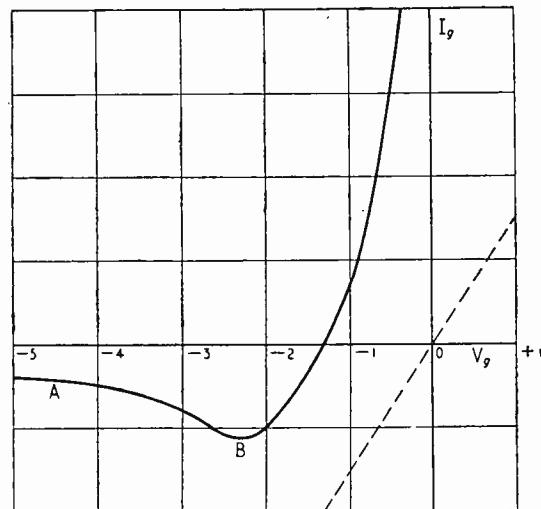
one may prefer to make sure of a grid current below 10^{-11} A by paying rather more for a ME1400 valve which is a special low- I_g version of the EF37A.

Fig. 2 shows that the grid current measured at any one bias voltage is not sufficient information to indicate the corresponding error in resistance measuring. In fact between A and B, where the working point is normally found, the grid-cathode resistance is negative. Instead of reducing the input voltage by its shunting effect, the valve would actually increase it. What happens is that when the grid voltage is made, say, less negative the resulting increase in anode current causes an increase in grid current, which flowing through R_g reduces the bias more, causing I_a to increase further, and so on. R_g has only to be sufficiently large and the system is unstable, so that the working point cannot stay on the negative slope AB but jumps straight to one end or the other.

Though the Fig. 1 method does not enable the grid-current error to be predicted, it does show how much the zero setting of the megohmmeter will be displaced by grid current, and, on the assumption that the greater the measured grid current the greater the error, it can be used for roughly comparing one valve with another. On the whole however it is better to test valves for grid current in the actual megohmmeter circuit.

With regard to that circuit: first, the tendency to instability can be nearly eliminated by using the valve as a cathode follower, because this keeps I_a much more nearly constant relative to V_g . In doing so, of course, it makes the changes in I_a more difficult to read directly, so a stage of current amplification is advisable. The general scheme thus turns out as in Fig. 3. The current passed by a known test voltage through the unknown resistance R_x is passed also through a known standard resistance R_s , and the resulting voltage drop is indicated by the two-valve voltmeter. For the sake of calibration stability the second valve (V_2) is also run as a cathode follower. The more sensitive the meter, the greater the resistance that can be used in series with it and the less the effect of changes in the characteristics of V_2 , but the greater its cost. A 0.1 mA meter was chosen as a suitable compromise: the valve is then only about one-fifth of the total series resistance, and if the anode voltage is kept constant by stabilization the calibration drift is not likely to be appreciable for a long period of normal use.

To be precise, the full test voltage ought to be maintained across R_x alone, but as the standard British voltage for measuring insulation resistance is 500 and the input to V_1 need not be more than 5 V the error caused by not doing so is at most 1%. Moreover, the higher the value of R_s the more costly and inac-



Right : Fig. 2. Typical shape of grid current characteristic, compared with that of a linear resistance (dotted).

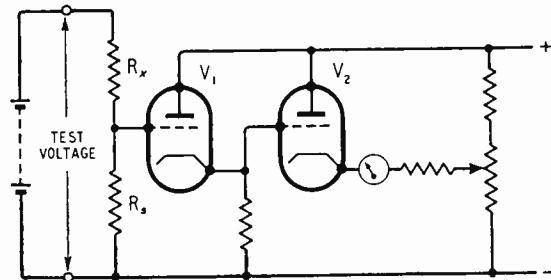


Fig. 3. General scheme of the megohmmeter described.

curate it is likely to be, and in any case the maximum value is limited by grid current. Experience with the EF37 class of valve suggests that there is no difficulty with $1,000 \text{ M}\Omega$ ($1 \text{ kM}\Omega$), across which a drop of 0.5 V is obtained through $10^{12} \Omega$ ($1 \text{ MM}\Omega$); and with care the grid-current error need not be excessive even with $10 \text{ kM}\Omega$, enabling at least rough measurements to be made up to $10 \text{ MM}\Omega$. High-stability resistors of these values are obtainable, but if the price is to be reasonable a considerably wider tolerance than 1% will have to be accepted; 20%, say. Because resistances high enough to be measured therewith are likely to vary widely with the slightest changes in humidity, and for other reasons, there is not much point in attempting high absolute accuracy—in fact, above a few thousands of megohms it is usually enough to determine the order of magnitude correctly—but the comparative accuracy is of course much better.

If the valves are set to give full-scale deflection with no input, and the test voltage is connected so as to make the grids more negative, then accidental excess input cannot over-deflect the meter; on the other hand, it is desirable to pass the least anode current through V_1 —and thus have least grid current—when the highest resistances are being measured, and since meter protection is obtained by other means it was decided to use positive test voltage, which is more convenient in practice.

If the resistance being measured is shunted by capacitance—whether or not what is being tested is

actually a capacitor—this capacitance causes any fluctuations in test voltage to be applied in almost full measure to the grid of V_1 . Fluctuations of one or two volts, which would be quite harmless if reduced in the ratio R_x/R_s , thus become intolerable, and as such fluctuation is only a fraction of 1% of the whole test voltage it is clear that if the voltage is derived from the mains it must be stabilized. Extensive smoothing is not a solution, because it can be shown that its time constant would have to be large compared with that of R_s in conjunction with the capacitance across R_x , and that is likely to be impracticable. Moreover a slowed-down drift of the reading is even more troublesome than rapid fluctuations.

The stabilizing system, shown in the full circuit diagram (Fig. 4), is conventional in principle,*** and serves not only the test voltage source but also the valve voltmeter, the anode supply for which is taken from across the stabilizer tube V_5 . The total current does not exceed 8 mA, so comes within the ability of the 16HT series of metal rectifiers. The only disadvantage of a metal rectifier here is that it has no time delay, so during the warming-up period the valve V_4 has to bear an anode voltage of the order of 900. Any risk attaching to this unorthodox practice could be avoided by using a slow-heating valve rectifier, but no reasonable type rated to include 770 V, 8 mA output appears to be available. No trouble has actually been experienced with V_4 , which can be almost any old medium triode one happens to have left over from the days when plain single triodes were the mainstay of the valve list; but it would be prudent not to pick on one with a high g_m in relation to heater current, achieved by reducing electrode clearances as much as the designer dared. Another reason for avoiding a small heater wattage will appear presently. A μ of about 20–35 is suitable.

Since the cathodes of V_2 and V_3 differ less than 100 V in potential these valves can be a double triode, but with a cathode at +500 V V_4 needs a separate heater supply. An ordinary 350-0-350 receiver transformer does all that is needful—the h.t. winding

*** "Stabilized Power Supplies," *Wireless World*, Oct., Nov. and Dec. 1948.

provides about 740 V end-to-end at this load current, and its rectifier heater winding is available for V_4 —but if its unnecessary size and weight are embarrassing a special transformer suitable in the alternative half-wave rectifier circuit shown, can be obtained from the Majestic Winding Co., 180 Windham Road, Bournemouth.

V_5 can be a Mullard 85A1 or 85A2 or Osram QS83/3, but these are unnecessarily precise for the job, and the Mullard 90C1 or 7475 or Osram ST11 are suitable. The main thing—which should be checked by noting that there is no jerkiness in the meter reading as the input to V_1 is varied steadily through its full range—is that there are no "steps" within the working range of current caused by sudden redistribution of glow. The value of resistance in series has been chosen so that of the total of about 6 mA V_5 takes about 2 mA at zero reading. As the reading increases, V_2 takes more current at the expense of V_5 : if too much of the test voltage reaches the grid terminal, the meter current is limited to little more than this 2 mA; after which V_5 goes out and the stabilizer begins to reduce the test voltage. If "+ H.T." is dead-shorted to "GRID," the meter reading may actually be less than full-scale: this is a very comforting thought. Risk to V_1 and V_2 is excluded by series grid resistors, and risk to the metal rectifier and the operator by $1 \text{ M}\Omega$ (R_1) in series with the test voltage. This means that $1 \text{ M}\Omega$ must be deducted from the reading, but it confers the advantage that there is no definite lower limit to the range of measurement—all that happens is that below about $1 \text{ M}\Omega$ the accuracy of reading begins to fall off steadily. The anode voltage to V_1 is reduced to 45–50 V by means of a potential divider.

For some purposes a test voltage of 500 may be too high, so it is convenient to be able to switch over to the voltage across V_5 . With the high-stability types this is usually between the limits 83–86 V, and the 90C1 86–94, but the 7475 or ST11 may be anything from about 88 to 105, so if one is lucky enough to get one running at 100 it is very convenient for

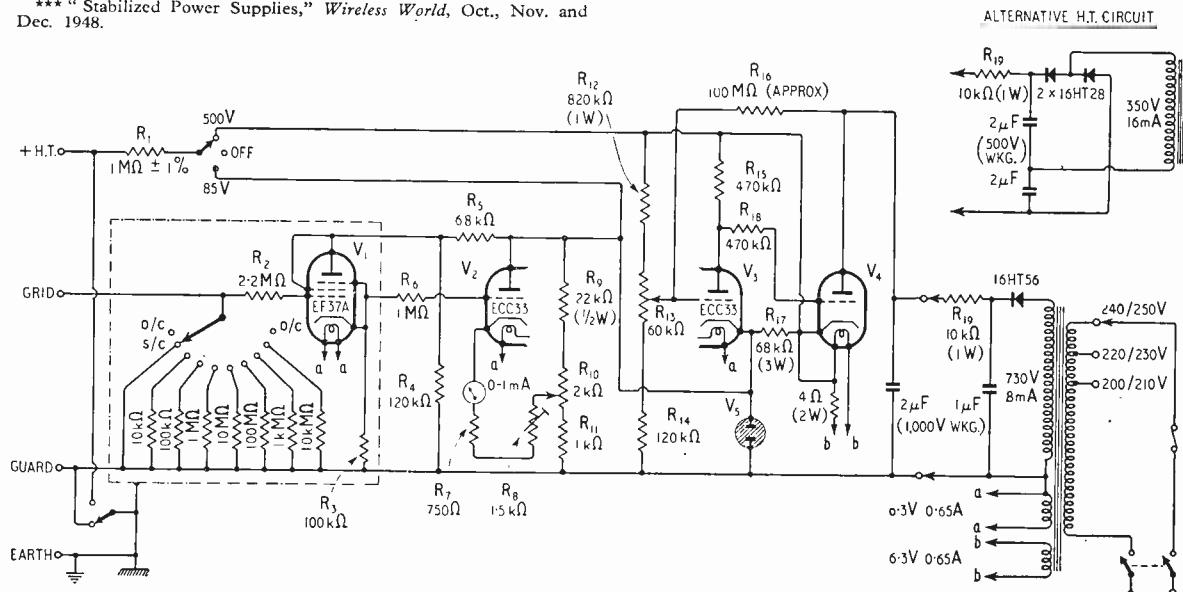


Fig. 4. Full circuit diagram of the megohmmeter. An old-type triode, as explained in the text, may be the most suitable for V_1 .

calculation. The possible error due to drop across R_s is of course greater than with 500 V, but for most purposes still tolerable (and in any case can be corrected). A considerable discrepancy between the values obtained for R_x with the different test voltages is not necessarily a cause for despondency; it is quite usual for the resistance of semi-conductors to vary with voltage, contrary to Ohm's Law.

When checking the circuit operation it is advisable to begin with the power unit and stabilizer, temporarily substituting a 25-k Ω resistor for the valve-voltmeter portion. Using a high-resistance voltmeter direct to cathode of V_4 , check that the test h.t. can be set by R_{13} to 500 V, with some margin for adjustment. Next, reduce the mains voltage from normal by 10% and see that the h.t. remains practically constant. Very close stabilization can be obtained by adjusting R_{16} which may be made by pencilling across between two terminals on a small strip of bakelite until the best results are obtained—a technique familiar to early practitioners in radio. If meanwhile the system behaves in a manner that appears to contradict basic electrical principles the explanation is likely to be spurious oscillation, but with common-sense layout and R_{18} this ought not to occur.

The valve voltmeter should next be restored in place of the temporary load resistor, and R_s and R_{10} adjusted alternately until with the "GRID" terminal at zero volts relative to "GUARD" the meter reads 0.1 mA and with +5 V it reads 1.0 mA. Fig. 5 shows two alternative methods for calibrating the meter in volts; in the second of these the 500 V and the 1 M Ω in series (R_1) must be reliable and the 0-10 k Ω is a decade box or the equivalent, and of course the range switch must be set to open-circuit. If there is room on the meter dial a resistance scale can be added, and the range switch marked with the factors by which the scale readings must be multiplied. It is wise to have a reminder on the panel that 1 M Ω must be deducted from the reading, if it is appreciable.

To guard against at least the less extreme onslaughts of load shedding and other occasions of low mains

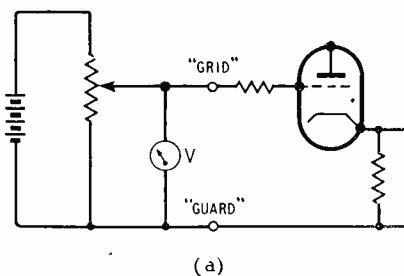
voltage, sufficient rectified voltage is provided to stand a 10% reduction. In the original set-up, in which an EBC33 was used for V_4 , it was found that 10% reduction in voltage from the h.t. winding alone had negligible effect; 10% reduction in heater voltages alone reduced the "zero" deflection of the meter slightly, and when this was adjusted by R_{10} the calibration was correct; but 10% reduction in both caused the stabilization to fail and the calibration to be upset. This situation was overcome by slightly overrunning the heater of V_4 at normal mains voltage, but it was rightly judged that if a valve with a more substantial heater was used it would not arise at all, and an old Tungsram HL4+ has proved entirely satisfactory. Low mains voltage is indicated by displacement of the meter zero, and when this is adjusted the calibration is practically correct.

At this stage it is a good idea to check the maximum possible meter overload by temporarily substituting a higher-range milliammeter and increasing the input voltage indefinitely.

Lastly the input circuit. Obviously special care must be taken to keep the leakage resistance from the grid lead of V_1 large compared with the highest standard resistance. The only places (apart from the valve itself) where there need be any leakage at all are the input terminal and the range switch. The original instrument failed on the top two ranges, and this was traced to a ceramic stand-off terminal that looked impressive but was found to be too conductive. At that juncture Belling & Lee came to the rescue with two new types of terminal specially made for this kind of job; the smaller, with a resistance of 3.6 million megohms, is quite good enough, and there is a larger one with 20 million megohms. The switch is more difficult; but an ordinary ceramic type was found to have a resistance from moving contact and one fixed contact to all other contacts and metal parts of about 180 kM Ω , and this was considered just about tolerable in relation to the highest R_s —10 kM $\Omega \pm 20\%$.

To check that the error due to grid current and switch leakage is small enough, the input voltage calibration process (Fig. 5) should be repeated with the highest standard resistance inserted in series with the grid as in Fig. 1. This test is equivalent to the unpractical one of checking the calibration by means of an accurately known 0-10 MM Ω variable resistance between "+H.T." and "GRID" terminals, with R_s (max.) in its normal position (see Appendix). This is so, even although the valve is a non-ohmic resistance. First of all the test should be done with the range switch disconnected from the grid, so as to confine attention to the valve. R_s is first shorted by a clip lead, and the meter zero set with zero input. If R_s is 10 kM Ω the zero is likely to shift slightly when it is unshorted. If the shift is more than slight, the excess may be due to stray field. V_1 and its grid lead should always be screened. The screening having been checked, any remaining zero shift is presumed to be due to grid current, and if the valve is reasonably good should certainly be less than 0.3 V. The magnitude of the shift is not necessarily a measure of the error it imposes on readings, for, as already explained, the grid current is usually relatively constant over the range of input voltage, and when the zero has been reset the error should be quite small. If not, try another valve.

Next, connect the switch and set it to the highest range; the resistor for that range will not be present, of course, for it has been placed in series with the



(a)

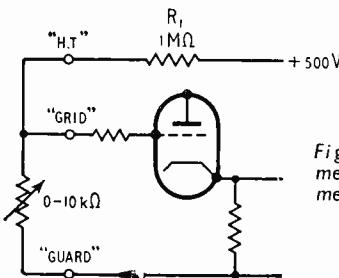


Fig. 5. Two alternative methods of calibrating the megohmmeter.

calibrating voltage, and the only effect of connecting the switch is to shunt its leakage resistance across the valve input (Fig. 6). Repeat the previous test, noting the effect on the calibration of unshorting R_s . It may well be that both zero shift and calibration error are less than before, because of the positive leakage resistance offsetting the negative valve input resistance. If however the error at first is distressingly large there is no need to lose heart. Leave the instrument on for about half an hour, or longer in damp weather, preferably in its box so as to raise the temperature throughout, and the story may be quite different. (Whenever the instrument is used on its upper ranges, and especially after it has been out of use for some time and has not been kept in a dry warm place, it is essential to have it on for perhaps an hour or so beforehand). If after all precautions the

leakage error on the top range when tested as just described much exceeds 10% it may be necessary to clean the switch with methylated spirit.

The method used to measure the switch leakage resistance may be of interest, as it affords an additional means of checking the megohmmeter calibration on the upper ranges. Provided that a capacitor with really high leakage resistance can be found, it is extremely simple. The capacitor is connected as shown in Fig. 7, the grid being short-circuited for obvious reasons. When the short circuit is removed the capacitor discharges through its own leakage and the grid potential slowly rises. There is no other leakage except that due to the valve, which should previously have been found to be satisfactory. The rise in voltage should be practically linear with time and quite slow if the capacitor is a good one. Since a charge often takes some time to "soak in," the test should be repeated until consistent results are obtained. A 4,000-V 0.01- μ F capacitor was found to discharge at 15 seconds per volt; and since this initial discharge rate, if maintained, would completely discharge it in CR seconds, R in this case is indicated as 750 kM Ω . With the appropriate switch leakage paths connected across the capacitor the rate quickened to 2.9 secs per volt, indicating 145 kM Ω for the combination, and therefore 180 kM Ω for the switch.

In measuring very high resistances the question of guarding usually arises, as explained in the earlier article. It will be noticed that the instrument as a whole is insulated from earth, so that either positive (+H.T.) or negative (GUARD) terminal can be earthed. If the resistance to be measured (R_x) has one terminal earthed, then that terminal should be connected to "+H.T." and it must not be forgotten that "GUARD" is 500 V below earth. Leakage resistance between the negative side of the instrument and earth, together with any leakage between the earthed end of R_x and "GUARD" comes across the h.t. supply, and unless excessive should be harmless. Leakage between the other end of R_x and "GUARD" comes across R_s , and care should be taken to see that its resistance is large compared with the R_s in use. If neither end of R_x is earthed, "GUARD" should be earthed, and the end of R_x having the higher leakage resistance to this point should be connected to "GRID," in the hope that it will be large compared with R_s and that the leakage resistance from the other end to earth will not be so low as to cause trouble when connected across the h.t. As an example, Fig. 8(a) shows how to connect a sample of insulating material for measuring volume resistivity. Compared with the connections shown in the earlier article, the "+H.T." and "GRID" connections have been interchanged, because in exceptional cases in which surface resistance is relatively low the resistance of the short path between upper electrode and guard ring may be low enough to shunt the appropriate R_s appreciably and cause a misleadingly high volume resistivity to be indicated. The surface resistivity connections shown in Fig. 8(b) are the same as previously; as mentioned then, this measurement is of little value unless it is possible to control ambient humidity.

The following British Standards specify in detail the procedure for tests of this nature, except that a sensitive galvanometer is shown in place of this valve instrument:

BS488 : 1948 *Moulded Insulating Materials for General Electrical Purposes*.

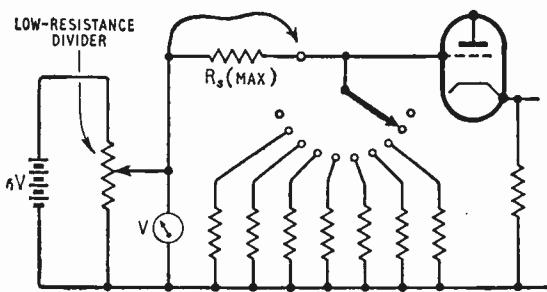


Fig. 6. Adaptation of the Fig. 1 method, for measuring the influence of grid current and switch and "GRID" terminal leakage on any range, especially the highest. Note that the appropriate range resistor is removed from its position in the switch and placed in series.

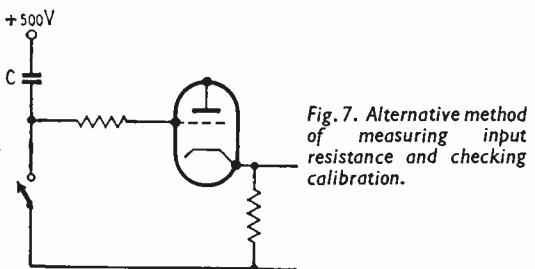


Fig. 7. Alternative method of measuring input resistance and checking calibration.

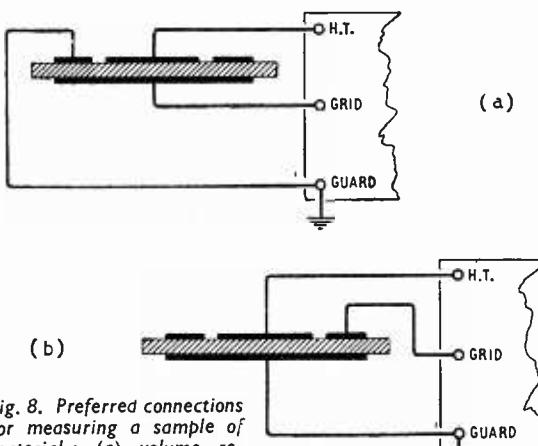


Fig. 8. Preferred connections for measuring a sample of material; (a) volume resistivity, and (b) surface resistivity.

A standard practice is to take the reading after the h.t. has been applied for one minute. It need hardly be mentioned that until the h.t. has been switched on, the range switch should be at the short circuit position to which position it should be returned after taking the reading. On the upper ranges the instrument is very sensitive to small changes in capacitance to grid, and one's hands should be kept well away while taking a reading.

APPENDIX

Validity of method shown in Fig. 6 for measuring megohmmeter error due to input current.

In Fig. 9(a), V_t is the h.t. voltage, normally 500; V_1 is the input voltage that would exist if leakage and grid current were nil; V_2 is the actual input voltage, the non-linear input resistance being denoted by R_i .

Then $V_1 = V_t R_s / (R_x + R_s)$; but since in the instrument described, with $V_t = 500$, R_s is never more than 1% of R_x it can be neglected in comparison, and $V_1 \approx V_t R_s / R_x$. On the same basis,

$$V_2 \approx V_t \frac{R_s R_i}{R_x (R_s + R_i)}$$

To set up the voltage V_1 at the input, using the circuit Fig. 9(b)—which is essentially the same as Fig. 6—with

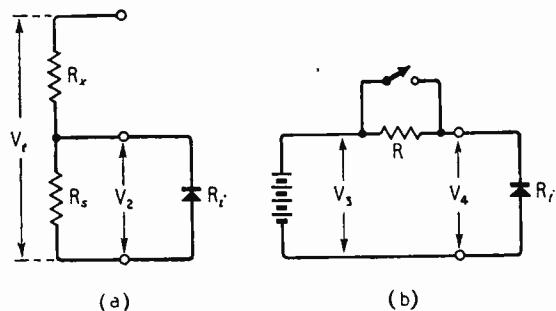


Fig. 9. Theoretical representation of input conditions, with (a) ohmmeter circuit, and (b) calibration circuit (Fig. 6).

the switch closed, V_3 must be made equal to V_1 , and if this is taken as $V_t R_s / R_x$ then

$$V_4 = V_t \frac{R_s R_i}{R_x (R_s + R_i)}$$

Except for the negligible difference already mentioned, this is the same as V_2 , and therefore the value of R_i —even if considerably non-linear—is the same in both cases, and the Fig. 6 calibration circuit correctly simulates the effect of leakage and grid current in the ohmmeter circuit, but without actually having to provide a known very high-valued resistance R_s .

If the instrument zero is reset on any range that has a perceptible zero error due to R_i , the effective error at any scale reading is the *difference* between the error measured at that reading and the error measured at zero.

SWISS RADIO SHOW

International Exhibition of Broadcast Receivers
and Sound Reproducing Equipment

By G. H. RUSSELL, Assoc. Brit.I.R.E.*

THE twenty-fifth Swiss radio exhibition was held in the Kongresshaus Building, overlooking the lake, in the city of Zürich, from August 29th until September 5th. This year, the exhibition coincided with the commencement of regular transmissions from the first television transmitter in Switzerland. This is situated on high ground at Uetliberg, a few miles from Zürich. The transmissions are broadcast on European channel 3, using the C.C.I.R. standard of 625 lines, with a power of 5 kW.

As Switzerland manufactures only a small proportion of her electronic needs, a great deal has to be imported from abroad. The exhibition, therefore, tends to be of a far more international character than its equivalents elsewhere. Countries represented were Austria, Denmark, Germany, Great Britain and the United States of America, but the majority of the exhibits were of German origin.

Apart from radio and television sets, tape-recorders, amplifiers, measuring instruments, components, valves, aerials and gramophone records were displayed in abundant variety. Altogether, there were

over fifty stands, many of them displaying goods from several manufacturers.

Television.—The main focus of interest was, quite naturally, on television. The majority of the receivers shown were tuneable over bands 1 and 3. All receivers were of the direct-viewing type, and tubes varied from 14 to 27 inches. British firms represented were Bush, Ferguson and Pye. Amongst the American exhibits were table and floor models with 21-in tubes by RCA, and a 27-in console model by Philco. From Germany there were 14-in, 17-in and 21-in receivers in great variety. One German "prestige" model contained a 21-in television receiver, all-wave radio, three-speed gramophone, tape-recorder, gramophone-record storage space and cocktail cabinet, all in one unit of truly massive proportions.

There did not appear to be anything revolutionary in the circuitry of these receivers. Some sets used continuous tuning, but the majority were switch tuned. Intercarrier sound was a very popular feature, but flywheel sync, on the other hand, was only used by a few of the manufacturers.

Sound Broadcasting.—Switzerland, being situated

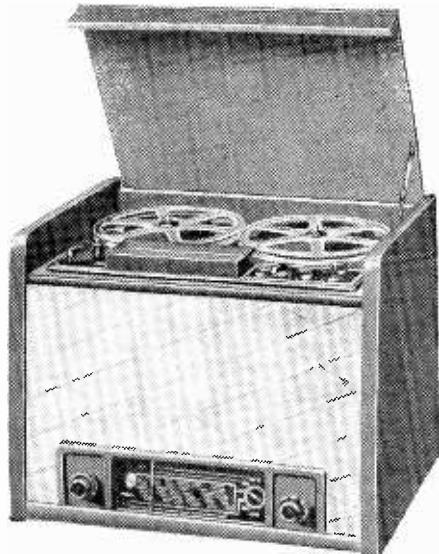
* Bush Radio, Limited.

in the centre of Europe and surrounded by large numbers of high-power stations, must of necessity use broadcast receivers which are highly selective. As there is only one station for each language group within Switzerland, a great deal of foreign listening is indulged in, which makes the selectivity of a receiver of even more importance than it might otherwise be.

One interesting method of coping with this selectivity problem is the "ferrite aerial," one example of which was shown by the Swiss firm of Sondyna. It consists of two lengths of Ferroxcube rod, on which are wound the medium- and long-wave aerial coils. These are screened in all directions but two. The whole unit is mounted well above the chassis on a rotating shaft, which is controlled by means of an external knob. Indication of orientation is given by a rotating device on the dial. Discrimination ratios of the order of 30 db and over are claimed for this aerial, not only against "off-beam" signals, but also against local electrical interference. It is further claimed that the directional properties of this aerial are far greater than can be obtained with a frame.

Because of the public desire for foreign listening, and because of propagation difficulties in such a mountainous country, wire broadcasting is extensively used. Until recently, this has been of the audio-frequency variety, but radio-frequency wire broadcasting is now coming increasingly into use. This provides at least three foreign stations, as well as two of the home programmes; the quality of reproduction is excellent. A channel spacing of 33 kc/s is used. A number of receivers were shown which make provision for the reception of these programmes, the bandwidth being automatically adjusted to take advantage of the improved frequency response.

The fact that one of the German f.m. stations is receivable in the German-speaking area of Switzerland has made the public there very v.h.f.-conscious. As nearly all German receivers incorporate a v.h.f. band as a matter of course, and as the medium and long wave selectivity of these receivers is adequate for Swiss needs, German radio tended to dominate the exhibi-



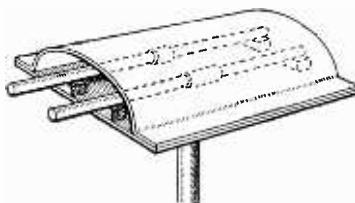
Three-band radio receiver, provision for receiving wire-distributed programmes and a tape recorder are combined in this Swiss domestic sound unit, made by Revox and costing about £130.

tion. A popular circuit line-up is: self-oscillating mixer, two i.f. amplifiers and ratio-detector. One Swiss firm showed an f.m. converter housed in a small wooden cabinet, the appearance being similar to that of an American midget receiver of pre-war days. Sondyna provide a v.h.f. adapter as an optional facility for their receivers. Permeability tuning is used, and this is operated by means of an eccentric drum attached to the receiver tuning spindle. The unit is built on a flat chassis, measuring about 4½ in by 3½ in, and is constructed so as to fit above the receiver tuning condenser. The valve line-up is: 6BK7, cascode r.f. stage; 6J6, mixer and oscillator; two 6BH6 i.f. amplifiers and 6AL5 ratio detector. It is claimed that full limiting takes place with an input of 30 µV. The ratio detector seems to have become a standard part of these f.m. receivers, and, with it, an intermediate frequency of 10.7 Mc/s.

Radio-gramophones were all provided with two or three-speed motors, and crystal pickups were universally employed.

Tape Recorders.—A great variety of tape recorders were displayed, including the British Ferrogram model. The Swiss firm of Revox showed their recorder housed in what can best be described as, a table radiogram cabinet, complete with radio and "wired wireless" receivers. Another Swiss manufacturer, Perfectone, demonstrated recorders which included the following features: twin-track recording with automatic track-change-over at the end of the reel, providing two hours continuous playing time, automatic stop at the end of the reel; automatic stop in the event of tape breakage; and instantaneous track-change-over at any point.

Test Gear and Components.—Among the test instruments shown were a wide selection from Advance Components and some of the Marconi Instruments range. American and German instruments were strongly represented. One of the General Radio exhibits was a very compact absorption wavemeter covering the range 250 to 1,200 Mc/s without switching. From the Danish company Radiometer was an f.m./a.m. standard signal generator with a frequency



Ferrite-rod directional aerial for two-band reception.

coverage of 54 to 216 Mc/s, with variable deviation from 0 to 300 kc/s. A piston attenuator is used and the output voltage reading is claimed to be $10\% \pm 1 \mu\text{V}$. Frequency calibration is claimed to be within 0.5% of the dial reading. An additional instrument which converts the above signal generator to the range 100 kc/s to 55 Mc/s is available. These two instruments together, therefore, provide a continuous f.m./a.m. signal source ranging from 100 kc/s to 216 Mc/s.

In the components field, British products were reasonably well represented, but as far as could be ascertained, all aerials were of German manufacture. They were invariably of the 300-ohm folded dipole type, and some very imposing arrays were shown, such as a triple aerial system covering bands 1, 2 and 3, complete with reflectors and directors.

Colour Television for Britain

Will a Compatible System be Too Difficult and Too Dear for Us?

THE Federal Communications Commission of the U.S.A. is now in the process of considering the proposed standards for colour television submitted to it earlier in the year by the National Television System Committee, a body representing most of the well-known American radio manufacturers. These standards are based on a system of compatible colour television (described on the following page) which has been devised more or less as a counterblast to the old non-compatible C.B.S. frame-sequential system. If the standards are accepted—and it seems fairly certain that they will be—it follows that this system will form the basis of design for all colour transmitting and receiving equipment in America.

At such an important point in the history of American development it is appropriate that some comment should come from this country about our own position. So far, the Television Advisory Committee has recommended that any future British system should be a compatible one. If this proposal is accepted by the Government it is probable that we shall adopt something similar to the N.T.S.C. system. There are, however, a good many problems that would have to be solved before such a system could be made suitable for use in Britain.

Critical Timing

Some of the limitations of the N.T.S.C. system that would make things difficult for us were discussed recently by F. C. McLean, Deputy Chief Engineer of the B.B.C., at a British Association meeting in Liverpool.* To begin with he placed a good deal of emphasis on the critical timing and phase relationships of the various components of the signal. It would be necessary, for example, to lock together the colour sub-carrier frequency, the line and frame frequency and the timing of any colour synchronizing signal. This would mean that the present practice of tying the line frequency to the mains frequency would have to be abandoned. From the transmitting point of view this would cause very little difficulty, but it might give trouble in some existing receivers which would be required to take a monochrome signal from the colour transmissions.

Referring to the distribution of the signal to the various transmitters, he pointed out that a system like the N.T.S.C.'s implies that "a very close tolerance must be maintained on the timing of the various carriers and pulses, and hence all parts of the transmission system must have a very small distortion in terms of amplitude and phase delay over the whole of the video band." Similarly the phase and amplitude distortion introduced by the transmitters themselves would have to be made negligible. All this would result in increased difficulty and cost.

Mr. McLean also thought that a simultaneous sub-carrier system might affect the range of transmitting stations by reducing the useful service areas within which satisfactory reception could be obtained. This limitation might be caused by differential fading or attenuation of the various components of the picture, and at distances of about 50 miles the colour information might be seriously distorted. To cover a given area would, therefore, require more transmitters and hence more channels. This could prove a serious matter for the establishment of a nation-wide colour service.

As for the question of our narrower channel widths in this country, he said it still remains to be decided whether all the colour information can be transmitted within the limitations of a 5-Mc/s channel, or whether such information will have to be sent outside in another channel.

On the subject of receivers, Mr. McLean said that there are likely to be some problems of even greater difficulty than those met by the N.T.S.C. in America. He pointed out, for example, that in this country the sound channel is amplitude modulated, so that separation of the colour sub-carrier might be more difficult than in the U.S.A. where the sound carrier is frequency modulated. Discussing the more general aspects, he said that a colour television receiver requires much greater stability of circuits, components and receiving conditions. We still do not know what effect any variations of these will have on faithful colour reproduction, since all receiving tests so far have been carried out under laboratory or restricted field-test conditions. Colour receivers would cost a good deal more than our present ones and their greater complexity would probably put up the servicing costs as well.

Interference Problems

One other problem which Mr. McLean did not mention but which has troubled a number of engineers is the possibility of the colour signal producing an interference pattern on the black-and-white picture. Although the N.T.S.C. system employs various tricks to reduce this effect it seems that they are not completely effective. It is felt, too, that the process of interlacing the sidebands of the monochrome and colour signals is not entirely foolproof because in practice there are sometimes large instantaneous peaks of energy occurring at frequencies outside the normal distributions and these can cause interference between the two signals.

These, no doubt, are some of the technical difficulties which Sir Ian Jacob, Director-General of the B.B.C., had in mind when he said that "neither here nor in America is there yet a system which has been developed to the point at which it can be confidently adopted."

* "The Application of Colour Television to Broadcasting", a paper read before Section G (Engineering) of the British Association.

American

Principles of the N.T.S.C.

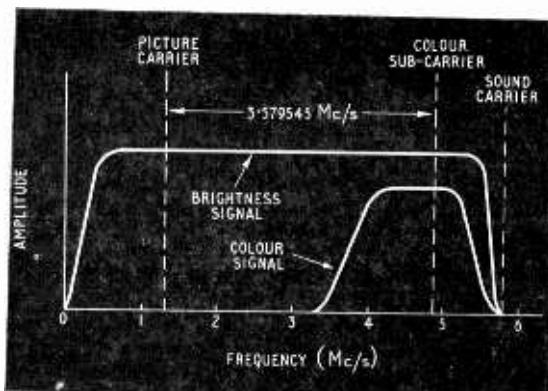


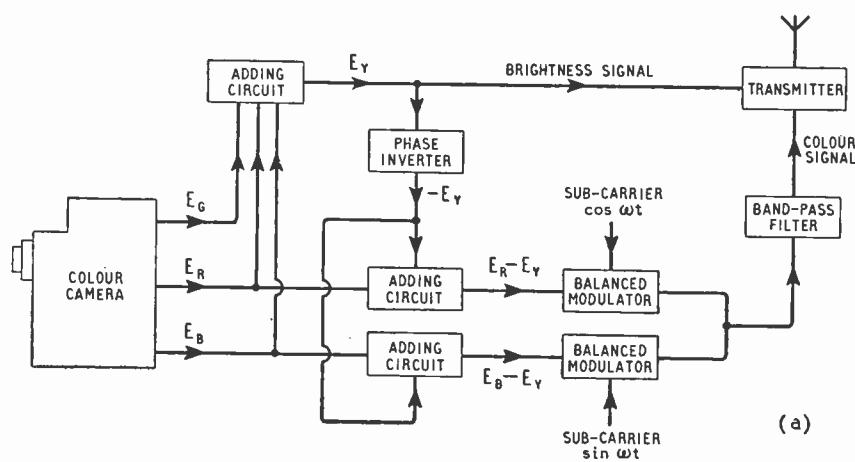
Fig. 1. Frequency characteristic of the N.T.S.C. colour transmission in its 6-Mc/s channel. The vestigial sideband system is used for both the picture carrier and the colour sub-carrier.

WHEN the National Television System Committee first set about the task of devising a colour television system for the United States they were faced with two main technical requirements. The first was that the system should be compatible, that is, the pictures should be receivable in black and white on existing receivers without any degradation from normal quality. The second was that the frequency band of the transmissions should be kept within the present American channel width of 6 Mc/s—in other words, all the vision information would have to be transmitted within a band of about 5 Mc/s. The system which has now been evolved satisfies first of all the compatibility requirement by taking the brightness information of the colour picture and transmitting it as a black and white picture which can be reproduced on existing receivers. The bandwidth requirement is satisfied by transmitting the colour information on a sub-carrier, of approximately 3.58 Mc/s, in such a way that the signal is kept within the normal vision band and yet does not interfere with the black and white picture. This is done by a process known as frequency interlacing. Fig. 1 shows the complete frequency characteristic of the transmission. Note that the vestigial sideband system is used and that the colour signal only occupies just over 1 Mc/s of the whole channel.

This idea of transmitting the picture in the form of two sets of information, brightness and colour, seems rather strange when one thinks of the classical method, evolved from colour photography, of transmitting it in terms of three colour components, usually the primary colours, red, green and blue. The reason for it is, of course, that a separate brightness component is needed to provide the normal black and white picture. It would

be possible, of course, to transmit this brightness component in addition to the three colour components, but that would be very wasteful of bandwidth because the colour components would already contain the brightness information and it would be transmitted twice. In the N.T.S.C. system this duplication is avoided by removing the brightness information from the three colour components. The remaining colour information on the sub-carrier then consists of hue (e.g. red, brown, yellow, purple) and saturation (i.e. the extent by which the hue is pure and not diluted by white light).

This method of specifying a colour picture in terms of brightness, hue and saturation instead of in red, green and blue components is rather unfamiliar, but the relationships of the three quantities can be illustrated quite well graphically as in Fig. 2, using the well-known colour triangle. At the corners of the triangle are the three primary colours, while in between are the secondary colours produced by mixing them additively. In the middle, where all the colours are mixed, is pure white. With this arrangement two of the quantities can be represented by a vector rotating about the centre of the triangle. The angle of the vector specifies hue, while its length (or the distance away from white) gives saturation. The third quantity, brightness, can be represented by another vector perpendicular to the plane of the paper and passing through the centre of the triangle. Along the length of this vector the white in the centre gradually changes through grey to black, or zero brightness. Thus, while the picture is being transmitted the colour vector can be imagined as rotating to specify the hue and lengthening and shortening to specify the saturation. (This is, in fact, the way in which the actual electrical vector of the colour signal specifies the information—the hue modulates the phase angle of the sub-carrier and the saturation its amplitude.) At the same time, the perpendicular vector (not shown) can be imagined as lengthening and



Colour Television

Simultaneous Compatible System

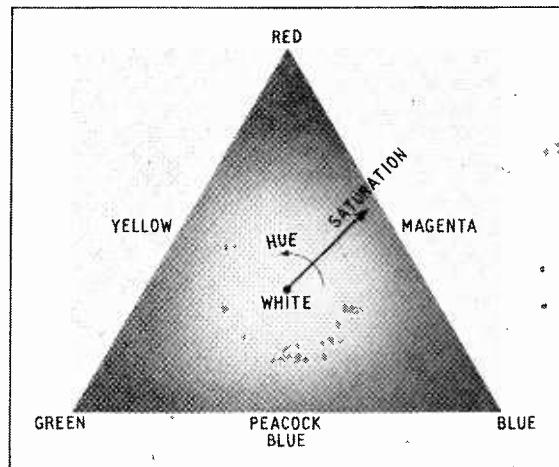
shortening according to the brightness information, and in this way it represents the normal amplitude modulation of the carrier. When there is no colour in the picture at all the rotating vector and the colour signal disappear completely.

As well as subtracting the brightness information from the three colour components it is possible to make a further saving in colour-signal bandwidth by removing one of the colour components entirely. The reason for this is that all three components are already being transmitted in the form of white light by the brightness signal, so that if only two colour components are transmitted by the sub-carrier they can be subtracted from the brightness signal at the receiving end to recover the third one. Actually it is the green component that is removed and recovered in this way. Thus in Fig. 2 one can imagine the rotating colour vector as being restricted in movement to the right-hand side of the triangle and not having to go through the green corner at all.

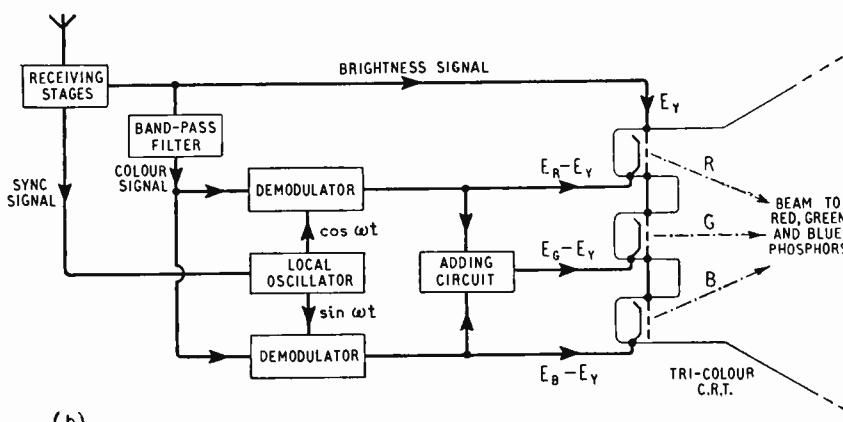
Yet another reduction in the amount of colour information to be transmitted is made by taking advantage of certain characteristics of human vision. It is a well-known fact that the eye is insensitive to fine detail in colour and can only see it in black-and-white form. Obviously, then, there is no point in transmitting this fine detail on the colour signal as long as it is carried by the brightness signal. Thus the information-content of the colour signal can be very much smaller than that of the brightness signal and consequently its frequency band can be limited to something quite narrow—just over 1 Mc/s, in fact. This characteristic of human colour vision is, of course, a gradual thing. With slightly larger detail, for example, the eye still cannot distinguish between blue and yellow—they both appear grey—or between brown and crimson or blue and green, but it can between red and green. In the N.T.S.C. system, therefore, the bandwidth requirements of the transmitted colour components are graded accordingly.

Those which can be distinguished in medium detail are given the full colour bandwidth of just over 1 Mc/s while those which can only be seen in broad areas are restricted to about 500 kc/s.

The broad functioning of the system can now be followed from the simplified block diagram Fig. 3. At the transmitting end (a) the colour camera analyses the picture and produces three signals representing the red, green and blue colour components, E_R , E_G and E_B . These components are recombined in an adding circuit to produce the brightness signal, E_Y , or black-and-white picture, which is sent straight to the transmitter and radiated in the normal bandwidth. The red and blue components are also fed to two circuits where they are added to the signal $-E_Y$ produced by a phase inverter—in other words the redundant brightness component is subtracted from them, as explained above. (The green component is simply ignored as that is also redundant for reasons stated above.) The two resultant signals, $E_R - E_Y$ and $E_B - E_Y$, now contain all the essential hue and saturation information that has to be modulated on the colour sub-carrier. As mentioned above, the hue information is conveyed by phase modulation and the saturation



Above: Fig. 2. Colour triangle with rotating vector representing the two quantities hue and saturation. A second vector representing brightness can be imagined as perpendicular to the plane of the paper and passing through the centre of the triangle.



Left: Fig. 3. Simplified block diagram of the system, with the transmitter at (a) and the receiver at (b). Note how the brightness signal (black and white picture) is shunted round the colour channel.

Information by amplitude modulation. The actual method of doing this is to split the sub-carrier into two components, one leading the other in phase by 90°, and modulate the leading component with the $E_R - E_Y$ signal and the lagging component with the $E_B - E_Y$ signal, as shown by the vector diagram Fig. 4. The two parts are then recombined and the resultant vector in Fig. 4 represents the modulated sub-carrier as finally transmitted.

One can now see exactly how the hue and saturation are represented respectively by the angle (phase modulation) and length (amplitude modulation) of this resultant. The E_R and E_B colour-component signals from the camera vary in amplitude according to the hue of the picture, and as a result the two vectors $E_R - E_Y$ and $E_B - E_Y$ vary in length and produce corresponding changes in the phase angle of the resultant. Thus we have the angle of the electrical vector specifying the hue in much the same way as the rotation of the vector in Fig. 2 specifies it in graphical form. Similarly, the E_Y brightness component in Fig. 4 varies in amplitude according to the saturation of the hue, since it represents the amount of white-light dilution. This causes the lengths of $E_R - E_Y$ and $E_B - E_Y$ to vary and consequently the length of the resultant vector. Again, we have the electrical vector lengthening and shortening to specify saturation in the same way as the Fig. 2 graphical vector.

This process of modulating the two components of the sub-carrier is actually done by balanced modulators (Fig. 3) so that the sub-carrier itself is suppressed. The components are then combined and the complete colour signal is fed through a band-pass filter (giving the characteristic shown in Fig. 1) to the transmitter.

At the receiving end of the system (b) the carrier is demodulated and the whole signal is fed into the brightness channel; it is also applied to a band-pass filter which passes only the band containing the colour signal. The brightness signal then modulates all three grids of a tri-colour cathode-ray tube. In the colour channel the two modulating voltages $E_R - E_Y$

and $E_B - E_Y$ are recovered from the colour signal by a process of synchronous detection. This involves heterodyning the incoming signal with two sine waves, each of which has the same frequency and phase as the desired component. Thus, the local oscillator producing these sine waves must be locked in phase to the colour sub-carrier, and for this purpose a synchronizing signal consisting of several cycles of sub-carrier frequency is transmitted during the back-porch period following each line sync pulse.

From the two colour-difference signals thus recovered the third one, $E_G - E_Y$, is derived by adding suitable fractions of them together. The three are then applied in a negative sense to the three cathodes of the tri-colour c.r. tube, and the E_Y brightness components that were subtracted at the transmitter are put back by the E_Y signal applied to the grids. In other words, the $-E_Y$ voltages at the cathodes become $+E_Y$ as a result of being applied in a negative direction, and as E_Y is fed to the grids in the same phase the two cancel out. This leaves E_R , E_G and E_B , the original three colour-component signals, applied between the grids and cathodes of the tube. Thus, the three electron beams and the three sets of coloured phosphor elements on the screen are modulated according to the three output signals of the colour camera.

An ordinary monochrome receiver tuned to the transmission cannot, of course, do anything with the information on the colour sub-carrier, so it simply responds to the brightness signal and reproduces from this a black-and-white picture in the normal way.

It was mentioned earlier that the colour sub-carrier is transmitted in the same band as the brightness signal (Fig. 1), without interfering with it, by a process known as frequency interlacing. This principle takes advantage of the fact that the sideband frequencies of a television transmission tend to be grouped in clusters around harmonics of the line scan frequency, leaving open spaces in between. The idea, then, is to interleave the sideband clusters of the colour signal between the sideband clusters of the brightness signal, so that neither set interferes with the other, although they are all within the same band. This is done in the N.T.S.C. system by arranging the colour sub-carrier to lie exactly half way between two harmonics of the line frequency—in other words by making it an odd multiple of half the line frequency. The interlacing process then works out as shown in Fig. 5 at line and half-line frequency harmonics.

Although the colour signal does not interfere directly with the brightness signal it will nevertheless get into the vision channel of an ordinary receiver, so that one might expect it to appear as an interference pattern on the black-and-white picture. Actually it does not. The reason is that the intensity modulation of the c.r. tube beam by the colour signal reverses in phase along each line in successive picture periods—blacks become whites and whites become blacks. So, whereas the light modulation produced by the brightness signal is summated in time by the storage effect of the screen and the viewer's persistence of vision in the normal way, that produced by the colour signal tends to cancel out. In practice the cancellation is not complete because the light storage is not long enough. However, the visibility of the interference is kept to a minimum by making the colour sub-carrier frequency as high as possible (see Fig. 1), so that the pattern produced on the screen is a very fine one.

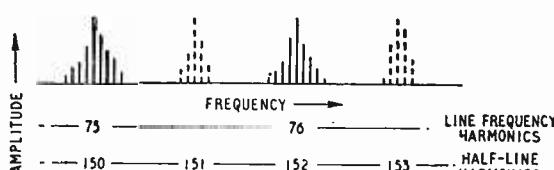
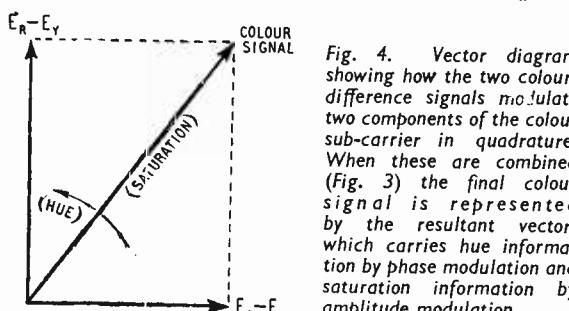


Fig. 5. Illustrating the technique of interlacing the monochrome and colour sidebands. The monochrome sidebands are shown as full lines and the interleaved colour sidebands as broken lines.

Radar Wind Measurement

New Meteorological Station Using the "Radar Sonde"

WHILE the main purpose of the balloon-borne radio sonde is to transmit meteorological data to the ground, it is also used nowadays for giving information on the speed and direction of the winds which carry it along. Hitherto the system has been to equip the sonde with a reflector and follow it about with a radar set on the ground. Changes in its range, bearing and elevation are then used to compute the required wind information. Unfortunately, this primary radar system is restricted in range to about 40 miles, so the latest step has been to use secondary radar, with a transponder instead of a reflector on the balloon. This increases the range to about 100 miles.

The original secondary radar system, or "radar sonde," was devised some years ago by T.R.E.* Now, an engineered version of it has been developed by Mullard and installed at a new meteorological station near Crawley in Sussex. A feature of this equipment is that it is completely automatic in operation. The radar aerial follows the course of the sonde automatically and gives range, bearing and elevation information from which the wind information is continuously com-

* "The Radar Sonde," *Wireless World*, April, 1951, p.155.

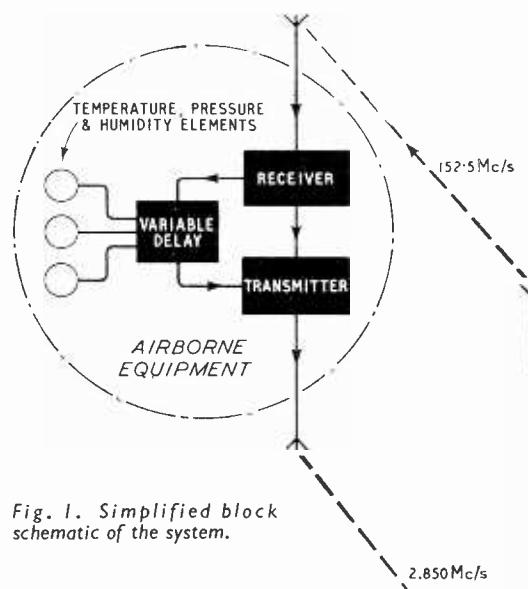
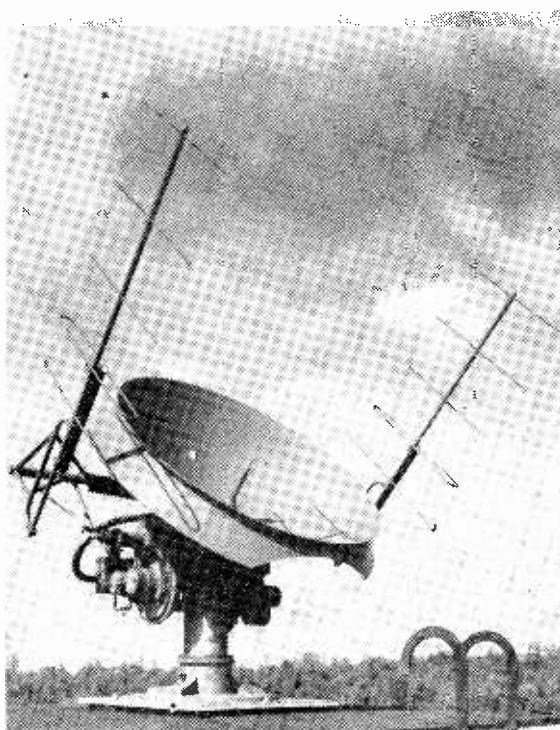
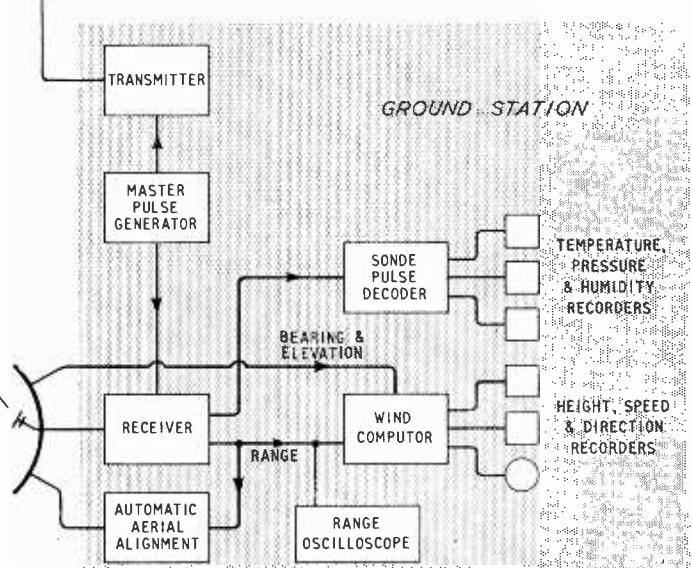
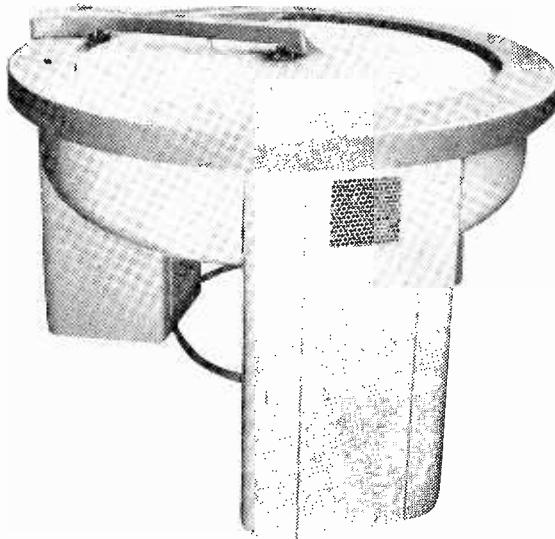


Fig. 1. Simplified block schematic of the system.

The automatic following radar aerial shown in the photograph at the top of the page is mounted on the roof of the station. The outgoing signal is transmitted by the 2-metre vertically polarized Yagi arrays while the 10-cm return signal is received by the 5-ft diameter paraboloid.





This unit houses the wind computor and carries the 4-ft diameter rotating polar chart which records the wind direction. A pen slowly traversing from the outside to the inside of the chart represents the time the sonde is in flight, while rotational movements of the chart represent changes in the wind direction with respect to the initial direction at launching.

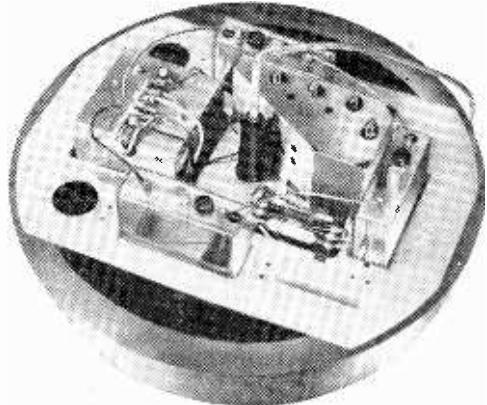
puted and recorded. At the same time the straightforward telemetering of other meteorological data is done through the channel provided by the returning radar signals, and the results are presented continuously by pen recorders.

Fig. 1 is a simplified block schematic of the system. Pulses of 2 μ sec duration are transmitted at a repetition rate of 404 per second with a peak power of 50 kW on a frequency of 152.5 Mc/s. They are received by the airborne transponder and arranged to trigger its 30-W transmitter, which sends back pulses on 2,850 Mc/s to the receiving paraboloid. The transit time of the pulses gives the range of the sonde and this information is displayed on a cathode ray tube and fed to the wind computor.

The system for keeping the receiving paraboloid continuously trained on the sonde makes use of a dipole which is offset from the axis of the reflector and rotates in such a way that the aerial beam traces out a cone in the sky. If the paraboloid is pointing in a slightly wrong direction and the sonde is to one side of the cone, the received signal fluctuates in strength as the beam swings around, at a frequency corresponding to the rotational speed of the dipole. The fluctuation frequency is then used as an error-signal to correct the alignment of the paraboloid. If the paraboloid is properly aligned and the sonde is exactly in the centre of the cone the signal strength remains constant and no error-signal is produced. From the positioning of the paraboloid the bearing and elevation of the sonde are obtained and the information is fed into the wind computor.

In the computor the speed and direction of the wind is derived from the rates of change of the range, bearing and elevation information. Wind direction is recorded on a polar chart, while speed and height (which is also computed) are registered on standard pen recorders.

Some of the balloons which are sent up carry just



An airborne unit with its cover removed. The miniaturized equipment is mounted in a light thermally insulating container and is suspended from the balloon by the quarter-wave receiving aerial. The transmitting aerial projects from the bottom. Power is supplied by 6.5-V batteries and h.t. is obtained by means of a vibrator.

a transponder for wind measurements only, while others have in addition meteorological elements for measuring temperature, pressure and humidity. The system for transmitting these additional measurements on the radar return signal makes use of a second pulse delayed slightly from the main one. The three meteorological elements are selected in sequence by a motor-driven switch and arranged to control the spacing between the two pulses. In the ground equipment the two pulses are used to trigger the front edge and the back edge of a square pulse, so that the duration of this square pulse represents the value of the meteorological measurement. An electronic chronometer then measures the duration of the pulse and gives the answer in the appropriate meteorological terms.

ULTRASONIC DRILL



IN this experimental machine, made by Mullard and shown recently at the Institution of Electronics Manchester exhibition, vibrations at about 22 kc/s are generated by a magnetostriction transducer and transmitted to a drilling tip by a tapered metal stub, which acts as a velocity step-up transformer. The box on top contains an amplifier, which forms part of an oscillatory circuit with the magnetostriction device below. Rapid drilling and cutting of most brittle materials is possible when a paste of carbide abrasive is fed to the tip. The use of the machine was demonstrated recently in the television programme "Science Review."

LETTERS TO THE EDITOR

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

Ignition Interference in U.S.A.

IN his letter in the October issue, Malcolm S. Morse states that "in the U.S.A. our television sets operate in the midst of millions of motor cars, all unsuppressed, yet never have I seen a case of ignition interference or even heard of anyone troubled by it."

Mr. Morse must have been singularly fortunate in his choice of viewing sites. If he will refer to an American book published this year ("Principles of Television Servicing," by Carter V. Rabinoff and Magdalena E. Wolbrecht: McGraw-Hill) he will find that the authors have quite a bit to say about it on pp. 432-434. Indeed, they say "some years ago an appeal was made to the automobile industry by the F.C.C. to study and if possible develop ways and means of eliminating ignition interference. The industry has been and still is co-operating by extensive research along these lines."

In spite of Mr. Morse's remarks about "poorly designed British sets" the fact remains that it is not possible by any known means to suppress ignition interference at the television set, but it can be done easily and cheaply on the car itself. Certain measures to reduce the interference can be taken in the receiver, it is true, such as by using limiters. In spite of the sets being so "poorly designed," all current British sets include them. They are such a normal fitting that they are taken as a matter of course.

London, N.14.

W. T. COCKING.

"Television Interference"

I WAS very interested to read the note on page 320 of your July issue on this subject, as I am one of the "suffering amateurs" operating on the 2-metre band.

Our particular trouble is caused by 2nd harmonics of local oscillators on about 72.5 Mc/s. They sound rough and unstable and some are weakly modulated, probably by a microphonic valve. Similar trouble has been reported by Scottish amateurs.

There are wider issues involved than interference to amateurs, which in all conscience is bad enough already. 72 Mc/s, the fundamental frequency, is used by business radio and certain users are, I understand, already being inconvenienced during TV hours. Our 2-metre band is shared with one of the armed forces, apparently, and whilst their stations are not at present likely to be troubled, an increase in this form of interference might give them cause for complaint. Another problem may arise when new TV channels open up, with the possibility of interference by higher-order harmonics, admittedly weaker but there all the same.

It seems to me that unless something is done now, things will get worse. I realize that TV receiver designers already have a lot to worry about, but in future I think they should give more attention to the "front end," making every effort to reduce unnecessary (and possibly illegal) radiation. This will apply also to converters, of course.

Until now, the v.h.f. bands, both commercial and amateur, have been fairly "clean" and free from the kinds of interference which plague the lower frequencies. Let us keep them that way!

Worthing, Sussex.

R. B. FORGE (G3FRG).

Technical Qualifications

AS a holder of the City and Guilds Full Technological Certificate I have followed the correspondence regarding this qualification with a spectator's interest. However, the letter by M. L. Barton in your October issue provokes a reply. It might well have been written by a sworn enemy of the Institute—or a disappointed candidate!

The reference to the mathematics standard is accurate

but unfair. Surely Mr. Barton does not think that Inter. B.Sc. maths. would equip one to sit the fourth and fifth year examinations in Telecommunication Principles? Whether specifically examined in mathematics or not, the C. and G. candidate has to reach the standard required to pass these examinations—which, like all advanced electrical papers, are exercises in higher mathematics.

The phrase "telecommunications as understood by Post Office engineers" is just trite nonsense. One imagines "Post Office" electrons rolling down the wire, painted engineer green and stamped G.P.O., while "Barton" electrons saunter along, varicoloured and with a look of independence. The Post Office has done as much work with super frequencies as any other large British organization—and the C. and G. fifth year syllabus is in a large part devoted to the technique of their use.

Mr. Barton finishes his letter with a backward somersault in supporting the Brit.I.R.E., apparently ignorant of the fact that this institution grants the holder of a full technological certificate complete exemption from the technical and maths. sections of its graduation examination.

If these arguments are the best that can be advanced in criticism of the C. and G. Full Technological Certificate it is no surprise to me that the Ministry by which I am employed (Supply) recognizes the qualification. Might it not be that they, the Admiralty and the B.B.C. are the ones in step?

Farnborough, Hants.

P. B. HAYES.

"Meter Overload Protection"

THE mechanical overload tests on microammeters described by J. de Gruchy (September issue) are liable to be misleading unless account is taken of the "transit time" of the meters concerned, a factor which depends not on meter damping alone, but also, in certain cases, on the load in which they are worked.

By transit time is meant the time the pointer takes, with current suddenly applied, to reach any steady reading up the scale, and, for a dead-beat condition, is independent of the magnitude of the deflection.

A normal microammeter of the type mentioned, if used in a high resistance circuit, will have a transit time of about one second. Subjected to a sudden overload of 250 times its full scale current, it will endeavour to maintain its transit time; i.e., the pointer tip will be given an acceleration such as to enable it to reach a point 250 times the scale length in one second. If the scale is 1.5 inches long, the distance it is attempting to travel is 1.5×250 inches per second, an average speed of more than 20 miles an hour!

The kinetic energy released at the top stop, and hence the damage done, will be lessened if the transit time is increased.

The transit time of a microammeter will begin to increase if the resistance of the circuit in which it is worked is taken below ten times its own internal resistance. Maximum transit time, which is considerably more than the open circuit value, occurs, as would be expected, at practically short-circuit conditions.

Therefore, a microammeter used heavily shunted, as, for instance, in a multi-range test set, will withstand more sudden actual meter current overload than one of the same type used in a high resistance circuit.

High Wycombe, Bucks.

T. H. FRANCIS.

Lamp Interference

REFERRING to W. B. Mansell's statement in your August issue that gas-filled filament lamps are also responsible for generating interference, I have made a number

LETTERS TO THE EDITOR . . .

continued

of enquiries to find support for this view, but so far as I can determine from my friends and colleagues in the interference and lamp manufacturing fields there is every reason to believe that only vacuum lamps are responsible.

It is, however, a fact that, in the past, some few lamps labelled "gas filled" have in fact been vacuum, and have given rise to conflicting reports.

The lamps causing the majority of the trouble are 40-, 60- and 100-watt "rough service" types. The 15- and 25-watt vacuum lamps which are the only sizes normally available to the public are only responsible in rare cases.

Enfield, Middx.

A. HALE.

I AM indebted to your correspondents for their helpful comments on the lamp interference problem raised in my letter published in your May issue.

They may be interested to know that the interference in question was ultimately traced to a vacuum lamp in my own home! It was, in fact, a 15-watt domestic type, purchased from a chain store, and was normally kept on all night in the children's bedroom. The interference, however, was not continuous during the time it was in use, but usually occurred some two or three hours after the lamp was switched on.

It appears that the oscillations arose as the result of a fault, since the lamp failed a week or so after the interference was first reported. Furthermore, they were probably mains-borne, because they were being generated inside a metal-clad pre-fab. which would undoubtedly be a big deterrent to direct radiation. The attenuation of incoming signals produced by these houses is sufficient, in this locality at least, to make portable receivers an impracticable proposition without an outdoor aerial.

Weymouth, Dorset.

K. ROBINSON.

"D.C. Restoration in Television"

W. T. COCKING, in his article in your March issue, analyses the simple case where the resistor of the RC coupling is connected directly in parallel with the diode (his Fig. 6). He makes no mention of more modern arrangements where the resistor is no longer so connected. At the time I anticipated that there would be a further article discussing such circuits. Since none has been forthcoming, and since such an eminent authority as Donald Fink makes no mention of them in the 1952 edition of "Television Engineering," I have made it my business to examine several current receiver designs; in no case has the improved circuitry been applied. I feel therefore that these circuits may not be as widely known as I had imagined, and would like to draw attention to them.

Referring again to Fig. 6 of Mr. Cocking's article, it is apparent that the mean circuit flowing in R_2 , the resistor in question, is a function of average picture brightness. This current can therefore vary, as Mr. Cocking points out, between very wide limits and, since the diode mean current must equal this current, the datum to which the sync pulse tips are "restored" will also vary with average picture brightness. This undesirable effect can be eliminated if we can maintain a constant current in the resistor.

One method which partially achieves this result is to connect the remote end of the resistor to a point of which the d.c. potential differs by a margin of several times the signal amplitude from the mean d.c. potential at the coupling. This is illustrated in my Figs. 1(a) and 1(b) for the two cases of negative-going and positive-going sync pulses. The potential V_A is chosen to give the desired range of signal excursion at the amplifier grid. V_B is a potential differing from V_A by an amount many times the amplitude of signal applied to C , being positive or negative to V_A , as required to cause the diode to conduct. It is obvious that the current in R (and in turn the diode current) is almost entirely dependent on the p.d. $V_A - V_B$ and only to a small degree on the variations in signal applied. This gives a close approximation to the desired condition and much improved restoration results.

Another method of attack is to connect R to a point in the circuit where the same signal excursion exists as that applied to C . The p.d. across R must then be constant, making the current in it constant. The p.d. across R must again be in correct sense to cause the diode to conduct. One simple embodiment of this idea is shown in my Fig. 2(a) where R is connected in parallel with C ; it can only be used when the p.d. across C is in the correct sense. The sync separator circuit illustrated in Mr. Cocking's article (Fig. 2) can be greatly improved by this method. This is shown in my Fig. 2(b), the grid cathode circuit of the valve forming the diode and R_2 and C_1 being connected to a source of signal positive to the cathode (via R_1).

In all these circuits, suitable values of C will be the same as those normally employed in restored coupling (say 0.1 to $0.5\mu F$). R must, however, be very much larger, (10 to 22 megohms), and is chosen to give about the same average current in the diode as obtains in the simple circuit.

I must point out, however, that while these arrangements alleviate one defect of the d.c. restorer, they do not appreciably reduce the other defect discussed by Mr. Cocking—the variation in signal datum which occurs during the frame sync pulse.

Chelmsford, Essex.

J. E. NIXON.

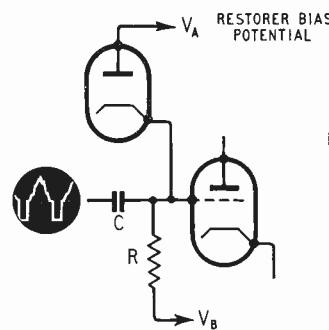


Fig. 1 (a)

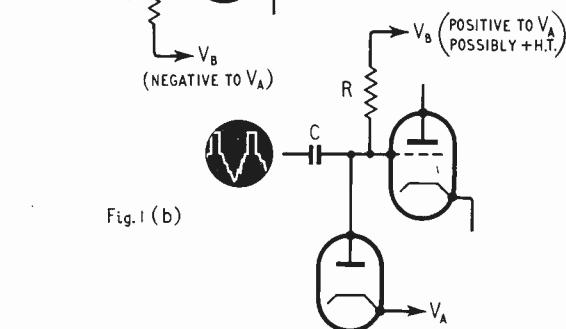
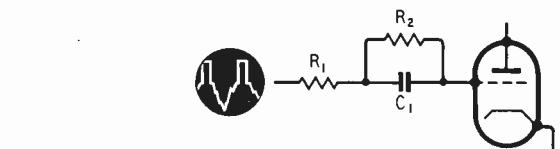


Fig. 1 (b)



$C_1 = 0.1\mu F$ } APPROX. VALUES
 $R_2 = 10M\Omega$

Fig. 2 (b)

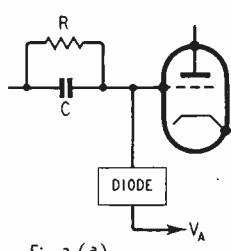
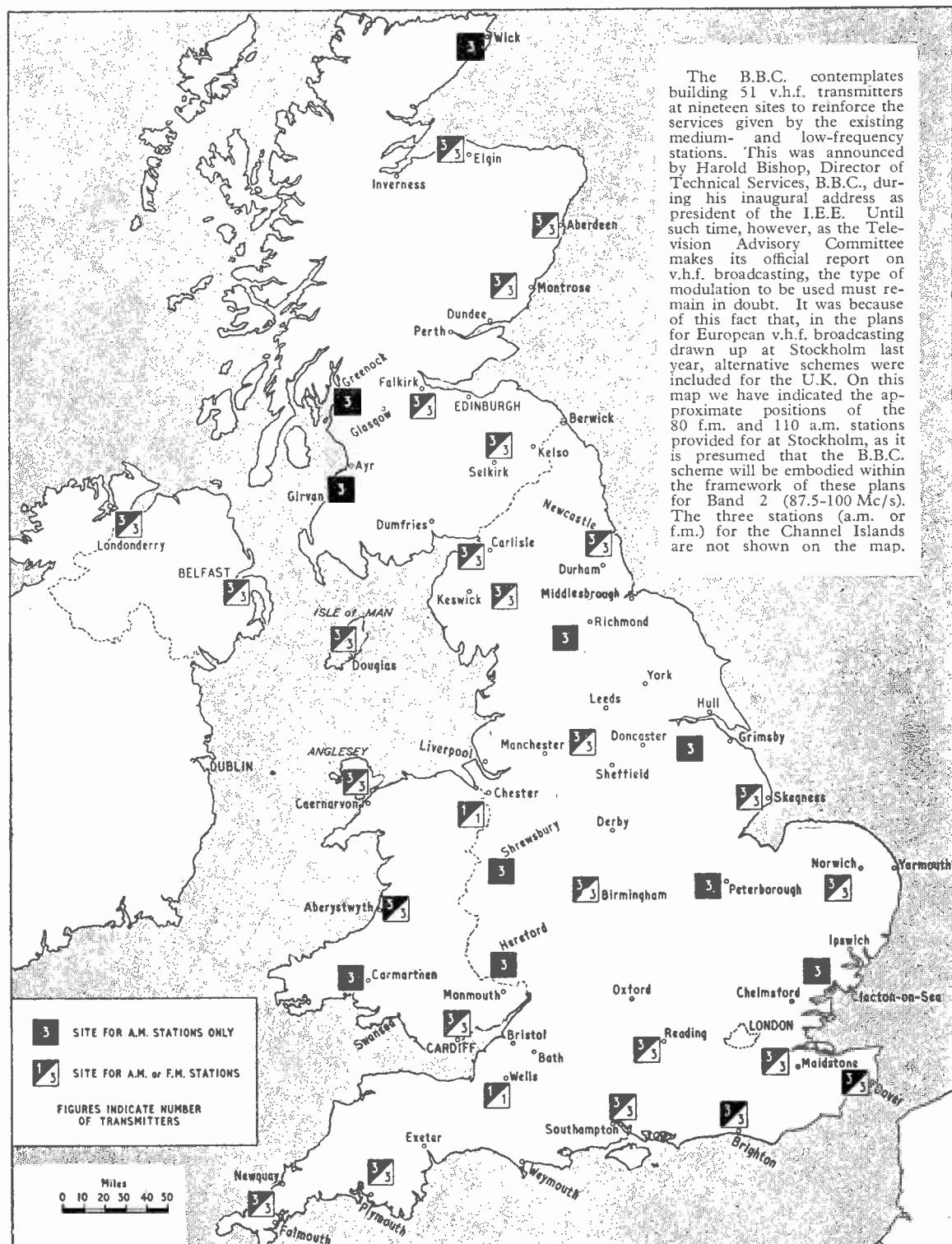


Fig. 2 (a)

V.H.F. Broadcasting: Plans for U.K.



The B.B.C. contemplates building 51 v.h.f. transmitters at nineteen sites to reinforce the services given by the existing medium- and low-frequency stations. This was announced by Harold Bishop, Director of Technical Services, B.B.C., during his inaugural address as president of the I.E.E. Until such time, however, as the Television Advisory Committee makes its official report on v.h.f. broadcasting, the type of modulation to be used must remain in doubt. It was because of this fact that, in the plans for European v.h.f. broadcasting drawn up at Stockholm last year, alternative schemes were included for the U.K. On this map we have indicated the approximate positions of the 80 f.m. and 110 a.m. stations provided for at Stockholm, as it is presumed that the B.B.C. scheme will be embodied within the framework of these plans for Band 2 (87.5-100 Mc/s). The three stations (a.m. or f.m.) for the Channel Islands are not shown on the map.

International Technical Questions

Summary of C.C.I.R. London Meeting

After five weeks' deliberations the 7th Plenary Assembly of the International Radio Consultative Committee (C.C.I.R.) ended on October 7th. The C.C.I.R., which is one of the four permanent bodies of the International Telecommunication Union, is charged with the study of technical radio questions and operating questions of a technical character. To facilitate the study of the questions tabled at each plenary assembly fourteen study groups have been formed and it is the task of these international groups to consider and report on the findings of their national counterparts. A list of the British study groups and their chairmen was given in our September issue (p. 396).

Some 300 representatives from 41 countries participated in the meetings, the findings of which will eventually be published by the C.C.I.R.

During the Assembly's protracted deliberations in London, some three or four hundred documents were considered and a vast number of recommendations approved. At this stage we can do no more than summarize a few of the recommendations which will be submitted to the I.T.U., and some of the study programmes to be undertaken before the next plenary assembly (to be held in Warsaw in 1956).

The approved recommendations of the study group concerned with both sound and vision receivers cover questions of stability, selectivity and sensitivity. In the recommendation regarding receiver stability it is pointed out that in cases where economic considerations prevent the use of effective frequency stabilizing devices attention should be paid to the stability of inductors and capacitors and of the oscillator circuit (including the valve and its power supply). It also recommends the use of temperature compensating components. Tables giving the single-signal and two-signal selectivity characteristics of various classes of receiver (W/T, R/T, domestic broadcast and television) are included in the recommendation that uniform methods of measurement of receiver selectivity be adopted. The same study group has drawn up a programme of investigation into the methods of measuring and expressing the amplitudes of undesired emissions from sound and vision receivers and also of means of suppression. It also calls for a study of the question of the choice of intermediate frequencies.

Three study groups are concerned with propagation—tropospheric, ionospheric and ground wave, respectively. The outstanding subject so far as the ionospheric group was concerned was probably the question of atmospheric radio noise. Study pro-

grammes have been agreed upon and one recommendation calls for the setting up of a world network of lightning recorders. It is also proposed to produce a new set of noise curves which can be used internationally in place of the theoretical data at present used.

The 1947 Atlantic City Conference entrusted the C.C.I.R. with the task of studying the establishment of a world-wide standard-frequency and time service. A report on the services provided by the existing stations in Washington, Hawaii, Tokyo, Rugby, Johannesburg and Turin was adopted, together with recommendations for improving the service. The possibility of employing the two-independent-side-band method of transmission for the standard frequency service is to be studied.

Standards for magnetic-tape recording of programmes for international exchange were recommended and approved, although not unanimously. The recommended tape speed is 15 inches per second with alternative speeds of 30 and $7\frac{1}{2}$ in/sec. Single-track recording is recommended and standards are given for tape, spools, frequency response and recording heads. In view of the increasing interest in the interchange of filmed television programmes it has been agreed that an investigation should be undertaken to find out what method or methods should be used for the recording of the accompanying sound for TV programmes intended for international exchange.

Short-wave broadcast receiver manufacturers will soon have to include the 26-Mc/s band in the coverage of their sets if a resolution passed at the meeting is acted upon. This called for the use of this band for long-distance broadcasting because of the very low atmospheric noise intensity in that part of the spectrum.

The vocabulary study group recommended the abolition of all adjectives and superlatives in describing frequency bands and the substitution of numbers as given in the following table, which it is intended should take the place of the table in the Atlantic City Radio Regulations. The lower limit of the frequency range is excluded and the upper limit included in each case. The formula is : Band "N" extends from 0.3×10^N to 3×10^N c/s.

Band Number	Frequency Range		Metric subdivision
4	3 to	30 kc/s	Myriametric waves
5	30 to	300 kc/s	Kilometric waves
6	300 to	3,000 kc/s	Hectometric waves
7	3,000 to	30,000 kc/s	Decametric waves
8	30 to	300 Mc/s	Metric waves
9	300 to	3,000 Mc/s	Decimetric waves
10	3,000 to	30,000 Mc/s	Centimetric waves
11	30,000 to	300,000 Mc/s	Millimetric waves
12	300,000 to 3,000,000 Mc/s		Deci-millimetric waves

To facilitate the preparation by the International Telecommunication Union of an international list of telecommunication terms, definitions and symbols, the C.C.I.R. is to produce a "provisional list of terms and definitions peculiar to the work of the C.C.I.R." which, it is intended, shall serve as a basis for the radio-communications section of the proposed I.T.U. vocabulary.

WORLD OF WIRELESS

International Conferences ♦ Television and Amateur Shows ♦ R.I.C. Awards ♦ R.T.E.B. Exams.

European Broadcasting Conference

A SERIES OF MEETINGS of the European Broadcasting Union is being held at Monte Carlo from November 3rd to 14th. The main meeting is the 1953 General Assembly of the E.B.U., which will be held on the 13th and 14th. This will be preceded, as usual, by meetings of the Technical Committee, Legal Committee, Television Study Group and of the Administrative Council.

The Technical Committee, under its chairman, E. L. E. Pawley of the B.B.C., will review the activities of its various working parties and of the E.B.U. Technical Centre in Brussels for the past year and will fix the programme of work to be undertaken during the following twelve months. The working parties, which are composed of specialists of member organizations, have during the past year been considering indirect-ray propagation on medium-waves, unattended broadcast transmitting stations, the implementation of the Stockholm v.h.f. plans and the standardization of equipment and operational procedure in tape recording. It is possible that the Technical Committee will, in conjunction with the Television Study Group, also review the development of international television exchanges in Europe.

Interference : International Agreement

APPROXIMATELY 60 delegates from 18 countries and various international organizations attended the meeting of the International Special Committee on Radio Interference (C.I.S.P.R.), held in London in the middle of October. The chief aims of the committee are to obtain international agreement on limits which should be imposed on the production of "man-made" interference, methods of measurement and safety considerations involved in the use of suppressors on electrical appliances.

As a result of the meeting, agreement was reached on interference limits in respect of certain classes of electrical equipment. The general adoption of the recommendations made would considerably benefit international trade. At present exporting manufacturers are confronted with a variety of specifications.

Among the items referred to national delegations for further study and consideration are: interference limits in the v.h.f. band; interference between receivers (from oscillator and line time-base circuits); interference from high-tension cables and from industrial, scientific and medical r.f. equipment.

TV Show

SOME 40 EXHIBITORS will be participating in the annual exhibition of the Television Society, which will be held from January 7th to 9th in the Electrical Department, King's College, Strand, London, W.C.2. The exhibition is not, of course, concerned only with domestic reception, but will also cover industrial television and television in research.

On the first day, the show will be open from 6.0-9.0 for members and the press only. On the second day it will be open at 12 noon and on the last day at 10.0, and will close on both days at 9.0. Admission will be by ticket obtainable from members of the society or the secretary, 164, Shaftesbury Avenue, London, W.C.2.

Amateur Radio Show

THE SEVENTH Annual Amateur Radio Exhibition, organized by the Radio Society of Great Britain, will be opened at the Royal Hotel, Woburn Place, London, W.C.1, at 12 noon on November 25th by Rene Klein, a

founder-member and vice-president of the Society. Mr. Klein, who is now managing director of McMichael Radio, was instrumental in the founding of the Society as the London Wireless Club in 1913.

In addition to the equipment exhibited by manufacturers there will be a wide range of home-constructed gear and a display of amateur television equipment arranged by the British Amateur Television Club.

At the time of going to press the following will be exhibiting: Air Ministry, Avo, Cosmocord, Denco, G.E.C., David Godwin, Grundig, Panda Radio, Philpotts Metalworks, Salford, Siemens, *Short Wave Magazine*, *Telecraft* and *Wireless World*.

The exhibition will be open daily (11-9) until November 28th. Admission 1s.

B.B.C. Tuning Notes

OUR REFERENCE in the September issue (page 409) to the "B.B.C. 1,000-c/s tuning note (not the Third Programme 440 c/s)" was not strictly accurate. There is actually a 1,000-c/s tuning note for the Third Programme. It is radiated for five minutes before the ten-minute 440-c/s note which immediately precedes the opening of the Third Programme.

Incidentally, the degree of accuracy of the radiated audio frequencies has recently been improved and is now ± 5 parts in 10⁶.

Writing Prizes

IT WILL be recalled that two years ago the Radio Industry Council launched a scheme to encourage, by the award of premiums, the writing and publication of technical articles to increase the prestige of the British radio industry. Last year five 25-guinea premiums were awarded and two additional £10 awards were made.

The panel of judges, which this year includes Dr. Willis Jackson (late Professor of Electrical Engineering, Imperial College), P. D. Canning, W. M. York, C. E. Strong and Vice-Admiral Dorling, will be meeting shortly to consider articles accepted for publication by journals on sale to the public between January and December this year. They should be submitted to the Secretary of the R.I.C., 59 Russell Square, London, W.C.1, by the author or editor not later than November 30th.

Do You Know ?

HOW LONG should the radiator be for a dipole for the reception of the Wrotham v.h.f. transmissions?

Where does one apply for an amateur transmitting licence?

What are the base connections for an X81?

What is the value of a resistor coloured orange all over?

What is the address of the Television Society?

The answers to these and very many other questions can readily be given by the possessor of a 1954 *Wireless World* Diary which includes, in addition to the usual week-at-an-opening diary pages, an 80-page reference section.

The Diary is obtainable from booksellers and newsagents, price 5s 10d (morocco leather) or 4s 1d (rexine), including purchase tax.

Servicing Exam. Results

OF THE 309 ENTRANTS for the Radio Servicing Certificate Exam. in May, 126 (40 per cent) qualified for the certificate—including 30 candidates who passed the practical test only, having been referred last year. A further 87 candidates were successful in the written paper, but were referred in the practical tests. As mentioned last month, the next exam. will be held on May 4th

and 6th for the written papers and May 15th for the practical test. The closing date for entries is February 1st.

The percentage of successes in the 1953 Television Servicing Certificate Exam. was higher than in the Radio Exam.—48 per cent. Of the 135 candidates, 64 were successful; including 24 who were referred in the practical test last year. Thirty-six passed in the written papers and may sit again next year for the practical test. The next exam. for the Television Servicing Certificate will be on May 10th and 12th and June 19th, for which the closing date for entries is January 15th.

Particulars and entry forms for both examinations are obtainable from the Radio Trades Examination Board, 9, Bedford Square, London, W.C.1.

PERSONALITIES

Professor F. C. Williams, of Manchester University, has been awarded the ninth Charles Vernon Boys Prize by the Physical Society in recognition of his "invention of the storage system for use in digital electronic computers." The award will be made at the Society's meeting at 5.00 on November 20th in the Lecture Theatre of the Science Museum, London, S.W.7, when Professor Williams will deliver a lecture on "Cathode-ray Tube Storage for Digital Electronic Computers."

Dennis McMullan, M.A., Ph.D., who for the past four years has been undertaking post-graduate research work at the Cambridge Engineering Laboratory, where he developed the scanning electron microscope, is going to Canada as head of the Simulator and Field Equipment Section of the Canadian Armament Research and Development Establishment in Quebec. He graduated from Cambridge in 1944 and went to Bush Radio under the Hankey scheme for the development of Services equipment. Dr. McMullan left Bush in 1946 and, before returning to Cambridge, was for two years with Cinema Television where he worked on high vacuum techniques and for a short while at Sperry Gyroscope designing analogue computers.

H. Walker, O.B.E., A.M.I.E.E., becomes Assistant Superintendent Engineer (Television Studios), B.B.C. He joined the engineering staff of the Corporation in 1931 and transferred to the Television Service in 1936. After war service in the R.A.F. in which he attained the rank of Wing Commander, he returned to the Television Service in 1945 and was appointed assistant engineer-in-charge at Alexandra Palace the following year. In 1950 he became engineer-in-charge of the London station and for the past eighteen months has been head of Technical Operations, Television Studios.

W. D. Richardson has been appointed Assistant Superintendent Engineer (Television Outside Broadcasts), B.B.C. He joined the B.B.C. as a maintenance engineer at Brookmans Park in 1930 and became senior maintenance engineer at Alexandra Palace in 1938. Throughout the war he served in the B.B.C.'s Planning and Installation Department and since 1946 has held various posts in the Television O.B. Department.

Wallace Rubin, B.Sc.(Hons.), Ph.D., who joined Multicore Solders a year ago, has been appointed chief chemist of the Research Laboratories in succession to Dr. P. M. Fisk, who has left after nine years' service with the company.

M. G. Hammett, M.I.E.E., A.M.I.Mech.E., who joined Murphy Radio as chief engineer of the Electronics Division at the beginning of September, held a similar position with E. K. Cole's Electronics Division at Malmesbury for some time. He has taken over responsibility for all electronic development and design at Murphy's works at Welwyn and Ruislip.



H. J. Leak, M.Brit.I.R.E., managing director of H. J. Leak & Company, went to the United States to attend the Audio Fair in New York (October 14th-17th) where the company's new products were demonstrated.

H. A. Hartley has gone to the United States to devote himself exclusively to the interests of his American company (H. A. Hartley Co. Inc., of 521, East 162nd Street, New York 51). The sole rights of manufacture and selling in the United States and its possessions are vested in the American company, but for the rest of the world these rights will remain with H. A. Hartley Co., Ltd., 152, Hammersmith Road, London, W.6.

OBITUARY

Allen Longstaff, who was for over 20 years the representative of Amalgamated Wireless (Australasia), Ltd., in London, died in Sydney, N.S.W., on September 19th. It was in 1925 that Mr. Longstaff first came to this country; he was then engaged in experiments being conducted preparatory to the establishment of the Anglo-Australian wireless telephone service. He attended the International Radiotelegraph Conference in Washington as A.W.A.'s representative in 1927 and immediately afterwards was appointed as European Representative of the company. He returned to Australia in 1946.

IN BRIEF

Broadcast Receiving Licences totalling 13,056,689 (including 2,539,103 for television and 196,161 for car radio sets) were current in Great Britain and Northern Ireland at the end of August. The number of television licences increased by 59,649 during the month.

Faraday Lecture.—This year's Faraday Lecture of the I.E.E. will be given by O. W. Humphreys, B.Sc., and will be entitled "Electric Process Heating—An Aid to Productivity." The lecture tour opens at Birmingham Town Hall on November 30th and continues at Leicester on December 3rd, Cardiff (February 1st), London (February 16th), Southampton (February 18th), Manchester (March 23rd), Liverpool (March 25th), Leeds (April 12th), Sheffield (April 14th), Newcastle (May 4th) and Glasgow (May 6th). Admission to the lectures is by ticket and application must be made to the honorary secretary of the I.E.E. Centre concerned, except in the case of London, when application must be made to Savoy Place, London, W.C.2.

Brit.I.R.E. Membership was 4,383 on March 31st—an increase of 365 on the previous year. This was recorded in the annual report given at the meeting on October 21st. In the course of the review of the past year it was stated that a report is being prepared on the use of primary materials in the radio industry. The first part will cover ceramics, constructional metals, magnetic materials and crystals.

Blind Operators.—Donations totalling nearly £540 were received at the Earls Court Radio Show by the United Appeal for the Blind (London) as a result of the demonstration of blind operators assembling components. It will be recalled that the demonstration was provided by Philips who employ about 20 blind operators at their Mitcham Works.

Trans-American Radio.—Radio equipment is being installed in the Sunbeam Alpine car which, with a caravan-trailer, is being driven from Alaska to the Strait of Magellan by a three-man team. The radio installation, which has been supplied by the British Communications Corporation, Ltd., Wembley, includes a 5-watt crystal-control transmitter for c.w. operation in the 20-40-metre amateur band. The operator, Marco McClintock, of Cleveland, Ohio, will use his own call W0DXT. The car will also carry v.h.f. transmitting and receiving equipment supplied by B.C.C.

Sponsored TV?—The organizers of the recent Nottingham Radio and Television Exhibition (the Nottingham Centre of the Radio and Television Retailers' Association) arranged for a series of commercial television programmes to be transmitted on a closed circuit to receivers in the main hall of the exhibition. The majority of the exhibitors at the show were local retailers.

"Old N'Ions."—The annual dinner and reunion of past students of the Northampton Engineering College, Clerkenwell, will be held on November 27th at the Connaught Rooms, Gt. Queen Street, London, W.C.2. Tickets are obtainable from A. F. Thompson, 10, Milborough Crescent, Lee, London, S.E.12.

"Navigation To-day," the exhibition being held at the Science Museum, South Kensington, will remain open until January 17th. It shows the various types of navigational instruments and equipment (including radar and other radio aids) used in navigation in the air, on land and at sea. The museum is open on week-days from 10 to 6 and on Sundays from 2.30 to 6. Admission is free.



C.C.I.R. BANQUET.—Delegates to the London meetings of the International Radio Consultative Committee (C.C.I.R.) were entertained by the Marconi Company at a dinner and dance at the Dorchester Hotel. Dr. Balth. van der Pol, director of the C.C.I.R., is on the right in this view of the head table. Sir George Nelson, chairman of the Marconi group of companies, is on the right of the microphone and H. Faulkner, who was chairman of the plenary assemblies, is next to him.

New Norfolk Transmitter.—As part of its plan to improve the coverage of the Home Service, the B.B.C. is building a new 2-kW transmitter at Hampstead, near Cromer, Norfolk. For technical reasons it will use the same wavelength and radiate the same programme as the Northern Home Service, 434 metres (692 kc/s). Its directional aerial will give a good service in the Sheringham, Cromer, North Walsham and Reepham area without affecting reception of the Moorside Edge transmissions in north-west Norfolk.

R.A.E. Reunion.—The first reunion of those who worked in the Wireless (10) Department of the Royal Aircraft Establishment, Farnborough, between 1922 and 1939, was held at Farnborough on September 25th. Dr. James Robinson, who was the first head of the department after it was moved from Biggin Hill, was the guest of honour. Others present included Air Commodore A. L. Gregory, the first serving R.A.F. Officer to take charge of the department, F. S. Barton (principal director of electronics research and development, M.O.S.) and Dr. J. S. McPetrie, present head of the R.A.E. Radio Department.

Marine I.F.F.—Development models of a device to ensure the identification of ships when seen on a radar p.p.i. are undergoing tests in the United States. The equipment has been devised by a committee of the American Radio Technical Commission for Marine Services to enable a port radar operator to know which of the numerous ships shown on the p.p.i. he is talking to.

Radio-control Equipment fitted in the target model aircraft exhibited by M.L. Aviation at the S.B.A.C. Exhibition (to which we referred on page 464 of our October issue) was made by Beme Electronic and Marine Equipments, Ltd., of Hythe, Hants. It was designed and developed under a M.O.S. contract.

R.A.M.A.C.—The thirteenth conference of the Radio Marine Associated Companies, which is an association of twenty-five marine radio operating companies in nineteen countries, was recently held in the London offices of the British member company—Marconi International Marine Communication. R.A.M.A.C. co-ordinates research and the exchange of technical information on marine radio communication and navigational aids among its members.

Fire!—The incidence of fires caused by television receivers decreased from 6.4 per 10,000 sets in 1947 to 1/10,000 in 1951. The incidence for sound receivers during the same period remained at approximately 1/40,000. These figures are given in "Fire Research, 1952," published by H.M.S.O. for the D.S.I.R., price 3s.

E.I.B.A. Ball.—The annual dinner and ball in aid of the Electrical Industries Benevolent Association will be held at Grosvenor House, Park Lane, London, W.1, on November 13th. Tickets, price 2½ guineas, are obtainable from the Association, 32, Old Burlington Street, London, W.1.

B.I.F.—Plans are already well advanced for the 1954 British Industries Fair, which will be held simultaneously in London and Birmingham from May 3rd-14th.

Non-ferrous Metals being used extensively in the radio industry, we draw readers' attention to the "Metal Industry Handbook and Directory, 1953," which is issued annually to subscribers to the weekly journal *Metal Industry*. A large section of the 456-page Handbook, which is in its 42nd year of publication, is devoted to general properties of metals and alloys, and there are sections covering standards and finishing processes and a directory of producers.

Plastics.—A 44-page booklet listing all the more important plastics materials produced in Great Britain has been prepared by the British Plastics Federation of 47-48, Piccadilly, London, W.1. Each of the 17 classifications of materials listed in the booklet is prefaced by a short note on its uses. The booklet, which is obtainable from the B.P.F. price 2s, also includes lists of manufacturers and trade names.

Association of Plastic Cable Makers has been formed with the objects of promoting and advancing the interests of the industry and the establishment of standards of quality for plastic cables. James, Edwards & Co., 381, Salisbury House, London Wall, London, E.C.2, have been appointed secretaries to the association.

BUSINESS NOTES

"Tape Deck."—In a recent case in the Chancery Division Truvox, Ltd., were the defendants in an action brought against them by Wright and Weaire, Ltd., concerning the use of the trade mark "Tape Deck." Judgment was given for Truvox, on the grounds that the plaintiffs had failed to proceed with their original case. We understand that as a result of these proceedings an application will be made to expunge the term "Tape Deck" from the Register of Trade Marks.

Switzerland has ordered from Marconi's a complete mobile television outside broadcasting unit comprising three image orthicon cameras and associated sound and vision equipment.

E.M.I. are to provide three complete Emitron mobile television microwave links to the Swiss Post Office for O.B. work. Switzerland recently started experimental transmissions from a station on the Uetliberg, near Zurich.

Valve Shrouds.—One of the two machines shown by Heenan and Froude, Ltd., of Worcester, at the recent European Machine Tools Exhibition in Brussels, was a strip-forming machine tooled for the manufacture of valve shrouds.

Hadley Sound Equipments, Ltd., of Smethwick, have advised us that the School Broadcasting Council has approved their new 5-watt amplifier with baffle-mounted loudspeaker as suitable for use in schools. The PR5 amplifier will, therefore, be added to the Council's "List of Approved Apparatus" to which we referred in our May issue.

International Aeradio, Ltd., are to provide and install radio and meteorological equipment at the Fiji Airways base, Nasouri, on the main island. Similar equipment will be installed at the other four airfields, Lambasa, Lautoka, Taveuni and Savu Savu. The company has also been given the contract by the

Government of Iraq for the provision of radio and radar engineering services and the establishment of an electronics training school in Baghdad.

Tanker Radio.—Six new 26,640-ton tankers on order for the Esso Petroleum Company are to be supplied with radio communication equipment and navigational aids by the Marconi International Marine Communication Company.

R.F. Dielectric Heater for the production from glued strips of wood or boards up to $80 \times 40 \times 2$ inches thick has been produced by the General Electric Company and Fielding & Platt, Ltd. R.F. power for this edge-gluing machine, which incorporates a pneumatically operated press, is provided by a G.E.C. 25-kW r.f. generator.

Tannoy in Canada.—To facilitate the distribution and maintenance of Tannoy equipment in North America, Tannoy (Canada), Limited, has been formed with offices in Toronto. F. A. Towler, who was for many years sales manager in London, is the resident executive.

Nera of England, Limited, is the new name adopted by Aten (Radio and Television), Limited, of Jeffries Passage, High Street, Guildford, Surrey. In addition to producing projection television receivers and TV components, the company is manufacturing electronic instruments.

Gillon Electric, Limited, Rockstone Works, Rosemary Lane, Camberley, Surrey (Tel.: Camberley 481), has been formed by G. D. Gilbert and A. L. Leeson (until recently with Allen Components, Ltd.) for the manufacture of radio and television components.

Truvox-Rola-Celestion.—The sale, distribution and service of Rola and Celestion loudspeakers and Truvox p.a. loudspeakers will in future be undertaken by Rola Celestion, Ltd., and not, as hitherto, by Truvox. All enquiries, correspondence, orders and units for service should be addressed to Rola Celestion, Ltd., Thames Ditton, Surrey.

The Sales office of the **Aluminium Wire and Cable Company** is now at 30 Charles II Street, St. James' Square, London, S.W.1. (Tel.: Trafalgar 6441).

Dupley Electronics, Limited, makers of transformers and battery chargers, have moved from Ealing to Athlon Road, Manor Farm Road, Alperton, Wembley, Middlesex (Tel.: Perivale 9126).

Glasgow Branch of W. T. Henley's Telegraph Works Company is now at 149/153, North Street, Glasgow, C.3. (Tel.: Central 1771.)

Aerialite, Ltd., have increased their factory accommodation at Slybridge, Cheshire, by an extension to the factory giving a further 20,000 square feet of floor space.

MEETINGS

Institution of Electrical Engineers

Discussion on "Safety Precautions in Electronic Apparatus, with Particular Reference to Medical Applications," opened by H. W. Swann and W. Grey Walter, M.A., Sc.D., at 5.30 on November 12th.

Radio Section.—"Some Aspects of the Design of V.H.F. Mobile Radio Systems" by E. P. Fairbairn, B.Sc., at 5.30 on November 11th.

"Loudspeaker Systems—Recent Trends in Design" by Major A. E. Falkus, B.Sc.(Eng.), at 5.30 on November 23rd.

Education Discussion Circle.—Discussion on "What are the Requirements of Electrical Engineering Textbooks?" opened by Instr.-Cdr. D. K. McCleery, M.Sc., at 6.0 on November 9th.

All the above meetings will take place at Savoy Place, London, W.C.2.

Cambridge Radio Group.—Address by J. A. Smale, B.Sc., chairman of the Radio Section, at 6.0 on November 3rd at the Cambridgeshire Technical College, Cambridge.

Mersey and North Wales Centre.—"Radio Telemetering" by J. Walsh, B.Sc., at 6.30 on November 2nd at the Liverpool Royal Institution, Colquitt Street, Liverpool.

"Telemetering for System Operation" by R. H. Dunn, B.Sc., and C. H. Chambers, at 6.30 on November 16th at the Town Hall, Chester.

North-Eastern Radio Group.—"A Method of Designing Transistor Trigger Circuits" by Prof. F. C. Williams, D.Sc., D.Phil., F.R.S., and G. B. Chaplin, M.Sc., at 6.15 on November 16th at King's College, Newcastle-upon-Tyne.

North-Western Radio Group.—"Some Aspects of the Design of V.H.F. Mobile Radio Systems" by E. P. Fairbairn, B.Sc.,

at 6.30 on November 25th at the Engineers' Club, Albert Square, Manchester.

North Scotland Sub-Centre.—"Electronic Telephone Exchanges" by T. H. Flowers, B.Sc., at 7.30 on November 11th at the Caledonian Hotel, Aberdeen, and at 7.0 on November 12th at the Royal Hotel, Dundee.

South-West Scotland Sub-Centre.—"Electrotechnical Ceramics—Survey of Compositions, Manufacturing Methods and Properties" by W. G. Robinson, B.Sc.Tech., and E. C. Bloor, B.Sc., at 7.0 on November 4th at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

South Midlands Centre.—"Printed and Potted Electronic Circuits" by G. W. A. Dummer, and D. L. Johnston, B.Sc.(Eng.), at 7.15 on November 19th at the Winter Gardens Restaurant, Malvern.

Faraday Lecture. "Process Heating" by O. W. Humphreys, B.Sc., at 6.0 on November 30th at the Town Hall, Birmingham.

South Midlands Radio Group.—"Printed and Potted Electronic Circuits" by G. W. A. Dummer and D. L. Johnston, B.Sc.(Eng.), at 6.0 on November 23rd at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Reading District.—"Sound Recording" by G. F. Dutton, Ph.D., B.Sc.(Eng.), at 7.15 on November 30th at the George Hotel, Reading.

London Students' Section.—"Scanning Generators" by Lt. M. J. Wyatt and 2/Lt. P. D. Gibbons at 7.0 on November 10th at the R.E.M.E. Depot, Arborfield, Berks.

"Metallic Resistance at High Frequency" by A. D. Stevens at 7.0 on November 17th at the Public Library, Chelmsford, Essex.

British Institution of Radio Engineers

London Section.—"A High-Definition General-Purpose Radar" by J. W. Jenkins, J. H. Evans, G. A. G. Wallace and D. Chambers, B.Sc. (Cossor), at 6.30 on November 11th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Scottish Section.—"Vibration Generators—Their Ancillary Equipment and Application" by H. Moore (Goodmans), at 7.0 on November 5th at the University, Edinburgh.

Merseyside Section.—"Multi-Channel Tuners for Television" by S. L. Fife and W. E. Hosey, B.Sc. (English Electric), at 7.0 on November 5th at the Merseyside and North Wales Electricity Centre, Whitechapel, Liverpool.

North-Eastern Section.—"Principles of Electronic Computing Machines" by Dr. B. V. Bowden (Manchester College of Technology), at 6.0 on November 11th at the Institution of Mining and Mechanical Engineers, Newcastle-upon-Tyne.

West Midlands Section.—"Remote Control Devices and Servomechanisms" by A. E. W. Hibbit (Muirhead), at 7.15 on November 24th at the Wolverhampton Technical College, Wulfruna Street, Wolverhampton.

Physical Society

"Some Magnetic Measurements—Techniques and Applications" by Prof. W. Sucksmith; and "Cathode Ray Tube Storage for Digital Computers" by Prof. F. C. Williams, D.Sc., D.Phil., F.R.S., at 5.0 on November 20th at the Science Museum, London, S.W.7.

Television Society

Discussion on "Competitive Television" at 7.0 on November 13th.

"Converters for V.H.F. or U.H.F. Television" at 7.0 on November 26th.

Both these meetings will be held at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Leicester Centre.—"Fly Wheel Synchronizing" by S. E. Gent, B.Sc. (Eng.), (Ferguson Radio), at 7.0 on November 30th at the College of Art and Technology (Room 45), The Newarkes, Leicester.

British Kinematograph Society

Film Production Division.—"Stereophonic Sound Systems" by A. W. Watkins, at 7.15 on November 18th.

Television Division.—"Medium Screen Television" by H. Ibbotson, B.Sc., at 7.15 on November 25th.

Both meetings will take place at the Gaumont-British Theatre, Film House, Wardour Street, London, W.I.

Radio Society of Great Britain

"The Television Society's new TV Station" by H. de L. Banting, D. N. Corfield, D.L.C. (Hons.), and E. A. Dedman, at 6.30 on November 20th at the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Institute of Practical Radio Engineers

Midlands Section.—"Television and Radio Suppression in Vehicles" by H. Harrison (Joseph Lucas, Ltd.), at 7.30 on November 2nd at the Crown Hotel, Broad Street, Birmingham.

SKIN EFFECT

By "CATHODE RAY"

Why High-Frequency Currents Tend to Flow on the Outside of Conductors

In connection with microwave valves, two months ago, I happened to mention that at such high frequencies it was better to use sheet than wire, because most of the current flowed at the surface—a peculiarity known as skin effect. With such a picturesque name, it could hardly fail to be known. But I wonder if it is understood. I suspect that many reasonably knowledgeable technical people regard it as one of the sweet mysteries of r.f. life that are better not inquired into too closely. There is some excuse for this attitude, because the books that do deal with it thoroughly make very heavy mathematical weather of it, full of special Bessel functions, wave propagation, and suchlike. Consequently the simpler treatises tend to laugh it off by hinting that you must be a fool if you can't see that it is in the nature of very high-frequency currents to keep to the surface. The thing is "skin effect," so—well, there you are!

For those who are not honours graduates, but nevertheless have inquiring minds, some of the books strike a happy medium. But the said inquiring minds may perhaps be a little troubled by the fact that several apparently quite different explanations of skin effect exist. There is, however, no cause for alarm; skin effect is one of those things that can be approached by different routes; some people may find one way easier, some another.

Basic Principles

Personally I think the best starting point for any expedition of this kind is with the basic principles of electricity. A bit more thought may be needed to work it out from there, but every time one does it makes those principles clearer in the mind. However, there is no reason against—in fact every reason for—supplementing this approach by views from other positions, which, although established from fundamentals indirectly, may be more familiar in practical work. For instance, one way of explaining skin effect is in terms of eddy currents. To anyone who has studied eddy currents and knows all about them, this may be a convenient short cut; but if one's understanding of eddy currents is itself rather shaky it is clearly not a sound proposition.

The simplest conductor to consider is a long straight round-section wire made of a non-magnetic material, say copper, and far enough away from other conductors for their effects to be neglected. When d.c. flows it does so uniformly over the cross-section, so that if the wire were imagined to be divided up into equal thick parallel strands each would be carrying the same current. Since each strand has the same e.m.f. between its ends and the same resistance, it could hardly be otherwise. What calls for some explanation is the fact that with a.c. it is otherwise. If the frequency is sufficiently high, the strands around the circumference are found to be carrying nearly all the

current, and those in the middle hardly any. Consequently the resistance of the wire as a whole is higher for a.c. than for d.c.

Students of the elementary books that try (regrettably) to make things easier by introducing reactance as a kind of resistance may need to be assured that this increase in resistance is quite apart from the increase in impedance due to the inductance of the wire as a whole. Such an assurance may be especially necessary because inductance does come prominently into my explanation. But not the inductance of the wire as a whole. May I emphasize, then, that there is an increase in actual *resistance* of the wire when the current becomes unevenly distributed from any cause whatever, whether by making the current alternate or by substituting Eureka for some of the copper.

Presumably it is obvious that the resistance of a wire is greater if current ceases to flow altogether through some portion of its cross-section, because that is the same thing as making the wire narrower. But anyone who does not find it obvious that *any* departure from uniform distribution of current flow increases the resistance should try calculating the total power dissipated in two parallel resistors when a given total current is shared between them in various proportions. Suppose, for example, that the resistors are each 10 ohms, representing (say) the core and outer parts of a 5-ohm length of wire (Fig. 1) and that the total current is 4 amps. If this is shared equally, each path takes 2 A and the power dissipated in it (I^2R) is $2^2 \times 10 = 40$ watts: total for both path 80 watts. Now suppose one path takes 3 A and the other 1 A. Dissipation in the 3 A path is 90 watts and in the other 10 W; total 100 W. Of course the voltages across the two paths are now unequal (assuming the current is d.c.), which is impossible if the paths are in parallel. But not with a.c. For if the low-current path has more inductance in series with its resistance than the other path, it is quite possible for the voltage across it to be the same as across the other.

But, you may say, surely all strands of a single wire have the same inductance, especially if (as we are supposing) the division of the wire into strands is only imaginary? Even when one takes two separate wires with which to wind a coil, if they are

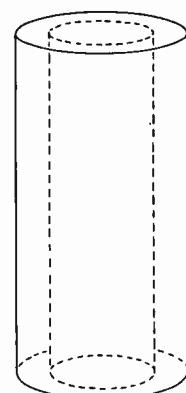


Fig. 1. A short sample (highly magnified) of a long solid wire, divided longitudinally by imaginary boundaries into two "strands," one inside the other, having equal cross-sectional area.

twisted together throughout their length the inductive coupling between them is very nearly 100%; any difference between two longitudinal halves of a single wire must be quite negligible! Regarding the inner and outer parts of the wire as separate strands, with boundaries as in Fig. 1, they obviously have the same length (and, if wound into a coil, the same number of turns), so assuming 100% coupling between them they could be represented electrically as in Fig. 2. At zero frequency the inductance would have no effect, so only the lower part of the diagram would apply, and the e.m.f. to pass 4 A (2 A through each path) would have to be 20 V. Since the wire is supposed to be stretched out straight, its inductance would presumably be quite small, so the d.c. conditions would not be much affected if the e.m.f. alternated at a low frequency, say 50 c/s. Very little more than 20 V would be needed to maintain the total current at 4 A. At high frequencies, however, the back e.m.f. generated by the flux set up by the current would become appreciable compared with 20 V, and a greater generator voltage would be needed to maintain the current. At a sufficiently high frequency, the inductance would become the dominating partner, swamping the resistance. But on the assumption of equal inductance and 100% coupling, the impedances of the two strands would be equal, whatever the frequency, so the currents in them would remain equal.

But now let us see if this representation—which at first sight might seem to be at least a close enough approximation to the truth—is justified. And this is where we get down to the bedrock of basic principles. One of the most important of them is that the magnetomotive force around any loop is proportional to the current enclosed (or linked). In the m.k.s. system it is actually equal to the number of ampere-turns; in the c.g.s. system it is 0.4π times the amp-turns. Our wire, being straight, has only one "turn," so the m.m.f. around any loop embracing it when it is carrying 4 A is (in the m.k.s. system) numerically equal to 4, or, in the c.g.s. system, 5.03. The path of the magnetic field at any point caused by current in a straight wire is a coaxial circle, and its strength is equal to the m.m.f. divided by the circumference of the circle. So just outside the wire, around its surface, the field strength (H) is m.m.f. πD , where D is the diameter of the wire. If D is, say 0.4 cm, H due to 4 A is 4 oersteds. The flux density B is equal to H multiplied by the permeability, μ , and in the c.g.s. system the μ for air is practically 1; so in our example B would be 4 gauss (or lines per sq. cm). In the m.k.s. system it would work out at 0.0004 weber. But for our present purpose numerical values are only of incidental interest, so there is no need to worry about systems of units—they do not affect the basic facts, namely, that the m.m.f. is the same in every concentric path around the wire, because all enclose the same current, and the field strength and flux density are therefore inversely proportional to the diameter, as shown in Fig. 3.

The same principles apply inside the wire itself, but of course we have to allow for the fact that the current enclosed, and therefore the m.m.f., progressively diminishes as the diameter of the path is reduced. The current, uniform distribution being assumed, is proportional to the cross-sectional area, and therefore to the square of the diameter. So the field, being proportional to the diameter squared, divided by the diameter, is simply proportional to the diameter and

we can complete the field/diameter diagram as in Fig. 4.

The one essential thing to grasp out of all this is that current flowing down the centre of the wire is linked with more flux than current in the outer "skin." The difference is the flux in the wire itself; this flux is proportional to the total current through the wire, but is independent of its gauge. This may seem rather surprising, but if you remember that the maximum flux density (which is at the surface of the metal) is inversely proportional to D , while the area through which it passes is directly proportional to D , you will see that D cancels out when calculating flux = flux density \times area.

Now if the current is alternating, the whole of the flux it produces is alternating, and therefore is inducing an e.m.f. in the wire. Other things being equal—frequency and length of wire—the e.m.f. induced is proportional to the peak flux. Since, as Fig. 4 shows, the flux linked with the core of the wire is greater than that linked with the skin, we see that more e.m.f. is induced in the core than in the skin. But the generator e.m.f. applied across all strands of the wire is the same, so after the induced e.m.f.s have been deducted there is less to spare for driving current through the resistance of the core than through the resistance of the skin. Consequently the effect of the unequal flux

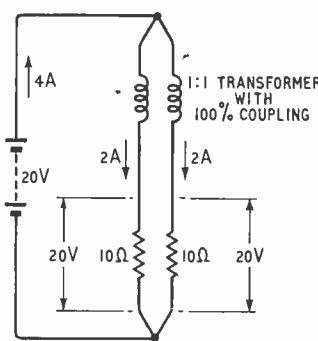
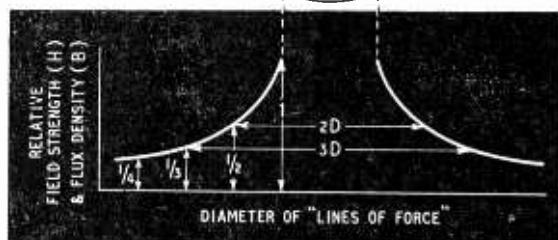
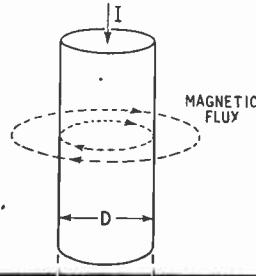


Fig. 2. If the resistance of the wire is taken as 5 ohms, the two "strands" can be represented by two 10-ohm resistances in parallel. Their inductances are also in parallel and very closely coupled; on the assumption that they are equal they are shown as making up a 1:1 transformer. At zero frequency the inductance has no effect, and an e.m.f. of 20 volts is sufficient to maintain a current of 4 amps, divided equally between the strands.

Fig. 3. The density of magnetic flux paths ("lines of force"), two of which are shown around the wire, falls off inversely as their length (which is proportional to their diameter) as shown in the lower part of the diagram. D is the diameter of the wire.



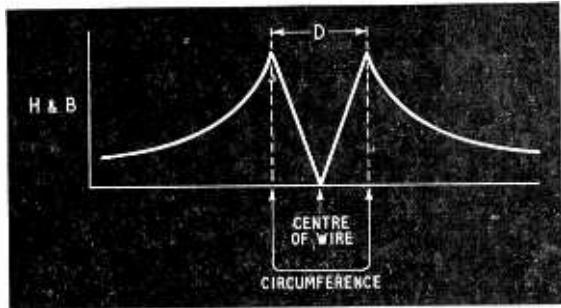


Fig. 4. To the field and flux density diagram for the field outside the wire is here added the portion applying to the field inside the wire, assuming the current is uniformly distributed. This diagram takes no account of the sign (direction) of the field.

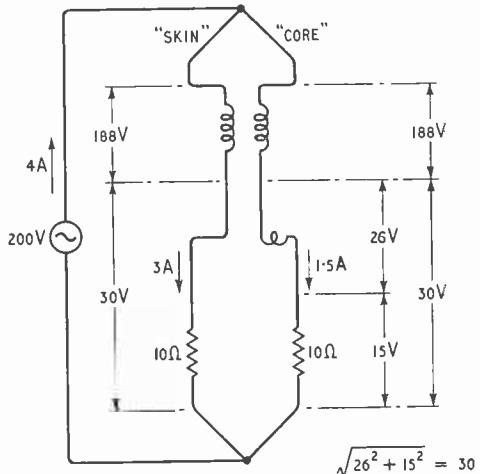


Fig. 5. This is Fig. 2 modified to apply to a frequency high enough for the reactance of the wire to be greater than its resistance. The fact that (as shown in Fig. 4) there is more flux outside the core of the wire, linked with it, than there is outside the skin, causes the core to have a higher inductance, so that less voltage is left to drive current through its resistance, and less current flows through it.

is to divert current from the core to the skin, and the resistance of the wire as a whole is increased.

Using conventional circuit symbols, this state of affairs can be shown as in Fig. 5, where the little extra coil in the "core" path represents the extra inductance corresponding to the flux inside the wire. The important point is that this inductance is not coupled to the "skin" path. Its back e.m.f. constitutes an extra voltage drop in the core path, and to make the situation clearer some figures are given on the diagram. For comparison with Fig. 2 the generator voltage has been raised sufficiently to maintain the total current at 4 A. The voltages across the two "windings" of the transformer *must* be equal and in phase, because the ratio is 1:1 and the coupling 100 per cent, so the voltages across the rest of each path must also be equal. But because of the extra inductance the current in the core path is not only less than the skin current but lags it in phase. In this case the phase difference is nearly 60°, which accounts for the fact that although the current in one branch has gone up by 1 A it has gone down in the other by only 0.5 A. So here is another cause of increased resistance. If you compare Fig. 5 with Fig. 2 you will find that the power dissipated, for the same

current, has risen more than 40 per cent, equivalent to a rise in resistance from 5Ω to more than 7Ω . Note that a large diversion of current has been caused by a relatively small difference between the inductances of the two paths.

One result of the diversion of current from the core is to modify Fig. 4. The field outside the wire (being determined only by the total current) remains unchanged, but there is less inside. This tends to reduce the excess of voltage induced in the core. The diversion therefore takes place only so far as is necessary to bring about a balance, such as that shown in Fig. 5. But if the frequency is very high indeed, and the resistance of the wire is very low (as it would be if made of heavy gauge copper), practically the whole of the applied voltage is used in overcoming the inductance. In other words, the voltage induced in all strands of the wire must be practically the same. This cannot happen if some strands are linked with more flux than others, so current ceases altogether except at the surface. Then there is no flux inside the wire and all parts of the wire are linked by the same flux, (i.e., the flux outside the wire). And the resistance of the wire is many times greater than it was. The resistances of the various "strands" are still the same as before; it is just that fewer of them are being used. Directly the resistance rises so much as to absorb an appreciable part of the voltage applied to the outermost skin, it makes possible a slightly greater induced voltage in the inner layers, which means that some current, though small, can flow there.

The thicker the gauge of the wire, the lower its d.c. resistance in proportion to its inductance, and the greater the skin effect. This fact sometimes makes unthinking people jump to the conclusion that at very high frequencies a thick wire has a greater resistance than a thin one. Actually, of course, the thick wire has the lower resistance, however far skin effect is developed, for it has more surface. It is true that *in proportion to the amount of metal used* its resistance is greater, because that goes up as the square of the diameter whereas the surface goes up in simple proportion to the diameter. So to obtain the lowest resistance with a given amount of metal it should be in the form of a thin-walled tube. It is also true that a coil wound with thick wire may have a higher r.f. resistance than a coil of the same dimensions wound with thinner wire. But if so it is not because of skin effect but because the lower resistance of the thick wire is being more than offset by greater dielectric losses in the insulation between the turns.

A moment or two ago we saw that skin effect brought about a reduction of magnetic flux inside the wire, the flux outside (for a given current) remaining the same. So the total flux produced by a given current is reduced, or in other words the inductance of the wire is reduced. The inductance of any circuit depends to some extent on frequency: it is greatest at zero frequency, when Fig. 4 holds good; it falls as skin effect comes into play; but there is a limit to the fall, for however high the frequency the circuit cannot lose more than all the flux inside the wire, and that is usually quite a small proportion of the whole. So at very high frequencies the inductance curve levels out again, towards a slightly lower figure than the d.c. value. The more refined formulae for calculating inductance provide a frequency correction.

We have already seen that skin effect is more pronounced with thick solid wire than with thin, in the sense that a given frequency multiplies its resistance by

a larger factor, though it never becomes so high as that of the thin wire. It should also have been clear that wire made of low-resistance metal develops skin effect at a lower frequency than high-resistance metal. Study of Fig. 5c shows that the lower the resistance of the wire—whether because it is thick or because it is made of low-resistance material, or both—the lower the frequency at which its inductance is large compared with its resistance, causing the current to crowd towards the skin in order to reduce the internal flux and thus equalize the inductive voltages in all strands. So a thick copper wire shows skin effect at a comparatively low frequency; a thick resistance wire or a thin copper wire is similarly affected only at a much higher frequency; and a thin resistance wire maintains its resistance within close limits up to a much higher frequency still. Finally, a wire made of iron or other magnetic material, though higher in resistance than copper and therefore less subject to skin effect, has an enormously higher permeability than copper, so the internal flux is multiplied accordingly, and the net skin effect is far greater even than with copper.

Skin effect is therefore increased by the following: conductance per unit length, permeability, and frequency. The exact calculation of the increase in resistance is, as I said, a matter for the brighter mathematicians, and practical people like ourselves fall back on tables or graphs. While it is easy enough to use

these to find the increase for an infinitely long straight wire with no other conductors anywhere near, no real circuit answers to that description. Even if one takes a practical view of "infinitely long" (in some circumstances a foot or so may be indistinguishable from infinitely long) there must be a return path somewhere if there is to be any current. However, if this is outside the more intense parts of the wire's magnetic field, it can be disregarded for purposes of calculating skin effect. But most often one is interested in r.f. resistance as it affects coils, transmission lines and other circuits that do not even roughly conform to the above description. Take a coil, for instance. The flux inside the wire forming any of the turns is caused not only by the current in that turn but also by the same current in other turns. So Figs. 3 and 4 do not hold good, and the explanation based on them falls down. But its conclusion does hold good if it is expressed more generally. What we really found was that when the frequency is high enough for the inductance to predominate over resistance in the impedance *the current tends to flow where it makes the inductance least*. If a straight wire, this is at the circumference of the cross-section; in short, the skin.

Fig. 6 shows a section through two adjacent wires carrying current in the same direction. Assuming their returns are relatively far away, the flux pattern will be somewhat as shown at (a). The parts of the wire linked with least flux are those farthest apart, so the greatest current density will be through them, as shown by the shading at (b). This modified distribution is sometimes given a separate name, *proximity effect*, but basically it is the same as skin effect. In a single-layer coil, the tendency is for the current to flow along the inside surfaces of the wire. Abacs for calculating r.f. resistance of coils are in *Radio Data Charts*.

Then there is the coaxial line. It is no surprise to learn that current through the inner conductor tends to flow at the outer surface, as in simple skin effect. But it may seem rather contradictory that the current through the outer conductor tends to keep to the *inner* surface. Yet it follows from the same sort of reasoning as we used for the isolated wire. If in Fig. 7 we work from the axis outwards, calculating the m.m.f. due to the zero-frequency current enclosed, and dividing by the length of the field path or "line of force," everything is as before until we reach the inside diameter of the outer conductor. Here we start to enclose a current flowing in the opposite direction, so the net m.m.f. decreases. By the time we reach the outside diameter we are enclosing no net current at all, because the currents in the inner and outer conductors are equal and opposite. So from here outward there is no magnetic field—which of course is one of the advantages of this type of cable. Looking at the possible current paths, we see that a path down the core of the inner conductor, and up the outer skin of the outer, links with all the flux there is, both in the space between the conductors and in the metal, so has maximum inductance. The path of *least* inductance, and therefore most popular with high-frequency current, is along the surfaces enclosing the space between the conductors.

The only metal having a lower resistivity than copper is silver, so where low r.f. resistance is worth the extra cost it is customary to silver-plate the surfaces where the current flows. But the resistivity of silver is only about 5 per cent lower, and it has been found* that plated surfaces are microscopically rough,

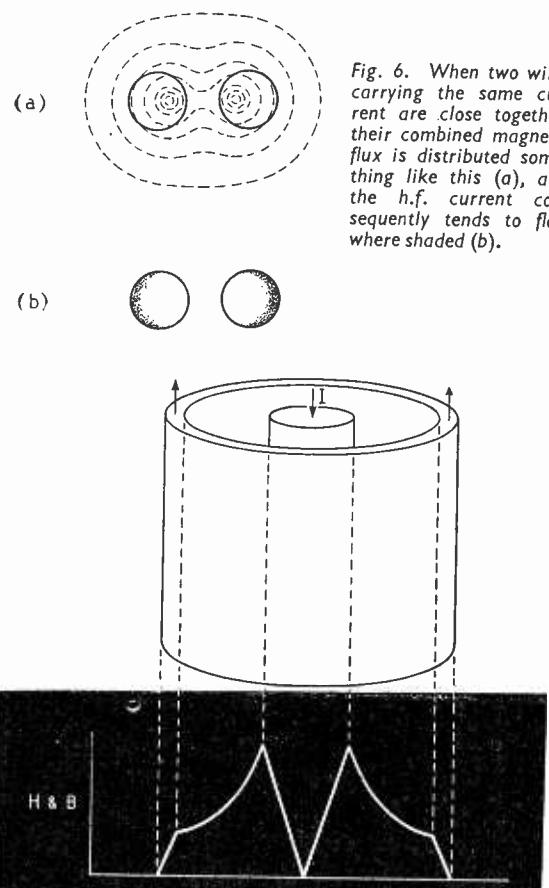


Fig. 7. This is Fig. 4 modified to apply to a coaxial line, where the external field is cancelled out by equal and opposite currents in the two conductors.

* "Attenuation and Surface Roughness of Electroplated Waveguides," F. A. Benson, Proc. I.E.E., Part III, July 1953, p. 213.

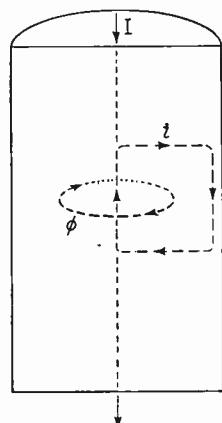


Fig. 8. In this wire, shown in section, the alternating flux (represented by the single line of force, ϕ) induces current around paths such as the square one marked. When all such paths are taken into account, the net result is skin effect.

and the extra distance the current has to go, up and down all these little hills, may more than swallow up the slight advantage.

For the sake of anyone who would like an alternative approach to simple skin effect, Fig. 8 shows a longitudinal section of our piece of wire with current flowing down it. Consider any closed path in a vertical plane inside the metal, such as the square one shown dotted. Provided that it is not exactly in the centre, such a conducting loop as linked with some flux, represented by the single coaxial line of force marked " ϕ ". As the current in the wire alternates, so does this flux, which therefore induces an alternating e.m.f. around the loop (and around all others like it), and because the loop conducts a current flows around it. According to Lenz's Law, the direction of current must be such as to oppose its cause; so inside the flux loop it must be opposite to the current that set up the flux, which means that nearer the surface of the wire it must be in the same direction as the current there (which was *not* responsible for the flux). In other words, the current near the axis of the wire is weakened, and the current near the surface is strengthened; in still fewer words —skin effect.

Some time ago, when discussing Energy (January 1952, to be precise) I mentioned that the electrical energy travelling along a resistanceless wire existed solely in the space around, in the form of electric and magnetic fields; it was only in so far as the wire has resistance that energy enters into the wire, there to turn to heat. In saying this I neglected the magnetic field inside the wire, but this was reasonable, for at most it is a small proportion of the whole, and, if a wire really could be devoid of resistance, skin effect would be full developed even at the lowest frequency and there would be no current or flux inside. Supposing now the wire *has* resistance, energy from the fields must enter it from the outside inwards, being dissipated as it goes. One would expect, therefore, the greatest dissipation to be at the surface, and (since energy must travel at a finite speed) the dissipation nearer the axis of the wire to be not only less intense but also delayed in time. This is exactly what we have already found: the current inside the wire being less, the I^2R loss is less than at the surface; and since the inductance is greater it lags in phase.

An interesting point is that when d.c. is switched on, the magnetic field around the circuit has to grow, so there is a transient skin effect as well as a transient inductive effect, and the current in the wire starts flowing in the skin first and spreads to the inner parts later, before finally becoming uniformly distributed.

The "strands" we have spoken about hitherto have been distinguished only by imaginary longitudinal boundaries in the solid wire. What if we were to make up the wire of a number of actual separately insulated strands? This idea would occur at once to anyone who viewed skin effect as a manifestation of eddy currents, as in Fig. 8, because the way to minimize eddy currents in iron cores is to break up the current paths by using insulated stampings. It might seem that the insulation of the strands would in the same way interrupt the eddy currents where they pass horizontally from axis to circumference. But in fact these currents do not exist anyway! The current path marked in Fig. 8 is by no means the only one; there is another above it, and its lower horizontal portion carries current equal and opposite to the upper portion of the first, so cancelling it out. And so on for other paths. The only places where the current can be regarded as flowing at right angles to the axis of the wire is at each end (where there must be a conducting path there if the strands are to be electrically in parallel!).

So stranding alone does not overcome skin effect. The way to do so is to arrange that equal flux links every strand. This can be done by organizing the strands so that each occupies inside and outside positions in the same proportion. Stranded wire so organized is known as litzendraht, or more commonly as litz, and by its use the r.f. resistance of coils of given dimensions can be considerably reduced. But not only is this wire itself much more expensive than solid, it must be handled carefully and connected with great care and trouble, for if there are short-circuits between some of the strands, or every strand is not soundly connected at the ends and unbroken throughout its length, the result falls considerably short of expectation. In fact, a badly made litz coil may be even worse than if the wire were solid. The higher the frequency, the more difficult it is to obtain the benefit of litz, for apart from defects of workmanship the capacitance between strands increasingly nullifies its purpose.

I.E.E. PREMIUMS

THE Kelvin Premium (£25) has been awarded by the I.E.E. to Dr. W. Culshaw (T.R.E.) for his paper on "A Spectrometer for Millimetre Wavelengths" which was read during the Symposium on Insulating Materials.

Many of the Radio Section awards are for papers read at last year's Convention on "The British Contribution to Television." The Duddell Premium (£20) went to D. C. Birkinshaw (B.B.C.) for his paper "Television Programme Origination: the Engineering Technique," and the Ambrose Fleming Premium (£10) to D. A. Wright (G.E.C.) for "A Survey of Present Knowledge of Thermionic Emitters."

Premiums valued at £10 have been awarded to the following for the papers quoted: H. Cafferata, C. Gillam and J. F. Ramsay (Marconi's), "Television Transmitting Aerials"; E. McP. Leyton, E. A. Nind and W. S. Percival (E.M.I.), "Low-Level Modulation Vision Transmitters, with special reference to the Kirk o'Shotts and Wenvoe Stations"; Prof. F. C. Williams and G. B. B. Chaplin (Manchester University), "A Method of Designing Transistor Trigger Circuits."

The following received £5 premiums: G. R. M. Garratt (Science Museum) and A. H. Mumford (Post Office), "The History of Television"; Dr. B. G. Pressey, G. E. Ashwell and C. S. Fowler (D.S.I.R.), "The Measurement of the Phase Velocity of Ground-Wave Propagation at Low Frequencies over a Land Path"; P. A. T. Bevan (B.B.C.), "Television Broadcasting Stations"; W. R. Piggott (D.S.I.R.), "The Reflec-

tion and Absorption of Radio Waves in the Ionosphere"; H. E. Holman and W. P. Lucas (E.M.I.), "A Continuous-Motion System for Televising Motion-Picture Films"; Dr. E. C. Cherry (Imperial College) and G. G. Gouriet (B.B.C.), "Some Possibilities for the Compression of Television Signals by Recoding"; Dr. A. J. Biggs (G.E.C.) and E. O. Holland (Pye), "The British Television Receiver"; L. C. Jesty (Marconi's), "Television as a Communication Problem"; Prof. H. E. M. Barlow, Dr. A. L. Cullen and A. E. Karbowiak (University College, London), "Surface Waves" and "An Investigation of the Characteristics of Cylindrical Surface Waves."

The premiums were awarded at the opening meeting of the session on October 8th.

BRIT.I.R.E. AWARDS

THE premier award of the British Institution of Radio Engineers—the Clerk Maxwell Premium (20 guineas)—has been given to Dr. Charles Süsskind of the Microwave Laboratory at Stanford University for his paper "Obstacle-Type Artificial Dielectrics for Microwaves."

I. A. Harris (M.o.S.) has received the Heinrich Hertz Premium (20 guineas) for his paper "A Systematic Method of Linear Small-Signal V.H.F. Analysis for Valve

Circuits." The Louis Sterling Premium (15 guineas) was made to Dr. R. T. Theile and H. A. McGhee (Pye) for their paper "The Application of Negative Feedback to Flying Spot Scanners." The award for the most outstanding contribution on aids to aircraft safety—the Brabazon Premium (15 guineas)—went to P. L. Stride (E. K. Cole) for his paper "Search Radar for Civil Aircraft."

The first award of the A. F. Bulgin Premium (15 guineas)—for a paper from a member of the Armed Services—was made to Lt.-Col. J. P. A. Martindale (formerly of the Royal Military College of Science) for his paper "Lens Aerials at Centrimetric Wavelengths." V. J. Cooper (Marconi's) received the Marconi Premium (10 guineas) for the paper "New Amplifier Techniques." The Leslie McMichael Premium (10 guineas) went to J. A. Hutton (Murphy) for his paper "The Focusing of Cathode Ray Tubes for Television Receivers." The Dr. Norman Partridge Memorial Award (5 guineas) was made to K. R. McLachlan and R. Yorke (University of Southampton) for their paper "Objective Testing of Pick-ups and Loudspeakers."

The awards were made at the annual general meeting on October 21st.

TECHNICAL TRAINING

THE central feature of the Technical Training Display at the Show, provided by a number of colleges under the ægis of the Radio Industry Council, was a map indicating the types of training available at educational establishments throughout the British Isles. This information, which was provided by the Ministry of Educa-

TRAINING

tion, is tabulated below. The initials against the name of the town or the college indicate the type of training provided: A, telecommunications engineering; B, servicing; C, Higher National Certificate with electronics or telecommunications; D, B.Sc. degree with electronics or telecommunications; and E, Higher N.C. in applied physics.

Angus	Dundee (A, B, C)	Fifeshire	Cowdenbeath T.C. (B)	Preston	(A, B, C, D, E)	Shropshire	Shrewsbury (A, B)
Bedfordshire	Bedford (A)	Glamorganshire	Cardiff (A, B, C, D)	Salford	(A, B, C, D, E)	Somerset	Bath (A, B)
Luton (C)	Rhondda T.I. (A)	Gloucestershire	Swansea (A, B, C, D)	Southport	(A)	Taunton (A, B)	
Berkshire	Treforest (A, B, E)	Leicestershire	Treforest (A, B, E)	Wigan	(A, B, C, D)	Staffordshire	Burton-on-Trent (A, B, C)
Maidenhead (B)	Gloucestershire	Leicester (B)	Bristol (A, B, C, D)	Deptford	(S.E. London T.C.)	Stafford (A)	Stoke-on-Trent (A, B)
Newbury (A)	Cheltenham (A, B)	Loughborough (B, C, D)	Cheltenham (A, B)	(A, B, C, E)		Walsall (B)	Wolverhampton (A, B, C, D)
Reading (A)	Cinderford (B)	Lincolnshire	Gloucester (A, B, C)	Finsbury	(Northampton P.)	Stirlingshire	Stirling High Sch. (A)
Buckinghamshire	Stroud (A)	Lincoln (A, B)	Stroud (A)	(A, C, D, E)		Suffolk	Lowestoft (A, B)
Bletchley (A)	Hampshire	London	Hampshire	Islington (Northern P.) (A, B)	Surrey	Croydon (A, B, C)	
High Wycombe (A)	Bournemouth (A, B, C, D)	Battersea P. (A, C, D)	Bournemouth (A, B, C, D)	Lambeth (Norwood T.C.) (A, B)	Richmond (B)	Richmond (B)	
Slough (A)	Portsmouth (A, B, C, D)	Deptford (S.E. London T.C.)	Portsmouth (A, B, C, D)	Paddington (B)	Wimbledon (A, B, C)	Wimbledon (A, B, C)	
Wolverton (A)	Southampton University College (A, B, C, D)	(A, B, C, E)	Southampton (Borough P.) (A, C)	Poplar (B)	Sussex	Brighton (A, B, C, D)	
Caernarvonshire		Hampshire	St. Marylebone (Regent St. P.) (A, B, C, D)	St. Marylebone (Regent St. P.) (A, B, C, D)	Hastings (B)	Hastings (B)	
Bangor (A)		Herefordshire	Southwark (Borough P.) (A, C)		Warwickshire	Birmingham (A, B, C, D, E)	
Cambridgeshire		Hatfield (A, B)	Woolwich P. (A, C, D)			Coventry (A, C, D)	
Cambridge (B, C)	Letchworth (A, B)	Kent				Leamington (A)	
Cheshire	Hereford (A, B)	Canterbury (A, B)				Rugby (A, C, D)	
Chester (A)	Dartford (A, B, C)	Dartford (A, B, C)					
Crewe (A, B)	Folkestone (A)	Dover (A)				Wiltshire	Chippenham (A, B)
Stockport (A, B, C)	Medway (A, B)	Hendon (C)					Salisbury (A, B)
Cornwall	Thanet (A)	Southall (B, C)					Swindon (A)
Camborne (A, B)	Tunbridge Wells (A)	Willesden (A, C)					
Falmouth (B)		Midlothian					
Cumberland		Edinburgh					
Carlisle (A, B)		Heriot-Watt (A, B, C, D)					
Whitehaven (A)		Leith T.C. (B)					
Denbighshire		Monmouthshire					
Wrexham (A, B, C, D)		Crumlin (C)					
Derbyshire		Newport (A)					
Chesterfield (A)		Norfolk					
Derby (A, B)		Gt. Yarmouth (A)					
Devon		Norwich (A)					
Barnstaple (A)		Northamptonshire					
Exeter (A, B, D)		Coutts (C)					
Plymouth (A, B, C)		Peterborough (A)					
Torquay (A, B)		Northumberland					
Dorset		Newcastle-on-Tyne (A, B, C, D)					
Weymouth (A, C)		Nottinghamshire					
Durham		Nottingham (A, C)					
Darlington (A)		Riversdale T.C. (A, B)					
South Shields (A, B)		Oxfordshire					
Stockton (B)		Manchester					
Sunderland (D, E)		Col. of Technology (C, D)					
West Hartlepool (A, B)		Openshaw T.C. (A, B)					
Essex		Old Swan T.I. (A)					
Chelmsford (C, D)		Riversdale T.C. (A, B)					
Dagenham (A, B, C)		Renfrewshire					
East Ham (C)		Col. of Technology (C, D)					
Southend (B, C)		Openshaw T.C. (A, B)					
Walthamstow (A, C)		Oldham (B)					
West Ham (A, B)		EIRE					
		Dublin (B)					
		NORTHERN IRELAND					
		Belfast (B)					

Abbreviations : P., Polytechnic; T.C., Technical College; T.I., Technical Institute.

TRANSISTORS

10.—*Analogue, "Field-Effect," and Tetrode Transistors : Junction Photocells*

By THOMAS RODDAM

In the first eight articles of this series the discussion related to the conventional transistors, the ones which are in production in America and elsewhere. Three types have been mentioned, the point type and the two polarities of junction transistor : in essence, as we have seen, these reduce to only two basic types, the point type with a current gain of more than unity and the junction type with a current gain of less than, though very close to, unity. A modified version of the junction transistor, the symmetrical unit, was mentioned in the ninth article. This month I want to describe some of the other members of the transistor family which have been constructed. Which of them will prove important is anyone's guess, but they serve to show the lines along which transistor development is proceeding.

The group of transistors to be described first is the general class of unipolar transistors. The most easily appreciated types of unipolar transistors are the analogue transistors, which are called by this name because they really are very analogous to ordinary triodes. Externally, it is true, the usual junction transistor is quite valve-like, but of course any fairly linear three-element system must be rather like some sort of triode. The analogue transistors are fundamentally like a valve. The description of these transistors follows closely that given by Shockley. To begin with, consider two electrodes in a vacuum—a vacuum capacitor, in fact. Assuming that a battery is connected to the two plates, there will be a potential difference between them, an electric field in the space between the plates, but no charge in the gap, because the emission is negligible. A very similar structure can be realized with semi-conductors by arranging an intrinsic semi-conductor, one which is absolutely pure, with a *p*-region at one end and an *n*-region at the other. Provided that the *n*-region is connected to the positive terminal of the battery and the *p*-region is connected to the negative terminal, very few carriers will enter the intrinsic region in the middle, and there will be a concentration of charge along the two boundaries. Of course, if the polarity is reversed the majority carriers in the two "doped" regions will flow into the middle.

In an ordinary valve the electric field is distributed

so that it tends to pull electrons out of the grid and cathode, and to catch them at the anode. This is obvious when the valve is cold, and when the cathode is hot the main change is that electrons come out from the cathode very easily, while the field at the cathode is reduced by space charge.

An analogue transistor can have the structure shown in Fig. 1, in which the "cathode" and "anode" are made of *n*-germanium, the "grid" of *p*-germanium, and the "vacuum" of pure germanium. At the "cathode" the electric field will tend to extract electrons, and these will form a space charge round the "cathode." As the "grid" is negative with respect to "cathode," the electrons will not flow into the "grid," and the "grid wires" will be surrounded by what Shockley calls depletion regions. As the "grid" potential is varied the number of electrons which slip through the gaps between "grid wires" will vary. The behaviour is thus very much the same as in an ordinary valve.

The analogy is not absolutely exact, of course. For one thing, the electrons do not flow in a stream, bouncing together like billiard balls and obeying the law of conservation of momentum. In consequence there may be no "grid" current even if the "grid" is positive with respect to "cathode," so long as the field at the "grid" is electron extracting.

The important distinction between the analogue transistor and the ordinary transistors lies in the fact that there is no emitter in the analogue transistor. In the junction transistor the controlled current and the controlling current both flow in the base region, so that input and output are mixed up together. In the point transistor, both holes and electrons are involved, and the injection of holes at the emitter is an essential feature of the operation. An electron-flow analogue transistor may have a small saturated flow of holes, just as the ordinary valve may have a small current due to ions, but the essential working depends on one kind of current carrier only.

For this reason the new kind of transistor is called a unipolar transistor to distinguish it from the bipolar transistor we have met previously.

There is a second variety of unipolar transistor, the field-effect transistor, which differs from the analogue

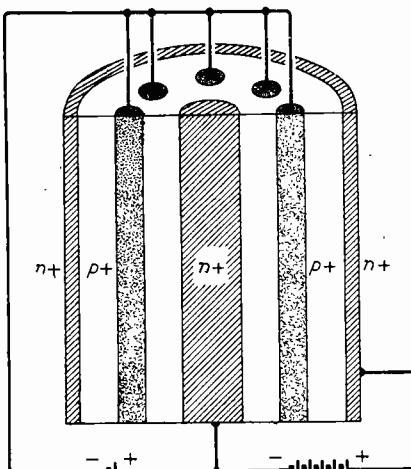


Fig. 1. Transistor analogue of a triode valve. The space between "electrodes" is pure (intrinsic) germanium.

transistor by having unbalanced chemical impurities in the "vacuum" region. But first we must introduce some terminology. It seems obvious that we should follow Shockley,¹ and this is what he says:

"Since the role of emitter is not played in the normal way in the unipolar transistor and since the collector also functions somewhat differently, it appears advantageous to introduce new terminology for the electrodes in the unipolar types. The choice proposed for the electrodes is as follows: *Source* for the electrode from which the carriers enter the region of relatively high electric fields; *drain* for the electrode at which they arrive and out of which they flow; in the analogue transistor the control electrode will be called the *grid* because of its close analogy with vacuum-tube structures. In the field-effect transistor it is proposed to call the control electrode the *gate*. The fact that gate and grid have the same initial letter leads to the use of a common subscript for these two similarly functioning electrodes. The choice of these names has been based partly on an attempt to find names which describe functions and partly on the value of the names from a phonetic and abbreviational point of view. It should be noted that none of the new subscripts are the same as those encountered in bipolar transistors. Furthermore, it may be noted that the names selected are all monosyllabic."

The typical structure of the unipolar field effect transistor is shown in Fig. 2(a). It is a triode, and is constructed from a sandwich of *p*-material between two layers of *n*-material, the latter being heavily doped so that it can be described as *n* + material. The

actual "space current" is carried by holes moving from left to right, and the current electrodes are made up of heavily doped *p*-material (*p*+) shown as 1 and 2. The *p-n* junctions are biased back, since both 1 and 2 are negative with respect to the earthed *n* + plates 3. Space charge regions near the *n* plates are formed, and in these regions there are very few carriers. All the carriers flow through the central channel.

The width of the channel is, of course, a function of the relative bias on the gate electrodes. If 2 is more negative than 1, the bias will be greater near 2 so that the channel will be narrower at the right-hand end than at the left. The approximate theory shows that if this effect is sufficiently pronounced the channel will be closed completely. In more detailed analysis we find there is a point known as the *extrapolated pinch-off point* or *expop*. The distribution of space charge is shown in Fig. (2)b, and the actual shapes and sizes of some experimental units in Fig. 2(c).

Quite obviously the hole current in the channel can be controlled by varying the potential of the gate. Analysis and computation lead to the conclusion that gain can be obtained at frequencies as high as 10 Mc/s in a device which has all the predictability of the junction class of transistors. This is of very great importance, because the point transistors still seem to present considerable difficulty to the manufacturers.

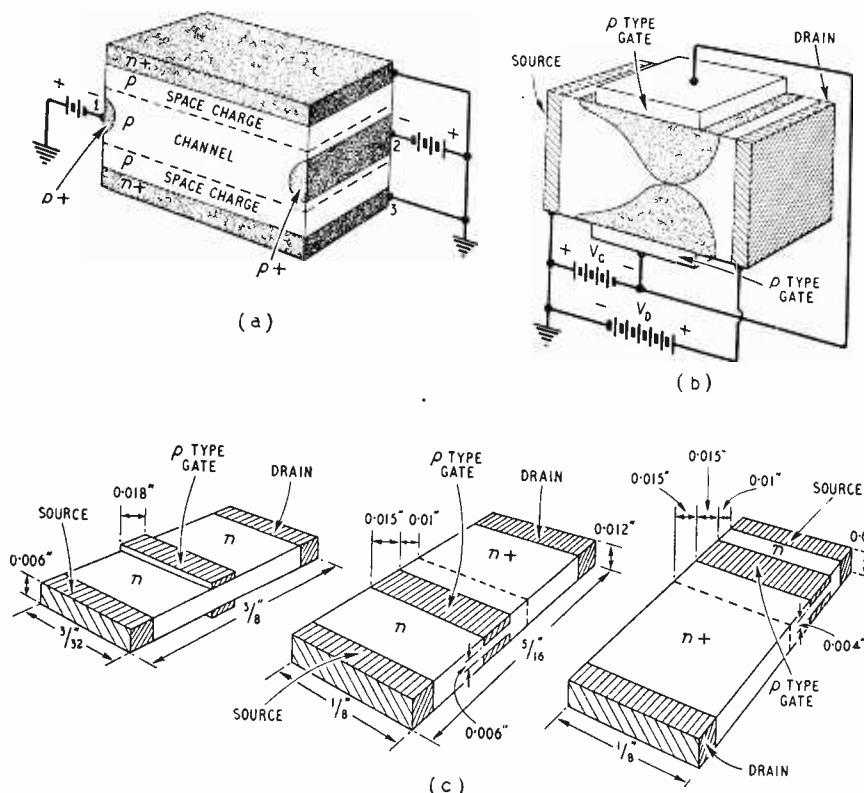
The actual experimental units had mutual conductances up to 0.3 mA/volt and flat responses up to 3 Mc/s. Important among their properties are high input and output impedances. Unfortunately the noise figure is high, and under particular conditions one unit had a noise figure of 68 db. Dacey and Ross² state that using 17 ohm-cm germanium it should be

possible to get a mutual conductance of 24 mA/V and an upper frequency limit of 140 Mc/s.

Another field controlled device is the junction "fieldistor" described by Stuetzer.³ This is shown schematically in Fig. 3. The *p-n* junction is biased in the non-conducting direction and a control electrode is mounted very close to the surface. As a biasing potential is applied to the control electrode, there is a surface effect at the germanium junction, and the back resistance varies. In this form the mutual conductance is only a few microamps per volt.

By adding a liquid of high polar moment in the

¹ Proc. I.R.E., Vol. 40, p. 1313, Nov. 1952.



² Proc. I.R.E., Vol. 41, p. 970, August 1953.
³ Proc. I.R.E., Vol. 40, p. 1377, Nov. 1952.

Fig. 2. (a) Structure of a unipolar field-effect transistor triode. (b) Distribution of space charge. (c) Dimensions of some experimental field-effect transistors.

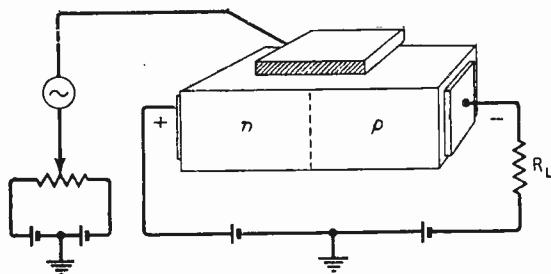


Fig. 3. In the "fieldistor" a liquid polar dielectric between control electrode and junction increases mutual conductance.

Right: Fig. 4. p-n-p-n junction transistor and its equivalent circuit.

space between electrode and germanium the device is completely transformed. The mutual conductance changes sign and becomes fairly large, the output impedance drops, and the frequency response, which without the liquid extends up to some hundreds of kilocycles per second, starts to droop at audio frequencies. A mutual conductance of some millamps per volt, already well down at 1000 c/s, can be produced.

This device seems to be one which has not much future. A study of its mode of action shows that it is a surface device, not a volume device, and it has one value. It shows why we must be careful in choosing the material if we want to embed a diode in wax. Polar waxes would be fatal.

The next type to be considered is the *p-n-p-n* junction transistor. Schematically this is shown in Fig. 4, and according to the early terminology this is a *p-n-p* transistor with a "hook" collector on the right. The effect of the hook collector is to increase the current gain, and as a result values of α of the order of 50 can be obtained. As we have seen earlier, in an ordinary junction transistor the value of α does not exceed unity.

The mechanism of operation of this type of transistor is, perhaps, too complicated for this series. It is, however, possible to carry out experiments connected with this type of transistor, since it can be simulated by connecting an *n-p-n* transistor and a *p-n-p* transistor together in the way shown in Fig. 5. Notice that the terminal on the right is marked ϵ_2 and is an emitter, not a collector. Used as an earthed-base hook collector transistor B is left disconnected and the equivalent circuit takes the form shown in Fig. 6. The value of α can be reduced by connecting a resistance between B and ϵ_2 . In an even more complicated arrangement a diode is connected here, and by building out r_{ϵ_2} with 22 ohms and using a *p-n*-diode between B and ϵ_2 an almost constant value of α over a range of 0.01 to 1.0 mA of I_{ϵ_1} has been obtained. The α was just under 3.

These *p-n-p-n* transistors are likely to be very hard to produce. It is anyone's guess whether other forms will be found to do the job before the production difficulties are solved.

A four-electrode junction transistor of another kind is the one described by Wallace, Schimpf and Dickten.⁴ This is a normal *n-p-n* transistor with an additional

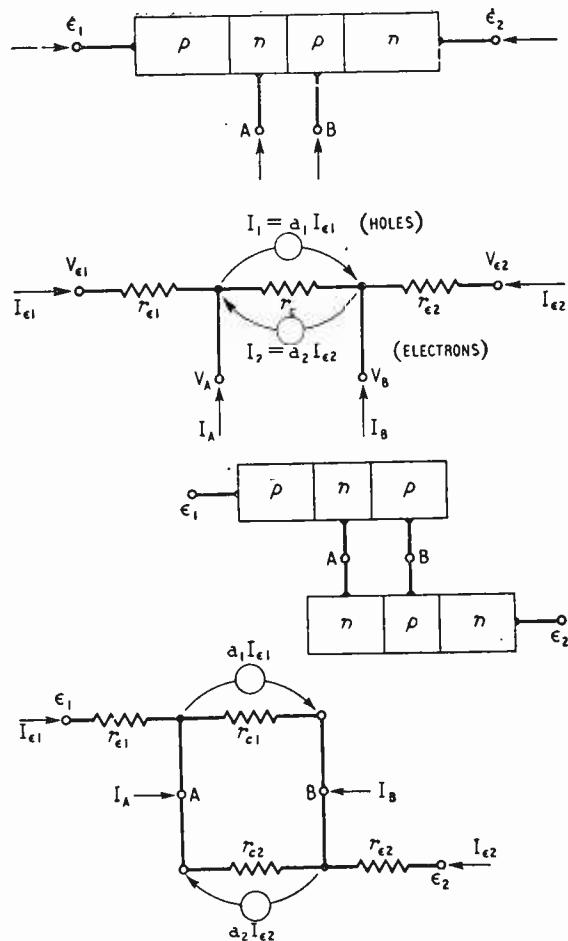


Fig. 5. Combination of p-n-p and n-p-n junction transistors.

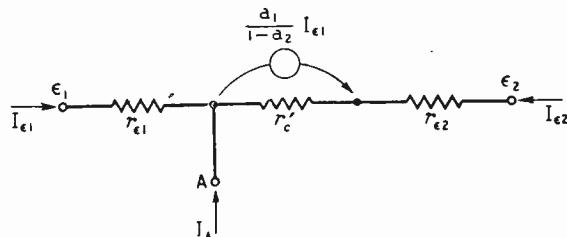


Fig. 6. Equivalent circuit of a "hook" collector transistor.

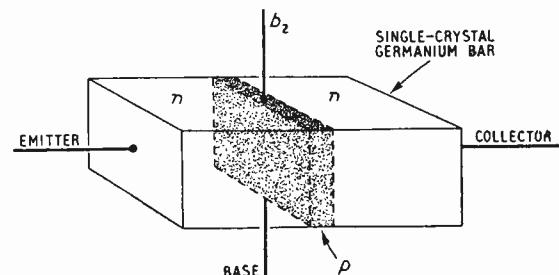


Fig. 7. Tetrode transistor with fourth connection b_2 .

⁴ Proc. I.R.E. Vol. 40, p. 1395, Nov. 1952.

connection made to the *p*-layer. The advantage of this type is its excellent high-frequency response. Even the first few experimental models oscillated at frequencies up to 130 Mc/s. A video amplifier with a gain of 22 db up to 5 Mc/s and a 15 db amplifier with a 9-Mc/s bandwidth centred on 32 Mc/s are examples of its first use. The structure of this tetrode is shown in Fig. 7. The actual thickness of the *p*-layer is rather thinner than in the ordinary *n-p-n* transistors : this helps to keep the cut-off frequency of α high. Another factor favouring high-frequency performance is the use of a smaller collector area, and in the units described this was only about 10^{-4} sq in.

The fourth electrode, b_2 , is fed with a bias current which corresponds to a negative potential at b_2 of about -6 volts. As the emitter is at about -0.1 volt with respect to base, the top of the emitter junction is biased negatively and does not emit electrons into the *p* layer. Only near the base electrode will there be any emission : excluding all other currents the bottom 1/60th will have a *p*-layer positive with respect to the *n*-layer of the emitter contact. This could be achieved equally by cutting away the top 59/60ths of the bar, but this would actually mean making a bar only 1/6000 inch thick. With this very low effective thickness the base resistance will clearly be very low, and measurements show that a very practical value of $I_{b_2} = 2$ mA, results in a reduction of base resistance to 40 ohms from an initial value of 1100 ohms for $I_{b_2} = 0$.

Unfortunately, at the same time as r_b is reduced, α is reduced, and in one example given α falls from

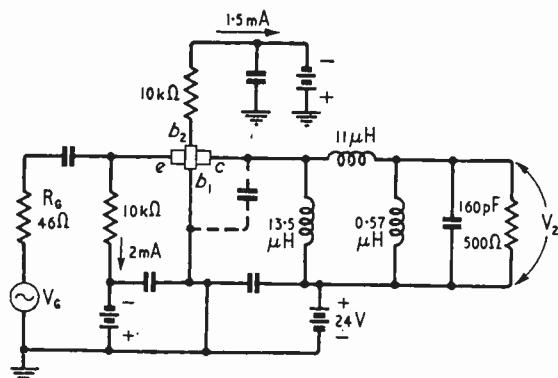


Fig. 8. Typical bandpass amplifier stage using the transistor tetrode.

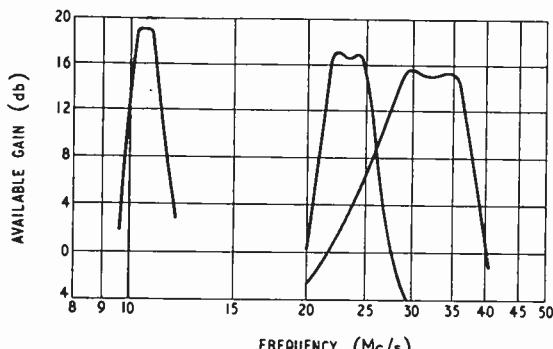


Fig. 9. Response curves of tetrode transistor amplifiers.

0.99 to 0.75. The frequency characteristic of α tends to flatten out a little, although the roll-off point is much the same. For these junction tetrodes α is about 3 db down at 15-20 Mc/s.

It is shown by Wallace, Schimpf and Dickten that the gain of an earthed-base transistor amplifier will be 3 db down at a frequency given by

$$\frac{f}{fc\alpha} = 1 - \frac{\alpha_0 r_b}{r_e + r_b + R_g}$$

where $fc\alpha$ is the frequency of cut-off of α and R_g is the internal resistance of the input generator.

When $r_b = 0$ the response is 3 db down at $fc\alpha$, which in this case is 15-20 Mc/s. For an example discussed in their paper, the gain with the fourth electrode inoperative is 3 db down at $f = 0.055 fc\alpha$, or about 1 Mc/s, while with the bias current flowing into the fourth electrode the gain is 3 db down at $f = 0.603 fc\alpha$. This is up in the region of 10-12 Mc/s. Gains of the order of 20 db are obtained under these conditions : a gain of 20 db, flat up to 10 Mc/s, with resistive terminations is a very useful thing for any video amplifier designer.

The television designer is interested in getting his gain in bandpass amplifiers. A circuit using the junction tetrode is shown in Fig. 8 : this gives 15 db gain over a 9-Mc/s band centred at 32 Mc/s, and the response curve is shown on the right-hand side of Fig. 9. The other two curves are the responses of amplifiers of the same basic type, but designed for narrower bandwidths and lower frequencies.

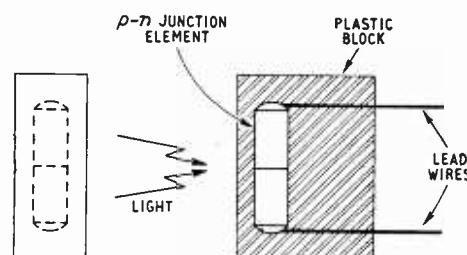
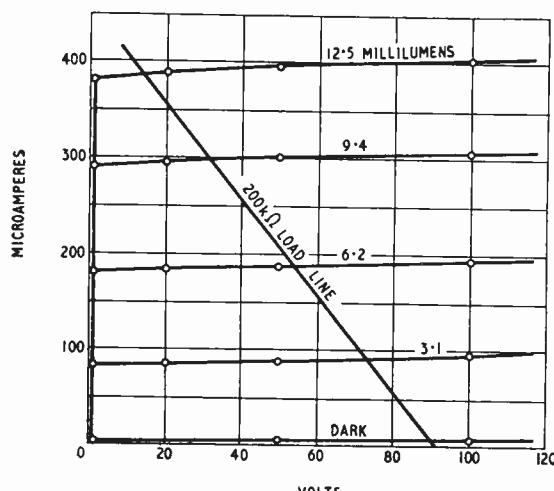


Fig. 10. Construction of a junction photocell.

Below : Fig. 11. Characteristics of the M-1740 junction photocell (average of ten).



In an oscillator, one transistor of this type gave an output of 0.25 mW at 100 Mc/s.

Another tetrode, quite different from this modified junction triode, is the new Sylvania point-contact tetrode, type 3N21. This is a point-type transistor with twin emitters and a single collector, the purpose of which has not been revealed. A transistor of this kind was made experimentally elsewhere some years ago, and could be used as a push-pull detector with gain, analogous to two triodes with the grids connected in push-pull and the anodes connected in parallel. Sylvania are promising a pentode, which will be provided with three emitters, and a common collector.

The general family of transistors must, I think, be considered to include the junction diodes, of which the *p-n* junction photocell is certainly entitled to be called a transistor. Fig. 10 shows diagrammatically the form of the Bell, M-1740 junction photocell, while Fig. 11 shows its characteristics. The photocell can be regarded as the base and collector of an *n-p-n* transistor, and it is connected with the *n*-electrode, the collector, positive with respect to the *p*-electrode, the base. When a light shines on the junction, hole-electron pairs are generated and these produce the "transistor conduction" effect at the rectifying barrier. This type of photocell is, of course, very small, and its other advantages are low dark current

at room temperature, high speed of response, high sensitivity and low noise. At the recent Radio Exhibition a photo-transistor (Type P50A, made by Standard Telephones) was shown operating an ordinary P.O.3000 type relay. The maximum operating current of this particular type of cell was 2.5 mA and the maximum operating frequency 50 kc/s.

The junction technique has also been applied to power rectifiers, and two types are now appearing in this country. The great feature of these rectifiers is that the drop in the forward direction is very small, about 0.5–0.7 volt, although they will give an output current of up to 500 mA at up to 100 volts. The home-produced variety has not yet reached these ratings, but the smaller type, with a maximum input of 100 V RMS and a d.c. output current of 30 mA, weighs only 0.0017 ounce (0.75 gm).

By the time this article appears there may be some more new types of transistor, as well as those I have overlooked.

"A slow sort of country!" said the Queen. "Now, here, you see, it takes all the running *you* can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!"

That is just what you would expect, since the transistor is a valve, through the looking glass.

NEW AIRFIELD RADAR EQUIPMENT

A COMPACT, mobile and easily operated surveillance radar giving a medium-range coverage for a small airport or Service airfield has been developed by Decca. Known as the Type 424, it employs much of the circuitry and technique which has been developed for their marine radar equipment and it is claimed that by utilizing some of the existing and well-tried practices a considerable saving is effected in the price of the apparatus. This new radar gear, while giving most of the facilities offered by a full-scale G.C.A. (Ground Controlled Approach) equipment, costs only £5,000.

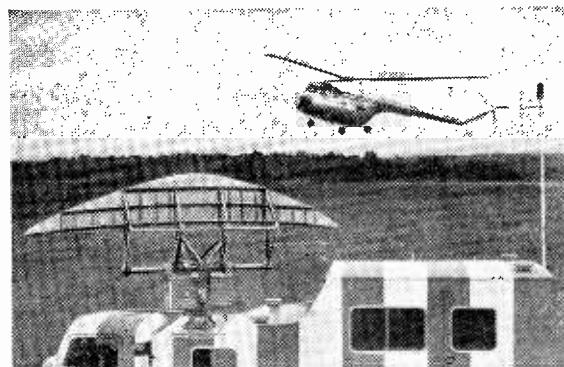
Its initial function is a Service one and it was conceived primarily for speeding up the landing of modern jet fighter aircraft which, owing to the very high fuel consumption, especially at low altitudes, must be brought down on to the airfield with the least possible delay.

Recent experience with the equipment has shown that it has definite applications in civil aviation and a complete set has, in fact, been ordered for use at one of the municipal airports in the north of England.

The Type 424 can be supplied in mobile, static or air-transportable forms, the latter being of particular interest to military air forces. It comprises the following basic units:

Scanner:—The parabolic cylinder-type scanner measures 14 ft across and gives a beam-width of 0.750 deg in the horizontal plane and 3.80 deg in the vertical. The scanner rotates at 24 r.p.m. and provision is made to tilt it between -2 deg and +20 deg to meet operational requirements.

Radio-frequency Head:—Immediately below and rotating with the scanner is a radio-frequency head containing a pulsed magnetron generator giving an r.f. output to the scanner on 9,375 Mc/s (3.2 cm). A



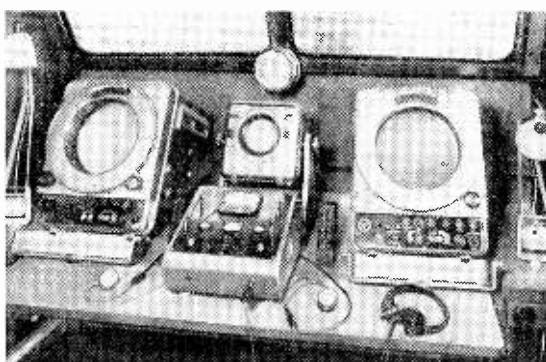
Horn-fed scanner and radar head of the Decca airfield radar forming part of a mobile control unit. A helicopter "talked-down" and about to land is seen in the background.

peak pulse output of 30 kW is available with two pulse lengths of 0.1 μ sec and 0.5 μ sec respectively. Contained also in the radar head are the detector and early stages of the receiver.

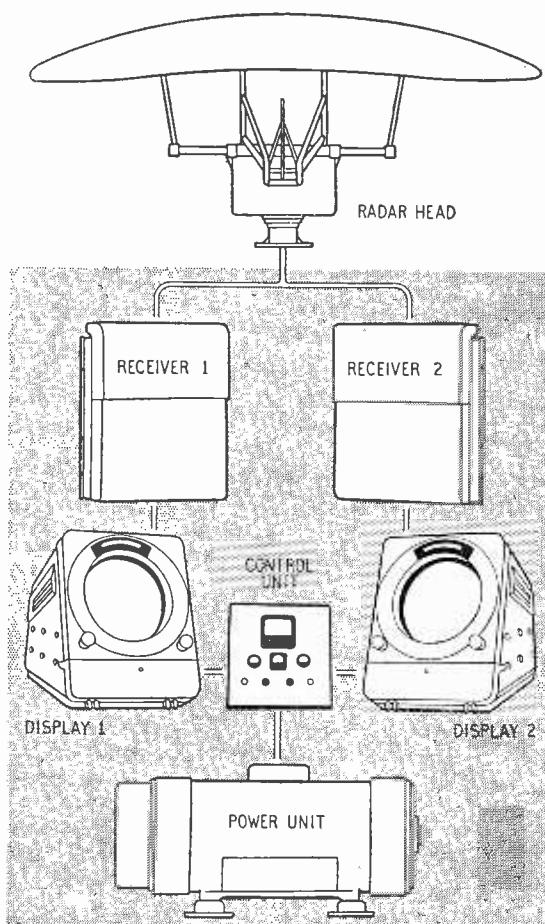
Receivers:—The output from the radar head is split and fed to two identical and independent receivers and these in turn feed two independent PPI (Plan Position Indicator) display units fitted with 12-in c.r. tubes. For normal operation one display unit would be used for marshalling aircraft from the limit of range of the equipment (20 to 25 miles) into 5 miles or so and the second display unit would take over the actual runway approach and landing control. Instructions to pilots are given over the normal v.h.f. radio-telephone equipment. Two controllers, one

handling the approach and marshalling and the other the actual landing, can thus be employed.

Each display unit has range adjustments for coverages of 0.5, 1.0, 2.5, 5.0, 10 and 25 miles radius with the radial scanning trace based on the centre of the tube.



Layout of the controller's position showing two airfield display units, miniature CRDF display, control box and v.h.f. radio telephone control units.



Schematic layout of the various units comprising the Decca airfield radar Type 424.

An illuminated marker line can be projected directly on to the c.r. tube showing the approach path for the airfield runway in use and on this line are projected range markers. This is said to obviate any likelihood of parallax error in positioning an aircraft on the approach line, such as might arise when the runway approach path and other airport features are displayed on the glass screen of the PPI unit.

Control Unit:—This is situated normally between and slightly to the rear of the two display units and carries all the controls including a remote indicator for tilt angle of the scanner.

Additional equipment developed for use with this radar is a miniature CRDF (Cathode Ray Direction Finder) display unit which operates in conjunction with the Standard Telephones v.h.f. D/F equipment and is intended for identifying the aircraft seen on the Decca display units.

Identification is, however, quite possible without this extra aid by adopting the familiar controller's technique of instructing each aircraft it is required to identify to embark on a particular manoeuvre, usually an abrupt change in course for a short distance.

Power Supply:—The equipment operates at 80 volts, 1,000 c/s from a rotary converter; consumption is about 4.5 kW.

During the course of a demonstration aircraft were picked up unmistakably at the maximum range of 25 miles, the characteristic bright "hyphen" on the PPI tube being of excellent definition. Its flight path under v.h.f. radio control was clearly followed, the speed of scanning (20 r.p.m.) keeping the response well illuminated right up to the touch-down point.

In bad visibility this radar can quite obviously be used to bring aircraft safely in to the airfield and exactly on to the end of the runway without any additional navigation aids.

INTERNATIONAL STANDARDS

A BRIEF summary of the results achieved by the various technical committees of the International Electrotechnical Commission during the meetings in Yugoslavia in July has been issued by the British Standards Institution. About three hundred delegates, representing seventeen countries, participated; the largest delegation being from the United Kingdom —43 in all.

A document on the procedure for applying basic climatic and mechanical robustness tests to radio components was approved for publication. A colour code for ceramic capacitors and a specification for fixed paper capacitors were passed for circulation to the National Committees for approval. Agreement was also reached regarding a group specification for ceramic capacitors and for carbon resistors which will be used in the drafting of detailed specifications.

The Committee on Insulating Materials has been considering the standardization of methods of test for specific properties, and at the recent meeting it reviewed in detail the tests for tracking, volume and surface resistivity, and heat resistance.

As the result of comments on a specification for valve bases, a number of additions and modifications to the text were made at the meeting and a revised draft will be circulated. The dimensions of sub-miniature valves were also discussed and a draft specification is to be prepared.

Neon Tube Measuring Device

Applications as a Microammeter and High-resistance Voltmeter

By H. E. STYLES, B.Sc.

THE neon gas discharge tube has become well established as a device for providing stabilized d.c. voltages, but little attention seems to have been given hitherto to the application of such tubes to the detection and measurement of minute electric currents. In a recent article¹ the author showed how measurement of high resistances may be effected by means of a neon tube shunted with a capacitance, and this application provides a good illustration of the fact that such discharge tubes can be employed for detecting and assessing the magnitude of extremely small currents.

Experience with the instrument described in that article has shown that the circuit of Fig. 1 produces in the telephone receiver a very clearly audible click every five seconds or so. As the mean potential of the capacitance in this circuit approximates to 100 volts, it follows that the average current passed by the resistance must have a magnitude of the order of only 0.01 microampere.

Despite the smallness of this current the device not only renders it readily detectable by ear but does so in a manner which enables quantitative measurements to be made. Furthermore, a current of 0.01 microampere by no means represents the limit of sensitivity obtainable as not only can a lower discharge frequency correspond to a lower mean current but, given a sensitive telephone receiver, the shunt capacitance may be reduced considerably without rendering the discharge pulses inaudible.

It is evident, therefore, that this simple circuit provides an extraordinarily sensitive device for the detection and measurement of electric currents. If, however, the utmost sensitivity is not required, an even simpler circuit may be employed, as, with pulses of sufficient magnitude, a telephone receiver is un-

¹"Inexpensive Megohmmeter," *Wireless World*, Oct., 1953, p.484.

necessary; the flash of the discharge can be clearly seen.

Elimination of the telephone receiver not only represents a simplification, but may be regarded as highly desirable if measurements are being made in very high voltage circuits. It has been found that a CV188 tube shunted with a capacitance of $0.01\mu F$ produces flashes which can be seen with reasonable facility, but for most purposes a shunt capacitance of $0.1\mu F$ is better.

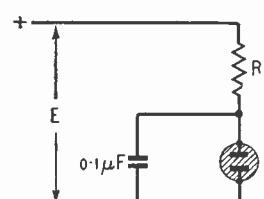
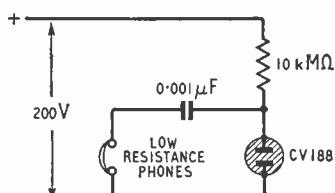
With such a capacitance the neon discharge is sufficiently intense to be easily visible in daylight whilst the capacitance is small enough to permit measurement of currents well below one microampere. For higher currents, of course, a larger value of capacitance may be required.

The mechanism whereby the neon oscillator circuit is able to render minute currents detectable is, of course, quite simple. The circuit merely integrates the more or less steady current flowing through the resistance over an appropriate period of time and subsequently releases the stored energy in precisely regulated pulses of sufficient magnitude to render them evident to the sense of hearing or sight according to the method of detection adopted, the former providing the greater sensitivity.

There are certain limitations to this method of current measurement consequent upon the fact that sufficient electromotive force must be available to raise the potential of the shunt capacitance above the striking potential of the discharge tube. The device is thus restricted to circuits associated with relatively high voltages and resistances, but within these limitations it can prove very useful.

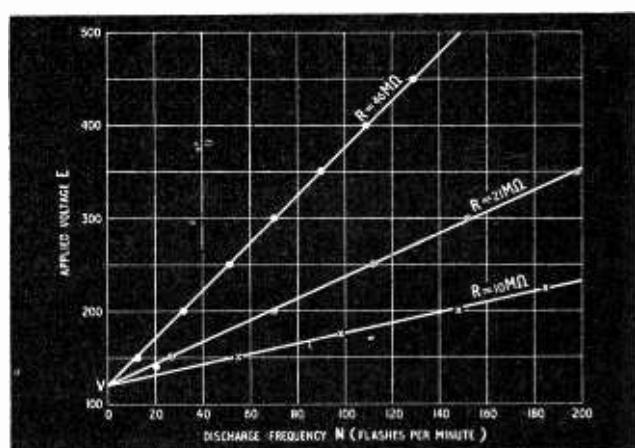
Experimental Investigations.—Experiments to assess the potentialities of a neon oscillator as a current measuring device were made with the circuit of Fig. 2,

Fig. 1. Circuit giving audible response for current of $0.01\mu A$.



Left : Fig. 2. Flashing oscillator used for experimental investigations.

Right : Fig. 3. Experimental results with circuit of Fig. 2.



the behaviour of which was observed over a range of applied voltages with various values of resistance R . The observed data are presented graphically in Fig. 3 from which the following conclusions may be drawn.

(a) For any particular value of series resistance R , the relationship between applied voltage E and discharge frequency N is linear, as would be expected on theoretical grounds.

The relationship may thus be expressed in the form

$$E = AN + V \text{ where } A \text{ and } V \text{ are constants.}$$

(b) For all values of series resistance the lines pass through a single point on the axis of zero discharge frequency. Hence V in the foregoing equation must be of fixed value whatever resistance is employed. The value of V is evidently numerically equal to the mean potential assumed by the shunt capacitance during the charge and discharge cycle and lies somewhere between the striking and extinction potentials of the particular neon tube employed.

(c) It follows from (b) that the difference $E-V$ corresponds to the mean voltage across resistance R . Hence the mean current flowing through the resistance

must be given by the expression $\frac{E-V}{R}$. Since

$E-V = AN$, it follows that if I be the current flowing through the resistance, then

$$I = \frac{AN}{R}$$

(d) Provided that there is no significant leakage across the capacitance, and/or the neon tube when the latter is not in its conducting condition, it is obvious that the whole quantity of electricity passing as a current through R must correspondingly pass in the form of pulses through the neon tube. The magnitude of these pulses, however, is maintained constant at a value dependent solely upon the size of the shunt capacitance and the characteristics of the neon tube. Hence the frequency at which the discharge pulses occur must be directly proportional to the magnitude of the mean current flowing through the resistance.

This implies that the ratio $\frac{A}{R}$ should itself be a constant

and that this is in fact the case is shown by the experimentally derived data :—

Value of R Megohms	Value of A	Value of $\frac{A}{R}$
10	0.56	0.056
21	1.17	0.056
46	2.55	0.055

This fresh constant $\frac{A}{R}$, which may conveniently be

termed K , is numerically equal to the mean current corresponding to a discharge frequency of one per minute and, in the case of the circuit experimentally investigated, had a value of 0.056 microampere. With lower values of shunt capacitance a correspondingly lower value of K would be obtained and *vice versa*. Strict proportionality between the values of shunt capacitance and K may conceivably not be obtained as it is possible that the striking and extinction characteristics of the neon tube may be slightly influenced by the intensity of the discharge pulses. This point has so far not been investigated but is regarded as of no great importance as empirical

calibration must of necessity be employed owing to the inherent variance of individual discharge tube characteristics.

(e) From what has already been said it is evident that the relationship between applied voltage and discharge frequency can now be expressed as follows

$$E = KRN + V$$

where K is a constant depending upon the value of shunt capacitance employed.

For a fixed value of E it follows that if N_1 and N_2 are the discharge frequencies obtained with resistances R_1 and R_2 then $KR_1N_1 = KR_2N_2$

Hence $\frac{R_1}{R_2} = \frac{N_2}{N_1}$ which is the relationship upon

which the design of the megohmmeter described in the article referred to previously was based.

Alternatively, since A , the slope of the voltage-frequency line, equals KR , it is evident that the ratio of the slopes of lines obtained with different resistances will be the same as the ratio of the resistance values themselves. If one of the latter is known the other can be derived from the slope ratios.

(f) If frequencies N_1 and N_2 correspond to two voltages E_1 and E_2 with a fixed value of resistance R and a particular shunt capacitance then

$$E_1 = KRN_1 - V \text{ and } E_2 = KRN_2 - V$$

$$\text{Hence } E_1 - E_2 = KR(N_1 - N_2)$$

$$\text{or } K = \frac{E_1 - E_2}{R(N_1 - N_2)}$$

Thus if R is of known value the value of K can be determined without having to take an elaborate series of measurements. For a shunt capacitance of $0.1\mu F$ a resistance value of about 20 megohms is convenient for determining discharge frequencies at 200 and 300 volts.

(g) One final conclusion can be drawn from Fig. 3 which, though having no great bearing upon the immediate problem, is nevertheless worth noting. It has already been mentioned that the mean potential V across the shunt capacitance must be less than the striking potential of the neon tube. In practice, therefore, it is not physically possible to obtain discharge frequencies corresponding to applied voltages lying between V and the striking potential (about 140V). A glance at Fig. 3 will quickly show that this frequency gap is greater the lower the value of the series resistance so that if, for any purpose, it be desired to generate a very low frequency discharge, a very high value of series resistance must be employed. The desired result cannot be obtained by using a lower applied voltage in conjunction with a lower value of series resistance though this is possible at frequencies of higher order.

Practical Applications. Having established the foregoing essential facts concerning the behaviour of neon oscillator circuits it becomes possible to consider the practical applications of the device. These would seem to be as follows :—

(1) *Measurement of High Resistances.* One method has already been described in reference (1); this possesses the advantage of requiring no measuring instruments of normal type and may still be regarded as the best method of using a neon oscillator for resistance measurement. It is evident that, since the neon oscillator can be made to serve as an extremely sensitive microammeter, such an oscillator, once calibrated, could be employed in conjunction with a

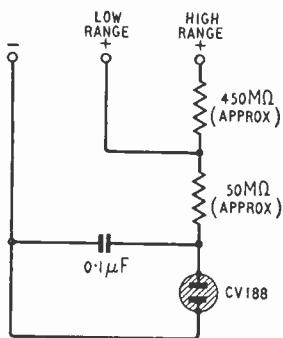
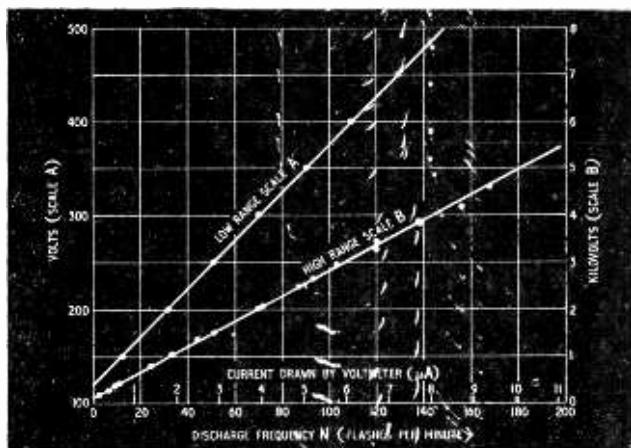


Fig. 4. Two-range neon voltmeter with maximum current of $10 \mu\text{A}$

Right : Fig. 5. Voltmeter calibration curves



voltmeter (neon or otherwise) for resistance measurement. In such case, in order to eliminate the possibly unknown effect of the potential drop across the shunt capacitance of the neon microammeter, resistance determination should be based upon the difference in current produced by a known change in applied voltage.

(2) *Measurement of High Voltages.* In radio and television work a need frequently arises for a means of measuring the voltage in circuits of high impedance or of sources of limited power output, e.g., r.f. oscillator e.h.t. generators. For such purposes it normally proves necessary to employ either extremely sensitive moving-coil meters or some form of valve voltmeter, though electrostatic instruments can be used for voltages in the kilovolt range.

All such instruments suffer from one or more of the drawbacks of high cost, delicacy and relative complexity, but the circumstances under consideration are precisely those for which it has been shown that the neon circuit is pre-eminently suited. Fig. 4 shows the circuit of a two-range neon voltmeter and it is difficult to imagine a cheaper, simpler or more robust instrument.

Experimentally determined calibration curves for this instrument are given in Fig. 5, from which it will be seen that the linear relationship between applied voltage and discharge frequency is well maintained with series resistances of the order of 500 megohms. The instrument covers voltage ranges of 150 to 500 and 150 to 5,000 with a maximum current of about 10 microamperes in both ranges. This corresponds to some 100,000 ohms per volt which far exceeds the figure obtainable with straightforward moving-coil meters and is likely to be adequate for most purposes. If necessary, however, the sensitivity could be greatly improved by reduction of the shunt capacitance, but this introduces some difficulty in obtaining the extremely high values of series resistance which must then be employed.

An upward extension of the voltage range can be obtained either by increasing the series resistance or by increasing the shunt capacitance, though the latter will involve an increase in the "full scale" current. It should, perhaps, be noted that for high-voltage work the series resistance should comprise a chain of resistors of lower resistance value in order to restrict the voltage drop across individual components. The author uses twenty such resistors, each of approxi-

mately 25 MΩ; high-stability components should be employed if possible. The shunt capacitor has only to withstand the striking potential of the neon tube, but must possess the highest possible leakage resistance to avoid error from voltage drop.

The high-voltage calibration points shown in Fig. 5 were obtained by means of a 2,000 ohms per volt moving-coil meter used in conjunction with an r.f. oscillator e.h.t. supply, and it is of interest to note that removal of the moving-coil voltmeter load resulted in an increase from 4,600 to 5,300 volts at the maximum setting of the oscillator. Deviations of individual calibration points from the straight line in Fig. 5 can be attributed to difficulties encountered in maintaining an entirely steady output from the e.h.t. supply.

(3) *Measurement of Leakage Currents at High Voltages.*

As a microammeter, the neon oscillator becomes inoperative at voltages below about 140 and this precludes its use for a number of purposes for which microammeters are needed. No such drawback applies in testing high-voltage television components, etc., for leakage at working potentials and for work of this character the neon oscillator has definite advantages apart from its great sensitivity.

The author employs an r.f. oscillator as a source of adjustable e.h.t. for tests of the kind in question and originally employed a moving-coil microammeter for measuring leakage currents. It was thought that the limited output available from the e.h.t. generator would automatically protect the meter from damage in the event of a breakdown in the insulation of a component undergoing test, but this proved to be a costly miscalculation. It was observed that when such breakdown occurred a spark discharge sometimes took place within the meter despite its low coil resistance and the fact that it was "earthing" on one side. This was attributed to the inductance of the coil offering a high reactance to the current surges produced by insulation breakdown, but the destructive nature of the spark discharge was not appreciated until eventually the coil became open-circuited. This unhappy experience has convinced the author that moving-coil meters are quite definitely unsuitable for high-voltage leakage tests, whereas the neon oscillator is able to withstand breakdown surges without damage.

The circuit of Fig. 6 indicates how a single neon

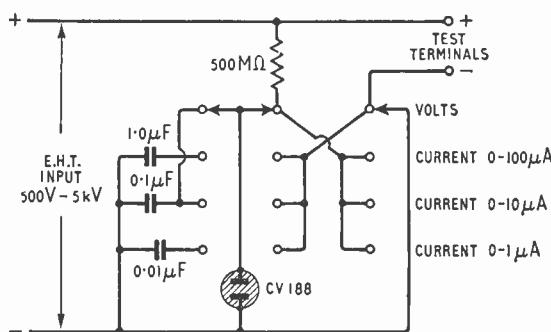
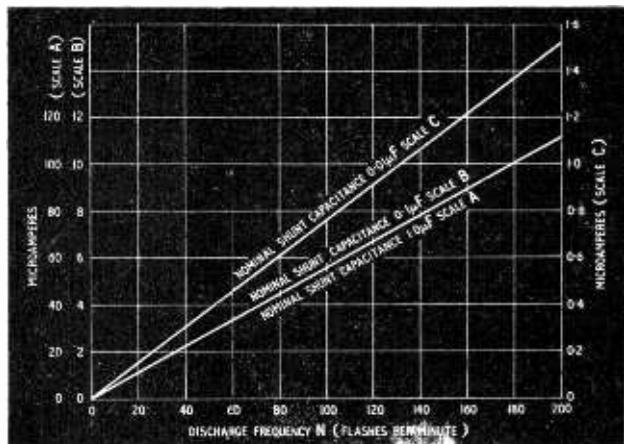


Fig. 6. Circuit for high-voltage leakage tests
Right : Fig. 7. Microammeter calibration curves

tube may be employed for both voltage and current measurements, the switching being such as to permit a choice of shunt capacitances for current measurement purposes. These capacitances can, of course, be calibrated at lower voltages in the manner already described and Fig. 7 shows curves which were thus obtained for capacitances of the values given in Fig. 6. The fact that the curves for the 1.0 and 0.1- μ F capacitances are superimposed in Fig. 7 is purely fortuitous, no special selection of capacitors having been made, though this could be done if considered necessary. The 0.01- μ F capacitor was evidently of higher capacitance than its rating compared with the other two.

A word of caution may perhaps not be amiss at this point regarding the dangers associated with high-voltage equipment. Whilst an e.h.t. generator of the radio-frequency or fly-back type may itself be quite safe by virtue of small storage capacitances and low power output, such a device can charge circuits of high capacitance with potentially dangerous amounts of energy. Very great care should therefore



be exercised in such circumstances, bearing in mind the fact that high voltages can spark across gaps which would be quite safe at lower voltages. A golden rule is to keep one hand in a pocket when working with live equipment; this at least ensures that a shock is not taken from one hand to the other via the chest.

Finally, there is one feature of neon discharge tubes which has to be taken into consideration in the design of equipment based upon them. The striking potential of a particular tube may be increased considerably if the tube is completely screened from light as the latter radiation serves to promote ionization of the neon gas within the tube. It is important therefore to design the equipment so that the tube itself is subjected to light radiation though a moderate amount of shading is permissible. Other components should preferably be housed in a well-closed box in order to obviate as far as possible the accumulation of surface deposits which may cause undesirable changes in the values of series resistors, or may give rise to leakage across capacitors or tube holder.

HIGH PULSE-RATIO RADAR

Methods of Range Extension in the Decca "45"

THE new Decca marine radar, Type 45, is a modified version of the Type 12 in which range scales having maxima of $\frac{1}{2}$ and 45 miles have been added to the existing ranges of 1, 3, 10 and 25 miles. The minimum range and range discrimination remain at 25 yards (with a pulse width of 0.1 μ sec), and the new $\frac{1}{2}$ -mile range gives an effective scale of 168 yards to the inch.

The 45-mile range, which has been added at the request of shipowners to enable earlier landfalls to be made, would not be effective without a substantial increase of power and/or overall efficiency, compared with that required for the 25-mile range which has hitherto been regarded as an adequate maximum. Decca have achieved this partly by increasing power 2.5 db (from 10 to 18 kW peak in the pulse), but chiefly by increasing the pulse length to 1.0 μ sec in the longest range, and by general improvement in the aerial and receiving circuit efficiency.

Specifically, the increased power output has been obtained with a more efficient type of magnetron and the power supply conditions are substantially unchanged, so that externally the appearance is the same as the Type 12, and the advantages of compactness, and ease of installation and maintenance have been retained. The aerial scanner

aperture has been increased and the width is 6ft, giving a beam width of 1.2 deg compared with 1.6 deg in the Type 12—an effective increase of 4.5 db in gain. The increased energy returned from a 1- μ sec pulse is supplemented by an increase in receiver efficiency, since a narrower bandwidth can be used. An overall gain of 8 db results from the use of this long pulse. In the mixer and pre-amplifier circuits an improvement of 3 db in noise factor has been effected, bringing the total gain improvement of the Type 45 over the Type 12 up to a total of 18 db. This is a maximum theoretical figure, but in practice 15 db (measured) is consistently achieved. To obtain a comparable performance solely by increasing power would require 320 kW in the pulse compared with the original 10 kW. This may seem a big increase for an extension of only 50 per cent in range, but it must be borne in mind that the range in radar is proportional to the fourth root of the power employed.

In the interest of long life, the h.t. supplies to the relatively expensive cathode-ray tube and magnetron are now controlled by a separate stand-by switch.

The price of the Type 45 is £1,900, compared with £1,750 for the Type 12 which will still be made.

Reflex Push-Pull Receiver

Two-valve Local-station Set

By G. J. POPE

A SMALL self-contained receiver forms a useful addition to the home as it can be taken from room to room which is not always convenient with a larger set. It is also invaluable in the case of illness. The set described here has three valves only, two being SP61 war-surplus type and the third is an EA50 diode. It is a t.r.f. set with the unusual feature that the r.f. valve forms one half of a push-pull output stage using a reflex circuit. This arrangement was particularly attractive since a ready means of achieving the necessary phase reversal between the output valves' grids suggested itself.

Considering the circuit diagram, Fig. 1, it will be seen that a conventional series diode detector feeds V_2 via the gain control. A common cathode return circuit is arranged to give the correct Class A bias condition for both valves. At r.f., V_1 cathode is bypassed adequately by C . An a.f. signal appears across R which is approximately half that available between V_2 grid and earth. This relationship may be shown to hold if the amount of negative-feedback occurring is calculated.

The gain of a feedback amplifier is given by the formula,

$$\text{Gain} = \frac{A}{1 + A\beta}$$

where : A = gain in absence of feedback
 β = fraction of output fed back

The feedback circuit is shown in Fig. 2, where series current feedback occurs due to a fraction $\frac{R_k}{R_k + R_l}$ of the output acting in opposition to the input signal

voltage e_g . Now since V_2 is a pentode, its gain is given by :—

$$g_m R_t \text{ approximatel}$$

The optimum load for the SP61 is $20 \text{ k}\Omega$, hence gain without feedback

$$= 9 \text{ ma/V} \times 20,000 \\ = 180 \text{ times.}$$

$$\text{With feedback, gain} = \frac{180}{1 + 180 \times \frac{100}{20,000}} = \frac{180}{1.9} \\ \approx 95 \text{ time:}$$

It will thus be seen that the gain is reduced by approximately 6 db. The voltage across R_k will be :—

$$\frac{1}{230} \times 95 \approx \frac{e_g}{2}$$

Since this voltage acts in opposition to e_g , the grid cathode voltage

$$\text{of } V_2 \text{ is also } = \frac{e_g}{2}$$

Since the cathode circuits are common, V_1 acts as a cathode driven push-pull stage, its grid being at earth potential to a.f. Approximately the same ratio of cathode volts to grid drive volts is obtained if the anode load is varied over wide limits, so that the exact value of anode load is

Fig. 2. The feedback circuit.

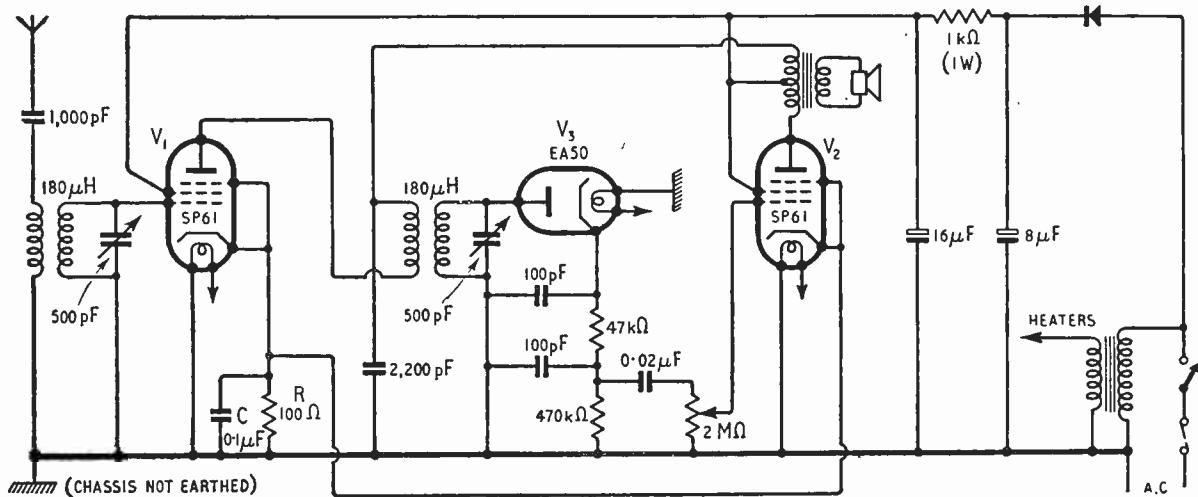
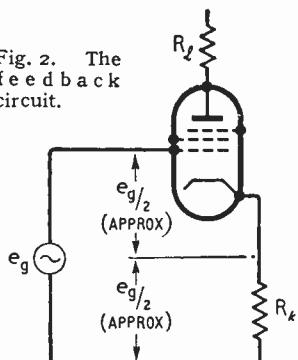


Fig. 1. Circuit diagram of the receiver, with the r.f. valve forming one half of a push-pull output stage using a reflex circuit.

unimportant on this account. This may be an advantage if a standard push-pull component only reflecting somewhat lower loads is available. The value of C at a.f. is insufficient to materially affect the response. The connection of this form of a.f. drive to the second valve causes 6-db drop in sensitivity as mentioned above, but a 3-db increase results from the added output stage, so that the final arrangement is 3-db less sensitive. The receiver is, however, capable of giving an extra 3 db output power, that is, twice that of a single valve. Since the receiver is built for local-station use the question of sensitivity is relatively unimportant, ample output being obtained on about 10 ft of aerial in London.

The push-pull circuit allows the use of a small output transformer since the core flux due to each valve's anode current cancels out. In practice for a given size component this means better low-frequency response. The writer uses a midget component and the bass response is very good. Another small advantage push-pull has is that a common un-bypassed cathode resistor can be used, so saving a low-voltage electrolytic capacitor which would otherwise be necessary. The omission of the bias by-pass capacitor from a power amplifier of this kind is usually not recommended, but no serious distortion has been apparent,

The author's model employs switched station selection which was considered adequate and possibly simpler for the rest of the household to handle. When operated in the London area it may be found advantageous to make the aerial connection switchable from the primary side of the aerial transformer to the grid connection, so that the sensitivity may be increased for the reception of weaker stations. This was found necessary for Third Programme reception with a short aerial and connections may obviously be adjusted to fit individual geographical locations.

Any coil with a tuned winding "Q" of approximately 100 and inductance of 180 μ H or so may be used in both positions, but for constructors not in a position to make their own, Osmor Q-type QA11 and QHF11 are suitable for aerial and intervalve transformers respectively.

There is no reason why a germanium crystal should not be used for the detector but in this case the value of the diode load should be dropped to about 100 k Ω . This may result in some loss of selectivity, but it is not likely to be troublesome.

With the output stage and loudspeaker matched to give an anode-to-anode load of 20 k Ω an output of about 0.75 W is provided. If a lower load figure is taken the output will be correspondingly reduced.

MANUFACTURERS' LITERATURE

Tubular M.C. Microphone of unobtrusive appearance, 1in in diameter and weighing 9oz. Leaflet giving brief specification and frequency response curves from Standard Telephones and Cables, Connaught House, Aldwych, London, W.C.2.

Rotary Switch Wafers with improved fixing of contact clips on stators to avoid loosening during soldering. Engineering data sheet on type DH and DM "Oak" sections from NSF, Keighley, Yorks.

Television Aerial Feeder Cables, coaxial solid, coaxial semi air-spaced, balanced screened twin and unscreened twin. A leaflet giving characteristics and dimensions from The Edison Swan Electric Company, 155, Charing Cross Road, London, W.C.2. Also new data booklets on Mazda receiving valves and c.r. tubes and Ediswan industrial and transmitting valves.

Crystal Microphones made by Ronette. A new illustrated catalogue giving technical specifications of the complete range is available from the Mail Order Supply Company, 33, Tottenham Court Road, London, W.1.

High-Voltage Capacitors, tubular paper types, suitable for smoothing television e.h.t. supplies, with working voltages of 20 kV and 25 kV. Technical bulletin No. 40 from The Telegraph Condenser Co., North Acton, London, W.3.

Small Soldering Iron, $\frac{1}{8}$ in diameter and $\frac{9}{16}$ in long, with four interchangeable bits and designed to operate from a 20-V bus-bar installation. Leaflet from the Electrical Remote Control Co., East Industrial Estate, Harlow New Town, Essex.

Dry Electrolytic Capacitors and others, with ratings, sizes and prices, listed in a booklet intended for the servicing trade. From A. H. Hunt (Capacitors), Bendon Valley, Garratt Lane, Wandsworth, London, S.W.18.

Sound Reproducing Equipment, a leaflet giving brief descriptions and prices of the products of Grampian Reproducers, Hanworth Trading Estate, Feltham, Middlesex.

Portable P. A. Equipment with vibrator power pack working from a 12-V battery. Descriptive leaflet from Easco Electrical, Brighton Terrace, London, S.W.9.

Interference suppressors for various types of electrical apparatus. A booklet describing the models available and methods of fitting them from Belling & Lee, Cambridge Arterial Road, Enfield, Middlesex. Also a booklet describing their sound, television and anti-interference aerials and accessories and a catalogue of components and accessories.

Coaxial Connectors, American military types for 50 Ω and 72 Ω and for various cable diameters between 0.2in and 1in. Also a leaflet giving information on how to connect cables to them. From Besson and Robinson, 6, Government Buildings, Kidbrooke Park Road, London, S.E.3.

Accessories and Electro-mechanical Devices, a list of Government surplus equipment from A. T. Sallis, 93, North Road, Brighton, Sussex.

A.C. Voltage Stabilizers for regulating mains voltages, including heavy-duty types for currents of 30A to 130A. Full descriptions in a supplement to their "Variac" catalogue V549 from Claude Lyons, 180, Tottenham Court Road, London, W.1.

Moulded Plastics for Industry, an illustrated booklet describing the moulding processes carried on by the G.E.C. works at Witton and listing some typical products. From the General Electric Company, Magnet House, Kingsway, London, W.C.2.

P-N Junction Crystal Diodes with similar characteristics to standard American types. A leaflet giving general features and prices from Detectron, 25, rue de Toulon, Bordeaux, France.

Television Aerials with elements already assembled but folded up. Single and multiple types described in leaflets from Antiference, Bicester Road, Aylesbury, Bucks.

Components and Accessories, tools and test gear; a comprehensive illustrated catalogue of 150 pages from Rudolph Schmidt, Gl. Kongevej 64, Copenhagen, Denmark.

Preferred Valves List, second edition, 1953. Takes into account greater range of miniatures now available and includes American and military equivalents. Full data and base diagrams are given. Available from the Scientific Instrument Manufacturers' Association, 20, Queen Anne Street, London, W.1, price 3s 6d, post free.

Valve Voltmeter for measuring the maximum amplitude of transient phenomena having a duration of at least 1 millisecond. It has a range of 0-20V and an input impedance of 33k Ω and there are two meters to cater for positive and negative peaks. Explanatory booklet with diagrams from Standard Telephones and Cables, Transmission Division, North Woolwich, London, E.16.

Aerials and Accessories for sound and television reception. A 1953/54 comprehensive catalogue from Arialite, Castle Works, Stalybridge, Cheshire.

Pressure Transducers, one type for measuring static pressures in ranges from 0-25 to 0-4,000lb per sq in and another for fluctuating pressures in ranges from 0-250 to 0-50,000lb per sq in. Also a dynamometer for measuring tensile loads in ranges from 0-50 to 0-10,000lb. Descriptive leaflets from J. Langham Thompson, Springfield Laboratories, Bushey Heath, Herts.

Small Motor Blowers with weights between 2lb and 40lb and power consumptions between 33 and 440 watts. Leaflet from Air Control Installations, Ruislip, Middlesex.

Glass Marking Colour, suitable for writing on valves, available in black, white, red, orange, yellow, green and blue. Leaflet from George T. Gurr, 136, New King's Road, London, S.W.6.

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

Output Transformer

THE illustration shows one of the latest type of push-pull output transformers now produced by Partridge Transformers, Roebuck Road, Tolworth, Surrey, using grain orientated strip-wound cores (generally known as "C" cores).

This model is the Type P3064 having a power handling capacity of 20 watts for less than 1 per cent distortion. The maximum d.c. per half-primary is 100 mA and a 20 per cent out-of-balance current can be tolerated. The d.c. resistance of each half primary is 100 ohms.

Four separate secondary windings are provided which by series or parallel connection give correct operating conditions with a primary loading impedance of 10,000 ohms for



Partridge Type P3064 push-pull transformer giving the choice of several output impedances.

loudspeakers of 0.95 ohm, 3.8, 8.5 and 15 ohms impedance respectively.

With the equivalent of 10,000-ohms resistive load on the primary the frequency characteristic is virtually flat having a deviation of ± 0.5 db only over the range 30 c/s to 30 kc/s. The leakage inductance is claimed to be less than 8 mH.

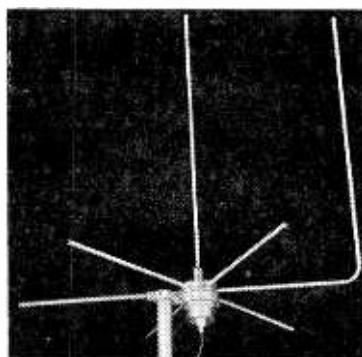
This transformer measures $2\frac{7}{8} \times 2\frac{7}{8} \times 3\frac{1}{2}$ in., weighs $2\frac{1}{2}$ lb and costs £4 18s.

Television Aerial-Amplifier Unit

A NEAT and workmanlike way of obtaining a good television signal with a simple aerial in fringe areas is shown in the illustration. It consists of a ground-plane aerial with reflector and in the centre hub of the system is housed a two-stage head amplifier. One valve is a neutralized triode amplifier, the other is a cathode follower.

The vertical elements of the aerial are a quarter-wavelength long and the horizontal members, which serve as an artificial "earth", measure a half-wavelength from tip to tip. It is reasonably light in weight and can be mounted on the usual 2-in. o.d. tubular mast.

The necessary heater and h.t. supplies are fed to the amplifier along a two-core screened cable which is



Spencer-West Type AC8 television aerial embodying a head amplifier.

also the feeder for signals from the aerial to the receiver. A small power supply unit is required and is mounted close to the receiver.

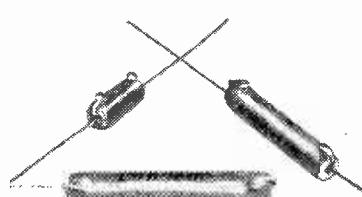
The aerial system can be fitted with a relay for automatically switching on the head amplifier when the main receiver is switched on.

The makers are Spencer-West, Quay Works, Great Yarmouth, and the aerial, known as the Type AC8, costs £33 15s including 65 ft of feeder and a power supply unit.

Vitreous Resistors

A RANGE of vitreous-enamelled resistors wound with nickel-chrome resistance wire on ceramic formers is now in production by Labgear, Ltd., Willow Place, Cambridge. They are at present available in $4\frac{1}{2}$, 6- and 10-watt types, these being the commercial ratings, but for Service equipment the ratings are lower at 3, 4.5 and 6 watts respectively.

All three types have the same outside diameter of $\frac{1}{4}$ in approximately, but differ in length, the smallest being $1\frac{1}{2}$ in and the largest $1\frac{1}{2}$ in. The resistance ranges are as follows: 4.5-W, 10 to 12,000 ohms; 6-W, 5 to 33,000 ohms and 10-W, 5 to 47,000 ohms. The normal tolerance is $\pm 5\%$.

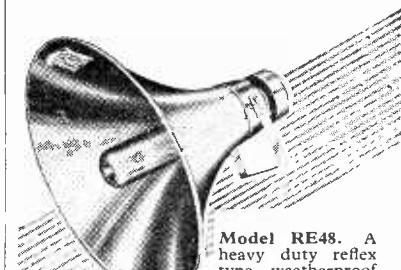


Labgear range of vitreous-enamelled wire-wound resistors in $4\frac{1}{2}$, 6- and 10-watt types.

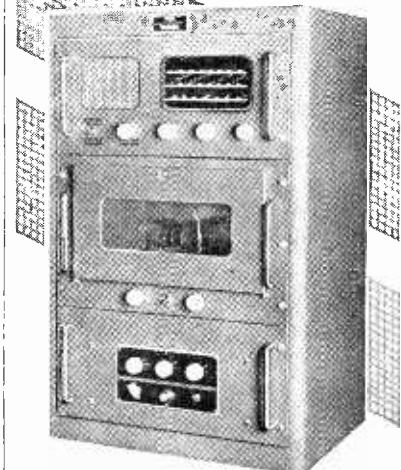
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RANDOM RADIATIONS

By "DIALLIST"

Oh for V.H.F.!

THIS COUNTRY'S v.h.f. sound broadcasting service can't come into being too soon for me; or, I expect, for a good many others who are growing very tired of the interference on the medium- and long-wave bands. Myself, I can seldom receive the Light Programme even reasonably well. To bring in the medium-wave transmission without interference from one or more stations selectivity must be pushed up until there is a marked decline in quality: on the long waves there is too often a poisonous heterodyne whistle. The Home Service from Brookmans Park is also liable to heterodyne troubles, while at times some foreign station provides an annoying background. I'm coming to rely more and more on the 90-Mc/s transmissions from Wrotham with their almost entire freedom from interference. The snag is that Wrotham sends out only one programme at a time; and too often it isn't the one I want.

It Shouldn't be Long

I haven't a doubt that f.m. will win the day for the official service. To two important points I can testify without reserve. The first is that, given a.f.c. (which you must have, anyhow, to look after oscillator drift) the f.m. receiver isn't the tiniest bit more difficult to tune than the a.m. The second is that f.m. is not just a little more effective than a.m. against impulsive interference: it's *vastly* better than a.m., even with a limiter. Once the modulation question is decided, it shouldn't take long to get the services going. Note that I say services in the plural, for the slot aerials below the dipole arrays on the mast of every television transmitting station can transmit two v.h.f. programmes on different carrier frequencies. It would seem hardly necessary to build giant transmitters, to begin with, at any rate. The 18-20 kilowatts of the now well-proved Wrotham transmitter appear to give a service area quite as large as that of either of the medium - wave Brookmans Park giants. I'm speaking, of course, of the f.m. transmissions with which the minimum necessary field strength is

much smaller than with a.m. The signal need only be strong enough to work the limiter to give you all that's going.

A New Contributor

TURNING THROUGH the pages of a learned American journal, I was electrified by finding in it a reference to a recent *Wireless World* article "by R. W. Hallows and M.A. Cantab." The latter belongs, of course, to the *coterie* of writers which includes such authorities as B.A. Oxon, M.D. Lond., D.D. Dunelm and M.B. Leeds amongst its English members. Well-known Scottish members of it are the Mac Antabs and Mus. B. Edin.

They Have a Word for it

I REALLY CAN'T swallow without many grains of salt Malcolm S. Morse's statement in the October correspondence columns that motor car ignition interference with television reception is unknown in the U.S.A. Nor can I accept for a moment his suggestion that American sets, though used in a veritable welter of radiation from millions of unsuppressed cars, provide undis-

turbed pictures because they are so much better designed than ours. There's no mystery about the design of the sets made on the other side of the Atlantic. They incorporate nothing in the way of anti-interference devices that our manufacturers don't know and use. There may be differences in the ways in which we use them, but these are due to our positive modulation. I suspect that Mr. Morse's "unsuppressed" means that the owners of the cars haven't deliberately had suppressors fitted. No need to do so if your new car has already been treated as a matter of course before delivery. But there must be noticeable interference, or one wouldn't read so many references to "auto-ignition static."

Useful Jobs of Work

THE SUBMARINE television camera is destined to play a very useful part in salvage operations. A diver working in deep water uses a cable with a heavy weight at its lower end, known as the shot-rope. It used to be impossible to tell whether the shot-rope had been put into the right position until the diver went down to find out. He can't move more than a foot or two from it with safety; if it is wrong, he must come up and another attempt must be made. You'll see that this can be a very slow business; a whole tide may, in fact, be wasted. With the TV camera it's just too easy. The camera goes down and the shot-rope is moved until it is seen on the receiv-



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ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1.

ing screen to be in exactly the right place. The diver then goes straight to his job. His partnership with the TV camera doesn't end there either. He can telephone for the camera to be moved to where he needs it when he wants to show observers above something of special interest that he has found. They can then make a permanent record by means of photographs or ciné films of the screen.

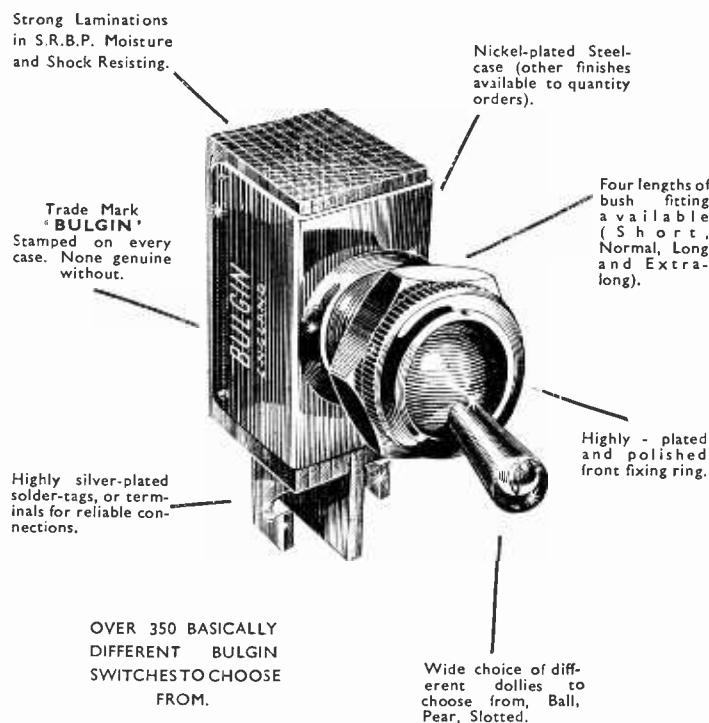
Not So Hot

MANUFACTURERS of television receivers can be pretty badly let down when their sets are installed by careless or inefficient service-men. The other day a non-technical friend told me he was a bit disappointed in the set (his first) which had cost him a tidy sum. When I dropped in to see how it was performing, I wasn't surprised. The first thing that struck me was that on the 14-inch screen the image was barely 10 inches in width. The aspect ratio was nothing like 4:3; the image appeared badly distorted, and this was confirmed when I tried the set on Test Card C a few mornings later. Though the set was in a back room, the aerial had been fixed to a chimney stack at the front of the house where it brought in the maximum amount of interference from every unsuppressed motor vehicle. Had it been mounted on a convenient high chimney at the back, the dipole would have been 40ft further from the road and probably outside the ignition interference zone. Luckily, one doesn't often see sorry jobs of that kind; it's sad that one should ever come across them.

Taxi!

WHEN I WAS just on the point of sending off the manuscript of this month's jottings the postman brought a letter from a reader in the W.9 district of London. In the early part of last year he made a tape recording on his own machine. On playing it back, he was amazed to hear two voices: his own and that of a taxi driver speaking to his headquarters. He now sends me a cutting from September 20th issue of *The Observer* describing a similar occurrence (except that on this occasion a voice speaking from headquarters and not the taxi man's was recorded). I haven't had time before writing this to think of an explanation of this queer business. Can any reader suggest one?

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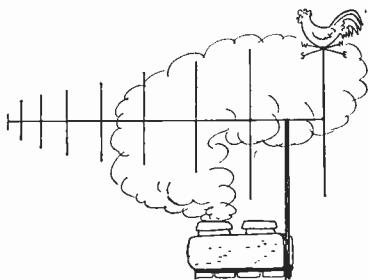
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UNBIASED

By FREE GRID

Strange TV Aerials

TRAVELLING to the wilds of East Anglia recently I was struck by the changing character of the TV aerials as the train rumbled from London. At first there was nothing but the familiar "H" type to be seen among the chimney pots, with here and there a plain dipole. As we drew nearer to that part of the country made famous and hallowed by Hereward the Wake and St. Etheldreda respectively the aerials began to assume strange shapes; weird and wonderful multiple arrays sprouted up here and there in an



Xylophone TV aerials

endeavour to catch the ever more elusive signals from the transmitter.

Eventually we passed the lofty West Tower of Ely Cathedral soaring majestically over the flat fen country surrounding it—surely a veritable gold mine for the Dean and Chapter if and when commercial television eventually goes a site-seeking. Beyond Ely the only TV aerials to be seen were what I can only describe as the xylophone or dulcimer type which I have endeavoured to illustrate in my sketch.

I subsequently had cause to visit Alexandra Palace and expected to see the aerials become less and less conspicuous until in the vicinity of the transmitter they disappeared

altogether as being unnecessary. To my surprise, however, I found that in one district bordering on the Palace they seemed more conspicuous than in remoter suburbs.

I naturally suspected the existence of some inexplicable pocket of low signal strength and I dropped in to a local dealer's place to discuss the matter. He shook his head, however, and pointed out that signal strength was so great that an attenuator rather than an aerial was needed. He went on to say that the people in the district were so afraid the neighbours would think they couldn't afford TV that they always demanded an aerial; in fact, one of his customers who had the largest car and the most beminked and be-jewelled wife in the district insisted on his erecting a mast having not an H but the letters TV at the top so that there could be no misunderstanding.

Etheric Anarchy

THERE HAS BEEN a lot of talk about the difficulties of clearing Band 3 of such things as business radio in order to make it safe for television. In my opinion, however, if v.h.f. communication goes on spreading at the rate it is doing at present TV will eventually be squeezed out of the ether altogether. I feel rather strongly on the matter as I have some personal experience of what is going on.

It so happened that a few weeks ago my eye was caught by a remarkable shop-window display of the potential and actual uses of business radio. One of the chief features of the display I saw was an errand boy on a bicycle with a v.h.f. "X-eiver" in his bicycle basket, and headphones over his ears, receiving instructions from his employer. I cannot tell you where this remarkable display was—and probably still is—as the Editor won't have any

suggestion of advertising in these columns. However, when I tell you that it was in a part of London with street names recalling the past glories of the de Vere family you obviously only need to ring up the Editor of Burke or Debrett in order to find out where I mean.

In a foolish moment I told Mrs. Free Grid all about it and then promptly dismissed the matter from my mind until a couple of weeks later I observed a friend of hers pushing a pram and apparently talking to herself. Closer observations revealed dainty hearing-aid type earphones, a mike and a neatly mounted rod aerial. The set, I discovered, was under the baby; a place where I should have thought it would be subject to a heavy damping effect.

This was not all as I presently encountered Mrs. Free Grid herself, complete with pram, grandchild and "X-eiver," and also several others of her coterie all busily chattering away nineteen to the dozen and spoiling good ether. If this sort of thing is allowed to spread we shall be faced with etheric anarchy.

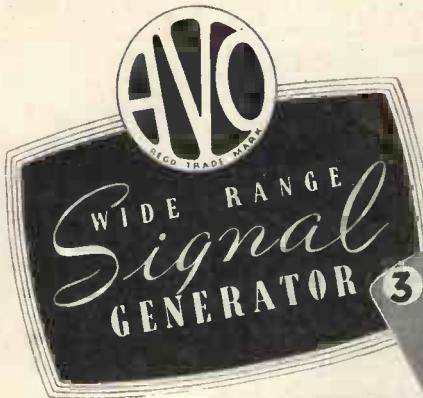
The "Elevated Electrode"

I WAS TALKING the other day to a friend who had been attending the meetings of the C.C.I.R. in London and he was telling me of the weighty matters which had been occupying its attention. One incidental question which cropped up was the correct form of the plural for antenna. There can be no doubt that it is antennæ but some delegates seemed to favour antennas as is used in America. It was, moreover, pointed out that "aerials" was also used in some of the official documents. After some discussion, the delegates agreed to accept the ruling of the *Concise Oxford Dictionary*.

This apparent climb-down on the part of the Yanks rather surprised me as the *Concise Oxford* says without any equivocation that "antennæ" is the plural and it has no truck with "antennas." The *Concise Oxford*'s big brother, *O.E.D.*, is far more tolerant of the weaknesses of human nature and gives "antennas" as a permissible alternative.



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150Kc/s.-500Kc/s. 5.5Mc/s.-20Mc/s.
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Gives rapid identification of operational band with intensified lighting round precise frequency. Fine hair line gives close discrimination, particularly on high frequencies.

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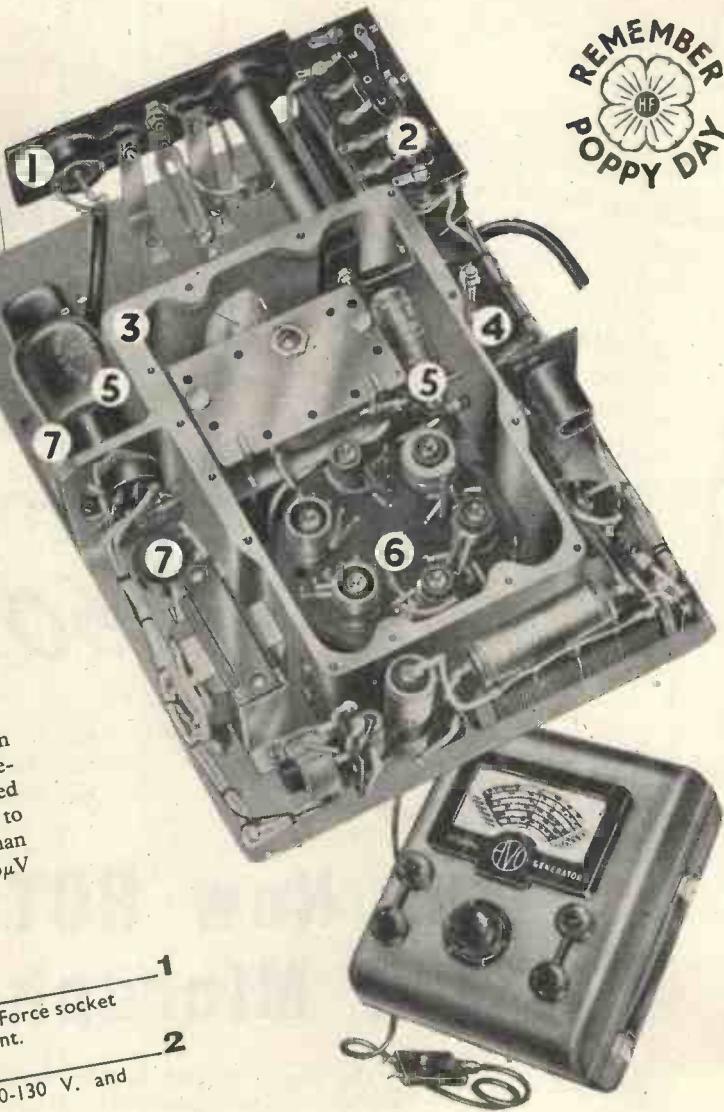


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S. G.2

A



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"... quality of
the recordings
improved...
not less than
60%...!"

says Mr. ALEX MORTIMER, Musical Director of the Black Dyke Mills Band when writing of the new Rothermel D.104 Microphone.

- the New ROTHERMEL D.104 Microphone

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A special feature of this valve that should prove of particular interest to designers of FM and AM/FM communication receivers is that its two sections may be operated independently. In FM circuits, it can be used as an R.F. or I.F. amplifier, or oscillator and thereby reduce the number of different valve types employed. Brief technical details of the ECH81 are given below. More comprehensive information will gladly be supplied on request.



ACTUAL SIZE

ECH81

PRINCIPAL CHARACTERISTICS

HEATER Suitable for series or parallel operation
A.C. or D.C.

V _H	...	...	...	6.3 V
I _H	...	...	...	0.3 A

TYPICAL OPERATING CONDITIONS OF HEPTODE SECTION AS A MIXER

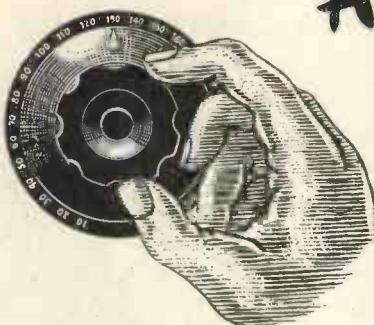
V _a =V _b	...	...	250 V
R _{g2+g4}	...	...	22 kΩ
R _{g3+gt}	...	...	47 kΩ
I _{g3+gt}	...	...	200 μA
V _{g1}	...	...	-2.0 V
V _{g2+g4}	...	...	103 V
I _a	...	...	3.25 mA
I _{g2+g4}	...	...	6.7 mA
g _c	...	...	778 μA/V
r _a	...	...	1.0 MΩ
V _{g1} for 100:1 reduction in g _c	...	...	28.8 V

CHARACTERISTICS OF TRIODE SECTION

V _a	...	...	100 V
V _g	...	...	0 V
I _a	...	...	13.5 mA
g _m	3.7 mA/V
μ	22

BASE B9A





Adjustable-Stabilized A.C. Voltage

WITH HARMONIC FILTER

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It provides a portable, simple to handle instrument for such duties as instrument calibration and testing and many other operations involving factors that are sensitive to wave form and voltage.

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- Total Harmonic Distortion less than 5%.
- Maximum Output 170 watts.

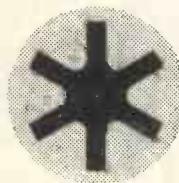
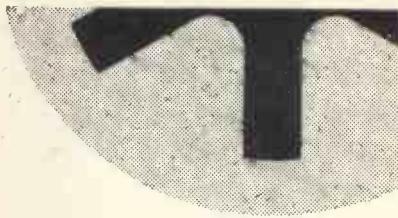
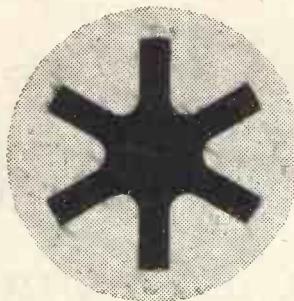
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The stellate core is featured only in the Enthoven range of cored solders which ensures perfect soldering.

Superspeed

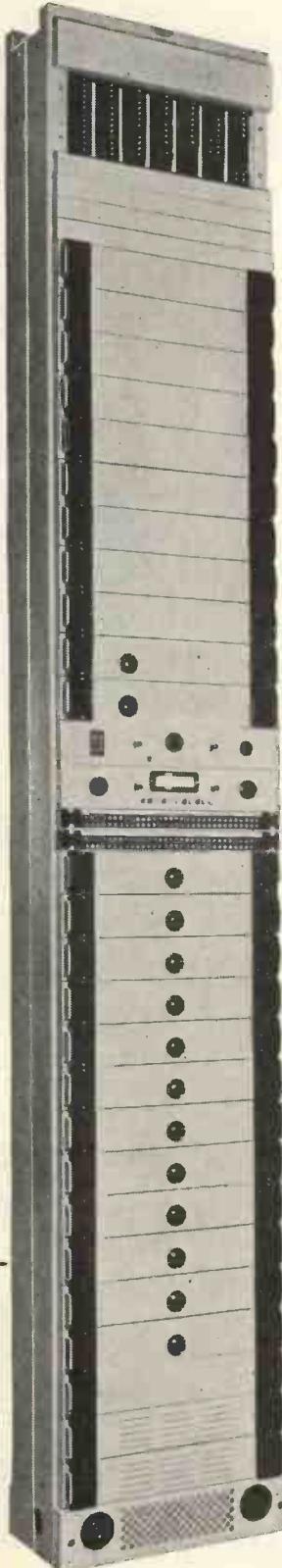
ACTIVATED ROSIN CORED SOLDER

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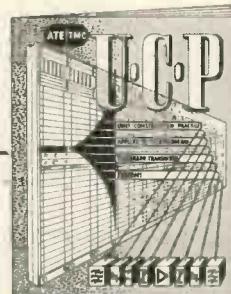
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ATE/TMC Transmission equipment is designed to offer an operating administration the maximum facility in the performance of maintenance routines. Jack-in panel frames fitted with quickly detachable functional units ensure the most rapid form of servicing yet devised. You are invited to apply for a copy of "Unit Construction Practice" which describes the technique employed.



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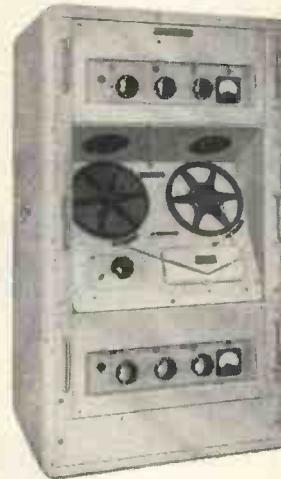
Wearite & Ferrograph

TAPE RECORDING EQUIPMENT



FERROGRAPH
MODEL 2A

Model 2A provides at a reasonable cost an instrument approaching professional standards — its specification commanding it especially to those engaged in educational and cultural pursuits.



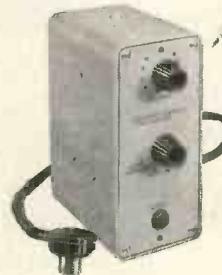
WEARITE
EQUIPMENT
TYPE YDC

Equipment Type YDC is a simultaneous dual-channel Recorder/Reproducer offering special facilities to those engaged in analysis problems in the medical, aeronautical and scientific fields.



FERROGRAPH
MODEL YD

Ferrograph Model YD. An instrument version of the famous 2A having balanced 600 ohm inputs and outputs, a tropicalised amplifier, and a performance up to professional standards. It can be rack mounted.



SIGNAL
OPERATED
SWITCHING
UNIT

A switching unit developed for use with recorders type YD and YDC. It switches on the recorder only when a signal is present and enables the traffic of many hours to be recorded on a normal length reel.

Wearite Publications are available as follows :—

The Manual of the Tape Deck, 2s. 6d.

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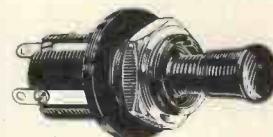
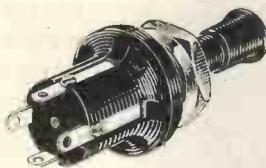
WRIGHT & WEAIRE LTD.
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By Appointment to the Professional Engineer



**MINIATURE
PUSH BUTTON
SWITCH**

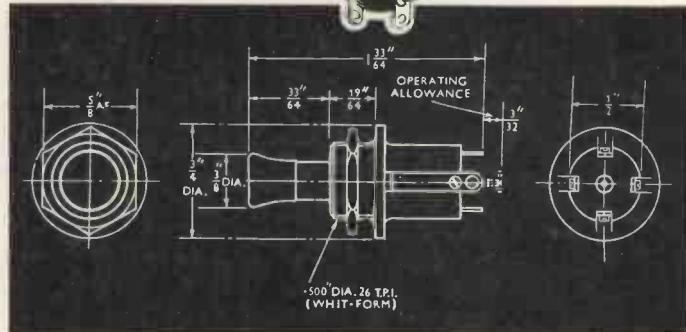
FEATURES

RATING : 0.1 Amp., 250 v. A.C./D.C.

CONTACT RESISTANCE : 0.01 ohm.

The new Painton Push Button Switch is an efficient and reliable miniature component combining safe electrical operation with robust mechanical action. The highest electrical grade material is used for the knob, shaft and inner body, which are produced as one solid moulding. The design of the contacts ensures minimum fatigue, and the retention of low contact resistance over a long period and under wide variation of atmospheric conditions.

The non-locking version is particularly suitable for metering, monitoring and also inter-communication system applications.



Cat. Number	501404	501405	501406	501407
Mechanical Action	Non-Locking	Locking	Non-Locking	Locking
Electrical Action				
501404}	Switch in normal position: Contacts 1 and 2 made, Contacts 3 and 4 open. Switch operated: Contacts 1 and 2 open, Contacts 3 and 4 made. (By cross connection of the contacts, single pole changeover operation may be obtained).			
501405}				
501406}	Switch in normal position: Contacts 1, 2, 3 and 4 open. Switch operated: Contacts 1, 2, 3 and 4 commoned.			
501407}				

PAINTON
Northampton England

ATTENUATORS AND FADERS • STUD SWITCHES • FIXED AND ADJUSTABLE WIREWOUND RESISTORS
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COSSOR presents ...



The new Cossor Double Beam Oscilloscope

MODEL 1052

Two identical amplifier channels with a maximum gain of 2000 and an upper frequency response of 3 megacycles are features of this new Cossor Double Beam general purpose oscilloscope. The repetitive or triggered time base has a sweep duration from 200 milliseconds to 5 microseconds.

The instrument will operate from power supplies of any of the various frequencies and voltages encountered in the Armed Services or from standard civil supply mains. The top and side panels are quickly detachable to allow inspection and a removable plate at the rear of the instrument allows access to tube plates, anode and modulator.

and Voltage Calibrator

MODEL 1433



Primarily designed to be used with the new Cossor oscilloscope the Cossor-Voltage Calibrator model 1433 provides an accurate means of calibration of input voltages to the plates or amplifiers of any oscilloscope. Calibrating voltages are read directly from a wide scale meter without any computation being necessary. Measurements can be made to an accuracy of $\pm 3\%$ and the instrument can be used in any application where a source of accurately-known voltage is required.

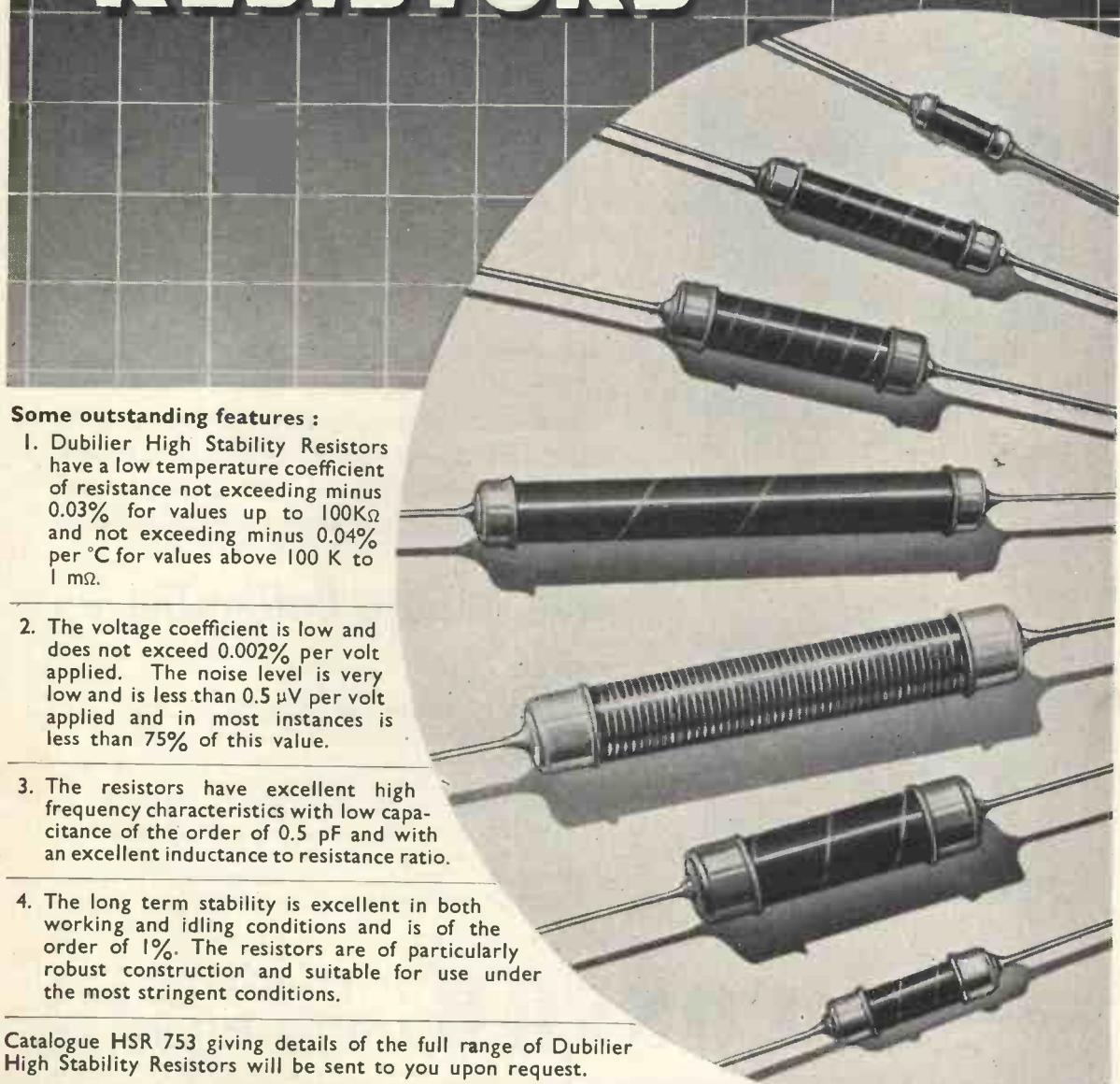
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Write for illustrated leaflets about both of these instruments
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HIGHBURY GROVE, LONDON, N.5
Telephone : CANNonbury 1234 (33 lines)

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COSSOR

TUBES &
VALVES

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Some outstanding features :

1. Dubilier High Stability Resistors have a low temperature coefficient of resistance not exceeding minus 0.03% for values up to $100\text{K}\Omega$ and not exceeding minus 0.04% per $^{\circ}\text{C}$ for values above 100 K to 1 m Ω .
2. The voltage coefficient is low and does not exceed 0.002% per volt applied. The noise level is very low and is less than 0.5 μV per volt applied and in most instances is less than 75% of this value.
3. The resistors have excellent high frequency characteristics with low capacitance of the order of 0.5 pF and with an excellent inductance to resistance ratio.
4. The long term stability is excellent in both working and idling conditions and is of the order of 1%. The resistors are of particularly robust construction and suitable for use under the most stringent conditions.

Catalogue HSR 753 giving details of the full range of Dubilier High Stability Resistors will be sent to you upon request.



A.F. MEASURING EQUIPMENT



POWER OUTPUT METER TYPE 708

- Frequency range of 30 c/s to 30 kc/s
- Power range of 1 milliwatt to 20 watts
- No tapped matching transformer employed
- Input impedances purely resistive over complete frequency range
- Seventeen input impedances from 2 to 5,000 ohms available by switching
- Cannot contribute to the distortion when testing high-power amplifiers

L.F. SIGNAL GENERATOR TYPE 702

- Frequency range 30 c/s to 30 kc/s
- Frequency stability $\pm 0.05\% \pm 0.5$ c/s
- A 600 ohm constant impedance attenuator provides steps of 20, 40 and 60 db of attenuation under all output conditions
- A screened and balanced transformer enables balanced, unbalanced and floating outputs to be obtained



Full details of these or any other Airmec instruments will be forwarded gladly upon request.

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The wealth of experience gained from these developments is available to all users of magnetic materials through the Mullard advisory service. An enquiry to the address below will put a team of specialised engineers at your disposal.



Mullard

'TICONAL' PERMANENT MAGNETS · MAGNADUR (Formerly Ferroxdure)
PERMANENT MAGNETS · FERROXCUBE MAGNETIC CORE MATERIAL

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The tape Recording SENSATION of the SEASON is now available. With an operating height of only just over 5 INCHES the Editor is the smallest MAINS OPERATED, FULLY AUTOMATIC tape recorder on the market. The Editor is EASY TO CARRY, EASY TO OPERATE and EASY TO LOOK AT. For the finest value and quality in any portable recorder we give you . . .

The Remarkable



—The **REALLY** portable tape equipment !
Covered in high quality leathercloth in various
attractive colours.

H.P. TERMS

£15 . 15 . 0 Deposit, 12 monthly instalments of 60/-.

CREDIT TERMS

CREDIT TERMS
Send only £6 to secure with 8 further monthly payments of £6.

ACCESSORIES

The "Editor" is supplied complete and ready for use with the famous Burgoyne crystal desk microphone made specially for this equipment by RONETTE. The Coronation microphone can be supplied as an alternative if desired.

A 1,200ft. reel of high coercivity BURGOYNE tape is also issued with every recorder.

This tape is especially recommended and is available at 35/- per 1,200ft. reel or 21/- per 600ft. reel.



it's perfect at only **45** gns

200-250V. A.C.

SPECIFICATION:-

- ★ Tape speed $7\frac{1}{2}$ in. per second.
 - ★ Miniature valves. ★ Twin track heads.
 - ★ Three high grade specially designed recording motors provide fast forward run and 50sec. rewind without unlacing tape.
 - ★ Independent Bass and Treble Controls for recording and playback.
 - ★ Negligible wow and flutter. ★ Overall negative feedback.
 - ★ 1,200ft. reel of tape will provide ONE hour playing time.
 - ★ High fidelity Record head. ★ Special high grade speaker.
 - ★ Provision for external speaker. ★ Positive servo braking on all functions. ★ Amplifier may be used for high quality record reproduction. ★ Extremely high output and brilliant reproductions. ★ Compact size for ease of handling.
 - ★ Magic eye recording indicator. ★ Size only $16\frac{1}{2}'' \times 12'' \times 7''$ (with lid) ★ Weight only approx. 40 lbs.

12" x 7" (with lid) ★ Weight only approx. 40 lbs.

**★ Magic eye recording indicator. ★ Size only 10 $\frac{1}{2}$ x
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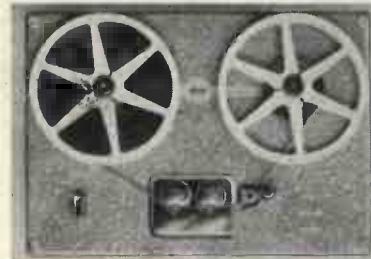
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Where you can choose from BRITAIN'S most comprehensive display of TAPE RECORDING equipment. Order in confidence

We recommend

★ THE LANE TAPE TABLE

incorporating several new features ensuring even better reproduction and simple handling.



£17 : 10s. CARR. PAID. H.P. Terms £5/16/8 deposit 12 monthly payments of 22/-, OR ON CREDIT TERMS.

ALL MAKES OF TAPE AVAILABLE from stock e.g.:—E.M.I.; Scotchboy; G.E.C.; Agfa; B.A.S.F.; Ferrovoice Sound Mirror and BURGOYNE.

and you can choose from the latest releases of the famous—

COLLARO

B.S.R.

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m a k e s o f G r a m o p h o n e E q u i p m e n t

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The B.S.R. MONARCH

AUTOCHANGER at £16 10s.

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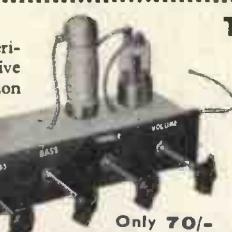
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(G.U.4) 3 speed motor unit
with lightweight P/u. £9 4/- Deposit £3 1/4 and 12
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TERMS available.

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We recommend this unit

Considerable time in research and experiment was spent to find an inexpensive method of providing complete correction for all recording characteristics as well as compensation for deficiencies in broadcast transmissions.



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This unit provides a wide range of bass and treble control without the need to readjust the main volume control when bass or treble are altered. The use of continuously variable controls is most necessary when dealing with unknown characteristics, for compensation of these can only be done by ear. As the characteristics of the human ear vary with intensity, the compensation required is a function of the loudness of reproduction. With a badly designed tone-control amplifier, the critical listener will find himself indulging in an orgy of knob twiddling which cannot be rationalised. This unit not only avoids introducing distortion into the reproduction, but precisely and easily overcomes the defects of the signal fed into it. The unit is supplied completely assembled and tested. A three-position input switch is incorporated:— RADIOPHONIC 78-33/45.



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4 pole 3in./.03 Torque. 38/-.

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or anti-clock — latest release.
Specially designed recording
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We recommend

★ BURGOYNE

high impedance half track Recording and Erase heads. Built-in tape guides. Single hole fixing.

only 37/6d each



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Burgoyne A.7	£21 10 0	11 0	Dreys 37A	£22 1 6	£2 11 0			
Leak Varislope	£21 12 0	£1 12 4	Trirette F258	£23 4 9	£2 8 0			
Leak Point One	£28 7 0	£2 12 0	Plus A Gram Table Model, 3-speed Auto.	£20 16 9	£2 12 0			
Acoustical Quad	£25 0 0	£2 9 0	Decca 347C/M	£18 10 0	£2 6 0			
Goodsell Williamson	£26 0 0	£2 11 6	Decca 33B	£28 19 6	£1 4 0			
Rogers Baby De Luxe	£14 0 0	£1 15 6	E.A.R. Auto 3-speed	£24 17 6	£2 2 0			
GRAMOPHONE UNITS								
Connoisseur 3-speed	£21 7 3	£2 14 2	E.A.R. Non Auto 3-speed	£19 15 0	£2 9 3			
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Chapman S5	£21 6 8	£2 14 2	PICK UPS					
Goodsell S.P. Tuner	£19 5 0	£2 9 2	Bonette 14KCS W/2 Heads	£23 16 3	12 10			
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Grundig Recorder	£84 0 0	£10 13 0	Connoisseur with 2 Heads	£59 5 6	£1 5 0			
Lanc Table	£21 10 0	£2 2 10	Leak Dynamic Ruby LP or 78	£11 11 0	£1 10 0			
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Wearite Deck	£35 0 0	£4 9 0	CATHODE RAY TUBES					
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			12in. Mullard	£16 13 8	£2 2 2			
			14in. Mullard	£19 9 3	£2 9 2			
			17in. Mullard	£23 12 8	£2 18 10			
			12in. Brimar	£17 14 6	£2 4 0			
			14in. Brimar	£20 10 0	£2 13 2			
			17in. Brimar	£24 13 6	£2 3 0			
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Valve Characteristic Meter	£60 0 0	£20 0 0	£3 15 0	Less transformer	£9 7 6	£3 2 6	13 9
D.C. Minor	£5 5 0	£1 15 0	9 2	Concentric Duplex 12in.			
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65A Signal Generator	£22 10 0	£21 10 0	£1 12 8	Cadet	£6 2 3	£2 0 9	10 1
70A Universal Meter 1,000 o.p.v.	£22 10 0	£24 3 4	17 3	Baby	£3 14 3	£1 4 9	7 3
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72A Universal Meter 1,000 o.p.v.	£22 10 0	£5 6 8	£1 0 6	Stuart	£3 6 0	£1 2 0	6 10
75A Universal Meter, 20,000 o.p.v.	£22 10 0	£5 0 0	£1 0 6	Tudor	£3 19 6	£1 6 6	7 6
77A Universal Meter, 20,000 o.p.v.	£22 10 0	£8 10 0	£1 6 0	Twin Corner Reflex Console	£23 14 9	£7 18 3	£1 10 9
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110C Bridge	£14 10 0	£4 10 0	£1 0 1				
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130A Insulation Circuit Tester	£15 0 0	£5 0 0	£1 0 6				
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HUNTS Bridge	£14 14 0	£4 14 0	£1 0 0				
PULLIN Universal Test Meter	£11 11 0	£2 0 0	£1 0 0				
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W10CSB				W10CSB	£2 12 6 6	£2 2 6	16 11
W12C8				W12C8	£9 15 9	£3 5 0	14 2
Super 12 CSAL				W12C8	£16 0 0	£5 6 8	£1 1 2
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Taylor

model 66A



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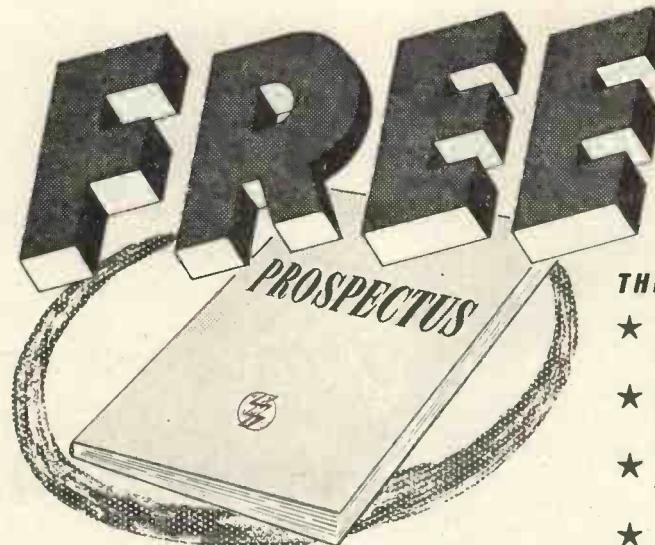
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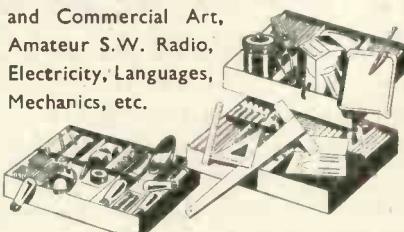
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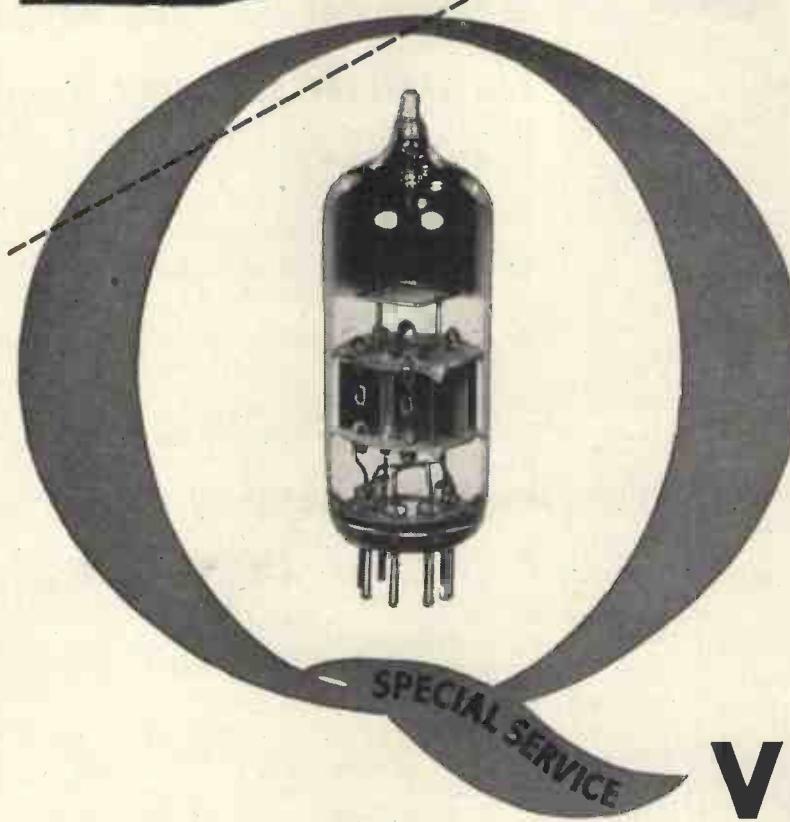
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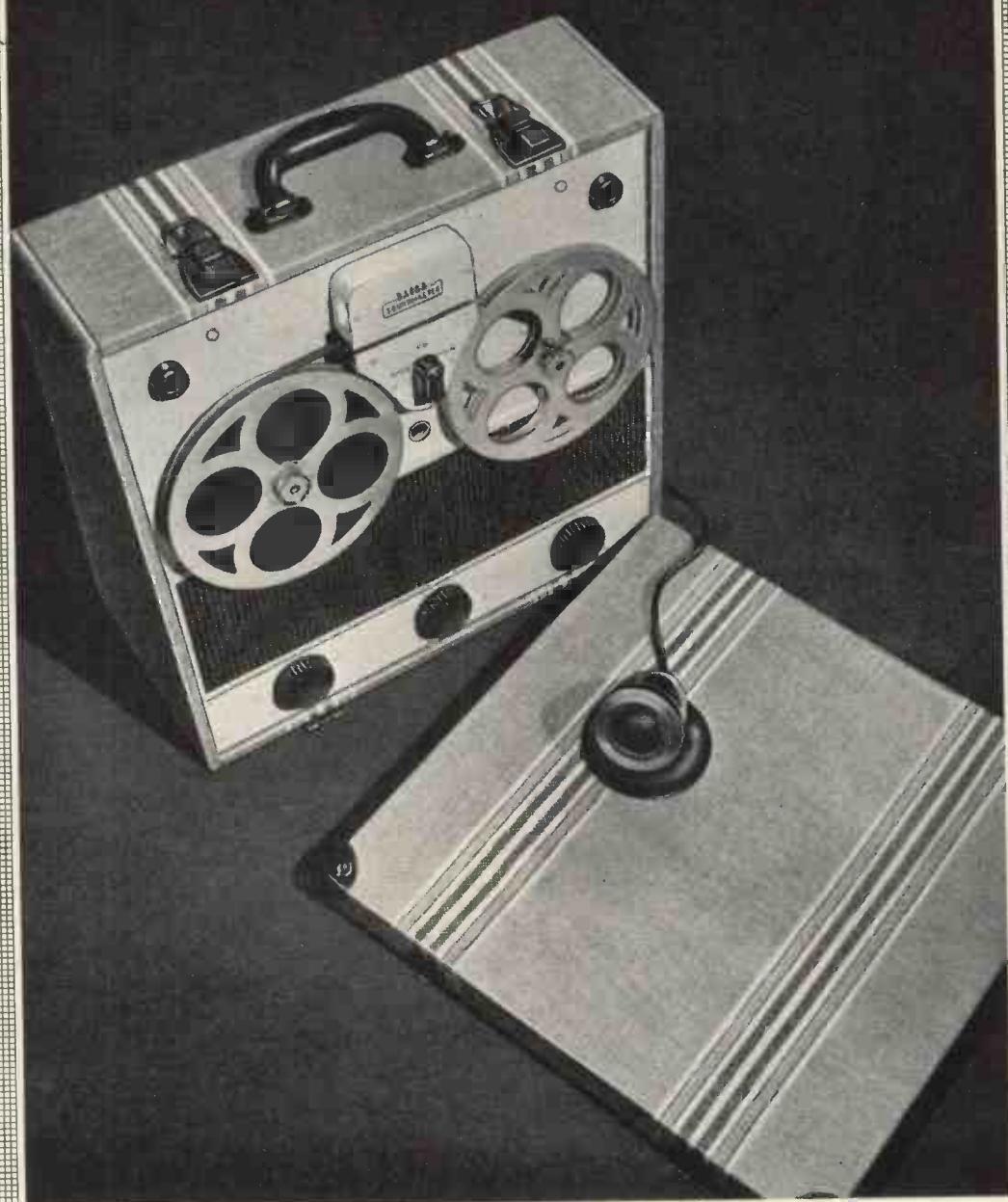
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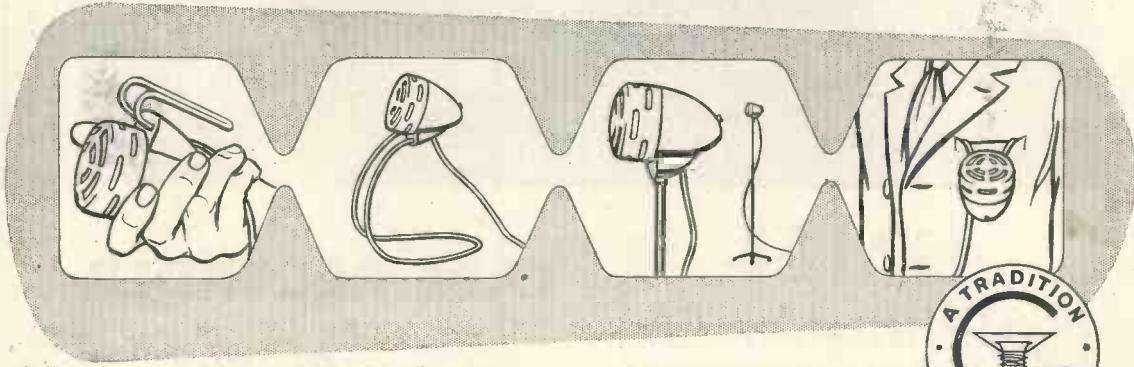
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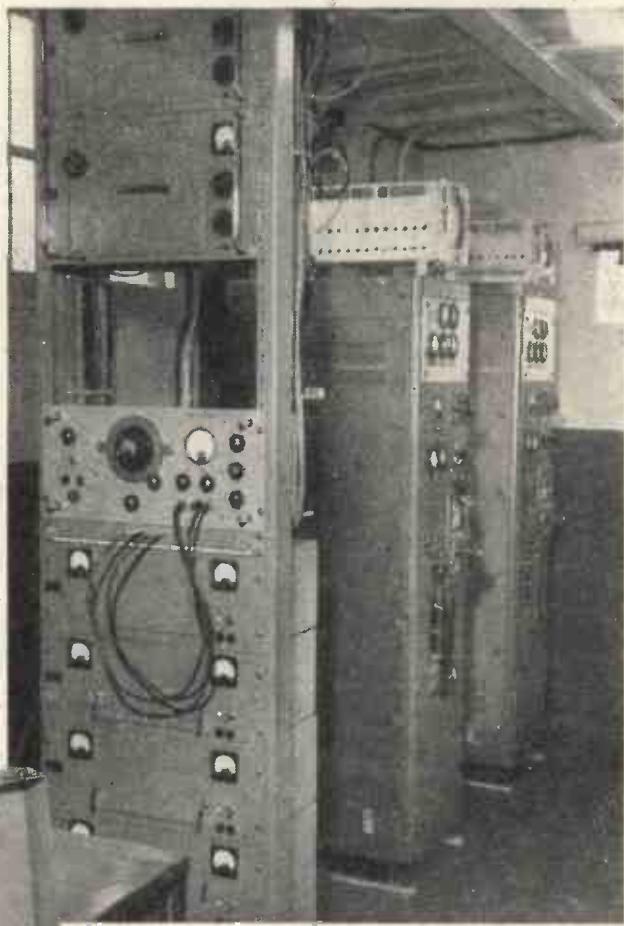
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An outstanding feature of the Wayne Kerr Video Oscillator Type O.222A is a thermistor bridge circuit stabilising the amplitude. Once set the output level will remain constant within 0.5 db while the oscillator frequency is varied over its full range of 10 kc/s to 10 Mc/s. Another advantage is its special facility for indicating the modulus of the load impedance to which the instrument is connected.



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<i>Output Level :</i>	Constant to ± 0.5 db at any frequency
<i>Output Impedance :</i>	75 ohms [setting
<i>Total Harmonic Content :</i>	less than 1%

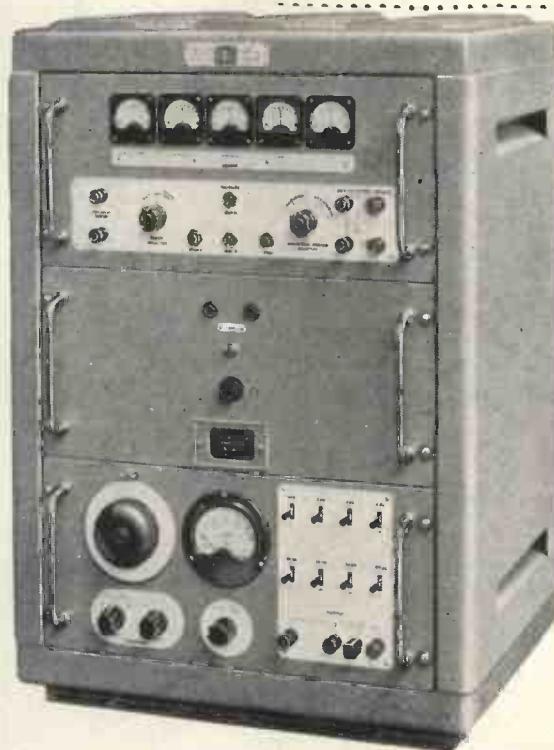


General view of the duplicate transmitters, distribution amplifiers, and testing equipment in the temporary television station at Truleigh Hill, near Brighton. The Wayne Kerr oscillator is used for checking the response characteristics of the vision transmitters over their full bandwidth.

Photograph by courtesy of the B.B.C.

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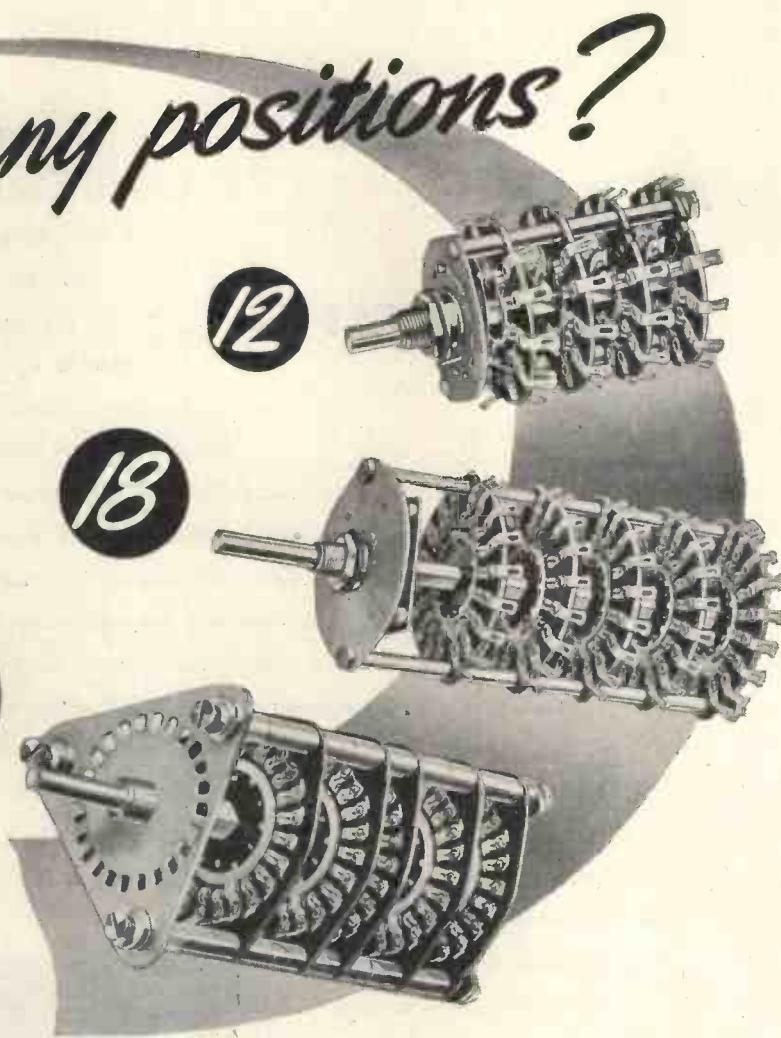
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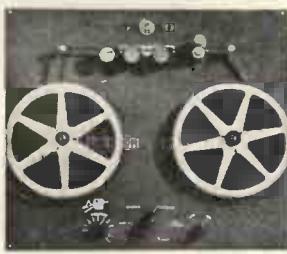
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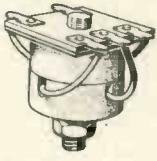
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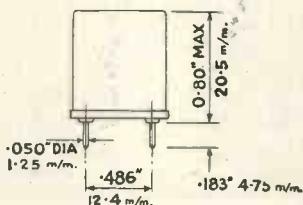
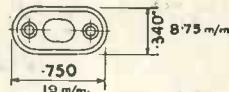
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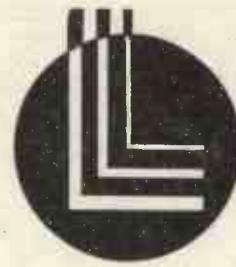
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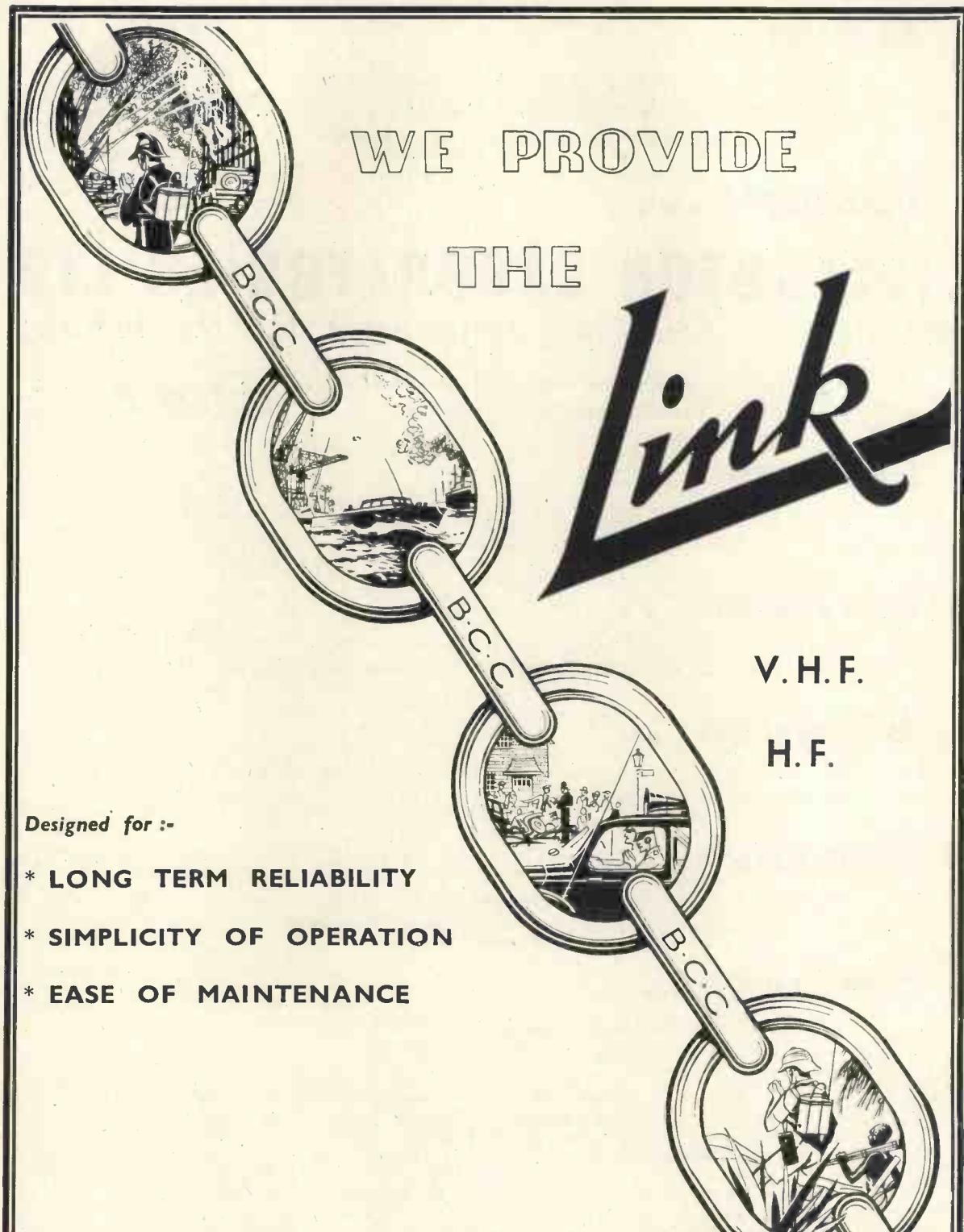
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This new range has been developed to take full advantage of the television sound transmissions and high fidelity recordings now available. The cone is made from uncured cambric and bonded pulp, the whole being completely cured together and made into one composite cone by a new manufacturing process.

The bass resonance is substantially lower than that using the conventional cone, and all coloration is therefore removed from the lower frequencies. No tiring or fatigue of the surround takes place. The high frequencies are well maintained, which, together with the extended bass response, provides a well-balanced overall response. The speakers are all fitted with high flux density Alcomax magnets and are completely dustproof.

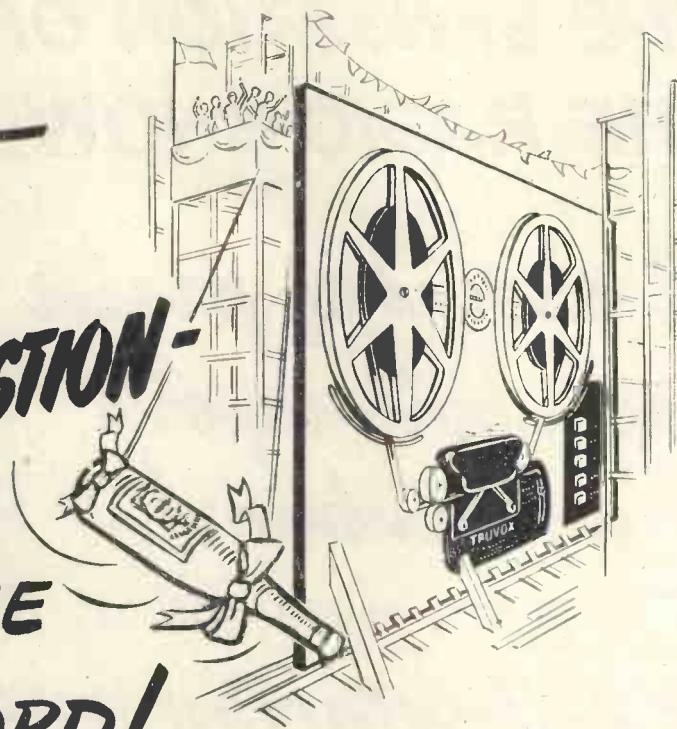
Write for leaflet giving full technical details and the experts' opinions, or ask your dealer to demonstrate. Alternatively, these speakers may be heard at our London Office, 109 Kingsway, W.C.2, any Saturday between 9 and 12 noon.



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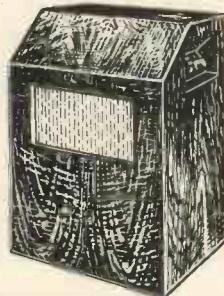
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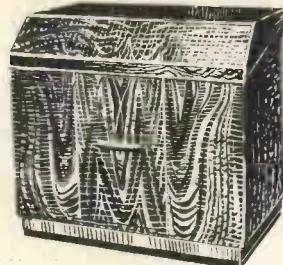
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4' x 3' PICTURE**

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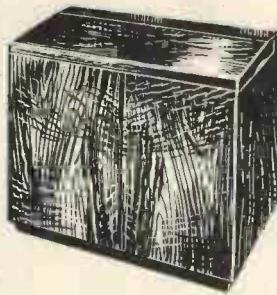
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30" x 22½"
PICTURE**

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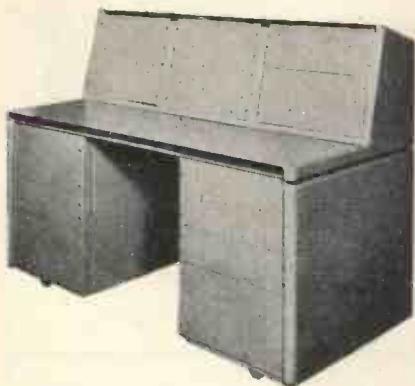
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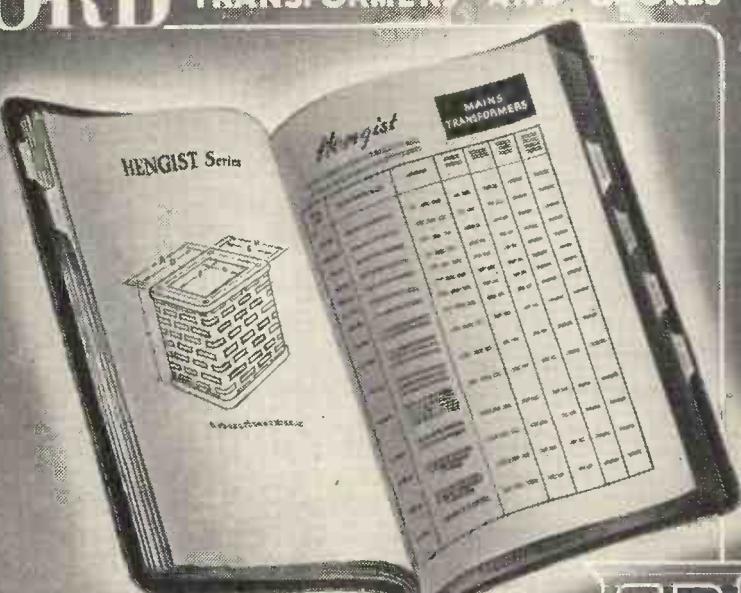
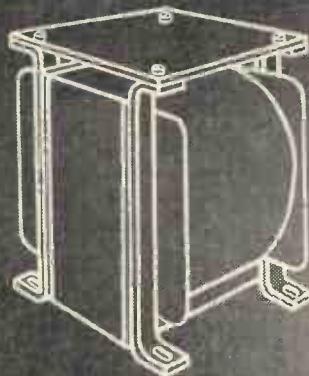
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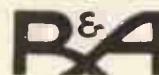
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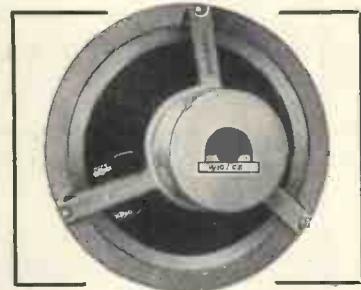
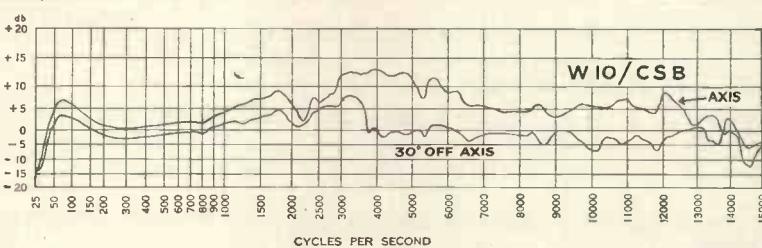
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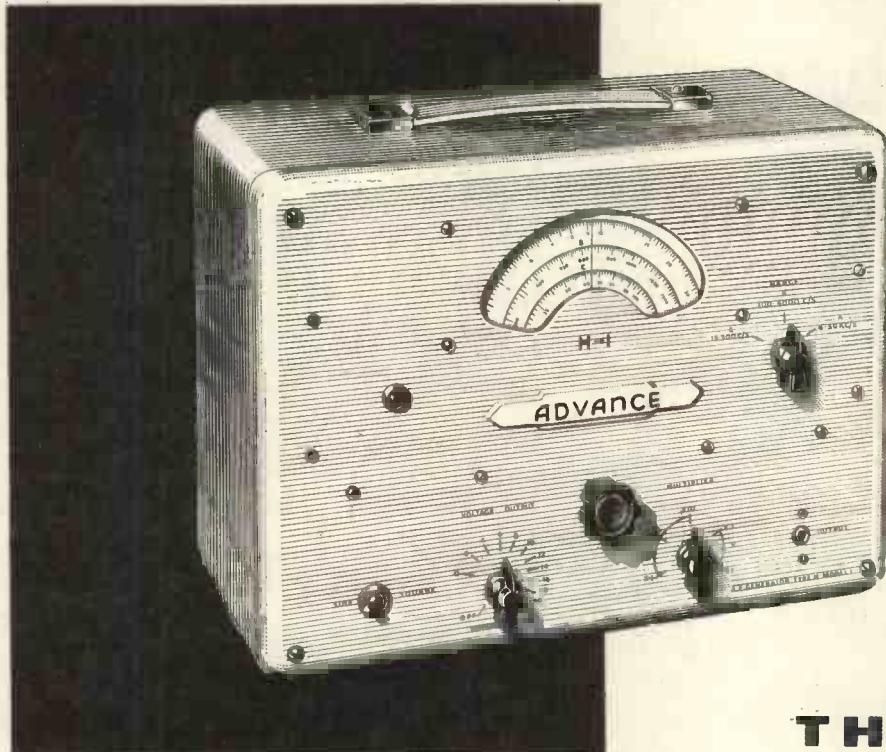
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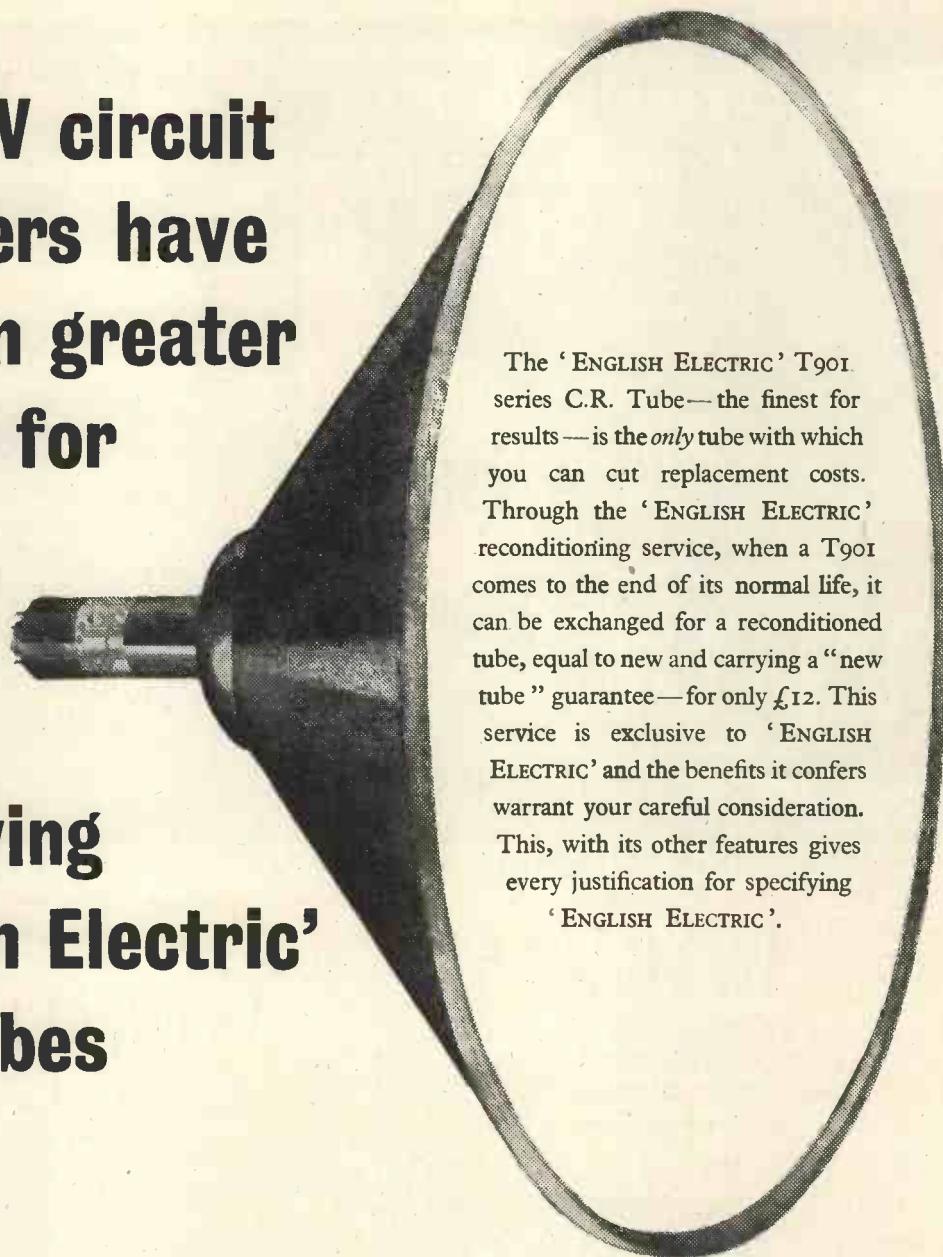


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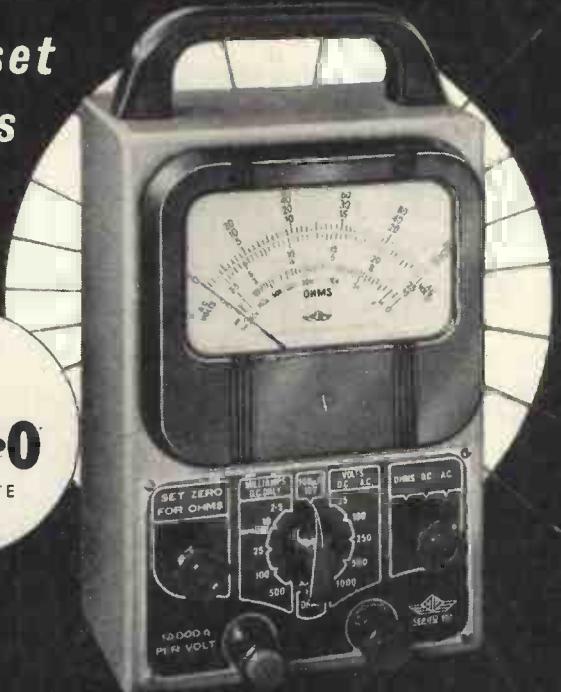


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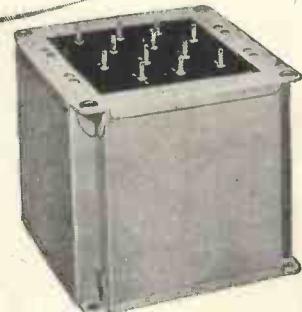
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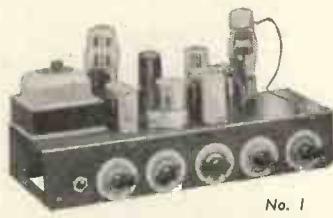
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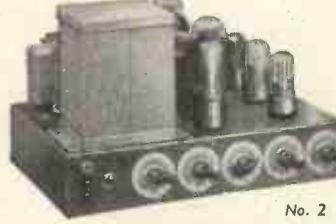
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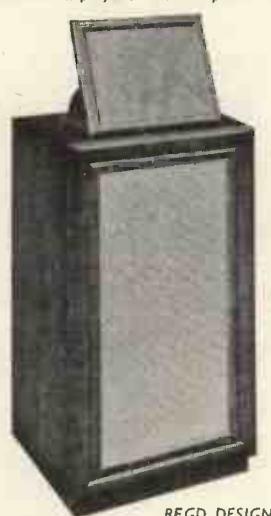
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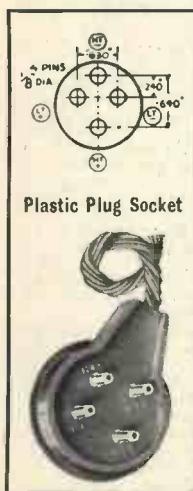
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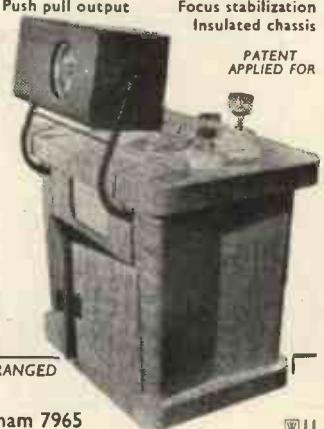
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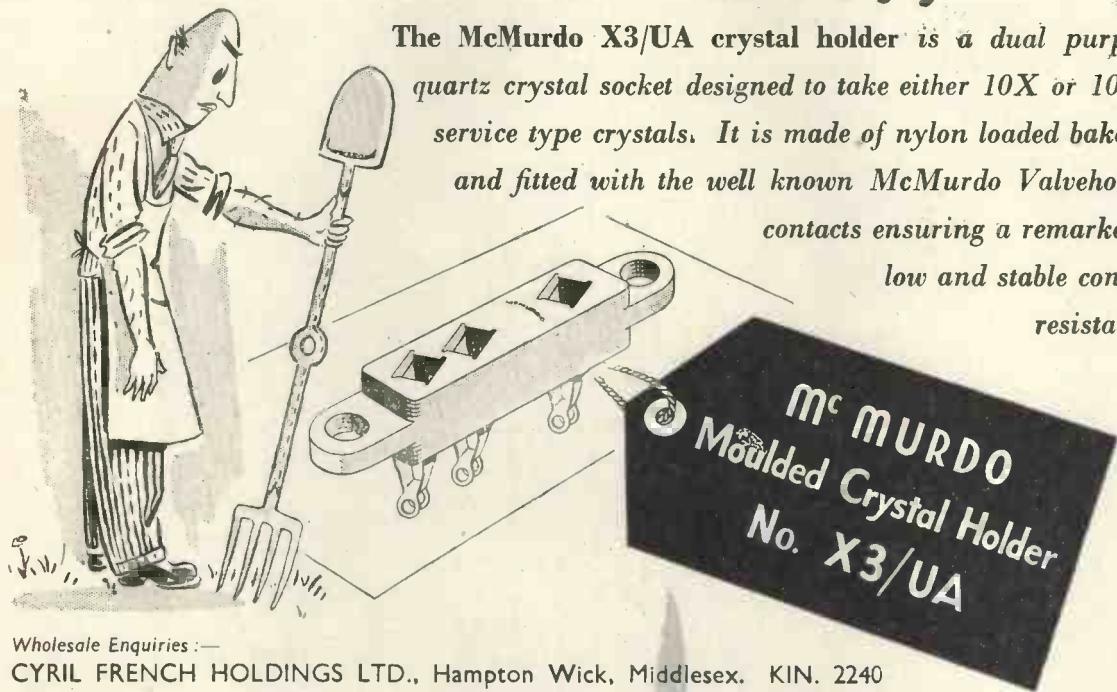
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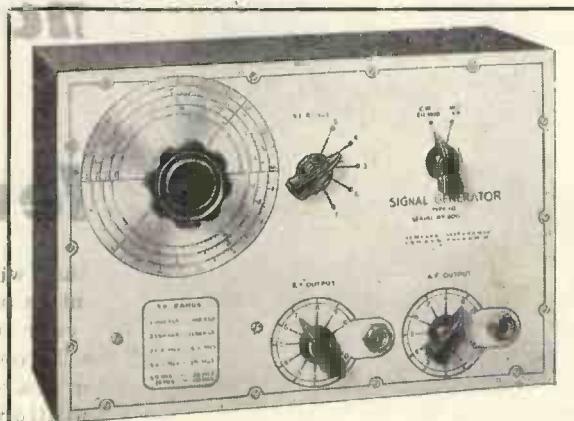
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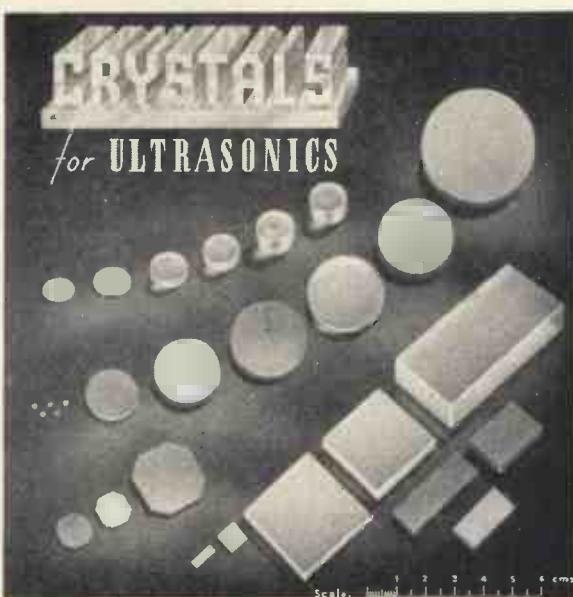
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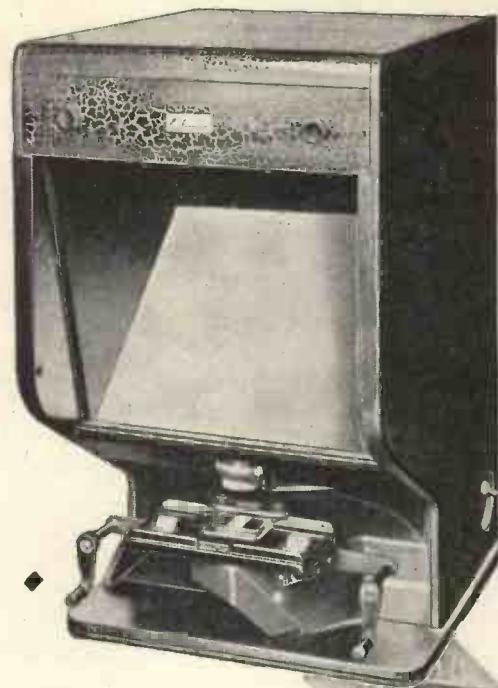
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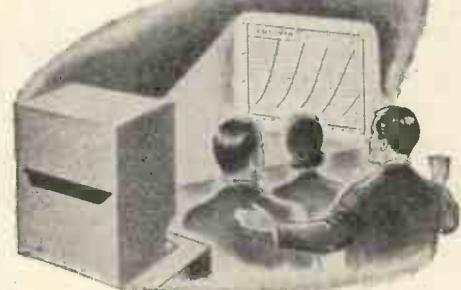
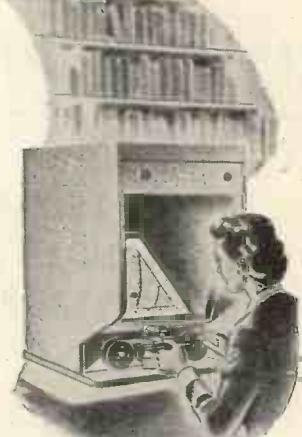
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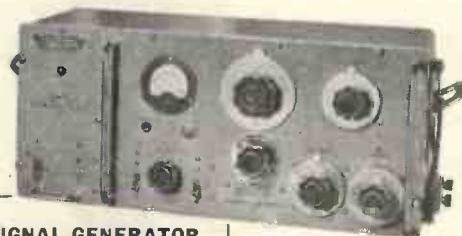
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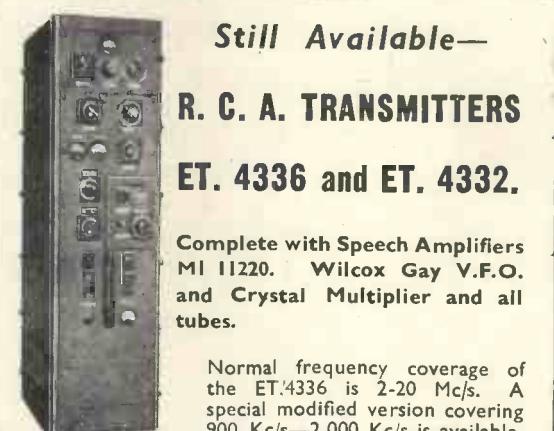
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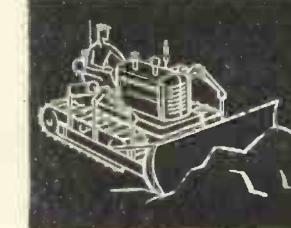
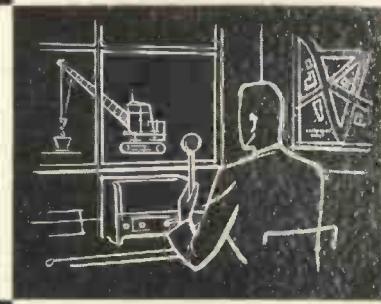
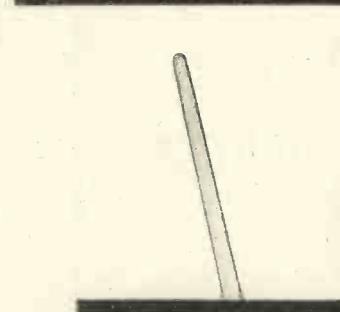
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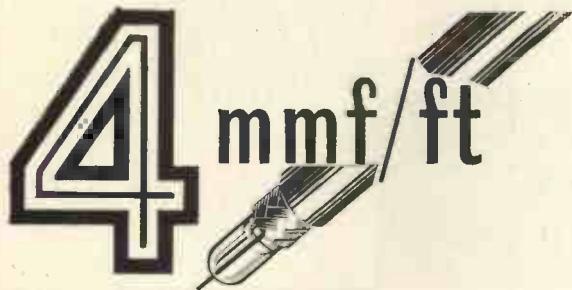
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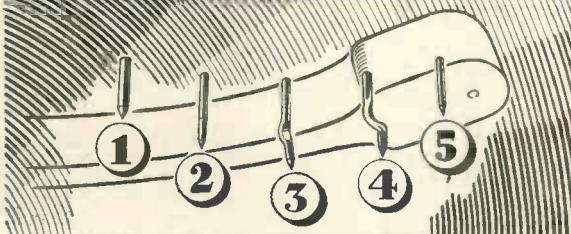
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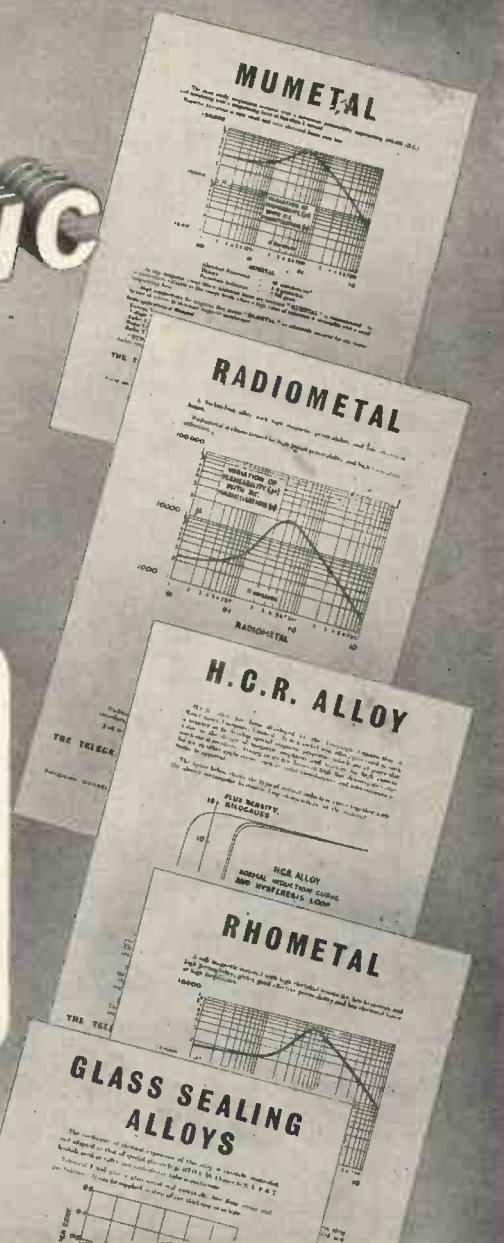
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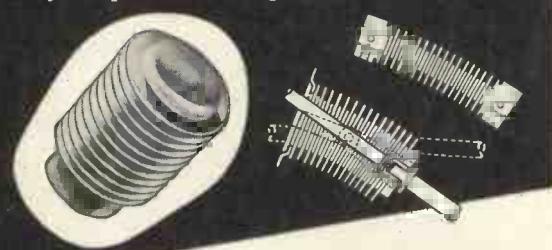


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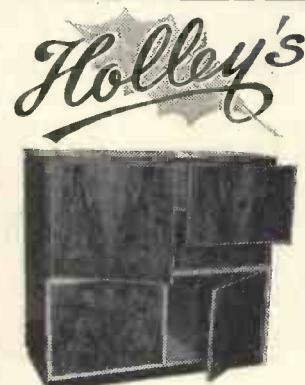
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to house all types
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**H.I-FIDELITY
EQUIPMENT**

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Other models from 5 gns.



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12in. Models from 57 gns.	
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**THE HUNTON UNIVERSAL BOLSTER OUTFIT
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Bolster Frame with
2 adjustable gauges
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1/16 in. to 3/16 in. bore
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Two Punch Holders
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Standardized Tools also available at short notice for Square, Oblong and other shapes, Louvre Forming (up to 8in. long), Corner Notching, Corner Radiusing, Angle Iron Notching and Piercing, etc.

Get the Outfit now—Buy Punches, Dies and Tools as you need them.

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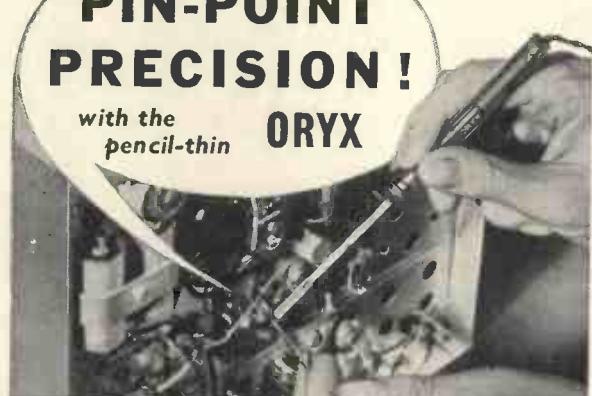
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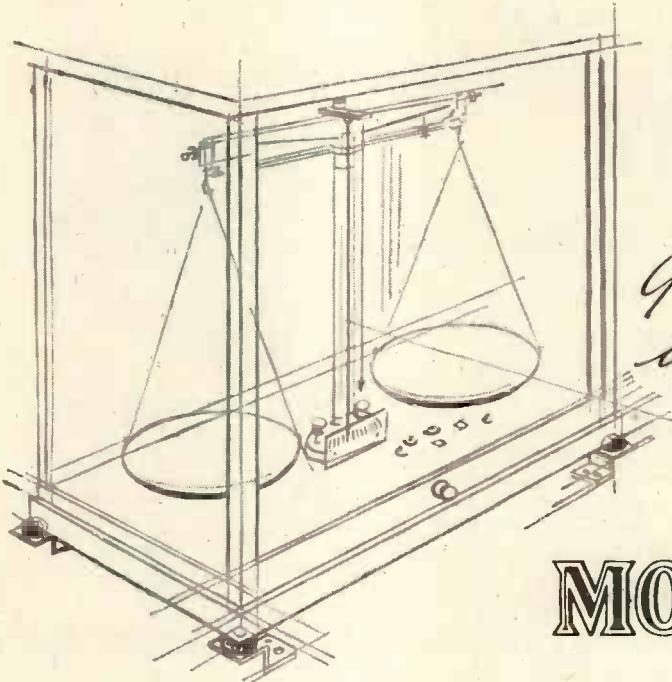
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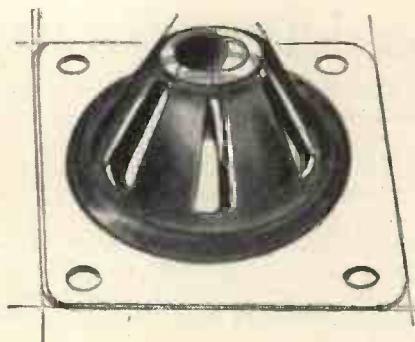
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IN this instance the Series 38 "Flexilant" Mounting protects a delicate instrument from vibration and shock. Other applications are manifold — from aircraft to power-station instrument panels: from ship's instruments to the protection of pyrometers in a steel works.

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Senior and Junior models have a power handling capacity of 15 and 10 watts respectively and provide a substantially linear response from 175 to 10,000 c.p.s. The Senior model is available with built-in tropicalised multi-ratio transformer a noteworthy feature much appreciated by sound engineers.

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The wide frequency range and low distortion of present day amplifiers will show up any deficiencies in the reproduction of radio programmes. Very severe distortion is often apparent and this is generally blamed upon the quality of B.B.C. transmissions. However, research has shown that the main cause of the trouble lies in the detector circuit of the receiving equipment. B.B.C. programmes are often modulated up to 100% depth, and under these conditions a conventional detector circuit can give as much as 20% distortion.

T. S. Marshall, designer for Lee Products, has developed a new diode detector circuit which has unity D.C./A.C. load ratio at all audio frequencies and it will accept up to 100% modulation without distortion. A superhet tuner unit, for quality reception and using the new circuit, is in production.

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ELPICO HOUSE, GT. EASTERN ST.,
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Tel. : Bishopsgate 0444-5-3 Grams. : Leprod, Ave. London
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Hefty & Frogg, Oslo, Norway, Storgaten, 15.

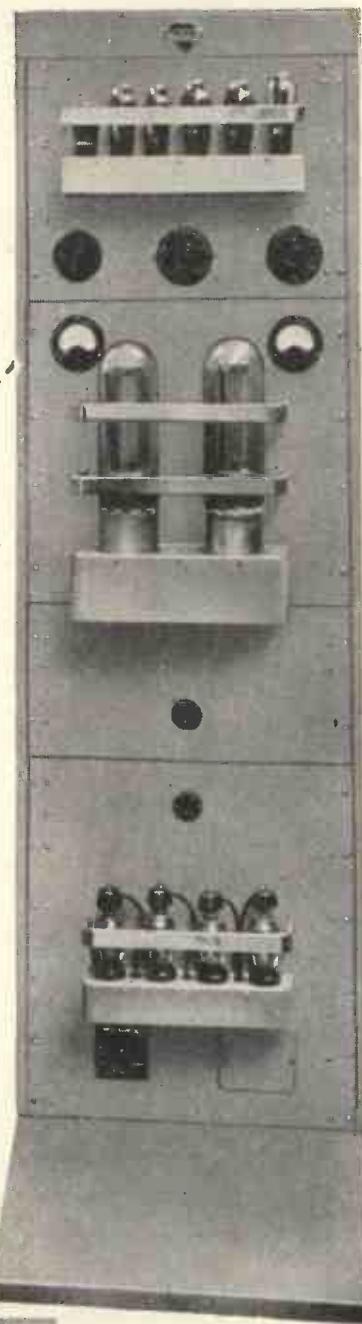
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ETA TOOL CO
(LEICESTER) LTD
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Ultrasonic Power for Industry



*H.F. Ultrasonic Generator
type E.7562*



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type E.7590*

MULLARD, pioneers in the application of ultrasonic power to industry, now make available the first of a range of h.f. and l.f. ultrasonic generators that provide from 50W — 1kW ultrasonic power at frequencies in the range 15 kc/s to 2 Mc/s.

These equipments are already being successfully applied to such processes as the tinning of aluminium and its alloys, the rapid cleaning of small engineered parts that are either inaccessible or that require delicate treatment, and the dispersion of particles in liquid media.

In addition to these proved applications, high power ultrasonics offers interesting possibilities in research projects where cavitation phenomena or high particle velocities are required.

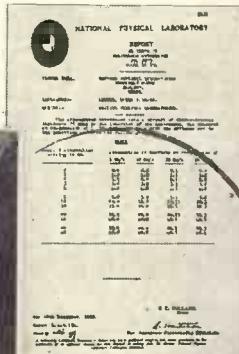
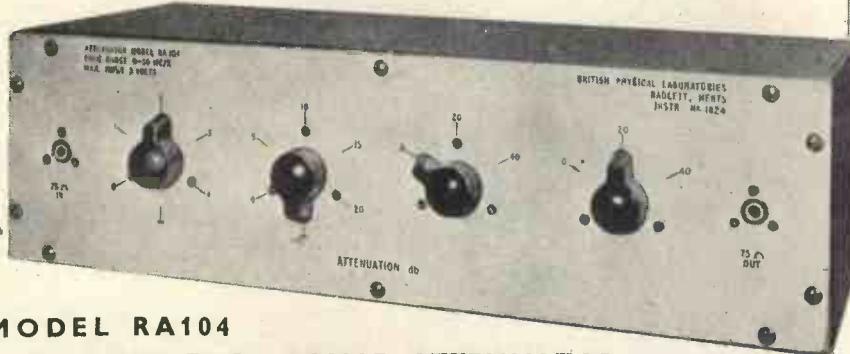
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SPECIALISED ELECTRONIC EQUIPMENT

**INCREMENTAL ACCURACY Within 1% up to 70 Mc/s
BACKED BY N.P.L. CERTIFICATE**



(EXTRACT)
Table

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WIDE FREQUENCY RANGE ATTENUATOR

It is the only unit of its type, independent of frequencies up to 70 Mc/s designed to operate between 75 ohms resistive loads.

THE ONLY COMMERCIALLY AVAILABLE INSTRUMENT

over the range 1-104 db, in steps of 1 db. A National Physical Laboratory Certificate quotes the adjoining figures.

Please write for full details.

BRITISH PHYSICAL LABORATORIES

Tel.: Radlett 5674-5-6



Radlett HERTS

Nominal attenuation setting in db.	Attenuation in decibels at frequencies of	1 Mc/s	10 Mc/s	30 Mc/s	50 Mc/s
0	0.0	0.0	0.1	0.2	
1	1.0	1.0	1.1	1.2	
2	2.0	2.0	2.1	2.2	
3	3.0	3.0	2.1	3.2	
4	4.0	4.0	4.1	4.2	
5	5.0	5.0	5.1	5.2	
10	10.0	10.0	10.15	10.3	
15	15.0	15.0	15.2	15.3	
20	20.0	20.0	20.15	20.3	
40	40.0	40.0	40.2	40.3	
20	20.0	20.0	20.1	20.3	
40	40.0	40.0	40.3	40.4	

dmBP11

SCREENED CONNECTORS

for cables of 0.2" to 1.03" O.D.

Single and multi-way types.

Special types fitted with coupling rings.

Cable joining connectors.

U.S. Type Connectors
as illustrated.

CABLE O.D.	TYPE	CODE NO.
0.41"	Straight plug	GD.071
0.25"	Reducing adaptor	RD.07/05
0.2"	Reducing adaptor	RD.07/03
fits on GD.071 CD.071 VD.071	Elbow plug adaptor	LD.071
fits on GD.071 LD.071	Bulkhead (Junction) adaptor	VD.071
fits on GD.071 LD.071	Chassis receptacle	CD.071

Other Transradio specialised products:

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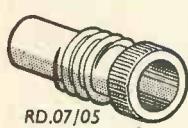
Very Low Loss Cables.

Microdual Two-speed Precision Drives.

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COIL WINDING MACHINERY



We invite your enquiries for the Type A1/1 automatic machine, as illustrated. Also for the Type H/1 hand coil winder and Type AW/1 Armature Winding Head.

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**AXIOM 150 MK. II****BRIEF SPECIFICATION**

Frequency Coverage	30/15,000 c/s
Fundamental Resonance	35 c/s
Max. Power Capacity.....	15 watts peak A.C.
Flux Density	14,000 gauss
Finish	Grey Rivelling Enamel
Price	£10 : 5 : 6 (Tax free)



Dimensional drawings of this specially designed Corner Reflex Cabinet measuring approximately 46" x 29" x 19", and illustrated literature covering the full range of Goodmans Loudspeakers will be sent on request.

Sound Appreciation



Here is an appreciation of high quality Sound reproduction, typical of many we receive from enthusiasts all over the world who own or have listened to a Goodmans High Fidelity or good quality Commercial Loudspeaker.

Berkeley, Glos.
September 7th, 1953

Dear Sirs.

On Wednesday last, the opening day of the Radio Show at Earls Court, I attended one of your sound demonstrations, and right now, please let me say how much I enjoyed it. I was greatly impressed, and in my humble opinion (just an ordinary person who enjoys high quality) considered the results from your new 8" speaker - STUPENDOUS.

of all was the speaker which attracted me most specially designed cabinet, and 12" in the please send me details of how such an identical cabinet can be constructed.

This is but one of the numerous unsolicited testimonials which are continually reaching us, the originals of which are available for inspection.



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AXIOM WORKS, WEMBLEY, MIDDLESEX

Telephone : WEMbley 1200

Cables : Goodaxiom, Wembley, England

FOR BRILLIANT SOUND RECORDING



G.81

12" speakers NOW TAX FREE!

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£2.12.6 } & £1 monthly
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Please supply
for which I enclose £ : : Deposit and agree to pay
further monthly payments of £ : : commencing on the first
day of next month.

Signed (usual signature).....

Name in full (CAPITALS)

Address.....

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FRITH RADIOCRAFT LTD., Churchgate, LEICESTER

- Two speeds, giving TWO HOURS perfect speech recording, or ONE HOUR high-fidelity music recording.

- Push-button control and magic eye tuning give instant mastery of both recording and reproduction.

- The same tape can be used repeatedly, each new recording automatically erasing the previous one, or recordings can be kept and played indefinitely.

- High-speed rewind mechanism returns you to any part of the two hour tape in two minutes.

- Unique condenser microphone, as sensitive as the human ear, faithfully reproduces all tone characteristics.

- Sound Frequency Range: 50-10,000 c/s at 7½ in. per second. 50-6,000 c/s at 3½ in. per second.

As compact and portable as a suitcase.

PRICE 80 GNS. H.P. TERMS AVAILABLE

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Reporter 700L

TWO SPEED TAPE RECORDER

*The Finest Tape Recorder
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- A magnetic Turnover Cartridge with high output and cantilever stylus.
- Entirely new principle. (Pat. applied for.)
- Output comparable to crystal pickups.
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- Stylus easily replaceable.
- Smooth extended frequency response on both standard and L.P. records.
- The ideal replacement Cartridge for 3-speed record changers and units.

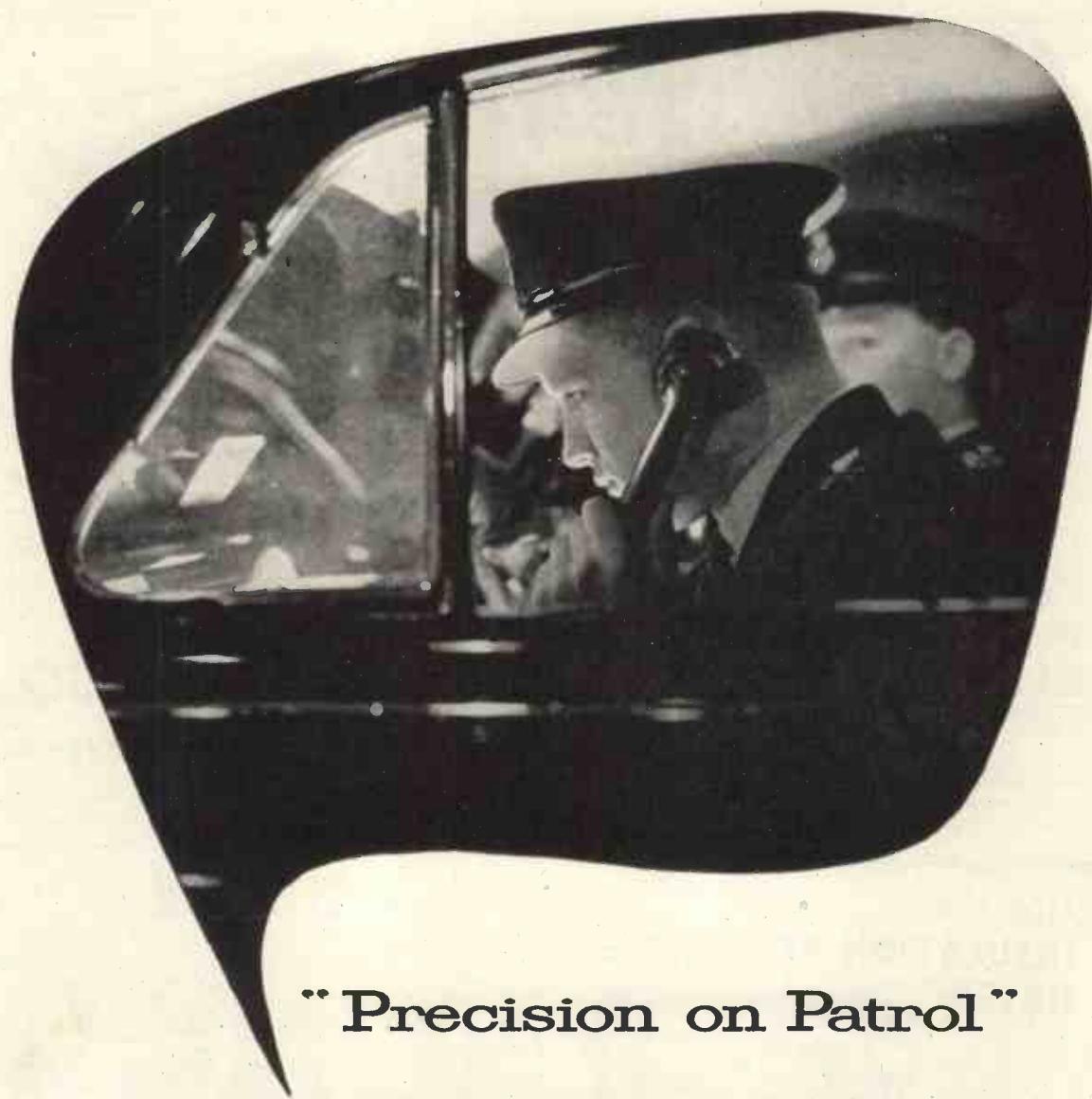
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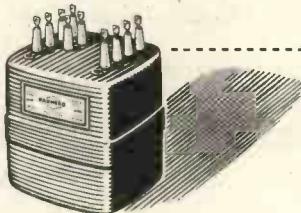


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"Hello KLN 3...attend R.T.A....A.6...6 miles from..."

Briefly—precisely—instructions are given and the patrol car is on its way. That the police are so quickly on the scene of action is due to the efficiency of their system, the skill of their men, and the dependability of their equipment.

Only the highest possible performance by its many components enables shortwave equipment to succeed in its task. Parmeko are proud of the part played by their transformers, whose absolute reliability is shown by their continued use, not only by the police and all branches of H.M. Services, but in every branch of industry



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Makers of Transformers for the Electronic and Electrical Industries

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Test this new motor at your earliest opportunity.

You will find it possesses all the qualities you have been looking for !
12in. turntable, 33½, 45 and 78 r.p.m. Synchronous motor, virtually vibrationless.

Suitable for standard, transcription and microgroove recordings.
Input voltages : 200-250 A.C. 50 cycles. 110 volts 60 cycles to order



3 Head PICK-UP

The CONNOISSEUR SUPER LIGHTWEIGHT PICK-UP

Extremely low mass at needle point (4/5 m.g. only), allowing for reduction in downward pressure to 8/10 grams for standard recordings, and 4/6 grams for microgroove recordings.

PRICES with one Head, £4/10/-, plus £1/9/3 tax.

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Spare Armature System with sapphire. 10/3, plus 3/4 tax.

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CANADA : The Astral Electric Co. Ltd., 44 Danforth Road, Toronto 13, Ontario.

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INSULATION RESISTANCE METER

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0.9 TO 10,000,000 MEGOHMS

Self-contained, mains operated with stabilised voltage compensation and incorporating meter overload protection in the case of sample breakdown, this resistance meter is designed for intensive use in testing high values of insulation. Test pressure variable from 0-1,000 V.D.C.
Write for full specification.

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K4 UNIT (shown above).....17 guineas

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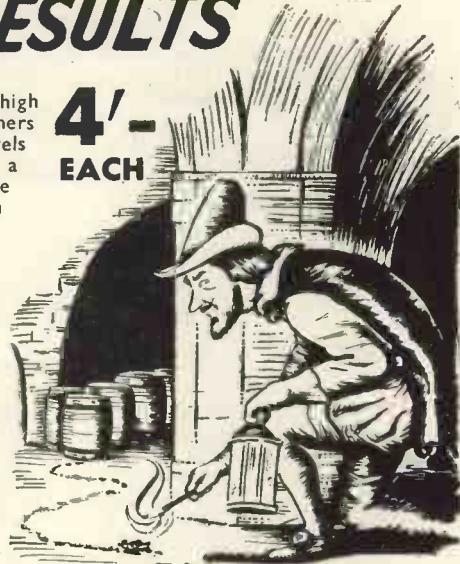


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- ★ Variable iron-dust cores.
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COILPACKS. Now at new lower prices! A full range is available for Superhet and T.R.F. Mains or Battery. Size only 1½in. high x 3½in. wide x 2½in. Ideal for the reliable construction of new sets, also for conversion of the 21 RECEIVER, TR 1196, TYPE 18, WARTIME UTILITY and others. Aligned and tested, with full circuits, etc. Fully descriptive leaflets available.

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A spotlight on just one of the range of **OSMOR** "Q" coils

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Frequency coverage 150 kc/s. to 20 m.c. Iron-dust core and single-screw fixing. Prototype tested and approved by M. G. Scroggie, B.Sc., M.I.E.E. Ideal as anode load in TRF receivers, for decoupling and general purpose. Price 4/-.



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The NEW **OSMOR**

CHASSIS CUTTER

of entirely new design. Cuts two sizes of holes with any one reversible punch and die; and can be operated with a spanner or tommy-bar. Blanks easily removed. For use on steel up to 18 swg. Brass and Dural up to 16 swg. Aluminium and Copper up to 14 swg.



P.P. 11325/53

Type	Hole Sizes	Price
1	1in. x 1½in.	19/6
2	1in. x 1½in.	18/9
3	1in. x 1½in.	22/6
4	1½in. x 2½in.	27/3

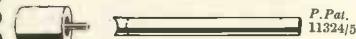
Post and Packing 1/- (any type).

Tommy Bars

..... 1/3 each

The OSMOR "JIFFY PUNCH"

For cutting smaller holes neatly and quickly with one blow of a light hammer.



P.P. 11324/53

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2	¾in.	7/6
3	1in.	8/9

For use on Steel up to 20 s.w.g. Brass and Dural up to 18 s.w.g. Aluminium and Copper up to 16 s.w.g.

(Dept. W.47) BRIDGE VIEW WORKS, BOROUGH HILL, CROYDON, SURREY.



Keep those small components—resistors, condensers, etc., neatly stored yet visible by using an

OSMOR "JAR-RACK"

(If you're a generous husband you'll buy one or two for your wife's larder, too—she will appreciate the extra space they make. Holds any 1 lb. jam jars, with or without lids. Easily removed, cannot fall out. Just the thing for the tidy "HAM" or Radio Dealer.

Type 1 for wall-fixing, 6/9 each, holds 8 jars. (Jars are not supplied but are easily obtained.)

Length 2¼in. enamelled olive green.

Type 2 (as illustrated) for screwing under a shelf, 5/9 each, holds 6 jars.

Length 18in., enamelled green.

Post and packing 1/- (either type).

(Trade supplied)

OSMOR "STATION SEPARATOR"

TYPE METRES
1—141-250
2—218-283
3—267-341
4—319-405
5—395-492
6—455-567
7—1450-1550
8—410-550 k/c

This is a device on the well-known "wave-trap" principle, which will reject an undesired signal when inserted in the aerial lead.

The Separator may easily be tuned to eliminate any one Station within the ranges stated and fitting takes only a few seconds. Sharp tuning is effected by adjusting the brass screw provided.

Complete with plug, socket and full instructions—nothing to add.

7/6 POST FREE. Satisfaction guaranteed.

FREE!

Send 5d. (stamps) for
FREE CIRCUITS and
full lists of coils, coilpacks
and radio components.

OSMOR **radio products ltd.**

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The Ideal Receiver for Point-to-Point
and Ground-to-Air Channels

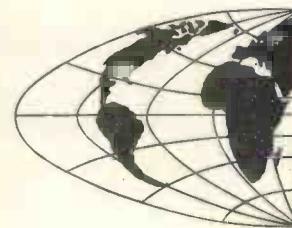
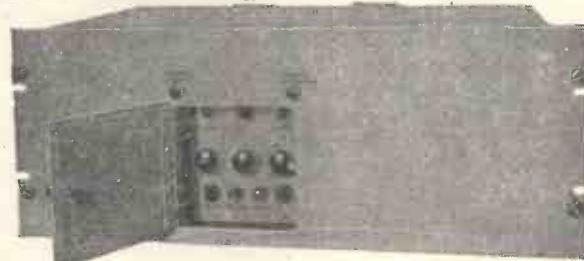
A Fixed Frequency, Single Channel Receiver
covering 2 to 20 Mc/s.

The crystal-controlled R.93 is an important receiver which has been designed to operate over long periods under either temperate, arctic or tropical conditions at unattended sites. A number of R.93's may be stacked in standard 19" racks for multi-channel working on R.T. or W.T. Double or triple diversity racks can also be supplied with suitable terminal equipment for direct teleprinter operation from frequency shift transmission. Enquiries will receive immediate attention.

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Redifon

DESIGNERS AND MANUFACTURERS OF RADIO COMMUNICATIONS AND INDUSTRIAL ELECTRONIC EQUIPMENT



TRUVOX TAPE RECORDING AMPLIFIER

built by KENTON LABORATORIES LTD.,
to the precise specification approved by
TRUVOX for use with their Tape Deck.

THREE MODELS ——————
HIGH FIDELITY ——————
HANDSOME CABINETS ——————
all complete with Deck and matched High
Fidelity P.M. Speaker.

CONSOLE —————— **77** gns.
TABLE MODEL —————— **65** gns.
PORTABLE —————— **57** gns.

YOUR TRUVOX Deck can be
incorporated if required.

KENTON
LABORATORIES LTD.
273 BRIXTON ROAD, S.W.9
Trade enquiries invited

BRI. 2147



The Minor, although small, possesses all features of the large models and no mechanical or electrical point essential to efficiency has been omitted.

Among other fine instruments manufactured by:—

THE RECORD ELECTRICAL CO LTD
BROADHEATH - ALTRINCHAM - CHESHIRE

Phone : Altrincham 3221 (4 lines) Cables and Grams: "Cirscale" Altrincham
London Office : 28 Victoria Street, S.W.1. Phone : Abbey 5148 & 2783
Grams : "Cirscale" Sowest, London. Cables : "Cirscale" London



OPEN TILL 8 P.M. SATURDAYS

TELEPHONES: AMBASSADOR 4922 & PADDINGTON 311/2

PREMIER RADIO Company

(Dept. W.W.) 207 · EDGWARE ROAD · LONDON · W2

Terms of Business:
Cash with order or
C.O.D. over £1. Please
add 1/- for Post Orders
under 10/-, 1/6 under
40/-, unless otherwise
stated.

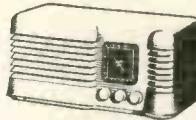
BUILD A PROFESSIONAL LOOKING RADIO AT LESS THAN HALF TODAY'S PRICE

We can supply all the parts to help you.	
Drum (2½in. dia.)	1/6
Driving head	1/6
Double pointer	1/6
Spring	1/6
Nylon Cord (yard)	9d.
Dial Front Plate	2/6
Engraved Glass Dial	1/6
Dial	1/6
180-550 and 300-	2/6
2,200 m. With station names, new wavebands	1/6
T.E.F. Colls. 180-550, 500-2,200 metres, pair	1/6
Punched chassis, 3-valve plus rectifier T.R.F.	3/9
Cabinet, Bakelite, in Walnut or Ivory or Wooden in Walnut Finish	17/6
Packing and Insurance	1/6
SEND 1/6 FOR EASY TO FOLLOW POINT-TO-POINT DIAGRAMS AND CIRCUIT DIAGRAM which shows how YOU can build the Receiver illustrated above.	



THE COMPLETE KIT to construct a 3-valve plus rectifier T.R.F. Receiver for use on 200/250 v. A.C. mains can be supplied at £19.6, plus 2/6 packing and carriage. Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow point-to-point diagrams are supplied, making construction very simple. The Dial is illuminated, and the Receiver housed in its Cabinet, size 12in. x 5in. x 6in. presents an attractive appearance. The valve line-up is: 717A - H.F. Pentode, VR116 - R.F. Detector, ATP4 - Output, and Metal Rectifier.

Waveband coverage is for the medium and long bands. Choice of 3 Cabinets: Bakelite in Walnut or Ivory, or Wooden (Walnut finish).



ONLY A FEW LEFT—BUY NOW! THE FAMOUS 'SOBELL' 4-VALUE SUPERHET TABLE RECEIVER

M. & L. WAVEBANDS

Valve line-up: 12J7, 35L6,

1470, 35Z4.

Entirely transportable and unusually sensitive owing to special feed-back circuit employed. Housed in attractive played cabinet.

Choice of 2 Colours—Brown

and Cream.

Carrying handle incorporated in design. For use on

200/250 A.C./D.C. mains.

Plus 5/- Pkg. Carr./Ins.

£8 . 8 . 0

Fully covered by Manufacturer's Guarantee



LIMITED QUANTITY ONLY AVAILABLE AT GREATLY REDUCED PRICE

The Famous 'ROBERTS' M.A.D.

All Dry Battery Portable (Ex.-R.A.F.)

This is a 4-valve superhet Receiver covering medium and long wavebands. Built-in Aerial. Housed in a superbly finished rexine covered case. Brand new in manufacturers' original carton. **£10 . 10 . 0**



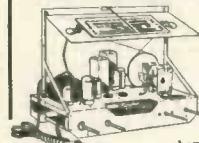
plus 7/6 pkg./carr. (Complete with Battery 17/6 extra.)

MANUFACTURER'S SURPLUS STOCK

5-VALVE SUPERHET RADIO RECEIVER CHASSIS, built to high standards ensuring quality reception. SPECIFICATION:—

VALVE LINE-UP: 787, 787, 7C6, 7C5, 7Y4, 3 WAVEBANDS Long, medium and short. CONTROLS: Tuning, wave change, volume, tone control, on/off Gram. Position on Switch. Pick-up and Extension Speaker Sockets Incorporated. For use on 200/250 v. A.C. mains. DIMENSIONS: Length 14½in., height 11½in. width 9½in. Distance between controls, left to right from edge of chassis: 11in. x 6in. x 3in. Plus 5/- pig./corr./Ins. **£7.19.6**

The above Receiver is less Speaker and Output Transformer. A suitable 10in. Moving Coil Speaker and Output Transformer can be supplied at 28/- extra.



LIMITED QUANTITY 1132A RECEIVER UNITS COMPLETE WITH CIRCUIT

11-valve Superhet Receiver, covering 100 to 124 Mc/s., using four VR53, two VR56, VR66, VS54 and VR57 valves. Fitted with Tuning Meter, slow motion drive, R.F. and L.F. Gain Control, etc. Circuit: R.F. amp., frequency changer, oscillator and stab., 3-IF.amps., B.F.O. Det., first audio and output. Brand new, with circuit diagram. Price 59/6 plus 7/6 carriage.

Price 59/6 plus 7/6 carriage.

POWER PACK for above completely wired and tested, will fit on Receiver chassis. Price 50/-, plus 2/6 pkg. and carr.

2 STAGE QUALITY AMPLIFIER Complete with 10in. Energised LOUDSPEAKER

4 watts output. A.C.
110/230 mains.

£6 . 19 . 6
plus 5/- carriage.



DECCA MODEL 33A DUAL SPEED RECORD PLAYER

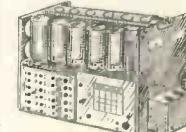
Includes crystal pick-up with sapphire stylus and a light weight plastic spring balanced arm. Heavy gauge pressed steel case with brown enamel finish in good quality for operation on A.C. mains 200/250 v. 50 c.p.s. Supplied complete with single head (either standard or long playing). **£4.19.6**

Extra Head can be supplied for 19/6. Plus pkg. and carr. 5/-.

**EX-U.S.A. U.H.F. AERIAL**

with untuned detector stage, consisting of V.R.92 valve. Brand new, in carton, 5/-.

MAINS NOISE ELIMINATOR KIT
Two specially designed chokes with three smoothing condensers with circuit diagrams. Cuts out all mains noise. Can be assembled inside existing receiver, 5/6 complete.

1124 RECEIVER UNITS

Range 30 to 40 Mc/s. Contains six new Valves 3-9D2, 1-8D2, 1-13D2 (frequency changer), 1-4D1, 24 ceramic trimmers, 6 ceramic valve-holders, 6 valve screening cans, 30 resistors, 1-W/W Pot. Meter Mica Tubular and Block Condensers, Ceramic coil former, 2 Westector WX6 and 1W/Westector WX4, 5-way 4-band switch with long spindle, I.F. transformers, etc.

17/6 plus 3/6 postage and packing.

1155 RECEIVER UNIT**SLIGHTLY SOILED**

In original cases, complete with 10 valves. Frequency range 18.5 Mc/s.—75 Kc/s. in 5 wavebands. **27/19.6**. Plus 10/6 packing and carriage.

**POWER SUPPLY UNIT**

for above, incorporating output stage. Supplies an output of 250 volts at 80 mA., which is ample for the R1155 with the output stage. Jones plugs for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and 6in. speaker is built into the unit. Price £5/5/-, plus 5/- packing and carriage.



We have a few Brand new R1155 Receivers in original cases, complete with 10 valves. Frequency range 18.5 Mc/s.—75 Kc/s. in 5 wavebands. **PRICE £11.19.6**. Plus 10/6 pkg. and carr.

As a special offer, power supply unit including speaker together with R1155 receiver. **PRICE £6.19.6**. Plus 15/- pkg. and carr.

R1355 RECEIVER AMPLIFIER with 5 I.F. Stages for T.V. conversion. Contains 7 VR55's, 1-5U4, 1-VU120, 1-EA50, £1/19.6. Plus pkg. and carriage 10/-.

RF 25 UNITS

Frequency covered 40-50 Mc/s (6-7.5 metres) switched tuning. 5 Pre-set positions complete with 3 VR55's. £1/5/- plus pkg. and carr. 2/6.

RF 26 UNITS

The ideal short-wave converter for T.V., variable tuning, contains 2-EF54, 1-VR137, £2/19.6, plus pkg. and carr. 2/6.

As a special offer we can supply the R1355 complete with RF.24 or RF25 at 59/6 or with RF26 at £4/17/0 plus carr.

R3136 RADAR RECEIVER UNIT

Containing 19 valves, 6-VR65, 2-6J7G, 2-VR116, 3-9Q79, 1-VR54, 1-VR137, 2-VR136, 1-VR92, 1-5Z5G, the Unit incorporates an R.F. strip followed by an I.F. strip, £5/7/6, plus pkg. and carr. 10/-.

*** CORRECT ASPECT WHITE RUBBER MASK—ROUND or FLAT**

6in. 8/6 9in. 9/6
12in. 16/11 13in. 27/6

T.V. PRE-AMPLIFIER

Amplifier Unit Type 208A using 2-VR91 valves suitable for operation on London frequency. Brand New **19/6** Plus 1/6 pkg. and carr.

A WORLD-FAMOUS Manufacturer's Surplus of RADIO RECEIVER CHASSIS 7-valve RECEIVER

Built to exacting specifications and incorporating features ensuring superior tonal qualities and world-wide reception. Specification: 8 watts push-pull output using 2 Mazda Pen. 45 valves. Ample negative feedback is applied over all the audio-amplifier. Amplifier Mazda Type HL41DD gives signal Detection A.V.C. and Phase Splitting. Two stages of I.F. amplification 465 Kc/s., using Mazda VP41.

FOUR WAVEBANDS—14 M.—24 M.—24 M.—55 M.—100 M.—500 M., 900 M.—2,000 M.

DIRECT AND VERNIER TUNING. Gram. position on Switch. Provision for external Loudspeaker. For use on 200/250 A.C. Mains. £13/10/- plus 21/- pkg. and carr.

Famous Manufacturer's Surplus of ANTI-INTERFERENCE AERIALS offered at a fraction of original cost



The aerial is designed for reception of long, medium and short waves, with any ordinary or communications receiver, having an input impedance greater than 1,000 ohms long medium waves and 150 ohms short waves. The installation discriminates against locally generated electrical interference, especially on the short wave bands. The equipment enables the installation of an 8.3 Mc/s flatly-tuned dipole which operates as a "T" aerial on medium and long waves. The aerial and receiver transformers are intended to be interconnected with a 70 ohm co-axial cable.

COMPONENT PARTS

Aluminium Aerial Transformer Assembly. Comprising one each: Aluminium transformer, Transformer clip, Rubber sucker, 1in. x 1in. brass screw, 4AB x 1in. brass bolt, 4BA nut.

Receiver Transformer. Complete with Insulators, clips, etc., Porcelain Insulators 2 each, 60ft. Insulated Aerial Wire, 60ft. Screened Co-Axial Down Lead.

Installation instruction leaflet included.

LESS CO-AXIAL CABLE & AERIAL WIRE 15/- plus 1/6 pkg. and carr.

COMPLETE 35/-, plus 1/6 pkg. and carr.

ROTARY CONVERTER POWER SUPPLY UNITS

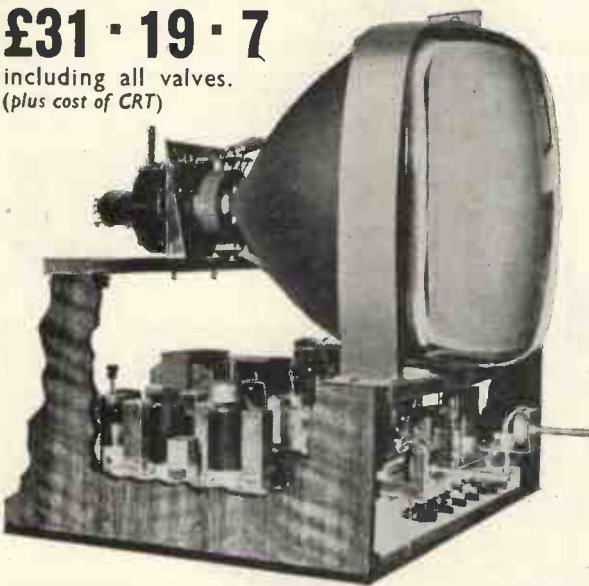
12 v. D.C. Input, 230 v. 30 m.A. Output. Completely smoothed. Complete with case, 19/6, plus pkg. and carr. 5/-.

PREMIER RADIO COMPANY

MAY BE BUILT FOR

£31 · 19 · 7

including all valves.
(plus cost of CRT)



THE COMPLETE TELEVISOR IS SAFE TO HANDLE, BEING COMPLETELY ISOLATED FROM THE MAINS BY A DOUBLE WOUND MAINS TRANSFORMER. ALL PRESET CONTROLS CAN BE ADJUSTED FROM THE FRONT, MAKING SETTING UP VERY SIMPLE.

The Televisor may be constructed in 5 easy stages : (1) Vision, (2) Time Base, (3) Sound, (4) Power Pack, (5) Final Assembly. Each stage is fully covered in the Instruction Book, which includes layout, circuit diagrams and point-to-point wiring instructions. The Instruction Book also includes full details for converting existing Premier Magnetic Televisors for use with modern wide angle tubes. All components are individually priced. Instruction book 3/6 post free.

The NEW **PREMIER TELEVISOR**

Three years ago we gave you the 6in., 9in. and 12in. Televisors which achieved tremendous popularity. Now after a considerable period of research our Technical Staff have designed a very worthy successor to these original Models.

Brief Technical Details are as follows:
19 valves (plus tube) Superhet Receiver, tunable from 40-68 Mc/s without coil or core changing. Wide Angle scanning Flyback EHT giving 14 kV, Duomax Focaliser permanent magnet focussing with simple picture centering adjustments, suitable for any 17in. or 14in. wide angle Tube, may also be used with a 12in. Tube with very minor modifications.

VISION CIRCUIT. Common RF Amplifier, single valve frequency changer, two IF stages, Video Detector and Noise Limiter followed by special type of Video Output Valve. ALL COILS PRE-TUNED ASSURING ACCURATE ALIGNMENT AND EXCELLENT BANDWIDTH.

SOUND CIRCUIT. Coupling from anode of frequency changer, two IF stages, Double Diode Triode detector and first LF Amplifier, Diode Noise Limiter and Beam type Output Valve, feeding a 10in. Speaker. ALL COILS PRE-TUNED.

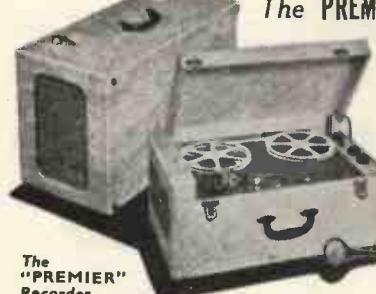
TIME BASES. 2 valve sync. Separator, giving very firm lock and excellent interlace.

LINE TIME BASE. Blocking Oscillator using a pentode driving a high efficiency output stage comprising Ferroxcube Cored Output Transformer with Booster Diode.

FRAME TIME BASE. Blocking Oscillator driving a Beam Output Valve coupled through a Transformer to the high efficiency FERROXCUBE Cored Scanning Coils.

POWER PACK. Double wound Mains Transformer supplying all L.T. and H.T. using two full-wave Rectifiers.

The PREMIER De Luxe PORTABLE MAGNETIC TAPE RECORDING KIT



PORTABLE

MAGNETIC TAPE RECORDING KIT

**PRICE
£37 · 4 · 0**

(Plus 15/- Pkg., Carr. & Ins.)

★ Including ALL parts, Valves, Portable Cabinet, 8 in. Loudspeaker, Tape-Table, Reel of 'Scotch Boy' Tape and Rewind Spool, and Microphone.

THE 7-VALVE AMPLIFIER IS SPECIALLY DESIGNED FOR HIGH QUALITY REPRODUCTION

BRIEF SPECIFICATION : VALVE LINE-UP : EP37A First Stage, 6SL7 Second Stage and Tone Control; 6V6 Output 6X5 Rectifier; VT501 Bias and Erase Oscillator; 7193 Record Level Amplifier; 6U3 Magic Eye Record Level Indicator. OUTPUT : 4 Watts. FREQUENCY RANGE : 50 c.p.s. to 9,000 c.p.s. at tape speed of 7½ in. sec. CONTROL : Volume ; Record/Playback Switch ; Treble Boost ; Bass Boost—on/off.

A VISUAL MAGIC EYE Record Level Indicator is incorporated. The unit is housed in a superbly finished rexine covered portable cabinet which incorporates a compartment for the Microphone when not in use. Weight complete 35lb. Dimensions : 21in. long, 12½in. deep, 9½in. high.

THE RECORDER incorporates an entirely NEW VERSION of the famous LANE TAPE TABLE. BRIEF SPECIFICATION : Made to high standards and incorporating features ensuring low level of "Wow" and "Flutter" throughout the full length of tape.

FAST REWIND. Provision for fast rewind and forward run in less than 1 min. in either direction. WIND AND REWIND WITHOUT UNLACING OF TAPE. INSTANTANEOUS BRAKING. THREE MOTORS obviating friction drive.

HIGH FIDELITY RECORD PLAYBACK (1 HOUR APPROX. PLAYING). The Table is fitted with high fidelity record playback head of new design wound to high impedance and a separate A.C. Erase Head. The Heads are half-track size allowing approx. 1 hr. playing from standard 1,200ft. Reel of Tape.

TAPE SPEED : 7½ in. sec. For use on A.C. 200/250, 50 cycles mains only.

MICROPHONE : Crystal—especially designed for Premier by famous manufacturer.

The "PREMIER" Recorder

This Recording Outfit has been designed for use with M.C.-2-III "SCOTCH BOY" Magnetic Tape. With this new and improved high-quality tape a frequency of 50 c.p.s. to 9,000 c.p.s. at tape speed of 7½ in. sec. can be readily achieved. Additional reels of 1,200ft. can be supplied at 35/-.

INSTRUCTIONAL BOOKLET . . . 2/6

This is credited if a complete kit of the Tape Recorder is ordered.

As is usual in all PREMIER KITS, every single item down to the last nut and bolt is supplied. The Chassis is punched and layout diagrams and theoretical circuits are included.

When compiled the PREMIER PORTABLE TAPE RECORDER compares MORE than favourably with any other make at double the price.

SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW

AMPLIFIER KIT (including 8in. Speaker)... £11 0 0 plus 5/- pkg./carr.

AMPLIFIER (already built, wired and tested) £14 15 0 plus 7/6 pkg./carr.

LANE TAPE TABLE & REWIND SPOOL £16 10 0 plus 7/6 pkg./carr.

PORTABLE CABINET (rexine covered)... £4 19 6 plus 5/- pkg./carr.

MICROPHONE £2 19 6 plus 1/- pkg./carr.

REEL OF NEW M.C.-2-III "SCOTCH BOY" TAPE £1 15 0 plus 1/- pkg./carr.

To those unable to build this PORTABLE TAPE RECORDER we can supply it completely wired, tested and ready to plug in at 39GNS

Plus 1 gn. pkg./carr.

MICROPHONES

LUSTRAPHONE: Moving Coil ; High Impedance. Stand Type: £5/15/- Hand Mike £6/6/0.

RONETTE—Crystal Mike; Incorp. the Filter Cell Insert; High Imped. Ball Type: £3/19/6.

CRYSTAL MICROPHONE—Rothermel 2AD56. Especially recommended. £2/19/6. Table stands for all the above 10/6 and 17/6.

CRYSTAL MICROPHONE

An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and sound projectors. Price 22/6.

MICROPHONE STAND BASE

Heavy moulded black base fitted with standard thread adaptor. Dimensions: 7½in. across, 2in. deep. Weight: 1½lb. Port paid 3/11.

MOVING COIL MICROPHONE

Low impedance. Incorporates press-to-talk switch. Housed in strong black bakelite case. Dimensions: 2in. wide, 2½in. high, 1½in. deep.

Plus 1/6 post and packing. 19/6

A matching transformer for high impedance can be supplied at 3/6 extra.



PREMIER RADIO COMPANY

WHY PAY MORE?

WILLIAMSON AMPLIFIER KIT 15gns.

plus 7/6 post, pkg. & ins.
This kit is absolutely complete and all components are guaranteed exactly to author's specification.

WILLIAMSON OUTPUT TRANSFORMER

(author's spec.), 3.6 ohms, sec. £4.40

MAINS TRANSFORMER SP425A (with

additional 6.3 v. 3a. and capable of supplying an extra 50 mA. for Pre-amp. or Feeder Unit) £3.76

PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-100 cycles. All primaries are screened. All LTs are centre tapped.

SP175B, 175-0-175, 50 mA., 4 v. @ 25/-

SP301B, 300-0-300, 120 mA., 4 v. @ 23 a. 4 v. @ 28/-

SP350A, 250-0-250, 100 mA., 5 v. @ 23 a. 6.3 v. @ 29/-

SP351, 350-0-350, 150 mA., 4 v. @ 12 a. 4 v. @ 23 a. 4 v. @ 36/-

SP352, 350-0-350, 150 mA., 5 v. 2-3 a. 6.3 v. @ 36/-

6.3 v. 2-3 a. 55/-

SP375A, 375-0-375, 250 mA., 6.3 v. @ 2-3 a. 6.3 v. @ 3-5 a. 5 v. @ 2-3 a. 6.3 v. @ 47/-

SP601, 500-0-500, 150 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 2-3 a. 5 v. @ 3-5 a. 50/-

SP602A, 500-0-500, 150 mA., 5 v. @ 2-3 a. 6.3 v. @ 2-3 a. 5 v. @ 2-5 a. 67/6

250-0-250, 80 mA., 6.3 v. @ 4 a. 5 v. @ 2 a. 19/6

350-0-350, 90 mA., 6.3 v. @ 4 a. 5 v. @ 2 a. 19/6

200-230-250, output 3-30 v. @ 2 a. 17/6

Charger, 2-6-12 v. @ 1.5 a. 12/6

SPECIAL OFFER

DOUBLE WOUND AUTO-TRANSFORMER 250 watts.

Input/Output 100, 110, 200, 210, 220, 230, 240, 250 volts. Output/Input 110, 113, 116, 119, 122, 134, 146 volts.

With the two windings connected in series a vast number of voltage tappings are available.

Plus 2/6 Pkg. and Carr. Price 35/-

PREMIER VARIABLE IMPEDANCE "MATCHMAKER" M.O.15 OUTPUT TRANSFORMER

Designed to meet the demand for an efficient variable ratio Output Transformer. 11 ratios from 13: 1 to 80: 1 all centre tapped and can be used to match any output valves either single- or push-pull. Class "A" "AB1" "AB2" or "B" to any low impedance speech coil or combination thereof. Primary Inductance 60 henries 15 watts audio 100 mA. Price 45/-

WEYMOUTH MINIATURE I.F. TRANSFORMERS

465 Kc/s., iron cored, permeability tuned, 10/8 pair.

WEYMOUTH MINIATURE COIL PACK Covering Med./Long/Short wave bands. Iron cored coils, gram position on switch. Dimens.: Height, 1in. Length, 3in. Width 2in. Spindle length 2in. Price 19/6.

MINIATURE TUNING CONDENSERS 2 gang .0005 mfd. with trimmers 6/9

CHARGER TRANSFORMERS

Input 230 v. A.C. Output 12 v. at 1 amp. Completely shrouded. Price 9/11

BATTERY CHARGERS

200-250 v. A.C. Will charge 2 v., 6 v. and 12 v. Car Battery at 1 amp. Housed in strong metal casing. Finished in Green hammered enamel. Size: 6in. long, 3in. wide, 3in. high. Guaranteed 12 mths. The above unit is manufactured by PREMIER and does not contain ex-Govt. components. Plus 2/6 post and pkg. 39/6

BATTERY CHARGER KITS

All incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. cycle mains.

Cat. No. 2002 Charges 6 volt accumulator at 1 amp. Resistance supplied to charge 2 v. accumulator.

2003 Charges 12 volt accumulator at 1 amp. 21/-

2004 Charges 2, 6 and 12v. accumulators at 1 amp 24/6

H. T. Eliminator Ex. Govt.

By famous manufacturer

NEW & UNUSED. Input

200/250 v. A.C. Output

120-at 30 mA., housed in

strong metal box size 10in.

long, 7in. wide, 6 1/2in. deep.

37/6

Plus 2/- pkg. and Carr.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT

All parts to construct an eliminator to give an output of 120 volts at 20 mA., and 2 volts to charge an accumulator. Uses metal rectifier, £2.20.

C.R. TUBES

VCR516

9in. Blue picture. Heater volts 4 Anode 4 KV. In manufacturer's original carton. £3/19/6. Plus 5/- pkg., Carr., ins.

VCR517C

9in. picture. This tube is a replacement for the VCR87 and VCR517. Guaranteed full size picture. Price 35/- Plus 2/6 pkg., Carr., ins.



ALL BRAND NEW

RECTIFIERS

E.H.T. Pencil Type S.T.C.

Type K3/25	650 v.	1 mA.	4/7
" K3/40	3.2 KV.	1 mA.	8/-
" K3/45	3.6 KV.	1 mA.	8/2
" K3/60	4 KV.	1 mA.	8/8
" K3/160	12 KV.	1 mA.	21/6

H.T. Type S.T.C.

Type RM1	125 v.	60 mA.	4/-
" RM2	125 v.	100 mA.	4/6
" RM3	125 v.	125 mA.	5/6
" RM4	250 v.	250 mA.	18/-

L.T. Type Full Wave

6 v. 1 amp.	.....	4/-
12 v. 1 amp.	.....	8/-
12 v. 2 amp.	.....	10/9
12 v. 4 amp.	.....	12/6

A.C.R. I.C.R. TUBES

5in. screen, 4 volt Heater. This Electrostatic Tube is recommended as eminently suitable for Television. 15/- plus 2/6 Pkg., Carr. and ins. Data sheets supplied

SUPER QUALITY TELEVISION MAGNIFYING LENS

5in. lens suitable for 8in.	.....	18/6
6in. lens	.....	25/-
10in. lens	.....	22/10/-
12in. lens	.....	23/10/-

ALUMINIUM CHASSIS 18 s.w.g.

Substantially made from Bright Aluminium, with four sides

7x 5/8 x 2in.	.....	4/-
7x 3/8 x 2in.	.....	3/9
9x 4/8 x 2in.	.....	4/3
10x 8x 2 1/2in.	.....	5/6
12x 9x 2 1/2in.	.....	7/1
14x 9x 3in.	.....	7/6
10x 10x 3in.	.....	7/9
14x 10x 3in.	.....	7/11
16x 10x 3in.	.....	8/3
16x 8x 2 1/2in.	.....	8/1

ALUMINIUM PANELS 18 s.w.g.

7x 6in.	.....	1/3
9x 6in.	.....	1/8
9x 9in.	.....	2/2
12x 9in.	.....	2/8
14x 9in.	.....	3/2
16x 9in.	.....	3/8
20x 9in.	.....	4/8
22x 9in.	.....	5/2

7x 4in. 1/1

9x 4in. 1/5

12x 4in. 1/11

14x 4in. 2/11

16x 4in. 3/15

20x 4in. 4/5

22x 4in. 4/11

LOUDSPEAKERS

ELAC—2in. dia., Moving Coil, 15 ohms imp.

PLESSEY—8in. dia., Moving Coil, 3 ohms imp.

ELAC—5in. dia., Moving Coil, 3 ohms imp.

E.M.I.—8in. Elliptical, 15 ohms imp.

PLESSEY—8in. dia., Moving Coil, 3 ohms imp.

PLESSEY—8in. dia., Mains Energised, 3 ohms imp. (600 ohms field), with Pentode Transformer.

PLESSEY—8in. dia., Mains Energised, 3 ohms imp. (600 ohms field)

PLESSEY—10in. dia., Moving Coil, 3 ohms imp.

GOODMANS—12in. dia., Moving Coil, 15 ohms imp.

Plus 5/- packing and carriage.

VITAVOX—K12—20 12in. dia., Moving Coil, 15 ohms imp.

Plus 5/- packing and carriage.

SPECIAL OFFER

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50 mA	1 1/2	24 x 21	M/C .. 7/6
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110C 14 10 0 1 3 6 1 7 9 16 1 0

120A 9 0 0 1 7 0 0 1 17 3 19 11 6

130A 15 0 0 2 5 0 1 8 8 16 11 2

170A 24 0 0 3 12 0 2 6 5 11 21 11 2

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104 Rogers Baby de-luxe.....	14	0	0
105 Lowther B.5F.....	21	0	0
105/1 Lowther A.10F 7.5 watts.....	35	0	0

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150 Leak "Vari-Slope".....	12	12	0
151 Goodsell Type U/TC.....	8	15	0
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257 Chapman S.4.....	16	0	0
259 Armstrong EXP.73 Superhet.....	23	13	0
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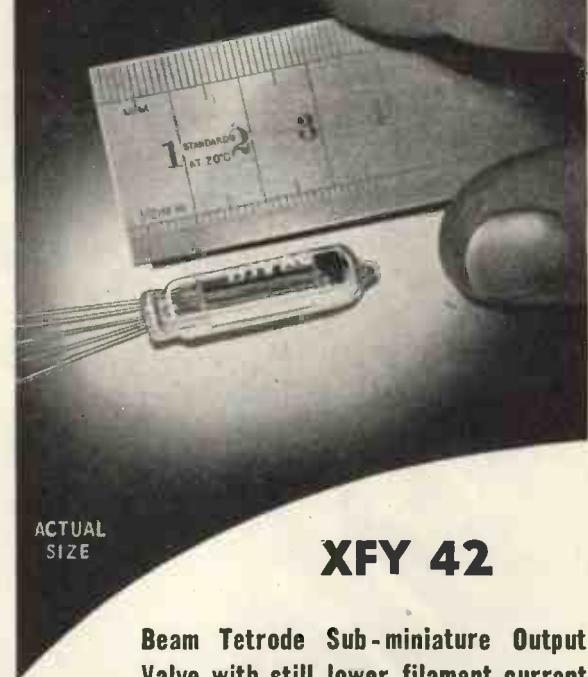
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H.T. Voltage.....	16.25	22.5	30 V.
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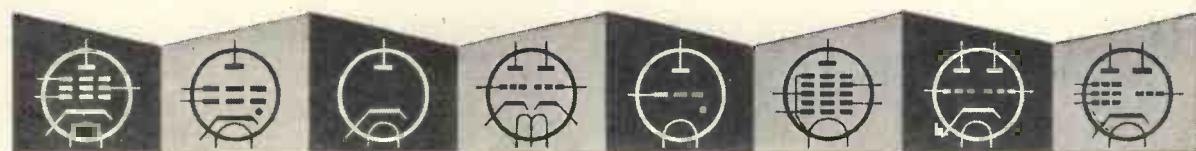


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VALVES, TUBES & CIRCUITS

11. PRE-AMPLIFIER PENTODE TYPE EF86

In most audio amplifier applications it is necessary to provide at least one stage of voltage amplification in which any hum, noise or microphony which could be introduced by the valve must be reduced to a minimum. This is particularly important in the early stages of high-gain amplifiers, in microphone pre-amplifiers and in magnetic tape recording applications.

These requirements have been specially considered in the design of the Mullard voltage amplifying pentode type EF86 which is recommended for all audio-frequency applications where low levels of hum, noise and microphony are essential. This valve is in the miniature all-glass range having a single-ended construction and a B9A (noval) base. Its heater, rated at 6.3V, 0.2A is suitable for series or parallel operation with either a.c. or d.c. Typical conditions of operation are given in the accompanying table of data.

HUM

In the design of the EF86 special precautions have been taken to reduce possible sources of hum in the valve. A bifilar heater construction minimises the effect of hum due to the magnetic field of the heater. Effective internal screening assists in reducing hum due to both internal capacitances and external fields. In addition the internal control grid lead is surrounded by a guard ring which is connected to pin 7 and is normally earthed. This reduces leakage to the grid across the base of the valve and also reduces the capacitance between grid and heater.

When used as a normal voltage amplifier with a line voltage of 250V, an anode load of 100 kΩ and a grid resistor of 470 kΩ the maximum hum level of the valve alone is 5 µV, the average value being about 3 µV when operated with one side of the heater earthed. This can be further reduced by centre-tapping the heater to earth. Under these conditions the maximum hum level is 1.5 µV.

The low levels of hum attained with this valve can be completely masked by an unsuitable choice of valve-holder in which leakage and capacitative coupling between pins can introduce considerable hum. For most applications it is found that a low-loss type of holder such as nylon-loaded phenolic or P.T.F.E. is adequate.

NOISE

The low-frequency noise generated by a valve is most conveniently specified as an equivalent voltage on the control grid for a specific bandwidth. For the EF86 under normal conditions, i.e. line voltage of 250 V and an anode load of 100 kΩ, the equivalent noise voltage is approximately 2 µV for the frequency range 25-10,000 c/s.

MICROPHONY

Care in the design of the valve to ensure that the electrode structure and its mounting are as rigid as possible has reduced the microphony of the EF86 to a very low level. There are no appreciable internal resonances at frequencies below 1,000 c/s. At higher frequencies the effect of vibration is usually negligible on account of the damping provided by the chassis and the valve-holder. In high-gain applications such as tape recording care should be taken in siting the valve, particularly when a loudspeaker is present in the same cabinet or when a motor is mounted on the same chassis. In such cases a flexible mounting for the valve-holder or a separate weighted sub-chassis is advisable.

VALVE DATA				TYPICAL OPERATING CONDITIONS AS R.C. COUPLED A.F. AMPLIFIER.								
HEATER	V _h	V	V _a	V _b	R _a	I _k	R _{E2}	R _k	V _{out}	V _{out}	D _{tot}	R _{g2} *
CAPACITANCES	I _h	0.2 A	V _{g3}	0	V	I _a	140	V				
C _{out}	5.5 µµF		I _a	3.0 mA			300	100	2.45	0.39	1.0	116
C _{in}	4.0 µµF		I _{g2}	0.6 mA			250	100	2.05	0.39	1.0	112
C _{a-g1}	0.025 µµF		V _{g1}	-2.0 V			200	100	1.65	0.39	1.0	106
C _{g1-h}	0.0025 µµF		gm	1.8 mA/V			150	100	1.0	0.47	1.5	95
LIMITING VALUES			r _a	2.5 MΩ			300	220	1.1	1.0	2.2	188
V _a max.	300 V		DIMENSIONS				250	220	0.9	1.0	2.2	180
P _a max.	1.0 W		Max. seated height	49 mm			200	220	0.75	1.0	2.2	170
V _{g2} max.	200 V		Max. over-all length	56 mm			150	220	0.55	1.0	2.7	150
P _{g2} max.	0.2 W		Max. bulb diameter	22.2 mm			300	100	1.5	—	2.2	28.5
I _k max.	6.0 mA						250	100	1.25	—	2.2	28
V _{h-k} max.	100 V						200	100	1.0	—	2.2	27.5
												50
												3.8
												330
												3.7
												330
												3.3
												330

*Grid resistor of following valve.

†V_{out} at commencement of grid current.

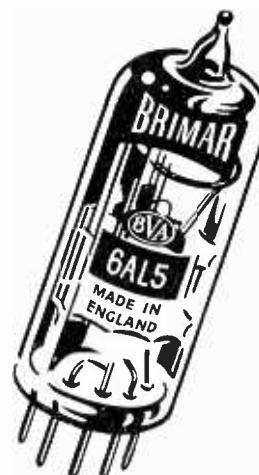


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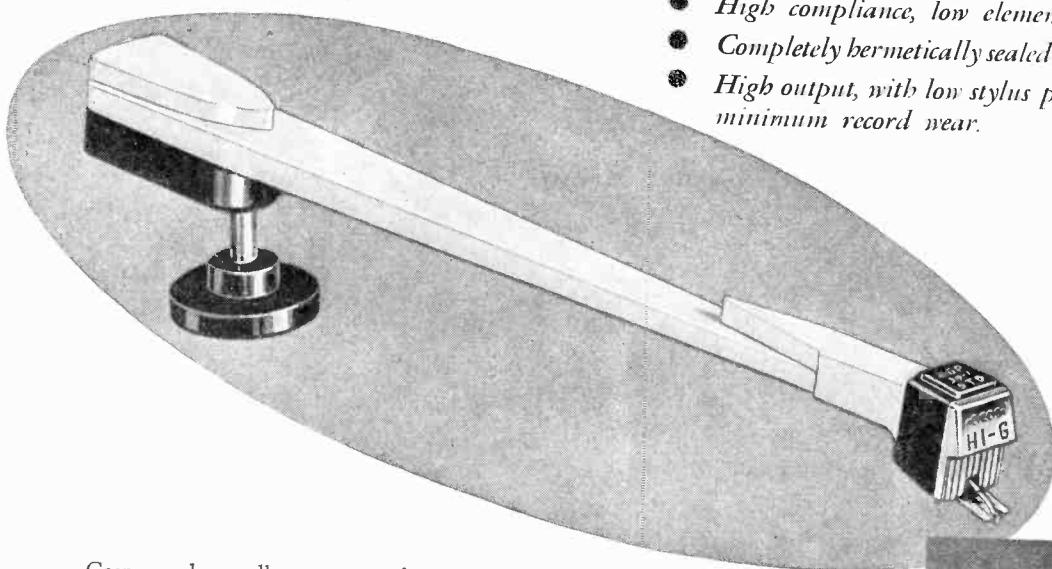
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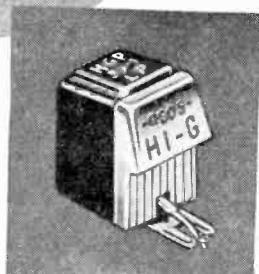
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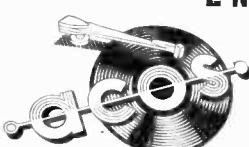
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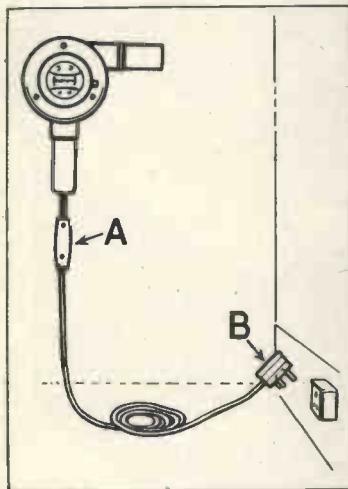
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THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

Split Suppression for T.V. Interference



Split suppression is the name given to a technique which is coming into more general use with the advent of TV flex lead suppressors.

It implies suppression in two stages; TV suppression "A" at one point in the appliance, and broadcast frequency suppression "B" at another.

It is well known that a suppressor must be fitted near the appliance to be effective; this is particularly important at TV frequencies, and if for any reason a TV suppressor has to be fitted in a flex lead, it must be within a few inches of the appliance. See "A." At broadcast frequencies some concessions to this can often be made, and provided that the flex is not too long, a broadcast frequency suppressor will work well at the mains outlet socket "B," possibly forming an integral part of the socket or plug. (There is much to be said for the latter arrangement, since this means that the appliance is suppressed when plugged into any socket.)

TV suppressors are inherently smaller than broadcast frequency suppressors, and "Split Suppression" takes advantage of this by providing a very compact TV suppressor "A" in the flex lead near the appliance, together with a suppressed mains plug "B" to take care of the long and medium wavebands. This is essentially an arrangement for the sake of convenience, and is of obvious value for

appliances normally held in the hand, where a bulky suppressor would be a nuisance.

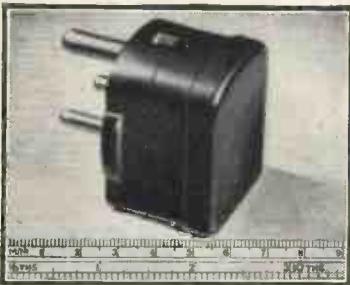
"Split Suppression" is therefore recommended for hairdryers, electric razors, electric drills, etc., with leads not greater than 6 feet. It is not suitable for vacuum cleaners and other appliances with long trailing flexes, but here a rather larger all-wave suppressor can be fixed to or near the appliance without causing inconvenience.

Electric sewing machines can be dealt with by either method.



Flex Lead Suppressor

L.799 is an Inductor and Capacitor suppressor indicated at "A" in sketch (see first column). The inductors are wound for 2 amp. To be effective at TV frequencies it must be fitted not further than 6 inches from the connectors of the motor in the appliance.



Plug Point Suppressor

L.1308 is the capacitor filter indicated at "B" in sketch. The capacitors are built into a 3 pin 5 amp. plug. Whilst the plug by itself provides ample suppression in most cases, on long and medium wavebands, it is only effective at TV frequencies when used in conjunction with L.799.

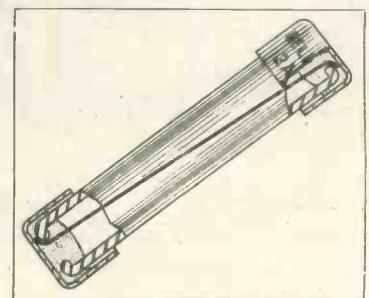
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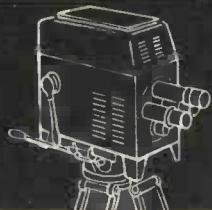
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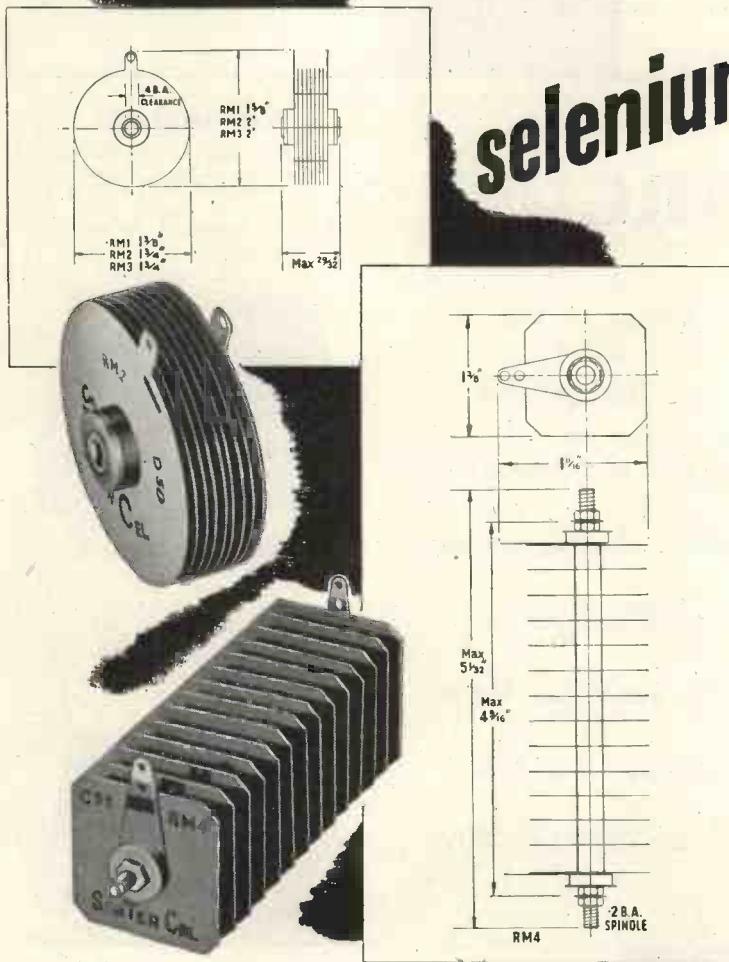


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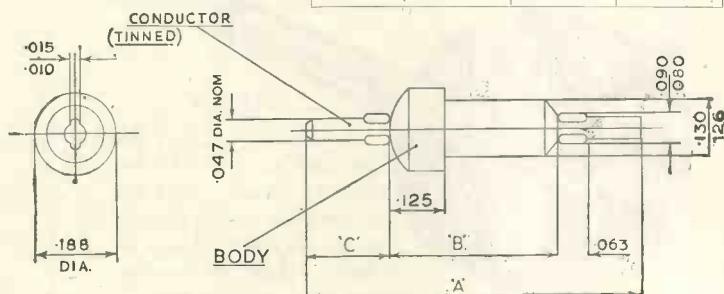
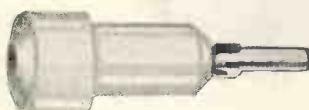
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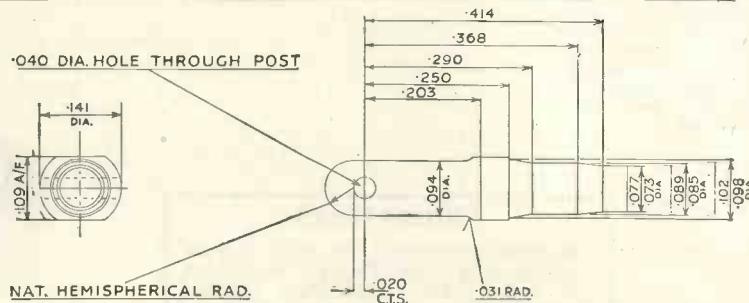


	A	B	C
PT 1	.750	.375	.188
PT 2	.875	.500	.188
PT 3	.563	.375	—
PT 4	.688	.500	—

PT 3 & 4. Stand-off



PT 5. Component mounting



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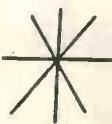
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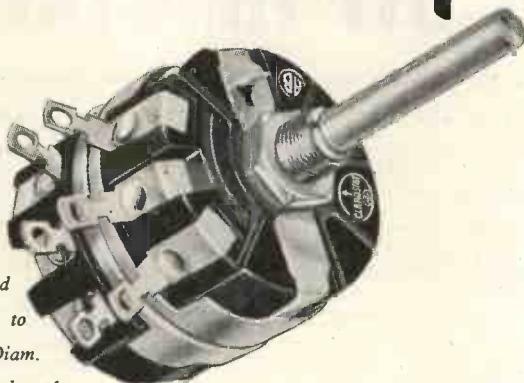
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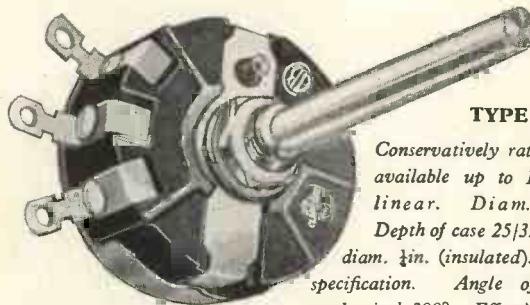
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**TYPE 58**

Conservatively rated at 3 watts: available up to 100,000 ohms linear. Diam. 1.21/32in. Depth of case 25/32in. Spindle diam. 1/8in. (insulated). Length to specification. Angle of rotation, mechanical 300°. Effective 280°.

All controls can be supplied with special windings and closer tolerances to specification. Can also be supplied fitted with single or double pole mains switch if required.

WHOLESAVERS

Clarostat wire-wound Potentiometers are supplied with a spindle 2½in. long with full length flat, individually packed in sturdy two-colour cartons. Delivery is prompt. Write for details of very attractive trade terms.

† Regd. Trade Mark

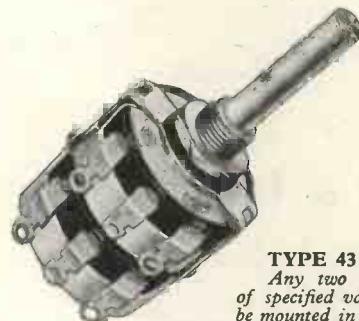
**Controls and Resistors****METAL PRODUCTS LIMITED.**

16, Berkeley Street, London, W.1.

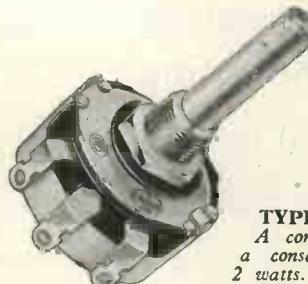
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**Further additions
to the range of
Clarostat
WIRE-WOUND
Controls**

All Clarostat controls are manufactured with high grade Bakelite cases of rugged construction. Solder tags are heavily silver-plated and of special design, removing all danger of turning or loosening under operating conditions. The controls are fitted with metal dust covers which are firmly keyed into the Bakelite casing and connected to the fixing bush, thus providing automatic earthing of cover. Samples available on application.

**TYPE 43 (Dual)**

Any two controls of specified value can be mounted in tandem operated by a common spindle. Diam. 1 1/8in. Total depth of case 1.3/16in.

**TYPE 43**

A compact control with a conservative rating of 2 watts. Available up to 25,000 ohms linear. Diam. 1 1/8in. Depth of case 19/32in. Spindle diam. 1/8in. (insulated). Length to specification. Angle of rotation, mechanical 300°. Effective 280°.

VORTEXION TAPE RECORDER



The amplifier, speaker and case, with detachable lid, measures 8½ in. x 22½ in. x 15¾ in. and weighs 30 lb.

PRICE, complete with WEARITE TAPE DECK £84 0 0

POWER SUPPLY UNIT to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder. **PRICE £18 0 0**.

★ The noise level is extremely low and audibly the hum level and Johnson noise of the amplifier and deck are approximately equal. Only 25% of this small amount of hum is given by the amplifier alone.

★ Extremely low distortion and background noise, with a frequency response of 50 c/s.—10 Kc/s., plus or minus 1.5 db. A meter is fitted for the measurement of signal level and bias level.

★ Sufficient power is available for recording on disc, either direct or from the tape, without additional amplifiers.

★ 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.

★ The .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 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ Facilities are provided for using the amplifier alone and using power output or headphones while recording or to drive additional amplifiers.

★ The unit may be left running on record or play back even with 1,750 ft. reels with the lid closed.

FOUR CHANNEL ELECTRONIC MIXER

is almost essential for the professional or semi-professional where a number of different items have to be mixed on one tape recording.

It is recommended by a number of tape recorder manufacturers for this purpose.

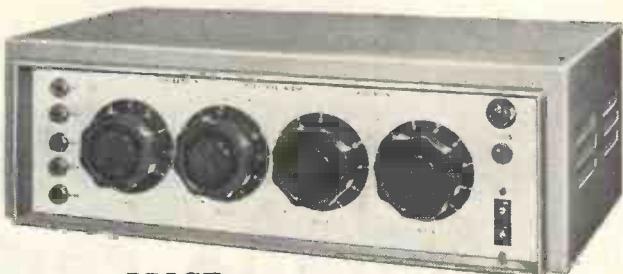
Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15-30 ohms balanced.

The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.

The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes.

An internal screened power pack and selenium rectifier feed the five low noise non-microphonic valves.

Used in many hundreds of large public address installations and recording studios throughout the world.



**PRICE
£36.15.0**

Manufactured by

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

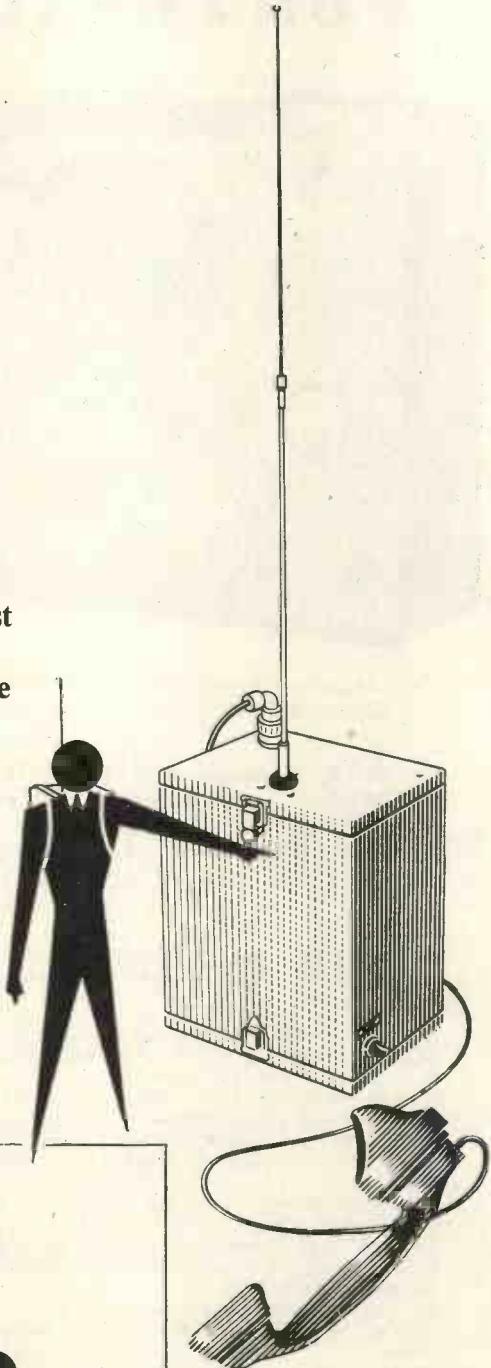
Telephones: LIBerty 2814 and 6242.3

Telegrams: "Vortexion, Wimble, London."

MARCONI

mobile radio

Marconi mobile radio is the general name for a range of V.H.F. transmitter/receiver equipment designed to work under the most strenuous operating conditions. The range offers a choice of power up to 12W and a wide selection of frequencies to meet all operating requirements.

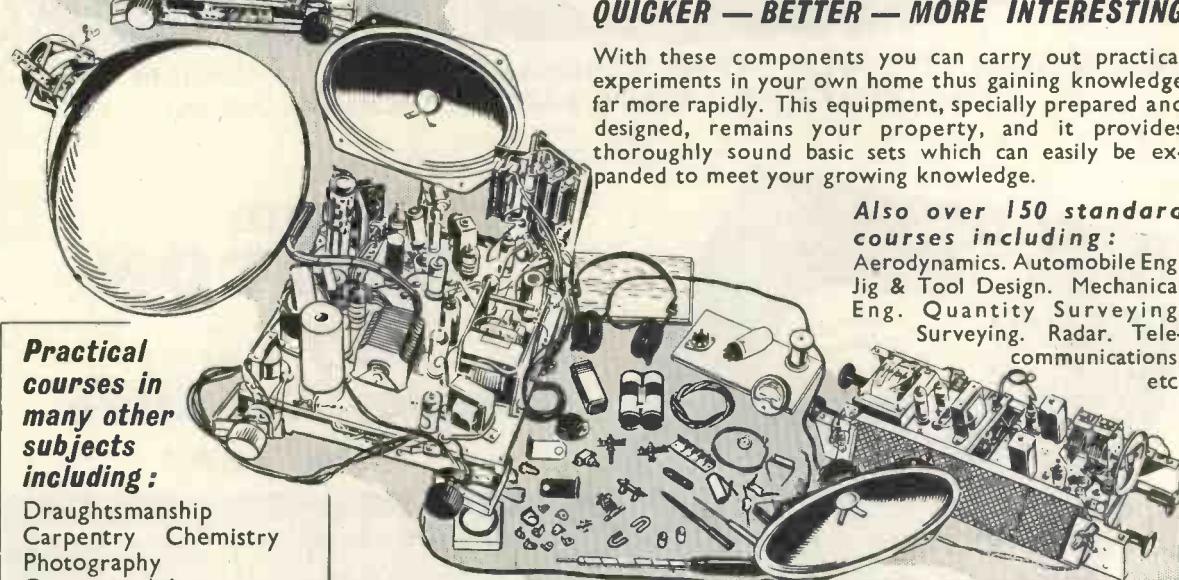


MARCONI

mobile radio

PLANNED • INSTALLED • SERVICED

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THE **WESTON** **E772** Super Sensitive Analyser

No 10. Multi-Range Testing Instruments

Best known of all instruments for the testing and servicing of radio and television equipment is undoubtedly the Weston Model E.772 Analyser, a first-class portable instrument with a sensitivity of 20,000 ohms per volt on all D.C. ranges and 1,000 ohms per volt on all A.C. ranges. The additional features of wide range coverage, robust construction and simplicity in operation contribute toward making the E.772 ideal also for laboratory and research work. Full details of this instrument and also of the Model S.75—a Test Set covering 53 ranges—will gladly be supplied on request.

SANGAMO WESTON LIMITED • ENFIELD, MIDDLESEX

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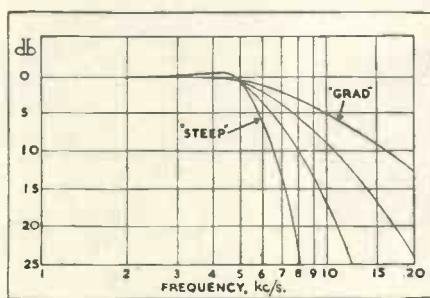
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LEAK equipment is unique—

It is acceptable to professional communications engineers for recording and broadcasting. The B.B.C. use several hundreds of the TL/12 Amplifier, and 1,000 are used by other Broadcasting Corporations.



The Vari-Slope



Frequency amplitude curves for the "TREBLE-3" position (5kc/s turn-over). Curves of the same slopes are obtained on the other two positions turning over at 7 kc/s and 9 kc/s ("—2" and "—1" positions).

Representing a unique feedback circuit development, the "Vari-Slope" pre-amplifier gives audibly better reproduction. This advance consists of variable-slope "electronic" low-pass filters operating on negative voltage feedback principles. No Inductors ("Chokes") are used, and their disadvantages are completely eliminated. The turnover frequencies are 5kc/s, 7kc/s, and 9kc/s, and the slopes of attenuation are continuously variable over the range 5db to 50db per octave.

The filters consist essentially of Twin-T resistor-capacity networks inserted in the return circuit of a single-loop feedback amplifier. The more obvious advantages of this electronic feedback method over conventional choke filters include:—

- (a) Improved transient response characteristics (due to absence of chokes having self-capacitance) and the consequent reduction of "ringing."

- (b) Extremely low harmonic and inter-modulation distortion due to negative voltage feedback action.
- (c) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below turnover. (Both these faults occur in variable-slope choke filters due to the slope control altering the terminating impedance and the insertion loss.)
- (d) No chokes to cause magnetic hum pickup.
- (e) Smaller size, lighter weight, greater uniformity in production.

LIST PRICE IN BRITAIN 12 Gns.

Point-One TL/12 Triple Loop Feedback Amplifier

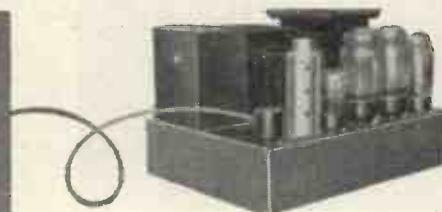
Used with the "Vari-Slope" pre-amplifier and the best available complementary equipment, the TL/12 power amplifier gives to the music-lover a quality of reproduction unsurpassed by any equipment at any price.

For laboratory use as a stabilised-gain audio frequency power amplifier. For the highest possible standard of disc recording. For the highest possible quality of reproduction from Pickup, Radio, Microphone, Film and Magnetic Tape. For use as a driver amplifier in the speech modulator chain of broadcast transmitters.

27 Gns.

The "Point-One" TL/12 Amplifier is built to a tropical specification and used throughout the world, including:

The British Broadcasting Corporation.
The South African Broadcasting Corporation.
The Swedish Broadcasting Corporation.
The Swiss Broadcasting Corporation.
The Italian Broadcasting Corporation.



£5. 10s.

Write for fully descriptive literature.

Steep-Cutting Filter

For use with the TL/12 power amplifier and pre-amplifiers preceding the Vari-slope. This filter unit is of particular interest to the record enthusiast.

H. J. LEAK & CO., LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3

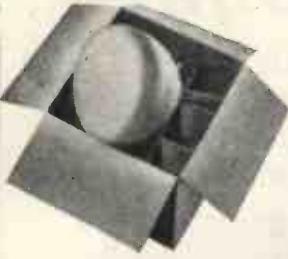
Phone : SHEpherds Bush 1173/4.

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ELECTRONIC PRECISION EQUIPMENT LTD.

LAST FEW



15in. MAGNETIC TELEVISION TUBE

By famous maker. Specification Blue/White screen 9 Kv. ion trap triode, heater 6.3 v. at .55 amp., 50° deflection. New, with written guarantee, offered at approximately half price, £13/10/- each, plus 10/- carriage and insurance. H.P. terms £4/10/- deposit and 12 monthly payments of 18/3. Limited quantity, so order immediately.

CARBON RESISTORS

These will now be supplied in individual packets, with the value and wattage clearly indicated.

Prices :
1-watt, 5d. each ; 1 watt, 6d. each.
Resistor Kits.
Each resistor individually packaged as above. Popular assortments as shown below.

A.	W.	No.	A.	W.	No.
22	1	1	39K	1/2	4
68	1/2	3	47K	1/2	4
150	1	1	68K	1/2	2
330	1/2	1	68K	1	1
470	1/2	4	150K	1/2	3
820	1/2	3	350K	1/2	1
22K	1/2	1	560K	1/2	4
6.8K	1/2	1	680K	1	2
10K	1/2	4	1Meg	1/2	4
22K	1/2	4	1Meg	1	2
25K	1	1	22Meg	1/2	1

Kit 1. 50 Resistors as above
table. 12/6
Kit 2. Double quantity ... 22/6
Kit 3. Four times quantity 37/6

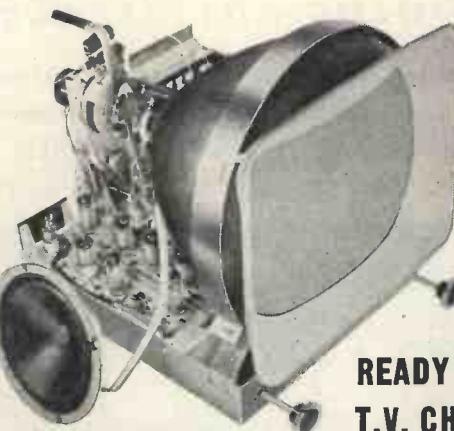
4in. NAVIGATION COMPASS



Sturdy and reliable. Floating dial, shock mounted in metal case. All cardinal points and degrees marked. Each compass in wooden box. Exceptionally low price. 20/-, plus 2/- postage.

TWO-VOLT ACCUMULATORS

Made for the Forces by one of the most famous firms in the world. 15 amp.-hour size approx. 6in. x 1 1/2in. in ebonite case, pre-charged, only need filling with acid. 4/9 each, plus 9d. post and insurance.

READY MADE
T.V. CHASSIS

These are Five Channel Televisors employing completely tunable superhet sound and vision receivers. They have noise suppression on both sound and vision and incorporate a special I.F. filter in the aerial circuit. The circuit is absolutely up to date, and in fact uses the latest Mullard valves. The 12in. model uses MV 31/74 with the tinted special daylight viewing face. The 15in. model uses the Cossor 85K tube. Price, either model, is £42/10/- complete ready to receive sound and vision. Carriage and insurance £2 (partly returnable). H.P. terms, £14/3/6 deposit. Cabinets : 12in. (table model), £3/17/6, carriage, etc., 7/6. 12in. Console model, £7/17/6, carriage, etc., 10/-; 15in. Console model £11/10/-, carriage, etc., 15/-. Any cabinet may be purchased by h.p. Simply send one-third as deposit.

PROFESSIONAL RADIOS
YOU CAN MAKE

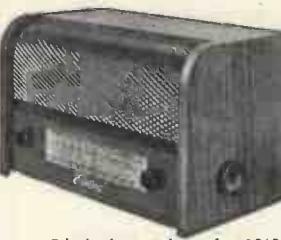
You will find that the building of our all-mains radio receivers is simplicity itself, and the more you make the less time each takes, everything down to the last nut and bolt is supplied, and everything fits together in a professional manner. When finished the receiver looks and plays as well as those being offered in radio shops at anything between £10 and £14.

The one illustrated above we call the "Occasional," in a choice of colours, Ivory or Walnut and the T.R.F. costs £6/1/6 to make, H.P. terms being £2/1/6 deposit and 10 monthly payments of 10/6. Constructor's booklet 1/6, post paid.



IDEAL GENERAL PURPOSE RECEIVER

The Elpreq "Wolsey" 5 valve A.C./D.C. superhet has a built-in aerial and is of convenient size and weight to carry from room to room. Powerful reception on long, medium and short waves — handsome wooden cabinet — illuminated glass dial, with station names, A.V.C. and usual refinements. Size 11in. x 5 1/2in. x 7in. with B.V.A. valves, 12 months' guarantee. Limited quantity only, £9/5/- or £3/2/- deposit and balance over 12 months, carr. and insur. 5/-.



R1155 COMMUNICATION RECEIVER FOR ONLY £2/14/- DEPOSIT



This set, as most will know, is considered to be one of the finest communications receivers available today. The frequency range is 75 kc/s to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F. so

obviously a robust receiver which will give years of use but completely overhauled and guaranteed in perfect working order. PRICE £7/19/6 or will be sent against deposit of £2/14/-, balance of 12 monthly payments of 11/6. If you cannot call to collect please include an additional 10/- to cover cost of transit and carriage. This partly returnable to you if and when you return the transit case.

MAINS POWER PACK FOR R.1155

With Pentode output stage. Plugs into socket on receiver so no internal modifications are required. Price £5/10/- complete with 5in. speaker ready to work, carriage 3/6.

RADIO STETHOSCOPE

A novel device aptly called a Radio Stethoscope is described in a recent edition of the "Radio Constructor." With it in most districts a receiver can be checked from the grid of the first valve right through to the output.

The only parts needed to make the simple circuit tracer are a pair of crocodile clips, a germanium crystal, and a paper tubular condenser, and we will supply whole outfit for 6/6, post free, and with each outfit we will give re-print of the article as it appeared in the "Radio Constructor."

NOTE.—If you wish to make it up as a pocket unit then you will need a few other odds and ends, solder tags, etc., from your spares box.



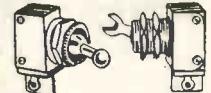
CHASSIS ASSEMBLY

3 colour, 3 waveband scale covering standard Long, Medium, and short wavebands, scale pan, chassis punched for standard 5 valve superhet, pulley driving head, springs, etc., to suit. Scale size 14 1/2in. x 3 1/2in. Chassis size, 15in. x 5in. x 2in. deep. Price 15/- plus 1/6 post. Note this is the one that fits our £7/10/- Radiogram cabinet and our 37/6 table cabinet.



DEMOBBED VALVES

Gives the commercial equivalents of many thousands of Service Valves, an invaluable publication recently revised. Price 2/3.



TOGGLE SWITCHES

Metal body standard size, made by a leading maker. Available with round dolly or with special V cut dolly. State which type when ordering. Price while stocks last only 2/3.



BRASS CASED PLUG

Seven-way brass cased plug, ideal for portable apparatus. Price 2/3 each half. D33BR and D33BL.

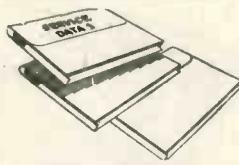
FUSED KNIFE SWITCH

For isolating and switching, complete with fuses. 5 amp., 3/6; 30 amp., 4/6; 60 amp., 6/6.

Note, spare fuses of the correct size are obtainable : 5 amp., 6d.; 30 amp., 9d.; 60 amp., 1/- But in any case a burnt-out fuse can be repaired.



ELECTRONIC PRECISION EQUIPMENT LTD.



SERVICE DATA

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makes are included : Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster-Branded, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips, Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price £1 for the complete folder.

Our folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry" etc., which have been imported into this country. Names include Sparton, Emerson Admiral, Crossley, R.C.A., Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is £1. Post free.



BE PREPARED

For a cold winter by making our low cost Electric Blanket. 27 yards of special heater wire and blueprint 20/- Blueprint only 1/6. Alternatively make a Bed Warmer. Constructional data 1/6.



CONNECTING WIRE SNIP
P.V.C. insulated 23 s.w.g. copper wire in 100ft. coils, 2/9 each. Colours available: Black, Brown, Red, Orange, Pink, Yellow, White, Transparent. 4 coils for 10/-.

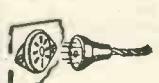
SOMWEAVE

This really lovely loudspeaker fabric we offer at approximately a third of today's cost. It is 42in. wide and our price is 12/- per yard d or panels 12in. x 12in., 1/9 each. This is also very suitable for covering plain wooden cases, for portable radio amplifiers, etc.



PLUGS FOR MODERN VALVE HOLDERS

Each is fitted with a rubber shroud. For B7G button base and type 2 for B8A. Price 1/4 each, discounts for quantities.



BARGAINS OF THE MONTH

SUPERHET RADIO BY BEETHOVEN

Extremely well built on chassis size approx. 9½ x 7½ x 8½ using only first class components, fully aligned and tested, 110-240 volt A.C. mains operation. Large clear edge-lit dial. Three wave bands covering 200-550, 35-120, 13-42 metres. Complete with five Mullard valves, frequency changer, double diode triode, pentode output and full wave rectifier. Complete with Rola loudspeaker ready to operate. Special cash with order price this month, £7 17/6, carriage and insurance 7/6. Hire purchase terms £3 deposit, balance over 12 months.

MULTI-METER KIT

The Multi-meter illustrated measures D.C. volts, D.C. m/amps and ohms. It has a sensitivity of 200 ohms per volt and is equally suitable for the keen experimenter, service engineer or student. All the essential parts including 2in. moving coil meter, selected resistors, wire for shunts, 8-point range selector, calibrated scale, stick on range indicator and full instructions for making are available as a kit price 15/- plus 9d. post and packing.

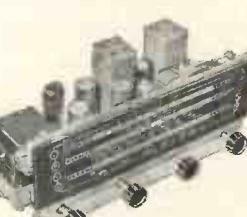


TABLE RADIO CABINET

Due to a special purchase, we are able to offer this very fine cabinet, size approx. 16 x 16 x 7—walnut veneered and satin finished. 37/6, carriage and packing 3/6. Note. This cabinet is the correct one for the chassis above.

RADIOGRAM CABINET

Console Type Cabinet. With full grained walnut finish, will take standard type auto change gram unit. Price £11/10/- H.P. terms, £3/17/- deposit, and 12 monthly payments of 16/9, plus 15/- carriage.

Radio Chassis to suit. £8/19/6. H.P. terms. £3 deposit and 10 monthly payments of 13/-, plus 7/6 carriage.

Auto Change Units. For long-playing and standard records with suitable pick-up head, £11/11/-.

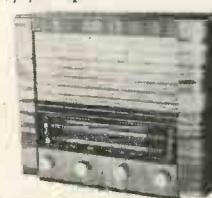
SPECIAL OFFER. Cabinet Radio Chassis and Auto Changer, 29 gns. H.P. terms, £10/14/- deposit and 12 monthly payments of £2/3/-.



HUGE NEW PURCHASE

We have purchased another large quantity of the Collaro Auto Record Changer, type R.C. 3/521, three speed suitable for all types of records and with the latest type crystal pick ups. Buy one this month as you will not be able to again at this special price of £10 plus 7/6 carriage and insurance.

This is a 5 valve A.C. superhet covering the usual long, medium and short wavebands. It has a particularly fine clear dial with an extra long pointer travel. The latest type loctal valves are used and the chassis is complete and ready to operate. Chassis size 15in. x 6in. x 6in. Price £9/19/6 complete with 8in. speaker. Carriage and insurance 10/-. H.P. terms £3/7/- deposit.



LAST FEW

£3/19/6.

LAST FEW

The Lectrooss warms room as it dries clothes bathing costumes, towels, etc. Size 3ft. wide, 3ft. high, and 5in. deep. It has four stove enamelled rails and works off AC or DC mains, consuming 650 watts. Fully guaranteed. Price £3/19/6 plus 7/6 carriage.

GREATLY REDUCED—CATHODE RAY TUBES

VCR97. Brand new and unused, ideal for 'scope, etc. Price 12/6. Carriage and insurance 5/- extra.

VCR517. 6½in. guaranteed full picture. 29/6 plus 5/- carriage and insurance.

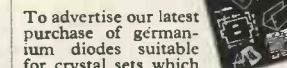
VCR139A. 2½in., 32/6 plus 2/6 carriage, etc.

VCR138. 3½in. electrostatic short persistence, suitable for T.V. and ideal for 'scope work, 37/6 plus 3/6 carriage, etc.

VCR112. 5in. electrostatic, persistence not known, 15/- each plus 5/- carriage, etc.

CV996. 6in. electrostatic, persistence not known, 15/- each plus 5/- carriage, etc.

CV1140, CV1590, CV1546. All 12in. magnetic long persistence £4/10/- plus 10/- carriage.

This Blueprint FREE

To advertise our latest purchase of germanium diodes suitable for crystal sets which we can offer at the very low price of 1/9. With each we give a free blueprint of a crystal set to be made from parts found in any junk box. You have a youngster friend who will be thrilled to make this little receiver.

FREE T.V. SERVICE SHEETS

The supplement to a new publication "Television Faults" contains complete circuit diagrams, component values, technical descriptions, etc., of 6 popular T.V. receivers as follows:

Baird Everyman, T.29; Murphy, V.120C; English Electric, 1150M; Philips projection model 704A and 1800; Marconi, VT.53DA; Ultra V.711.

The book itself in the introductory chapter tabulates over 60 common faults from complete failures to such troubles as shadows in the corner. Against each fault symptom is given probable causes and a reference to the part of the book where more detailed information can be found. Following the quick fault finding guide are 10 chapters, each giving typical circuits and data indicating the actual components likely to be at fault. The book is invaluable to novice and experienced T.V. serviceman alike because it contains a wealth of practical experience and priced at only 5/- it will undoubtedly save its cost the first time you have to refer to it. Order now to ensure getting the free supplement.

"Superior 15"

SOME QUESTIONS ANSWERED



QUESTION

Can I expect sound and pictures equal to factory made sets?

Is it robust and likely to go for long periods without trouble?

Why is it so much cheaper than any other big picture televison?

Does it look like a home-made set?

How about soldering? Is it difficult like repairing a kettle or saucepan?

Is aligning the set difficult?

Will the Elpreq "Superior 15" receive all B.B.C. stations?

What happens if I cannot get my televison to work once I have it finished?

ANSWER

The picture compared favourably with any set at the Radio Show.

Yes, because all parts are standard size and proved types.

The reason is because you assemble it yourself and thus save labour and other costs.

No, because it isn't really home made, it is simply assembled from factory made parts, just as are all so-called "factory made" T.V. models.

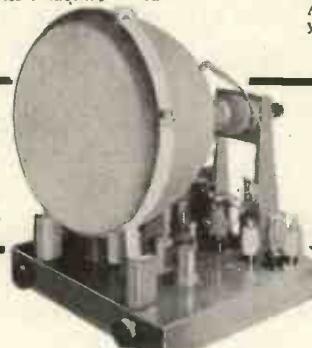
Soldering radio parts is simplicity itself.

No, the coils are all specially designed which "pre-aligns" them and you have only to follow the simple directions to ensure receiving the perfect picture. No instruments are necessary.

Yes, and all constructors will be notified of the modifications that will be necessary when Commercial T.V. starts.

You send for a service form which you complete and then our engineer will indicate your trouble. Alternatively, for a nominal charge, we will take your chassis and make it perfect.

UP TO THE MINUTE BIG PICTURE T.V.



**ONLY £37.10
OR £12.10 deposit**

— MORE QUESTIONS ANSWERED

QUESTION

What is the cost?

Are Hire Purchase terms available?

Are there any guarantees?

Are cabinets available?

How much is the data and can I have it on approval?

How can I order?

ANSWER

All components, valves and Cossor 15in. cathode ray tube cost £37-10-0.

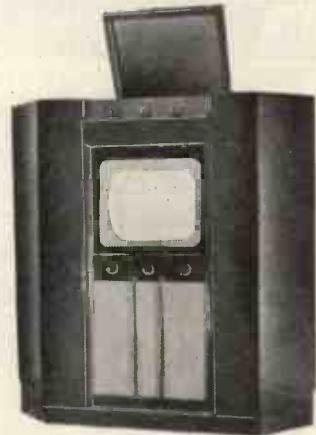
Yes, the deposit is £12-10-0, the balance is spread over 12 months.

You are covered by two guarantees, one covers the components and the other ensures that you will get perfect results.

The illustrations show the cabinets which are available. The Console costs £11-10-0 and the Super corner model £18-0-0. H.P. terms again are available.

The data costs 7/6, but providing you keep it clean and in good condition you can return it within 7 days. If after studying it you feel you cannot make the televison 7/- will be refunded to you.

An order form is enclosed with the 7/6 data, which you can complete and post to us.



— AS DEMONSTRATED AT THE NATIONAL RADIO SHOW

ELECTRONIC PRECISION EQUIPMENT LTD.

Post orders should be addressed to :—

**ELPREQ HOUSE (Ref 2.), HIGH STREET,
WEALDSTONE, MIDDX.**

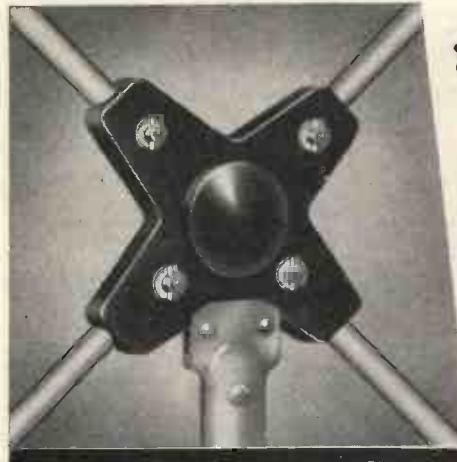
Personal shoppers however must continue to call at :—

**42-46, WINDMILL HILL, RUISLIP, MIDDX.
Phone: RUISLIP 5780 Half-day. Wednesday.**

**152-153, FLEET STREET, E.C.4.
Phone: CENTRAL 2833. Half-day. Saturday.**

**29, STROUD GREEN RD., FINSBURY PARK.
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With the Snapacitor Action

Prov. Pat. No. 10074/53

A major development of
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MODEL X4L/*

Chimney Lashing. Complete with 6ft. x 1in. dia. Aluminium alloy mast and chimney lashing equipment.

LIST PRICE 75/-

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MODEL X4P/*

Pole Top Mounting. Complete with mast cap bracket for either wooden or metal masts.

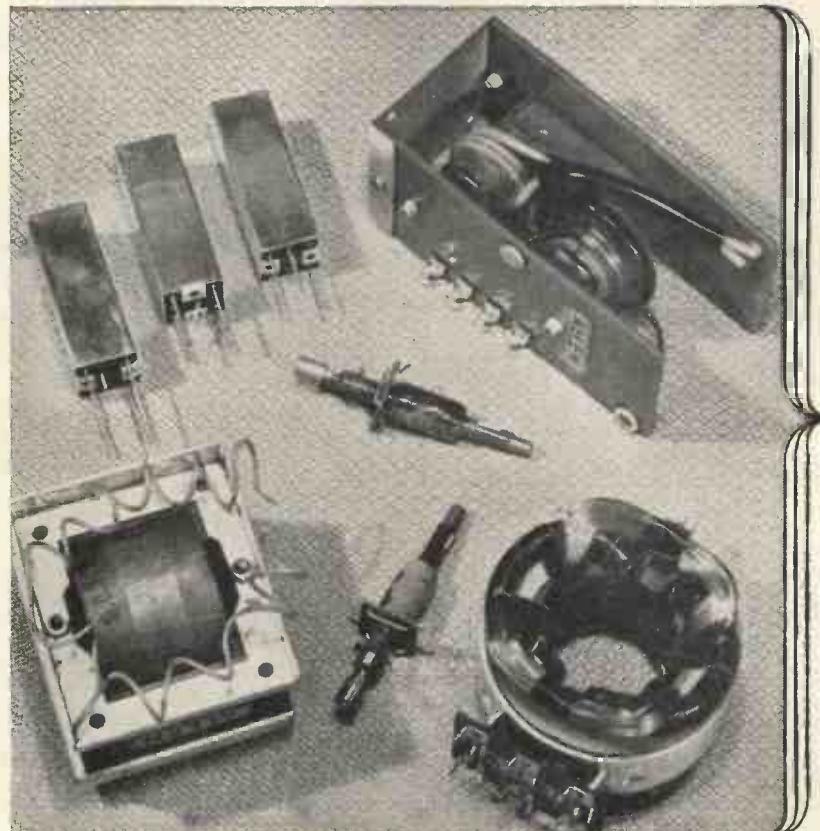
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L.R.S.

1925

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Armstrong

Two New Chassis

From personal experience we can say that these are really first-class and the reproduction is quite remarkable, showing a considerable improvement on previous models which, as is well known, were very good.

MODEL FC38 incorporates many new features:

- New and Improved Tuning Scale.
- Magic Eye Tuning Indicator.
- Controls to lift Bass and Treble Ranges.

Eminently suitable for use with the latest 3-speed gramophone player. It has 3 wavebands: 16-50 m., 190-500 m., 1,000-2,000 m.

Flywheel tuning and push-pull output giving 8 watts of audio.

Cash Price £23/13/0 (incl. P.T.)

MODEL RF41. A highly sensitive 10-valve 4-waveband chassis with numerous refinements, 12-35, 35-90, 190-550 and 800-2,000 metres.

- Variable selectivity.
- Cathode Ray Tuning Indicator.
- Large open slide-rule tuning dial with flywheel action.
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The complete range is available on Terms.

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20/-
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Point-One TL/12 12 watt
Triple Loop Feedback Amplifier



Cash Price £28/7/0

For the highest possible quality of reproduction from Pick-up, Radio, Microphone, Film and Magnetic Tape. This amplifier has won worldwide recognition by its pre-eminence in performance, reliability and craftsmanship. As used by the B.B.C. and many overseas Broadcasting Corporations.

The New VARI-SLOPE Pre-Amplifier

Gives audibly better reproduction. No Chokes to cause magnetic hum pick-up. Extremely low harmonic and intermodulation distortion.

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TERMS FOR THESE TWO UNITS

£9 deposit with order and 18 monthly instalments of 40/-. Passenger carriage 10/- extra, payable with deposit.

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We invite you to take advantage of our

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**ALL NEW
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**The L.R. SUPPLY COMPANY LIMITED
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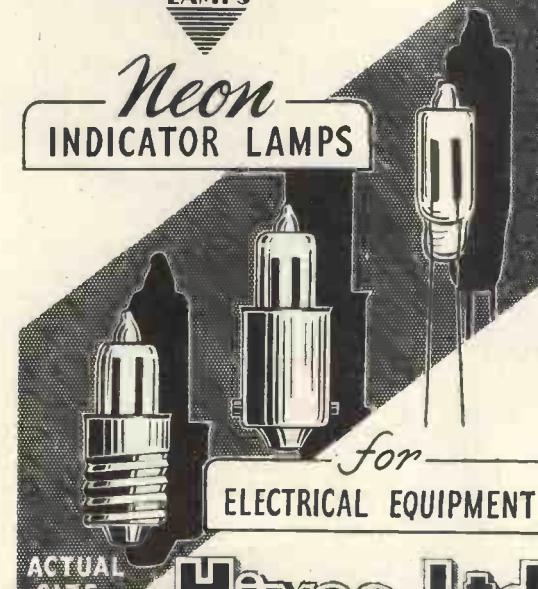
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T.C.1 *10hy. 80 m/a. 250 ohms	5/3	T.C.6 12hy. 150 m/a.	20/-
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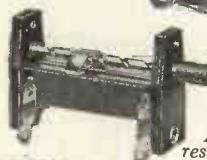
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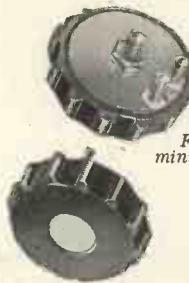
Type 105 is identical to Type 115 except that a 2-pole Q.M.B. switch is incorporated.



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PRE-SET RESISTORS
A wire-wound pre-set resistor for panel or chassis mounting



SUB-MINIATURE VOLUME CONTROLS
For use in Deaf Aids and other miniature electronic apparatus

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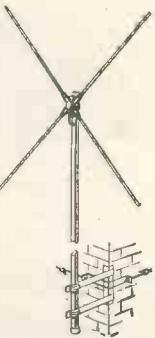


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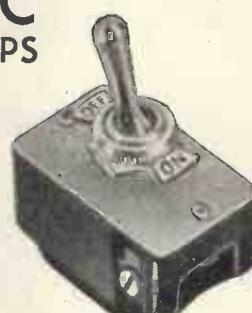
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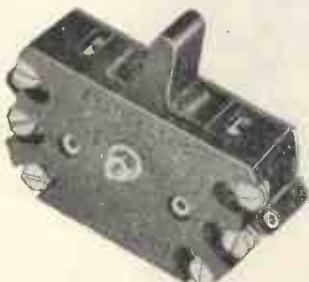
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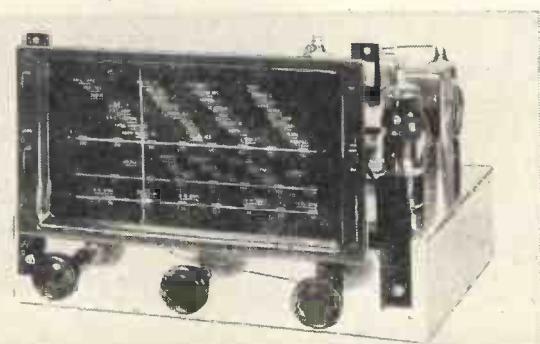
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a) 2 waveband 3 valve Feeder Unit. (b) 3 waveband 3 valve Feeder Unit. (c) 3 waveband 4 valve Feeder Unit (with B.F. stage). (d) 3 waveband 5 valve Receiver (i) for A.C. (ii) for A.C./D.C. (e) 3 waveband 5 valve Receiver (i) for A.C. (ii) for A.C./D.C. In addition, working from the handbook, any of the sets can be built and later converted to any alternative model desired. Other contents include: How to build a crystal set; How to construct a 2 w/band Plus Gram coil pack; Circuits of two very different T.R.F. sets; and a 10W Quality Amplifier. Pages of constructional and servicing hints, soldering and metal working instructions, resistance colour code, etc.

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with the basic essentials for visual presentation and designed to provide in simple and convenient form the best means of demonstrating signals from your existing equipment. They will also form display units for the Unitel System of instruments.

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Since its introduction only some five months ago, this new amplifier has won universal praise both in this country and abroad and has firmly established its position as the finest medium priced amplifier in the World.

Prices:

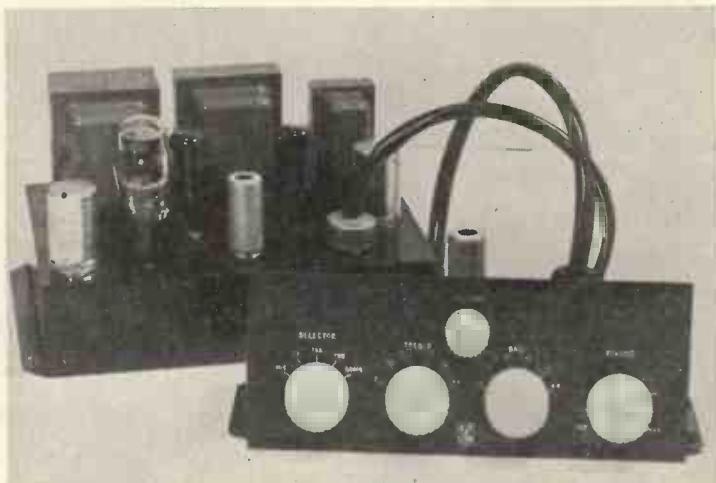
The "RD BABY de-luxe Mk. II" main amplifier. £14

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Detailed technical specifications, including response curves and an illustration, will gladly be forwarded post free on request.

Available from leading dealers in London and the Provinces, or if in any difficulty, please apply direct.

Trade and Export enquiries invited.



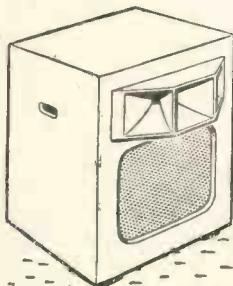
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MANUFACTURERS OF PRECISION BUILT SOUND EQUIPMENT
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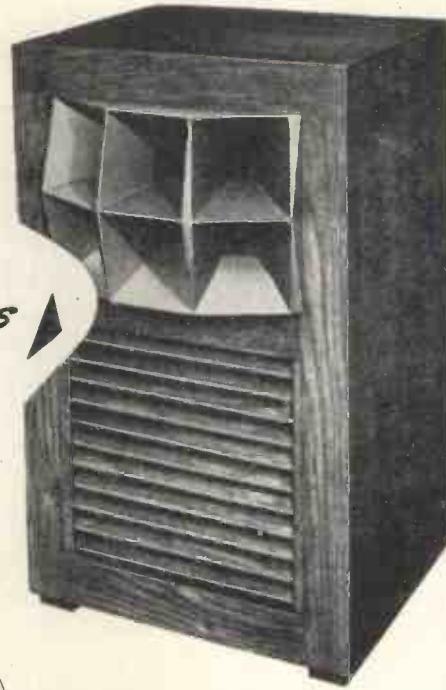
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When the demand is for sound reproduction giving maximum audibility and fidelity to every member of the audience, then you can confidently install the Vitavox Bitone Reproducer. We will gladly send you fullest information on request.

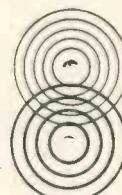


Model	3101	6201
Peak watts	10	20
Impedance (nom)	15 ohms	15 ohms
Filter cross-over frequency	1,000 cps	1,000 cps
Filter attenuation per octave	6 db	12 db
H.F. distribution (nom)	60° x 20°	60° x 40°
Finish	Medium oak with metallic bronze horn (and grille on 3101)	



VITA VOX Bitone

Vitavox Limited, Westmoreland Road, London, N.W.9.



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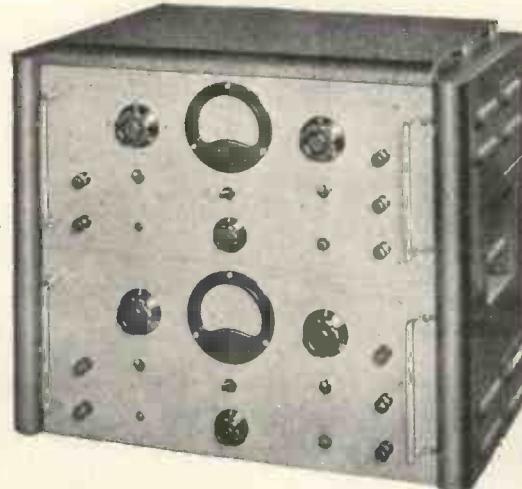
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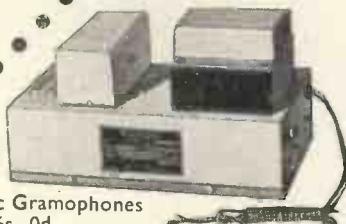
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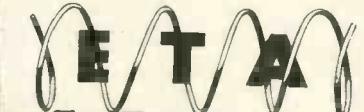


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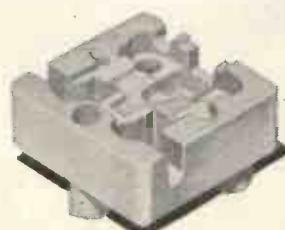
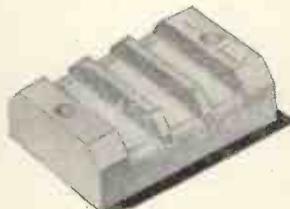
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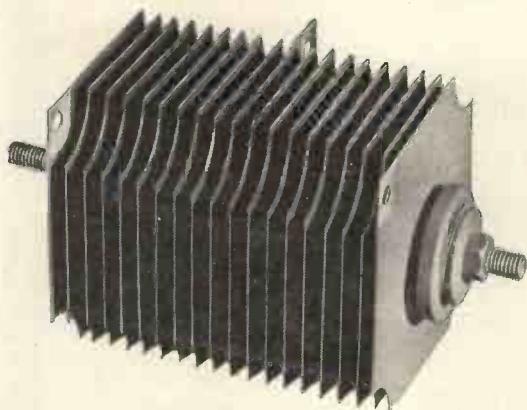
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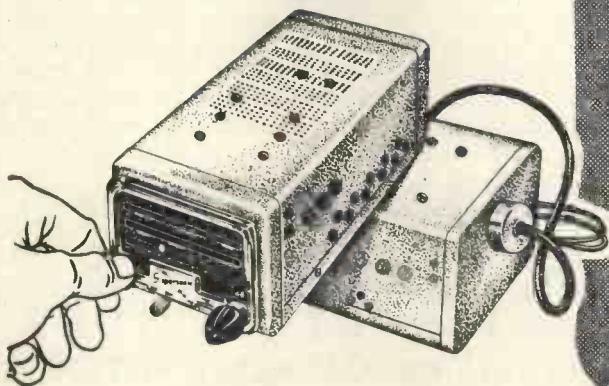
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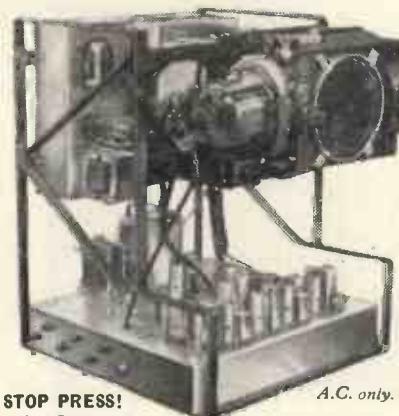


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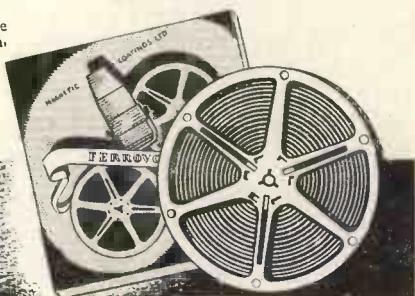
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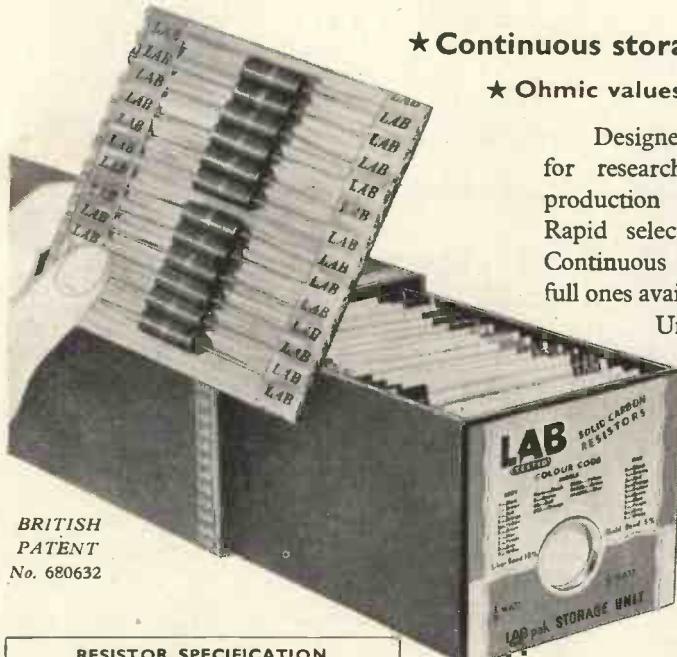


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T	1-watt	1-watt	250	10 ohms to 10 megohms	$\frac{3}{4}'' \times \frac{1}{4}''$ $\frac{3}{4}'' \times \frac{1}{4}''$
R	1-watt	1-watt	500		

Tolerance available $\pm 20\%$, $\pm 10\%$, $\pm 5\%$

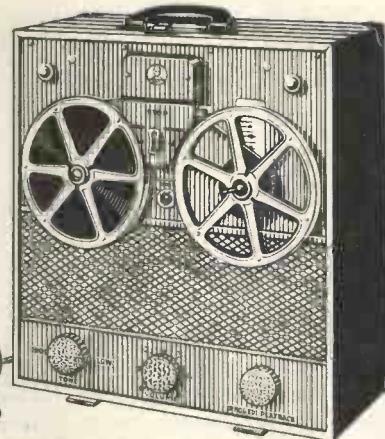
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For multi-speaker assemblies it is designed for use with 12in. bass unit and one or more top units and crossover between 800 and 2,000 c.p.s. Recommended for use with Goodman and Wharfedale units, this heavily built cabinet is completely free from cabinet resonance even at large output.

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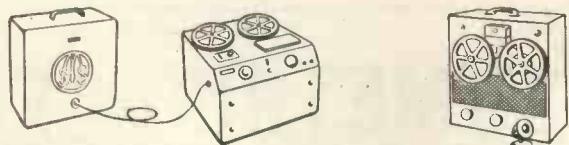
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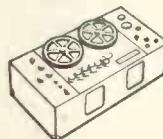
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I.F. STRIP 194. An easily modified strip recommended for T.V. constructors who want good results at moderate cost, or for those who have built televisions but are having trouble in the sound or vision receivers. Size 18in. x 5in. x 5in., it is complete with 6 valves VR65, 1 of VR92, and 1 of VR56 or VR53. Mod. data supplied. ONLY 45/- (postage, etc., 2/6). Less valves, 19/6 (post, etc., 2/6). Less valves,

RECEIVER R.1355. as specified for "Inexpensive Television," a copy of which is supplied. Complete with 8 valves SP61 and 1 each 5U4G and VU120 or VU111. Used, but good condition, ONLY 29/6 (carriage, etc., 5/6).

RF UNITS TYPE 26 and 27. For use with the R.1355 or any receiver with a 6.3 v. supply. These are the variable tuning units which use 2 valves EF54 and 1 of EC52. Type 26 covers 65-50 Mc/s (5.6 metres), and Type 27 covers 85-65 Mc/s (3.5-5.0 metres). Complete with valves, and BRAND NEW IN MAKER'S CARTONS. ONLY 59/6 each.

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COMMUNICATIONS RECEIVER R.1155

The famous ex-Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges : 18.5-7.5 Mc/s, 7.5-3.0 Mc/s, 1,500-600 kc/s, 500-200 kc/s, 200-75 kc/s, and is easily and simply adapted for normal mains use, full details being supplied. Aerial tested before despatch. BRAND NEW AND UNUSED IN MAKER'S TRANSIT CASES, ONLY £11/19/6.

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R.1155 "N" Model. This is the latest version which covers the Trawler Band and in addition has ultra-slow motion tuning. Used, in good condition, and tested working before despatch, £17/19/6.

A Factory-made Power Pack, Output Stage and Speaker, contained in a black crackled cabinet to match the receiver, can be supplied for ONLY £5/10/- Plugs on to the receiver, and operates it immediately.

DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

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RECEIVER R3118, ideal for conversion to T.V., having a built-in A.C. mains Power Pack for 180-240 volts, is tremendously powerful employing 7 I.F. stages of 12 Mc/s with 4 Mc/s Bandwidth and has 16 valves as follows : 6 of SP61, 4 of EA50, 2 of VR136, 1 each VR137, P61, 5Z4, and Y63 "MAGIC EYE" in new condition, only 97/6 (carriage, etc., 7/6).

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THE WILLIAMSON AMPLIFIER

We have the complete range of specified Components in stock for this famous quality Amplifier. Enquiries are welcomed and immediately dealt with. The complete assembly instructions and diagrams are available for 3/6.

MAINS OR BATTERY PORTABLE KIT

A Midget 4-valve Superhet Portable Set covering medium and long wavebands.

Designed to operate on A.C. mains 200/240 volts, or by an "Aldry" battery. The set is so designed that the mains section is supplied as a separate unit which may be added at any time. The kit therefore can be supplied (a) as an "Aldry" Battery Superhet Personal Set which can then be accommodated in the attache case as illustrated (size 9in. x 4in. x 7in.), this is attractively finished in lizard, maroon, dark green or blue rexine, or (b) as a combined Mains/Battery Superhet Portable Receiver, for which a polished cabinet is available to accommodate both Mains Unit and Batteries together.

Circuit incorporates delayed A.V.C. and pre-selective Audio Feedback. Kit is complete in every detail and includes ready-wound frame aerials, fully aligned I.F. trans. and drilled chassis, etc. Overall size of assembled chassis 8in. x 4in. x 2in. This receiver, as illustrated, can be completely built for approx. £2/10 (plus Mains Unit if required). Send 1/9 for the fully descriptive Assembly Book which includes Practical Layouts and complete price list of Components. Attach case available separately, 37/6.

TWO BATTERY PORTABLES

(a) THE "MINI TWO-THREE"

An "Aldry" Battery Portable of midget size, 6½in. x 4in. x 3½in., designed to cover medium waveband 190-859 metres, with use of short trailer aerial.

The simple design of this Receiver is so arranged that either a 3-valve set or a 2-valve (afterwards easily converted to the 3-valve) can be made.

Consists of a T.R.F. circuit using a regenerative detector with H.F. stage and a high gain output pentode. Valve line up IT4-IT4-DL94.

The 2-valve set can be completely built for £4/3/6 (less case), and the 3-valve for £5/5/- (less case). Each price includes valves, speaker and drilled chassis.

Send 2/- for the assembly instructions : they include simple and complete practical component layouts and diagrams which enable the most inexperienced constructor to successfully build either set. All components available for separate sale, a price list being supplied with assembly instructions.



(b) THE "MINI-FOUR"

A 4-valve Battery Superhet Receiver designed to receive 4 pre-set stations, three on medium waveband and one on long wave to suit local conditions. Each station is obtained on the set by the turn of a rotary switch. No tuning is necessary.

It is of midget size, being only 4½in. x 6½in. x 4½in. when completely built and is very easily assembled from diagrams supplied.

Cost of all components to build this set, in accordance with the design, including a drilled and cut chassis and panel and new valves, is £9/10/- (or less valves for £8/7/6). Attractive carrying case finished in blue leatherette, 16/9. Complete constructional data with a blue print, which shows the practical component layout and wiring diagram, together with an individual component price list, is available separately, 1/6. Our battery eliminators (illustrated above) available in kit form are suitable for use with this set.

WE HAVE THE NEW W. B. "STENTORIAN" HIGH FIDELITY SPEAKERS IN STOCK

Model H.F. 6-inch	£2 10 0
Model H.F. 9-inch	£23 7 0
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These speakers are of the very latest design and provide reliable reproduction for the lower-price range. 3 or 15 ohm models are available.

THE VIEWMASTER TELEVISOR

We have had very considerable experience in assisting customers to build this TV set and can supply SPECIFIED COMPONENTS EX-STOCK. The assembly instructions showing practical layouts and price list are available for 7/6 for London, Sutton Coldfield, Holme Moss, Kirk-o-Shotts and Wenvoe.

"PERSONAL SET" BATTERY ELIMINATOR

A complete Kit of parts to build Midget "Aldry" Battery Eliminator, giving approx. 69 volts and 1.4 watts. This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltage as above, or approx. to 69 watts.



The Kit is quite easily and quickly assembled and is housed in a light aluminium case, size 4½in. x 1½in. x 3½in. Price of complete Kit with easy-to-follow assembly instructions, 42/6. In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and 1.4 watts. Size of assembled unit 7in. x 2½in. x 1½in. Price 47/6.

The "Wireless World" 3-Valve Set

A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands. We are able to supply all the components to build this set, as designed and specified in the Feb. 1950 issue, including the drilled chassis, Valves and moving coil speaker, etc., at the following prices :—

To construct complete chassis, less dial and drive assembly, £5/5/-.

Ditto including dial and drive assembly, £6.

To construct the complete set, including dial and drive assembly and cabinet, £7/3/6. Overall size of cabinet is 7½in. x 3½in. x 1½in. A reprint of the designer's article, giving circuit and assembly instructions (this is available separately for 9d.) together with a practical component layout is included with each of above assemblies.

"MINI-TWIN" 1-VALVE BATTERY SET



A design of a simple 1-valve 2-stage Battery Receiver, giving excellent results on medium and long wavebands and having exceptionally low battery consumption. Drilled chassis and practical diagrams make it the ideal set for the beginner to build. The complete chassis, including valve, can be built for 37/6 plus 8/11 P/Tax. The attractive plastic case is 9/6 and suitable headphones 14/9. The complete assembly instructions, layouts and a component price list, are available for 1/6. This Receiver also performs excellently, without modification, as a tuning unit, and, in addition, with simple modifications for which a complete diagram is provided, makes a first-class pre-amplifier for pick-up or microphone.

A DUAL CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

This comprehensive PRE-AMPLIFIER and TONE CONTROL UNIT provides a full control of bass and treble in conjunction with a main Volume/Mixer Control.



It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit affording ample compensation for all types of pick-up and all natures of recordings, i.e., English, American and long-playing, without recourse to pick-up correction.

The extreme flexibility of the bass and treble controls is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier. Response characteristics are given in 12-watt amplifier advt.

The unit measures only 7in. x 4in. x 2in., including self-contained power supply, and can be accommodated either on or away from the main radio amplifier, i.e., on the front panel of the radio or any other position.

Price, including drilled chassis, valves (6SN7 and 6J5), £3/16/9. Complete assembly data is available separately for 1/-.

Completely assembled and ready for use, £5/5/-.

A Famous Manufacturer's SHADED POLE GRAM MOTORS

10/6
(Plus 1/- carriage and ins.)

Clockwise rotations and incorporates a Mains Adjust. Panel. Could also be used as Recording Take Up or Rewind Motor.

A COMPLETE "CAR RADIO" FOR THE HOME CONSTRUCTOR



A design of a complete 5-VALVE SUPERHET RECEIVER employing an R.F. Stage and incorporating a separate VIBRATOR PACK size 4½ x 2½ x 6½in for use on 6 or 12 volt D.C. supplies. We can supply all components to build this complete Receiver and Vibrator Pack including a Metal Case, Valves, Drilled Chassis and 5in. F.M. Speaker for £12/19/6. (Carr. and ins. 5/6 extra). Or the receiver Components for £9/19/6, and the Vibrator Components for £3. This is NOT an EX-GOV'T. Receiver, it is a new design employing new Components.

Send 2/8 for the complete set of ASSEMBLY INSTRUCTIONS, CIRCUITS and PRACTICAL LAYOUTS, including a complete individual Component Price List.

THE DENCO ULTRA MIDGET SUPERHET COIL TURRETS WITH A ROTARY TURRET ACTION

Type CT9 consists of a four-station "pre-set" unit from which any three stations on medium waveband and one on long wave can be received by a turn of the turret switch. Price 39/6.

Type CT10, is a 3 waveband coil pack incorporating a fourth switch position for Gram. Complete coverage is, long waveband 700-2,000 metres, medium waveband 190-570 and shortwave 15-50 metres. Price 22/8/-.

A complete receiver circuit and all necessary data are included with each turret. These can be supplied separately for 9d.

SPECIAL OFFER

A 12in. P.M. SPEAKER (2-3 in. Voice Coil) by a very famous manufacturer, for only (plus 2/- carriage and insurance). THESE ARE BRAND NEW IN MAKER'S CARTONS

"HOME CONSTRUCTORS" THE NEW

"SOUNDMASTER"

TAPE RECORDER IS NOW AVAILABLE

Send 6/- for the complete set of building and operating instructions. These provide for an easily assembled complete PORTABLE TAPE RECORDER including a component price list enabling all components to be bought separately.

When submitting, please include post and packing charge.
STERN RADIO LTD.
109 & 115, FLEET STREET, E.C.4
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The "TELE-VIEWER"

5 CHANNEL TELEVISOR

A Design of a Complete 12 in. or 9 in.

SUPERHET T/V RECEIVER FOR THE HOME CONSTRUCTOR

This receiver has been developed after most careful research and affords a high standard of Television entertainment by producing a picture of really outstanding quality.

We confidently believe that not only have we achieved a T.V. Receiver that surpasses in efficiency any other designed for the home constructor, but that successful construction, even by the most inexperienced, is assured by the step by step wiring detail and diagrams provided, and at about half the cost of the nearest comparable commercial receiver.

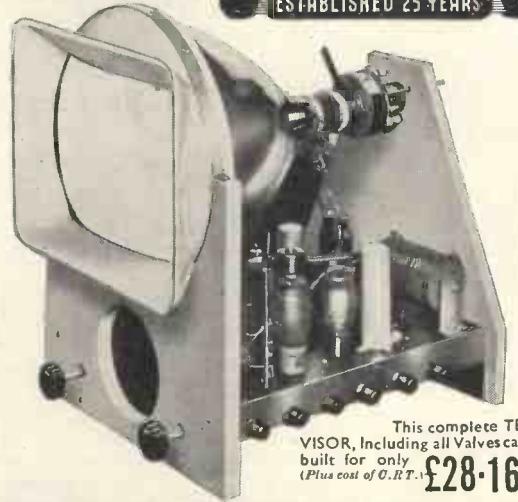
Here are some of the features which combine to make this such a fine receiver.

- The Superhet circuit easily tuned to any of the five channels, i.e., LONDON, SUTTON COLDFIELD, HOLME MOSS, WENVOE and KIRK-O-SHOOTTS. (The extreme ease of tuning is accomplished by the provision of pre-aligned I.F.T.'s.)
- A lifelike, almost stereoscopic, picture quality made possible by the following factors :
 - a. Excellent band width of I.F. circuits.
 - b. A really efficient video amplifier.
 - c. C.R.T. Grid modulated from low impedance source.
 - d. High E.H.T. voltage (approx. 10 kV.).
- The picture brilliancy is also much above the average and enables comfortable viewing with normal room lighting or daylight.
- FIRM picture "HOLD" circuits (Frame-Line) ensure a steady picture, free from bounce or flicker even under the most adverse conditions met with in "fringe" areas and excellent "interlace" ensures the absence of "liney effect."
- Negative feedback is used in the audio frequency circuits which provide 2/3 watts of High Quality Sound.
- Entire receiver built on two chassis units, each measuring 14½ in. x 6½ in. x 3½ in.
- Rigid C.R.T. mounting enables entire receiver to be safely handled with tube in position.
- All pre-set controls are mounted on side of chassis enabling all adjustments to be carried out whilst facing the C.R. Tube.

We can sometimes supply New Mullard 12in. C.R.T. at the specially reduced price of

£13'17'6

These, when available are for purchasers of the Televiewer only.



This complete TELE-VISOR, Including all Valves can be built for only

£28'16'4

(Plus cost of O.R.T.)

As no hire purchase terms are available the receiver can be bought in five separate stages (practical diagrams and circuits are provided for each stage) thus enabling hire purchase interest rates to be avoided. The complete set of ASSEMBLY INSTRUCTIONS is now available, price 5/-.. The instructions include really detailed PRACTICAL LAYOUTS, WIRING DATA AND COMPONENT PRICE LIST.

ALL COMPONENTS ARE AVAILABLE FOR INDIVIDUAL PURCHASE. A CABINET WILL ALSO BE AVAILABLE.

SURPLUS TO AN EXPORT ORDER A 5 VALVE SUPERHET RECEIVER

covering the COMPLETE MEDIUM WAVEBAND and TWO SHORT WAVEBANDS. ENTIRELY COMPLETE and CONTAINED IN ATTRACTIVE BAKELITE CABINET. (Plus 10/- Carr. and Ins.).

● INCORPORATING THE LATEST RANGE OF B.V.A. MINIATURE VALVES. UY.41, UL.41, UBC.41, UF.41 and UCH.42 AND A 5 INCH P.M. SPEAKER.

● Complete Waveband Coverage 13-35, 35-100 and 195 to 550 Metres.

● We have a limited number only, some being for A.C. Mains and some AC/DC Mains operation. They are genuinely BRAND NEW, being surplus to an export order recently completed.

!! The TRUVOX TAPE UNIT !!

We can now offer this very successful Unit ex stock. Price

£23/2/0

(Plus 5/- Carr. and Ins.)

A really good class TAPE AMPLIFIER is also available. Price

£16/16/0

(Plus 5/- Carr. and Ins.)

The combination of these two Units provides a really first-class complete TAPE RECORDER. Send S.A.E. for complete details.

One of the best known makes !!

A 3 SPEED AUTOCHANGE UNIT COMPLETE WITH THE TWIN STYLUS CRYSTAL PICK-UP

£13/15/0

(Plus 7/6 Carr. and Ins.)

These Units will autochange on all three speeds, an adaptor, price £1/0/7, being required for the 45 r.p.m. Records.

● They have separate sapphires for L.P. and 78 r.p.m. which are moved into position by a switch on the pick-up head.

These Units are one of the best made today, they are brand new, complete with mounting instructions, etc.

!! STOP PRESS !!

A COMPLETELY ASSEMBLED CHASSIS OF A 3 WATT A.F. AMPLIFIER WITH SELECTIVE FEEDBACK

For A.C. Mains **£4/9/6** (Plus 5/- Carr. and Ins.)

- Designed for good quality Gram. reproduction up to a maximum output of 3 Watts.
- The selective feedback circuit incorporates separate Bass and Treble Control.
- New Valves are used, the line up comprising the new Mullard types EP.40, EL.41, EZ.40. Suitable P.M. Speakers are available at 16/-, 18/9, 25/- and 34/4.



ANOTHER REDUCTION !!

The COLLARO Model A.C. 514 Record Player

£3/19/6

(Plus 5/- Carr. and Ins.)

RIM DRIVE 78 r.p.m. complete with the COLLARO Plug in type MAGNETIC HEAD and 10 inch TURNTABLE. These are COMPLETE BRAND NEW UNITS for A.C. Mains 200-250 Volts.

A COMPLETE

4 VALVE T.R.F. CHASSIS

Including a 5in. P.M. SPEAKER and VALVES.

**FOR ONLY
£6.9.6**

(Plus 7/6 Carr. and Insurance).



This receiver is of the very latest design covering both Long and Medium Wavebands, and includes the modern B.V.A. valves. The line up being 12 BA6- 12AT6- 12A6-35W4. It incorporates Permeability Tuned Coils thus ensuring excellent selectivity and sensitivity. The overall size of the complete chassis including speaker is 10in. x 4½in. x 6½in.

An attractive Bakelite Ivory finished Cabinet size 11½in. x 5½in. x 6½in. is available for 18/6 (plus 2/6 carriage and insurance).

THE "WEYRAD" SIGNAL GENERATOR

Accuracy better than 2 per cent on all ranges. Coverage 100 Kc/s to 70 mcs. (on fundamentals), modulated on CW output. 500 c/s A.F. source. Has large clearly calibrated scale. Price £8/10/0. (Plus 5/- Carr. and Ins.)

MICROPHONES FOR THE HOME CONSTRUCTOR

The Lustraphone Model LX.55 Crystal mike. Designed for use as either a hand mike or desk type. Price £2/10/- Model C61 Dynamic mike, low impedance £5/5/-, or high impedance £25/15/6. Carr. and Ins. on each of above 2/-.

GOODMAN'S SPEAKERS

5in. 3 ohm. with trans.	21/-
5in. 3 ohm. less trans.	19/6
8in. 3 ohm. less trans.	25/-
8in. 3 ohm. with trans.	25/-
10in. 3 ohm. less trans.	25/-

HALF-WAVE H.T. RECTIFIERS

250 Volts 150 mA 12/8 : 250 Volts 250 mA. 16/9.

BATTERY CHARGER TRANSFORMER
for 2, 6 or 12 Volt Charging. Input 200 to 240 volts. Output 17 volts tapped 11 and 17 Volts at 1½ amp., 11/6.



AMPLIFIERS TWO COMPLETE KITS OF PARTS

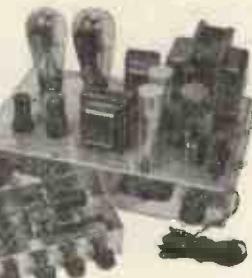
A 4-VALVE QUALITY "PUSH-PULL" 6-8 watt AMPLIFIER for A.C. mains. Incorporating Negative Feedback Filter Input Circuit and employing 6V6's in Push-Pull. A simple arrangement is provided to enable either a magnetic-crystal or lightweight pick-up to be used, and is suitable for use with Standard or long-playing records. A tone control is incorporated, and the control is incorporated, and the 10-watt output transformer is designed to match

2 to 15 ohm speakers.

The overall size of the assembled chassis is 10in. x 8in. x 7½in. high, and full practical diagrams are supplied. Price, including drilled chassis and valves, of complete kit, £8/17/6. Price of assembled chassis, supplied ready for use, £8/12/6. Full descriptive leaflets are available separately for 1/-.

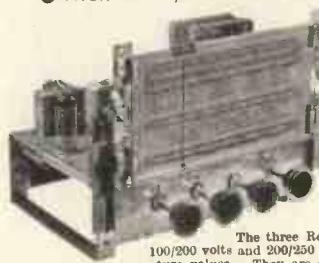
A 12-watt HIGH FIDELITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, employs 6 valves plus rectifier, with negative feedback, and comprises a main amplifier chassis and a remote controlled Preamplifier and Tone Control Unit, incorporating four controls—base, treble, main volume or mixing control, and a radio, gramophone, selector switch. This control unit measures only 10in. x 4in. x 2in. The assembled chassis of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore, that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV. 6.3 volts at 2 amps and 30 mA. H.T. is provided for tuning unit, etc. Price of complete kit, including drilled chassis and valves, £14. Complete specification and layout, 2/- We can also supply completely assembled and ready for use at £17.

THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THEIR COST.



THREE COMPLETELY ASSEMBLED ALL-WAVE SUPERHET CHASSIS

- Model B.3. A 5-valve 3-waveband Receiver.
- Model B.3.P.P. A 6-valve 3-waveband Receiver with PUSH-PULL OUTPUT.
- Model B.3.P.P./R.F. A 5-valve 6-waveband (4 Bandspread) Receiver.



MODERNISE YOUR OLD RADIOPHONIC FOR

£25

(plus 10/- carriage and insurance)
with the very latest equipment. We will supply the 3 waveband chassis on the left with the 3-speed auto changer on the right, complete with 10in. speaker for £25 (£28/7/6 with the Model B3.P.P. Or £31/5/- with B3.P.P.R.F.) This is less than half the price of comparable commercial three speed auto radiograms.



Brand new in Makers' Cartons, complete with mounting instructions.

The three Receivers are for operation on A.C. mains 100/200 volts and 200/250 volts, and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent clarity of speech and music on both gram and radio, making them the ideal replacement chassis for that "old Radiogram" etc.

Brief specifications: Model B.3. 5-Valve line-up, 6BE6, 6BA6, 6AT6, 6BW6, 6X4—waveband coverage, short 16-50 medium 187-550, long 900-2,000 metres. Controls: (1) Volume with 10/15; (2) Tuning (flywheel type); (3) Wavechange and gram; (4) Tone (3-position switch operative on gram and radio). Negative feedback is employed over the entire audio stages. Chassis size: 11 x 78 x 8in. high. Dial size: 9in. x 4in. Price, complete and **READY FOR USE**, excluding speaker, £12/12/- (carr. and ins. 7/6 extra). Model B.3. P.P. This model in the B.3 Receiver but incorporates two 6BW6 VALVES in PUSH-PULL, resulting in really excellent quality reproduction up to approximately 6 watts. Price £15/15/- (plus 7/6 carr. and ins.).

Model B.3. P.P./R.F. This model is similar in appearance and has same waveband coverage as the Model B.3, but in addition it incorporates an R.F. STAGE together with PUSH-PULL OUTPUT, employing a total of 7 valves with two type 6BW6 in Push-Pull. This makes for a really sensitive receiver with genuine quality reproduction. Price £18/18/- (plus 7/6 carr. and ins.).

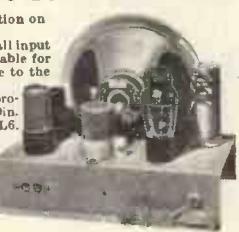
A COMPLETE KIT OF PARTS TO BUILD A 3-4 WATT HIGH GAIN AMPLIFIER

For operation on A.C. or D.C. Mains, 200-250 volts.

This amplifier will give 3 watts output for the small input voltage of only 75 millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the miniature H/F Magnetic type.

A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 9in. x 5in. x 7in. and valve line-up 25Y5+6AT6+2L6. Price of complete kit, including drilled chassis and valves, £4/2/9, plus 6/6p. P.M. (which fits on chassis), 16/- or 8in. P.M., 18/9. Price of fully assembled chassis ready for use, £5/5/- (plus cost of speaker).

Copy of assembly instructions and components price list available for 1/3.



S.T.C. RECTIFIERS

TYPE	K3/15	4/5	TYPE	K3/60	9/8
K3/25	5/8		K3/70	11/-	
K3/30	6/-		K3/80	12/4	
K3/35	6/10		K3/90	13/6	
K3/40	7/6		K3/100	14/8	
K3/50	8/8		K3/160	21/6	

BATTERY CHARGER KITS

All Kits are for A.C. Mains 200-250 Volts. They comprise of a Metal Rectifier and Transformer, tapped for 6 or 12 Volt charging, and a tapped Resistor, with Selector Switch, to enable the charging rate to be varied.

For 6 or 12 volt batteries at max. 1 amp. £1/17/6
For 6 or 12 volt batteries at max. 24 amp. £2/5/3
For 6 or 12 volt batteries at max. 4 amp. £3/2/6
An easily followed Wiring Diagram is included with each Kit.

VARLEY HEATER TRANSFORMER

Input 200-250 volts. Output 4 volts (centre tapped) 5 amps. 14/9 (1/- postage).

When submitting orders, please include post and packing charges.

STERN RADIO Ltd. 109 & 115, FLEET STREET, E.C.4

Tel.: CENTRAL 5812-3-4

WE OFFER

or with B3PP Model for £28/- (plus 10/- C. and I.), or with Model B3 PP/RF for £29/10/0 (plus 10/- C. and I.).

The DENCO
M.T.O.I.
MODULATED
TEST
OSCILLATOR
£3/15/0

(Plus 2/- Carr. and Ins.)
Has Frequency range continuously variable from 170-475 Kc/s. and 550-1,600 Kc/s. Battery operated and thereby completely self contained.

GENUINE REDUCTION!

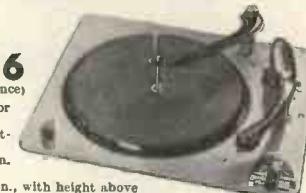
The COLLARO MODEL 3RC/514.
3 SPEED NON-AUTOCHANGE
RECORD PLAYER

(Normal Price £6/19/6)

(Plus 5/- Carr. and Ins.)

Incorporating the New Ortho Dynamic Hi-Fi Magnetic head fitted with Twin alloy stylus and matting transformer, together with pick-up weight adjustment.

These units are quite new and contained in the makers original cartons complete with Mounting Template.



RADIO TRADERS LTD.

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Grams: "Radiotrade"

**Component Specialists for 20 years.
The Largest Selection of Radio and
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SPECIAL OFFER of famous manufacturer's stock of electrolytics

16+8 mfd., 350 v., 15/- per doz.	64 mfd., 350 v., 30/- per doz.
32 mfd., 350 v., 15/- per doz.	25 mfd., 50 v., 12/- per doz.
32+8 mfd., 350 v., 18/- per doz.	12 mfd., 50 v., 12/- per doz.
32+8+8 mfd., 350 v., 24/- per doz.	

Volume Controls with switch, 50K and 500K, 2/6 each.

All are BRAND NEW goods, C.O.D. or C.W.O. Reduced prices for large quantities. Orders for less than £2, add postage.

Large Selection of silver mica, moulded mica and tubular paper condensers, etc., etc., at much below manufacturer's cost.

Trimmers Variable CERAMIC TRIMMERS. Capacities from 5 to 100pF. Spindle and pre-set types. Also Philips trimmers and trimmer tools and many other types.

Resistors HIGH STABILITY, close tolerances from 1%, $\frac{1}{2}$, $\frac{1}{4}$, 1 and 2 watts. All values up to 2 meg., including 8, 13 and 30 meg.

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CARBON. $\frac{1}{4}$ watt to 5 watt. All popular values. Standard Car Suppressors, 15,000 ohms.

Volume Controls MORGANITE "A" "H" type, "LH" type, "M" type and WIRE WOUND. Most values and popular makes in stock.

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This Month's Bargains

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DEAF AID CRYSTAL MIKE UNITS 12/6 each, post 9d.

CERAMIC SWITCHES, 2 bank, 2 pole, 4 way each bank, 6/-, post 9d.

SPECIAL TRANSFORMER OFFER. PRI. 115, 210, 240 v. SEC., 260/260 v. 100 mA, 6.3 v. 3 a., 6.3 v. 1 a. (for 6X5 Rec.) Universal Mounting. Limited Quantity, 17/6 each, post free.

TWIN RIBBON FEEDER. Standard K25 300 ohm ribbon, 9d. per yd. Co-axial, $\frac{1}{2}$ in. dia. 50 ohm, 8d. per yd. 7ft. length $\frac{1}{2}$ in. dia. Co-axial with Pye plug one end, 1/6, post free. All other Co-axial and feeder, plus 1/6 post any length.

SPECIAL OFFER, AR88 SPARES. Cabinets complete with base, feet and side strips, £4/15/- each. Pkg. and Carr. 5/-. Set of 14 valves for "D" or "LF" model receivers, £5/10/-. Panel escutcheons 22/6 each "D" type I.F.S., 12/6 each. Matching Speakers by R.C.A., fitted rubber feet and 6ft. lead, 65/-.

TAPE RECORDING EQUIPMENT. Desks by Bradmatic, Tamsa, Lane and Qualtape. Ex stock. Heads, Oscillator Coils, Tape and Reels always available. **GERMANIUM DIODES.** B.T.H. 2/-, G.E.C., 2/6.

POTENTIOMETER Carbon Type Potentiometers, 25k., 50k., 100k., $\frac{1}{2}$ meg., 2meg., 1/6. Many W.W. slot types available for T.V. replacements.

METERS. 2 $\frac{1}{2}$ in. Flush mounting M.C. 100 mA., 12/6 each; 2in. Flush Square 5 mA 10/-; 4 amp. thermo. 5/-; 2 $\frac{1}{2}$ in. thermo. 0-2 a., 7/6; 2 $\frac{1}{2}$ in. 2in. Flush 0-15 a. thermo. Proj. 2 $\frac{1}{2}$ in., 7/6 each. 0-9 a. Hot wire 5/-.

SPECIAL VALVE OFFER. 83 MV Rectifiers 10/-, 866A 17/6 each, or 30/- pair. 807's 12/6 each or 22/6 pr. 931A 45/-, 832 35/-, 829B, 80/-, 813, £5.

Carriage paid on all orders over £1 except where stated. Please include small amount for orders under £1.
Please print your name and address.

CHAS. H. YOUNG, G2AK

Mail orders to 102 HOLLOWAY HEAD, BIRMINGHAM
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I KW TELEGRAPH TRANSMITTERS. Two HF 300's output. Operation 3.5 mc. to 16 mc.

BC610 TRANSMITTERS with speech amplifier, aerial tuning unit, etc. Brand new.

RCA TRANSMITTERS. Type FT-4336. Complete with original speech amplifier, crystal multiplier and VFO units. Unused and re-conditioned. Can be supplied with very large quantity of spares.

RCA TRANSMITTERS. Type ET-4332 modified by R.A.F. for use on crystal or master oscillator. Complete with speech amplifier.

MAGNETO 10 LINE U.C. TELEPHONE SWITCHBOARDS (complete).

NO. 33 TRANSMITTERS.

A.R.88D's, A.R.88LF's, A.R.77's, S27's, HRO, R.109 and others.

SCR510's complete with Power Pack and telescopic aerial.

All above items in excellent working condition.
Working demonstration upon request.

SPARES A large selection available for SCR399 (BC610), ET4336, SCR610, EE8 Telephones, and Teleprinters type 7B.

TX VALVES 805, 807, 813, 861, 866A, DET-16, 100TH and many others.

Large stock of Tx condensers, crystals and other components. Alignment and repair of communication receivers and all other short-wave equipment undertaken.

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COLLARO 3-SPEED AUTOMATIC RECORD CHANGERS

MODEL 3 RC/521.
Brand new and unused, in maker's original carton.

Fitted with twin crystal heads.

LASKY'S PRICE
£9.19.6

Carriage 3/6 extra.



Available also with either orthodynamic or high fidelity studio heads. Price on application.
Now in stock: 3-speed mixer changers. Prices on application.

TANNOY PRESSURE UNITS
10 watts. 7.5 ohm impedance.
Last few only. **PRICE** **59/6**
Carriage 4/6 extra.

MICROPHONE STANDS
Table model. 2-section chrome plated.
Crackle finish base. **15/-**
Floor model. 2-section. Brass. heavily chrome plated. **69/6**
Carriage 2/6 extra.

GRAM MOTORS
Shaded Pole



Rim drive, synchronous. For 200-250v.
50 c.p.s. Many uses. **9/6.**

METAL RECTIFIERS
6 and 12 volt F.W. Bridge.

0.6a.	4/6
2a.	9/-
3a.	9/11
4a.	12/-
6a.	17/6
6 volt Centre Tapped Bridge.	
0.75a.	3/9
1a.	3/11

R.1155 RECEIVERS

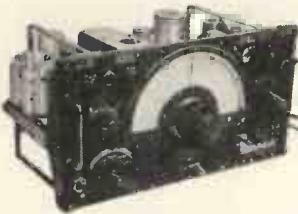
BRAND NEW AERIAL TESTED BEFORE DESPATCH

These well-known ex-Air Ministry Receivers need no further introduction.

Supplied complete with 10 valves.

LASKY'S PRICE **£11.19.6**

USED MODELS **£7.19.6**



Fully Assembled Power Pack and Output Stage, for R1155 Receiver. For use on 200-250 volts A.C. mains.
LASKY'S PRICE **79/6**
Carriage 5/- extra.

SOLON SOLDERING IRONS
220-250 volts

Latest model instrument iron 19/8
Standard model 19/-

CRYSTAL DIODES

Germanium 1/6 each, post free.

12 VOLT D.C. MOTOR GENERATORS

Output 300 volts at 150 m.A.
D.C. 7,500 r.p.m. Size: 2½in.
diam. 6in. long. **17/6**

LASKY'S PRICE

I.F. TRANSFORMERS

465 Kc/s Iron dust cores in cans, midget type. Size 1½in. x 1in. x 2½in. By Plessey. Price 9/6 per pair.
WEARITE TYPE 550. 445-520 Kc/s. 10/- per pair.
WEARITE TYPE 500. 450-470 Kc/s. 10/- per pair.

3 SPEED GRAM MOTORS

Complete with motor board and turntable. Size: 8½in. x 11½in. x 5½in. high. For use on 200-250 v. 50 c.p.s.
LASKY'S PRICE **49/6**

ALL WAVE RADIO INTERFERENCE SUPPRESSOR UNITS, 5/6 each.

JACK PLUGS AND SOCKETS
Standard size, 3/11 per pair.

INTRODUCING THE SOUNDMASTER

You can now build your own HIGH FIDELITY TAPE RECORDER (both tape deck and amplifier) AT HOME. Uses precision machined parts and standard radio components.

Easily wired and assembled without previous experience. SEND NOW for 26 page booklet giving full data to build in 6 easy stages, with full size wiring diagrams. All the latest developments in home recording. Life-like reproduction of voice, music and events. 3 speeds, twin track recording at 3½in., 7½in. and 15in. per second. Fast forward and fast rewind using 3 motors.

POST FREE **6/6**

BY THE CREATORS OF THE VIEWMASTER

All components in stock. Write for list. Wearite, Bulgin, T.C.C., Collaro, etc



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R.M.1	3/10
R.M.2	4/3
R.M.3	5/-
R.M.4	18/-

WESTINGHOUSE RECTIFIERS

250 v. R.M.S.	14A976. 80 m.a 8/6.
200 m.a. 20/4.	14A86. 200 m.a. 20/4.
200 m.a. 21/6.	14A100. 270 v. R.M.S.

CONDENSERS. ELECTROLYTICS.

Cans Tabular

16 mfd. 500 v.w.	3/8	1 mfd. 200 v.w.	1/-
24 mfd. 450 v.w.	3/11	2 mfd. 150 v.w.	1/-
32 mfd. 500 v.w.	5/11	3 mfd. 350 v.w.	1/6
60 mfd. 350 v.w.	3/4	4 mfd. 350 v.w.	1/3
64 mfd. 450 v.w.	4/11	8 mfd. 150 v.w.	1/6
8 + 8 mfd. 450 v.w.	3/11	8 mfd. 350 v.w.	2/-
8 + 16 mfd. 450 v.w.	3/11	8 mfd. 450 v.w.	1/9
8 + 32 mfd. 475 v.w.	3/11	8 mfd. 500 v.w.	2/3
16 + 8 mfd. 500 v.w.	4/8	8 mfd. 500 v.w.	2/3
16 + 24 mfd. 500 v.w.	4/8	13 mfd. 200 v.w.	2/3
16 + 24 mfd. 450 v.w.	4/11	18 mfd. 250 v.w.	2/3
16 + 32 mfd. 450 v.w.	4/11	18 mfd. 350 v.w.	2/3
20 + 20 mfd. 275 v.w.	2/9	18 mfd. 450 v.w.	2/3
32 + 32 mfd. 500 v.w.	4/11	16 mfd. 500 v.w.	3/6
32 + 32 mfd. 350 v.w.	3/11	32 mfd. 350 v.w.	3/6
60 + 100 mfd. 350 v.w.	7/8	32 mfd. 450 v.w.	4/9
250 mfd. 350 v.w.	4/11	50 mfd. 350 v.w.	4/6
8000 mfd. 3 v.w.	6/11	250 mfd. 12 v.w.	2/11
		250 mfd. 25 v.w.	3/-
		8 + 8 mfd. 350 v.w.	3/11
		12 + 12 mfd. 350 v.w.	2/6

MANY OTHER TYPES IN STOCK

SPECIAL T.V. CONDENSERS
32 + 100 mfd. 450 v.w. 7/6 .04 mfd. 12.5 Kv. 7/6

Bias

.1 mfd. 2.5 Kv. 2/6
.1 mfd. 3 Kv. 3/6
.1 mfd. 3.5 Kv. 4/6

.1 mfd. 10 Kv. 12/6
.25 mfd. 2.5 Kv. 5/6
.1 + .1 mfd. 3.5 Kv. 5/11

T.C.C. VISCONOL HIGH VOLTAGE CONDENSERS (Cathodray)
.001 mfd. 12.5 Kv. 7/6

.001 mfd. 15k.v. 10/-

.001 mfd. 25 Kv. 18/-

.0005 mfd. 25k.v. 18/-

.0005 mfd. 12.5 Kv. 10/-

Plastic case, single bolt fixing. Other h.v. types.

.1 mfd. 7 Kv. 15/-
.04 mfd. 12.5 Kv. 7/6

Supplied in maker's original wood transist case.

Frequency coverage 100-124 Mc/s. 11 valves: 1 VR65, 1 VR66, 4 VR53, 2 VR54, 1 GJ5, 1 VS70, 1 VR57. Large tuning scale with slow motion drive. 0-5 mA. tuning meter R.F. and L.F. gain controls, jack sockets for line and phone. Totally enclosed in metal case, grey enamelled with plated handles. Size: 13 x 10 x 11in. Supplied with all valves, also circuit and calibration chart.

GRADE 1. Brand New 79/6. **GRADE 2.** Soiled 49/6.

GRADE 3. Secondhand 39/-. Carriage 10/- per unit extra.

R.1132.A RECEIVERS



TWO-GANG TUNING CONDENSERS .0005M D. No. 1. Miniature. With Perspex dust cover and trimmers. Size: 1½in. x 2in. x 1½in. ¼in. spindle.

LASKY'S PRICE 8/6.

No. 2. Midget. With trimmers. Size: 2½in. x 1½in. x 1½in. ¼in. spindle. **LASKY'S PRICE** 8/6.

No. 3. Midget. Less trimmers. Size: 2in. x 1½in. x 1½in. ¼in. spindle. **LASKY'S PRICE** 6/-.

No. 4. Standard type. Size: 2½in. x 2½in. x 1½in. ¼in. spindle. **LASKY'S PRICE** 15/-


**LINE TRANSFORMERS FOR
"ETRONIC"
T.V. RECEIVERS**

No. 1. For models 1536 and 1637. Complete with EY51 rectifier, 45/-.
No. 2. 7Kv. type, 35/-.

POT/METERS. All values. Wire wound from 3/6. Depending on wattage and length of spindle. Carbon. Less switch 3/3 each. With s.p. switch ... 4/3 each. With d.p. switch ... 5/6 each

VCR97 C.R. TUBES, new unused. 35/-. Carriage 5/-.

EHT. Trans. For VCR97. 2.5 Kv., and 4v 1.1a and 4v 1.5a (CT). 45/-.

Screen Enlarger for VCR97. Filter type, 17/6. Postage 2/6.

BASES for VCR97. 2/6.

C.R.T. Neck Protectors. 2/6.

10 K.V. METROSIL E.H.T. REGULATORS. By Metrovick. Pencil type, 5/- each.

TELEVISION SELENIUM RECTIFIERS

The very latest "Sentercell" S.T.C. range.
K3/40, 3.2 kV. 7/6
K3/45, 3.6 kV. 8/2
K3/50, 4.0 kV. 8/8
K3/100, 8.0 kV. 14/8
K3/160, 12.8 kV. 21/6

DARK SCREEN FILTERS
18in. x 14½in. 25/-
14in. x 12½in. 19/6
13in. x 11in. 14/11

PERSPEX. 13½in. x 10½in. x ½in. Neutral shade, slightly marked, 4/11 per piece.

TEST PRODS
Fully fused, with retractable points, 4/11 per pair (1 red, 1 black).

9in. TABLE T.V. CABINETS


Medium shade mahogany finish. Complete with back, safety glass, speaker-fret. Internal dimensions: 19½in. high, 16in. wide, 14in. deep.
LASKY'S 39/6 Carriage 7/6 PRICE extra.
Adaptor frame available for 6in. C.R. tubes. The aperture can easily be enlarged to take 12in. or 14in. tubes.

SPECIAL C.R.T. OFFER	
Brand new and unused	12in. ion trap cathode ray tubes.
6.3 volt heater, 7-9 Kv. E.H.T.	35 mm. neck. Black and white picture. By famous manufacturer.
PERFECT £12/19/6	Carriage and insurance 15/- per tube extra.

**FOR CALLERS ONLY.
USED T.V. CHASSIS.**
In all sorts of conditions at very low prices. Come along and pick one out. The price will be right.

**MANUFACTURERS:
SURPLUS T.V. COM-
ONENTS**

Wide Angle Scanning Coils. Low imp. line and frame ... pair	19/6
Scanning Coils. 35 mm. Low imp. line and frame ...	12/6
Frame multi ratio output trans.	10/6
Focus Coil. 35 mm. electro magnetic ...	12/6
P.M. Focus magnets. With Vernier adjuster. For all 35 mm. tubes	25/-

PLESSEY

Scan coils per pair 25/-
Width Control 6/6

**NOW AVAILABLE
LARGE SCREEN WIDE
ANGLE CONVERSION
DETAILS FOR THE
VIEWMASTER**

Send 3d. stamp for full data. Fully itemised price list of all Viewmaster components now available.

Co-Axial Cable. 70-80 ohms impedance.

Single core, 9/- doz. yards. Twin core, 12/- doz. yards. Twin feeder, 6/- doz. yards.

Co-Axial Connectors. For standard 1in. cable, 1/11.

**WIREWOULD POT/
METERS.**

Type 901. Most values. 2/6 each.

**C.R.T. MASKS
Brand New
LATEST ASPECT
RATIO**

9in.	7/-
10in.	7/6
12in.	15/-
12in. Flat Face	15/-
12in. Old ratio	9/6
12in. Plastic, with dk. sc. filter and gold finish escutcheon	17/6
14in. Rectangular ...	21/-
16in. Eng. Elect.	42/-
16in. Double D	31/6
16in. With dark screen filter and gold finish escutcheon	32/6
17in. With dark screen filter and gold finish escutcheon	37/6
17in. Rectangular ...	21/-

**SOILED, NEW ASPECT
RATIO**

9in.	5/-
12in.	7/6
12in. with fitted armour plate glass, cream	11/6
12in. do. Black	8/6

**ARMOUR PLATE
GLASS**

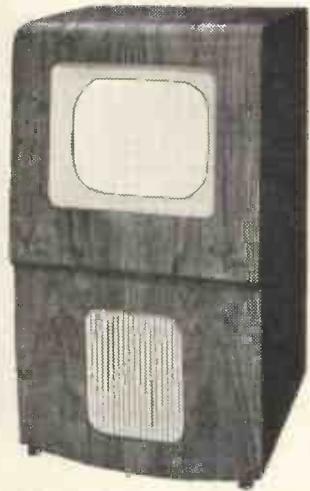
16in. Actual size 17½ x 15½ x 4½ inch ...	7/11
15in. Actual size 16½in. x 13in. x 4in.	6/11
12in. Actual size 13in. x 10½in. x 4in.	4/-
9in. Actual size 9in. x 8in. x 4in.	3/-

DE LUXE T.V. CABINETS

NEW 1954

12 INCH MODEL

(Mark II)



This cabinet is now supplied complete with mask, glass, castors, shelf, bearers, c.r.t. neck end protector, back, speaker fret and baffle board. Finished in beautiful figured medium, light or dark walnut veneer, with high polish. Suitable for most home constructor T.V. receivers, including the "Viewmaster," "Practical Television," "Tele King," "Magniview," "Wireless World," etc. Can be supplied with cut out for 16in. c.r. tube at no extra cost.

WHY NOT CONVERT YOUR TABLE RECEIVER TO A CONSOLE MODEL

Adaptor frames for fitting 9in. or 10in. c.r. tubes can be supplied if required.

LASKY'S PRICE
Carriage 12/6 extra.

£8.10.0

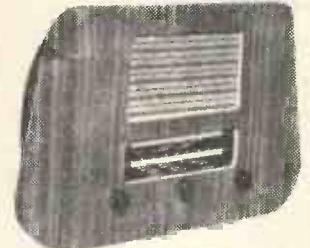
An allowance of 4s. 6d. will be made if the mask is not required.

Inside Dimensions: Depth 16½in.; width 17½in.; height 28in. Overall height 2in. and width 18½in.

THE VIEWMASTER

Construction envelope 7/6 POST FREE. All components in stock. Write for price list.

BAFFLE RADIO CABINETS



Pleasing design, complete with knobs, drilled chassis, dial, drum drive and back. Finish in satin mahogany veneer, natural colour polish. Outside dimensions: 17½in. wide, 11½in. high, 5in. deep.

LASKY'S PRICE

36'6

Carriage 2/- extra

15-INCH CATHODE RAY TUBE MASKS
Cream rubber. Latest aspect ratio. Overall dimensions: 17in. wide, 13in. high. Price 17/6. Postage 2/- extra.

RF25 UNITS. New, with valves, 19/11. Carriage 2/6.

**T.V. TYPE
MAINS
AUTO
TRANS-
FORMER**

200, 220, 250 and 375 volt	tappings, 250 mA. Also 5 v.
3 a. ; 6.3 v.	7 a. and 6.3 v.
3 a. secondaries.	Price 25/-.
Hours: Mon. to Sat. 9.30 a.m. to 6 p.m., Thurs. half-day 1 p.m.	

LASKY'S

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370 HARROW ROAD, PA

(Opposite Paddington

Telephones: CUNningham

THE TELE-KING

A practical 5-channel

SUPERHET TELEVISION RECEIVER

Using the new 16 and 17 inch cathode ray tubes and wide angle components for the home constructor.

Complete instructions, wiring diagrams and 32-page descriptive booklet.

6/- POST FREE

**ALL COMPONENTS IN STOCK
WRITE FOR LIST**

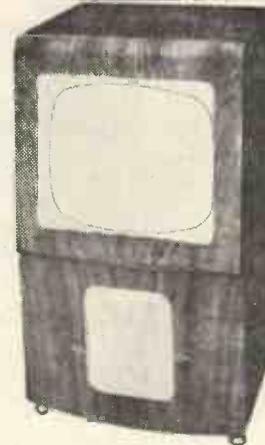
16"

17"

Alexandra Palace,
Sutton Coldfield,
Holme Moss,
Wenvoe,
Pontop Pike,
Belfast,
Kirk o' Shotts.



NOTICE TO ALL PURCHASERS OF THE ENGLISH ELECTRIC 16 inch G.R.T. TYPE T.901. The first and only reconditioning service. By English Electric. A reconditioned 16in. metal tube costs £12 and carries maker's full guarantee. Write for further details.



ALLEN WIDE ANGLE COMPONENTS

D.C. 300 latest type Ferroxcube Coils 39/6 GL.16 Coil 7/6 GL.18 Coil 7/6 Focus Coil 31/- FO.305 trans. 21/- Frame B.O. transformer 15/- Line E.H.T. transformer, 40/-

CHASSIS

Power pack Sound-vision and Scan chassis. PRICE 11/- each. All other metal work available from stock.

CONDENSERS

All condensers. As specified. Manufacturers surplus £3/16/- COILS 13 all exactly as specified. Price 44/6.

RESISTANCES

72 Resistances, all exactly as specified, 18/-.

CABINET

Walnut veneer, £8/10/- plus carriage 12/6 extra. As illustrated here.

WIDE ANGLE CATHODE RAY TUBES

14in. MW36-22	£19 9 3
14in. C14B	£20 10 1
16in. MW41-1	£22 4 10
16in. T901	£22 4 10
17in. MW43-64	£23 12 8
17in. C17BM	£24 13 0

Carriage and insurance extra.

OUTPUT TRANSFORMERS

40 mA Multi ratio	4/11
80 mA Multi ratio	14/11
80 mA Pentode	12/6
60 mA Plessey, 6,000 ohms	5/11
Standard pentode	4/11
Pentode	3/6
Midget Pentode	3/6
Miniature Pentode, 3S4, 1S4	4/6
PX4 Intervalve	8/6
5:1 Intervalve	5/11

P.M. LOUDSPEAKERS

All with 3 ohm speech coil.	
2½in. 15/-	6½in. 13/6
3in. 12/6	8in. 15/-
4in. 9/6	10in. 17/6
5in. 14/6	

NOW AVAILABLE 12 inch Goodmans heavy duty speaker. Capacity 15 watts, 15 ohms speech coil impedance.

LASKY'S PRICE £5/19/6. Car. 3/6 extra. All loudspeakers offered are first grade and of highest quality construction. Many other types in stock. Send us your requirements.

THE "UNIVERSAL" LARGE SCREEN AC/DC TELEVISOR

By A. S. Torrance, A.M.I.P.R.E., A.M.T.S.

A 28 page booklet giving full instructions for building a large 17 inch screen televiser.

* A.C. and D.C. mains.

* P.M. focussing.

* Mullard valves and c.r. tube.

* 5-channel superhet.

3d. POST FREE.

COIL PACKS
Medium and 2 short wave bands. Price 16/-.

COIL PACKS
Long, medium and short wave bands. Price 29/6.

INTERCOM UNITS
4-station operation. For use on A.C./D.C. mains 200-250 volts. Supplied complete, with 3 new valves, ready for immediate installation. Fitted in attractive plastic cabinet.

Suitable for use as baby alarm.

MASTER UNIT £5.19.6

Carr. 5/- extra.

Extension Units. Price 21/- each complete.

Carriage 2/- each extra.

LASKY'S LINE TRANSFORMER

RF.EHT for line fly back. 6-8Kv, with EY51 heater winding. Suitable for home construction T/V 25/-.

DUOMAG FOCALISER

Low Flux	37/6
Med. Flux	39/6
High Flux	42/-

POSTAGE STAMP TRIMMERS

Paxolin. Up to 100pf.	
6d. each. 5/- per doz.	
Ceramic. Up to 100pf.	
9d. each. 7/6 per doz.	
350 and 550pf. Ceramic.	
1/- each. 10/6 per doz.	

Duodecal (B12A) bases. VCR139 c.r.t. bases. 1/- each. 10/6 dozen.

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Hospital)

485/487 Harrow Road, Paddington London, W.10

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TERMS: Pro Forma, Cash with order, or C.O.D. on post items only. Postage and package on orders value £1-1/- extra, £5-2/- extra, £10-3/6 extra. Over £10 carriage free. All goods fully insured in transit.

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. An ideal replacement trans. Price 18/-.

MBA/6. 325-0-325 v. 100 mA. 6.3 v. 3 a., 5 v. 2 a. With mains tapping board Price 22/6.

MBA/7. 250-0-250 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. Price 18/-.

AT/3. Auto transformer. 0-10-120, 200-230-240 volts 100 watt. Price 17/6.

FILAMENT TRANSFORMERS

6.3 v. 1.5 a., 5/9.

6.3 v. 3 a., 9/6.

6.3 v. tapped at 4 v. 2 amps., 7/9. **Special Transformer.** 2 amps., with the following tappings: 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts. Price 17/6.

SMOOTHING CHOKES

20 mA 40 H. 3/6

40 mA 8 H. 3/6

40 mA 10 H. 4/3

100 mA 10-20 H. 7/3

250 mA 10 H. 18/6

WIRE RECORDERS



BRAND NEW AND UNUSED

By a very well known British Manufacturer. Original list price £69/10/-. Records from Records, Microphone, Radio. Includes a Garrard pick-up arm, and can be used as a record player complete with its own amplifier.

Supplied in perfect working order, with 7 valves, full operating instructions, circuit diagram and spool of recording wire.

Fitted with tone control and magic eye recording level indicator. In attractive wood cabinet with roll top. Medium walnut finish.

LASKY'S PRICE

£27.10.0

Carriage 25/- extra.

RECORDING WIRE. 1 hour spool 32/6, ½ hour spool 17/6.

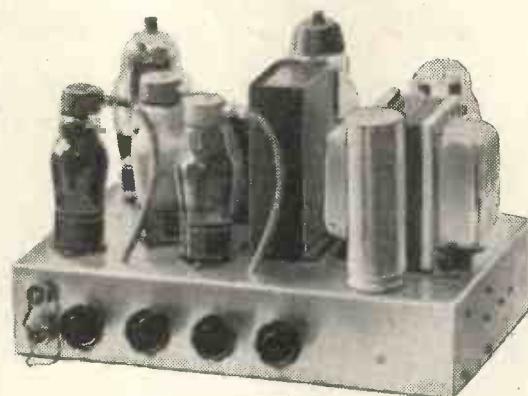
Moving Coil Insert. Ideal for use as a microphone with the above wire recorder. PRICE 5/-.

R.S.C. 25 WATT "PUSH PULL" AMPLIFIER

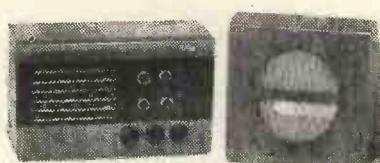
Now firmly established and proving extremely popular, our All Quality Amplifier we consider to be the best value in amplifiers offered to-day. The volume of its high fidelity reproduction is completely controllable, from the sound of a quiet intimate conversation to the full glorious volume of a great orchestra. Its sensitivity is so high that in areas of fair signal strength it can be operated straight from a crystal receiver. Entirely suitable for standard or long playing records in small homes or in large auditoriums. For electronic organ or guitar or for garden parties or dance bands.

The kit is complete to the last detail, and includes easy to follow point-to-point wiring diagrams.

Twin volume controls with twin input sockets allow SIMULTANEOUS INPUTS for BOTH MICROPHONE and GRAM. or TAPE and RADIO. SEPARATE BASS and TREBLE CONTROLS giving both LIFT and CUT. FOUR NEGATIVE FEEDBACK LOOPS with 15 db in the main loop from output transformer to voltage amplifier. Frequency response ± 3 db. 50-20,000 c.p.s. Hum and distortion LESS THAN 0.5 per cent. measured at 10 watts. This is comparable with some of the highest priced amplifiers. Six B.V.A. valves, Marconi/Osram KT series output valves. A.C. only, 200-230-250 v. 50 c/cs. input. 420 v. H.T. LINE. Paper reservoir condenser. Compact chassis. Matched components. OVERALL SIZE 4-10-9in. approx. Output impedances for 3 and 15 ohms speakers.



Available in kit form at **9 gns.** Plus the amazingly low price of **5/-** carriage 5/- Or ready for use 50/- extra.



R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 "Listen-Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring diagrams are supplied. A walnut veneered wood cabinet is included. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHASSIS IS NOT "ALIVE." Ideal also for use as "BABY ALARM." Sound amplification 4 watts. Price only £5/19/6. "Listen-Talk Back Unit" as illustration can be supplied at 27/6 each. Full descriptive leaflet 1/-.

The Master Unit can be supplied assembled and tested for 27/6 extra.

R.S.C. BATTERY CHARGER KITS. For mains input 200-250 v. 50 c/s. To charge 6 v. accumulator at 2 amps., 25/8.

To charge 6 v. or 12 v. accumulator at 2 amps., 31/6.

To charge 6 v. or 12 v. accumulator at 4 amps., 49/9.

ABOVE KITS CONSIST OF BLACK CRACKLE STEEL CASE, MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER, FUSES, FUSE-HOLDERS AND CIRCUIT. Due to careful design the use of resistors for regulation of charge

has been obviated. The mean charging rates are as indicated above, and complete safety is ensured by fusing of both input and output. Chargers supplied assembled and tested for 6/9 extra.



A PUSH-PULL 3-4 WATT HIGH-GAIN AMPLIFIER FOR £3/12/6, plus carr. 2/6. For mains input 200-250 v. 50 c/s. Complete kit of parts including point-to-point wiring diagrams and instructions. Amplifier can be used with any type of feeder unit or pick-up. Output is for 2-3 ohm speaker. (We can supply a very suitable 10in. unit by Goodmans at 31/-.) The amplifier can be supplied ready for use for 25/- extra. Full descriptive leaflet 9d.

COLLARO 3-SPEED AUTOMATIC RECORD CHANGERS (brand new), type RC521, complete with 2 plug-in P.U. heads. Mains input 200-250 v. Limited number available at only £9/19/6.

COLLARO GRAM MOTORS, TYPE AC37. Governor controlled at 78 r.p.m. Mains input 110-200-230-250 v. Shaded pole type, 35/-.

COLLARO TAPE DESK MOTORS. Shaded pole type. Clockwise or anti-clockwise. Mains input 110-200-250 v., 31/6.

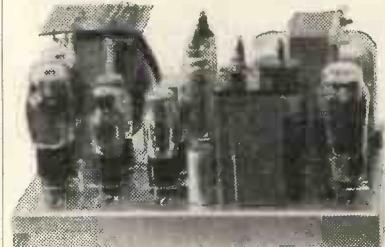
PERSONAL SET BATTERY SUPERSEDER KIT.

Complete with case. Supplies 90 v. 10 mA. and 1.4 v. 250 mA. fully smoothed, from normal 200-250 v. 50 c/s. mains. For 4-valve superhet receivers. Price with circuit 35/9. Or ready for use 42/6. Size of unit 5-4-1/2in.

BATTERY SET CONVERTER KITS. All parts for converting any type of battery receiver to all mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed H.T. of 120 v. 90 v. or 60 v. at up to 40 mA., and fully smoothed L.T. of 2 v. at 0.4 a to 1 a. Price complete with circuit and instructions only 48/9. Supplied ready for use for 7/9 extra.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT. Consists of h.t. and l.t. transformer, h.t. and l.t. rectifiers, smoothing electrolytic, choke, and steel case. For mains input of 200-250 v. Output 120 v. 40 mA. and 2 v. 1/2 a. Price with circuit 29/6. Or in working order, 37/6.

WILLIAMSON AMPLIFIER KIT. Complete set of parts (exact to author's specification) for construction of the original amplifier.



PRICE COMPLETE 14 gns.

R.S.C. TONE CONTROL-PRE-AMP. UNIT. A complete set of parts for the construction of a very efficient but simple pre-amplifier and tone control unit. Suitable for use with any amplifier and pick-up. Fil. supply is self-contained. Overall size is 7-5-5-1/2in. approx. Full descriptive leaflet 9d.

PRICE INCLUDING WIRING DIAGRAMS 37/6. Or ready for use 15/- extra.

CHASSIS



18 s.w.g. undrilled aluminium amplifier type (4 sided)	
12in. x 9in. x 2 1/2in.	6/11
14in. x 9in. x 2 1/2in.	6/11
14in. x 10in. x 3in.	7/11
16in. x 10in. x 3in.	8/3
18 s.w.g. aluminium, receiver type. 6in. x 3in. x 1 1/2in.	1/11
7 1/2in. x 4 1/2in. x 2in. ....P.	2/9
10in. x 5 1/2in. x 2in.	3/3
11in. x 6in. x 2in.	3/11
16 s.w.g. aluminium, receiver type, 12-8-2 1/2in.	5/3
16in. x 8in. x 2 1/2in.	7/6
20in. x 8in. x 2 1/2in.	8/11
16 s.w.g. aluminium, amplifier type, 4 sided.	10/11
12in. x 8in. x 2 1/2in.	7/11
16in. x 8in. x 2 1/2in.	10/11
20in. x 8in. x 2 1/2in.	13/6
14in. x 10in. x 3in.	13/6

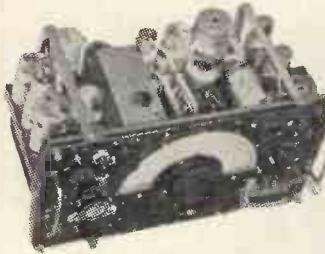
RADIO SUPPLY CO.

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32 THE CALLS, LEEDS 2

Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/- extra under £1, 1/9 extra under £3. Full Price List 6d. Trade List 5d.
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Prices slashed at Clydesdale



RI155 RECEIVER UNIT
Communications, D.F.C. and "Ham" 20, 40, 80, 5 ranges 18.75 Mc/s, 7.5-3 Mc/s, 1500-600 kc/s, 500-200 kc/s and 200-75 kc/s. Complete with 10 valves. SM drive, ME tuning, BFO, etc., in metal case 16½ x 9 x 9in. External Power Supply required. APPEARANCE AS NEW ASK FOR X/E6

\$8.19.6 CARR. PAID
APPEARANCE GOOD ASK
FOR X/H916 **\$6.19.6**
CARR. 7/6 EXTRA.
APPEARANCE ROUGH ASK
FOR X/H898 **£5.19.6**
CARR. 7/6 EXTRA.

Circuit 1/3.



TII54B TRANSMITTER UNIT

Medium/High powered, for C.W.-M.C.W.-R/T. 3 Ranges 10-5.5 Mc/s, 5.5-3 Mc/s, 500-200 kc/s. Complete with 4 valves, etc., in metal case 14 x 16½ x 8½in. External Power Supply required.

ASK FOR **39/6** Each CARRIAGE X/E5A 7/6 EXTRA

Circuit 2/3

POWER UNITS for TII54/R155 UNITS

Types 33 or 33B. Input 24 v. D.C. 16 a. Output 1,200 v. D.C. 200 mA. ASK FOR X/E7A.

Types 35 or 35A. Input 18 v. D.C. 12 a. Outputs 7.2 v. D.C. 13 a. and 225 v. D.C. 110 mA. ASK FOR X/E8A.

Each a Motor Generator Unit, smoothed, etc., in metal case 16 x 7½ x 6in.

LOOSE STORED

ANY UNIT **42/6** Each CARRIAGE PAID

TEST SET SE2 PATTERN NO. W5799

Brand New

Contains:—Wavemeter, oscillator and noise generator working on frequency of 180 to 220 mcs. Valves are 1/6X5, 1/655, 1/63, 2/EA50, 1/EC52, 1/E1468. Mains Transformer 80V., 180V., 230V., 50-2,000 cps., 10-500 microamp meter. All sections are separately screened with their own brass boxes, which are silver plated. Complete with leads and attenuators in wooden case. Grey finish. Size 20 x 10 x 11 ins. Wgt. 55½ lbs. Calibration chart on lid of box.

ASK FOR **£3.19.6** Each CARRIAGE X/H937 PAID

OSCILLATOR (SIGNAL GEN.) TYPE 35

Ex. Admiralty. Robustly constructed Signal Generator with frequency coverage 15-600 kcs. 0.8-25 mcs. in 11 switched bands, 200-1 ultra S.M. Drive. Input 200V. D.C. H.T. and 250V. A.C. or 12 V. D.C. for valve heaters, L.T. Supply. Shorting strips for altering heater circuit beneath valves. Valve types KTW61 and 2/DL63 or equiv.

NOT SUPPLIED. Chassis and Panel construction in steel and finished in grey and black.

Dim.: 28 x 7½ x 12 ins. Wgt. 7½ lbs. LESS VALVES.

ASK FOR **£6.19.6** Each CARRIAGE X/E787 PAID

A UNIVERSAL ELECTRIC MOTOR.

For 200/250 v. A.C. or D.C. Mains. By simple external wiring, full data supplied. New method gives better than 1/6th h.p. Using Ex-R.A.F. Motor Generator dim.: 11 x 5½ x 5½ in.

TYPE 29. ASK FOR X/E880.

TYPE 28. ASK FOR X/E880A.

EITHER UNIT **25/-** CARRIAGE PAID

Or giving slightly less power, ½ h.p. Motor Generator Type 30.

ASK FOR **19/6** Each CARRIAGE X/H488 PAID

ROTARY TRANSFORMER TYPE 44,

Ref.: 10KB/409.

Input 18 v. D.C. 3.13 a. Output 450 v. D.C. 0.05 a. Spindle extended each end. Dim.: 8½ x 3½ x 3½in.

ASK FOR **12/6** Each POST X/H845 PAID

STARTER MOTOR TYPE FE-I CA4750.

Heavy Duty 24 v. D.C. Starter Motor, as used in Aircraft, with recessed splined spindle, 6 hole end etc. dim.: 8½in. long 4½in. dia.

ASK FOR **10/-** Each CARRIAGE PAID

RECEIVER CHASSIS, RANGE 150-200 mcs. Contains: 1 Transformer prim 85M. henries, sec. 155M. henries, 5 coil in cans, 3 95 acorn valves, 4 acorn valve bases, 9 1.0 Valve-bases, 1 25pf. miniature tuning condenser with knob and coupling, 4 co-ax. sockets. On metal chassis size 8in. x 13in. x 5in. Wgt. 8½ lbs.

ASK FOR X/H940 **21/-** Each POST PAID

EGG INSULATOR TYPE H6, 10B/153 Standard, medium, large, insulator finished in brown. 3in. long, 2in. max. dia. ASK FOR X/E192 **1/9** Each POST PAID Box of 4 for 5/6. Gross lots for £7/4/-.

SUPPLY UNIT RECTIFIER for No. 43 Transmitter

Ex. Cdn. Army in original wood case. Input 110 volts A.C. 50/60 c/s. 1.7K. V.A. Output (HT1) 2,100V. 375mA. (HT2) 500V. 400mA. plus HT Lines, 450V. 275V., also 383V. regulated and neg. bias 250V. 150V. 80V. Making 3 complete power supplies all fed via double choke, condenser. Input circuits. Valves are 4/B66A/866, 5Z3, 6SJ7, 2/6A3, VR150/30 (Stab.) and IV. (Time Delay). The complete unit mounted in metal case with lid shock mounted. Dim.: 2ft. 6in. x 1ft. 6in. x 1ft. Finish olive drab. Wgt. 420 lbs. ASK FOR X/H26 **£25** Each CARRIAGE PAID

SELSYN MOTOR TYPE 5J/2512

Ref.: No. W.325A. 230 volts A.C. input single phase, torque transmission value 45 lb./ins. with 2in. long, ½in. shaft. Overall 12½ x 7 ins. diam. With fixing base.

ASK FOR X/H83 **39/6** Each CARRIAGE PAID

POWER UNIT TYPE 266 in Transit Case

Input 80V 1.5K cps. A.C. Outputs HT 120V. D.C. bias 3 and 9. LT. 2V. Smoothed and Stabilized. Complete with 5U4G valve V5110 stabilizer. 12V. 1A metal Rectifier, etc., etc., in attractive metal case with handles. Dim.: 11 x 9½ x 7½ ins.

ASK FOR X/E870 **22/6** Each CARRIAGE PAID

STILL AVAILABLE

As detailed in September Issue.

JEFFERSON-TRAVIS UF 2

Transceiver Chassis. (U.S.A. made)
Less valves, partly stripped by the M.O.S.

ASK FOR X/H518 **17/6** Each CARRIAGE PAID

Circuit 2/6.

BC-456 SPEECH MODULATOR UNITS.

ASK FOR X/E42 **27/6** Each CARRIAGE PAID

Circuit 1/3.

S-440-B VHF TRANSMITTER CHASSIS.

Less valves, partly stripped by the M.O.S.

ASK FOR X/H517 **15/-** Each CARRIAGE PAID

Circuit 1/3.

MODULATOR 169.

BRAND NEW. In original wood case.

ASK FOR X/H713 **21/-** Each CARRIAGE PAID

WS-18 RECEIVER CHASSIS

ASK FOR X/H22 **25/-** Each POST PAID

WS-18 TRANSMITTER-RECEIVER CHASSIS.

Partly stripped by M.O.S.

ASK FOR X/H349 **33/6** Each CARRIAGE PAID

GYRO ANGLING POWER UNIT 9/2201.

ASK FOR X/E874 **12/6** Each POST PAID

MONITOR CRYSTAL TYPE 2 10T/11390.

Less valves and Crystals.

ASK FOR X/H872 **5/-** Each POST PAID

FLUXMETER TYPE I. WY 0023.

ASK FOR X/H361 **55/-** Each CARRIAGE PAID

RECORDER MK. II 24 VOLTS.

ASK FOR X/H88 **27/-** Each POST PAID

MAGNETIC MARCHING COMPASS Mk. I

ASK FOR X/H406 **12/6** Each POST PAID

PUMP, DESSICATOR, Adm. Patt. No. 12128

for Telescopes and Binoculars.

ASK FOR X/S/358 **£3.10.0** Each CARRIAGE PAID

ROTARY CONVERTER TYPE 195.

ASK FOR **£5.19.6** Each CARRIAGE PAID

AMPLIFIER AI368.

For Battery operation.

ASK FOR X/E898 **8/6** Each POST PAID

GUN SIGHT PROJECTOR UNIT TYPE 30

ASK FOR X/H882 **19/11** Each POST PAID

THROAT MICROPHONE, Ref. ZA.13935.

ASK FOR **3/11** Each POST PAID

THROAT MICROPHONE, Ref. ZA.19374.

ASK FOR X/H955 **4/11** Each POST PAID

THROAT MICROPHONE.

(U.S.A. made.)

ASK FOR X/H57 **3/11** Each POST PAID

MICROPHONE, Ref. 10A/14381.

(Flying Helmet Type.)

ASK FOR X/E16 **3/11** Each POST PAID

CARBON HANDSET MICROPHONES

No. 8 Ask for X/H480.

No. 4A Ask for X/E13.

EITHER UNIT **7/6** Each POST PAID

CARBON POWER MICROPHONE.

And Moving Coil Headphone Assembly, Ref. ZA17604. In Original Carton.

ASK FOR X/E13 **15/-** Each POST PAID

CANADIAN R.E.L. BINOCULARS

Brand New and guaranteed optically perfect. Individual eye-piece focussing (diopter setting) and variable inter-ocular setting, leather neck-strap.

In original cartons	Magnification 6 x 30.	POST PAID
ASK FOR X/H920	£8.19.6 Each	
In fitted Leather Case.	Magnification 7 x 50.	POST PAID
ASK FOR X/H921	£21.10.0 Each	

PLOTTER FIELD Mk. IV, Ref. OS.739A

A precision made Protractor Unit, first-class condition. With 2 scales 0-180 deg., moving crossarms, scaled 21-65 each 12½ in. long. Straight edge base scaled 0-3500 length 25in. fully extended. In soiled leather case 16 x 5½ x 2in.

ASK FOR X/H864	9/11 Each	POST PAID
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ELECTROSTATIC KILOVOLTMETER.

Range 0/2 kV. 2½ in. round mld. case, drilled flange.

ASK FOR X/E333	27/6 Each	POST PAID
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500 MICROAMP METER REF. ZN2106

For WS-18 Transmitter. 2in. round, clip mounting case. Res. 500 ohms.

ASK FOR X/E303	15/- Each	POST PAID
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WALNUT-FINISH WOOD RADIO CABINET.

Dim.: Internal 8½ x 15½ x 7½ in. approx. External 9½ x 17 x 8 in. approx.

ASK FOR X/H394	12/6 Each	POST PAID
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Or Cabinet as above with 3 waveband glass dials, expanded metal L.S. Grill, 3 knobs 1½ in. dia. fluted type.

ASK FOR X/H945	17/6 Each	POST PAID
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PLASTIC RADIO CABINET.

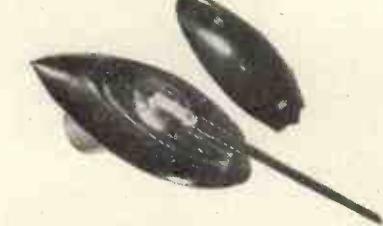
Dim.: Internal 11 x 6½ x 4½ in. approx. External 12 x 7½ x 6½ in. approx.

ASK FOR X/H720	12/6 Each	POST PAID
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AERIAL SYSTEM TYPE 62.

U.H.F. Antenna on streamlined moulding with VR92 (EA50) untuned detector stage. Overall dim.: 13½ x 4½ x 2½. Antenna 22.5 cm.

ASK FOR X/H496	3/6 Each	POST PAID
	Circuit 1/3.	

**AERIAL ROD.**

15in. lengths, copper plated steel tube, ferruled to interlock and an Aerial of desired length.

½ in. dia.: Ask for X/H709.

¾ in. dia.: Ask for X/H710.

EITHER SIZE	5/6 Doz.	POST LENGTHS	6d. EXTRA
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RADAR REFLECTOR AERIAL MX-137/A.

Spider Web mesh Aerial in original moisture proof carton, with assembly instructions.

ASK FOR X/E175	4/11 Each	POST 9d. EXTRA
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STAINLESS STEEL AERIAL WIRE

7/0.015 in reels of approx. 1,600ft. made by Temco.

ASK FOR X/E143	25/- Per Reel	CARRIAGE PAID
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DINGHY TELESCOPIC MAST.

Aluminium Telescopes from 14½ in. to 7½ ft. Seven sections, base dia. ½ in., top dia. ½ in. Wgt. 4 oz.

POST X/H489	4/6 Each	6d. EXTRA
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MORSE PRACTICE BOARD ONLY.

Comprises Key, buzzer, and phone terminals on board 6½ x 6½ x ½ in. with battery clamps.

ASK FOR X/EIX	5/6 Each	POST 9d. EXTRA
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Further Reductions**CALIBRATOR UNIT R.D.F. No. 1 ZA.14401.**

In Original Wood Case. Complete with valves 2/VR65 (SP61), 2/VR66 (P61), 2/VR92 (EA50) 5Z4G and VGT128 (G7K) 80 v. 400 c/s Power Supply, condensers, resistors, etc. Dim.: 13 x 7½ x 9½ in.

ASK FOR X/H829	21/- Each	CARRIAGE PAID
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TEST OSCILLATOR TS-24/ARR-2.

(U.S.A. made.) For alignment of TBX Aircraft Receivers. H.F. Osc. signal of 245 Mc/s. L.F. Osc. tuned 540-830 kc/s. 2/955 acorns, safety time switch, calibrated dial, etc. Complete less batteries. In metal box 9½ x 7½ x 7in.

ASK FOR X/H364	21/- Each	CARRIAGE PAID
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TEST OSCILLATOR TS-24A/ARR-2.

(U.S.A. made.) As TS-24/ARR-2 but having additional tone modulation section, with further 955 acorn, this provides optional Audio Signal Switch controlled.

ASK FOR X/H364A	27/6 Each	CARRIAGE PAID
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TEST SET TYPE 102.

A 250 v. A.C. 50 c/s Test Set emitting 25 c/s and 50 c/s synchronising pulses. Amplitude calibrated 0/2 a. and 1.4 watts for output lamp. Complete with valves, 6J5 and CV18 (double triode) photometer type comparitor, spare lamps, output cable, etc., in steel box 11 x 9 x 10in., with carrying handle.

ASK FOR X/H561	21/- Each	CARRIAGE PAID
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AMPLIFIER AI271. Ref.: 10U/549.

Used with T/R's 1133, 1143, 1143A, 1430, 1464, and Aerial System type 62. With valve VR56 (EF36) Relay, Transformers, etc., in metal case, dim.: 5 x 5 x 4½ in.

ASK FOR X/H532	4/11 Each	POST 1/- Circuit 1/3.
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F24 AIRCRAFT CAMERA
in Transit Case

Lens 5 inch F/4, with internal iris diaphragm stops to F/11, fixed focus set at infinity, screw in housing projects 5½ in. Focal plane shutter speeds 1/60th to 1/1,000th of a second and time, fitted



in film magazine designed for 5½ in. wide film, picture size 5½ x 5½ in. Shutter release and rewind spindle fits standard spanner. Hand operated as it stands. Net. wgt. 17 lbs. Packed in fitted transit case 42 lbs. Dim.: body 6½ x 9 x 9½ ins. overall incl. lens housing 11½ x 9 x 9½ ins. Provision for external motor drive (not supplied). Lens housing grooved for fitting to aircraft camera port. A precision Air Survey Camera, could be adapted for Laboratory, Industrial or Portraiture uses.

ASK FOR X/H302	£4.19.6	CARRIAGE PAID
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14 INCH F/5.6 LENS FOR F/24 CAMERA

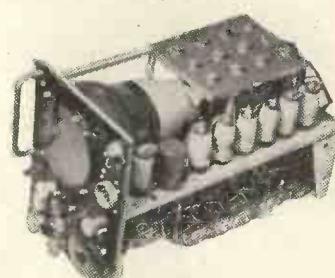
Complete with Iris, Filter, Mount and Extension in Transit Case.

ASK FOR X/H563	£9.19.6 Each	CARRIAGE PAID
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INEXPENSIVE T.V.

INDICATOR UNIT TYPE 62A with EF50's Containing VCR-97 Tube and Valves. 12-VR91 (EF50) 4-VR65-CV118 (SP61) 3-VR92 (EA50) 2-VR-54 (EB34), etc., etc., in metal case 18 x 18½ x 11½ ins. Used, good condition.

ASK FOR X/H868	79/6 Each	CARRIAGE PAID
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**INDICATOR UNIT TYPE 6.**

Used, good condition. In original wood case.

ASK FOR X/E774	49/6 Each	CARRIAGE PAID
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INDICATOR UNIT TYPE 6H.

In Original Wood Case.

ASK FOR X/E777	89/6 Each	CARRIAGE PAID
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INDICATOR UNIT TYPE 305

Brand New. Ref.: 10QB/6504 Contains:—VCR524A-VCR525, 7 EF50, 2 VR54, 6 EA50, 2.01 high voltage condensers, 3 relays 4 make, 4 break, 500 ohm. coil. Numerous condensers, Pots., and Resistors. Dim.: 12 x 7 x 18 ins. Wgt. 30 lbs

ASK FOR X/H943	£3.19.6 Each	CARRIAGE PAID
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SCPI CATHODE RAY TUBE.

In Original Carton.

ASK FOR X/H529	19/6 Each	CARRIAGE PAID
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ION TRAP MAGNET ASSEMBLY.

Mfg. Surplus. Type 1T/6 by Elas for 35 mm. tube neck.

ASK FOR X/H919	2/6 Each	POST 3d. EXTRA
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IF/AF AMPLIFIER UNIT R1355

In transit case.

ASK FOR X/E770A	37/6 Each	CARRIAGE PAID
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ALSO STILL AVAILABLE

R1355 as above but loose stored.

ASK FOR X/E770B	22/6 Each	CARRIAGE PAID
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R.F. UNIT TYPE 24.

In Original Carton. Switched tuning 20-30 Mc/s with valves, etc.

ASK FOR X/H850	22/6 Each	CARRIAGE PAID
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R.F. UNIT TYPE 25.

In Original Carton. Switched tuning 40-50 Mc/s with valves, etc.

ASK FOR X/H847	22/6 Each	CARRIAGE PAID
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R.F. UNIT TYPE 27.

With broken dial. Variable Tuning 65-85 Mc/s with valves, etc.

ASK FOR X/E771	39/6 Each	CARRIAGE PAID
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THE POWER UNIT TYPE 285

Ready made for T.V.

A.C. mains Input 230V. 50 c/s. Outputs E.H.T. 2K.V. 5mA. HT. 350V. 150mA. LT. 6.3V. 10A and 6.3V. 5A. Fully smoothed and rectified with valves VU120, SU4G, VR91 (EF50) plus cond., Resistors, etc.

ASK FOR X/H947	£4.19.6 Each	CARRIAGE PAID
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Order direct from:—
CLYDESDALE SUPPLY CO. LTD. 2, BRIDGE STREET GLASGOW - C.5
Branches in Scotland, England and Northern Ireland

"UNITELEX PRIMA" PORTABLE TAPE RECORDER. We are appointed stockists for this recorder. Features include ultra-modern cabinet design, giving exceptional lightness and portability without sacrifice of quality. Push-button control on mechanical side, twin-track heads, dual-speed (7½ in. and 3½ in. per sec.), giving up to two hours playing on one reel of tape; latest type miniature valves used; genuine 10 kcs. response; separate bass and treble controls; magic eye recording level indicator; provision for use as straight playback amplifier from record players or changers; 4-watts output to internal 10in. elliptical high-flux speaker, with provision for feeding two external speakers or amplifiers. Price, complete with filter cell microphone housed in recorder, and with 1,200ft. reel of high coercivity tape, 57 guineas. H.P. terms 19 gns. deposit, 12 monthly payments of £3 11/6. Send 2d. stamp for illustrated brochure.

GARLAND AMPLIFIER ACIV. A high-fidelity gramophone or microphone amplifier with a maximum output of 11.5 watts. The exceptionally wide frequency range (20-30,000 c.s. ± 1 db.) and extremely low harmonic distortion (0.5 per cent. at 1,000 c.s. for 8 watts output) are unusual among amplifiers in this price bracket. Separate high and low gain inputs, bass, treble and volume controls. Output to 150 ohm or 3 ohm. speaker. Standard valves throughout. Price 15 guineas, plus 15/- carriage, etc. Weight 20 lb.

SPECIAL OFFER. COLLARO RC 3/521 3 SPEED AUTO-CHANGER with 2 plug-in heads. £9 19/6.

COLLARO 3 SPEED RECORD PLAYER DESKS with 2 plug-in ortho-dynamic heads. £6 8/6. Limited stock only.

MAGNETIC RECORDING COMPANY PORTABLE TAPE RECORDER, single speed (7½ in.), twin track; magic eye recording level indicator, 3 watts output provision for mixing. Price complete 48 guineas.

BELLING AND LEE PLUGS AND SOCKETS. 5 way, 2/-; 7 way, 2/3 complete.

JONES PLUGS AND SOCKETS. 6 way, 1/9; 8 way 2/- complete.

GOODMAN'S H6 OUTPUT TRANSFORMERS. Rated up to 30 watts push-pull; ten-section wound on silicon steel laminations with primary inductance of 100 H and negligible leakage inductance and capacitance. Primary 10,000 ohms C.T. Secondary 3.75 plus 3.75 ohms. Price £3 3/-, plus 2/6 p. and P.

TAMSA TYPE 100 TAPE RECORDING HEADS. As used by the leading commercial tape recorder manufacturers. Housed in chromium plated brass case on adjustable mounting. Record/playback heads have ¼-thou. gaps and erase heads have 2.5 thou. gaps. These heads are of high impedance. Price 45/- each.

VARLEY MAINS TRANSFORMERS. Primary 10-0-200-220-240 volts. Secondary 300-0-300 volts at 150 mA., 5 volt at 3 amps., 6.3 volt at 4 amps., 6.3 volts at 1 amp. Open type construction. Price 45/- post 2/6.

BRENNETTE MICROPHONES. Large sales of these popular microphones has enabled us to make substantial reductions in the prices. The following range is available: Type 9ND : Multi-directional ball-type, in black and chrome, £2 2/-, post 2/-. Type 7D : Directional type, for instrumental or vocal use ; black and chrome, £3 15/-, post 2/6. Type IIA : A wide-frequency-response microphone, in brown cast case with chrome grille, £5 5/-, post 2/6. Type I3U : A highly sensitive studio microphone with outstanding frequency characteristics. Flexible mounting enables it to be used directionally or not as required. Black and chrome finish, £6 6/-, post 3/6.

TWO GANG TUNING CONDENSERS. 0.0005 mfd., with fixing feet. Price 7/9 each.

THYRATRONS. Type NGTI (CV1141), 4 volt heater. Price 5/6 each.

E.H.T. PLUGS AND SOCKETS. 1/- complete.

PYE & COAXIAL PLUGS AND SOCKETS. 1/- per pair, complete.

4-WAY MOULDED PLUGS AND SOCKETS. 2/6 per pair.

L.F. CHOKES. 10 Henry, 70 mA. Price 4/9 each.

ENGRAVING TOOL. For 200-240 v. A.C. mains. Suitable for use on metals or plastics. Price 10/- each.

COAXIAL CABLE. Stranded centre conductor, ½ in. diameter, 80 ohms, 4/6 per ½ doz. yds.

CONDENSER CLIPS. Vertical mounting 1½ in. 4d.; 1½ in., 4d.; Horizontal mounting, 1½ in., 4d.; Double, 1½ in., clips, 4d. Minimum order 3/-.

CATHODE-RAY TUBES. Type SCPI. 5in. green screen, electrostatic focussing and deflection. Callers only. Price 22/6 each.

PAXOLIN PANELS. 3½ in. x 1½ in. x 3/32 in. 5/- per 100. 2½ in. x 2 in. x 1/16 in., 6/- per 100. Many thousands available.

CRYSTAL DIODES. Germanium Vacuum sealed glass type with wire ends, 2/6 each or 24/- per dozen.

CARBON RESISTORS. ½ watt, 3/6 per doz. (minimum). Virtually all standard values in stock. Nearest value supplied, unless otherwise stated.

SILVER MICA OR CERAMIC CONDENSERS (PFs). 2, 4, 10, 15, 27, 30, 50, 75, 100, 160, 200, 220, 300, 330, 350, 500, 1,000, 2,000, 4,500, 4,700. All at 4/- per doz. (minimum quantity).

MOULDED MICA CONDENSERS. .01 mfd. 500 v., 5/- per doz. (minimum quantity).

EHT CONDENSERS. .001 mfd., 5kV. A.C. Test, 1/6 each or 15/- per doz. .02 mfd., 5kV. D.C. working, 1/6 each or 15/- per doz.

Garland Bros

GARLAND AMPLIFIER ACII. Self-contained general-purpose amplifier, providing 3.5-watts output. All power supplies derived from mains transformer, ensuring isolated chassis. Standard valves

throughout. Volume and Tone Controls incorporated. Negative feedback loop. Price £6 12/6 plus 5/- carriage, etc. Weight 10 lb.

THE LATEST LANE TAPE TABLE. Incorporating three heavy duty Lane motors; fast rewind and wind-on without tape handling; automatic braking; high impedance half-track heads; hub locking device. Tape speed 7½ in. per second. Price £17 10/-; Carriage 10/-:

OUTPUT TRANSFORMERS. Standard pentode matching to 2/4 ohms. Price 4/6 each.

ROTARY TOGGLE SWITCHES. 4 pole bunting. Price 1/6 each.

EXTENSION SPEAKER CABINETS, modern design in walnut. For 6½ in. speaker 19/6; for 8 in. speaker 21/6.

CV73 A HEAVY DUTY BEAM TETRODE for pulse operation, also used in stabiliser circuits. 5/- each.

MR COMPANY AMPLIFIER, only suitable for use with Lane, Motek or other high impedance desks. £15.

MAGNETIC TAPE. Now available, the new Scotch Boy High Coercivity Tape MC2-III, with higher output and signal-to-noise ratio. Price 35/- per 1,200ft. reel. Still available: Scotch Boy MC1-III : 1,200ft., 35/-; 600ft., 21/-; 300ft., 12/3. Spare 7in. spools, 4/3. Ferrovoice, the new kraft-based medium coercivity tape : 1,200ft., 22/5. Spare 7in. spools, 4/6. Magnetophone Tape : £2 per 1,200ft. reel.

ZINC PLATED CHASSIS. 13½ x 6 x 2½ in. drilled for five valves, 2/6.

DUMMY AERIAL LOADS. Tapped at 20, 10 and 5 ohms, 100 watts. British 5-pin base. Callers only, 1/6 each.

PLASTIC SPEAKER CABINETS. Louvred for 5in. speaker. Callers only. Price 10/- each.

IGNITION SWITCHES. Low voltage, high current, in bakelite case. Price 9/- per doz.

S.W. TUNING CONDENSERS. 160 pF. with fixing feet. Price 2/3 each.

FLEX CONNECTORS. 2½ x ½ in., for 250 v., 1/- complete.

TRIMMERS. 50+50 pF, 100 + 100 pF, 100 + 500 pF, 500 + 500 pF, ceramic mica, 9d. each; 250 pF, 1,000 pF, 9d. each; 50 pF, 75 pF, airspaced pre-set, 1/3 each; 75 pF, air-spaced, 2in. spindle, 2/- each. 33½ per cent. discount in dozen lots.

LINE CORD. 3-way, 0.3 amp., 60 ohms per foot, 1½ per yard.

ELECTROLYTIC CONDENSERS. These are current production, not surplus stocks.

32 mfd., 450 volts, 250 mA. ripple, can., 4/6; 8 mfd., 450 v., 1/9; 8 + 8 mfd., 450 v., 3/3;

8 + 16 mfd., 450 v., 4/-; 8 + 32 mfd., 450 v., 4/6; 16 + 16 mfd., 450 v., 5/-; 32 + 32 mfd., 350 v., 3/6 mfd., 25 v., 1/9; 50 mfd., 12 v., 1/9.

MAINS DROPPERS. Standard 0.2 and 0.3 amp. Price 3/9 each.

HEATER TRANSFORMERS. 230 v. input, 6.3 v., 1.5 amp. output, 6/- each.

MOULDED BAKELITE ESCUTCHEONS. 8½ in. x 2½ in. with opening 6½ in. x 1½ in., 4/6 per ½ doz.

MINIATURE LIGHT WEIGHT RELAYS. 270 ohm, 18 v. Single pole on-off. Ex-American equipment. Price 2/9 each, 13/6 per half-dozen.

MICA "POINT ONES." Actual value 0.108435 ± 0.5 per cent. Suitable for use on A.C. mains voltage. Special offer at 1/- each, 9/- per doz. or £3 per 100.

ELECTROLYTIC CONDENSER OFFER.

Tubular cardboard cased, with wire ends, 8 mfd., 450 v. wkg., 525 v. surge, 2/- each, 21/- per doz. Current production.

TRUVOX TAPE DESK MARK III. Incorporating high impedance mu-metal twin-track heads. Two-speed capstan, for tape speeds of 7½ and 3½ inches per second. Three heavy-duty motors allowing for fast forward and rewind facilities without tape handling. All controls operated by electrically and mechanically interlocked push buttons. Price £23 2/- Send S.A.E. for full particulars. Plus 10/- carriage, etc. Delivery from stock. Send 2d. stamp for details of this and of suitable amplifier.

AERIAL AND OSCILLATOR COILS. For medium and short waves. Price 5/- per set of 4 coils.

HEADPHONES. 4,000 ohms; per pair, 11/-.

SWITCH SOCKETS. Flush mounting 250 volt, 3 pin, 5 amp., bakelite. Price 3/6.

POTENTIOMETERS Ex-Govt. or Manufacturers Surplus.

Value	Track	age	length	Price
33	Carbon	1	lin.	1/9
2.2k	W/W	5	lin.	3/9
3k	C/Trop	2	lin.	1/6
3k	W/W	5	Preset	2/3
5k	"	2	lin.	2/6
8k	"	5	lin.	2/3
10k	C/Trop	2	lin.	1/9
10.4k	W/W	5	lin.	3/-
20k	"	3	Preset	1/9
20k	C/Trop	5	lin.	3/-
25k	W/W*	5	lin.	1/3
25k	C/Mini	½	Preset	9d.
50k	W/W*	3	lin.	2/6
50k	C/Mini	½	lin.	9d.
100k	"	½	lin.	9d.
200k	Carbon	1	lin.	1/3

All new and unused. Spindle diam. ½ in. in all cases. * are earthed slider.

Above prices less 20 per cent. in dozen lots, less 33 1/3 per cent. in 100 lots.

RECTANGULAR KNOBS. Size 1½in. x ½in., with gold indicating spot; to fit standard ½in. spindles. Price 5/- per doz., 37/6 per 100.

BOOKS FOR RADIO ENGINEERS.	
Mullard Valve and Service Reference Manual	5/-
Mullard Amateurs Guide to Valve Selection	1/6
Osram Valve Manual, Part I	5/-
Brimar Radio Valve and Teletube Manual	5/-
Wireless World Radio Valve Data, 3rd edition	3/6
Radio Valve Guide, By W. J. May	5/-
The Williamson Amplifier Manual, latest edition	3/6
Wireless World High Quality Amplifier Manual	2/6
T.V. Fault Finding	5/-
Television Faults	5/-
Television Explained (Miller)	5/-
Viewmaster Envelope (state transmitter for which required)	7/6
Tele-King Envelope	6/-
The Oscilloscope Book	5/-
Magnetic Recording (Quartermaine)	4/6

(Add 3d. to price in all cases for postage.)

TYANA SOLDER IRONS. Lightweight, 40 watt irons with easily interchangeable elements and 3/16in. diameter bits. Voltage ranges, 6 v., 100/110 v., 200/220 v. and 230/250 v. Price 16/9. "The iron that makes soldering a pleasure."

LARGE DIAMETER SLEEVING. Transparent plastic, ½in. diameter, 6/- per doz. yards.

LITZ WOUND INDUCTORS. 199 micro Henry, wound on Aladdin ½in. coil former (no iron dust core). Price, 2/6 per half dozen, 4/6 per dozen, 30/- per 100.

TOGGLE SWITCHES. Black bakelite. SPCO 1/- each, 9/- per doz. DP on-off 1/3 each, 12/- per doz. Suitable for use on mains voltages.

L.F. CHOKES: Tropicalised 8H 120 mA., 8/6 each; 40 mA midget type, 3/- each.

CLEARANCE OF EX-GOV'T. MOTORS, Rotary Transformers, etc. Many different types available. All one price to clear, for callers only, 6/6 each.

MINIATURE MUMETAL TRANSFORMERS. Auto-wound, giving approx. 2/1 ratio. Ideal rewind as head lift transformer, or lamps can be used for recording heads, 2/6 each or 11/- per half-dozen.

CONNECTION BLOCKS. 3-way on porcelain base, 6/- per dozen.

GOODMANS OUTPUT TRANSFORMERS. 10 watts push-pull to match into 10,000 ohm, with two 3.75 ohm, secondaries for 3 or 15 ohm speaker. Price 14/9.

MINIATURE LIGHT WEIGHT RELAYS. 270 ohm, 18 v. Single pole on/off. Ex-American equipment. Price 2/9 each, or 13/6 for 6.

COMMERCIAL POTENTIOMETERS. All usual values. Less switch, 2/3 ; with single pole switch, 3/6 ; with double pole switch, 4/-.

CARTRIDGE FUSES. All usual values in 1½in., 5d. each. Other sizes 6d. each.

SWITCHBOARD METERS. 6½in. scale, 0-5 v. A.C./D.C. full scale. Price 30/-.

GARLAND TAPE RECORDER OSCILLATOR UNITS. With valve, for use with high impedance heads only. Price 35/-.

TYANA SOLDER GUNS. Weigh 30 oz., for 220-250 v. A.C. mains only; consumption 100 watts. The low voltage bit can be easily bent to reach into corners and is insulated from the earthed case. Price 3 guineas.

WINDSOR SAPPHIRE NEEDLES. Available in the following three patterns: trailer type for magnetic or heavyweight pick-up; straight type for crystal pick-up; midget type for lightweight or high fidelity pick-up. Price 2/6 each.

MIDGET 2-GANG CONDENSERS. American manufacture, 500 pF, 6/- each.

VARIABLE RESISTORS. 50 ohm, 1 amp., with calibrated very fine worm drive. Price 7/6.

RADAR REFLECTORS. Type MX138/A. These consist of 6-2ft. x ½in. durable tubes covered with fine wire mesh. The whole assembly can be used as an omni-directional aerial, and the mesh has many horticultural applications. Price 3/9 each, post 9d.; 36/- per doz., carr. paid. Type MX137/A : similar to above, but also include a telescopic aerial rod, extending from 11in. to 3ft. 6in. approx. Price 4/9 each, post 9d.; 45/- per doz. or £15 per 100, carr. paid.

TELEVISION MAGNIFYING LENSES. 6in. clear, 19/6; 9in. clear or filter, 50/-; 12in. clear or filter, 70/-. Please state which and add 5/- for carriage and packing.

WHANDA WIRE AND CABLE STRIPPERS. to take all size flexes and cables up to ½in. diam. with 3 alternative heads and triple screw adjustment. These are brand new and boxed, and the original price was 15/- each. Our price 5/- each, post paid.

AERIAL RODS. These popular rods, of tough steel, copper-plated, are 12in. long, and fit into each other to make any length. Many hundreds of thousands sold to TV aerial manufacturers and to the public. Price 3/6 per doz. or £1 per 100, post paid. £10 per box of 1,800 carriage paid U.K.

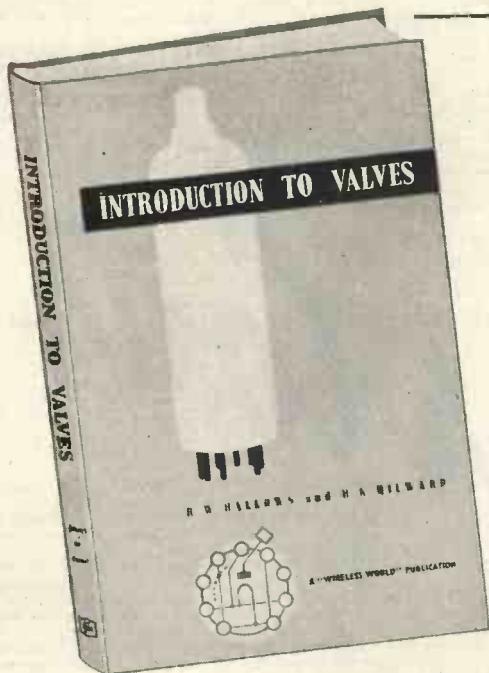
DECALS. 500 ½in. high white transfer letters and words for marking electronic equipment. Price 4/9 per book. The new Decals book for the amateur now available. 29 words per page, 4 pages radio and audio, 4 pages T/V and Scope, 2 pages misc. incl. Tx. and Tape Recording, 3/6 per book, post 3d.

H.F. PENTODES. Type 6SH7, 6.3 v. 0.3 a. heater, int. octal base, high slope. Special offer, 5/6 each, 27/- per half-dozen, £20 per 100.

SMALL PAPER CONDENSERS. In tubular metal cases with wire ends. 0.25 mfd. 250 v., ½in. diam. x ½in., 1/- each; 1 mfd. 150 v., ½in. diam. x ½in., 1/3 each; 2 mfd. 250 v., ½in. diam. x 2½in., in Neoprene sleeve, 1/9 each. Above prices less 25 per cent. in dozen lots.



WIRE WOUND RESISTORS. Open, cement coated or vitreous enamelled. 4 watt, 50, 90, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650 ohm. 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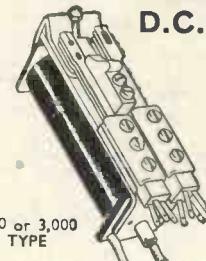
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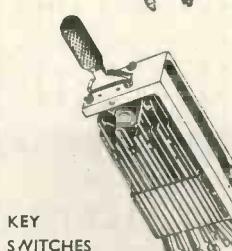
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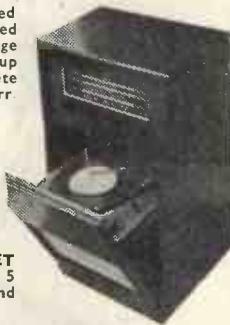
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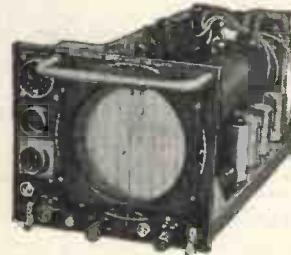
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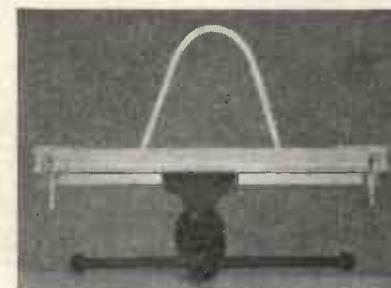
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Heater Transformer. Pri. 230-250 v. 6 v. 1.5 amp., 6/-; 2 v. 2.4 amp., 5/-, 2 or 6 v. at 2 amps., 7/6; 2 v. 2.4 amp. and 6 v. 0.6 amp. E.H.T. insulated, 8/6. 12-0-12 v. 2 amp., 9/6. P. & P. each 1/-.
800-0-800 250 mA., 4 v. 2 amp., 27/6. P. & P. 5/-.

1000-0-1000 v. 250 mA. 4 v. 3 amp. 37/6. P. & P. 5/-.

P.M. SPEAKERS (closed field) with less trans. trans. trans.
2½in. — 15/6
3½in. — 13/6
5in. 16/6 12/6
6½in. 16/6 12/6
8in. 18/6 15/6
P. & P. on the above 1/- each.
10in. less trans., 21/-, P. & P. 1/6.

R. & A. Sin. M.E. Speaker field coil, 1,600 ohms O.P. trans. 5,000 ohms. Imp., 18/6. P. & P. 2/-.

5in. M.E. field coil 750 ohms with O.P. trans., 17/6. P. & P. 1/-.

Truvox BX11. 12in. P.M. 3 ohm speech coil, 45/-, P. & P. 3/6.

6in. M.E. Speaker, 1,000 ohm field 15/-, P. & P. 1/6.

Extension speaker cabinet, in contrasting walnut veneers, size 15 x 10in. Will take 6½ or 8in. speaker, 17/6. P. & P. 2/-.

Volume Controls, Long spindle less switch, 50K, 500K, 1 meg., 2/6 each. P. & P. 3d. each.

Volume Controls. Long spindle and switch ½, 1 and 2 meg., 4/- each; 10 K. & 50 K., 3/9 each, ½ and 1 meg., long spindle double pole switch, miniature, 5/6. P. & P. 3d. each.

Trimmers, 5-40 pfd., 5d.; 10-110, 10-250, 10-450 pfd., 10d.

Twin-Gang .0005 Tuning Condenser, 5/-, With trimmers, 7/6. P. & P. 1/-.

Line Cord, 2-way 0.3 amp., 60 ohms per foot, 1/3 per yard.

Twin-Gang .0005 with feet, size 3½ x 3 x 1½in., 6/6.

3-gram .0005, with feet, size 4½ x 3 x 1½in., 7/6.

Hoover Variable Speed 600-1,200 revs. Tape Recording Motor. Silent running, 200/250 v. A.C. Shaded pole with fixing. Weight 5 lb., 27/6. Plus P. & P. 2/6.

PERSONAL SHOPPERS ONLY. 9in. Enlarger 17/6, 12in. 27/6.

Germanium Crystal Diode, 2/3 post paid.

Television Masks. White Rubber 9in. with glass, 7/6. Green Rubber, 12in. with armour-plate glass, 15/-, 15in. Cream, 17/6 plus 1/6 P. & P.

T.V. Width Control, 3/6.

T.V. Sub Assembly, all-chassis, 12in. x 3½in. with frame osc., line osc., 12 mid., 275 wkg., Metrosil, 8 condensers, 4 resistors and tag panel 15/-, p. & p. 1/6.

CRYSTAL PICK-UP by famous manufacturer, complete with sapphire trailer, needle and volume control 23/-, P. & P. on each 1/-.

EX-GOV'T. RECEIVER TYPE B28. Coil unit, 6 bands, 60 kc/s., 420 kc/s., 500 kc/s.-30 Mc/s., 21/-, Plus 2/-, P. & P. Circuit for above. 4/-.

Variable selectivity IF switch to suit above, 7/6. 465 Kc. I.F.'s to suit above, type 3, 4 and 5, 6/-, I.A. I.F.T.2 incorporating 465 Kc/s. Xtal, 19/6. BFO, 7/6. Special 4-gang, to suit, 15/-.

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Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/- up to 10/-, 1/6 up to £1, and 2/- up to £2. All enquiries and lists, S.A.E.

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COLLAR RECORD CHANGER, Model RC3/521, 3 speed, twin crystal heads. Brand new in manufacturer's original carton. A.C. mains 200/250. £9/19/6. P. & P. 3/6.

V.H.F. SUPERHET TUNING UNITS by famous manufacturer, brand new. Input 300 ohm balance line. Frequency range 54-89 Mc/s., 174-217 Mc/s. I.F. 45 Mc/s permeability tuned. Provision for automatic gain control. Size 9 x 6 x 4in. 9in. scale. Valves used: 2 6AK5 and One 6C4. Complete with circuit diagram and val. vars. 19/6. P. & P. 2/6.

CABINET as illustrated, 11½ x 6½ x 5½ in walnut or cream, complete with T.R.E. chassis, 2 waveband scale, station names, new waveband, back-plate, drum, pointer, spring drive spindle, 3 knobs and back, 22/6. P. & P. 3/6.

AS ABOVE but complete with 5in. speaker and O.P. trans. (these speakers have been used but tested O.K.), 30/-, P. & P. 3/6. Metal rectifier 4/6. Gang with trimmers, 7/6. Medium and long T.R.F. coils 5/6. 3 obsolete ex-Gov't. valves, 3 valveholders and circuit of an A.C. mains 3-vane plus rec. T.R.F. which can be built for approx. £4, 8/6. Heater trans. 6/-, Volume control with switch 3/6. Wave-change switch 2/-, Condenser kit 4/-.

Cabinet as illustrated above complete with 5in. speaker chassis, 23/6. P. & P. 3/6.

As above but complete with new speaker and O.P. trans. (these speakers have been used but tested O.K.), 30/-, P. & P. 3/6. Medium and long-wave superhet coils with circuit 6/6. Iron cored 465 Kc. I.F.'s 7/6 pair. Miniature gang 5/6. Volume control with switch 4/-, Wave-change switch 2/6. Heater trans. P.R. 230/250 4 v. 3 amp. 7/6. 5 valveholders 2/-, 3 obsoletes Ex-Gov't. valves with circuit 14/6. 25 mid. 25 wkg. condenser 11d. 8+16 mfd. smoothing condenser 3/6. Condenser kit (17) 7/6. Resistor kit (14) 3/6.

PERSONAL PORTABLE CABINET. In cream-coloured plastic; size 7 x 4½ x 3in. Complete 4-way chassis. Scale and 3 knobs. Takes miniature 90 v. and 7½ v. batteries 9/- post and pkg. 1/6.

3in. P.M. Speaker to fit above, 10/-, Miniature output transformer, 5/-, Miniature wavechange switch, 1/6. Miniature 1-pole 4-way used as Volume and Off, 1/6. 4B7G valve holders 2/4. Midgit twin gang 5in. dia., 1in. long and pair medium and longwave TRF coils 1in. long x 1in. wide; complete with 4-valve all-dry mains and battery circuit 8/6. Condenser Kit, comprising 11 miniature condensers, 2 6L6's. Resistor Kit, comprising 16 miniature resistors 4/-. The above receiver (less valves and batteries) could be built for approximately 51/-. All valves to suit above available. Point to Point Wiring Diagram 1/-.

T.V. POWER SUPPLY CHASSIS, size 13 x 5½in. A.C. mains 200/250 v. Complete with smoothing choke, mains transformer, 40 mfd. 350 wkg., 3 16 mid. 450 wkg., 32 mfd. 450 wkg., 5 U4G, twin main fuse, 11 pin output socket and mains lead. Smoothed output 350 v. 200 mA. heaters 6.3 v. 7 amp., 70/-, P. & P. 2/6.

FULLY SHROUDED MAINS TRANSFORMER, input 110/250, sec. 350-0-350 175 mfd. 6.3 v. 7 amp., 5 v. 3 amp. 35/-, P. & P. 3/6.

FULLY SHROUDED PUSH-PULL TRANS. Pri. 6,000 ohms, sec. 15 ohms (2 6L6's in push-pull) £1. P. & P. 2/-.

FULLY SHROUDED CHOKE 15 Henry 180 mfd. 15/-, P. & P. 2/-.

FULLY SHROUDED CHOKE 5 Henry 120 mfd. 8/6. P. & P. 2/-.

These last 4 items by very famous manufacturer.

USED C.R.T. TUBES. Heater cathode short 9in. 45/-, 12in. 75/-, Ion burn 9in. 35/-, 12in. 55/-, P. & P. on each 7/6.

COMpletely BUILT SIGNAL GENERATOR. Coverage 110 Kc/s.-320 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-275 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8.5 Mc/s.-25 Mc/s., 17 Mc/s.-50 Mc/s., 25.5 Mc/s.-75 Mc/s. Metal case 10 x 6½ x 4½in. Size of scale 6½ x 3½in., 2 valves and rectifier, A.C. mains 230/250 v. Internal modulation 400 cps., to a depth of 30 per cent, modulated amplitude, R.F. output containing fully variable 100 millivolts. P. & P. 4/-, 24/5/- We will convert our previous model, as above, with new front panel for 24/5/-, post paid.

CONSTRUCTOR'S PARCEL, comprising chassis 12½ x 8 x 2½in., cad. plated 18 gauge, v.b./. IF and trans. cut-outs, back-plate, 2 supporting brackets, 3 waveband scale, new wave-length station names. Size of scale 11½ x 4½in., drive spindle, drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin International octal valve holders, 4 knobs, and pair of 465TFe, 16+16 mfd. 350 wkg. semi-shrouded drop thru 200-0-250 60 mA., 6 v. 3 amp. P.R. 200-250, and twin-gang 31/6. P. & P. 3/6.

CONSTRUCTOR'S PARCEL. Chassis 8in. x 4in. x 1½in. 5in. P.M. speaker with transformer twin gang with trimmers, pair T.R.F. coils long and medium, four valveholders, 20 K. volume control and wave-change switch, 23/6. P. & P. 1/6.

R.I. MAINS TRANSFORMERS, chassis mounting, feet and voltage panel Primaries 200/250.

300-0-300 60 mA. 6.3 v. 1 a. tapped at 4 v. 6.3 v. 2 a. tap 4 v., 13/6.

350-0-350 75 mA. 6.3 v. 3 a. tap 4 v. 6.3 v. 1 a. 13/6.

350-0-350 120 mA. 6.3 v. 3 a. tap 4 v. 5 v. 2 a. tap 4 v., 25/-.

350-0-350 70 mA. 4 v. 5 a. 4 v. 2.5 a. C.T. 18/6. P. & P. on the above transformers, 2/-.

500-0-500 125 mA. 6.3 v. C.T. 4 a. 6.3 v. C.T. 2 a. 5 v. C.T. 2 a. 27/6.

500-0-500 125 mA. 4 v. C.T. 4 a. C.T. 4 a. 4 v. C.T. 2 a. 5 v. C.T. 2 a. 27/6.

500-0-500 250 mA. 4 v. C.T. 5 a. 4 v. C.T. 5 a. 4 v. C.T. 4 a. 39/6.

500-0-500 250 mA. 6.3 v. C.T. 4 a. 6.3 v. C.T. 3 a. 5 v. C.T. 3 a. 39/6. P. & P. on the above transformers 3/-.

Valve Holders, moulded octal Mazda, and loctal, 7d. each. Paxolin, octal, Mazda and loctal, 4d. each. Moulded B7G, B8A and B9A, 7d. each. B7G moulded with screening can, 1/6 each.

32 mfd., 350 wkg. 2/-
16 x 24 350 wkg. 4/-
4 mfd., 200 wkg. 1/3

40 mfd., 450 wkg. 3/6
16 x 8 mfd., 500 wkg. 4/6
8 mfd., 350 wkg. 5/9
8 x 16 mfd., 500 wkg. 5/9
8 x 16 mfd., 450 wkg. 3/9
32 x 32 mfd., 350 wkg. 4/-

32 mfd., 25 wkg. 6/6
25 mfd., 25 wkg. 11d.

250 mfd., 12 v. wkg. 1/-
16 mfd., 500 wkg., wire ends .. 3/3

8 mfd., 500 v. wkg., wire ends .. 2/6

8 mfd., 350 v. wkg., tag ends .. 1/6

50 mfd., 25 v. wkg., wire ends .. 1/9
100 mfd., 350 wkg. 4/-
100+200 mfd., 350 wkg. 8/6
16+16 mfd., 350 wkg. 8/6

Ex-Gov't. 8 mfd., 500 v. wkg., size 3½ x 1½, 2 for .. 2/6
60+100 mfd., 280 v. wkg. 7/-

16 x 32 mfd., 350 wkg. 6/-
50 mfd., 180 wkg. 1/9

65 mfd., 220 wkg. 1/6
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60+100 mfd., 280 wkg. 8/6
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50 mfd., 50 wkg. 1/9

Miniature wire ends moulded, 100 pt., 500 pt., and .001 ea. 7d.

Combined 12in. mask and escutcheon in lightly tinted perspex. New aspect, edged in brown. Fits on front of cabinet, 17/6. P. & P. 2/-.

Frame Oscillator Blocking Trans., 4/6. I.D. Mounting Bracket, size 9½ x 1in., 12in. tube clamps, 2/-.

Smoothing Choke, 2 henry 150 mA., 3/6. 250 mA. 4 henry, 5/-; 250 mA. 10 henry, 10/6; 250 mA. 8 henry, 8/6.

P.M. Focus Unit for any 9 or 12in. tube except Mazda 12in., with Vernier adjustment, 17/6. P. & P. 1/6.

Wide Angle P. & P. Focus Units, Vernier adj., state tube, 25/-, P. & P. 2/-.

Emphasized focus coil, low resistance mounting bracket, 17/8 plus 2/-, P. & P. Scan Coils, low line low impedance frame, complete with O.P. transformer, 17/6. P. & P. 2/-.

Ion Traps for Marconi or English Electric tubes, 5/-, post paid.

465 Kc. I.F.s, size 2½ x 1½in. Q.110 removed from American equipment, 5/- per pair. Standard 465 Kc. iron-cored I.F.s. 4 x 1½ x 1½in., per pr. 7/6. Wearable standard iron-cored 465 Kc. I.F.s, 3½ x 1½ x 1½in., per pr. 9/6.

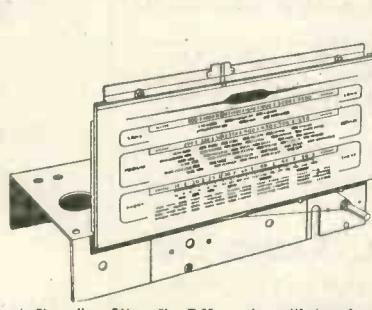
Iron-Cored 465 Kc. Whistle Filter, 2/6.

OUTPUT TRANSFORMERS, Standard type 5,000 ohms imp., 4/9, 42-1 with extra feed-back windings, 4/3. Miniature 42-1, 3/3. Multi-radio 3,500, 7,000 and 14,000, 5/6. 10-watt push-pull, 6½v matching, 7/-.

PUSH-BACK CONNECTING WIRE, Doz. yds., 1/6, post paid.

STANDARD WAVE-CHANGE SWITCHES, 6-pole 3-way, 2/-, 4-pole 3-way, 1½, 5-pole 3-way, 1½/1; 3-pole 3-way, 1½/1; 9-pole 3-way, 3/6; Miniature type, long spindle, 3-pole 4-way, 2-pole 5-way, 4-pole 3-way and 4-pole 2-way, 2/6, each. P. & P. 3d.

465 Kc. MIDGET I.F.s, Q.120, size 1½in. long, 1in. wide, ½in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, 12/6.



CONSTRUCTOR'S PARCEL, comprising chassis 12½ x 8 x 2½in., cad. plated 18 gauge, v.b./. IF and trans. cut-outs, back-plate, 2 supporting brackets, 3 waveband scale, new wave-length station names. Size of scale 11½ x 4½in., drive spindle, drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin International octal valve holders, 4 knobs, and pair of 465TFe, 16+16 mfd. 350 wkg. semi-shrouded drop thru 200-0-250 60 mA., 6 v. 3 amp. P.R. 200-250, and twin-gang 31/6. P. & P. 3/6.

CONSTRUCTOR'S PARCEL. Chassis 8in. x 4in. x 1½in. 5in. P.M. speaker with transformer twin gang with trimmers, pair T.R.F. coils long and medium, four valveholders, 20 K. volume control and wave-change switch, 23/6. P. & P. 1/6.

G. W. SMITH & CO., (RADIO) LTD.

Solenoids. 12/24 volt D.C. operation, size 2½in. x 1in. diameter, operational pull 1½in., ideal for model work, 3/6 each.

Ceramic Transmitter Switches, with extra heavy duty silver plated contacts, 3 bank single pole 6 way, spacing between contacts 1in. spacing between wafers 1½in. and 5in., 9/6 each.

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Mains Isolation Transformers for industrial purposes. 230 volt A.C. 50 cycles input. Output 230 volt 50 cycle 1,000 watts, supplied complete in heavy duty metal case, size 13in. x 10½in. x 8in. Price £6/10/-.

Smoothing Chokes. Heavy duty. 20 Henry 300 M/a., 2,000 volt insulation test, Admiralty rating will pass 500 M/a., 17/6 each.

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Ceramic Switches. Standard spacing, 4 pole 3 way 3 bank. Special price, 6/6 each. Brand new and boxed.

Meters. 0-250 M/a. 2in. Round Thermo, coupled, 5/6 each.

Battery Chargers. Ex-W.D. 200/250 volt A.C. input. Outputs 3 switched position 4, 6 or 12 volt at 7 amps., with Low, Medium or High charging rate fitted with 2½in. amp. meter, manufactured by Heyberds. Offered at fraction of their original cost, £6/10/- each.

Transmitting Transformers. Primary input voltage tapped 100/250 volt. Secondary output voltage 2000-0-2000 at 400 M/a. Size, 10in. x 10in. x 10in., 92/6 each.

Indicator Units Type 96. Brand new in sealed boxes. Complete with VCR97 tube, 6 SP61, 2 EB34 valves. High voltage condensers, Pots resistors etc., etc. The unit for Television or Scope conversion. Our price, 52/6 each.

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R.F. Units, Type 26. Frequency coverage. 45/65 Megacycles, brand new complete with valves 59/6 each. Ditto with broken dials, 39/6 each.

A.C. Mains Transformers, suitable for many purposes. Input voltage 200/250 volts A.C. Output 45 volt 4 amps. Enclosed in attractive ventilated case with carrying handle. Size : 5in. x 4in. x 3in., 19/6 each.

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American Rotary Transformers. 12 volt D.C. input. Output 255 volt at 65 M/a. Size : 4½in. x 2½in. For Car Radio Operation. Also suitable for running Electric Shavers from your car supply, 22/6 each. Brand new.

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Muirhead Switches. Precision built. 8 pole 2 way. Key switch action, brand new, boxed, heavy contacts, 4/6 each.

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Valves. VU111, 4 volt E.H.T. Rectifier output 6,000 volts 50 M/a., brand new and boxed, 2/6 each. SP61 ex-units, 2/6 each. EF50 ditto, 3/6 each.

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Transformers. Ex-W.D. A.C. input 230 volt 50 cycle. Outputs 330 x 330 volt at 100 M/a., 4 volt 3 amp., 10/6 each.

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Operates from 12/24 volts D.C.

Total Weight : 37 lb.

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Ideal ship to shore equipment.

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NATIONAL H.R.O. RECEIVERS, complete with tubes but less coils. Rack and table models available. £19 each.

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20,000 ohms, 10 watt, type M. Separately tapped at 5,000, 10,000, and 15,000 ohms with final connections to a 6 terminal strip. Complete with 2½in. instrument knob with 3in. skirt, and a 3½in. plated brass dial scaled 0/100.

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15/- each complete as above.

List available of 50,000 various potentiometers available from stock at low prices.

RACKS. Standard 6ft. P.O. type for 19in. panels, steel channel sides correctly drilled, heavy angle base.

RELAYS—P.O. TYPE 3,000
Built to your specification—early delivery—quotation by return—please state resistance of coil required and contact build up.

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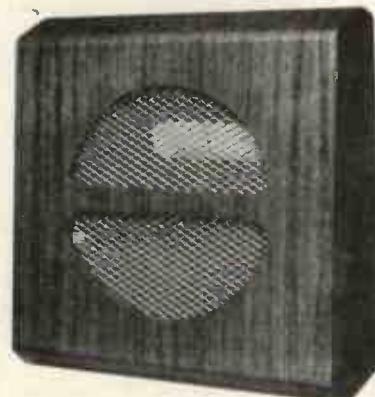
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TYPE 6L. BRAND NEW. CONTAINS 9 WIRE WOUND CONTROLS AND VCR97 TUBE LESS VALVES. CARRIAGE 5/-.

LOUDSPEAKER CABINETS

Available for 6½in. and 8in. speaker units. Polished walnut finish. A very attractive cabinet at quarter of today's prices.
Price. 6½in. Type Cabinet, 15/6 each.
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1½in. dia. for ½in. spindles, available Cream or Brown as follows:— "Focus," "Contrast," "Brilliance," "Brightness," "Brilliance On/Off," "Wavechange," "On/Off," "Tuning," "Volume," "S.M.L. Gram," "Tone," "Vol. On/Off," "Radio-Gram," "Bass," "Treble," "Record-Play." Price 1/6 each. Plain knobs to match 1/- each.

BURGEES MICRO SWITCH. Base type switch. Type Sc/19/0. Price 3/6 each.

VARNISHED COTTON SLEEVING. 1 M.M. 1/6 doz. yds.

CRYSTAL DIODES, wire ends, 1/8 each.

MULTI RATIO OUTPUT TRANSFORMERS. 5/9 each.

6½in. Plessey Lightweight Speaker Unit. 10/6 each.

HEADPHONES. DHR A real quality job. 13/- pair.

HEADPHONES. CLR Low resistance type. 7/6 pair.

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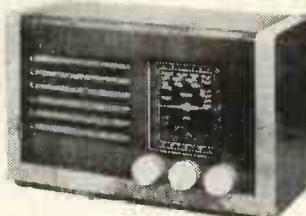
IDEAL FOR TV CONVERSION—I.F. 12 MEGS. BAND WIDTH, 4 MEGS. CO-AXIAL INPUT AND OUTPUT SOCKETS COMPLETE 55/-. CARRIAGE 5/-.

CONSTRUCTOR'S PARCELS

Contain a very good selection of resistors. All packed separately and marked with sizes. Condensers of all types and sizes and numerous other components suitable for all constructors. Price 10/- each. Post 1/-.

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3in. Plessey Round Type for Portables ...	12/9
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Rola/Celestion, 8in. ...	16/6
Rola/Celestion, 10in. ...	25/6
12in. Truvox BX11 Lightweight Extension Loudspeaker in mottled baked-lime case, suitable for bedrooms or kitchenettes ...	19/6
Plessey Mains Energised 8in. Unit, 1,500 Field	21/-

WALNUT CABINET

Complete with drilled chassis, dial, back plate, pointer, dial drive and drum, etc. Price 27/6 Post 2/-.

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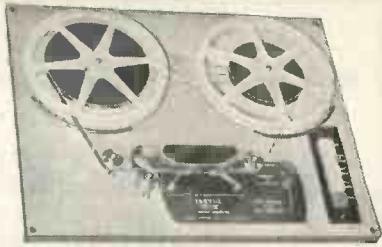
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WARNING

Readers are warned that Government surplus components which may be offered for sale through our columns carry no manufacturers' guarantee. Many of these components 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 components purchased.

NEW RECEIVERS AND AMPLIFIERS

12-watt high quality amplifiers, pass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co. Ltd., Tombard, Norwich. [1905]

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., Bickford Rd., Witton, Birmingham, 6 (Eas. 0435), the Midlands specialist manufacturers of high fidelity sound reproduction equipment for the world-famous Williamson amplifier and associated accessories including tone control stages, loudspeaker crossover units, distortionless contrast expanders and radio feeders; send for details and prices.

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

MULLARD TV projection unit; £25.—Box 1153. [1934]

HALLICRAFTER SX28 receiver, excellent; £4/9s or offer.—Ilford 2668. [1928]

HALLICRAFTER SX24, perfect order, best offer over £20.—Box 1129. [1917]

MARCONI type CR.100, 12-valve tuner amplifier, B.M. B.35; £20 o.n.o.—Box 1040. [1887]

EDDYSTONE 740, as new; nearest £28.—E. Parnell, 67, Holderness Rd., Hull, Yorkshire. [1859]

EDDYSTONE 740 plus speaker, £35; within E. guarantee, little used; carriage paid N.W.—Box 1131. [1919]

EDDYSTONE receiver 750; £40 or exchange E. good 670.—Williams, 107, Riverview Rd., Ewell, Surrey. [1865]

SX28 unmodified and in good order; £40 or S. near offer.—Judd, 68, Mayfield Ave., Orpington, Kent. [1941]

BC348L, £25 or offer; RF24, 26, 27, price £12/—, £2, £2.—Howe, 108, Monkleigh Rd., Morden, Surrey. [1942]

EADYSTONE 640 receiver, medium speaker, E. Brown's phones, all as new; £24, or £30 or offer.—Tel. Cro. 5708. [1826]

COMMUNICATIONS receiver R1116A 8-valve C double superhet 7-band 2KC-20MC, complete, offers?—Box 1130. [1918]

A RMSTRONG EXP83, 8V 10 watts chassis, A speaker, in Bush cabinet; offers around £14.—Platts, 1a, Croxted Rd., London, S.E.21. [1890]

35-watt quality amplifier (a.c.) by sound sales, with set spare valves; little used; £15.—Cryseco, Ltd., Kempston Works, Bedford. [1935]

FERROGRAPH, model LD, walnut, factory overhauled, guaranteed as new; £55, seen London Industrial Engineering, Ltd., 23, Albany St., W.1. [1812]

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [1903]

FOR sale, Savage audio amplifier, 1kW output; £100.—Hornchurch Broadcast Relay Co. Ltd., 30, Victor Gardens, Hornchurch, Essex. [1841]

R880, AR77E, SX28A, SX42, in perfect condition; new Garrard RC80 changer with astatic turnover pick-up; what offers for lot or separately?—Box 1118. [1911]

A RDENTE high fidelity 10 watt amplifier, A pre-amplifier stage and tone control, input for microphone and gramophone, new condition; £14, or nearest offer.—Box 0820. [1837]

LOUDSPEAKERS—SURPLUS AND SECONDHAND

HORNS.—12 new exponential 4ft long, 3ft sq mouth, fin throat, with 1½in flange, 18g. M/S painted 500 watts.—Box 1115. [1907]

LOUDSPEAKERS—SURPLUS AND SECONDHAND WANTED

WANTED Acoustic corner ribbon or similar quality loudspeaker for Leak amplifier; send full details and price.—Box 1128. [1916]

WANTED horn speakers, complete, any type; offers to—Radiquipment Co., Brook St., Raunds, Wellingborough, Northants. [1949]

TEST EQUIPMENT—SURPLUS AND SECONDHAND

TF14G, attenuator, coil turret, variable condenser, output meter, new; offers; Cossor 3339 oscilloscope, perfect condition, £25.—Box 1102. [1898]

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TEST EQUIPMENT—SURPLUS AND SECONDHAND

SIGNAL generators, oscilloscopes, output multi-range meters in stock; your enquiries are invited.—Requirements to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [1905]

NEW DYNAMOS, MOTORS, ETC.
BATTERY chargers, 4 models, 2-6-12v, 1-2-4 Amp D.C.; any mains voltage; also larger types special transformers, chokes, test gear, interior car heaters, etc.—The Banner Electric Co., Ltd., Hoddesdon, Herts. [1912]

ALL types of rotating electrical machinery up to 20kva available, including rotary converters, rotary transformers, motors, petrol and diesel-engined generating plants, alternators and d.c. generators. We are in a position to quote for power transformers; as actual manufacturers we will be glad to quote for any quantity for home or export.

MOTSEY Electrical generating plants, 3kva, 230v, with push button remote control, starting equipment, ready for use; £225.—
CHAS. F. WARD, Lordcroft Works, Haverhill, Suffolk. Tel. 253. [1903]

THE Pearce new model diesel alternator plant, on standard steel frame, 230/1/50 3kva plus 32v 15a d.c. Petters latest AVA 150 air-cooled diesel engine alternator self-energised automatic-voltage control by winding arm stator d.c. output charges lighting and starter battery up to 15amps, 24v lighting is used when plant is not in use, remote control push-buttons complete with main switch and fuses, battery cables: £255.

SEND p.c. for full description and photographs. ALSO above plant fitted Lister slow-speed water-cooled diesel and electric flywheels.

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T. W. PEARCE, 66, Great Percy St., W.C.1 (near Angel). [1903]

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

TRUVOX tape desk, as new, dem. London. £18.—Box 1127. [1914]

H.F. alternators, 80v, 25a, 1,500 cycles; also hot wire ammeters, 0-1, 2 amps.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [1913]

TWO ex-Admiralty generators, 220 d.c. a.c. 230/50/200 watts, rating will take 100% overload, weight 100lb; £5/15 each, £10/10 two. —Gummer, Frinton-on-Sea 712. [1939]

LISTER 1½kw 110v D.C. petrol gen. set with R auto switchboard, batteries, lamps, exhaust pipe, etc., all good condition, £50.—Weston batt. signal gen. less instruction book, £5; electro-dynamic 230 D.C. in 230 A.C. 150w out, with silence cabinet, £10; shooting gold cond., £7; another 230 D.C. in 6 to 12 D.C. 2-amp out, silence cabinet, £2.—Hill, Elect. Eng., Tadcaster 2253. [1929]

NEW GRAMOPHONE AND SOUND EQUIPMENT

RECORDING equipment to the trade.

WEARITE tape decks and special parts, disc recording machines.

BLANK discs, Scotch-boy tape, Emetape.

RADIO feeder units, microphones, etc.

ALL from stock—Sound Discs (Supplies), Ltd., 173, Bispham Rd., Southport, Lancs. [1908]

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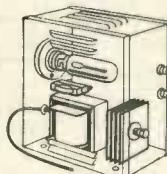
TRUVOX, Lane, Motek, 12 watts p.p. a.mps. to suit, £21; 3 input channels, m. eye ind., bass and treble, var. bias, etc.; others from £12.

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HARDING ELECTRONICS, 120a, Mora Rd., London, N.W.2. [1958]

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NEW GRAMOPHONE AND SOUND EQUIPMENT

FERROGRAPH magnetic tape recorder, model 2A now available; price 76gns.; demonstration daily by appointment.

SOUND DISCS (SUPPLIES) Ltd., 178, Bishop Rd., Southport. Tel. 68153. [1802]

HIGH-FIDELITY FM, the very best RF signal converted to AF. See display advert.—Bel Sound Products Co., Marlborough Yard, N.19. [1815]

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., manufacturers of high quality portable and console magnetic tape recorders for professional and amateur use; full details on application.

BICKFORD Rd., Witton, Birmingham, 6. East 0822.

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POLLOCK lightweight m/c pick-up, response 40cs to 20 kc.s. h.i. resonance 25 kc/s approx.; complete set of parts for constructing head 25/-, plus 1/- postage and packing; building instructions. 5/-; sapphire stylus .001in or .0025in, 7/6; model also with thorns; 100/- input transformer, size case 20/- plus 1/- post, etc. S.a.e. for details to A. M. Pollock, 14, Broomfield Lane, Hale, Cheshire. [1857]

PICK-UP arm/pvt for Pollock m.c. pick-up head now available as a kit. price 26/-, post free; s.a.e. for details as above.—A. M. Pollock, 14, Broomfield Lane, Hale, Cheshire. [1901]

MAGNETIC recorders, all types, new and secondhand for sale; hire service in greater London area only; mechanical and electronic repairs carried out by specialists: "Magnograph" limpet telephone pick-ups, suitable for all types of recorders, 25/-; tape storage racks for 12 reels, 37/6; B. & H. recording wire, new and used, from 15/- reel; tape, accessories, etc.; full details s.a.e.—The Magnograph Recording Co., Ltd., 1, Hanway Place, W.I. Tel. Langham 2156. [10236]

GRAMOPHONE AND SOUND EQUIPMENT — SURPLUS AND SECONDHAND

PYRENE gram., £50 o.n.o. cost £90.—Tel. Hill 4204. [1873]

SIMON tape recorder. Model Ia, new June, '53, less mic.; £65.—Frankton, 22, Barleycroft, Welwyn Garden City, Herts. [1874]

H.M.V. radiogram table model (automatic change), in new condition; £25, or exchange good tape recorder.—Box 0821. [1838]

GRUNDIG two-speed reporter, as new, complete tape, mike, list £84.—£65.—Tayor 125, Manchester Rd., Denton, M.C. [1880]

SOUNDMIRROR T411 mil 22/2, perfect, must sell, going abroad; £55, o.n.o.—Swales, Airport Club, Northolt Airport, Ruislip. [1803]

BRADMATIC model 5 tape deck, £29; Wearite, £28; both as new.—Plant, Asfordby, Melton Mowbray. Tel. Asfordby 241. [1842]

WEARITE tape deck type "B," three heads, synchronous capstan motor, nearly new, perfect order; £50, London area.—Box 1041. [1888]

6FT G.P.O.-type relay rack, two amplifiers, three power packs, mixer unit, r.f. tuner, etc., oscilloscope, reproducing equipment, other bargains, odds and components; s.a.e. list 3, Coombe Gdns., New Malden, Surrey. [1947]

1 Complete public address unit, comprising: 3 constant speed turntables by Garrard, 1 amplifier and power pack, 2 large speakers plus extra B.T.H. speakers, 4 large baffle boards; bargain.—Vicar, St. Sepulchre's Church, E.C.1. [1828]

CROWN magnetic recording wire, type 302 Milstain .0036, unused on metal reel, average net weight 1.1lb., as used in Chicago Webster recorders, ohms per yd 115-122; £2/5 each.—Robinson, 847, Kingsway, Manchester 20. [1904]

FERROGRAPH magnetic tape recorder, £60; 10 spools Empire, unopened, 23/- each; disc recording machine, 1953, £48; B.S.R. Marchant self-changer (unopened), £12; Wharfedale 10in. speaker (second-hand), £3; Reslo ribbon mike and stand, £7; Leak amplifier and prestage, as new, £30.—Box 0405. [1761]

ANY of you tape types building your own? Although we deal primarily in standard cine equipment, it's quite possible that our "Bits and Pieces" list might be useful: s.a.e. please. We also wish to buy tape decks, recorder components, etc. Burgess Lane & Co. Block 1, Sunleigh Works, Sunleigh Rd., Wembury, Tel. Wemb. 2378. [0253]

VALRADIO converter, tape or TV, etc. £7/15; E.M.I. cutterhead, £5; groove locator and Hi-Fi pick-up, £4/15; radio feeder, £6; 250watt p.p. amplifier, £17; M.S.S. studio condenser disc recorder, £65; 10in. moving-coil mike, £4; moving-coil mike, 30/-; C.J.R. tape recorder, £80; 10in. Wharfedale speaker in reflex cabinet, £7; 40 assorted gram records, £3; exponential horn speaker, £4; several amplifiers, mixers, recording equipment, blanks, transformers, etc.; exchanges considered; s.a.e. please.—Matthews, Bentworth Priory, Tower Hill, Dorking. Tel. Dorking 3426. [1885]

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Heavy turntables with smooth 3-speed drive giving negligible rumble, a turnover crystal pick-up with unusual range tracking at low pressure on the most difficult microgroove record, fully tropicalised, handsome cream enamel units bespeaking confidence by their immaculate appearance.

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50% Reductions in tape and disc recorders, 50 microphones, pick-ups, gramophones, etc.—Arcade Recording Circuit, Arcadian Gardens, London, N.22. [1936]

VALVES WANTED
WANTED, one or two 1/LE3 valves.—W. J. Temple, 94, Park Ave., Sale, Cheshire. [1896]

45/- paid for 813 valves, 60/- 723 A/B; also wanted, 805, 803, 807, 2J32, 2K33, TZ240, 808, etc.; any quantity; write.—Pype Hayes Radio, 606, Kingsbury Rd., Birmingham, 24. (Erddington 4942.) [1861]

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NEW ownership! New policy!
INTRODUCTORY OFFER. All goods, carriage and packing, free for this month only. All goods specially selected for quality and value. Prompt service. Money-back guarantee. Watch for next month's display advertisement. It will pay you to wait us!

COLLARO 3RC/520 3-speed auto-changer, complete with two GP27 Crystal plug-in heads (standard & L.P.) at £9/19/6 only. Stupendous half-price offer. Decca Record-Players Model 35A. Complete playing desk, brand new, ready to plug-in can be supplied with either standard or long-playing crystal heads, £4/19/6, or complete with both heads at £5/19/6. Also in stock Collaro 3RC/531 and 532, AC3/534 and AC534 complete with latest plug-in heads. Also Garrard RC75 A.C./D.C. 3-speed changer, at £24/11/4 complete with plug-in heads. Also special offer Garrard Model E. A.C./D.C. synchronous motors—auto-stop and start 78 r.p.m. speed regulator, at £7/19/6. Connoisseur 3-speed motors, pick-ups, Pick-ups and heads, by Garrard, Decca, Collaro, Acos, Chancery, etc., etc., all at current prices! Radiogram Chassis, 3-wave-band super-het. Latest type. Mullard Miniature valves, A.C., 110/250v. Chassis size 13½in × 6½in × 2½in. Dial 10in × 5½in. Provision for ext. speaker. Price £10/5. Or with the same valve line-up. Chassis size 11in × 7in × 2½in, scale size 8in square. Price the same!

DULCI radio/radiogram chassis. All types available ex-stock, as advertised by the manufacturers elsewhere in this issue at list prices! Remember all chassis advertised can be demonstrated to personal shoppers! The "Economy Four" T.R.F. kit. A three-valve plus metal rectifier receiver. A.C. mains 200/250v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up 6E7 6J7 and 6V6. Chassis ready drilled. Cabinet size 12in long by 6in high by 5in deep. Choice of ivory or brown bakelite or wooden, walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price £5/15 complete. Remember this set is being demonstrated at our shop premises, and remember for this month only, all goods carriage and packing free!

DREGGON cabinets, we have in stock available 5in extension speaker cabinets at 13/6, for 6½in at 17/6 and for 8in at 22/6. All modern walnut finish. We can also offer portable record player cabinets, from 55/-, T.V. console cabinets from £7/19/6, and radiogram cabinets from £10/19/6. Sorry, we've had insufficient time to prepare literature. So, for the present, personal shoppers get the benefit of seeing them!

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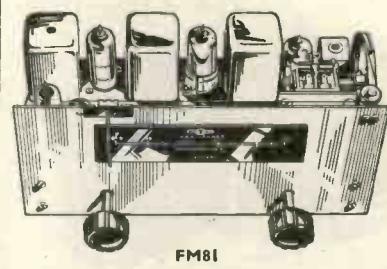
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(This advertisement continued on next page)

WIRELESS WORLD

TUNERS

V.H.F./FM



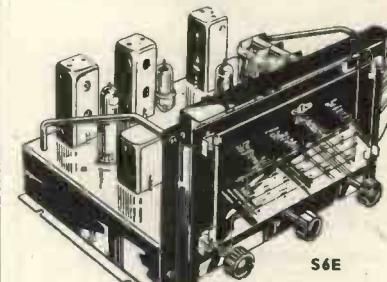
FM81

After considerable research into the many problems of V.H.F. Frequency Modulation reception, we are pleased to announce that our Tuner Type FM81 is available to experimenters and enthusiasts.

The excellent reproduction with absence of background noise provides an amazing degree of realism when used with Wide Range reproduction equipment.

The FM81 uses the latest valves and techniques; Tuned R.F. stage; Frequency Changer; 2 I.F. stages; Ratio Discriminator; A.V.C.; FM/AM switch. Tunable between 87.5 Mc/s-100 Mc/s, the FM81 will receive the B.B.C. Frequency Modulated or Amplitude Modulated V.H.F. transmission approximately 50 miles radius from WROTHAM.

Please send for leaflet.



S6E

9 Band (6 Electrical band spread) with R.F. F.C. 2 I.F. Delayed Amplified A.V.C. Variable Selectivity. Fly Wheel Tuning. Tropicalised. Suitable for use with any High Quality Amplifier. £44. Tax paid.

S6 As new model similar to the well-known S6B but only 3 Wave Bands; 16m-50m, 195m-550m, 800m-2,000m. £30. Tax paid.

S6E As S6 but 4 Wave Bands; 12.5m-37m, 35m-100m, 90m-250m, 190m-550m. £30. Tax paid.

S5 3 Wave Bands, 16m-2,000m, R.F. Pre-amplifier, variable selectivity I.F. Delayed Amplified A.V.C. very low distortion. £21/6/8. Tax paid.

S5E As S5 but 12.5m-550m. £21/6/8. Tax paid.

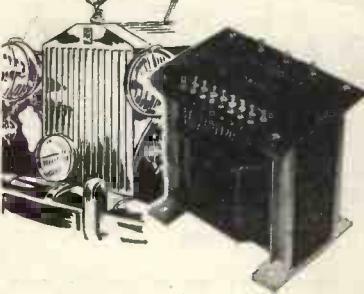
S4 The Standard high-quality Feeder Unit. Specification as S5 but without R.F. amplifier. £16. Tax paid.

A modified version of all models is available for use with Leak, Acoustical and other High Quality Amplifiers.

C. T. CHAPMAN (Reproducers) LTD.
RILEY WKS., RILEY ST., CHELSEA, S.W.10
FLAXMAN 4577/8

Export Enquiries Invited

Transformers good enough for ROLLS-ROYCE



1928 1953
SILVER JUBILEE

We can add nothing to the obvious inference that none but the best is good enough for the Rolls-Royce Laboratories.



SAVAGE TRANSFORMERS LTD.
Nursted Road, Devizes, Wilts.
Telephone: Devizes 536

SPECIAL OFFERS

DOUBLE READING AMMETER—In leather case A.C./D.C. reading 3 and 15 amps, 2½in. dial, portable type, with test leads, 22/6, post 1/-.

AMMETER, 2½in. Flush 0/25 amps. Moving Iron. D.C. 7/6, post 1/-.

MILLIAMMETERS. Moving Coil, D.C., 2½in. Flush 0/30, 0/900, 0/250, 12/6; 3½in. Flush, reading 150-0-1,500, a very useful meter with a good open scale. 29/8, post 1/-.

VOLTMETERS, 0-300 A.C. Moving Iron 3in. Surface type, 25/-; 0-300 Flush D.C. Moving Coil, 10/6; 0-2000, 0-900, 0-250, 12/6; 3½in. Flush, reading 150-0-1,500, a very useful meter with a good open scale. 29/8, post 1/-.

MILLIVOLT METER, 0-300 A.C. Moving Iron 3in. Surface type, 25/-; 0-300 Flush D.C. Moving Coil, 10/6; 0-2000, 0-900, 0-250, 12/6; 3½in. Flush, reading 150-0-1,500, a very useful meter with a good open scale. 29/8, post 1/-.

RECEIVER, R.1355. As specified for "Inexpensive Television." In original packing, as new. Complete with all valves, 38/6, carriage 7/6.

EF50 VALVES, Red Sylvania, or British guaranteed unused, ex-new equipment, 7/6, post 6d.

PORTABLE TEST METER. Just the job for the home constructor, in nest case, 6in. x 5in. x 4in., reading 1.5, 3, 150 volts, 6 and 60 mA. D.C., 5 k. and 25 k. ohms 25/- each to clear. Post 1/6.

SLOW MOTION DIALS, 6in. Scaled 0-100, reduction 200 to 1 or direct, ideal for wavemeters, signal generators, etc. Our Price, while they last, 5/6, post 1/-.

POWER PACK, Type 3 specially made for the Receiver R.1132A, input 200/250 v. A.C. Only a few left at 54/10/-, pkg. and carr. 7/6.

45 Metres PVC STRIP vision unit for London; condition new, complete with 6 EF50 and EA50 valves, 65/-, carriage 9/6.

INSPECTION LAMP. Complete with battery case. Fits on forehead. Leaves both hands free, 7/6, post 1/-.

"ELF" CIRCUIT BREAKER, avoids blown fuses if the mains are overloaded. Reset in an instant. Very useful on test bench. Size 5in. round, 10/6, post 1/-.

VOLTMETERS, CELL-TESTING. 3-0-3 volts Moving Coil D.C., complete with test leads in leather case, 35/-, post 1/-.

METRO-VICK AUTO TRANSFORMERS. 230/115 v., 500 watt, totally enclosed, 24/10/-.

Comprehensive List! Now Ready 6d.

WILCO ELECTRONICS

DEPT. WW

204 LOWER ADDISCOMBE RD., CROYDON

NEW COMPONENTS

(This advertisement cont'd. from previous page) Rectifiers Type K3/25 at 5/3, K3/40 at 7/6, K3/45 at 8/2, K3/50 at 8/8, K3/100 at 14/8, K3/160 at 21/6 and K3/200 at 26/-. Meter Rectifiers, 1m/a by G.E.C. at 11/6, also 5m/a by Westinghouse at 8/6. Introducing L.T. Rectifiers of selenium rectifiers fully guaranteed for 12 months from date of purchase. No Govt. surplus materials used in their production. At present available are 6v 1a C.T. at 5/-, also full-wave bridge types, 12v 2a at 11/3, 12v 3a at 12/6 and 12v 4a at 15/-. Wholesalers, retailers and manufacturers are invited to apply for trade terms. Watch future advertisements for further additions to this range. Ex-Govt. meters in stock, include 2in square 0-5m/a thermo-couple at 4/6, 0-5m/a m/c at 7/6, 0-50m/a at 7/6, 0-500m/a at 17/6 (round), 0-1m/a at 2½in desk-type at 27/6. Many others in stock.

WE also offer very limited supply of ex-Naval all-purpose test meters by Everett, Edegburne. These instruments are not brand new, but all have been serviced and guaranteed 100 per cent condition. Complete in strong wooden case. Size 9in. x 6in. x 5½in. Leather carrying handle. 3/4in. Scale—1,000 ohms per volt. Measures 0-1,000 volts A.C./D.C.—Capacity .02mfd—16mfd—Resistance to 10 megs. While stocks last—Price £7/19/6 only!

ALSO in stock, descriptive envelopes for "Viewmaster," "Tele-King," and "Soundmaster." All components for these circuits are available, and note that we are demonstrating a fully assembled "Soundmaster" tape-recorder at 18, Tottenham Court Rd., W.1, situated 50 yds. from Tottenham Court Rd. Tube. Don't forget the new name in retail radio—CLYNE RADIO, Ltd. Clyne Radio, Ltd. Clyne Radio, Ltd.!

WE nearly forgot to mention it. We have in stock, tape decks by Motek, Wearite and the Truvox Mk. III. All at current list prices. One last word. If you require a packet of BBA nuts and screws, or a ¼lb reel of enamelled copper wire from 16 swg to 42 swg. We have that too! Don't forget for this month only we are supplying all items post free. Money-back guarantee, prompt service, quality goods, at CLYNE RADIO, Ltd., 18, Tottenham Court Rd., W.1. Museum 4539/2453. Shop hours Mon.-Fri. 9-6 p.m. Saturday 9 a.m.-1 p.m. Clyne Radio, Ltd. Why not pay us a visit?? 1883

CRYSTAL microphone inserts (Cosmocord Mic—6), guaranteed brand new; 15/6 post free—Radio-Aid, Ltd. (Retail Dept.), 29, Market St., Watford.

COIL sets for TV converter. May issue "Wireless World," 12/6, post free: money-back guarantee—C. O. Preston & Son, Healey Lane, Batley, Yorks.

COIL packs, miniature 3-wave, 22/6; t.r.f. coils, 4/6 pair, w/maction, 5/6; i.f. trans's 465 Kc/s. miniature, 9/- pair; stamp bargain list spare and components—Channon Electric Co., Hazelville Rd., London, N.19. Tel. Archway 5208. [1948]

TELEVISION screens, Ilac tinted, laminated safety glass, 15½in. x 11½in. at 5/- each, postage 2/6 extra, also television plastic Ilac tinted, 12in. x 10½in., at 2/- each, postage 6d extra—Dubar Safety Glass Co., Ltd., Darwin Rd., W.5. Ealing 4960.

TELEVISION—New "High Q" C.5 TRF matched L and MW coils are now available; we claim the finest made for the price of 8/- per pair. Inc. battery and mains circuit diagrams; if unobtainable locally send direct to: Creton Radio, 349, Copnor Rd., Portsmouth.

TELEVISION—New 5in. canned formers 2/3 ea., coil sets, EE, VM, PT, etc., from 18/6; FM Rx. coil sets 75/-; 6mm cored formers 7/-do.; 8mm 10/-; 3W4B min. switches 10/- doz.—Bel Sound Products Co., Marlborough Yard, N.19. Arc. 5078. Trade supplied.

FOR really good results you can do no better than use Osmor coils and col/packs, ask anyone of experience! Send 5d (stamps) today for beautifully-drawn free circuits, our new collata leaflets, and latest lists of matched radio components. A speedy mail order department is at your service, and remember, a.i. Osmor lines are guaranteed. (Trade enquiries invited.) Dept. C.W.1.

OSMOR RADIO PRODUCTS, Ltd., Bridge View Works, Borough Hill, Croydon. Tel. Croydon 5148-9.

FLUORESCENT 80 watt 230v complete ballast unit, 39/6; 80w brick choke and starter lamp, 14/6; 40 watt complete ballast 230v, 28/9; complete fluorescent fittings from 45/-; metal rectifiers, 12v 4amp f/w bridge, 13/9; suitable charger transformer, 16/6; 0-4 ampimeter 8/6; brand new small radio cabinets, 16/6; multi-ratio output transformers, Goodmans, 7/6; Diamond H switches, 4/6; 4-pole cooker switches, 5/- charge your dry cell batteries with our special charger from mains, complete unit, 14/9; new G.E.C. ½hp electric motors, 230v S.p. £4/16—Malden Transformer Supplies, Rear of 5, Coombe Rd., New Malden, Surrey. Tel. 2655 (Longside of Malden S.R. Station).

COMPONENTS - SURPLUS AND SECONDHAND

6in. TV kit, mostly constructed; £18—Fox, 91, Showell Green Lane, B'ham, 11. [1906]

G. A. RYALL, "Utopia," Mayfield Rd., Herne Bay (Kent); please refer to previous adverts.

SOUTHERN RADIO SUPPLY, Ltd. 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 154.

NEW G.E.C., S.T.C. AND "WESTALITE" SELENIUM RECTIFIERS. Largest L.T. range in Great Britain. Latest Current Products. NOT Surplus.

CURRENT PRICE LIST

S.T. & C. E.H.T. K3/15, 4/5; K3/45, 8/2; K3/50, 8/8; K3/100, 14/8.

BRIDGE CONNECTED FULL WAVE

17 v. 1.2 a., 16/4; 1.6 a., 26/-; 2.5 a., 29/-;

3 a., 30/-; 4 a., 34/6; 5 a., 37/6, all post free.

33 v. 0.7 a., 24/3; 1 a., 28/-; 1.5 a., 45/-;

2 a., 51/-; 3 a., 52/-; 4 a., 62/-; 5 a., 67/-; all post 11/-; 54 v. 1 a., 38/6; 1.5 a., 62/-;

2 a., 69/-; 3 a., 70/-; 5 a., 93/-; 72 v. 1 a., 49/-; 1.5 a., 78/-; 2 a., 81/-; 3 a., 92/-; 5 a., 112/-; 2 a., 128/-; 5 a., 174/-; all post 1/2.

BRIDGE CONNECTED HEAVY DUTY

7½in. SQUARE COOLING FINS. 17 v.

6 a., 49/6; 10 a., 56/-; post 1/6.

BRIDGE CONNECTED HEAVY DUTY

Funnel Cooled, also

7½in. SQUARE COOLING FINS. Revised price, same both types. 17 v. 12 a., 102/-; 20 a., 118/-; 30 a., 164/-; 50 a., 257/-; 24 v. 1.2 a., 15/10; 2.5 a., 27/8; 5 a., 51/-; 10 a., 92/7; 20 a., 176/2; 36 v. 1.2 a., 27/8; 2.5 a., 51/-; 5 a., 69/6; 10 a., 130/9; 12 a., 72 v. 6 a., 154/-; 10 a., 178/-; 100 v. 6 a., 211/-; 10 a., 212/15/-; all post 1/10.

"WESTALITE" (BRIDGE), 12-15 v.

D.C., 1.2 a., 15/10; 2.5 a., 27/8; 5 a., 31/9;

10 a., 54/6; 20 a., 99/6; 30 a., 144/10; 50 a.,

257/-; 24 v. 1.2 a., 15/10; 2.5 a., 27/8; 5 a.,

51/-; 10 a., 92/7; 20 a., 176/2; 36 v. 1.2 a.,

27/8; 2.5 a., 51/-; 5 a., 69/6; 10 a., 130/9;

E.H.T. RECTS., 14D, 134, 22/-; 36 E.H.T. 60,

31/10, all post extra.

Wholesale and Retail

T. W. PEARCE

66 GREAT PERCY STREET, LONDON, W.C.1
Off Fentonville Rd. Between King's Cross and Angel

Free from distortion

cannot introduce hum

E.M.G.

STEEP-CUTTING INFINITELY VARIABLE FILTER

No other filter combines all the advantages of this model which are, briefly, to cut response above any desired level between 4,000 and 8,000 c.p.s. at an average steepness of 30 db. per octave, easy fixing (connects between 15 ohm speaker and amplifier output), robust construction, no distortion or appreciable loss of volume. Recommended for reducing surface noise on '78' records, cutting 'edge' on some L.P. records, and eliminating high-pitched interference on radio. Price £4/10/0. Leaflet on request.

E.M.G. HANDMADE GRAMOPHONES, LTD.

6, Newman St., Oxford St., W.1

Telephone: Museum 9971-2-3

BENSON'S BETTER ARGAINS

METERS	New and boxed.	Scale FSD	Size	Type	Fitting	Price
30 mA	2in.	MO	Proj. R.	7/-		
100 mA	2½in.	MO	Flush R.	8/-		
200 mA	2½in.	MO	Flush R.	8/-		
300 mA	2½in.	MO	Flush R.	8/-		
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500 mA	2½in.	MO	Flush R.	8/-		
1 A or 2 A	2in.	TC	Fl. or proj.	8/-		
3 A	2in.	TC	Square	6/-		
20 A	2½in.	MI	Flush R.	8/6		
30 A	2½in.	MO	Proj.	8/-		
50 A	6in.	MI	Proj. Met.	30/-		
20-30 A	2in.	MC	Square	8/-		
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500 µA (6 mA)	2½in.	MO/TG	Flush R.	17/6		
15 v.	2½in.	MI	Flush R.	10/-		
15-30-15 v.	2in.	MO	Flush R.	10/6		
15 v.	2in.	MO	Flush R.	10/6		
2,500 v.	3½in.	EL	Flush R.	30/-		
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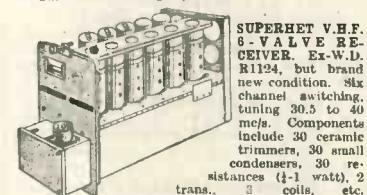
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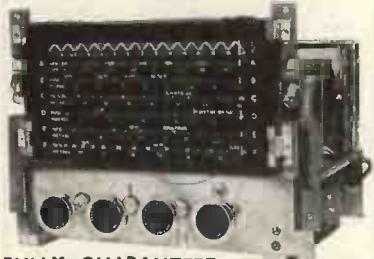
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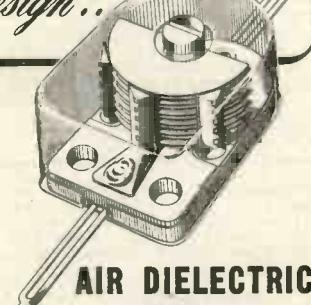
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The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

SERVICE or Maintenance Engineer.

A FIRST-CLASS engineer is required for the maintenance of electronic instruments and control equipment used in the Research Laboratories of D. Napier & Son, Ltd.; experience of this type of work is essential; radio and television servicing is not sufficient qualification.—Applications, giving details of education, qualifications, experience and salary required, to Dept. C.P.S., 336/7, Strand, W.C.2, quoting ref. 1187. [1866]

RADAR technician required by the

NIGERIAN Government, Meteorological Department, for one tour of 12 to 24 months in first instance with option of appointment (a) on agreement with prospect of permanency with salary, etc., in scale £750 rising to £1,175 a year or (b) on contract with salary, etc., in scale £807 rising to £1,269 a year; outfit allowance £60; free passages for officer and wife and assistance towards cost of children's passages or their maintenance in this country; liberal leave on full salary; candidates must be competent radar mechanics and must be able to maintain GL III radar equipment and to take charge of a radar wind station; established Civil Servants should submit their applications through departmental channels. WRITE to the Crown Agents, 4, Millbank, London, S.W.1; state age, name in block letters, full qualifications and experience and quote M2C/30169/WF. [1879]

ASSISTANT Signals officer required by the

GOVERNMENT OF NIGERIA for the Aviation Department for one tour of 18 to 24 months in the first instance. Salary, etc., either (a) in scale £750 rising to £1,315 a year with prospect of permanency, or (b) in scale £807 rising to £1,453 a year on a temporary basis with gratuity at the rate of £100 a year. Outfit allowance £60. Free passages for officer and wife, and assistance towards cost of children's passages, or their maintenance in the United Kingdom. Liberal leave on full salary. Candidates must have a knowledge of the fundamental principles of electricity and magnetism and of radio engineering with experience in the maintenance of aeronautical radio transmitters and receivers, direction finders, test equipment and small petrol and diesel engine generator sets. Workshop experience and knowledge of radar will be of advantage. Minimum examination qualifications are C. & G. Certificate in radio communications or technical electricity, or satisfactory pass in M.C.A. radio mechanics course. WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/29637/WF. [1856]

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SOME knowledge of servo mechanisms would be an advantage. Should have university degree.

THESE appointments are pensionable and offer good prospects to individuals with initiative and technical ability. SALARY will be in accordance with experience and qualifications.

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WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/28927/WF.

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Resistances. Vitreous 2,000/30 watt, 5/- per doz.; 2,500/55 watt (shoepoled), 5/- per doz.; double pots 30K + 30K, 5/- per doz.; variable (sliding) 1 ohm 12 amps., ea., 6/-; 5 ohm 5 amp., 8/-; 22 ohm 2½ amp., 12/6; 60 ohm 1 amp., 12/6.

F.W. Rectifiers. 12 v. 1 a., 5/6; 12 v. 2 a. 7/-; 12 v. 5 a., 15/-; other sizes on application rectifier/transformers kit for 12 v. 4 a. charger 25/-.

Rotary Converters. Various types 40-1,450 cycles output, cheap, details on application.

Battery Chargers. Various, up to 1,800 watts, cheap, details on application.

Transformers. 85-115/12.6 + 12.6 v. 150-5,000 cycles, 2/6.

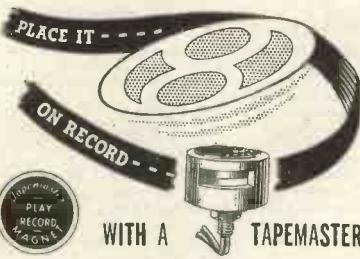
Headphones. Single, boxed, 300 ohm. 10/- per doz.

Meters. 3 mA. movement, M.C., offset zero, temperature scale, 5/-.

U.K. carriage paid, all letters answered, everything tested before despatch:—

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**TAPEMASTER RECORDING COMPONENTS**

Suitable for use with either Hartley or Culpits circuits.

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JUNIOR MODEL. Play/record, imp. 3,000 ohm at 1 Kc. Erase ... at each £1 19 6**SENIOR MODEL.** Play/record, imp. 5,500 ohm at 1 Kc. Erase ... at each £2 5 0

Oscillator Coil in can each 10 6

Oscillator Unit, incl. coil and 6V6GT valve each £2 5 0

TAPEMASTER MAGNET FEATURES. Electrically balanced to ensure low "hum" level. Play/Record Model with .0005in. gap ensuring max. top response. Beryllium Copper, non-magnetic gapping. Mu-metal cores for Play/Record models. Track width, Play/Record, .082in., Erase, .10in. To match for tracking. Bias frequency 45 Kc., exactly matching Tapemaster oscillator units and coils. Output 10 mV. Recording level, 15-20mV. With optimum bias, recording level and suitable correction of Amplifier response in frequency equals tape speed in inches/sec. Full instructions included for oscillator units and amplifier circuits.

AVAILABLE FROM ALL GOOD
RADIO DEALERS.**WINTER TRADING CO. LTD.**

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Electronic Engineering Principles

By John D. Ryder, Ph.D. The Second Edition of this successful American book offers a thorough grounding in the subject. A new chapter on solid stage devices and the transistor has been added in this edition. The book is profusely illustrated. 37/6 net.



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SITUATIONS VACANT

INSTITUTE of Cancer Research: Royal Cancer Hospital, Fulham Rd., London, S.W.3.
TECHNICIAN (male) required in the Physics Department; applicants should be capable of constructing, wiring, and initial testing of experimental electronic apparatus from theoretical circuit diagrams; salary £410x15-£470 plus London Weighting.—Applications, giving the names of three persons to whom reference can be made, must be received by the Secretary not later than November 10th, marking envelope "Technician—Physics Department."

[1875]

RADIO/TV Engineer reqd., top wages paid.—
Coynes Stores, 105, Talbot Rd., Bayswater, Bay. 4860. [1844]

MINISTRY OF SUPPLY, R.A.E. (Guided Weapons Dept.), Farnborough, Hants, requires

EXPERIMENTAL Officers and Assistant Experimental Officers for work on design, development and performance of new weapons and associated guidance and control systems; instrumentation of flight trials and investigation of trials results. Experience in any of the following fields desirable: Light engineering development; hydraulic and servo mechanism design; electrical control devices; centimetric radar techniques; design of light electrical, electronic or optical mechanisms; aircraft design, ballistics or aerodynamics; scientific computing or design of high-speed computing machines. Minimum of Higher School Cert. (Science) or equivalent required, although further qualifications in mechanical, electrical or electronic engineering, physics or mathematics may be an advantage. Salaries within ranges: Experimental Officer (Min. age 26) £649-£799, or Assistant Experimental Officer, £264 (age 18)-£576.

WOMEN somewhat less. Appointment unestablished. Application forms from M.L.N.S., Technical & Scientific Register (K), 26, King Street, London, S.W.1, quoting A232/53/A. Closing date 10th November, 1953. [1807]

THE FAIREY AVIATION Co., Ltd., invite applications from the following for work of outstanding interest and opportunity:-

ELECTRONIC Engineers to become Section Leaders of small teams responsible for the preparation, testing in the field and further laboratory development of guided weapons; applicants should normally have at least H.N.C. and 5 years' experience in either the microwave, pulse or communication field.

ASSISTANT Engineers to form such teams either (a) with a similar background to the above or (b) having considerable experience of developing and testing small prototype electro-mechanical instruments.

THE vacancies are at the Research and Armament Development Division at Heston Aerodrome, Middlesex. Periods of work away from this base at outstations in the U.K. are covered by subsistence allowances and week-end leave privileges. Good salary with bonus. Pension scheme.—Details of experience and qualifications should be sent to the Assistant Manager (A), Dept. W., The Fairey Aviation Co., Ltd., Heston Aerodrome, Hounslow, Middx. [1931]

RADIO and television engineer required, fully experienced all makes, for bench and outside; good driver, clean licence; good salary. references. **ELECTRICAL SERVICE (EDGWARE)**, LTD., 117, Edgware Rd., W.2. Pad. 2342. [1726]

ELECTRONIC Engineers required by The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry, in their Development Laboratories, for work on:-
(a) TRIALS Team in connection with guided weapons; 1 senior engineer, also 3 engineers.
(b) SERVO-MECHANISMS; 1 engineer.
(c) PULSE circuitry; 3 engineers.
(d) MICROWAVE circuits; 1 engineer.
(e) TEST equipment; 2 engineers.
(f) GENERAL radar circuit development; 2 engineers.

APPLICANTS, preferably with a degree or an equivalent qualification, should have had at least two years' experience in the development and engineering of service equipment as well as experience in one of the above. HOUSES on the outskirts of Coventry, near our laboratories, are now available for offer to successful applicants and this offer can only remain open for a few months. Applicants' holiday requirements will receive special attention.—Reply, stating age, qualifications and experience, to the Personnel Manager, Ref. R.G. [1882]

EXPERIENCED TV engineers required for tall service; permanent positions at good salary.—Full details to Shenstones (op. Town Hall), Leyton, E.10. Ley. 1362. [1926 Hall]

KEEN young radio improver required (facilities given for learning television); excellent prospects.—Write or call Morgan Radio, Ltd., 89, St Albans Rd., Hatfield, Herts. [1805]

TELEVISION Engineer required, Waltham Cross area; must be capable driver; accommodation available to right man.—Write, Teleradio, 18, Turnpike Lane, N.8. [1863]

RADIO service mechanics required by Smiths (Radiomobile), Ltd., for all parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. [10342]

TRANSFORMER designer required by old-established company (South London area); candidates must be fully conversant with the design of all types of transformers up to 100 K.V.A. rating; progressive and permanent appointment; salary according to experience.—Box 1132. [1924]

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TOGGLE SWITCH. Single hole panel mounting, 250 volt, 2 amp. Single pole changeover or on/off. Brand new at 6 for 5/-.

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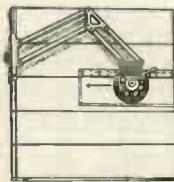
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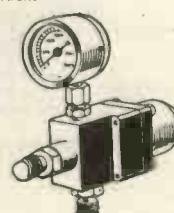
17in. sq. complete with pantograph arm, protractor head and perspex scale. Each 25/-.

**ACCUMULATOR CUT-OUT**

12 or 24 v., 60 A., Ex.R.A.F., originally cost over £6 each, suitable for battery charging, etc. Limited quantity at 15/- each.

HIGH PRESSURE REDUCING VALVE

Complete with 0.3,000 lb. per sq. in. pressure gauge. Suitable for compressors, cylinders of gas, etc. Brand new, 8/6.

**MODEL MAKER'S MAINS TRANSFORMER**

All purpose low voltage. Input 210/250 Volts. Output 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 Volts. Rating 2 amps. Brand new, fully guaranteed, 24/-.

IMPELLER PUMP. Approx. 20in. long x 2in. dia. Adjustable flange fixing, 2 amps. at 24 v. d.c. or will work on 12 v. at 4 amps. d.c. Ideal for bilge pumps or for transferring fuel or water to header tanks. Pump is self-cooled by liquid passing through it. Brand new and boxed, 39/6 each.

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For welding, brazing and soldering from normal 6 or 12 v. battery (as in a car). Complete with spare carbon rod and welding iron. Unrepeatable at 25/-.

ALL ITEMS CARRIAGE PAID IN U.K. ONLY

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SHERMAN'S SUPPLY CO. (W.6)
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KEYING RELAYS. As used in .1154 Transmitter. These contain 5 sets of change over contacts and 2 sets of make contacts and have two 24v. coils. Brand new in maker's carton. Price 7/6. Post 1/3.

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REV. COUNTERS BY SMITHS LTD. 3½in. dial. Scaled 10 to 5,000 revs. per minute. Luminous pointer. Flexible metal drive. Approximately 12in. long. Brand new and boxed 29/6. Postage 1/6.

POST OFFICE TYPE RACKS. For equipment 19in. 5ft. 6in. high for accommodating amplifiers, transmitters, receivers, etc., 39/6. Carriage 5/6.

MINE DETECTOR. For the detection of ferrous or non-ferrous metals, underground, under water or in animals, timber or chemicals, etc., etc. Originally intended for detecting mines. This equipment has never been used. The equipment consists of a 3 section battery amplifier in a steel case, a shoulder harness and a long counter balanced search coil, short search coil, headphones, junction box, operating instructions and circuit diagram. As we have to clear our store, we offer these at a very low figure of 39/6 carriage 7/6.

These Mine Detectors were tested and in working order before being stored, but, in view of the very low price, we can give no guarantee other than of completeness. Batteries not supplied.

AIR RAID WARNING CONTROL UNITS.

TYPE "A." DC Bias unit consisting of 230 v. mains transformer auto type tapped at 210 volts, twin coil polarised relay 50 ohms with 2 sets of break contacts, indicator light, two toggle switches, both 2 way 2 pole buzzer and housed in black bakelite case 4in. x 3½in. x 6in. deep. Price 15/- Postage 2/-.

TYPE "B." Operated by audio frequency consisting of tuned relay with two reeds which in turn operates a 10 amp mercury switch through a train of gear wheels by means of a ratchet. A frequency of 390 C.P.S. applied will operate switch to off position and a frequency of 427 C.P.S. will operate the switch to the "ON" position. Made by G.E.C. and contained in a waterproof case iron box 5½in. x 6in. x 4in. deep. Complete with terminal block. Price 17/6. Postage 2/6.

TYPE "C." DC Bias. Similar to Type "A" but consisting of transformer buzzer and small relay with single pole make contacts. Short flexible lead 2 pin 5 amp universal plug. Unit 3½in. x 4in. x 6in. deep. Price 9/6. Postage 2/6.

SERIES BOOSTER—5U8212. New 12 v. input, 24 v. output, or in reverse. Price 15/6. Postage 2/6.

CHASSIS AND COVER. Steel Chassis 7½in. x 10in. front panel with handles 9in. x 8in. suitable for mounting new front panel as existing one is over drilled. Cover 8in. x 7½in. x 10in. deep. Very clean condition. Price 3/- Postage 1/6.

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93 North Road, Brighton, Sussex
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SITUATIONS VACANT
RADIO and television manufacturers require technical assistant for development work; factory, 5-day week; staff canteen.—Full details of experience and salary required to Box 0724. [1824]

TELEVISION/RADIO service engineer, competent and experienced man reqd. by H.M.V., Murphy, Pye dealer, W. London; able drive.—Write fully Box 149, c/o Gosden's, 76, Strand, W.C.2. [1922]

SENIOR mechanical and electrical design engineers required for television transmission equipment, salary between £900 and £1,500 per annum.—Apply Technical Director, Pye, Ltd., Cambridge. [1820]

WORTHING district, television and radio service engineer required; state qualifications, experience and salary required.—Bowers & Wilkins, Ltd., 1, Becket Buildings, Littlehampton Rd., Worthing. [1815]

SERVICE engineer required for recording equipment, thorough knowledge of audio engineering necessary, should be able to drive service van.—Apply to Personnel Dept., E.M.I., Ltd., Blyth Rd., Hayes. [1814]

THE Brown's Lane Engineering Division of the G.E.C. Stanmore Laboratories urgently requires first-class experienced men to undertake pre-production engineering development work in the following fields:—

1. Gyroscopically stabilised aerial systems.
2. Servo-mechanisms and Magnetic Amplifiers.
3. Microwave Transmitters and Receivers.
4. Pulse Circuits.

THE right man can expect very attractive salaries. There is also a number of less senior positions open to men with less experience.

REPLY to Personnel Manager, Brown's Lane Division, G.E.C. Stanmore Laboratories, The Grove, Stanmore Common, Stanmore, Middlesex, quoting ref. WW/BLS/E4. [1851]

ALUMINIZING Engineer, thoroughly familiar with aluminizing techniques as applied to Cathode ray tubes, for responsible position with leading United States independent manufacturer of Cathode Ray tubes.

LOCATION in New York suburban area.

SALARY no object to right man.

THIS is a permanent set-up; no "feast or famine" deal.

YOU will become associated with a company noted for its liberal employee policies; a company which recognizes individual achievement and rewards it accordingly.

UNBEATABLE working conditions.

CONGENIAL, progressive associates; top executives who extend every conceivable co-operation that makes for mutual success.

INTERVIEWS will be held in London; to arrange for an appointment, at your convenience, please send complete details of experience to—Box 0851, c/o Wireless World. [1848]

JUNIOR and Senior circuit engineers required capable of building and proving performance of specialised equipment; applicants should state age, qualifications and experience.—Box 1006. [1871]

VENNER, Ltd., require a production supervisor with practical experience of electronic assemblies.—Applications to Personnel Manager, Venner, Ltd., New Malden, Surrey (Malden 2442).

ELECTRICAL and radio installation draughtsmen required for design work on new aircraft and guided weapons projects.—Apply Employment Manager, Vickers-Armstrongs Ltd. (Aircraft Section), Weybridge, Surrey. [1892]

COILWINDING.—Location near Rickmansworth; new concern requires engineer to control transformer, general coilwinding and assembly shop; commencing salary £750 rising as business increases in size.—Box 1135. [1925]

ELECTRICAL and TV engineer for the development of components and accessories; wide experience with variety of receivers (e.g., from servicing) essential; East London area; state age, salary, experience, qualifications.—Box 8866. [1661]

RADIO testers and inspectors required for production of communication and industrial electronic equipment.—Apply Mr. D. J. Lewendon, Winston Electronics, Ltd., 1, Park Rd., Hampton Hill, Middx. Tel. Molesley 2985. [1645]

TECHNICAL representative. A vacancy of unusual scope exists with old-established London company marketing acoustic correction and sound reinforcement equipment; applicants should have good technical background in radio or audio engineering.—Reply Box 0693. [1827]

FIRST-CLASS radio and television engineers required by old-established, expanding business; good salary and prospects; permanent; all leading agencies, including Murphy, Bush, Pye, Ecko, etc.—E. P. Fox, Ltd., East Molesley, Surrey. Molesley 2721. [10442]

ELECTRONIC Engineer required to work on development projects in small organization situated on South Coast; experience on design of communications receivers essential. H.N.C. standard; write full details and salary expected.—Box 8840. [10251]

ELECTRONIC development engineers required for work in laboratory on instrumentation, industrial electronics and guided weapons must have sound knowledge and experience of electronics and be capable of working on own initiative; salaries up to £1,000 p.a. depending on experience; excellent opportunities for capable men to progress in rapidly expanding organisation.—Apply Technical Director, Winston Electronics, Ltd., 1, Park Road, Hampton Hill, Middx. Tel. Molesley 2985. [1644]

SOUTHERN RADIO'S WIRELESS BARGAINS
TELESonic 4-Valve Battery Portable. Complete with 4 Hivac Valves. In Metal Carrying Case. Easily convertible to Personal Portable. £2 including conversion Sheet.

TRANSMITTERS-RECEIVERS. Types "38" Mark II and III. "18" Mark III. Still available, as previously advertised. ALSO RI10 RECEIVERS. See last issue of "W.W."

MINISCOPES. G.E.C. M861B. Brand New Complete in Carrying Case with plugs. £12/10/-.

BOMBIGHT COMPUTERS. Just arrived new parcel of this USEFUL UNIT. Ex-R.A.F. Brand New. Contains GYRO MOTORS, REV. COUNTERS, GEAR WHEELS, ETC., ETC. Worth many Pounds to Model Makers, Experimenters, etc., etc. £3/5/-.

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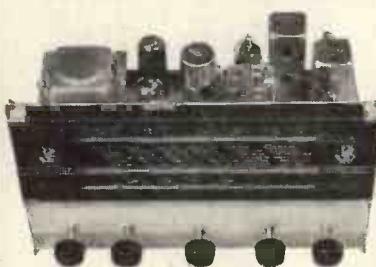
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Much of the brilliance of classical recordings and transmissions is lost in reproduction because of the compression employed in the studio. To ensure true reproduction it is necessary to restore all passages to their original relative level, this may be achieved by means of an expansion circuit. Such a circuit has been incorporated in the RG/250. A control has been provided so that the amount of expansion can be adjusted to suit the listener. Other refinements included in the RG/250 are, bass and treble controls, variable selectivity, indicators for tuning and contrast level, 10 valve circuit (plus indicators), 10 watts output.

Price £35. Tax paid.

Other models are:—

RG/160. 7 valve chassis, bass and treble controls, £20. Tax paid.

RG/127. 6 valve chassis, push-pull output, £17/5/- Tax paid.

RG/100/6 All-wave radio feeder unit, £14/15/- Tax paid.

Full details gladly sent on request

298, Wightman Road, London, N.8.
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**SOLE SUPPLIERS OF THE
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INDUCTANCE BRIDGE KIT, 42/6.

Continuous coverage from 50 micro/Hy to 100 Hy in 5 ranges.

Treble and Bass boost Chokes, R.F. Coils, Video Chokes, Whistle Filters, Smoothing Chokes, Scratch Filters, Audio, R.F. and A.C. Inductances in general. This instrument checks them all. **READY CALIBRATED.**

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MEASURE AND BE CERTAIN.

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5 Megohms—50,000 ohms. 50 mfd.—2 mfd.
100,000 ohms—1,000 ohms. 1 mfd.—0.1 mfd.
1,000 ohms—10 ohms. .01 mfd.—.0005 mfd.

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The I.F. Aligner Kit still available at 15/-, tunable over the 465 Kc/s range of I.F. frequencies. Pre-tuned ready for use.

Full instructions and diagrams with all Kits. Post and Packing 1/6 in each case.

RADIO MAIL

RALEIGH STREET, NOTTINGHAM
Stamp with all enquiries please. Cash with order or C.O.D.

SITUATIONS VACANT
SERVICE engineer needed by S.W. Lond. dealers; full TV exp essential; only first-class men interested in their own future with a directorship in the business need apply; applicants must write giving full details of prev. exp. etc.—Box 1150. [1930]

SENIOR draughtsman required to work with minimum supervision on electric switches and devices, plastic/porcelain moulding, press-work, etc.; good salary for experience: West London area; 5-day week; canteen.—Write, giving full details of experience, to Box 8925. [1672]

AIRCRAFT radio mechanics skilled in workshop practice or aircraft installations to work at Stansted Airport, Essex; hostel accommodation available; minimum hourly rates 3/9.—Write to the Personnel Manager, Skysways of London, 7, Berkeley St., W.1. [0019]

EXPERIENCED radio testers and inspectors required for production of communications and radio apparatus, also instrument makers, wiremen and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0238]

TECHNICAL writer.—Decca Radar, Ltd., invites replies from young engineers interested in the preparation of technical literature concerning radar and associated systems; a sound knowledge of electronic techniques is essential.

APPLICANTS must be of British nationality and completed their National Service.—Replies to J. M. Decca Radar, Ltd., Research Laboratory, 2, Tolworth Rise, Surbiton, Surrey. [1818]

FERRANTI, Ltd., Edinburgh, have a vacancy in their laboratories for a first-class engineer for interesting development work in connection with a control project involving digital computers, data recording and servo-mechanisms.

APPLICANTS should possess a B.Sc. degree and experience in some, or all, of these fields.

PERMANENT appointment, offering excellent prospects in a pleasant and desirable part of Scotland. Staff Pension Scheme.

APPLY, giving full details of training, qualifications, and experience in chronological order and quoting Ref. E/AL, to the Personnel Officer, Ferranti, Ltd., Crewe Toll, Edinburgh, 5. [1889]

TELEVISION engineer required by leading radio and television dealers for servicing department at Halewood, Birmingham; must be fully qualified; rates in excess of R.T.R.A. min. will be paid; write, giving full details of experience, age, etc., to—Box 1029. [1881]

AUDIO frequency service engineer for Radyne R.F. equipment in Midlands, must have had previous experience in this or similar type of work.—Apply by letter, giving fullest particulars, including salary expected, to T. W. Wall & Son, Ltd., 79, Church Rd., Moseley, Birmingham, 13. [1884]

LAYOUT engineers required for design of industrial electronic equipment; excellent opportunities for capable men to progress in rapidly expanding organisation.—Apply Technical Director, Winston Electronics, Ltd., 1, Park Rd., Hampton Hill, Middx. Tel. Molesley 2885. [1884]

FERRANTI, Ltd., require electronic equipment testers, radio diagnosticians and radio mechanics for their North and South Manchester factories; standard rates of pay and excellent working conditions.—Write giving age and details of experience, to Labour Manager, Ferranti Ltd., Moston, Manchester, 10. [1728]

ENGINEER with layout and small-batch production experience required to initiate and take charge of small assembly section for medical electronic equipment.—Write fully stating age, experience and salary required, to Box 86, Aldridge Advertising, 1, Whitefriars St., London, E.C.4. [1836]

DEVELOPMENT engineer required by established firm manufacturing wire-wound components and electronic equipment; ability to work on own initiative essential; write, giving details of age, experience and salary, to: Dagnall & Kendall, Ltd., Cranfield, Nr. Bletchley, Bucks. [1895]

BERRY'S (SHORT WAVE), Ltd., have vacancy for counter sales assistant; must have had previous retail experience of quality amplifiers and tape recording equipment; also bright lad for general work.—Write only stating age, past experience, salary required, to 25, High Holborn, London, W.C.1. [1835]

RADIO and television engineers required by well-known manufacturer, interesting and varied work for skilled men, good rates of pay and conditions, five-day week, canteen facilities, pension scheme, employment Perivale district.—Write, giving details of experience, etc., to Box 0596. [1811]

TELEVISION aerials.—Vacancies occur with well-known manufacturers for practical technical riggers capable of supervising multi-point installation in London and provinces, good pay and prospects for suitable applicants, must hold clean driving licence and be prepared to travel.—Box 0595. [1810]

E.M.I. Eng. Dev., Ltd., have an interesting progressive vacancy for a circuit engineer to work with a small section of transistor applications, applicants should have at least five years' experience on circuit development associated with wide range of electronic equipment.—Write, giving full details and salary required, to ED/135, Personnel Dept., E.M.I. Eng. Dev., Ltd., Hayes, Middx. [1821]

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MAINS TRANSFORMERS (NEW), input 200/250 volts in steps of 10 volts, output 350/0/350 volts, 180 m/amps, 4 volts 4 amps, 50 volts 3 amps, 6.3 volts 4 amps, 45/- each, post 1/6; another 350/0/350 volts 180 m/amps, 6.3 volts 8 amps, 0/4/5 volts 4 amps, 45/- each, post 1/6; another 500/0/500 volts 150 m/amps, 40 volts 4 amps C.T., 6.3 volts 4 amps, C.T., 5 volts 3 amps, 47/6 each, post 1/6; another 425/0/425 volts 160 m/amps, 6.3 volts 4 amps, C.T. twice 5 volts 3 amps, 47/6 each, post 1/6.

MAINS TRANSFORMERS (NEW), suitable for spot welding, input 200/250 volts, in steps of 10 volts, output suitably tapped for a combination of either 2/4/6/8/10 or 12 volts 50/70 amps, 95/- each, curr. 7/6.

MAINS TRANSFORMERS (NEW), 200/250 volts input in steps of 10 volts, output 0, 6, 12, 24 volts 6 amps, 42/6 each, post 1/6. Another as above but 10-12 amps, 55/- each, post 1/6; another, as above, but 25/30 amps, 75/- each, carriage 3/6; another, input as above, output 0/18/30/36 volts 6 amps, 47/6 each, post 1/6.

MAINS TRANSFORMERS, 200-250 volts input, output 400/0/400 volts, 280 m/amps, 6.3 v. 8 a., 2 v. 3 a., 5 v. 3 a., 4 v. 2 a., 4 v. 2 a., the last two heaters insulated at 8,000 volts, 85/- each; another 200/230 volts input, output tapped 0, 9, 18 volts at 4 amps, 25/- each, post 1/6. MAINS TRANSFORMERS, input 180/250 volts, output 435/0/435 volts, 250 m/amps, 6.3 volts 10 amps, 6.3 volts 8 amps, 6.3 volts 8 amps, 5 volts 6 amps, 65/- each; another, input as above, output 4,000 volts 24 m/amps, 4 volts 1 amp, 2 volts 2 amps, 45/- each.

MAINS TRANSFORMERS, 200/250 volts input, output a combination of 6, 12, 18, 24, 30, and 36 volts at 6 amps, 45/- each, post 1/6. MAINS TRANSFORMERS, input 200/250 volts, output 45/50 volts, 70 amps, suitable for arc welding, £15 each; another 70 volts, 50 amps, £15 each.

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ROTARY TYPE RESISTANCES, stud S/arm type 10 ohms 3 amps, 17/6 each. (Other types in stock, please ask for quotation.)

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ELECTRONIC engineers to inspect and service A.A. equipment; salary £550 (age 28 or over) and £20 to £628; generous paid annual leave.—Application forms from O.C. 1 A.A. Group Wksp. R.E.M.E., Shrapnel Barracks, London, S.E.18. [1869]

DEVELOPMENT engineer (electronics) required for work on radio communications and sound recording equipment; London area; practical experience essential; ample scope for advancement.—Apply in writing, giving age, previous experience and salary required, to Box 1005. [1868]

DRAUGHTSMAN wanted for a small drawing office engaged in design of electronic equipment; good opportunity for man with initiative in rapidly expanding organisation.—Apply Technical Director, Winston Electronics Ltd., 1 Park Rd., Hampton Hill, Middlesex. Tel. Molesey 2953. [1846]

ELECTRONIC Engineer with experience of special amplifier and test equipment design, degree desirable but not essential, salary according to qualifications and experience.—Apply Personnel Officer, Louis Newmark, Ltd., Prefect Products, Stafford Rd., and Purley Way, Croydon, Surrey. [1945]

ASSISTANT transformer designer required by established firm manufacturing wire-wound components and electronic equipment; the position offers excellent prospects for a keen engineer; write, giving details of age, experience and salary, to: Dagnall & Kendall, Ltd., Cranfield, Nr. Bletchley, Bucks. [1894]

TECHNICAL Writer, experienced in compilation matter for publication in Radio and Television Service Manual, Instruction leaflets, etc., required for engineering department; reply stating age, qualifications, etc., to Employment Manager, Ferguson Radio Corporation, Ltd., Gt. Cambridge Rd., Enfield, Middlesex. [1864]

ENGINEER required to undertake the development of electronic instruments; the successful applicant must be capable of working substantially on his own initiative; salary will be in accordance with qualifications and experience; degree or equivalent preferred.—Apply in writing to Advance Components, Ltd., Back Rd., Shernhall St., London, E.17. [1909]

A GOOD opportunity exists for a man with a common sense, patience and organising ability to take charge of a small but expanding section in modern factory in N.W. London; work is concerned with assembly of precision electro-mechanical products and offers permanent employment and a good salary.—Write Box W.W.701, c/o, 191, Gresham House, E.C.2. [1869]

DECCA RADAR, Ltd., have vacancies for men with a sound knowledge of radio and/or radar as installation engineers, the work is interesting and varied and in all cases specialist training given.—Write in the first instance, giving details of past experience and salary required, to the Manager, Decca Radar, Ltd., 50, Southwark Bridge Rd., London, S.E.1. [1813]

JUNIOR electronics engineer required to assist in the development of an analogue computer; previous development experience is essential and a knowledge of d.c. amplifiers would be advantageous; applicants, who should be 21-24 years of age and hold the Higher National Certificate, should write, quoting full particulars.—The Personnel Officer, E. Cowes, Isle of Wight, ref.: W.W.C.3. [1719]

THE ENGLISH ELECTRIC Co., Ltd., want a senior graduate familiar with computing techniques (analogue and/or digital) to undertake development work on high priority defence project; must possess initiative and originality; permanent progressive post; salary according to age and experience.—Applications, quoting ref. 862E, to Dept. C.P.S., 336-7, Strand, London, W.C.2. [1754]

SENIOR and junior engineers required for responsible work in radio and television laboratories; applicants for senior position should be able to undertake development work with minimum supervision; excellent conditions and salary available for applicants who are accepted.—Apply in first case to Personnel Manager (Dept. R.D.), McMichael Radio, Ltd., Wexham Rd., Slough. Applicants must be of British nationality. [1527]

McMICHAEL RADIO, Ltd., require senior and junior engineers in their equipment division laboratory at Slough; training and experience in the field of applied electronics (including communications) and experience of working with Government departments at the chief qualifications required.—Write, stating age and full details of training, qualifications and experience, to the Chief Engineer, Equipment Division, McMichael Radio, Ltd., Slough, Bucks. [10198]

ELECTRONIC engineers interested in the testing of radar and microwave equipment in a new production establishment, are required by an old-established leading electrical company; sound technical knowledge and a wide experience of testing techniques and equipment are necessary; positions of responsibility are available to suitably qualified applicants, with further openings and scope for advancement arising in a South Coast area; salary will be according to experience and ability.—Please reply, giving full details of experience, qualifications and age, to Box 1116. [1908]

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PARTRIDGE TRANSFORMERS, Ltd., have a vacancy for post of chief engineer; applicants must possess university degree or equivalent and have had considerable experience in the design and development of all types of audio and power transformers.—Written applications to Managing Director, Partridge Transformers, Ltd., Tolworth, Surrey. [1813]

EXPORT manager required by leading firm of electronic components manufacturers to work under jurisdiction of sales manager; essential qualifications, similar previous experience, working knowledge of foreign languages, and thorough knowledge of radio and television from the manufacturing angle; must also be free to travel; write full details and salary required.—Box 0692. [1817]

TEST gear design engineers and maintenance engineers required with practical experience of this class of work, based on sound knowledge of electronic principles; these vacancies are permanent and progressive; a company pension scheme in operation; London area.—Please write in confidence, quoting reference WW/758, giving full details of qualifications, to Box 0631. [1816]

FIRE-SETTERS required for electronic valve production unit with at least two years' experience (valves or lamps) on sealing-in machines and other automatic glass working equipment; all applications will be treated in confidence.—Write stating age, salary required and giving details of experience to Personnel Officer, Ericsson Telephones, Ltd., Beeston, Nottingham. [1854]

EXPERIENCED electronic technicians required to work on Service radar and gun control equipments in the North-west, West Midlands and South Wales areas, in the grade Technical Assistant Grade III; salary at age 28 approximately £520 p.a. £420—£600 p.a.—Apply, quoting age, qualifications and experience to ADME, HQ 4 AA Group, Peninsula Barracks, Warrington. [1855]

ELECTRONICS Test Engineer; a vacancy exists for an engineer to take charge of a new test room dealing with final testing of electronic and microwave instruments, in conjunction with design laboratories; salary in the range £500 to £650 at start depending on qualifications and experience.—Apply to Chief Engineer, W. H. Sanders (Electronics), Ltd., Bedwell Lane, Stevenage, Hertfordshire. [1843]

BUSH RADIO, Ltd., require experienced senior design draughtsman for work in connection with development on commercial radio and television receivers and electronic units for these services; apply giving full particulars of age and experience to the Personnel Manager, Bush Radio Ltd., Power Rd., Chiswick, W.4. Tel. Chi. 6491. Interviews may be arranged for Saturday mornings. [1804]

DRAWING office staff required, draughtsmen and drawing office clerk, to take charge of print room and drawing office records, for a well-established firm, situated within half an hour of Waterloo Station; draughtsmen should have workshop experience and preferably a knowledge of electronics; good salary paid to suitable applicants; 5-day week.—Apply D.O. Box 1709, 15, Hill St., London, W.1. [0246]

FACTORY engineers are required for Cathode Ray tube factory in North London area; previous knowledge and experience desirable but not essential; applicants should have at least Higher National Certificate in Electrical Engineering and some knowledge of chemistry; they must be capable of investigating and solving manufacturing problems on their own initiative.—Box 0982. [1867]

ELECTRONIC engineer required by a large food organisation centred in London, for the construction and maintenance of specialised factory electronic equipment, and to assist in the development of new apparatus; applicants should possess initiative and be capable of working without undue supervision; salary according to age and experience.—Write Box W.W.785, c/o 191, Gresham House, E.C.2. [1937]

JUNIOR test assistant with some telecommunication knowledge required by Company, S.E.10; a young man studying for City and Guilds Telecommunications Course in Engineering would be considered; experience desirable but not essential; all welfare facilities; 5-day week; salary according to age and qualifications.—Apply Staff Officer, Telcon Works, Greenwich, S.E.10. [1893]

HIGH-DEFINITION FILMS, Ltd., require Junior Engineers and Technical Assistants for development and operation of studio electronic equipment; preference will be given to applicants who have had previous experience in the development and/or operation of television studio equipment; candidates must have completed their National Service.—Write, giving full details, to Personnel Manager, 98, Highbury New Park, N.5. [1926]

BELLING & LEE, Ltd., Cambridge Arterial Rd., Enfield, Middlesex, require research assistants in connection with work on electronic components, fuses, interference suppressors and television gases; applicants must be graduates of the I.E.T. or possess equivalent qualifications, together with similar laboratory experience; salary will be commensurate with previous experience; 5-day week; contributory pension scheme.—Applications must be detailed and concise, and will be treated as confidential. [0230]

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ELECTRONIC engineer, over 28 years of age, with degree in physics or engineering, and some practical mathematical ability. At least 6 years' experience in a development laboratory working on problems involving VHF techniques and subminiaturization. Must be familiar with problems of design for production, in small or large quantities, of small complex electronic units, and able to lead a small team of engineers and draughtsmen. Applicants would give full details to ED/134, Personnel Dept., E.M.I., Eng. Div., Ltd., Hayes, Middx. [1822]

BRITISH EUROPEAN AIRWAYS require engineers for overhaul and maintenance of electronically operated flight simulators at London Airport; applicants should possess thorough knowledge of electronics and have had maintenance experience on apparatus using servo-mechanisms actuating repeater instruments; commencing salary between £10/19-£13/19 p.w. according to qualifications. Written applications to Personnel Officer, Flight Operations, B.E.A., Keyline House, Ruislip, Middlesex. [1806]

ENGINEERS with radio and radar installation and maintenance experience are required for interesting work which will involve working in various parts of Great Britain; applications will be welcomed particularly from ex-Servicemen who have had extensive experience. In this field these positions offer good prospects in a large flourishing company which operates a generous pension scheme. Applications, which will be treated in confidence, should be addressed to Box WW 526, L.P.E., 110 St. Martin's Lane, W.C.2. [1946]

ELECTRONIC engineer required by new division of prominent engineering company in Northern Ireland for development work on guided weapons and other projects; degree or equivalent in electrical engineering or physics, with good practical experience, preferably of d.c. amplifiers, electronic computation, pulse techniques, or miniature equipment; good salary and prospects for man with initiative; pension scheme, assistance with housing.—Send full particulars of age, qualifications and experience, and salary required, quoting E.E.2, to Box 8888. [1863]

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ELECTRONIC technician required to construct and maintain electronic equipment; duties are not solely of this nature as unit is small; satisfactory qualifications are, for example, National Service together with five years' experience in the electronic field, or Inter. B.Sc. together with ten years' experience; good prospects exist for further education, formally or informally; minimum salary £450 p.a.—Reply, stating age, qualifications and experience, to Dr. H. D. Darcus, M.R.C. Un. Department of Anatomy, University Museum, Oxford, by November 9, 1953. [1944]

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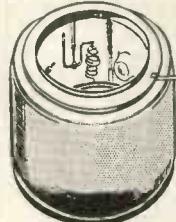


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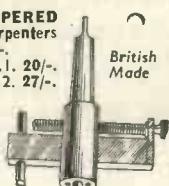
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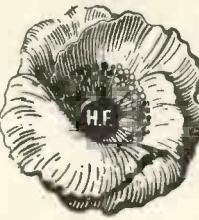
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