

AUGUST 1957

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# Wireless World

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**Radio · Television**



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# Wireless World

ELECTRONICS, RADIO, TELEVISION

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AUGUST 1957

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## Transistor

## Base-to-Emitter Voltage Compensation



It is well known that satisfactory transistor performance can only be obtained by restricting the variation of collector current with temperature. Under the worst conditions of operation, stabilisation of the working point is also essential to prevent thermal runaway. The most widely used method of d.c. stabilisation consists in deriving the base bias from a potential divider connected across the base in conjunction with an emitter resistor. One possible refinement is to give the emitter resistor a positive temperature coefficient. This method is of particular importance in circuits using power transistors, such as the OC16, with low impedance bias supplies.

#### Temperature Dependence of Base-to-Emitter Voltage

The increase in collector current with temperature arises in part from the temperature dependence of the base to emitter voltage. Under certain conditions, and particularly with power transistors, this increase may become more important than that produced by the temperature dependence of the collector leakage current. Referring to the figure, the base to emitter voltage which can be measured on an actual transistor exists between b and e, and itself depends on the internal base resistance,  $r_{bb'}$ , and the voltage between  $b'$  and e. This latter voltage,  $V_{b'-e}$ , changes with temperature at a rate which is theoretically the same for all transistors, and is equal to  $-2.5\text{mV}/^\circ\text{C}$ . The minus sign indicates that  $V_{b'-e}$  decreases with temperature.

#### Emitter Resistors of Pure Metal

The change of  $V_{b'-e}$  with temperature can be compensated by using temperature sensitive elements in the circuit. Thermistors having a negative temperature coefficient can be used in the bias circuit, but as their temperature coefficient varies with temperature, it is not possible to obtain exact compensation. On the other hand, if the emitter resistor is wound from wire made of some pure metal, such as copper or nickel, it will have a positive temperature coefficient and compensation for changes in  $V_{b'-e}$  can be obtained over

the entire temperature range.

For exact compensation, the voltage across  $R_e$  should have an equal and opposite coefficient to  $V_{b'-e}$ , that is, the voltage across  $R_e$  should increase by  $2.5\text{mV}/^\circ\text{C}$ . Pure metals such as copper and nickel have temperature coefficients of about  $+0.004/^\circ\text{C}$ . If the value of  $R_e$  is chosen to give a voltage drop of about  $630\text{mV}$ , this voltage drop will increase by about  $630 \times 0.004 = 2.5\text{mV}/^\circ\text{C}$  as required.

If the drop is higher, or if in fact  $V_{b'-e}$  decreases by less than  $2.5\text{mV}/^\circ\text{C}$ , the circuit will be overcompensated. However, overcompensation is not a disadvantage as it helps to stabilise against the collector current changes produced by the temperature dependence of the collector leakage current.

#### Advantages

In general, an emitter resistor having a positive temperature coefficient reduces variations in collector current but does not directly improve the stability of the circuit with respect to thermal runaway, because the emitter resistor reacts to changes in ambient temperature, not junction temperature.

Signal handling capacity is reduced to a smaller extent by any rise in ambient temperature.

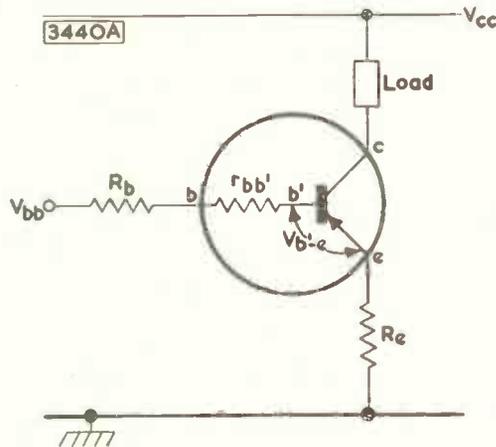
The collector dissipation does not rise so much with temperature. It is therefore possible to increase the dissipation by 10 or 15%, or to permit a higher ambient temperature, with any given heat sink: under these conditions the runaway stability remains unaltered. Alternatively, a somewhat smaller heat sink suffices: the runaway stability then deteriorates somewhat and better circuit stabilisation is required.

Mounting the positive temperature coefficient resistor on the heat sink makes only a negligible improvement to the runaway stability and may actually be inadvisable because of the heat dissipated in the emitter resistor itself. It would, however, reduce the current changes which occur when first switching on.

#### Heat Sinks

Transistors with higher dissipation ratings, such as the OC72 and OC16, have to be fitted with some sort of metal cooling fin or mounting plate which serves to conduct away, and radiate away, heat generated in the transistor itself.

Although these heat sinks operate on such a simple principle, it becomes necessary at the power rating of the OC16 to specify the dimensions, material, and the gauge and finish of the metal plate rather exactly. Usually the chassis can be designed to be the heat sink, but, if the chassis gets hot because of the presence of valves or other heat generating components, a separate sub-chassis may be necessary.



It is regretted that the circuit shown in Fig. 2 on this page of the July issue was incorrect. The electrolytic capacitor C should be omitted. There should be a single load resistance Z as shown in Fig. 1 and the top of the resistor  $R_1'$  should be connected to the collector of  $Tr_1$  (point X).



## Endurance Test

WHEN the International Geophysical Year began last month an SWI (Special World Interval) was already in force and observers in all parts of the world were hard at work measuring the effects of large solar flares on the ionosphere, the earth's magnetic field, the aurorae and many other phenomena. The sun had collaborated in confirming the choice of timing of the experiment, the world telecommunication network (tested by practice alerts since January) went "operational" for the first time, and all the months of elaborate preparation for this massive international scientific experiment gave place to the second phase, namely that of observation.

Much of the information we have about the constitution of the ionosphere is obtained by radio pulse reflection at vertical incidence. The number of stations making this type of continuous automatic measurement has been trebled and particular attention is being paid to the regions near the earth's geomagnetic equator. The basic information given by radio sounding methods is the time taken for the pulse to go and return through a heterogeneous stratified dielectric, and although much has been deduced from studies of the behaviour of pulses of different frequency, the direct physical measurement of electron density and dielectric constant has only recently been extended by rockets above the 20-mile limit of balloons. During the IGY there is to be a much-increased expenditure of rockets, including at least twelve rounds of the specially designed "Skylark" from the Woomera range.

Studies of the turbulence of the upper atmosphere and the measurement of drifts in the ionosphere, hitherto made from observations of the scintillation of noise from radio "stars," will, if all goes well, be given an element of greater precision when the fixed-frequency, point-source transmitters of the artificial satellites come into operation. Those stations which are fortunate enough to be able to plot the track of the satellites visually, as well as by radio methods, will have a double check on the refracting properties of the ionosphere. It is confidently expected that signals will be heard in this country from the

American satellite, though its power will be only of the order of milliwatts, and plans have been made to follow its course with the Jodrell Bank telescope and by means of a special interferometer to be set up and operated by the Royal Aircraft Establishment at Lasham aerodrome in Hampshire. At this distance and with a low-elevation propagation path through the atmosphere the apparent track of the satellite will show measurable deviations from its true velocity. From these deviations it is hoped to learn something more of irregularities of the ionosphere and their variation with height.

Which turns our attention to the third and most important phase—the reduction and digestion of results. This will not begin in earnest until the end of IGY in 1958, when copies of all the figures will be sent to the World Data Centres in the U.S.A., U.S.S.R. and elsewhere.

The IGY already stands as a monument to Man's ability to organize on an international scale, and will require of him qualities of steadfastness and concentration in making what will often be dull routine observations. In this country, Sir David Brunt, Secretary of the Royal Society, has been intimately concerned with the detailed preparation of the British contribution, including responsibility for the establishment of the Halley Bay observatory in the Antarctic, and we can wholeheartedly endorse his hope, expressed at a recent conference, that we shall be given the wit and perseverance, when the time comes, to make good use of the results of all this collective effort. Some lines of enquiry are already laid down with reasonable precision and have as their object the filling in of blank areas of world maps of known geophysical phenomena by the addition of data from strategically placed new observing stations. Others, deriving from the use of new tools for measurement, such as the rocket and the artificial satellite, will extend the range of measurement and confirm or refute those of our ideas which at present rest only on hypothesis. But the hidden treasure of new knowledge can be revealed only by painstaking sifting and imaginative correlation of apparently unrelated data.

# Colour Television Marks Time

RESEARCH TRENDS FROM THE PARIS INTERNATIONAL SYMPOSIUM

**A**PART from a new French colour system which may prove a competitor to the N.T.S.C. system on 819 lines, *Wireless World* did not find anything at the Paris Symposium to indicate a turn in the tide away from the broad principles and techniques of American colour television. It is true that development is going ahead on a simple and cheap receiver display device to make colour television an economic possibility for the ordinary viewer. And if, as seems possible, this turns out to be something like the single-gun beam-switching or -indexing tubes, it may recommend a transmission system somewhat different from the American pattern. But no hint of this came out in Paris. Rather we found that most of the papers described researches which either lent direct support to the N.T.S.C. system or were neutral on this point.

It was perhaps significant that the French company Laboratoires d'Electronique et de Physique Appliquées, which described and demonstrated its own "double-message" system, also described and demonstrated 819-line and 625-line versions of the N.T.S.C. system. (Under the particular viewing conditions and with the display equipment available it was difficult to see much difference between any of them.) Moreover, it appears that the powerful Philips organization in Holland, which has devised its own "two-subcarrier" system, is now virtually won over to the N.T.S.C. system. In a paper describing their experiments with a 625-line version, they stated the definite opinion that such a system would be the best one for introduction in Europe.

## Bandwidth Requirements

A question which seemed to concern a great many contributors to the Symposium was the bandwidth of colour television signals—particularly with regard to the subjective requirements of the viewer in picture sharpness and clarity. Here the general view seemed to be that the bandwidth of the luminance, or brightness, signal could be considerably smaller than that generally laid down for existing monochrome transmissions. For example, a paper from the Sylvania-Thorn company (Britain) described subjective viewing tests which found the optimum bandwidth for 405-line monochrome pictures, viewed at ten times the picture height, to be only 1.5 Mc/s (and for 625-line pictures only 3.0 Mc/s). In colour pictures a B.B.C. communication stated that if the chrominance component is given our full 3-Mc/s bandwidth, then the luminance component can be somewhat degraded before any loss of sharpness becomes visible. An R.C.A. paper mentioned that some statistical redundancy in American television pictures can be removed simply by passing the video signal through a 2-Mc/s low-pass filter and the result is still very acceptable. All this was confirmed, said a representative of one British receiver manufacturer, by the fact that the

buying public do not seem to show any preference for commercial receivers with wider bandwidths.

The point here seems to be that in the N.T.S.C. system there is really no need for the colour sub-carrier signal to share the same band as the brightness (monochrome) signal because the viewer's eye is unable to perceive the brightness information over the shared part of the video spectrum. In other words the brightness signal could be band-limited at the optimum point so that the two signals would not overlap and there would be no sub-carrier interference problem. It is well known, of course, that American monochrome receivers do in fact achieve this effect when displaying compatible N.T.S.C. pictures by virtue of their somewhat restricted video bandwidths.

## High Definition Pictures

The idea was illustrated in another way by the demonstration of the French 819-line N.T.S.C. system, with its exceptionally wide 10-Mc/s monochrome bandwidth. Glancing at the compatible picture on a black-and-white receiver, one was almost impelled by the extreme fineness of detail to view it at close quarters—much closer than ten times the picture height—but then the disadvantage of the wide bandwidth became immediately apparent in the marked visibility of the colour sub-carrier dot pattern.

Incidentally, it was perhaps significant to hear two representatives of British television broadcasting privately, enthusing over the French 819-line monochrome pictures, which at their best are undoubtedly superior to the best we can do on 405 lines and 3-Mc/s bandwidth. On the other hand, it was observed that the higher definition does not seem to offer much advantage in colour television—particularly when the R.C.A. tri-colour tube with its restricted resolution of 400 lines is used as a display device.

Indeed it is true to say that most of the existing colour display devices leave much to be desired in general performance, quite apart from the question of cost. A comparative paper from Hazeltine in the U.S.A. put the single-gun beam-switching and beam-indexing tubes first in order of performance, followed by the three-gun focus-grid tube, the three-gun shadow-mask tube and finally the three-tube projection system. This was also roughly the order of increasing cost. A representative of Pye, however, disagreed with the low performance assessment of projection systems. Describing a large-screen projection equipment using three Schmidt-type optical systems, he mentioned that the problem of accurate registration had been largely overcome by making all adjustments mechanical in form so that any drifts resulting from electrical controls were eliminated. This equipment used large dichroic mirrors for optical superimposition, but another speaker said he had used side-by-side Schmidt systems successfully (with

optical correction) and thereby gained in light output, definition and contrast ratio.

Another problem in registration, but this time in direct-viewing colour c.r. tubes, is to get the electron beam to fall accurately on the required phosphor at all points without energizing adjacent colours. An improved tube described in a Philips paper gave a "post focusing" action between a mask (comparable with a shadow mask) and the screen. The focusing was obtained by slits in the mask of almost elliptical shape and a reducing voltage gradient between the mask and screen. Because the holes in the focusing mask were larger than in the R.C.A. shadow mask, a considerable improvement in transparency was obtained (actually a transparency of 60 per cent), but since the screen potential was reduced by a factor of 4 there was not an equivalent gain in brightness. However, further improvements were being made by the introduction of a second mask.

A difficulty comparable with registration is the accurate matching of the gamma characteristic in the three electron guns of a tri-colour c.r. tube or in three separate projection tubes. Discrepancies can cause errors, particularly in the reproduction of brightness information. A subjective viewing test described in a Mullard paper was designed to discover what differences were permissible between the transfer characteristics of the three primary-colour channels of a colour system, and this led to the conclusion that the tolerances on tube manufacture would be very tight indeed.

At the transmitting end, there are equivalent difficulties in the registration and matching of the three camera pick-up tubes, and any discrepancies are particularly noticeable in the quality of the composite black-and-white picture. A paper from Telefunken (Germany) emphasized the desirability of using just a single tube with a three-colour filter to avoid this situation but here of course the optical and instrumental difficulties are enormous. The photoconductive pick-up tube was said to have great possibilities for three-colour cameras, and a new type using a layer of lead monoxide for the light-sensitive element was described in another Philips paper. This tube was characterized by its high sensitivity, fast response at low light levels and negligible dark current. The usual problem of storage in photoconductive tubes was overcome because the decay of the signal after interruption of light was primarily determined by the discharging scanning beam and not by the inherent inertia of the photoconductor itself.

### Receiver Performance

It was disappointing to hear no results of the B.B.C. experimental transmissions on the N.T.S.C. system, but one British receiver manufacturer (G.E.C.) described subjective viewing tests which took advantage of these transmissions to discover permissible tolerances in colour receiver performance. In particular the phase stability of the local colour reference oscillator is important because it controls the hue of the displayed colours. Deliberate phase changes were made gradually to simulate drift and it appeared that the more discriminating viewers would not tolerate more than a  $\pm 5^\circ$  variation in phase angle. At the same time, there was a range of adjustment as wide as  $30^\circ$  over which they were willing to actually set the reference phase control

for optimum colour reproduction. Viewers' ideas of what constituted pure white on the screen were somewhat varied, and changed with the room lighting. The results, moreover, were not centred round the official Illuminant "C" on the C.I.E. chromaticity diagram.

The G.E.C. contributors had also investigated the subjective effects of noise in colour television receivers. Another kind of interference, resulting from multi-path reception, was discussed in a paper from the Swiss P.T.T., who had taken advantage of the Swiss mountains to study the effect of this phenomenon on the frequency spectra of monochrome television signals. A swept frequency oscillator was used at the Band-I transmitter and the disturbances resulting from the multi-path propagation were assessed statistically from measurements at various domestic receivers. It was concluded that for colour television the narrower the bandwidth of the colour signal the better. These effects, of course, are likely to create quite a problem in any future colour services in Bands IV or V.

For colour television recording, a method using a lenticular film was described in a paper from the Eastman Kodak Company. The film has a fine cylindrical lenticular pattern on one side and its emulsion on the other. Three primary colour component images are directed on to the lenticular surface from different angles and they appear on the emulsion as three separate sets of interlaced thin bands—the exposure in each case corresponding to the primary colour content. One big advantage is the speed and simplicity with which the film can be developed and copies can be made.

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## Electronics in Automation

Viewpoint on the Brit. I.R.E. Convention

**T**HE introduction of digital computers into process control systems was probably the most significant thing discussed at this year's Brit. I.R.E. Convention. Significant, because it is a definite step in the direction of Norbert Wiener's imaginative forecast of ultimate automation to which we drew attention two years ago\*—the overall control and co-ordination of complete factories by electronic systems comparable with large-scale digital computers.

Hitherto digital computers have been isolated in laboratories and business offices and used merely as aids to human calculation. Even when employed for production planning in factories they have needed human supervisors to feed in and take out information. But there are signs of a change in this situation. Already engineers are beginning to explore the possibility of incorporating digital computers directly into control loops so that more variables can be taken into account than by ordinary servo-mechanisms.

Many people think that digital computers are

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\* "The Automatic Factory," *W.W.* August 1955.

inherently too slow for operation in "real-time" control systems. This idea was refuted by one speaker at the Convention who described a "real-time" digital computer which received its input information from shaft rotations (coded into digital form) and gave an output which directly operated an electro-hydraulic servo-mechanism. The "real time" in this instance did not mean instantaneously but extremely fast—the process of addition, for example, taking only 40 $\mu$ sec.

This high speed was attained by using the "parallel" mode of operation (all digit pulses of a number advancing simultaneously on separate wires instead of in sequence on one wire). The programme of instructions was built into the connections and very little storage capacity was required because of the direct manner of receiving, processing and despatching the numerical data. High-frequency transistors were used for the logical circuits and the whole machine occupied only about one-third of a cubic foot.

The technique of feeding information directly into a digital computer from measuring instruments, instead of via the medium of punched cards on tape, was mentioned by another speaker, who described how an existing business machine (the Elliott "405") was adapted for this purpose. The output, incidentally, was used to operate an analogue type of plotting device.

### Conveyer-belt Systems

In some applications, the "real time" could mean something really slow—for example, in the control of manufacturing processes based on conveyer belts. One of the Convention papers discussed the control of a conveyer-belt system in which the products on the belt could be varied in design (e.g., different paint colours on motor-car bodies) according to the day-to-day fluctuations in demand from customers. In the control apparatus the slow movement of the conveyer belt was simulated by a storage medium moving equally slowly past a complexity of "reading" and "writing" heads connected to the digital computer. Numerically coded information about the items on the belt was "written" by the computer at corresponding places on the storage medium. As a particular item reached a "decision point" on the belt, the stored information on what was to be done at that point came to a reading head, which gave out the appropriate signals for actuating the process.

Another paper considered the use of computers in control systems applied to continuous-process chemical manufacturing plants. Here the object was to keep the plant output as near as possible to a desired specification. The outputs from local control loops already existing in the plant would be continuously monitored in a scanning sequence and compared in the computer with the desired values for the product. According to the results, the computer output would be used to apply correcting signals to the control-loop equipment. It was felt that electronic circuits using such components as transistors and cryotrons would be desirable in this application so that voltages could be kept to low values for safety reasons.

A particular feature of computers used for this type of production control would be a multiplicity of input and output devices distributed about the fac-

tory. One speaker went further and suggested that the computing circuits themselves would probably have to be decentralized and distributed in a similar manner.

In order to feed information from measuring devices into digital computers it is usually necessary to convert an analogue type of indication into digital form. When, say, the angular movement of a shaft has to be measured, this can easily be done by using a commutator disc or "digitizer" on the shaft. When the output of a measuring transducer is in the form of a varying voltage, however, it is necessary to use an all-electronic converter. A high-speed electronic converter described in one paper was basically a servo-mechanism using a non-linear feedback element. The voltage to be measured was compared with a voltage analogue of a number held in a register. Any resultant error signal was used to gate digit pulses into the register in such a way that the error was reduced to zero. Thus the number in the register increased and decreased in accordance with the input voltage variations.

A somewhat sophisticated digital measuring technique described in another paper gave its output as a ratio, or as a percentage of some reference value. For this, independent sources of pulses were counted and then compared. The device was said to have applications in revolution counting and tachometry and where comparative measurements have to be made between driving and driven apparatus. Another rather complex type of digital measurement under discussion was the evaluation of correlation functions from statistical operating data taken from different points in a control system. This could be used, for example, for determining the transfer function of a control system while it was still in operation. Correlation computers are traditionally analogue devices, but greater accuracy can be obtained from digital methods, and a digital machine was described which accumulated the sum of products of pairs of numbers for this type of evaluation. It operated in the decimal scale, using Dekatrons for the arithmetic circuits. Working on pairs of two-digit decimal numbers, it could accumulate 100 products per minute.

### Analogue Techniques ?

The emphasis on digital computers in control loops is perhaps rather unexpected when analogue computers seem at first more obviously suited to the purpose. Analogue computers do have certain applications in continuous-process control loops, but, as one paper pointed out, when the manufactured product consists of a number of items, each with a particular identity, then these machines are quite inappropriate. It is the arithmetical accuracy, ability to perform logical operations and facility for storage of data and instructions which make the digital machine more suited to the complex organization of overall control.

Many other aspects of automatic control and inspection were discussed—machine-tool position control, ultrasonic inspection, pH control, fluid density measurements, to name just a few. It was, however, rather surprising to find a whole day's session devoted to simulators. If these come under the heading of automation then *Wireless World* gives up all hope of discovering what automation really means.

# WORLD OF WIRELESS

## Medical Electronics

AN international organization to foster the application of electronics to medicine is being formed by Dr. V. K. Zworykin, the well-known American pioneer in electronic television. Interviewed recently by *Wireless World* in Paris, Dr. Zworykin said he felt that electronics should be applied more directly than it has been to the benefit of humanity. Already he has been instrumental in establishing a Medical Electronics Centre in the Rockefeller Institute for Medical Research in New York. The aim here is to develop new electronic techniques for the medical world without any form of commercial exploitation and already several devices have been produced on this basis. Dr. Zworykin has also composed a bibliography of medical electronics literature. He hopes to organize an international conference on the subject, possibly at the time of the 1958 Brussels Exhibition.

## Further Education

WITH the opening of the scholastic year in September, we have received prospectuses of radio and electronics courses from a number of polytechnics, colleges and other bodies.

The Northern Polytechnic, Holloway, London, N.7, has introduced a one-year evening course (one evening a week) covering the audio-frequency engineering syllabus, Part 5, for the Brit. I.R.E. Graduate Exam. The television engineering course (evenings) has been extended to two years and now includes the fundamentals of colour systems.

Among the short courses provided at the South-East London Technical College, Lewisham, S.E.4, is again one on transistors and their applications. The College also has a four-year C. & G. electrical technicians' course in which specialization in industrial electronics is provided.

Details of evening courses on v.h.f. techniques, radar maintenance, and radio and television servicing, plus full-time day courses in telecommunication engineering are given in the prospectus issued by the Norwood Technical College, London, S.E.27.

Courses in preparation for the Radio Amateur Examination are again being provided at the Brentford (Middlesex) Evening Institute, Ilford (Essex), Literary Institute and Northwood (Middlesex) Evening Institute.

## NATIONAL RADIO EXHIBITION

(Earls Court, Aug. 28th—Sept. 7th, 11 a.m.—10 p.m.)

### WIRELESS WORLD SHOW NUMBERS

**September: Show Guide** (publication date August 27th). Plan of the stands with stand-to-stand guide to the exhibits.

**October: Show Review** (publication date September 24th). An assessment of trends in the design of television and sound receivers.

## I.E.E. Premiums

APPROXIMATELY a third of the awards made by the I.E.E. for papers read, or accepted for publication, during the 1956-57 session are for contributions in the radio and electronics field.

Two papers on signal-noise ratio in radio-telegraphy have won for H. B. Law, of the G.P.O. Research Station, Dollis Hill, the Kelvin Premium (£25). Mr. Law also shares the Fabie Premium (£10) with his Post Office colleagues, J. W. Allnatt and E. D. J. Jones, for their paper "Frequency diversity in the reception of selectively fading binary f.m. signals."

For their paper "Fading of long-distance radio signals and a comparison of space- and polarization-diversity reception in the 6-18 Mc/s range," Dr. G. L. Gridale (Marconi's), J. G. Morris (Government Communications Headquarters), and D. S. Palmer (Marconi's), receive the Duddell Premium (£20). Professor H. E. M. Barlow (University College, London), is awarded the Ambrose Fleming Premium (£15) for "Hall effect and its counterpart, radiation pressure, in microwave power measurement." There were also ten extra premiums, valued at £5 each, awarded for papers presented to the radio and telecommunication section.

## Tape Exchanges

DURING the past five years various organizations have been formed, both in this country and abroad, to encourage the exchange between individuals of tape recordings.

World Tape Pals, which issues a bi-monthly publication *Tape Topics*, was founded in Dallas, Texas, in 1952. The British representative is Roger D. Smallwood, of 28, Wrekin Road, Sutton Coldfield.

The only British organization is the recently formed British Amateur Tape Recording Society, of which E. Yates, of 210, Stamford Road, Blacon, Cheshire, is general secretary. The society is issuing a tape-recorded bulletin—playing time, one hour—and also a quarterly tape "magazine" for blind members.

B.A.T.R.S., the Voicesspondence Club (Noel, Va., U.S.A.), and the Australian Tape Recordists Association (Adelaide), are the founder members of the International Association of Recording Clubs.

In addition to the American clubs already mentioned there are Tape Respondents International, United Recording Club, International Tape Worms, and National Tapespinners.

**Amateur Recording Contest.**—Copies of the rules and entry forms for the Concours International du Meilleur Enregistrement Sonor, which is organized by the world's amateur recording associations, are obtainable from H. J. Houlgate, 12, Strongbow Road, London, S.E.9, on receipt of a stamped addressed envelope. Last year two British entries won prizes in this international contest organized to find the best amateur examples of recording techniques for various subjects. The closing date for entries is September 15th.

**I.G.Y. Broadcasts.**—Warnings of expected increases in solar activity and declarations of Special World Intervals, issued by the Royal Society during the International Geophysical Year, are being broadcast by the B.B.C. at 11.03 p.m. in the Home Service after the news and before the weather forecast. These announcements supplement the communications system already established by the World Warning Agency.

**Test transmissions** from the site of the I.T.A. station being built at St. Hilary, Glamorgan., to serve South Wales and the West of England will start on September 2nd. The station will operate in Channel 10 (199.75 Mc/s vision, 196.25 Mc/s sound). The test transmissions will be radiated from an aerial mounted at a height of about 350 feet on the partially completed 750-foot mast, and will have an e.r.p. of about 1 kW. It is hoped to start programme transmissions from the station before Christmas.

**Scottish Television.**—With the opening on August 16th of the B.B.C.'s television station at Rosemarkie, near Inverness, the coverage of the Scottish television service will increase to 93% of the population. The station, which is the B.B.C.'s seventeenth, will operate in Channel 2 (vision 51.75 Mc/s, sound 48.25 Mc/s) with horizontal polarization and an e.r.p. of 1.5 kW. Test transmissions will be radiated from 10.0 a.m. to 1.0 p.m. each weekday from July 31st until the station is brought into service.

**Welsh V.H.F.**—A site at Cynr-y-Brain, near Llangollen, Denbigh, has been chosen by the B.B.C. for the north-east Wales v.h.f. sound transmitter. It is expected that the station will be brought into service by the autumn of next year. It was originally intended to build the station at Corwen, Merioneth., and to transmit only the Welsh Home Service, but it is now planned as a three-programme station radiating on 88.9, 91.1 and 93.3 Mc/s with an e.r.p. of 6 kW.

**Television licences** increased by 68,390 during May bringing the total to 7,118,698. The overall number of broadcast receiving licences in the United Kingdom, including those for television and 312,528 for car radio, was 14,583,256 at the end of May.

**1958 Audio Fair.**—Next year's London Audio Fair will again be held at the Waldorf Hotel, but it will be for five days instead of four (April 18th to 22nd). A day will be reserved for trade buyers, overseas visitors and the press.

**Northern Audio Fair.**—Plans are being made to hold a three-day Audio Fair at the Grand Hotel, Harrogate, from October 25th. Particulars of this show and next year's London fair are obtainable from Audio Fairs, Ltd., 42, Manchester Street, London, W.1.

**Band IV television** from the Television Society's transmitter installed at the Norwood Technical College are being discontinued during the summer vacation, but will be resumed on September 9th. The transmissions, which are radiated on 427 Mc/s, vision, and 423.5 Mc/s, sound, and consist of Test Card C and a tone, will be on Mondays, Wednesdays and Fridays from 7.0 till 9.0.

**Mobile Radio.**—Reference was made at the British Electrical Power Convention at Eastbourne to the growing use of v.h.f. radio-telephony by the electricity supply industry. There are now 99 fixed stations and well over 1,000 mobile transmitters in use by electricity boards.

**Amateur Television.**—There are now 32 amateur television transmitting stations in the U.K. A list of call signs and locations is given in the summer edition of *CQ-TV*, issued by the British Amateur Television Club.

**Circuit details**, or instruction manual, of the Eddy-stone 358X receiver is being sought by a reader. Information should be addressed to M. Osborne, c/o The Editor.

**Electronic Telephone Exchanges.**—The Post Office has entered into an agreement with five telephone equipment manufacturers for the pooling of ideas with the object of "designing the best possible electronic switching system," and to this end a research committee has been set up under the chairmanship of the Post Office engineer-in-chief. This is recorded in the annual report of the Telecommunication Engineering and Manufacturing Association.

**Computer Society.**—Last year the London Computer Group was formed and from this has now grown the British Computer Society with headquarters at 29, Bury Street, St. James's, London, S.W.1. The primary object of the Society is to "further the development and use of computational machinery." Among the members of the provisional council is Dr. A. D. Booth, of the Birkbeck College Computational Laboratory.

**Computer Exhibition.**—Plans for this country's first Electronic Computer Exhibition, to be held at Olympia, London, from November 28th to December 4th next year, include an international technical symposium organized by the National Physical Laboratory. It is also proposed to hold a business computer symposium arranged by the sponsors of the exhibition, the Radio Communication and Electronic Engineering Association and the Office Appliance and Business Equipment Trades Association. Incidentally, the Exhibition is non-profit making and any excess of receipts over expenditure is to be returned to exhibitors.

**Thorn-Champion.**—Rumoured change of ownership of the Champion Electric Corporation was confirmed when Thorn Electrical Industries (makers of Ferguson receivers) announced on July 8th their acquisition of a group of three companies—Champion Corporation, Newhaven Cabinet Works, Ltd., and Austin Clark (London), Ltd.

**Thorn-Bendix.**—An agreement with Bendix Aviation Corporation, of the U.S.A., permits Thorn Electrical Industries to manufacture the Bendix range of A.N. Pigmy and Unitor connectors.

**Soviet Television.**—According to a note in *Soviet News*, which is issued by the Soviet Embassy in London, the U.S.S.R. now has 24 television stations and a further ten will be opened this year. In April there were about 1.5M television receivers in the Union.

"**Operation Smoke-Puff**" is the title given to a series of tests being undertaken in the United States to establish two-way radio communication by reflecting signals from man-made ionized clouds produced by releasing nitric oxide gas from rockets. Members of the American Radio Relay League are participating in the tests which are sponsored by the U.S. Air Force.

**Audio Engineering.**—This year's convention of the Audio Engineering Society of America, at which some fifty papers will be presented, is to be held in conjunction with the New York High Fidelity Show. Both will be held in the New York Trade Show Building from October 9th to 12th.

**U.S. Electronics Conference.**—The 13th annual National Electronics Conference will be held from October 7th to 9th at the Hotel Sherman, Chicago. Information on the Conference and the associated exhibition is obtainable from the N.E.C., 84 E. Randolph Street, Chicago 1, Illinois, U.S.A.

**Interkama**—an International Congress and Exhibition of Measuring Instrumentation and Automation—is being held in Düsseldorf, West Germany, from November 2nd to 10th. Particulars are obtainable from Nordwestdeutsche Ausstellungsgesellschaft m.b.H., Ehrenhof 4, Düsseldorf.

**I.E.E. Students.**—The 1957-58 chairman of the London Graduate and Student Section of the I.E.E. is F. L. Fielding, of Standard Telephones & Cables, and the honorary secretary, L. A. Harris, of Marconi's.

**I.E.E. Council.**—The new president of the I.E.E. is T. E. Goldup, a director of Mullard, and Dr. Willis Jackson, director of research and education, Metropolitan-Vickers, is elected a vice-president for the second term of three years. Those elected to fill the vacancies among the ordinary members of the council include F. C. McLean, deputy chief engineer, B.B.C., and C. E. Strong, chief radio engineer, Standard Telephones & Cables, who was a member of the council from 1949 to 1953.

**Radio Section Committee.**—The new chairman of the committee of the I.E.E. radio and telecommunication section is Dr. J. S. McPetrie, and the new vice-chairman M. G. L. Pulling. The three vacancies among the ordinary members of the committee will be filled by R. J. Halsey, an assistant engineer-in-chief at the G.P.O., Dr. B. G. Pressey (Radio Research Station, Slough), and W. E. Willshaw (G.E.C.).

**B.S.R.A. Committee.**—New members of the executive committee of the British Sound Recording Association are F. Langford-Smith, appointed a vice-president, and G. W. Higgs, E. F. R. Lilley and C. W. Morle elected members. J. F. Doust continues as president.

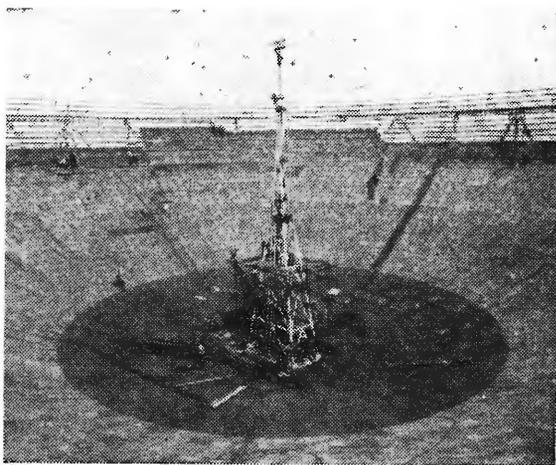
**C. and G. New Headquarters.**—A site has been secured at 76-78, Portland Place, London, W.1, together with the premises at the rear, for the new headquarters of the City and Guilds of London Institute. It is planned to be ready for occupation early in 1959.

**"Foreign Attachments."**—In the past telephone users in the U.S.A., as in this country, have not been permitted to fit "foreign attachments" to telephone instruments except in certain circumstances. The Federal Communications Commission has, however, now ruled that the telephone companies must permit the use of devices which do not impair the operation of the telephone service.

**Recommended materials and finishes** for telecommunication and allied electronic equipment and components are listed under "new work started" in *B.S.I. News* issued by the British Standards Institution.

## FORTHCOMING EVENTS

<b>National Radio Show (R.I.C.)</b> Earls Court, London, S.W.5.	Aug. 28-Sept. 7
<b>Engineering, Marine, Welding &amp; Nuclear Energy Exhibition</b> Olympia, London, W.14.	29-Sept. 12
<b>Farnborough Air Show (S.B.A.C.)</b> Farnborough, Hants.	Sept. 3-9
<b>British Sound Recording Association Exhibition and Convention.</b> Waldorf Hotel, London, W.C.2.	Sept. 20-22
<b>Conference on Automatic Measurement of Quality in Process Plants</b> (Society of Instrument Technology), University College, Swansea, Glamorgan.	Sept. 23-26
<b>Radio Hobbies Exhibition (R.S.G.B.),</b> Royal Horticultural Society's Old Hall, London, S.W.1.	Oct. 23-26



**RADIO TELESCOPE**—The interior of the 250ft diameter bowl of the fully steerable radio telescope at Jodrell Bank, Manchester (now nearly complete), showing the 60ft aerial mast with two dipoles at right angles for simultaneous observation on 90 and 170 Mc/s.

## PERSONALITIES

**T. E. Goldup, C.B.E.,** elected president of the Institution of Electrical Engineers for 1957/58, is a director of Mullard, which he joined in 1923. He had been a vice-president of the Institution since 1952. Mr. Goldup is particularly interested in technical education and training, and has been a member of the board of governors of the Ministry of Supply's College of Electronics, Malvern, since 1949, and chairman of the board since 1952. Mr. Goldup, who was appointed C.B.E. in 1954, was from 1950 to 1954 a member of the Radio Research Board of the Department of Scientific and Industrial Research.



**J. S. McPetrie, Ph.D., D.Sc.,** the new chairman of the committee of the radio and telecommunication section of the I.E.E., has been head of the radio department of R.A.E., Farnborough, since 1950. For the previous six years he was superintendent, signals research and development in the Ministry of Supply, prior to which he was for a short time radio-physicist on the staff of

the British Joint Services Mission in Washington. From 1925 to 1943 Dr. McPetrie was at the National Physical Laboratory.

**M. J. L. Pulling, O.B.E., M.A.,** who becomes vice-chairman of the I.E.E. radio and telecommunication section, has been senior superintendent engineer (television) with the B.B.C. since 1949. After leaving Cambridge University in 1929 he went into industry and was for a few years with Murphy Radio, where he was in charge of production testing. He joined the engineering division of the B.B.C. in 1934 and was for eight years superintendent engineer (recording) prior to being appointed to his present position.

**J. N. Aldington, B.Sc., Ph.D., F.Inst.P., M.I.E.E.,** managing director of the new company Siemens Edison Swan, Ltd., joined Siemens at Preston in 1923 as an analytical chemist in the lamp works laboratory. Dr. Aldington was appointed head of the company's lamp research laboratories in 1935 and in 1949 was elected to the board of Siemens Electric Lamps and Supplies, Ltd. Three years later he became managing director of the company, and when, in 1955, it ceased to act autonomously, he became managing director of Siemens Brothers, the parent company. He is also chairman of Submarine Cables, Ltd., which is jointly owned by Siemens Edison Swan and the Telegraph Construction and Maintenance Company.

In addition to those mentioned last month, **Air Commodore A. V. Harvey, C.B.E., M.P.,** a director of Mullard, Ltd., since 1950, was created a Knight Bachelor in the Birthday Honours, and **J. A. Dunkley,** senior development and experimental engineer at R. B. Pullin & Company, was appointed M.B.E.

# News from the Industry

**Siemens Brothers & Company** and the **Edison Swan Electric Company** have now finally been merged into a single company to be known as **Siemens Edison Swan, Ltd.** It will be recalled that in 1955 Siemens Brothers joined the Associated Electrical Industries group of companies, of which Edison Swan has been a member since 1928, and that last year a temporary company, **Siemens-Ediswan, Ltd.**, was set up to co-ordinate the activities of the two companies. The new company, of which Dr. J. N. Aldington is managing director, has been divided into 18 "product divisions," each specializing in a particular type of equipment. Each division will have a chief engineer, manufacturing manager and sales manager, but there will be a single research organization for which three blocks of buildings are being built at Harlow New Town, Essex. The director of research is Dr. T. E. Allibone.

**British Tungstram Radio Works, Ltd.**, West Road, Tottenham, London, N.17, announce that in consequence of the merger, of Siemens and Edison Swan, Tungstram valves will no longer be distributed by Siemens but by its own distribution organization.

**British Communications Corporation** have been awarded a contract for the supply of a large quantity of multi-channel recording equipment for the Ministry of Transport and Civil Aviation. The equipment, which will be used for air traffic control, provides for the simultaneous recording of up to twenty channels on a single tape.

**Avo, Ltd.**, is the new name adopted by the Automatic Coil Winder & Electrical Equipment Company, manufacturers of the well-known series of Avo test and measuring instruments and Douglas coil-winding equipment.

**Amphenol (Great Britain), Ltd.**, has been formed jointly by Gas Purification and Chemical Company and Amphenol Electronics Corporation (of Chicago) for the handling of Amphenol components in the British Commonwealth (except Canada) and on the Continent. Initially components will be imported, but it is planned eventually to manufacture in this country. Among the subsidiaries of Gas Purification and Chemical Company are Grundig (Great Britain), Wolsey Television and A.B. Metal Products.

**Livingston Laboratories**, of Retcar Street, London, N.19, have been appointed exclusive sales representatives for the United Kingdom by Hewlett-Packard Company, of Palo Alto, California.

**Battery-operated industrial television** equipment was recently installed experimentally in a Swiss train by Pye. Tests were conducted to assess the possibilities of its use for examination of inaccessible parts of the train especially whilst in motion.

**Metro-Sound Manufacturing Company** has been formed by M. S. Myers (until recently with Goldring Manufacturing Company) for the manufacture of gramophone accessories. The address is 64, Stoke Newington High Street, London, N.16 (Tel.: Clissold 1549).

**Radio Heaters, Ltd.**, manufacturers of Radyne radio-frequency heating equipment, have opened a new research laboratory at Wokingham, Berks, where they have their works. The services of the laboratory will be available to any potential industrial user of r.f. induction and dielectric heating equipment.

**Plessey Company** have transferred the production of their standard communication equipment from Ilford, Essex, to West End Mills, St. Ives, Hunts. (Tel.: St. Ives 2095.) P. A. Tremaine remains as unit manager.

**Morganite Resistors, Ltd.**, announce the appointment of M. G. B. Mason as general sales manager and of Dr. W. W. Marshall, as manager of their technical department.

**Marconi Instruments** are building an extension to their factory at Longacres, St. Albans, Herts., which will provide an additional 22,000 square feet of manufacturing space.

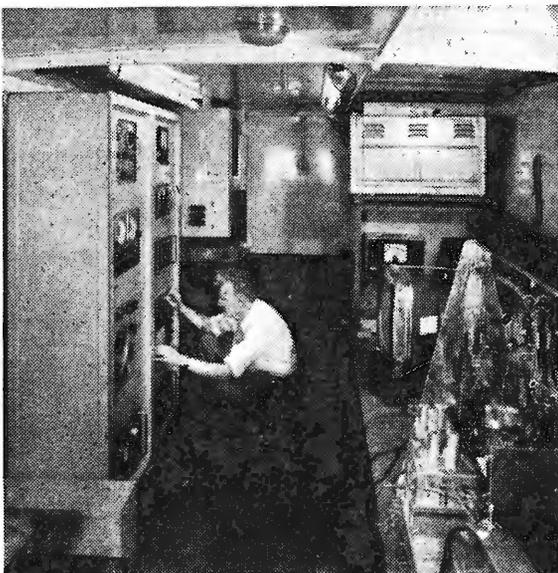
## EXPORT NEWS

**G.C.A.**—Three British manufacturers working together have secured a contract for the supply and installation of a complete ground-controlled approach system for one of the airfields of the Royal Rhodesian Air Force. Standard Telephones and Cables are responsible for the overall planning of the G.C.A. installation and are supplying the precision approach radar, Cossor are manufacturing the surveillance radar and International Aeradio are supplying the control and communication equipment.

**Public address equipment**, incorporating facilities for simultaneous interpretation, for the new Paris headquarters of U.N.E.S.C.O. is to be supplied by Pamphonic Reproducers.

**Electronic control equipment** for machine tools is being shown by E.M.I. Electronics at the Machine Tool Exhibition to be held in Hanover, West Germany, in September.

**Electro-acoustic apparatus**, including domestic broadcast receivers and sound reproducing equipment, is amongst the consumer goods to the value of nearly £6M which Yugoslavia is permitting to be imported this year. The names and addresses of Yugoslav organizations participating in the scheme are obtainable from the Board of Trade, Commercial Relations and Exports Dept., Horse Guards Avenue, London, S.W.1. (Ref. C.R.E. 5919/56.)



*ON THE SPOT investigations, to check the results of laboratory work on a.g.c. systems for 625-line television receivers, are being undertaken on the Continent by Mullards with a mobile experimental unit. The comprehensive equipment in the vehicle, which carries an extendible aerial system for Bands I and III, includes a line selector unit for the analysis of individual line waveforms and a line pulse generator used for measuring flywheel sync characteristics.*

# An Alternative Colour TV System

By E. J. GARGINI\*

BETTER QUALITY REPRODUCTION  
FROM NON-REDUNDANT COLOUR  
INFORMATION

HERE is a great temptation in Britain to adopt the American N.T.S.C. colour television system—suitably modified for 405-line standards—exactly as it stands. This would be very unwise, however, until the details of the system have been critically examined, particularly in the light of recent developments.

The author has been investigating colour systems with the ultimate aim of finding the best method of transmission to result in a simple and cheap domestic receiver—on which the success of colour television so much depends. In the course of this work several deficiencies of the N.T.S.C. system have come to light, and these have led to a proposal for an improved alternative system using a fundamentally different method of transmitting the colour information. However, the broad principle by which the N.T.S.C. system obtains its compatibility is retained—that of transmitting a luminance, or brightness, signal in the correct form for monochrome receivers, together with a colour signal providing the additional hue and saturation information required for colour receivers.

Three major features of the N.T.S.C. system are open to criticism, and these have already been discussed in *Wireless World*†. The first is the nature of the colour signal. This signal conveys colour-difference information—that is, differences from

white—and is formed from colour-difference components  $E_R - E_Y$ ,  $E_G - E_Y$  and  $E_B - E_Y$  (where  $E_R$ ,  $E_G$  and  $E_B$  are the red, green and blue camera-tube outputs and  $E_Y$  is the luminance or “whiteness” signal). As colours become more saturated for a given brightness level, the  $E_R$ ,  $E_G$  and  $E_B$  camera outputs become larger and more significant in the  $E_R - E_Y$ ,  $E_G - E_Y$  and  $E_B - E_Y$  colour-difference signals, while the  $E_Y$  signal remains constant. Thus, any brightness detail in a saturated colour (e.g., dark shadows on a bright red curtain) will produce larger amplitude changes in the appropriate colour-difference signals than with a less saturated colour (e.g., the same shadows on a pale red curtain of equal brightness). In other words, the brightness information, which properly belongs in the luminance channel, is carried increasingly by the colour signal. Since in the N.T.S.C. system the colour signal is band-limited by filters to give a narrow-band colour signal—and hence slower rates of change—the result is that with saturated colours a good deal of the brightness detail (to which the eye is particularly sensitive) is completely lost.

In the proposed alternative system this particular disadvantage is avoided by transmitting a colour signal which carries no redundant brightness informa-

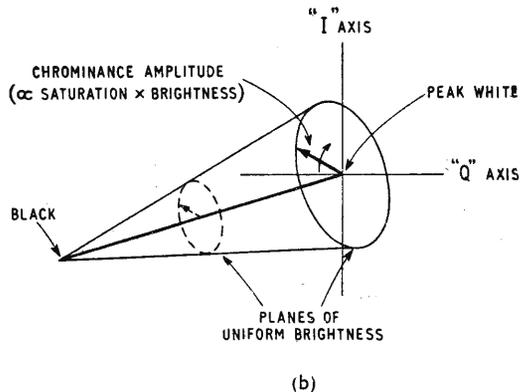
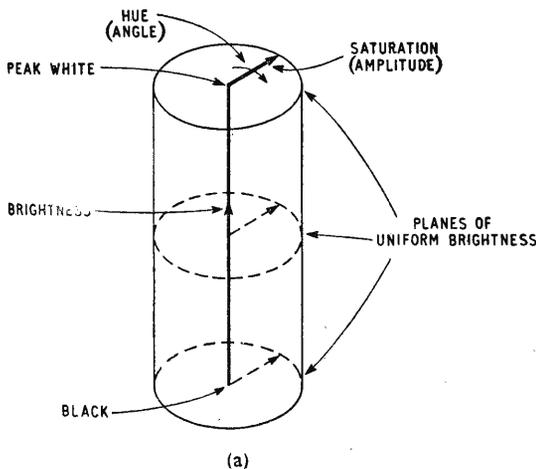


Fig. 1. Three-dimensional vector diagrams illustrating the difference between a chromaticity signal (a) and a chrominance signal as used in the N.T.S.C. system (b).

tion. Consequently only true colour information—that is, hue and saturation—is conveyed. For this reason the colour signal is called a *chromaticity* signal, as distinct from the *chrominance* signal of the N.T.S.C. system. The difference between the two is illustrated by the three-dimensional vector diagrams in Fig. 1. Here the colour signal vector represents hue by its phase angle and saturation by its amplitude. In the chromaticity signal (a) the colour signal amplitude is not influenced by different brightness levels, but in the chrominance signal (b) the amplitude is determined partly by the colour content and partly by the brightness.

### Gamma Correction

The second feature of the N.T.S.C. system under criticism is the composition of the luminance signal. This is formed from a mixture of the red, green and blue camera-tube outputs (actually  $E_y = 0.59E_G + 0.3E_R + 0.11E_B$ ) which are first individually gamma-corrected. The fact that an inverse square-law correction is applied to the individual components of the luminance signal at the transmitter leads to inaccuracies in the displayed luminance information at the receiver. Moreover, if the individual gamma corrections are not balanced properly the displayed colours will alter in hue and saturation at different intensity levels. This problem does not arise in the improved alternative system, since the luminance signal is gamma-corrected after formation.

The third questionable feature of the N.T.S.C. system is the use of a sub-carrier inside the normal monochrome vision band. In American receivers it is well known that the video response is substantially reduced at the sub-carrier frequency so the effect of interference from the colour signal is not very severe. In addition, although the so-called "I" modified colour-difference signal has extended sidebands to convey the more detailed information which the eye can appreciate at the red end of the optical spectrum‡, this extra information is not, in fact, utilized in current receivers.

Consequently the N.T.S.C. system as used in America is not really a band-sharing system, but one in which colour information is virtually transmitted outside the monochrome band in the unused area close to the sound carrier. If the system were adopted in Britain, however, the wider bandwidth

of the average domestic model would insufficiently attenuate the colour sub-carrier and thus permit a display of dot patterning.

Although this may not be a severe price to pay for colour broadcasting, the fact that the colour receiver must treat the colour transmission as an outside-the-luminance-band transmission, means that the luminance detail at the colour receiver is restricted. This band restriction comes about because the sub-carrier itself must not appear at the colour receiver c.r.t. control electrodes otherwise it will increase the brightness of the colour components upon rectification in any particular electron-gun assembly. Moreover, if the guns are in any way fed with unequal amounts of colour sub-carrier the colour balance will no longer be maintained at different brightness levels.

A further difficulty arises because in practice it is necessary to use a "notch" filter at the transmitter to prevent those brightness transients which produce components at frequencies close to the colour sub-carrier from beating with the receiver's synchronous-detection local oscillator and so causing low-frequency colour beat patterning. This filter inevitably reduces the bandwidth of the brightness signal.

If it were possible to use a 3-Mc/s colour sub-carrier in Britain, however, instead of one at 2.66Mc/s, most domestic receivers would display very little dot patterning. This, in fact, is what is proposed in the alternative system. Moreover the "notch" filter mentioned above is not necessary because the low-frequency colour beat patterning is reduced by other means. In the N.T.S.C. system the interaction between the brightness transients and the colour sub-carrier actually occurs because the sub-carrier is positioned in the single-sideband part of the monochrome band. This is avoided in the alternative system by removing from the colour signal the component most susceptible to interference—the hue information—and transmitting it over the double-sideband part of the monochrome band around the main carrier. It is clearly not possible to have a sub-carrier at the same frequency as the main carrier, so the method adopted is to transmit the change of hue angle by phase modulation of the main carrier. The 3-Mc/s sub-carrier is then merely concerned with conveying the saturation information—transmitted by amplitude modulation.

The complete signal of the alternative system has a frequency spectrum as illustrated in Fig. 2. Summarizing the situation, it can be said that the chromaticity information to be transmitted is separated into its two components, hue and saturation, and the hue is conveyed by phase modulation of the main carrier and the saturation by amplitude modulation of a 3-Mc/s sub-carrier just outside the normal monochrome video band.

It will be noted, first of all, that the chromaticity signals are restricted in bandwidth, compared with the luminance signal, in the same way as the chrominance signals in the N.T.S.C. system. This restriction takes advantage of the general principle that the eye is less sensitive to small colour detail than it is to small brightness detail, and that a sharp colour picture can be synthesized by combining blurred, or narrow-band, colour information with sharp or wide-band, brightness information.

Actually the rate-of-change of hue information has been restricted to a bandwidth corresponding to that

‡ The other modified colour-difference signal, called the "Q" signal has a narrower bandwidth and conveys the less detailed information required at the blue end of the optical spectrum.

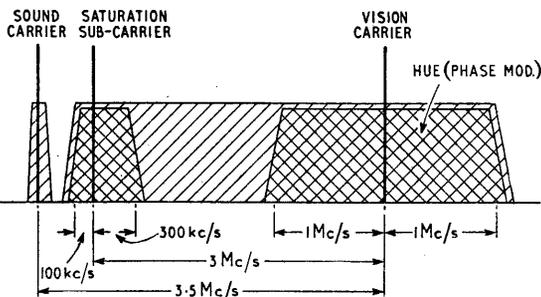
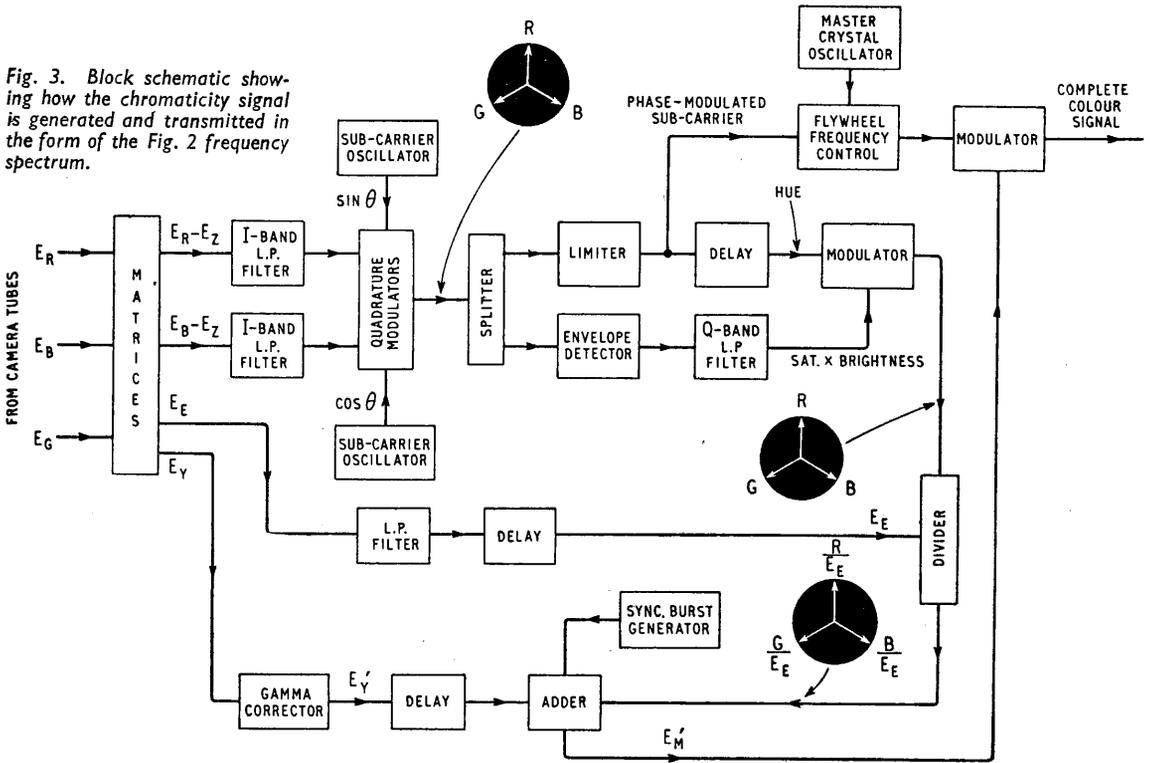


Fig. 2. Frequency spectrum of the proposed alternative system. The sub-carrier is at 3Mc/s instead of 2.66Mc/s as in the British N.T.S.C. system.

Fig. 3. Block schematic showing how the chromaticity signal is generated and transmitted in the form of the Fig. 2 frequency spectrum.



of the "I" modified colour-difference signal in the N.T.S.C. system, and the rate-of-change of saturation to a bandwidth corresponding to that of the "Q" modified colour-difference signal. This has been arranged purely for the purpose of comparative tests with the N.T.S.C. system. The fact that the saturation component is assigned the narrower band is mainly a matter of expediency—and it provides another reason why the transient hue information should be phase modulated on to the main carrier. With this arrangement it will be noted that the transmission of the colour information corresponds to the colour vector diagram in Fig. 1(a)—the hue being represented by angle or phase and the saturation by amplitude.

### Signal Synthesis

It now remains to be shown how the chromaticity signal is manufactured in the form of hue and saturation components and how these are combined with the luminance information to form the complete colour signal in Fig. 2. A block schematic of the system is shown in Fig. 3. To begin with, the red, green and blue camera-tube outputs,  $E_R$ ,  $E_G$  and  $E_B$ , are passed into proportional adding circuits known as matrices. Various proportions of these voltages are then combined to form three brightness type signals. The first is a luminance signal  $E_Y$ , as in the N.T.S.C. system ( $E_Y = 0.59E_G + 0.3E_R + 0.11E_B$ ), the second is an "equal-energy" brightness signal,  $E_E$ , formed from equal amounts of the three camera outputs ( $E_E = (E_R + E_G + E_B) \div 3$ ), while the third,  $E_Z$ , has a special composition which will appear shortly.

This  $E_Z$  signal is subtracted from  $E_R$  and  $E_B$  to

form two colour-difference signals  $E_R - E_Z$  and  $E_B - E_Z$ , as shown. These are passed through low-pass filters which limit them both to a bandwidth corresponding to that of the I signal in the N.T.S.C. system. The two colour-difference signals are then used to amplitude modulate two components of a 3-Mc/s sub-carrier having a phase difference of  $90^\circ$  between them. The two modulated components are combined to produce a single chrominance-type signal at 3Mc/s which conveys hue information by its phase angle and saturation and brightness information by its amplitude. It differs from the N.T.S.C. chrominance signal, however, in that the composition of the  $E_Z$  signal is arranged so that the phase angles which represent the three primaries, red, green and blue, are equally spaced at  $120^\circ$  intervals. This arrangement is called a *symmetrical* colour-difference signal.

The symmetrical signal is passed to a splitter unit, one output of which is taken through a delay device, and the other to an amplitude detector. The output of this detector is the saturation  $\times$  brightness component of the colour signal (see Fig. 1(b)) and has the character of a video type of signal. As the  $E_R - E_Z$  and  $E_B - E_Z$  components have been passed through "I-bandwidth" filters before modulation, it follows that the chrominance signal will possess phase and amplitude changes which are related to the rise times of the two component voltages. The detected saturation signal will therefore have a rise time which depends on the rise time of the original I-bandwidth modulation signals. Consequently this signal should be passed through a narrow-bandwidth filter to restrict the saturation  $\times$  brightness amplitude rates of change to that of the Q band if a narrow-band saturation signal is desired as in Fig. 2.

The hue signal is formed by passing the chrominance signal from the splitter into a limiter circuit which limits on the first perceptible colour change from white (i.e., from zero amplitude). The output of this limiter, therefore, for any picture element other than white is a continuous 3-Mc/s signal, the phase of which is determined by the hue of the transmitted colour. This signal is next passed through a delay network to ensure that hue changes occur in step with the corresponding saturation changes and finally the restricted saturation signal is used to remodulate in amplitude the steady-amplitude hue carrier. A chrominance-type signal is thus re-formed which has the special feature that hue angle changes occur at a rate determined by the I bandwidth and saturation amplitude changes at the slower rate fixed by the Q bandwidth.

### Segregating Colour Information

This signal now has to be converted from a chrominance-type signal, containing redundant luminance information, into a chromaticity signal. What is required is to remove the inherent modulation due to the brightness changes, and this is done by arithmetically dividing the instantaneous value of the chrominance signal by the instantaneous value of the  $E_B$  brightness or intensity signal occurring at the same time $\S$ . In other words, any changes due to brightness in the chrominance-signal "numerator" are automatically cancelled out by the same brightness changes in the "denominator," leaving just the changes due to pure chromaticity information.

Since the brightness rates-of-change in the "numerator" have already been restricted by a Q-bandwidth filter (used on the saturation  $\times$  brightness information to give a narrow-band signal), it is obviously necessary to restrict the brightness rates-of-change in the "denominator" in the same way. This is achieved by passing the  $E_B$  signal through a low-pass Q-bandwidth filter, as shown, before it goes to the dividing circuit. (It is also passed through a "trimming" delay line to keep it in step with the "numerator" brightness changes.)

As a result of the division process a true chromaticity signal is produced, consisting of a 3-Mc/s oscillation modulated in phase by hue changes and in amplitude by saturation changes. It now remains to be shown how the hue and saturation components are separated as in Fig. 2. In the first place the 3-Mc/s chromaticity signal is added to the  $E_Y$  brightness signal (after the last-mentioned has been gamma-corrected), together with short bursts of sub-carrier frequency for colour synchronizing purposes. This gives the combined signal  $E_{M'}$ , which can be expressed mathematically as

$$E_{M'} = E_Y^{1/\gamma} + \frac{\sqrt{(E_R - E_Z)^2 + (E_B - E_Z)^2}}{E_B} \sin(\omega t + \theta)$$

where  $\theta = \tan^{-1}(E_R - E_Z)/(E_B - E_Z)$ , representing the changes of the hue phase angle.

The hue information, provided by the phase angle of the limited 3-Mc/s sub-carrier, is phase modulated on to the main vision carrier by means of a flywheel frequency control circuit $\parallel$ , as shown,

and the output of this is in turn amplitude modulated by the  $E_{M'}$  signal. As a result of modulating an already phase-modulated carrier wave with the phase-modulated 3-Mc/s sub-carrier contained in the  $E_{M'}$  signal, the transient phase modulation of the 3-Mc/s sub-carrier disappears. There remains only the saturation amplitude modulation of the sub-carrier, which appears as in Fig. 2.

Having transmitted a signal of the form shown in Fig. 2, we may now consider briefly the situation at the receiving end of the system. After the complete colour signal has passed through the usual r.f. and i.f. stages it is fed to a detector, which recovers the  $E_{M'}$  signal as already defined—that is, an  $E_Y$  brightness signal plus a symmetrical chromaticity signal in which hue changes are I-bandwidth and saturation changes are of Q-bandwidth. Although originally the sub-carrier, considered as a transmitted signal, was modulated with the saturation signal only, the effect of heterodyning the steady-phase saturation signal against the hue phase-modulated main carrier at the  $E_{M'}$  detector is to transfer automatically all the hue phase modulation, transmitted double sideband, to the sub-carrier signal.

This symmetrical chromaticity signal is synchronously detected, using a local 3-Mc/s reference oscillator, and the outputs are multiplied by an "equal-energy" brightness signal of the form  $E_B$  (necessary because of the division process at the transmitter). These operations subsequently yield the original  $E_R$ ,  $E_G$  and  $E_B$  voltages which may be applied to the colour display device. The  $E_B$  signal at the receiver is actually derived by a converter circuit $\parallel\parallel$  from the received  $E_Y$  signal.

### Lower Receiver Costs

It will be noted, incidentally, that the rate of change of colour information is determined by the transmitter filters, and no expensive filters or delay lines are required at the receiver. Nor is there any need, in certain receivers with single-gun colour tubes, for matrices as used in the N.T.S.C. system receivers. As far as the average monochrome receiver is concerned, there is substantially no sub-carrier to cause visual interference at the reproducing tube because of the considerable drop in the receiver's video response at 3Mc/s.

It would be an advantage in an alternative system to dispense with the colour sub-carrier altogether. This could be achieved by using the existing sound carrier as the colour sub-carrier as well as for conveying its own sound information. This is not possible with the existing 405-line system, in which the sound signal is broadcast as an amplitude modulation of the sound carrier. It is possible, however, to consider the inauguration of a new high-definition service in Band IV or V in which a number of changes could be made. For example, a 625-line system with brightness signals transmitted in the conventional vestigial side-band fashion, the hue component of the colour signal transmitted as phase modulation of the main vision carrier, the saturation signal transmitted as an amplitude modulation of the sound carrier, and the sound signal transmitted by the conventional 75-kc/s deviation of the f.m. sound carrier.

$\S$  British Patent Application No. 10976/56.

$\parallel$  British Patent Application No. 19201/56.

$\parallel\parallel$  British Patent Application No. 6576/57.

# Ionospheric Problems

By T. W. BENNINGTON\*

## APPLICATION OF IGY DATA TO RADIO COMMUNICATION

**M**ANY geophysical phenomena are to be specially investigated during the course of the International Geophysical Year and among them are to be found several appertaining directly or indirectly to the ionosphere. From 1st July, 1957 to 31st December, 1958, ionospheric measurements of different kinds, and observations upon extra-terrestrial phenomena which affect the region, are to be made upon a world-wide scale, and from the mass of data thus accumulated it is hoped that much will be learned.

Our present knowledge of the ionosphere has been built up largely on the basis of the information obtained by the use of exploring radio waves; but much may be missed by such a process, for the echoes bring little information about the regions lying between the points where ionization maxima exist. Knowledge of the conditions within such regions is arrived at largely by deduction, which may not always be correct. Rocket flights into the ionosphere give different ideas as to the distribution of ionization with height, but the information so far obtained in this way is sparse. It is well, therefore, that the "radio" measurements to be made during the IGY will be supplemented by those obtained by flights into, and perhaps beyond, the ionospheric regions.

The IGY is, of course, mainly a scientific project, aiming to obtain more knowledge of the physical nature of the earth and its atmosphere and of the extra-terrestrial phenomena which affect them. But it is hardly conceivable that the ionospheric and other data obtained by this effort will not have direct application to the engineering problems of long-distance communication. And it must be admitted that communications engineers are sorely in need of more ionospheric information, for it cannot be claimed that their present techniques for making use of the ionosphere are by any means completely satisfactory. In this article, therefore, we will discuss one or two outstanding ionospheric problems which are of direct consequence in radio communication. "Sporadic E". One feature of the E layer about which little is known is that of the localized "clouds" of high ionization which frequently occur within the layer, and which are known collectively as "Sporadic E". This remains as perhaps the outstanding mystery of the ionosphere, for no real notion as to its cause yet exists.

The high ionization density of the sporadic E clouds are capable of reflecting radio waves of much higher frequency than is the normal layer. In fact, their ionization density is often high enough to "blanket" the wave from the  $F_2$  layer, which lies higher up, and which would normally be the refracting medium for the wave in long-distance communication. Fig. 1 shows the highest frequencies which would have been reflected from the E,  $F_2$  and sporadic E at oblique incidence during a day in June, as obtained from the vertical incidence ionospheric measurements made at a mid-latitude northern hemisphere station. It is true that during June sporadic E is

especially prevalent in such latitudes, but it is seen that, for the greater part of the day, its MUF (maximum usable frequency) was far higher than that for the other layers. Thus, the sporadic E can modify the transmission mechanism for long distances in an important manner.

Over most of the earth's surface the sporadic nature of this phenomenon is most marked: it appears to form for no apparent reason, remain in being for up to several hours, then decrease in intensity and disappear. Nevertheless, in spite of this, it has some well defined general characteristics, which Fig. 2 will help to make clear. In point of fact, there appear to be several different types of sporadic

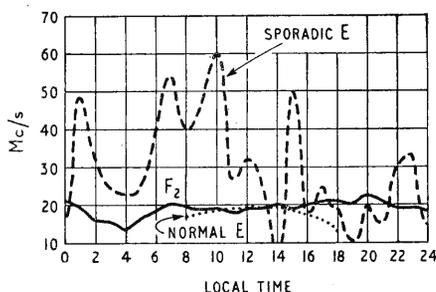


Fig. 1. Highest frequencies on which transmission could have been sustained during a June day at a mid-latitude northern hemisphere station.

E, even at a given location. There is certainly considerable difference between the types which predominate over different zones of the earth's surface, as is evidenced by, amongst other things, differences in the distribution with time of day and month of year. In the temperate zone, of which the location of Slough is typical, it is seen that the more intense sporadic E is largely a summer-time phenomenon, and, at that time, is chiefly prevalent during the day. In the auroral zones surrounding the geomagnetic poles, of which the Greenland station is representative, it is prevalent throughout the year, but is chiefly present at night, with a peak occurrence before midnight. At a station like Ibadan, near the geomagnetic equator, it is again prevalent throughout the year, but is largely confined to the daytime, with a peak occurrence around noon. In all zones it is often present for more than 30% of the time, and in the equatorial zone, during the daytime, has such a high degree of prevalence as to be practically a permanent feature of the daytime ionosphere. An ionospheric phenomenon such as this, capable of reflecting, at oblique incidence, frequencies higher than 25 Mc/s, and present over certain transmission paths for from 30% to over 90% of the time, is evidently of considerable importance, yet the

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means necessary for taking account of its effects are at present inadequate.

The pronounced diurnal and seasonal features in its occurrence rate point to some sort of solar control, but, on the other hand, its generally sporadic nature would seem to indicate that it is not directly caused by the sun. In the auroral zones the sporadic E occurrence has a high degree of correlation with auroral and with geomagnetic activity, and both of these phenomena are almost certainly due to the action of solar corpuscles which, on arriving in the vicinity of the earth, are carried by its magnetic field towards the geomagnetic poles. So the auroral sporadic E may also be due to the effects of these corpuscles upon the atmospheric gas. But over the rest of the earth's surface there is no such correlation, and the origin of the "clouds" remains unknown. Various possibilities have been investigated by different workers: for example, that they are due to electric energy discharged into the E layer from thunder-clouds in the troposphere, that they are a by-product of the large electric currents which circulate in the ionosphere, that they are caused by meteors or by ionospheric winds. Some evidence has been presented in support of each of these possibilities, but none has been by any means proven.

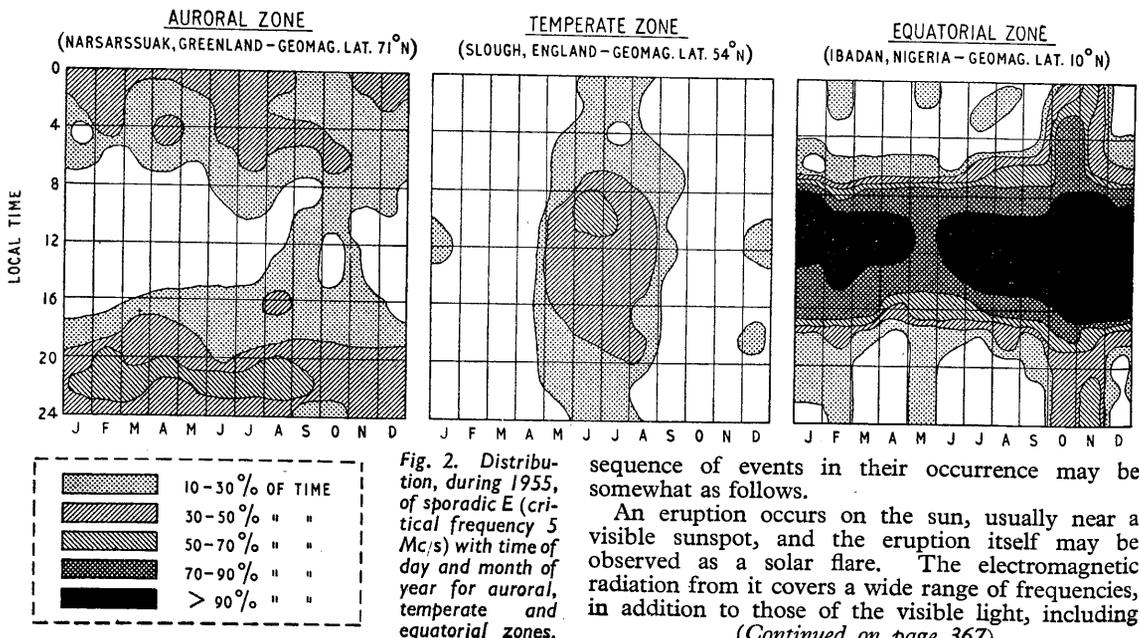
**Night-time E Layer.** In general, the behaviour of the E layer closely resembles that of a Chapman layer, in which the maximum ionization is proportional to the square root of the cosine of the sun's zenithal angle. This follows from a consideration of the rate of ion production by the absorption of solar radiation by the gas molecules, and of the rate of recombination and attachment, which depends on the density conditions in the atmospheric gas.

At the height of the E layer the gas is relatively dense, and during the day the ionization increases from a low value at sunrise to reach a maximum around noon, and to fall again to a low value around sunset. After sunset it would be expected to continue falling rapidly, and shortly to disappear entirely;

but in point of fact, after falling rapidly for a time the rate of decay gradually diminishes until, sometime before sunrise the ionization appears to assume a constant value. The result is that the E layer has a low but definite ionization level throughout the night. It would appear, therefore, that there is a component in the E layer ionization which has a different recombination rate from that of the main body of the daytime ionization, and is due to a different cause, and that, after dark when the ionization due to the sun has disappeared, it is this which is maintained. Its origin is not, however, known, though it has, for many years, been thought to be due to the influx into the atmosphere of countless numbers of small meteors which, by reason of their high velocity, could ionize the gas atoms. It would seem that the ions produced in this way have a lower ionization potential and, therefore, a slower recombination rate, than those produced by the sun, and that, in this way, the ionization could be maintained. This night-time E-layer ionization is, at any rate, of considerable importance in communication, and particularly so in the new system which uses ionospheric scattering as the transmission mechanism, for this scattering occurs, both by day and night, in the ionization "turbulences" permanently existing in the E layer.

**Ionospheric Disturbances.** Long-distance communication via the ionosphere is subject to relatively frequent dislocation and interruption due to the effects of ionospheric disturbances. Yet little definite is known about the major kind of disturbance experienced; or, at least, insufficient is known about its cause and the mechanism of its production to be put to much practical use. If, for example, it were possible to tell within a day or two, or even within several hours, that such a disturbance were coming, extenuating measures could often be taken to prevent its worst effects.

Ionospheric disturbances are of two distinct kinds, though one kind is often associated with the other, and both have their origin in the sun. The



sequence of events in their occurrence may be somewhat as follows.

An eruption occurs on the sun, usually near a visible sunspot, and the eruption itself may be observed as a solar flare. The electromagnetic radiation from it covers a wide range of frequencies, in addition to those of the visible light, including

(Continued on page 367)

some far into the ultra-violet part of the spectrum. This latter penetrates into the earth's atmosphere to the level of the D layer, where it temporarily raises the ionization to a very high level. Radio waves travelling through this much enhanced ionized region, where, at the same time, there is a high density of neutral gas molecules, are subject to a greatly increased amount of absorption, due to the frequency of the electron/molecule collisions which they engender, and the resultant dissipation of their energy as heat. They therefore fail to reach the ground again, and communication is interrupted by what is called a "sudden ionospheric disturbance." The condition giving rise to this does not last long, however, for the burst of solar radiation usually dies down within a few minutes and, the recombination rate at the height of the D layer being high, the abnormal ionization within it usually disappears within an hour.

The sequence of events so far is pretty clear and well established, and, since the incidence of solar flares varies with the degree of sunspot activity we should expect that of the sudden ionospheric disturbances to correlate with sunspot activity also. Fig. 3 shows that, in general, there was, over the years 1947 to 1956, a good correlation between the Annual Sunspot Number and the annual number of sudden ionospheric disturbances.

But the latter is not the cause of the major interruptions to which h.f. communication is subject (since it is of such short duration). At the same time that the electromagnetic radiation from the flare occurs there is also emitted from the solar atmosphere, according to present ideas, a stream of corpuscles, which, in the form of a cone-shaped jet, has the disturbed solar region at its apex. Though the corpuscles constituting it possess individual charges the stream as a whole is neutral, and the corpuscles travel with a velocity of approximately 1,600 km/sec. The earth in its orbit encounters this stream (if it is emitted in such a direction that this is possible) about 26 hours later. As the corpuscles approach the earth they are affected by its magnetic field, and are swept towards the magnetic poles, so that the effects which they produce are more intense in zones surrounding the magnetic poles (the auroral regions) than elsewhere. These effects are of several kinds, viz.:

1. Disturbances in the earth's magnetic field (magnetic storms).
2. Disturbances in the ionosphere (ionospheric storms) consisting of abnormal decreases in the ionization level and in the height of the  $F_2$  layer, giving rise to deteriorations in h.f. radio propagation via that layer.
3. Displays of the polar aurorae and the setting up of abnormal earth currents.

All these phenomena, it should be noted, are different effects due to a common cause, the origin of which is a flare (or a sunspot region with which it is associated) on the sun. This type of ionospheric disturbance constitutes the major form of interruption to h.f. radio services, since it generally lasts for one or two days, and sometimes for as long as a fortnight.

The problem of forecasting these disturbances, which, given an up-to-date knowledge of the positions of sunspots and the occurrence of flares, might appear to be a simple one, is, in fact, very

difficult. This is because, whilst the sequence of events leading to them appears often to be as just described, in many other cases it appears not to be so. Many ionospheric storms occur without there being a flare or even a sunspot on which to pin their occurrence, and, on the other hand, many

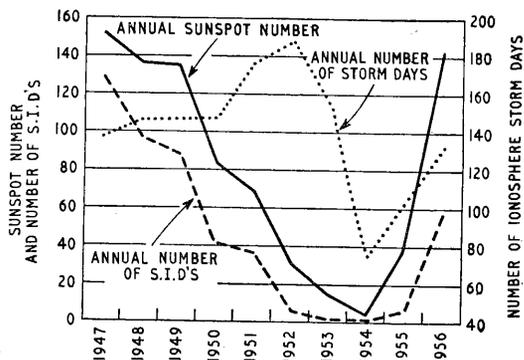


Fig. 3. Variation with sunspot activity in number of sudden ionospheric disturbances and in number of ionospheric storm days.

sunspots cross the solar disc without giving rise to any ionospheric disturbance. In short, the solar/terrestrial relations appertaining during the build-up and course of ionospheric storms are not yet properly understood, and it is well appreciated that the solar phenomena mentioned (and other solar data obtained by visual and radio means) do not correlate well with ionospheric disturbances.

In Fig. 3 the dotted curve is a plot of the annual number of days affected by ionospheric storms. In 1947, when sunspot activity was at a maximum, the number was high, having increased considerably from the previous sunspot minimum, and this was, no doubt, due to the connection of many storms with sunspots. But in 1951 when the sunspot activity was decreasing sharply, the number of storm days was increasing, and continued to increase in 1952. Only towards sunspot minimum in 1954 did the number of storm days decrease to a very low value. The 1952 peak in storm days corresponds with the well-known fact that, during the declining phase of sunspot activity, many storms of a type quite unconnected with sunspots occur. These storms show a very marked tendency to repeat themselves at 27-day intervals, and the mean period of the sun's synodic rotation, that is after allowing for the earth's motion in its orbit, is 27.3 days. Thus it is apparent that the cause of the storms is a certain region on the sun, which will always be "pointing" at the earth at approximately 27-day intervals. But these solar regions—called M regions—show no significant observable features to distinguish them from the rest of the visible disc, unless it be, as has occasionally been observed, a localized magnetic field, which may be a clue as to the special activity of the region.

Fig. 4 may be of interest in this connection. During 1953 the ionospheric storms associated with solar M regions were much in evidence, and 6th May marked the beginning of such a storm, as was evidenced by a deterioration in h.f. reception over transatlantic circuits. By calling this day and the next five days occurring at 27-day intervals from

t "zero days", and by taking the average reception quality for these circuits for the six periods about these zero days as shown, the full-line curve was obtained. This shows that there was a marked deterioration in reception during the periods following the days at 27-day intervals from 6th May. In 1955 the M-region storms had subsided and the storms which occurred may have been due to sunspots. A disturbance started on 25th May and, in the same manner as described, the dashed curve was plotted for the average of reception during six periods at 27-day intervals from it. The dotted curve is that giving the average reception during the periods around six zero days which were the days following the central meridian passage of six large sunspots during 1955, which occurred at May 21.3, June 16.4, Aug. 10.9, Oct. 7.0, Oct. 28.8 and Nov. 13.6. Neither the dashed nor the dotted curves show any significant reception variation connected with the zero days, the inference being that during 1955 there was neither a marked 27-day recurrence tendency in the ionospheric storms, nor any marked connection between the storms and the passage of the six sunspots across the sun's central meridian.

It is of interest to note that geophysicists are able to distinguish the *magnetic* storms associated with M regions from those due to other solar causes, such as sunspots. The latter are usually of the type with a sudden commencement (S-C type) as though they were produced by the sudden beginning of a corpuscular stream, whereas the recurring storms are more often of the non-S-C type, as though

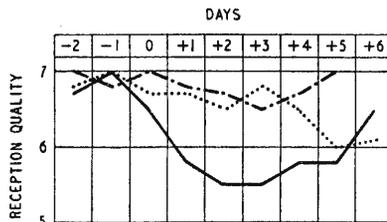


Fig. 4. Superposed epoch curves for quality of h.f. reception from eastern America based on the first day of the following events:

Full-line curve: Six 27-day intervals from 6th May, 1953.  
Chain dot curve: Six 27-day intervals from 25th May, 1955.  
Dotted curve: Day following CMP of six large sunspots 1955.

Reception quality: 7 = good; 6 = fair to good; 5 = fair.

produced by a persistent and long-lived stream. It has not, however, been possible to distinguish different types of *ionospheric* storms in this way, except by reference to their magnetic counterparts.

It will be gathered from the above—and that is the point of this discussion—that much remains to be learnt about this interesting subject, and the solar-terrestrial relations require to be better understood, before much practical use can be made of the data.

These, then, are three ionospheric problems affecting radio communications. And there remain, of course, many others. The IGY world-wide data should, when analysed and co-ordinated, throw some helpful light upon some of them.

## French Air Show

New Electronic Developments at the 22nd Salon International de l'Aeronautique

VISITORS to aeronautical exhibitions are now accustomed to a large proportion of the apparatus shown being of an electronic nature and for new systems and devices to appear each year. However, although electronics are now more important than ever for the successful and safe operation of aircraft, a period of stabilization is being reached when the accent is more on the improvement of apparatus and its reliability than on new devices.

This position was confirmed at the 22nd Salon International de l'Aeronautique held at Le Bourget aerodrome near Paris recently, where aeronautical electronic equipment from a number of countries was shown. Specifications of apparatus were more comprehensive than hitherto, and guarantees of satisfactory performance at altitudes in excess of the existing world's record were given for some of the apparatus exhibited. As an example, for such a simple device as a 75-Mc/s marker receiver aerial for use with radio ranges and instrument landing systems (ILS), Collins supply curves of the v.s.w.r. over a temperature range between  $-60^{\circ}\text{C}$  and

$+60^{\circ}\text{C}$  together with a polar diagram of reception. S.T.C. quote the aerodynamic drag of their Bent Sleeve v.h.f. aerial as 6.25 lb at 400 m.p.h. The operating life of the American DF301 airborne DF equipment is quoted both in terms of stability before readjustment of pre-set controls is required and in terms of minimum operational hours before removal for a bench test is needed, these characteristics being equated to the *g* forces, vibration and acoustic noise of very high-speed aircraft.

An examination of the latest airborne radio equipment shows that much thought is being given to rapid servicing facilities, not only for military apparatus but also for that used in civilian aircraft. If it is borne in mind that the Boeing Type 707 jet air transport is designed to carry 55,000 passengers per year across the Atlantic (equivalent to the number carried by a large ocean-going liner) the small amount of time which this aircraft can be on the ground for servicing will be appreciated. The introduction of this aircraft into regular service in the very near future will probably bring about drastic

changes in aeronautical radio and radar technique, as well as in equipment design, as it will fly at twice the altitude and twice the speed of existing airliners. As these aircraft will be entering control zones where aircraft of much slower speed are flying and, due to their high speed, will only be visible for a relatively short period on surveillance radars, their early identification will be essential. At present the procedure for identification is for aircraft to carry out a turn while under observation from the radar; such a manoeuvre would of course be unsuitable for the fast jet aircraft and to meet the new requirement Collins have introduced their Type 621A Air Traffic Control Interrogator-Transponder. With this system a directional aerial and associated transmitter and receiver are installed at the ground radar site and the aerial rotation is synchronized with that of the surveillance radar. The ground station sends out a pair of spaced pulses on a frequency of 1,030 Mc/s which is received in the aircraft. The reply is sent back from the aircraft on a frequency of 1,090 Mc/s and consists of a group of 2 to 8 pulses, each spaced by 2.9  $\mu$ sec.

Exhibits at the Paris Salon showed that transistors are gradually finding their way into aircraft equipment where they are making an important contribution to the reduction in the size of units. A typical fully transistorized item of airborne equipment was shown by Collins in the form of their "Interphone" which measures 12  $\frac{3}{16}$  in deep, 2  $\frac{1}{4}$  in wide and 7  $\frac{3}{8}$  in high and weighs about 5 lb.

For medium frequency operation transistors in their present state of development work satisfactorily and it is therefore logical that a fully transistorized radio compass should be produced for airborne use. Lear Incorporated appear to be the first manufacturers to introduce such an instrument; it is their model ADF100. A total of 23 transistors is used with the Type 2N247 in the radio frequency stages, the Type 2N139 in the i.f. amplifier and a 2N158 supplying the AF output of 150 mW. In this receiver 80% of the circuits are of etched type and of standardized (modular) construction with plug-in units to facilitate servicing. The performance of the ADF100 is equal to that of a conventional instrument, the full band from 1,705 to 190 kc/s being covered, with a sensitivity varying between 10 and 20 microvolts for a 50-milliwatt output. The compass bearing accuracy and sensitivity are  $\pm 2^\circ$  with a signal of 50 microvolts per metre. The total weight

of the equipment is under 20 lb and its current drain does not exceed 0.75 A.

Doubtless transistors will find increasing uses in aircraft, not only for radio and radar units but also for instrumentation and servo mechanisms. S.T.C. exhibited a device in this latter category, the type A1205 Transistorized Aircraft Catastrophic Warning Unit, designed to alert a pilot of an aircraft acoustically to an emergency. Normally this is done visually by warning lights on the dashboard, which illuminate in similar emergency circumstances. The A1205 Unit is connected into the circuit which normally operates these lights and it generates a sound closely resembling that of an alarm bell.

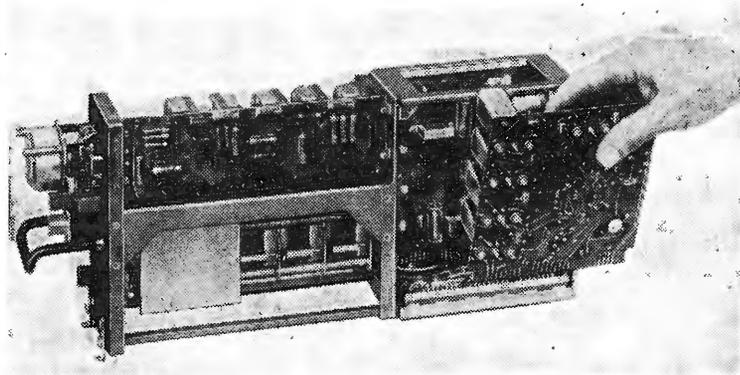
At the last Paris Salon in 1955, one prototype u.h.f. airborne equipment was shown for the first time publicly in Europe. This year one American and three French made airborne u.h.f. equipments were on view, in addition to a comprehensive range of u.h.f. ground station transmitters and receivers. The u.h.f. band lying between 225 and 399.9 Mc/s will be used exclusively by military aircraft eventually, but at present a large number of American aircraft operating in Europe are using this band for communications.

### More Channels

Operational needs with modern aircraft engaged on military duties are evidently very exacting, since, whereas in the 1939-45 war a total of 12 v.h.f. frequencies sufficed for most operational needs, today a total of 1,750 channels is required, any of which can be selected by the pilot, and 20 are needed for instant use. In addition, a guard-frequency receiver, entirely separate from the main receiver, is essential for command purposes. Such a specification has made it necessary to develop most advanced techniques in circuits and construction of sub-miniature units. In the American u.h.f. transmitter-receiver ARC52, pressurization is used to prevent flash-over at maximum altitudes of working, which are in the neighbourhood of 70,000ft. In all of the airborne equipments exhibited, printed wiring, modular construction and sub-miniature components are used. Pencil and sealed-disc valves are fitted in the r.f. circuits and cavity tuning is included in receiver input and transmitter output circuits. The table shows the main characteristics of these exhibits.

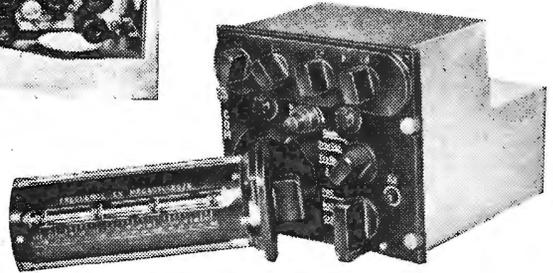
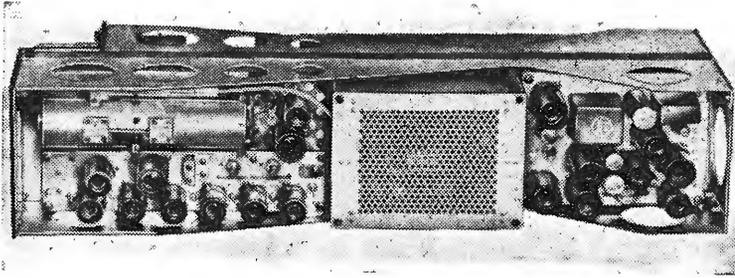


Type FR308 life-jacket beacon "transceiver" for airmen forced down in the sea.



Lear transistorized radio compass, Type ADF100.

Collins Type 621A Air Traffic Control Transponder for aircraft identification on ground surveillance radars.



Control box of S.F.R. Type SU205 u.h.f. aircraft equipment.

In the u.h.f. equipments at the Salon, all the control boxes are provided with a 20-frequency selector switch and also with a tuning arrangement consisting of four dials with which the hundreds, tens, units and tenths of megacycles are selected. The pre-setting of the 20 frequencies is very much simpler than with previous multi-channel apparatus, such as Service v.h.f. types, and is all done at the control box. A switch turret is removed and the contacts corresponding to each channel are adjusted to the frequency required by setting them up against a calibrated scale engraved on the turret.

To provide the 1,750 channels required, a master oscillator unit is used in current designs. Its output is multiplied and amplified directly up to the frequencies required for the first local oscillator in

tion on a normal radio compass dial display and has a bearing accuracy under service conditions of  $\pm 5^\circ$ , and an "indicator hunt" of one degree on level flight. It is designed to operate to altitudes of 70,000 ft and between temperature limits of  $-55^\circ\text{C}$  and  $+100^\circ\text{C}$ .

The DF aerial, which in the form of a loop flush-mounted in the aircraft fuselage, receives the signal and a mechanically-operated switch reverses the polar diagram at a frequency of 100 c/s. This switching has the effect of modulating the signal with a square wave, the amplitude and phase of which varies with the angle of the aerial. The modulated signal is fed to the receiver where it is amplified and the r.f. component is removed. The 100 c/s square wave is then passed to a phase detector which in turn feeds a saturable transformer controlling the aerial drive motor, which can turn it in either direction, and which will find the null position when the input level to the receiver is constant and there is zero error signal. A synchronous transmitter associated with the aerial motor feeds the necessary voltage to the pilot's bearing indicator.

A useful outcome of the introduction of the u.h.f. radio compass is an improvement in the Air Sea Rescue service. It is now possible to home on to a u.h.f. signal and as a consequence of this development very small transmitters, such as the British Ultra "Sarah" and the Burndep "Talbe," have been designed which can be carried in the "Mae West" life jackets worn by Service pilots and which can be used to enable search aircraft to locate "ditched" airmen. A further example of these life jacket equipments is the Type FR308 made by Telecommunications Radioelectriques et Telephoniques. This model gives a tone-modulated transmission on the u.h.f. channel of 243 Mc/s, the international distress frequency, and also has facilities for the transmission of speech and for reception of u.h.f. signals. The speech sending and receiving facilities have been included for the practical reason that it is often easier for a "ditched" airman to see the search aircraft against a background of sky than for the search aircrew to see the man in the water against a background of sea, and it has been found that if the "ditched" airman can communicate with the aircraft he can often guide the aircraft to his position.

Make	Channels	Stability	Power output (watts)	Max. working altitude ( $\times 1,000\text{ft.}$ )	No. of valves	Recvr. Sens. ( $\mu\text{V}$ )	No. of crystals	Weight
S.A.R.A.M. Type 7-50	20	$\pm 10$ kc/s	15	65	—	5	—	25 kg
S.F.R. Type SU205	20	"	10	—	65	5	18	25 kg
Derveaux Type 157B (pressurized)	20	"	9	—	—	—	21	25 kg
Collins Type ARC52 (pressurized)	19	"	20	70	43	5	36	23 kg

the double superheterodyne receiver. At the v.h.f. stage of multiplication some output is drawn for the transmitter and it is applied to a transposition stage where it is heterodyned with a crystal-controlled oscillator. This arrangement enables the same fundamental frequency to be used both for transmission and for the receiver local oscillator. The frequency of the master oscillator is held stable by a frequency-controlled stage consisting of a number of crystal oscillators operating into a phase discriminator. The output from this stage is used to control a reactor valve working directly on the master oscillator and also on the motor driving the variable tuning controls of the multiplier, amplifier and output stages associated with the transmitter; and the multiplier, amplifier and input stages of the receiver.

An interesting accessory to the u.h.f. airborne equipment, the Collins DF301, was shown for the first time in Europe. It presents bearing informa-

# LETTERS TO THE EDITOR

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

## Gramophone Reproduction

IN your June issue Mr. D. A. Barlow refers to my article in *Electronic Engineering* for May 1950 and he suggests that the three components of load on the walls of a gramophone record groove, the lateral stiffness, the lateral inertia and the vertical stiffness, do not add but that they are largely complementary.

Consider Fig. 1 where a plan of a groove is shown cut with a pulse of long wavelength and large amplitude, and superimposed on this is a short wavelength modulation. This type of cut often happens with loud music passages. The force acting on the needle due to the long wavelength pulse is equal to the product of the horizontal stiffness of the movement and the amplitude of the pulse. The force acting on the needle due to the short wavelength modulation is equal to the product of the horizontal inertia of the movement and the acceleration of the needle; the latter should not be greater than that which will be obtained when the minimum radius of curvature of the modulation is approximately equal to that of the radius of the needle tip.

Now in position A, Fig. 1, it is true to say that the inertial force acts on one groove wall and the stiffness force on the other. But in position B this is not true and the two forces add. Thus the tracking weight must be sufficient to counteract these added forces.

Fig. 2 shows a plan of a groove and the consequent vertical motion of the needle due to the pinch effect. Without modulation of the groove the needle remains in its lowest position such as at C. If the needle is pulsed vertically then no extra tracking weight is required to hold the needle down, in fact the force between the needle and the groove is increased due to the action of the vertical stiffness of the cantilever. But suppose we have a modulation giving a large-pinch effect amplitude continuing for

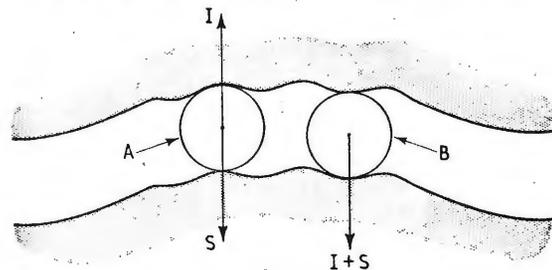


Fig. 1

a time longer than half the inverse of the low-frequency vertical resonance (and this happens often on records), then the pickup head will be raised and the needle will take up a mean position such as that shown by the line D and when the needle drops to a point such as E the vertical force on the needle will have been reduced by the product of the vertical stiffness of the cantilever and the maximum vertical amplitude (DE). This amplitude is not likely to be more than one-fifth of that I originally suggested, this later figure assumes a maximum velocity of cut of 20 cm/sec at 70 r.p.m. Unfortunately this reduction of vertical force occurs at a point when the force due to lateral stiffness and inertia is a maximum so that it is essential that the tracking weight counteract the sum of the three forces considered. Incidentally the vertical inertia may be ignored, not because it is unimportant but because its contribution to the tracking weight is small in the design of pickup considered. As the tracking weight is greater than the author suggests,

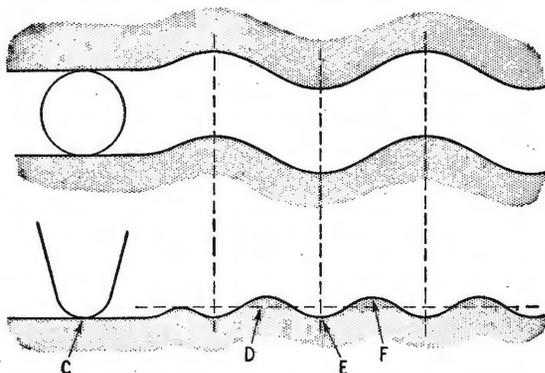


Fig. 2

the static load on the groove wall will be increased. Moreover the load will be greater still at points such as F, especially when there are only a few pulses of vertical motion. This makes the design of the pickup suggested even more difficult, perhaps impossible.

Be that as it may it is heartening to see yet one more article written by someone striving for better quality from gramophone records. The worst fault of present records is their radius or acceleration overmodulation. The recording companies are like a railway company who slowly improve their service from the "Rocket" days to the present time—the trains travel faster, are more comfortable, their meals become eatable—but they do not cure the unfortunate habit of laying their tracks with sharp corners so that the trains keep coming of the rails!

I maintain that some of the records cut before the war, e.g.—the Weingartner Beethoven Symphonies, are superior to most of those of the present day. On these old records there was a recording high-frequency cut-off at about 6,000 c/s and the modulation depth was lower than that of to-day, consequently there was no radius overmodulation. I would like better quality even at the expense of the high-frequency boost on recording which would give a noisier playback, or at the expense of the frequency response on recording which would give a consequent narrow playback frequency response, and then nobody could ask me to enthuse over the sound of pennies dropping or the spurious noises of orchestral instruments. However, as I grow older I tend towards the philosophy suggested in your June editorial and treat distortions as I do coughs and splutters in a live performance of music—something I do not like but which I must ignore.

Aldershot.

E. S. MALLETT.

I FEEL that I should comment on Mr. D. A. Barlow's remark in the May issue that "it used to be the practice of record companies to monitor the original wax or lacquer disc before plating to make the master."

It was toward the end of 1922 that I joined J. E. Hough, Ltd., to organise the Radio Research Dept. That company (which later became Edison Bell, Ltd.) was then making Edison Bell records, gramophones, and also mouldings for the radio trade, and wished to make components and sets.

At that time, horn recording was used in the studio. That is, one or more horns were coupled to a special soundbox driving the sapphire cutting stylus directly. I had not been with the firm long before it occurred

to me that with a microphone, amplifiers and some cutting device actuated electrically (as the B.B.C. did its carrier), it should be possible to record a better representation of the original sounds.

The suggestion was well received and I was allowed to make experiments on the subject when my radio work permitted. So by 1924 I was in and out of the studio quite often and had first-hand knowledge of their methods.

By 1926, the new system which used a slack diaphragm condenser microphone and a moving coil cutter was being operated, and in 1927 I spent six months with duplicate equipment on a recording expedition to Zagreb, Yugoslavia, where I recorded over 600 titles. Other foreign expeditions followed and my last trip for Edison Bell was in 1933 to Scotland where we were recording for the Beltona label. Edison Bell ceased operations in the slump that year. I can therefore claim to have an intimate knowledge of recording as practised at Edison Bell in the decade ending 1933.

During the whole of that period master waxes were never played (monitored) prior to processing. Such an idea would have been condemned instantly by everyone connected with the work, for the wax used for making masters was very soft and would most certainly have been damaged most seriously.

The idea that waxes were monitored may have arisen from the fact that certain waxes were regularly played back. The waxes used for that purpose however were of a harder texture, were called test waxes and made a hissing noise while being cut. When the music had been selected, cut to fit into the time, the musicians rehearsed etc., the usual thing was to make a trial recording on to a test wax. This was then immediately played back to the artists on a special machine.

When I was recording, I allowed any master waxes spoiled by technical or musical faults to cool off and played them privately after the session before releasing them for re-shaving. This gave me a better check on the equipment, for the better wax with its silent background was more revealing than the noisy test wax.

Needless to say, in due time pickups and loudspeakers were used for the playback system, but no matter how delicate the pickup might be, satisfactory masters were never played prior to processing.

Lacquer discs are a subsequent development and I do not know what other companies did when using these. However, I would expect that the tradition that

the master wax *must* be left intact would be carried forward indefinitely in professional circles.

Toronto.

P. G. A. H. VOIGT.

## Mobile Radio 25-kc/s Channelling Trials

THE report in your June issue (p. 256) regarding the Post Office trials of 25-kc/s mobile equipment, is not quite accurate. Trials, as recommended by the Mobile Radio Committee in fact commenced in May of this year, and are now under way using three adjacent channels in the low band and operating in the London area. They are being carried out with standard "Ranger" equipment manufactured by our Company.

The target 25-kc/s channelling specification referred to in the Committee's report, has been established with manufacturers' agreement, and is based on the same principles and requires the same degree of channel isolation laid down in the 50-kc/s specification. The Pye equipment has recently been approved to this 25-kc/s specification and some 500 "Ranger" mobiles meeting it are now in constant use in this country alone.

Our Company policy is to recommend 25-kc/s channelling equipment for all standard mobile schemes in this country even though the channels are at present spaced at 50 kc/s. At the same time all "Ranger series" equipment is readily convertible from one standard to another. In these circumstances users will have little difficulty in deciding which specification will give them maximum technical life and the minimum of channel sharing in the longer term.

Cambridge.

J. R. HUMPHREYS,

Pye Telecommunications, Ltd.

## Services Charges

MR. MAYER, in his review of colour TV in the U.S.A., refers to the "lively imagination" of those who report that an engineer is required per set installed. Your contributor has made use of a good deal of the same thing in quoting £17 as the comprehensive service charge in this country for a black-and-white 17-in receiver.

My own company offers these facilities for £7 per annum; the dearest quotation I can trace is only £9.

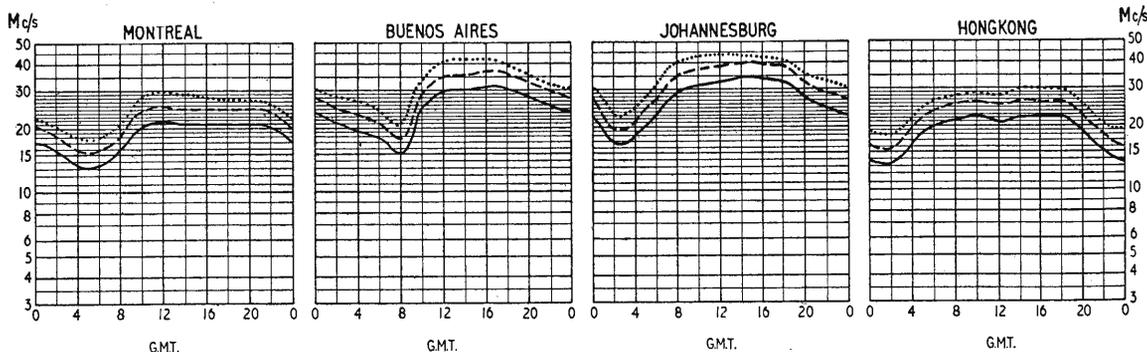
It is to be hoped that his conclusions are not coloured by any other imaginative figures of conditions in the U.K.

MAURICE SOKEL,

Edgware.

JMS Radio and Television, Ltd.

## SHORT-WAVE CONDITIONS Prediction for August



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

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

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

# Multi-Valve Cathode Follower Circuits

## 2—PRACTICAL DESIGN CONSIDERATIONS

By J. G. THOMASON, B.Sc.

(Concluded from p. 313 of the previous issue)

**T**HE various cathode followers described so far may be classed as single-stage circuits since only one valve is directly providing loop gain, other valves (or neon tubes) merely improving the gain and signal-handling capacity of this valve.

**Two-stage Cathode Follower.**—Where a greater increase in performance is required, it is logical to try to add an extra stage to the cathode follower in order to secure a larger loop gain and feedback factor. It is not a straightforward matter of adding a stage to the forward circuit as in the conventional negative feedback system, since the negative feedback in the cathode follower is inherent with the configuration and not an external connection imposed by the designer. The only way in which negative feedback may be applied to two cascaded plain amplifying stages is by making a connection from the anode of the second valve to the cathode of the first valve. The output is taken from the anode of the second valve. Both valves now give gain in the forward circuit, which is superior to the use of local feedback in individual stages.

For operation at frequencies down to zero frequency, however, an anode output terminal is often inconvenient because of the inherent large positive quiescent voltage (say, +150 V). A simple resistive d.c. coupling network connected to a negative line can be used to obtain zero quiescent output voltage, but the price paid is a higher output impedance.

For this reason it is attractive to add an extra stage in cascade with the basic cathode follower and to make a shunt feedback connection from the

cathode follower output to the grid of the first valve. A simple example of such a circuit is shown in Fig. 8, using the 12AT7 double triode. The gain of the outer negative feedback loop, via the two 1 MΩ resistors is about 12 and this reduces the output impedance of the overall circuit to about 16 ohms compared with the 200 ohms of the second triode as a simple cathode follower. The circuit will function as a feedback amplifier if the ratio of the feedback resistor (R<sub>2</sub>) to feed-in resistor (R<sub>1</sub>) values is increased above the figure of unity used in the circuit in Fig. 8. It may be shown that in any shunt feedback system the overall gain G is given by:

$$G = - \frac{R_2}{R_1} \cdot \frac{L}{1+L} \dots \dots \dots (9)$$

where R<sub>1</sub> and R<sub>2</sub> are the values of the feed-in and feed-back resistors respectively and L is the loop gain of the system. The minus sign indicates a phase reversal. By careful adjustment of R<sub>1</sub> and R<sub>2</sub> it is possible to make the circuit give an overall gain of exactly unity if required. This condition would only hold for a certain value of L, however, i.e.

$$R_2 = R_1 (1 + 1/L) \dots \dots \dots (10)$$

The quiescent output voltage of the circuit (earthed input terminal) will be positive and equal to (R<sub>1</sub> + R<sub>2</sub>)/R<sub>1</sub> times the grid bias on the left-hand triode e.g. approximately +3.5 V for the circuit values shown, corresponding to a grid-cathode voltage of -1.75 V in the left-hand valve.

The circuit is a multiple-loop negative feedback system, but as the inner loop (i.e. the output stage cathode follower on its own) is stable and the outer loop remains stable whether the inner loop is operative or not, it is quite permissible to analyse the system disregarding the fact that the cathode follower stage derives its characteristics from an inherent feedback connection.

In this circuit, however, the input impedance is no longer determined by the inherent series feedback of the cathode follower but is controlled by the overall shunt feedback, giving a low input impedance (equal to R<sub>1</sub>, approx.) which may limit the applications of the circuit as a buffer stage. Where it is desired to retain the high input impedance the added triode amplifier stage in Fig. 8 may conveniently be replaced by a long-tailed pair as shown in Fig. 9. The long-tailed pair (or "difference amplifier") now performs the dual function of mixing, i.e. subtracting the input and feed-back voltages, and also providing extra gain for the external negative feedback loop. The long-tailed pair gives only half the gain of the single stage, but this loss is conveniently offset by changing to a low current high-μ valve such as the 12AX7, since one half is no longer

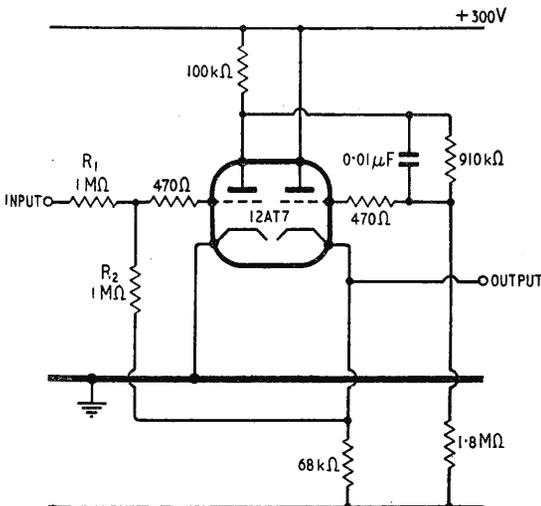


Fig. 8. Two-stage shunt feedback cathode follower.

required to function as an output stage. The loss of loop gain in the feed-back and feed-in resistors of Fig. 8 is eliminated and the circuit shown has a gain of 19 round the external loop. The feedback factor is thus 20, giving an output impedance of 10 ohms compared with the 200 ohms of the cathode-follower stage alone. Note that a control is provided for arranging to feed back only a fraction of the output voltage so that the finite feedback factor may be allowed for an exactly unity gain obtained.

A further useful feature of the circuit shown in Fig. 9 is its ability to provide a quiescent output voltage of zero. This condition is set up when the long-tailed pair is adjusted so that the two grid voltages must be equal for the current partition to be such that the anode voltage of the right-hand valve sits at the design value. The "balance" control shown enables this condition to be found since, for a given current partition, it varies the anode voltage of the left-hand valve and therefore its grid base with respect to the right-hand valve. This circuit is particularly useful where a simple buffer circuit is required which introduces neither attenuation nor d.c. shift. The long-tailed pair also assists in reducing drift due to heater fluctuations and cathode ageing, giving an improvement factor of about 10 compared with the single-ended circuits.

There are no stability problems with the multi-stage feedback circuits shown in Figs. 8 and 9. In the circuit of Fig. 8, there are two lags of almost equal time constant, at the amplifier triode anode and at its grid, a situation which can give a dangerously large phase lag when considering also the third small time constant lag at the cathode-follower cathode. The low value of loop gain in the circuit given, however, precludes the danger of oscillation and where a valve of higher gain is used, the lag at the amplifier stage grid could be removed by shunting  $R_2$  with a 22 pF capacitor. The frequency response of the overall system is restored by similarly bypassing  $R_1$  with the same value of capacitance. This stabilization method, of course, places an extra 22 pF capacitive load on the signal source.

The circuit of Fig. 9 is inherently more stable since there are only two lags, the lag of large time constant at the right-hand anode of the long-tailed pair (about  $2\mu\text{sec}$ ) and the lag of small time constant at the cathode-follower stage cathode (about  $0.005\mu\text{sec}$ ).

In both circuits the capacitor in the d.c. intervalve coupling network prevents the formation of an extra lag at the cathode-follower grid, at the expense of increasing the time constant of the lag at the preceding anode. It is, of course, standard practice in negative feedback work to reduce the number of lags to the absolute minimum in the interests of stability.

**Two Examples of Complex Multi-stage Cathode Follower Circuits.**—When two amplifying stages are added in cascade with the basic cathode follower

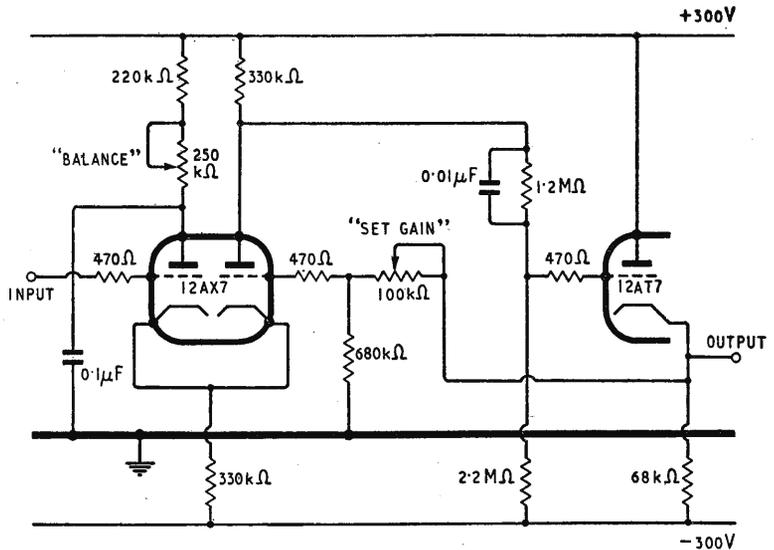


Fig. 9. Two-stage cathode follower with difference amplifier.

the individual phase reversals of the extra stages add to give no total phase reversal, and it is therefore possible to revert to cathode feedback in the first stage, as in the simple cathode follower or the two-stage a.c. circuit mentioned earlier. A simple version of this three-stage cathode follower is shown in Fig. 10, using a double triode to provide the two extra stages. Series feedback is provided by injecting almost the entire voltage from the output cathode follower into the input valve cathode. With the component values shown, the measured loop gain at 500 c/s is about 4000. At zero frequency the gain falls to about 700 due to losses in the inter-stage couplings and the local feedback caused by the cathode resistor of the input valve.

The input stage and second stage are both connected as low-consumption voltage amplifier stages, using the high- $\mu$  triode, 12AX7. The output stage is conveniently made a simple cathode-follower using a single triode, a pentode or a double triode. The output cathode-follower load is divided so that a fraction of the output may be fed back, to secure an overall gain of exactly unity for operation at very low frequencies. The quiescent output voltage may be adjusted to be zero by arranging cathode bias on the first stage as shown. With the input earthed, the 1.5 k $\Omega$  resistor and 1 k $\Omega$  potentiometer combination may be set so that their voltage drop is equal to the 1.6 volts grid bias required by the input stage plus the 3.1 volt drop across the 270-ohm resistor. The 100  $\mu\text{F}$  cathode decoupling capacitor is effective for frequencies down to about 1 c/s, and at z.f. the stage gain is reduced to one-third approximately by the presence of this cathode biasing resistance.

The feedback loop is not inherently stable since there are three lags, at each of the amplifying stage anodes and at the output cathode follower cathode. Allowing 130 pF at the first valve anode, including anode-earth capacitance (0.4 pF), Miller effect at the grid of the second valve (110 pF), and wiring capacitance (20 pF), would give a lag of time constant:  $(65\text{ k}\Omega)(130\text{ pF}) = 8.5\mu\text{sec}$ . (approx.)

The lag at the second valve anode is formed by,  
(Continued on page 375)

say 20 pF capacitance to earth, giving a time constant:—

$$(65 \text{ k}\Omega) (20 \text{ pF}) = 1.3 \text{ }\mu\text{sec. (approx.)}$$

In both cases the anode-earth resistance is calculated as the value of the load resistance in parallel with the valve differential anode resistance (80 k $\Omega$ ).

The time constant of the lag at the output is calculated from the differential resistance at the output stage cathode (100 ohms) and say 30 pF load capacitance, giving:—

$$(100 \text{ ohms}) (30 \text{ pF}) = 0.003 \text{ }\mu\text{sec. (approx.)}$$

The phase advance provided by the cathode decoupling of the input stage and the two inter-stage couplings is arranged to be distributed over the band 1 c/s to 200 c/s (approx.) and does not affect the h.f. stability of the loop. The phase advance contributed by the 100 pF capacitor shunting the 270-ohm resistor is negligible at any frequency. The simple theory of the stability of the three-lag feedback loop indicates that with these three values of time constant, a h.f. loop gain of 2,940 (approx.) or higher will make the loop unstable. This critical value of loop gain  $L$  is calculated from the formula:—

$$L = (m + n) \left(1 + \frac{1}{m}\right) \left(1 + \frac{1}{n}\right)$$

where  $m$  and  $n$  are the respective ratios of the two larger time constants to the smallest one. In this design, stability has been achieved by the common method of increasing the largest time constant, in this case increasing the time constant of the lag at the input stage anode from 8.5  $\mu$ sec. to 333  $\mu$ sec (approx.) using the 0.005- $\mu$ F capacitor shown shunting the anode load resistor.

The critical value of loop gain is increased to about 110,000, giving a generous gain margin and adequate bandwidth for most applications where circuitry with triode amplifying stages is considered appropriate. The phase margin is 90° over most of the cut-off interval. Low frequency stability is assured by the absence of a.c. couplings and the staggering of the phase-advance time constants. The output stage shown in Fig. 10 operates at 11.6 mA quiescent current and the overall output impedance is about 0.13 ohm at z.f., falling to about 0.025 ohm at 500 c/s.

The circuit shown in Fig. 10 has a very large loop gain at mid-band frequencies and if a smaller fraction of the output voltage is fed back, some of the loop gain may be conceded in exchange for overall gain. The reduced feedback is achieved simply by altering the ratio of the resistors forming the output stage cathode load, at the same time adjusting the d.c. conditions, or else changing to a.c. couplings. In this form it is usual to replace the triode amplifying stages by pentodes, when the circuit

becomes the familiar "ring-of-three" fast pulse-counting amplifier commonly used in nuclear physics.

It is important to note that in the circuit of Fig. 10, the fraction of the output voltage which must be fed back in order to secure unity overall gain has not the value (loop gain)/(1+loop gain) which was used in the shunt feedback circuits (Fig. 8). The cathode injection method of subtracting the input and feed-back voltages does not give a perfect subtraction of the grid and cathode voltages since for a fixed anode current in the first stage, the difference between the grid and cathode voltages varies with the working anode-cathode voltage (screen-cathode voltage for a pentode). The ratio is simply the amplification factor  $\mu$  of the first valve and it is seen that even if the stages following the input valve gave infinite gain, it would still be necessary to feed back a fraction  $\mu/(1+\mu)$  of the output voltage in order to secure an overall gain of unity. In the circuit shown in Fig. 10, the  $\mu$  of the first valve is 100 and with a loop gain of 700 at z.f., it is necessary to feed back about 1/90 of the output voltage to obtain unity overall gain at low frequencies and z.f. The overall gain stability must therefore be controlled largely by the characteristics of the first valve, however high the loop gain. Several ingenious refinements are available to remove this weakness of the circuit, the simplest being to use a pentode input stage with a.c. bootstrap screen decoupling, similar to the circuit in Fig. 6 in the first part of this article.

Imperfect signal subtraction caused by the changing valve operating conditions also occurs in the long-tailed pair. In the circuit of Fig. 9, for example, variations in the "tail" current of the double triode necessitates feeding back an appreciably larger voltage to the right-hand grid than the fraction (loop gain)/(1+loop gain), to give unity overall gain. For example, suppose the "balance" control in Fig. 9 has been adjusted so that with zero input

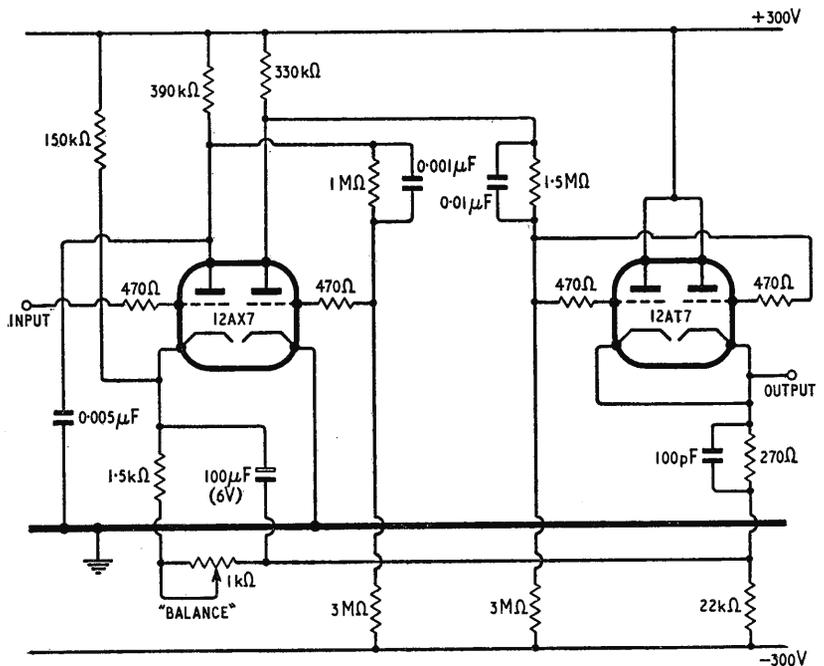


Fig. 10. Three-stage cathode follower.

voltage the two grid voltages need to be equal to produce a given voltage at the right-hand anode (say +150 V, which would give zero output voltage from the output cathode follower). If the left-hand grid voltage is now made, say +50 V, the +150 V at the right-hand anode will only be restored if the right-hand grid voltage is made slightly lower than +50 V. The common cathode voltage has increased, also by about 50 V, turning on an extra 0.15 mA in the 330 kΩ common cathode "tail" resistor. All this extra current, however, must flow into the left-hand triode since the current in the right-hand triode is constant, by virtue of its assumed fixed anode voltage. It is seen, therefore, that the grid of the left-hand valve will need to become more

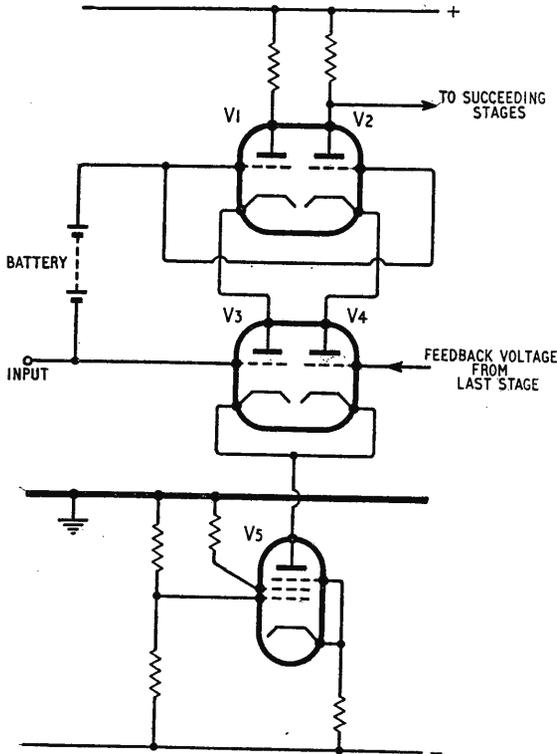


Fig. 11. Basic precision difference amplifier (Benjamin and Tomlin).

positive than that of the right-hand grid by a voltage equal to the increase in current divided by the working mutual conductance, in this example:—

$$\frac{0.15\text{mA}}{1\text{mA/V}} = 0.15 \text{ volt}$$

Both grid-cathode voltages must now be less since both valves have suffered a reduction of 50 V in anode-cathode voltage whilst one passes the same current as previously and the other even more current. In general, however, the simple long-tailed pair is a better difference amplifier than the cathode-injection stage, since the unbalance for a given input voltage is seen to depend on (mutual conductance) × (tail resistor), which can be made appreciably higher than the  $\mu$  of a single stage without bootstrap refinements.

The major source of imperfection in the long-tailed pair difference amplifier can be removed

by replacing the "tail" resistor by a good approximation to a constant current generator. The simple pentode "tail" as used in Fig. 7 of the first part of this article is usually convenient, giving a differential anode resistance of tens of megohms for values of  $R_o$  of about 2 or 3 kΩ, with the grid returned to a voltage of between +10 V and +20 V referred to the lower end of  $R_o$ . The long-tailed pair using this refinement is capable of good accuracy, since the extra "tail" current turned on or off with varying cathode voltage can be made negligible.

Even when the valves in the long-tailed pair are operated at constant current, the changing anode-cathode (or screen-cathode) voltage will cause slight unbalance unless the valve characteristics are identical. An ingenious circuit\* for overcoming this problem has been reported by Benjamin and Tomlin. Auxiliary cathode followers are used to maintain a constant anode-cathode voltage in each valve of the long-tailed pair, even though the input voltage is varying. The basic circuit is illustrated in Fig. 11, where V3 and V4 form the input long-tailed pair of a feedback circuit and V1 and V2 are cathode followers which maintain the anodes of V3 and V4 at a voltage  $e_b$  higher than that of the input grid, whatever the input voltage. The valve V5 provides an almost constant current to the common cathodes of V3 and V4. The load resistors for V3 and V4 are transposed to the anodes of V1 and V2 as shown.

In practice, the battery might be replaced by a neon tube connected to the long-tailed pair cathode (similar to the circuit of Fig. 5 in the first part). Alternatively where further stages are used to give a high loop gain, a method described by Benjamin and Tomlin is more convenient. In Fig. 12, V3 and V4 form the precision long-tailed pair triodes, using V1 and V2 to maintain substantially constant anode-cathode voltages and V5 to maintain substantially constant anode currents. The output from the precision long-tailed pair is taken from the anode of V1 and direct-coupled to the amplifying stage V6 as shown. The coupling between V6 and the output cathode follower V7 uses a further constant-current network. The high differential anode resistance of V8 ensures that almost the full voltage excursion at the anode of V6 appears at the grid of V7. When the overall gain is made unity, the output voltage will exactly equal that at the input and also the voltage on the grid of V7 will be almost equal to that at the output, being slightly larger in fact, due to the slight loss in V7. Due to the absence of attenuation in the coupling network between V6 and V7, it may therefore be assumed that at the tapping point in the resistors in this coupling network, the voltage is also equal to that at the input, except for a positive bias, and a tapping point may therefore be chosen to provide the correct drive voltage for the cathode followers V1 and V2.

The z.f. loop gain of the circuit in Fig. 12† is about 10,000 and it is seen that a fraction (loop gain)/(1 + loop gain) of the output voltage is fed back to the input precision long-tailed pair, no allowance being made for imperfect subtraction of the two grid voltages.

The 500-ohm "balance" potentiometer in the cathode circuits of V3 and V4 enables the output

\* Included in a publication of the Royal Naval Scientific Service (May, 1954)

† This is a variant suggested by the author.

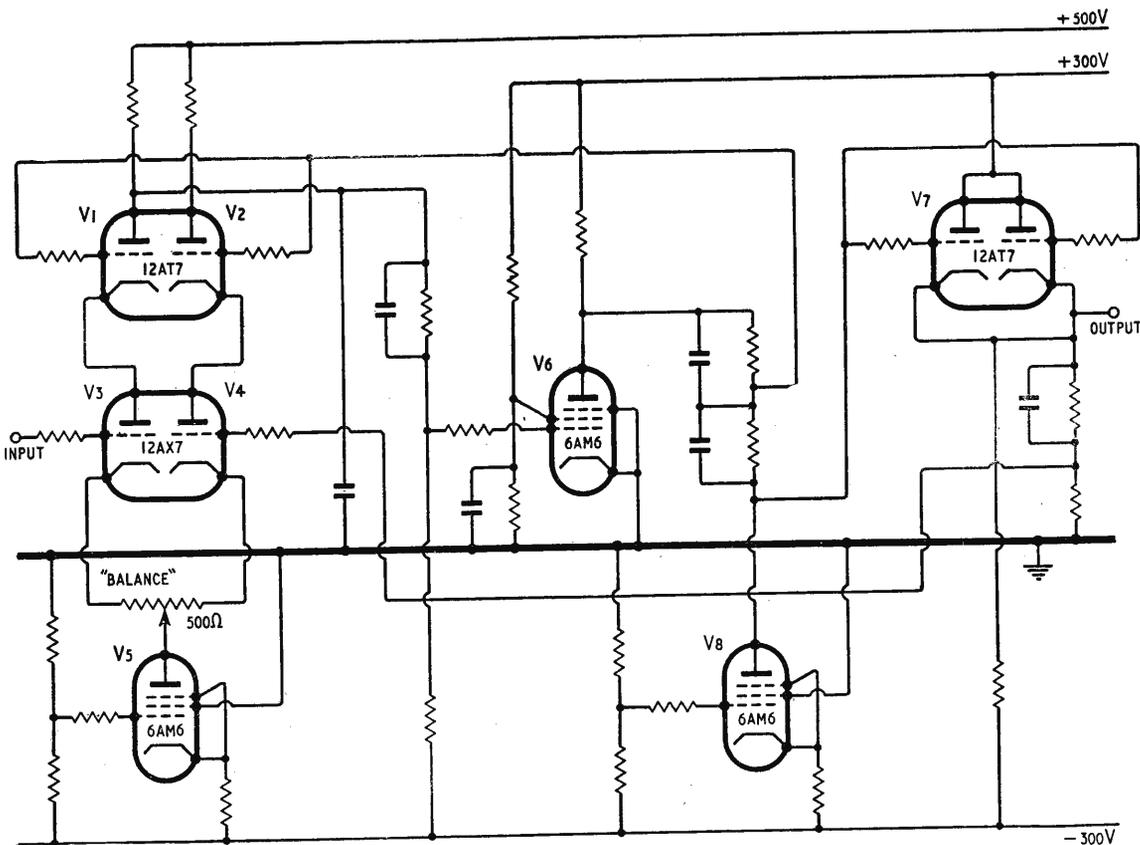


Fig. 12. Multi-stage cathode follower with precision difference circuit.

to be set to zero for zero input, and this initial adjustment for V3 and V4 grid-base symmetry once set, should be independent of the varying input voltage. The h.f. gain is about twice the z.f. gain due to the z.f. loss in the coupling network at the grid of V6.

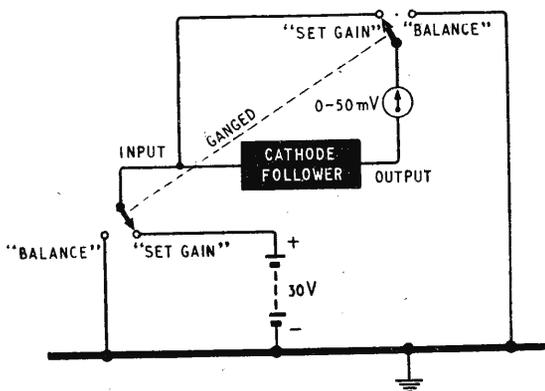
The loop gain is quite high and, as in the circuit of Fig. 10, it is necessary to increase the time constant of one of the lags in order to ensure h.f. stability. The anode load resistor of the second triode is shown padded with the  $0.01 \mu\text{F}$  capacitor, choosing a point in the loop where the signal level is small so that the

increased time constant is less likely to cause overloading with high-frequency signals.

It is interesting to note that in the precision long-tailed pair, the triodes V3 and V4 (Figs. 11 and 12) are enabled to give a stage gain of the full value of their amplification factor  $\mu$ , by virtue of their constant anode-cathode voltages.

**Setting-up Procedure for Unity Gain Cathode Followers.**—A simple but effective method of setting the “balance” and “set gain” adjustments for a multi-valve cathode follower of the types discussed (except that of Fig. 8 which gives an overall phase reversal) is illustrated in Fig. 13. The 0-50 mV meter is switched as shown to read either output with earthed input (“set balance” position), or the difference between output and input (“set gain”) position. Progressive setting of each control alternately until the meter reads zero in both positions is seen to set up the conditions of zero quiescent output voltage simultaneously with exactly unity gain for a 30-V, signal (i.e. about half the overload level). For the circuits with extremely high loop gain (Figs. 10 and 12), a somewhat more sensitive millivoltmeter would be necessary if the setting is required to the utmost accuracy made possible by the precision of the circuits.

Fig. 13. Test circuit for cathode followers.



**“Portable Transistor Receiver”:** An  $8\text{-}\mu\text{F}$  electrolytic capacitor ( $C_{33}$ ) should be inserted in the lead from  $R_{14}$  to the earth line in the circuit diagram of this set on page 341 in the July issue. It should be connected with the positive lead to earth.

# Limiters and Discriminators for

## 5.—MEASUREMENT OF A.M. SUPPRESSION RATIO : TYPES OF LIMITER

**T**HE purpose of a limiter stage in a f.m. receiver is to reduce the magnitude of the amplitude-modulation component of an applied signal. The performance of a limiter may be judged by the degree of reduction of the modulation depth which it achieves, and this degree of reduction may be termed the a.m. reduction factor. However, a figure for the reduction of the modulation depth would not be directly applicable to self-limiting detectors such as the ratio detector. Furthermore, many discriminators have some degree of inherent a.m. rejection. For example, with a perfectly balanced Foster-Seeley discriminator there is zero output when the carrier is at the centre frequency and hence no output if the carrier is amplitude modulated. Thus a criterion is required which provides a figure of merit for a combination of limiter and discriminator, and which is applicable to self-

ment of the a.m. suppression ratio is that recommended by the B.B.C. Research Dept. The modulation depth of both a.m. and f.m. components of the test signal is 40 per cent ( $\pm 30$  kc/s frequency swing for the f.m. component) and the frequencies of the f.m. and a.m. components are 100 c/s and 2 kc/s respectively. The measurement is carried out as follows.

The apparatus under test is fed from a signal generator which can be modulated simultaneously in amplitude and frequency. The a.f. output is fed to a power-measuring instrument, preceded by a standard aural weighting network. (This network has a frequency response substantially flat in the region of 2 kc/s, where measurements are made, and therefore does not appreciably affect the measurements, save in exceptional circumstances, as, for example, when the a.m. component produces a substantial output of high-order harmonic components.) The input signal is set to the required amplitude for the test, and is first modulated by f.m. only to a swing of 35 kc/s by a signal at 2 kc/s. The a.f. power output  $P_1$  is then measured. (If the apparatus under test is a complete receiver, the gain control is adjusted to give the standard power output of 50 mW). The value of 35 kc/s frequency swing is greater than the modulation depth of 40 per cent specified, and is used to allow for the effect of a 50 microsecond de-emphasis network, so that the a.f. power output is the same as that which would be obtained with a signal of  $\pm 30$  kc/s frequency swing at 100 c/s.

The frequency-modulating signal is then set to 100 c/s, and the frequency swing to  $\pm 30$  kc/s. The amplitude modulation signal at 2 kc/s is then applied, with a modulation depth of 40 per cent. The fundamental-frequency component in the output due to the frequency modulation is then filtered out by means of a high-pass filter having a cut-off frequency of 250 c/s. The a.f. power output  $P_2$  due to the remainder of the signal is then measured. The a.m. suppression ratio is then the ratio of  $P_1$  to  $P_2$  expressed in decibels.

It was mentioned earlier that the Foster-Seeley discriminator has some degree of inherent a.m. rejection, and its a.m. suppression ratio can be calculated as follows. In an ideal discriminator of this type, the a.f. output is very nearly equal to  $I_f$ , over a region near the centre frequency, where  $I$  is the magnitude of the input signal current, and  $f$  is the difference between the signal frequency and the centre frequency. If the input current  $I$  is amplitude modulated, its value is given by  $(1+m \cos \omega_2 t) I$ , where  $m$  is the amplitude modulation depth expressed as a fraction,  $\omega_2 = 2\pi f_2$ , and  $f_2$  is the frequency of the a.m. component. If the f.m. component has a frequency of  $f_1$ , then the a.f. output is proportional to  $(1+m \cos \omega_2 t) \cos \omega_1 t$ . Such an output gives rise to oscillograms of the type shown in Fig. 1. The expression for the a.f. output

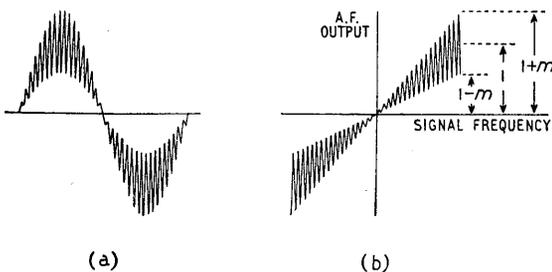


Fig. 1. Oscillograms of a.f. output from perfectly balanced Foster-Seeley discriminator with input signal simultaneously modulated in amplitude and frequency (a) with sawtooth time-base (b) f.m. component applied to X plates as time base.

limiting discriminators. Such a criterion is obtained by employing a test signal modulated simultaneously in frequency and amplitude, and measuring the ratio of the components of the output signal due to the two components of the signal modulation respectively. This criterion is termed the *a.m. suppression ratio*. If a limiter has a given a.m. reduction factor, it would appear that its effect, in combination with a given discriminator, would be to increase the a.m. suppression ratio by an amount equal to the a.m. reduction factor. However, this is not always true as the limiter may introduce spurious f.m. in the course of its limiting action.

However, there is general agreement as yet as to the test conditions to be employed in making a measurement of a.m. suppression ratio; the result is that any one device may have a number of values of a.m. suppression ratio, depending on the conditions of measurement. There is also the undesirable result that the minimum figure for the a.m. suppression ratio of a receiver, under given conditions of operation, is subject to a margin of uncertainty, unless the conditions adopted for the measurement of the a.m. suppression ratio are defined. In this article, the definition and measure-

# F.M. Receivers

By G. G. JOHNSTONE\*, B.Sc.

(Concluded from page 280 of the June 1957 issue)

waveform is precisely similar to the expression for an amplitude-modulated carrier. It can be resolved into three components, corresponding to the carrier and sidebands of an a.m. signal. However, the "carrier" component in this case is the fundamental frequency component of output due to the frequency modulation, and the power output due to this component alone may be taken as unity. When this component due to the frequency modulation is filtered out, there remains two components due to the amplitude modulation. These are of equal amplitude,  $m/2$ , and have frequencies  $(f_1 - f_2)$  and  $(f_1 + f_2)$ . With the test frequencies postulated, i.e., 100 c/s for the f.m. component and 2 kc/s for the a.m. component, these two residual components of the a.f. output have frequencies of 1900 c/s and 2100 c/s. The total power output is then proportional to  $2(m/2)^2 = m^2/2$ . With the value of  $m$  postulated, 0.4, this power output is proportional to 0.08. Thus the ratio of the power outputs due to the f.m. component to that due to the a.m. component is 1 : 0.08, i.e., some 11 dB. However, this figure includes no allowance for the effect of the de-emphasis network, which introduces a loss of some 1.5 dB in the region of 2 kc/s; thus the value of the a.m. suppression ratio is some 12.5 dB.

The effect of a change of test conditions upon the value of the a.m. suppression ratio can be judged from the foregoing; if the amplitude modulation depth used had been 30 per cent., the a.m. suppression ratio would be 15 dB.

If the input signal carrier frequency is not precisely at the centre frequency of the discriminator characteristic, the a.m. suppression ratio alters. The output signal, with the input signal simultaneously modulated by a.m. and f.m., is then proportional to  $(1 + m \cos \omega_2 t)(F \cos \omega_1 t - f_0)$ , where  $f_0$  is the displacement of the carrier frequency from the centre frequency of the discriminator, and  $F$  is the frequency swing of the f.m. component. The types of oscillogram obtained under these conditions are shown in Fig. 2. In addition to the two components, each of amplitude  $m/2$  relative to the fundamental frequency f.m. component, discussed previously,

Fig. 2. Carrier frequency displaced by frequency  $f_0$  from centre frequency.

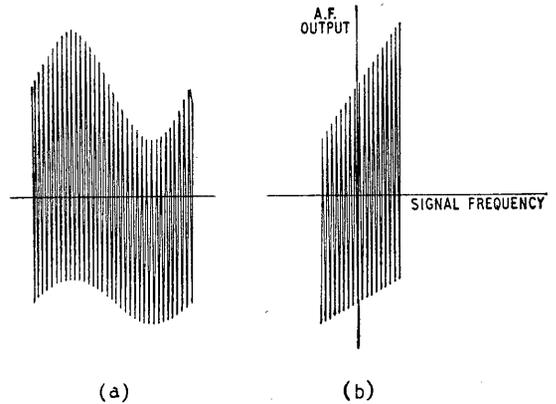
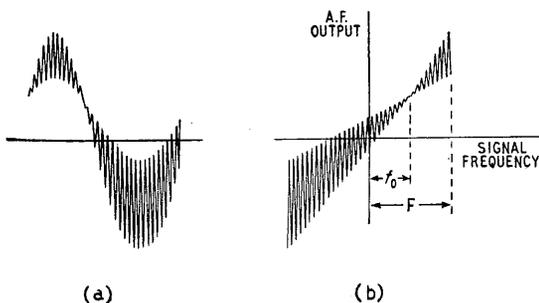


Fig. 3. Oscillograms of a.f. output from a counter-type discriminator with input signal modulated simultaneously in amplitude and frequency (a) with sawtooth time base (b) f.m. component applied to X plates as time base.

there is now a further a.f. component of amplitude  $mf_0/F$  at the a.m. modulating frequency  $f_2$ . The power output due to the a.m. component is thus increased to  $(m^2/2) + (m^2 f_0^2 / F^2)$ . If, for example, the carrier frequency is displaced 30 kc/s from the centre frequency, the power output due to the a.m. component rises from 0.08 to 0.24, i.e., the a.m. suppression ratio falls by some 4.8 dB. to 7.7 dB.

This special case was considered because it can be extended to other discriminators. For example, the counter-type discriminator gives zero output at zero frequency, and its output is proportional to the input signal amplitude and the signal frequency. Thus if a counter-type discriminator is operated at a centre frequency of 200 kc/s, a typical figure, the value of  $f_0$  is 200 kc/s. The type of oscillogram obtained with the input signal modulated simultaneously in amplitude and frequency is shown in Fig. 3. Applying the formulae given previously, the a.m. suppression ratio is - 6.1 dB. Thus a counter-type discriminator requires that very careful attention be given to the performance of the preceding limiter.

The minimum desirable value for the a.m. suppression ratio measured in the manner described above, depends upon the type of a.m. interference encountered, and upon the class of service desired. For a broadcasting service, giving a signal output of good quality, a minimum value of 30 dB would seem to be necessary, and it would appear preferable that the ratio should be greater than 35 dB. It is doubtful if any aural change is perceptible if the value is increased beyond 40 dB.

Although the a.m. suppression ratio provides an excellent criterion of performance, another important factor must not be overlooked. This is the range of input signal amplitude over which a.m. rejection is maintained. The test for a.m. suppression ratio

\*B.B.C. Engineering Training Dept.

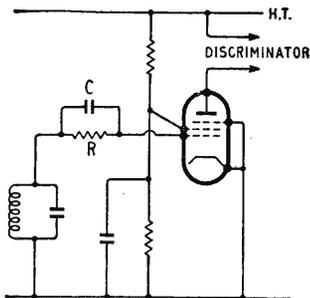


Fig. 4. Basic circuit of grid limiter.

explores limiting performance over a range of 40 per cent. modulation depth, but it is important to know the maximum modulation depth which the limiter can handle. Dependent upon the type of limiter, there may be a minimum signal amplitude below which limiting action fails, or alternatively, there may be a maximum modulation depth which the limiter will handle. In general, limiting action fails when the signal amplitude is decreasing. If the limiter has a minimum value of input signal below which limiting action fails, the limiter is said to have a threshold value. The maximum modulation depth in the "downward" direction then varies with the amount by which the mean signal amplitude exceeds the threshold. With limiters of the type which have a fixed "downward" modulation handling capacity, there is no fixed threshold. However, with such limiters, the a.m. suppression ratio generally falls with mean carrier amplitude, and there is thus a quasi-threshold fixed by the input signal amplitude above which the a.m. suppression ratio is satisfactory.

For most purposes, it would seem desirable that satisfactory limiting action should be maintained for "downward" modulation of 50-70 per cent., although in some locations the depth of amplitude modulation due to reflections may exceed this value. Thus if a limiter has a threshold input of 1 volt for satisfactory limiting, the mean carrier level should normally be greater than 2-3 volts. With a limiter or self-limiting discriminator (e.g., ratio detector), having maximum "downward" modulation handling capacity, this modulation handling capacity is fixed in the course of design and should be in the region 50-70 per cent.

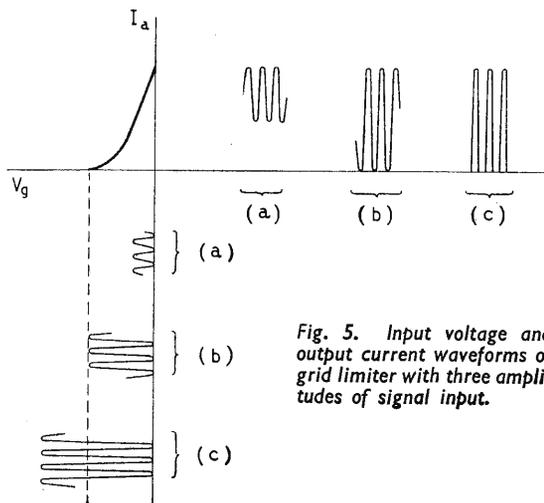


Fig. 5. Input voltage and output current waveforms of grid limiter with three amplitudes of signal input.

**Grid Limiter.** The grid limiter has been widely used in f.m. receivers, particularly in conjunction with Foster-Seecley discriminators. It comprises a pentode operated with a low screen voltage, fed at the control grid through a self-biasing network, as shown in Fig. 4. No cathode bias is usually employed, and one of the reasons for employing a low screen voltage is to prevent the valve drawing excessive current in the absence of an input signal. The low screen voltage also results in the valve having a short working grid-base, so that the limiting action commences with a relatively small input. The action of the circuit is as follows.

The grid and cathode of the valve function as a diode detector. When the input signal is positive-going, grid current flows at the tip of the cycle, and the capacitor C is charged, biasing the valve. With a reasonably large value grid resistor R (i.e., large compared with the resistance of the grid-cathode path when conducting), the bias so adjusts itself that grid current flows only on the tips of the positive peaks of the input signal. As the input signal amplitude increase from zero, the valve behaves first as a class A amplifier. When, however, the input signal amplitude exceeds half the cut-off bias, the valve is driven beyond cut-off on the negative-going peaks of the signal. As the input signal amplitude increases still further, the periods when the valve conducts become progressively shorter, as shown in Fig. 5.

The resultant anode current waveform may be

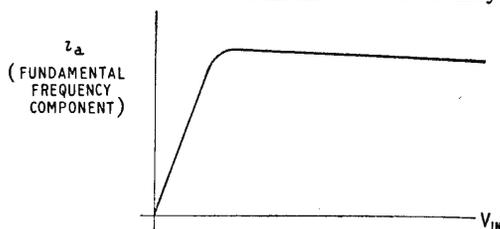


Fig. 6. Fundamental frequency component of anode current plotted against input voltage for typical grid limiter.

analysed into components at the input signal frequency, and harmonics of this frequency. We may plot this fundamental-frequency component against input signal amplitude and obtain a curve of the type shown in Fig. 6. It will be seen that this fundamental-frequency component rises linearly at first with increasing input signal amplitude, until a "threshold" is reached, beyond which the output current is substantially independent of input signal amplitude. With a typical circuit of this type, comprising a pentode having a screen voltage of the order of 40-50 volts, the threshold input signal is of the order of 1 volt.

In practice, the portion of the curve above the threshold is not flat, but generally tends to fall slowly. This tendency may be minimized by careful choice of screen feed resistor, anode feed resistor and grid resistor. The selection of these components is usually done on test. A well-designed grid limiter will have an a.m. reduction factor of the order of 20-30 dB.

The grid limiter of the type described above has one major disadvantage. This is bound up with the time constant CR of the grid circuit components.

(Continued on page 381)

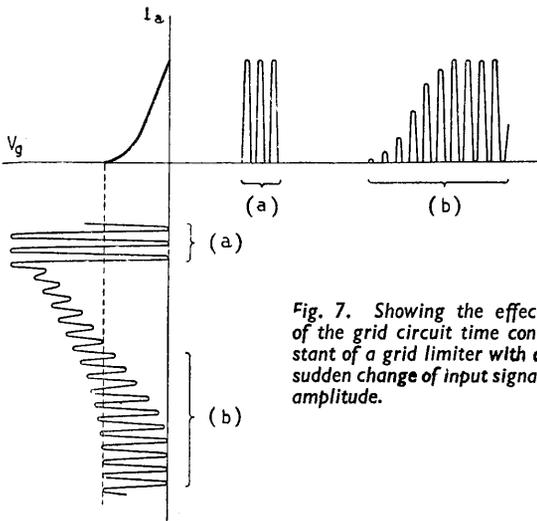


Fig. 7. Showing the effect of the grid circuit time constant of a grid limiter with a sudden change of input signal amplitude.

For satisfactory operation, the bias developed across the capacitor  $C$  should change instantaneously with any change of signal amplitude so that the positive-going peaks of the signal are always at zero bias. With an increasing signal amplitude, this condition is very nearly fulfilled, since the capacitor is charged through the relatively low resistance of the grid-cathode path. When, however, the input signal amplitude falls, the capacitor has to discharge through the resistor  $R$ , and whilst this is happening, the amplitude of the signal may be insufficient to cause the valve to conduct at all, or only partially. This is shown in Fig. 7. Thus, to ensure rapid discharge of the capacitor when the signal amplitude is decreasing, the time constant  $CR$  must be small. The desirable value of the time constant depends upon the maximum rate of change of input signal encountered, and the problem is the same as that of avoiding "tracking" distortion in conventional diode detector. It can be shown that this form of distortion can be avoided if  $CR < 1/2\pi f m$ , where  $f$  is the modulation signal frequency, and  $m$  is the maximum modulation depth. To consider the simplest case, co-channel interference, if the wanted signal is at one extreme of the frequency swing, and the unwanted signal is at the other, the wanted signal will be amplitude modulated at a rate of 150 kc/s. If the ratio of wanted to unwanted signal is 2:1, then  $m$  is 0.5, and in this case  $CR$  must be less than 2.1 microseconds approximately. In practice a value in the region of 2.5 microseconds is frequently adopted.

The choice of values for  $C$  and  $R$  individually is limited in two ways. If  $C$  is made small, a capacitance potential divider with the input capacitance of the valve is formed, and the signal appearing at the grid is materially reduced. Thus there is a lower limit to the value of  $C$  which can be tolerated; if the valve input capacitance is 10 pF, this minimum value is of the order of 20 pF. If the value of  $R$  is reduced, the damping of the tuned circuit feeding the limiter is increased. Since the grid and cathode of the valve behave as a diode detector, the damping resistance is given by  $R/2\eta$ , where  $\eta$  is the rectification efficiency of the circuit. Thus if the preceding circuit has a dynamic resistance of 20 k $\Omega$ , the

minimum value of  $R$  would appear to be in the region of 40 k $\Omega$ , giving a reduction of approximately one-half in the working  $Q$ -value of the tuned circuit feeding the limiter. Values of  $C$  and  $R$  often adopted for a time constant of 2.5 microseconds are 50 pF and 47 k $\Omega$  respectively.

There is one variant of the grid limiter which is worthy of special mention. This is the form of grid limiter in which the valve employed has a high input resistance at the input grid, even when driven positive with respect to the cathode. Valves of this type have been discussed before in the section on gated-beam discriminators. Thus the valve type 6BN6 may be employed, and because of its high input resistance, it may be operated without the grid-current biasing network. The valve is biased to a class A operating condition in the absence of a signal by the cathode components, and when the signal amplitude is sufficiently large, square waves of anode current are generated, the magnitudes of which do not vary appreciably with input signal amplitude above the threshold value. This type of limiter thus has the advantage over the conventional type of grid limiter that its operation is not affected by the action of the grid circuit time constant. The damping presented to the input circuit under operating conditions is of the order of 20 k $\Omega$ .

A similar type of action to that described above may be secured with a normal pentode by inserting a resistor in series with the grid as shown in Fig. 8. When the signal drives the grid positive with respect to the cathode, the series resistor limits the flow of grid current, and ensures that the grid is not driven appreciably positive with respect to the cathode. The behaviour of the circuit is thus essentially similar to that of the 6BN6 type of limiter described above, the input signal driving the valve between anode current cut-off and its value at zero bias. However, there is one major disadvantage

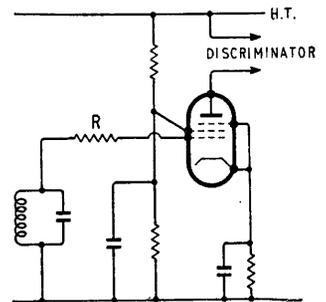


Fig. 8. Series-resistor grid limiter.

of this circuit: it is not suitable for use at high frequencies because of the effect of the grid-cathode capacitance of the valve. This, in conjunction with the series resistor, introduces a loss of signal increasing with increasing frequency. The circuit is thus useful only for maximum frequencies of the order of hundreds of kilocycles per second.

Another form of grid limiter sometimes used has a tuned circuit directly coupled to the grid of a pentode stage operated with a small bias. Grid current then damps the circuit, and gives a limiting action.

**Anode Limiter.**—The anode limiter relies for its action upon the existence of the "knee" of the  $I_a$ - $V_a$  characteristic of a pentode. The valve is operated with a high value of anode load impedance,

so that when the grid voltage is a few volts negative, the anode voltage "bottoms" at the value given by the intersection of the load line and the portion of the  $I_a$ - $V_a$  curve below the "knee" of the characteristic, as shown in Fig. 9. The anode-current/grid-voltage characteristic is modified by the "bottoming" action to the form shown in Fig. 9(b). If the valve is biased to the working voltage  $V_g$  indicated in Fig. 9(b), symmetrical limiting of the input wave form occurs. Such a limiter was described by Scroggie\* for use with a counter-type discriminator with the added refinement that a series grid resistor was used to assist the limiting action when the grid-cathode voltage was driven positive.

**Dynamic Limiter**—The dynamic limiter operates by presenting a varying impedance to a source of signal, the impedance varying in such a way as to tend to maintain the output signal at a constant amplitude. In its simplest form the circuit is shown in Fig. 10. We shall assume that the diode has a very low forward resistance compared with its load resistance. Then under quiescent conditions, the damping of the tuned circuit by the diode circuit is approximately equivalent to a parallel resistance  $R/2$ . This resistance is usually comparable with, or less than, the dynamic resistance of the tuned circuit. The time constant of the load circuit of the diode is made large compared with the period of the a.m. signals it is desired to suppress. Under quiescent

conditions the diode load capacitor charges to a voltage just less than the peak signal voltage. If now the signal amplitude tends to increase, the diode will take increasing current on the peaks of the signal, in an attempt to increase the voltage across the capacitor. If the capacitor is large, however, the voltage across it cannot increase appreciably and the damping of the tuned circuit will increase, so that the load presented to the driving valve falls, and the gain from grid to anode decreases. The decrease in gain largely offsets the increase of input signal amplitude, so that there is only a small change in output signal amplitude.

If the input signal amplitude decreases, the opposite effect occurs, the damping decreasing, so that the driving valve gain rises, offsetting the fall in signal amplitude.

However, there is a lower limit below which the limiting action ceases. This occurs when the signal across the tuned circuit falls below the voltage across the diode load capacitor, and the diode fails to conduct on the peaks of the signal. Below this signal amplitude, the driving valve behaves as a linear amplifier. The range over which limiting is maintained can be calculated from the graph of Fig. 11. The curve of  $E=R_d i$ , where  $R_d$  is the dynamic resistance of the tuned circuit, shows the relationship between the output voltage and the current supplied by the driving valve in the absence of the diode circuit. The curve of  $E=R' i$  is the curve obtained when diode limiter is connected,  $R'$  being equal to

\* Wireless World (April, 1956)

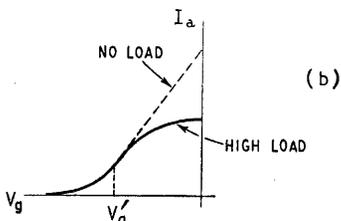
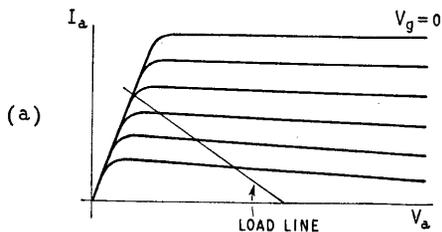


Fig. 9 (a) Showing the "bottoming" effect occurring with an anode limiter with a high-value anode load. (b) Modification of the  $I_a$ - $V_g$  curve of the valve by the high-value anode load.

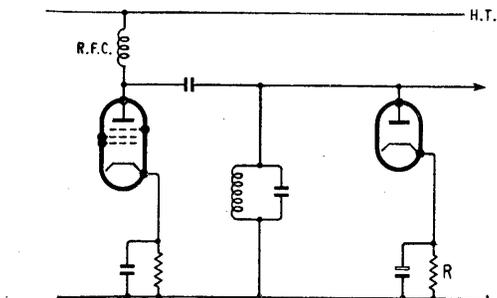


Fig. 10. Basic circuit of dynamic limiter.

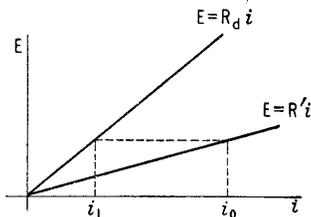


Fig. 11. Showing graphical construction for determining maximum "downward" modulation handling capacity of dynamic limiter.

$R_d$  in parallel with  $R/2$ , the equivalent damping resistance due to the diode circuit (the diode rectification efficiency is assumed 100 per cent.). In plotting this graph, the input current is assumed to change its amplitude very slowly, so that at each stage the diode load capacitor charges to the peak value of the output voltage.

Under dynamic conditions, when the input signal amplitude decreases from the quiescent value  $i_0$  the charge on the diode load capacitor does not have time to change appreciably, and the output voltage amplitude remains constant until the input current falls to the value  $i_1$ , when the diode ceases to conduct; the equivalent damping resistance due to the diode circuit is then infinite. If the input current decreases further, the output voltage falls linearly, following the curve  $E=R_d i$ . Thus the maximum "downward" modulation depth which the limiter will suppress is given by  $(i_0 - i_1)/i_0$ . From the geometry of the figure, this modulation depth is given by  $1 - (i_1/i_0) = 1 - (R'/R_d)$ . But  $R' = R_d(R/2)/(R_d + R/2)$ , so that this maximum value is given by  $R_d/(R_d + R/2)$ . Thus for good "downward" modulation handling capacity,  $R_d$  must be large compared with  $R/2$ . This means that the tuned circuit is heavily damped under quiescent conditions, and hence the gain of the driver stage is low.

Because a diode employed in a practical circuit

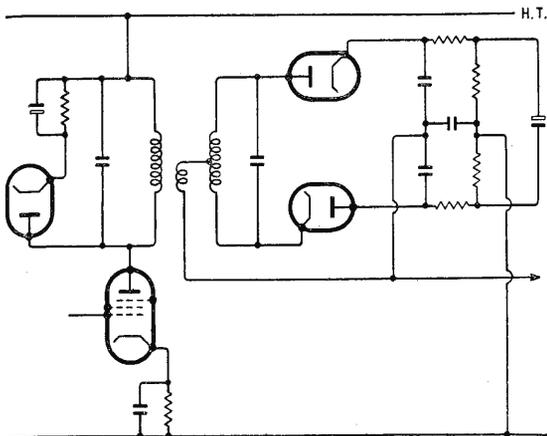
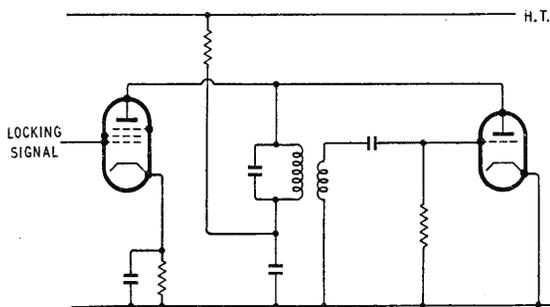


Fig. 12. Ratio detector with added dynamic limiter.

Fig. 13. Basic locked-oscillator circuit.



cannot have 100 per cent. rectification efficiency, the limiting action is not perfect, and the a.m. reduction factor is usually of the order of 10-20 dB. This type of limiter offers no protection against long-term changes of input signal amplitude or slow flutter due to reflections from aircraft, as the diode load capacitor will charge to the mean value of the input signal amplitude. It has, however, the advantage that the limiting action is maintained over a constant range of modulation depth at all levels of input signal amplitude, down to the quasi-threshold value at which the diode efficiency falls to the point where the limiting action is seriously impaired.

The damping imposed on the tuned circuit under operating conditions varies with the amplitude modulation of the input signal, and so, therefore, does the pass band of the tuned circuit.

The dynamic limiter may be employed with advantage in combination with those forms of limiter/discriminator where the a.m. suppression ratio falls somewhat short of the desirable value. In particular, it may be employed with a ratio detector, connected in parallel with the primary circuit, as shown in Fig. 12.

**The Locked Oscillator.** The type of oscillator used widely in receivers employs grid-current biasing, and in this resembles the grid limiter. The limiting action which takes place stabilizes the oscillation amplitude. Thus if an oscillator of this type can be made to change in frequency in step with an applied signal, the oscillator output amplitude will tend to remain constant independently of changes in the input signal amplitude. A suitable arrange-

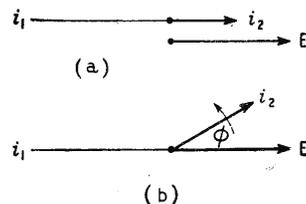


Fig. 14. Vector diagrams for circuit of Fig. 13.

ment for locking an oscillator to an applied signal is shown in Fig. 13.

Consider firstly the conditions of operation when the applied signal frequency is equal to the free-running frequency of the oscillator. The equilibrium relationship between the vectors representing the oscillator valve anode current ( $i_1$ ), the locking valve anode current ( $i_2$ ) and the voltage across the tuned circuit ( $E$ ) are as shown in Fig. 14(a). The current vectors are in anti-phase, and the oscillator valve anode current is also in anti-phase with the tuned circuit voltage, indicating that the oscillator valve is equivalent to a negative resistance in parallel with the tuned circuit. The locking valve current is in phase with the oscillator voltage, corresponding to a damping resistance of magnitude  $E/i_2$ . If now the locking signal frequency increases, the locking valve anode current vector will commence to rotate in a clockwise direction, as shown in Fig. 14(b). There will now be a component of the locking signal current in quadrature with the oscillator voltage, i.e. the locking valve now behaves as a resistor and reactor in parallel. The reactance is equivalent to an inductive component under the conditions postulated, and this equivalent inductance re-tunes the oscillator, circuit to a higher frequency. Equilibrium is restored when the oscillator frequency is equal to that of the locking frequency, i.e. synchronization has been achieved. If the phase angle between the locking valve anode current and the oscillator voltage in this equilibrium condition is  $\theta$ , then the reactance of the equivalent parallel inductance is  $E/i_2 \sin \theta$ . The range over which locking occurs is limited because when the phase angle between the oscillator voltage and the locking valve anode current is equal to 90 degrees, the equivalent parallel inductance is at its minimum value; any increase of phase angle beyond 90 degrees increases the magnitude of the equivalent parallel inductance. At the minimum value of inductance, the reactance is given by  $E/i_2$ . For maximum effect, this reactance should be as small as possible, and hence for locking over a wide frequency range,  $E$  should be small, and  $i_2$  large. Further, the main tuning inductance of the oscillator circuit should be as large as possible, for the equivalent parallel inductance to have maximum "pulling" effect.

The argument applied above can be applied also when the locking signal frequency is below that of the oscillator; in this case the locking valve behaves as an equivalent capacitor.

The relationship between the oscillator frequency and the locking frequency is as shown in Fig. 15(a). Outside the locking range, the oscillator frequency tends to swing between wide limits, as the heating effect with the locking signal produces alternately the effect of a parallel capacitance and parallel inductance; the mean frequency tends to follow the curves shown dotted in Fig. 15(a). In practice, however, non-linearity in the oscillator valve causes

the oscillator to lock over a succession of small ranges at fractional multiples of the locking signal frequency (e.g. 10/9, 9/8), as shown in Fig. 15(b).

The greater the amplitude of the locking signal current, the greater is the frequency range over which locking is maintained. When the input signal is amplitude modulated, therefore, the minimum value to which the input current falls must be sufficient to lock the oscillator over the full frequency range of the f.m. signal. The locked oscillator thus resembles the grid limiter, in that there is a threshold limit of signal which must be exceeded for satisfactory performance. The "downward" a.m. modulation handling capacity is determined by the ratio of the mean input signal amplitude to this threshold amplitude.

The locked oscillator limiter may also suffer from the effects of the time constant of the grid-biasing components in the same way as the grid limiter, and the grid components must thus be chosen with care.

Examples of the locked oscillator limiter were given in Part 4 of this series. This type of limiter is not now widely used. One of its principal disadvantages is the feedback of the oscillator signal to early i.f. stages, which can lead to overloading in the i.f. amplifier. A number of schemes have been proposed for locking an oscillator at a sub-multiple of the intermediate frequency to avoid this effect. Additionally, a single stage locked oscillator limiter-discriminator has been described by Bradley (see references).

**The "Clipper."** This type of limiter employs two triodes cathode coupled as shown in Fig. 16. It thus comprises a cathode follower driving an earthed-grid triode. Under quiescent conditions, both triodes are conducting, and each is biased approximately to the mid-point of its grid base. If now the input signal at the grid of V1 increases positively, the anode current of V1 increases. The cathode potential therefore rises, and this in turn leads to a decrease of anode current in V2. In fact,

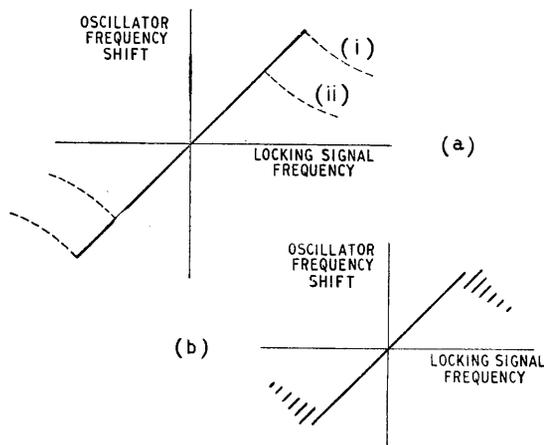


Fig. 15. (a) Locking of oscillator frequency to that of locking signal. The dotted portions of the curves indicate the mean value to which the oscillator frequency tends outside the locking range. Curve (i) is that for a larger locking signal input than curve (ii); (b) Showing locking of the oscillator frequency at fractional multiples of the locking signal frequency over restricted ranges outside the true locking range.

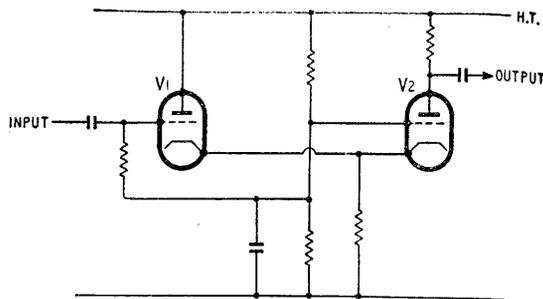


Fig. 16. Basic circuit of the "clipper" type of limiter.

the common cathode potential rises by an amount equal to half the increase of V1 grid potential. If the input to the grid of V1 increases sufficiently, the common cathode potential rises to the point where anode current is cut off in V2. The degree of feedback applied to V1 then increase sharply, and V1 behaves as a true cathode follower. During the rise of common cathode potential the anode of V2 rises to h.t. potential, and when anode current is cut off, it remains at this value, i.e. the output signal is then limited.

When the input signal at the grid of V1 is negative-going, the common cathode potential falls, and the anode current in V2 rises. Whilst both valves are conducting, the change in cathode potential is approximately half that of V1 grid. If the input signal rise to a value sufficiently negative, anode current in V1 is cut off, and there is no further change in common cathode potential. Thus this circuit "clips" the input signal symmetrically, providing a chain of square-wave output pulses.

This form of limiter is very useful at low frequencies, and may be used with input signal frequencies of the order of a few Mc/s. It has a fixed threshold of the order of 5-10 volts above which limiting occurs. As it does not depend for its action upon the charging and discharging of capacitors, it is free from "blocking" effects.

The author wishes to record his thanks to Dr. G. J. Phillips and Mr. J. G. Spencer for helpful discussion.

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### Nickel-Iron Laminations

THE new British Standard BS2857/1957 covers laminations for transformers and chokes of 0.004, 0.008 and 0.015 in thick respectively and containing between 36 per cent and 75 per cent of nickel with the residue mainly or wholly iron.

Measurements of permeability are to be made normally at 50 c/s, but by arrangement between user and manufacturer audio tests can be effected at six frequencies between 300 c/s and 4,000 c/s, or at a single frequency of 800 c/s. Details are given of a method of testing for compliance with the minimum values of permeability laid down in the specification.

Copies of BS2857 are obtainable from the British Standards Institution, 2, Park Street, London, W.1, price 3s (3s 6d by post).

# "Rainbow 'Round my Shoulders"

An American Serviceman Faces Up to Colour Television

By JACK DARR\*

SOME several years ago, television came over the Arkansas Hills into our little town. It wasn't too far behind the bigger towns, at that. To most of the radiomen it came as no surprise: we'd heard rumours of its existence! We're speaking, of course, of the old-fashioned monochrome, or "B. & W." (black and white) TV, not the multi-hued version. "The papers were full of it," literally. In consequence of this, we felt pretty well at home when TV finally did put in an appearance. At least, we weren't perfect strangers! But we found the inevitable assortment of troubles not mentioned in the books: the normal ratio between "book-larin'" and practical experience still holds in this, as in every other trade! It was several years before we become as "at home" in the underside of a TV set as we were in radio chassis.

The average American serviceman accepted the advent of television as a challenge, as do servicemen everywhere in the world, whenever a new piece of equipment is introduced. He set out to learn all he could about it, and today, even in the smaller towns such as ours, there are several shops, staffed with well-trained technicians and provided with an astonishing array of modern test equipment. (This does not, of course, include *my* home town, and *my* competitors!)

## Literature

We accepted the advent of colour TV with the same aplomb that we had B. & W.: the magazines began to run articles about it, and are still doing so: the set-manufacturers put out study courses on the fundamentals of colour, some of them free, some at a very nominal figure. RCA, for instance, sent out an excellent course, prepared by RCA Institutes, beginning with the wavelength of coloured light and winding up with a detailed description of convergence and setup procedures for the latest sets then available. I obtained mine free by agreeing to buy a few hundred tubes! Other set-makers had similar material: Philco, for instance, published a single-volume course, illustrated in colours, showing test patterns, etc., to be found under certain conditions.

In addition to this, RCA, Philco, Hoffman, and others held "Colour Clinics," schools, in the larger cities, and some servicemen travelled many miles to attend them. Service meetings held by manufacturers and service groups became devoted almost exclusively to colour, and after a while even the most remotely situated serviceman could answer without hesitation when asked, "What angle is Green?" (299.4 degrees, by the way!) Fundamentals and theory came out of our ears: chromaticity diagrams became as familiar to us as our own front lawns. All we needed now was some practical experience!

Came the day when a customer in our town, possessed of more money than most of us, ordered

a colour set, and called upon us to set it up. Came also the day when we discovered that all was not going to be multi-chrome beer and skittles! Came also our first experiences with what one of my associates described with some bitterness as "pink trees and purple people!" We made the same discovery all over again, that we'd made with B. & W. TV. Easy as it might sound in the books, actually sitting down on one's haunches before a huge colour TV receiver, confronted with an array of controls bearing such exotic names as "Green Horizontal Dynamic Slant" and "Blue Vertical Static Parallax" was a far cry from sitting at home in an easy chair reading about it!

## Preliminary Adjustments

To set up a colour TV receiver correctly, a series of adjustments must be made. These should be made after the set is installed in the owner's home, as any moving of the set afterwards disturbs them; not from a shifting of the adjustments themselves, but from the changing magnetic fields from metallic objects, such as radiators, etc. This process is known as "convergence," although it covers a great deal more than that. Strictly speaking, the convergence adjustments are those made to enable the beam from each of the three guns in the c.r.t. to strike its own colour dot on the screen, through the same hole in the shadow mask. Improper convergence or, indeed, errors in any of the other adjustments, means that the set will not only not give a good colour picture, or even a good black-and-white picture: such ill effects as colour fringing, tinting, etc., will interfere with the use of the set. This is the "rainbow 'round the shoulder" effect so common in badly adjusted sets.

RCA and most other manufacturers recommended the use of a "dot generator" for alignment, a signal generator which creates a pattern of small dots on the screen. Test equipment makers leaped eagerly into the breach, and assorted pattern generators were soon available at all prices.

After the proper test gear is assembled, then arises the problem of learning how to use it. Fortunately, the distributor sent along his own expert technician, a happy character named Gene, complete with dot generator and other equipment. His main purpose was to check me out on the set. He turned it on, and suggested that I make the first setup on it, to gain experience. Happily I agreed, and sat down in front of the monster. Thoughtfully, the maker had mounted all the adjustments on the front panel of the set, exposed by removing the knobs and a couple of small screws, after which a small panel

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came off, and there they were. These were all plainly labelled, a feature unfortunately sometimes omitted!

Gene handed me the instruction sheets, and stood back, hands in pockets, with a knowing grin on his face. I casually glanced at them, then laid them down, after locating the various controls. After all, hadn't I finished my colour TV correspondence course with honours? I knew all there was to know about it! Deftly I made the initial connections, finally obtaining a pattern of small multi-coloured dots on the screen, about an inch apart. Apparently, none of the blasted things was converged: I didn't see a white dot anywhere! This is one of the charming paradoxes of colour TV work: you must adjust for a complete *lack* of colour!

## Dot and Carry Two

Gene mildly suggested that I select a dot in the centre of the screen, since I had to start somewhere! This individual was selected, and I tentatively wiggled one of the adjustments. This resulted in the blue dot taking off wildly for the left side of the screen, winding up about a half-inch away from where I wanted it. Reversing the direction brought it back to the other side, then finally to centre, where it overlapped the red dot, anyhow. The green dots were still about 11 o'clock, high. Adjusting that control brought them down; it also moved the red dots over to about 2 o'clock. Adjusting the red dots brought them back: the blue dots, meanwhile, had apparently found something interesting going on over at the right side of the screen: at any rate they were all wandering off in that direction! Turning their control halted their flight and brought them back toward the centre, at the same time separating the red and green dots, so that I once again had a perfect triad: translated, this means that I was right back where I started!

At this point, we had to stop and revive Gene, who was rolling helplessly on the floor behind me. After we had administered restoratives, and wiped the tears from his eyes, and he had recovered some degree of coherence, we followed the standard American custom in such circumstances: we took a coffee break. Bringing the instruction sheets along, he tactfully explained to me that the main trouble was my complete ignoring of the instruction book! (This is an unusually frequent occurrence among us technicians: I recently read the instruction book on a piece of test equipment I'd owned for ten years, and discovered three things that I didn't know it would do!)

Back at the store we sat down with the instruction sheet, a very detailed and lucid piece of technical literature, and began at the beginning! First, as in B. & W., we made the vertical linearity and size adjustments: once convergence is started, these must never be touched. Next, we measured the high voltage on the tube, using a special test socket provided on the back of the set. After the horizontal size and linearity adjustments were checked, *then* we began the setup procedure.

First, under constant supervision, I made the purity adjustments. This consists of turning the blue and green guns off, through their gain controls, and adjusting pots, etc., for a pure red screen. This was slightly marred by patches of orange and magenta at the edges. Adjustments of small magnets

at the tube's rim failed to eliminate these completely, so we went through a mystic rite known as "de-gaussing" it. This consists of waving a large ring-shaped coil, about 18 inches in diameter, plugged into the mains, before the face of the tube, genuflecting and backing away the while. Appropriate incantations are chanted throughout this process. The coil is then unplugged, and the rites continue. Correctly done, this enables the attainment of a pure red screen. The red is turned off, and the procedure repeated for blue and green.

Now, the fun begins: convergence. A dot is selected in the centre, and it is "converged," to make a white dot; all three colours must be perfectly overlapped before this will happen. There is a total of four adjustments needed for this: for the blue, a small magnet on the neck of the tube is moved to move the dot sidewise, and the control on the front moves it up and down. The same control for red moves the red dot from 2 o'clock to 7 o'clock: the green dot moves from 10 o'clock to about 4 o'clock. The idea is to find a combination setting which will zero all dots in at a given location! At least fifteen adjustments were provided to accomplish this: vertical and horizontal static convergence, vertical and horizontal dynamic convergence, and vertical "tilt" for each colour: the last named are to correct any bowing in the lines of dots and to enable convergence to be achieved over the entire screen. Adjustment of these controls, I learned, must follow the proper order: failure to do this will upset the whole process and require repeating it from the beginning. (How did I learn this? *Please!*)

The end result of the procedure, after much patient coaching from Gene, was a pattern which was converged over almost the entire area of the screen, with the exception of about eight or ten dots at the corners. Gene assured me that this was very good, and that these would never be noticed in the picture. (This took place a year ago: since then, with perfection of techniques and adjustments, I've seen screens 100% converged!)

## Black and White Check

Now, we gave it the acid test; we tuned in a picture! In black and white, of course. Incidentally, this set was connected to a community-antenna system, and one of the things we wanted to check was the ability of the system's amplifiers to carry the colour signals, without clipping colour burst, etc., which they did, perfectly. The black and white picture was perfect. In fact, it appeared to have much better detail than that seen on a B. & W. set nearby. One could view it from a much closer distance, and get a better picture. This was due to the shadow mask inside the colour c.r.t., which broke up the scanning line structure and gave the picture the appearance of a newspaper halftone print, with its multitude of tiny dots.

This all took place in the morning: not until afternoon would we be able to view a colour programme. NBC was running "Howdy-Doody" every afternoon, between 3 and 4 p.m., in full colour. Gene had to leave as he was on his way to an appointment with another hopeful dealer, so he wished us well, and departed, with a few final guffaws at my attempts to converge. Eagerly we awaited the start of the programme. After the inevitable commercials, the familiar kaleidoscope

pattern was seen: this time in colour. But what colours! Instead of the bright rainbow we had expected, they were all washed out, pale and wan looking! We twiddled the various operating controls, with no results, no good ones, that is: the picture retained its weak pastel tones! The signal strength was measured and found to be around 1,000 microvolts: no trouble there, still pastels.

The next day we made further checks. The set still made beautiful B. & W. pictures, but once again the familiar pastels met our eyes. This time there was a great difference, however. The day before, the colours had at least "stayed put"; today, great waves of colour washed back and forth across the face of the tube! Red, green, blue; they waved back and forth like a demented rainbow, resulting in a very picturesque display, but hardly the one intended! Repeated adjustments of the controls had no effect. In desperation we tried to call Gene on the telephone, but he had vanished: no one knew where he was, and they didn't expect him back to his home until the last of the week!

### Chromatic Climax

Many alternatives were discussed, including suicide, without result. A careful study of the instruction sheet gave us no help. A glum group of technicians and salesmen watched the remainder of the show in a grim silence, broken only near the close of the show when a fat-faced trumpet player, in a close-up, puffed out his cheeks and blew a mighty blast on a final high note: as he did, his face turned a brilliant purple! It stayed purple until he took the horn from his lips, when it turned a pale blue! This wound up an otherwise dismal performance on a jovial note, and most of the audience departed, leaving the community-antenna technician and myself to further study of the situation.

Another colour show, a short 15-minute musical affair, follow the first. This displayed the same symptoms. We watched it for a few minutes, and then turned to each other and said simultaneously, "Let's try another station!" Fortunately, we had another NBC station on the cable system; one which had been included as a "standby," which was so far away that the signals were usually too weak and snowy to watch. Tuning the set to this station, we watched open-mouthed as the colours suddenly snapped into place with an almost audible "click"! Faces once again became flesh-coloured: dresses were red or green, hair lost its magenta tinge and became brown, etc. The salesmen came running from the back of the store, wanting to know what we were screaming about. We showed them. Turning back to the original station the colours once again wandered; on the weaker station they locked perfectly into place! With this as a clue, we came to the conclusion that the colour bursts were being clipped from the signal at the transmitter! This left us the colour, but no colour sync information, hence the wandering!

With this off our mind, we were free, the next day, to pursue our original problem: Why the pastels? No audience this time. The salesmen had abandoned all hope and disappeared, leaving only two puzzled technicians. Halfway through the show, I decided to attempt another adjustment of the much-adjusted controls, and reached for the "Chroma" knob. Watching the picture, I gave it a slight turn. The scene being televised was brightly coloured, or

should have been: gay drapes and costumes abounded, and the whole thing should have been a riot of colour; instead they were all pale and washed out. Suddenly as I turned the control, they leaped into vivid life: reds glowed, blues and greens became deep and rich, and the whole thing came up to the colour standard of a Technicolor movie!

Amid loud shouts of "Hey! Whadja do?" "Boy! Looka that, willya?" and similar exclamations, I investigated. Fortunately, my hand had frozen to the knob, and I discovered that I had turned the *brightness* control, instead of the "Chroma"! Further investigation revealed the horrifying truth: we had simply had the brightness turned up to maximum all the time! This gave our colour picture the same aspect as a black and white under the same conditions: it was just washed out! A few experiments with brightness and contrast controls showed us their proper settings, and the pictures we got were simply beautiful!

As a result of these experiences, we have come to this conclusion: the installing technician is the key man in the success or failure of any colour TV installation. If this worthy has the proper equipment and the "know-how" to use it, and the humility to read and heed the manufacturers' instructions, he will be able to obtain first-class colour pictures! The "know-it-all" type, who assumes that all sets have been constructed by a group of morons far below his technical level, and that he can make setup adjustments alone, using his own version of the procedure, is in for a rude awakening!

One dealer in another city told us that he'd had a new colour set which worked perfectly when unpacked: no adjustment at all! This happy state continued until his serviceman decided to check the convergence adjustments, using only a signal for reference; no dot generator! Ever since then, he moaned, everybody's had rainbows "round their shoulders"!

### Ready to Go

The practising TV technician's biggest problem, right now, outside of acquiring the extra cash to buy colour TV test equipment, is the lack of material to practice on! Although colour TV has taken hold to some extent in the larger cities, it is still a case of "few and far between" in the smaller towns, such as ours. In fact, here we have only two colour TV sets, at the moment: both are still on the dealers' floors! This is caused, of course, by one simple fact: the price! Although colour sets have been reduced tremendously during the past two years, from RCA's beginning with a 15-incher at \$15,000 down to the latest production of 21-inch sets listing around \$450 they are still away out of reach of the average TV buyer, and most especially the mass market. Until colour circuits are simplified enough to enable a price reduction to about \$300 we do not look for any drastic increase in colour-TV density! (The preceding statement is entirely the writer's own personal opinion, and is entirely uncluttered by such things as facts, etc.!)

One optimistic note is seen in recent articles in radio and TV magazines, detailing new and simpler circuits for colour matrixing, new colour c.r.t.s, such as Philco's Apple tube, the Lawrence Chromatron now under investigation by Dumont, and others. The last two named are single-gun tubes, and offer

the possibility of simpler convergence adjustments. (Speed the day!) These developments may bring the price down, by allowing elimination of many special tubes now necessary, and bring on an upturn in sales.

The broadcasters are doing everything they can to assist in this project. All of the major networks, and especially NBC, are programming many more hours of colour shows than ever before. NBC stations in this area send out to TV servicemen and dealers a colour TV programme schedule, listing all shows in colour for the coming month. Last year this did not fill a single sheet: this year it fills three sheets, and many of the shows listed are on every day under a single listing, such as NBC's Matinee Theatre, in colour every afternoon from 1 to 2 p.m. However, the future remains doubtful, as far as any drastic upturn in colour TV sales is concerned, especially in this area. We await with optimism new developments, and do whatever we can to further the cause.

So, in conclusion, as far as the average American

TV serviceman is concerned, with colour, he regards it mainly as he did black and white TV: as a challenge to his technical skill. He expects no trouble from the sets themselves. (Note: I did *not* say he was going to *have* no trouble; I merely said that he *expected* no trouble!) Just as before, he's in for troubles, and plenty of 'em! He's facing the same situation right now that he did with the B. & W.s. He didn't expect much trouble from those, either. "After all, they're just like radios, only bigger!" (The bitter laughter you hear in the background is from the author and his colleagues!)

However, he has a massive body of help available, in the form of literature, technical information, training courses, manufacturers' literature and schools, and the like, so the chances are he'll be able to attain a degree of proficiency in this, as he did in black and white TV, radio, "hi-fi," and all of the other subjects he's been called upon to cope with. He'll still have plenty of problems, but as the costers sing in the Broadway version of "My Fair Lady," "With a little bit of luck he'll get by!"

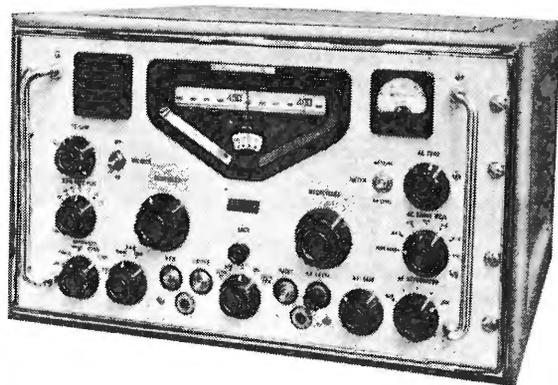
## Unconventional Communications Receiver

Continuously Variable Crystal Control; Wide-band Coverage Without Waveband Switching

**V**ARIOUS systems have been devised to apply the stability of crystal control to wideband communications receivers, the most common being a multiplicity of crystals used in various combinations. These involve complicated switching systems and often restrict the equipment to operation on a number of fixed spot frequencies.

An attractive system which forms the basis of the design of a new communications receiver, Type RA17, being produced by Racal Engineering Ltd., of Bracknell, Berks, makes use of the harmonic spectrum of a single crystal to cover a tuning range of 500 kc/s to 30 Mc/s without gaps of any kind and without any of the conventional forms of waveband switching.

The block schematic diagram shows the basic arrangement, from which it will be seen that the received signal is first amplified by an aperiodic r.f. amplifier covering 0 to 30 Mc/s, then mixed with the output of a variable oscillator covering 40.5 to 69.5 Mc/s in a single range to produce an input to the first i.f. amplifier of 40 Mc/s. This amplifier has a bandwidth of 1.3 Mc/s. At the same time part of the output of the local oscillator is combined in a second mixer with the harmonics, up to the 32nd, of a 1-Mc/s crystal-controlled oscillator and a second i.f. output at 37.5 Mc/s appears at the output of a tuned filter having a bandwidth of  $\pm 150$  kc/s. In order to obtain the 37.5 Mc/s i.f. the 40.5 to 69.5 Mc/s oscillator (Mc/s



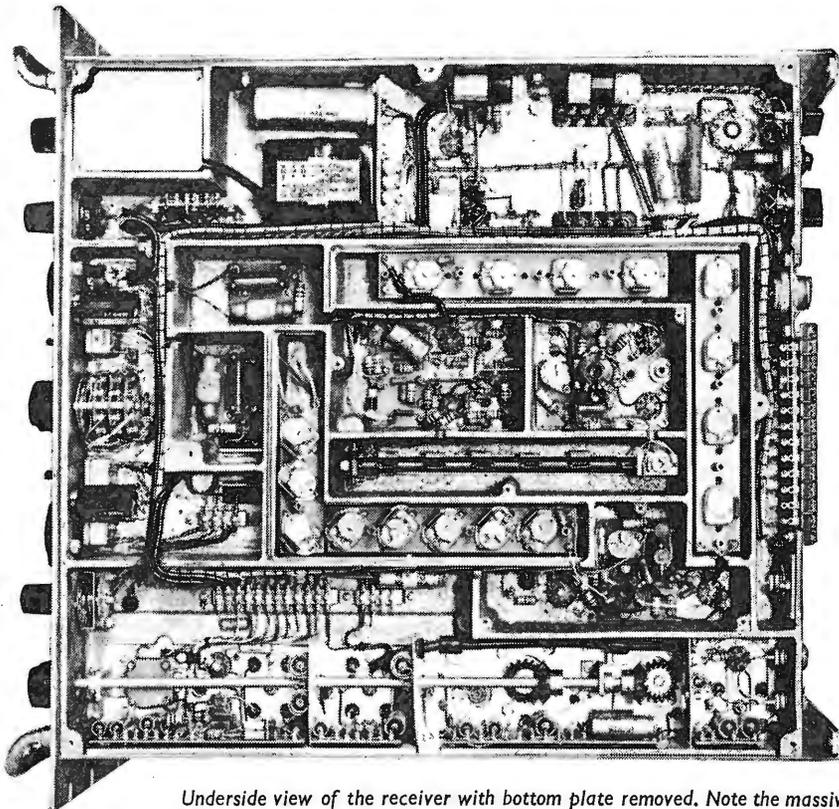
scale) must be set to within 500 kc/s,  $\pm 150$  kc/s tolerance, of a harmonic of the crystal-controlled oscillator. Any change can only be steps of 1 Mc/s, so that for every setting of the variable oscillator a 1-Mc/s panorama of signals, derived from the first mixer, is presented to the 40-Mc/s i.f. amplifier. Its bandwidth must be, therefore, 1.3 Mc/s wide in order to accommodate this band of signals, plus the 300-kc/s tolerance in the setting of the oscillator brought about by the 300-kc/s bandwidth of the 37.5-Mc/s i.f. filter.

The 37.5-Mc/s i.f. and the 1-Mc/s panorama of signals from the 40-Mc/s i.f. amplifier are then combined in a third mixer which gives a "panoramic" output from 2 to 3 Mc/s and this is passed to a conventional form of superheterodyne receiver (interpolation receiver) which selects the wanted signal from the 1-Mc/s panoramic input. Its tuning is linked with the long film scale calibrated in kilocycles.

It will be apparent that with so many r.f. oscillators of one kind or another very great care has had to be given to the screening and filtering of these circuits in order to eliminate set-generated whistles and the effectiveness of this filtering was apparent by the almost entire absence of whistles in the receiver demonstrated to *Wireless World*.

Tuning is effected by two operations, both quite simple. First the megacycle scale (40.5 to 69.5 Mc/s oscillator) is adjusted to the nearest megacycle of the signal frequency, then the fractional part of the frequency is set up on the horizontal film scale (the 2 to 3 Mc/s receiver tuning), which is 60 in long and provides a setting accuracy of 200 c/s. Any drift in the local oscillator is of no consequence as it cancels itself out in the third mixer and the setting of the megacycle scale is, therefore, not critical. By using an unusually high first i.f. and a low-pass filter passing 0 to 30 Mc/s in the r.f. amplifier, conventional tuned r.f. circuits have been dispensed with.

The complete absence of mechanical waveband switching in the signal and oscillator circuits contributes significantly to the re-setting accuracy and stability of the receiver over long and short periods of time. To assist further in accurately setting the receiver to a particular frequency there is a built-in 100-kc/s pulse calibrator with pulses derived from the main 1-Mc/s crystal oscillator.



Underside view of the receiver with bottom plate removed. Note the massive die-cast chassis divided into several fully-screened compartments.

This supplies calibration "pips" at every 100 kc/s of the film scale.

A calibrated and stable BFO, adjustable to  $\pm 3$  kc/s is included, together with a tone control, a variable selectivity control giving alternative bandwidths of 100 c/s, 350 c/s, 750 c/s, 1.2 kc/s, 3 kc/s and 8 kc/s respectively, noise limiter and "s" meter.

The dimensions of the set are 19 in wide, 10½ in high and 20 in deep; the weight is 56 lb without case and 79 lb in case. The power consumption is about 90 watts from the a.c. supply mains.

Block schematic diagram of the Racal RA17 receiver.

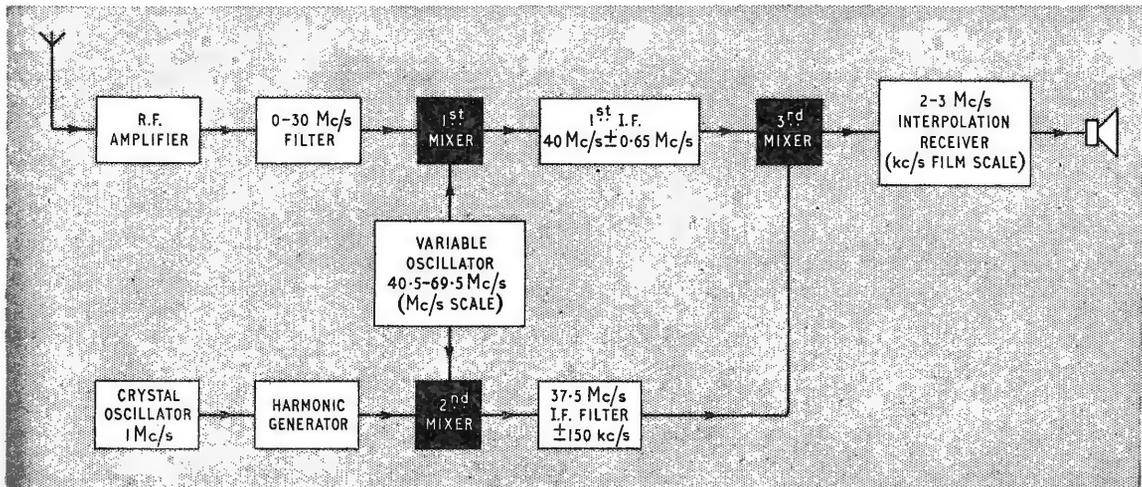
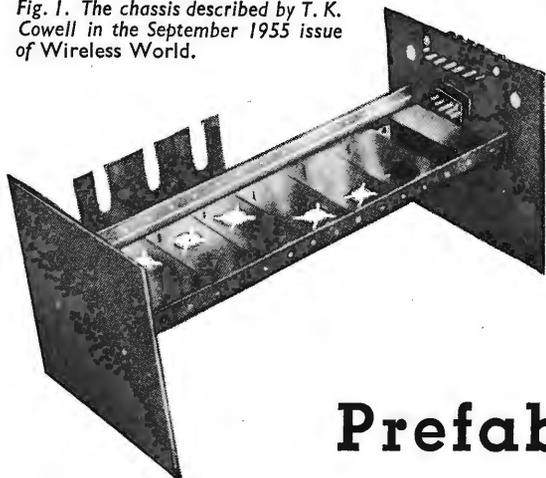


Fig. 1. The chassis described by T. K. Cowell in the September 1955 issue of *Wireless World*.



DESIGN COMBINING SIMPLICITY  
WITH VERSATILITY

By D. M. NEALE\*, B.Sc., A.M.I.E.E.

## Prefabricated Chassis

**I**N the September 1955 issue of *Wireless World*, T. K. Cowell described a chassis (Fig. 1) for experimental and development work. It was assembled from a number of standard parts so designed that arrangements could be chosen meeting most practical requirements. The system filled a need which had previously been felt in our physics research laboratory and it was disappointing to find that the parts were not being marketed.

Cowell's system was based on the use of eight

standard parts. It is accordingly uneconomic for one, relatively small, user to have these parts made to order since the cost of tooling up is prohibitive. The writer has therefore developed the idea further to provide a system more flexible than the original yet requiring only one specially produced component.

It will be seen from Fig. 1 that Cowell's system consisted of valveholder plates and potentiometer brackets bolted to angle-brass runners. These runners were supported at either end by angle brackets bolted to end-plates of which there were four different types. In the modified system, illustrated in Fig. 2, "Meccano" angle girders are used for the runners and angle brackets. These components are already mass produced and readily available. It is therefore unlikely that anything more economical or more convenient can be devised. In fact, the retail price of the finished Meccano parts is about half that of the raw material for parts made in brass. In the original

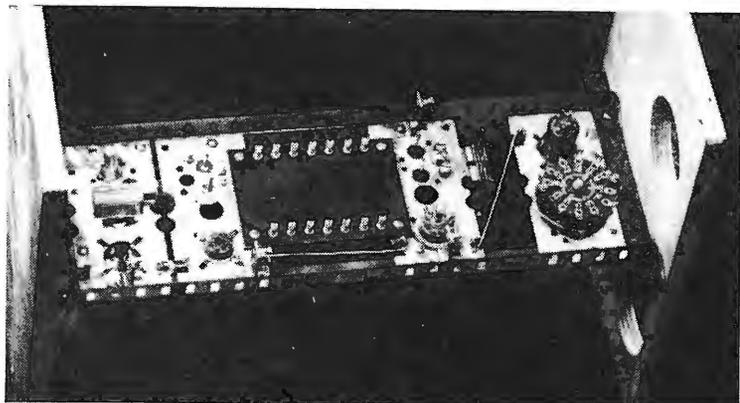
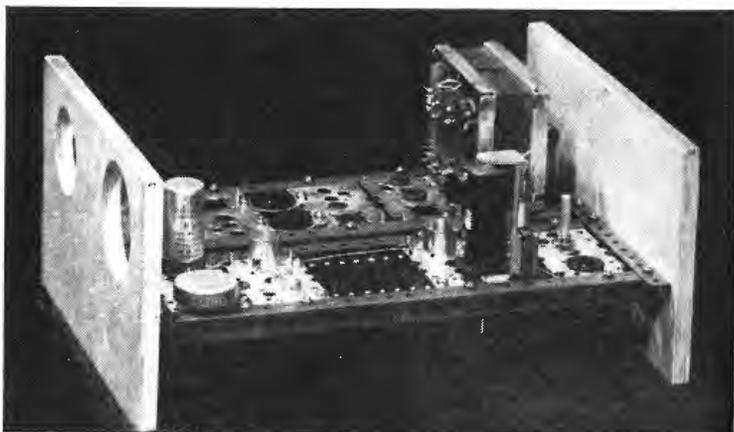


Fig. 2. Underside view of a  $12\frac{1}{2}$  in  $\times$  4 in chassis using the new design of plates, Meccano angle girders and wooden end-boards.

Fig. 3. Top view of a chassis assembled with two  $12\frac{1}{2}$  in  $\times$  4 in units using the same wooden end-boards as shown in Fig. 2 but with the long sides horizontal.



\*Ilford Limited.

system, the runners were drilled and tapped, but a further economy has been effected by using  $\frac{1}{4}$ -in 4-B.A. bolts and nuts in the Meccano perforations.

By using wooden end-boards, the need for four specially produced metal end-plates was eliminated. Only one size is used and this may be produced quickly by unskilled labour. Holes may be cut in some of the end-boards to accommodate 2in and 2½in instruments, but no other components are as a rule mounted on these boards. Figs. 2 and 3 show that the same 10in x 6in end-boards may conveniently be used to support either one or two 12½in x 4in chassis assemblies.

The essence of the new system is a new valveholder plate (Fig. 4) designed to suit the  $\frac{1}{2}$ -in hole spacing of the Meccano runners. So far as possible, this plate has been made to accommodate all the more common types of component, whilst at the same time keeping to a minimum the number of holes to be formed in the plate. The new type of plate will accept a B7G or B9A valveholder with retaining can and/or a carbon or wirewound potentiometer, several stand-off pillars, rubber grommets, a wafer switch, a toggle switch, two coaxial sockets, a pilot lampholder, an electrolytic capacitor or a Type 3,000 Post Office relay. Fig. 5 shows clearly how provision has been made for various locating spigots and also how rubber grommets are held by semi-circular cut-outs in adjacent plates. Other components may be mounted between one valveholder plate and the next, or between the valveholder plate at one end of the chassis and the cross-bearer supporting the runners. In this way, it is possible to mount terminal boards, Jones plugs and sockets and the larger types of valveholder and electrolytic capacitor without drilling any further holes in the valveholder plates.

Since the potentiometers are mounted in the valveholder plates, rather than at right angles to them, it is a simple matter to transfer successful "bread-board" circuits to rack mounting when required. It is necessary only to remove four nuts and bolts to detach the wooden end-plates and Meccano bearers from the assembled 12½in x 4in chassis. Four of these chassis may be mounted side by side across the width of a 19-in rack with a  $\frac{1}{2}$ -in space between each. Standard 18½-in Meccano angle girders may be used as horizontal bearers, but it then becomes

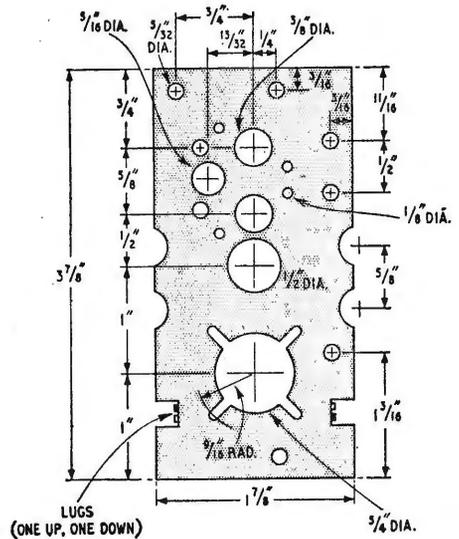


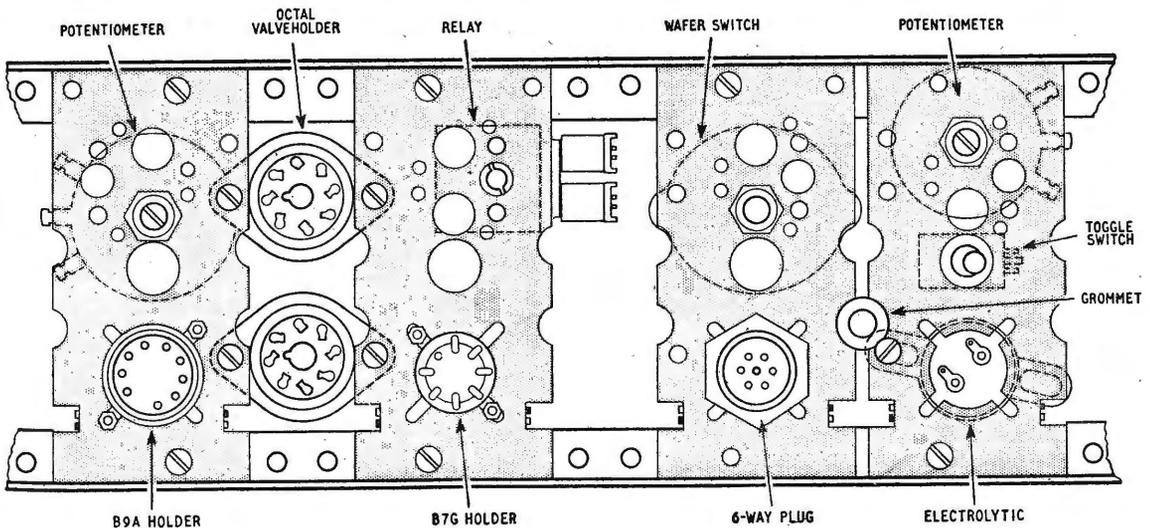
Fig. 4. Dimensions and drilling details of the new valveholder plate.

necessary to drill and tap the rack at non-standard spacings. However, not many such holes are required and these do not conflict with standard hole positions.

Valveholder plates may be made in 22 s.w.g. bright mild steel, electro-tinned after stamping. A cadmium finish may also be used provided it is not passivated. The electro-tinned finish simplifies soldering to the earthing tags on the plates. It is, of course, essential to bond all plates together by a tinned copper wire joining the earthing tags since the enamel finish of the Meccano runners makes earthing through the securing bolts uncertain. It was expected that earthing troubles might arise with r.f. circuits, but a 7-stage video amplifier with 2 Mc/s bandwidth has given no trouble at all.

The above design is proving a very satisfactory

Fig. 5. Showing how components can be mounted between valveholder plates and how rubber grommets are accommodated in semi-circular cut-outs.



compromise between flexibility and economy. By virtue of its asymmetry, each plate may be mounted between runners in four possible orientations. A further four orientations are possible if the valveholder plate is mounted longitudinally between transverse plates. This is not generally done, how-

ever, because it involves flattening or removing one of the earthing tags on each plate.

Normal usage of the plates calls for no cutting, bending or drilling. When a chassis is dismantled, therefore, all plates may be returned to stock as good as new.

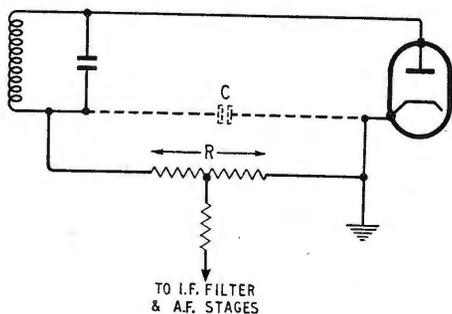
## Diode A.M. Detector Circuits

### A Note on Reduction of Distortion

IN PRACTICE (though not necessarily in theory), the reception quality attainable from f.m. transmission is better than that from a.m. However, f.m. transmissions have a shorter range than a.m. In the absence of relay systems, long distance transmissions which are thus only available with a.m. may have sufficient programme value to make it worth while to try to receive them with the best quality obtainable.

In a.m. reception it is quite possible for the detector to provide a major part of the total distortion in the system. Thus it is worthwhile trying to reduce the distortion in a.m. detectors. The theory of this is well known†; but two useful practical details seem to have been little mentioned.

In such diode detectors it is usual to have a shunt capacity (C say) across the diode load (R say), in order to fill in the half cycles at r.f. (which would otherwise be the only output from the detector) to the full a.f. envelope, and thus to increase the detection efficiency.



A well-known type of distortion in diode detectors arises at high modulation levels due to shunting of the load R at a.f., so that the resultant a.f. load is less than the d.c. load R. Generally only the unavoidable resistive shunts are considered and the shunting produced by the capacity C is neglected.

The usual method of reducing the a.f. shunting is to take the a.f. output from a tap down the diode load. The shunting can be still further reduced by also putting a resistance in series with the output\*, a method which appears to have been seldom mentioned.

By these two methods it is easy to make the equivalent a.f. shunting resistance across the d.c. load R at least 20 R, even at the highest a.f. where high modulation fractions may occur (5 kc/s say). It is particularly easy if the a.f. is fed into a sensitive pre-amplifier; in which case the low-pass filters usually provided can often be useful in combating interference.

† See for example, "Radio Receiver Design," by K. R. Sturley; Part 1, Chapter 8. Published by Chapman and Hall.

\* D. T. N. Williamson, *Wireless World*, Vol. 55, p. 477, 1949.

Thus, to reduce distortion due to shunting by C at a.f. to the same level as that produced by other a.f. shunts the reactance of C at 5 kc/s should be not less than 20 times the diode load R. This leads to much smaller values of C than those usually used.

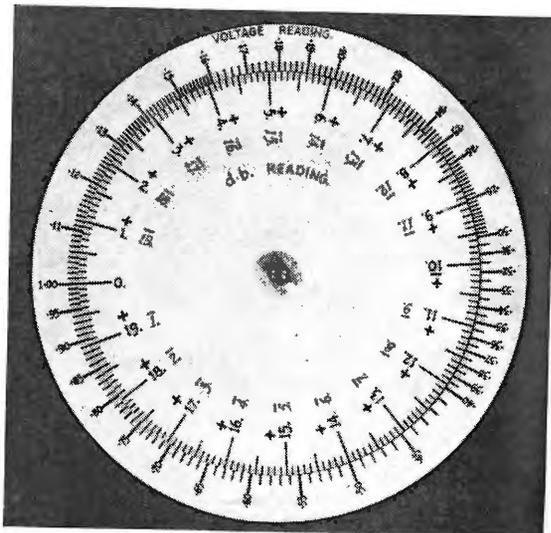
The argument in the last paragraph assumes that, as regards this type of distortion, C acts at any one frequency like a resistive shunt of amount equal to the reactance of C at that frequency. Actually, owing to the elliptical loadline produced by C, the equivalent resistive shunt will be only half the reactance of C, so that C should be further reduced by a half. In any case, if the reactance of C at 5 kc/s is 20 R, at the i.f. of 465 kc/s it will still only be about R/5, and it will not properly fill in the half cycles at r.f.

C could thus perhaps best be omitted altogether. This also has the advantage of reducing the damping on the last i.f. transformer secondary by a factor of about four, and thus of increasing the selectivity. A practical test gave a marked decrease in the distortion produced by off-tuning (a way of effectively raising the modulation fraction at high a.f.).

M. G. L.

## Decibel Circular Slide Rule

THE Gerry dB Calculator is virtually a two-scale circular slide rule—one scale being linearly marked in decibels and the other being an antilog scale divided by twenty. Thus voltages or currents into constant impedance on the antilog scale correspond to decibels on the other. The scale is accurately made within the limits of the rather thick lines, but this limitation is unlikely to be of importance in normal radio or audio work. The rule costs 15s and may be obtained from Blundell Rules, Ltd., Lynch Lane, Weymouth, Dorset.



# POTENTIAL — MAP READING IS A GREAT HELP

By "CATHODE RAY"

IT is customary for the people who unravel the intricacies of semi-conductor theory to illustrate their remarks with diagrams showing the variations of electrical potential in the material. Fig. 1, for example. This represents a p-n-p junction transistor, and it is pointed out (though probably in more refined language) that if the "holes" shown reposing on the emitter shelf are jerked up the slight hill to the base they are very likely to topple over the potential precipice on the other side and land on the collector.

Assuming it is clear to all why the potential diagram should have this particular shape, fair enough. But is it safe to assume this? If the relative heights of the various parts of the graph corresponded to the voltages imposed from without on the electrodes corresponding to those parts, all is well. So far as the collector is concerned, all is well, for its depressed potential corresponds to the relatively large negative voltage applied by a battery. But on the same principle the base potential ought to be slightly lower than that of the emitter, to correspond with the small negative bias applied.

Presumably the instructor will have already dealt with this anomaly by some preliminary work on the simple p-n junction, in which he may well

people who talk about potential would be unable to say what it means?

There are various textbook definitions; for example: "Potential is the quantity whose space rate of change in any direction is the field strength in that direction." That is delightful for people who thrive on textbook definitions, but what does it mean in terms that can easily be visualized?

## Potential, Height and Energy

One thing we can hardly have failed to notice at a very early age is that where differences of height occur between two places there is a tendency for things to move from the higher place to the lower. Further observation shows that the greater the gradient between the two places the greater the tendency. This tendency has been named gravitation. To sound more scientific we can call the tendency the force due to a gravitational field—the one in which we happen to be situated. Another name for gradient is rate of change of height. So if we look again at the textbook definition we discover that it defines what we usually call height. Height, in fact, is the particular kind of potential when the field is a gravitational one. A gravitational field manifests itself by the force it exerts on the mass of objects. An electric field manifests itself by the force it exerts on the electrical charge of objects. But whereas electric potential (which is the one we are supposed to be discussing) is difficult to visualize, gravitational potential in the guise of height is familiar to all. No wonder, then, that it is the favourite analogue for potential. A particularly attractive feature of the analogy is that diagrams like Fig. 1 become more than mere graphs; they are also drawings of working models whose mechanical performance gives quite a good idea of the electrical performance of the thing repre-

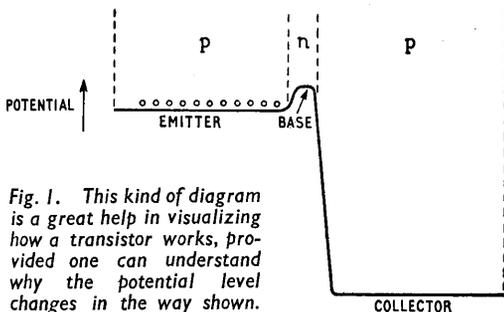


Fig. 1. This kind of diagram is a great help in visualizing how a transistor works, provided one can understand why the potential level changes in the way shown.

have exhibited something like Fig. 2. Here it is supposed that no batteries are connected, the potential changes shown below being a result of the distribution of charges shown above. Now this is the point where I suspect the assumption of obviousness often comes unstuck. I feel that those whose studies have tended towards the practical rather than the theoretical are likely to associate potentials with applied voltages and are not particularly enlightened by potential diagrams derived from vague charges inside a chunk of material. It was for this reason that I carefully avoided potential diagrams when on this semi-conductor subject just a year ago.

But such diagrams do appear, and if it is true that some of us are not too clear how they are arrived at, then it is time we went back to first principles to find out. Is it unkind to suggest that a lot of

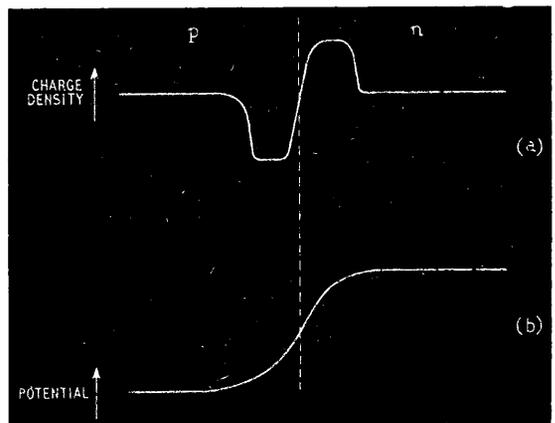


Fig. 2. This is the usual explanation, but is it clear why (b) follows from (a)?

sented. (Like most attractive things, however, this analogy can lead one astray if one doesn't know where to stop.)

If the dimension along the arrow in Fig. 1 represents height, the diagram is a vertical section of the gravitational analogue of the transistor. In the same way Fig. 3(a) is a vertical section across a tract of country. In this form, the information is limited to a single line on the ground, so it is more usual to transfer it to the horizontal plane as shown at (b), forming a contour map. Of course, this one vertical section locates only a row of points along AB; to draw the contour lines it is necessary to plot the heights at many more places. Alternatively, Fig. 3 shows how a contour map can be used to construct a vertical section along any line. It is the same with potentials; given one form of diagram, the other can be derived.

Now although a scale of height is shown in Fig. 3(a), what usually matters most is the relative height. The appearance of this piece of country, and the behaviour of loose objects on it, would not be affected if all the figures in the scale were increased or decreased by some fixed amount. There is really no such thing as absolute height; the figures usually specified are heights relative to mean sea level. In the same way there are only relative potentials. Unless the contrary is stated, "earth" is the "mean sea level" in the electrical world.

The meaning of a contour line is that all points on it are at the same height. It could be called an "equi-height line." Analogous to it on a potential map is an equipotential line. As Fig. 3 illustrates, steepness of gradient can be judged from a map by closeness of contour line spacing. So without looking at (a) we can easily see that there would be a stronger tendency to fall down the right-hand slope of the hill than the left. What we may actually have done by now, however, is to have fallen into a trap. How did we reckon the gradient?

## Rolling Stones

The usual procedure is to measure the distance on the map between two contour lines. Take the points  $x$  and  $y$  on Fig. 3(b). Suppose the distance scale shows them to be 200ft apart. Then, as  $x$  is 100ft higher than  $y$ , the gradient is said to average 1 in 2, or  $\frac{1}{2}$ . If somewhere two contour lines were found to touch, the gradient there would be 1 in 0, which is infinity. According to our textbook definition, that ought to mean an infinitely large gravitational force! It would certainly mean an infinitely large electric force if two equipotential lines touched. But we know in fact that even at a vertical precipice, where the gradient is (according to usual reckoning) 1 in 0, the force on a body is no more than equal to its weight. Where is the catch?

No doubt you have already spotted it—the practice of reckoning land gradient in terms of height difference per *horizontal* distance (because that is what one can measure on the map). In applying the textbook definition to a hillside we tacitly assumed that the gravitational field strength is reckoned along the surface of the ground, because that is the only place where stones, etc., can roll; so for that purpose gradient ought to be reckoned as difference of height per distance *along that surface*. The maximum is therefore 1 in 1, or the full vertical gravitational pull. The operative word in the definition is "space rate

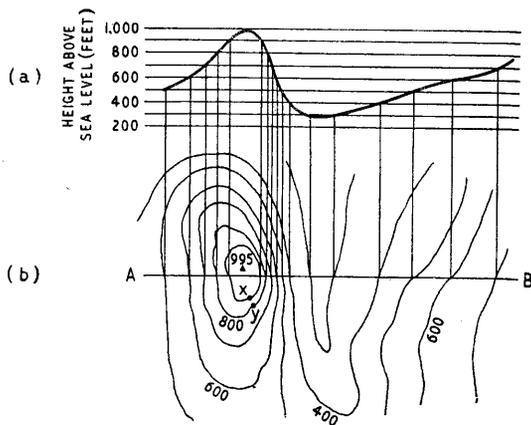


Fig. 3. Vertical section and contour map of a hill. It would be strictly correct to refer to the height scale as a potential scale.

of change." Our interest in electric force is not usually limited to the two dimensions of a surface, but may occupy three-dimensional space. So electric contour maps are not necessarily based on a horizontal plane.

This shows how careful one must be not to swallow an analogy whole without making sure that there are no differences in custom regarding method of reckoning.

An advantage of a contour map over a vertical section is that it shows not only the amount of gravitational pull (when correctly reckoned!) but also its direction. Obviously the gravitational force is a maximum in the direction of steepest downhill gradient. And the steepest gradient between two parallel contour lines is at right angles to them, because that gives the shortest distance from one level to the other. So a ball will tend to roll in that direction, along what we might call a line of gravitational force. In the same way, the so-called lines of electric force are everywhere at right angles to the equipotential lines.

We mustn't jump to the conclusion that the lines of force (gravitational or electric) are the paths that would actually be taken by a freely rolling ball or a freely moving charge. Fig. 4 shows a succession of contour lines, and we can plot a line of force beginning at A by drawing it at right angles to them (and to all the intermediate ones, not shown but estimated). It arrives at B. But a ball released at A would depart from this line directly it began to turn the corner, because its own inertia would tend to carry it on in a straight line (Newton's first law of motion). The ball's path—probably something like the dotted line—would be determined by the resultant of its movement in the direction of the line of force and its previously acquired movement in another direction. Roughly the same is true of a charged body in an electric field; even an electron has some inertia, minute though it is. But here there is another slight flaw in the analogy, for the ball rolling under the influence of gravity is rather a special case, in that the gravitational force tending to deflect it from its original direction is proportional to its mass and therefore to its inertia, so that (apart from secondary effects such as friction) balls of every weight would

follow the same path\*. Charged bodies are not so; the force brought to bear on them by an electric field is proportional to their charge, which is quite a different thing from their mass or inertia. This distinction is not merely academic; it has an important bearing on the design of the domestic television tube. When an electron is knocked off an atom, it and the damaged atom (or *ion*) have equal though opposite electric charges, so have equal forces acting on them in a given electric field. But the mass of the ion is enormously greater than that of the electron, so the field deflects the ion far less. Advantage is taken of this fact in devising ion traps to prevent negative ions from bombarding the screen.

A very important part of the subject of potential concerns work and energy. Rolling a ball or anything else uphill is work in the strictly technical sense, and can only be done at the cost of energy. If a 10-lb weight is raised 50 feet, measured vertically, 500 ft-lbs of work have to be done (not counting friction); and the weight gains 500 ft-lbs in potential energy. Its potential is increased by 50 feet. So another way of defining height could be as the amount of work that had to be done on a standard weight—say 1 lb—in order to lift it from the lower to the upper level.

If a weight is allowed to go downhill, its potential energy is (neglecting friction) converted into kinetic energy—energy of motion—which is capable of doing work. For instance, it could carry the weight some way up a hill. So alternatively height could be defined as the amount of energy acquired by a standard weight in falling from the upper level to the lower. This amount could be judged by the velocity it has acquired.

It happens that height can usually be much more conveniently and accurately measured as vertical distance. But one cannot measure difference of potential in any such simple and direct way, so reckoning it in terms of work is of practical as well as

theoretical importance. In fact, potential is commonly defined as the amount of work required to transport unit charge from one place to the other—a definition apparently quite different from the one quoted at the beginning, but amounting to the same thing.

Of course it is necessary to be consistent with the units. If you want the potential difference to be in volts, the unit charge must be taken from the same set of units, viz., one coulomb, and the work must be reckoned in joules (= watt-seconds). In electronics one is so often concerned with the very minute amount of work required to push a charge of one electron up a potential hill reckoned in volts that a semi-official unit of work or energy—the electron-volt (eV)—is commonly used. It is about  $1.6 \times 10^{-19}$  joule.

It is also necessary to get the signs right. Saying the difference in height between A and B is 50 feet is not much help unless one knows whether A is higher or lower than B. If work has to be done on the standard weight to move it from A to B, that implies at once that B is higher than A. But it is really meaningless to ask which of two points has the higher electric potential because, in relation to potential, "height" is only metaphorical. It has however been generally agreed to describe the potential at A as higher than at B (relative to B) A has a surplus charge of the kind arbitrarily called positive. (This is the same thing as B having a surplus of the other kind of charge, called negative). Now it is an experimental fact that charges of the same kind repel one another, so one of them has to have work done on it to make it move nearer the other. It follows that if a positive charge needs an external effort to make it go in a certain direction, then that direction is towards a higher potential. The natural tendency of a positive charge, then, is to run "downhill," so it is the analogue of the rolling stone on a hillside. A negative charge, on the contrary, tends to move "uphill" towards points of higher potential.

For the purpose of this explanation I attributed the high potential at A to a positive charge there, but it is not necessary to have any charges at either point between which there is a difference of potential. In the arrangement shown in Fig. 5(a) the battery transfers electrons from plate  $P_1$  to  $P_2$ , charging  $P_2$  negatively and  $P_1$  positively. This establishes a difference of potential (equal to the voltage of the battery) between the plates, and there will be a potential gradient from one to the other, A being at a higher potential than B; see Fig. 5(b). An electron in the space between them would tend to move towards A and would have to be forced to move towards B. An analogue of this could be constructed of a large sheet of thin rubber stretched on a horizontal frame, with a horizontal rod to represent  $P_1$  pushed up from below to raise the rubber into a ridge, and another one ( $P_2$ ) pushing it down. Bearing balls could represent loose positive charges. If the space beneath the rubber were filled with liquid, electrons could be represented by small air bubbles, which would tend to run towards  $P_1$ .

All this may be simply underlining what I began by assuming everyone understood—the potential patterns due to batteries and other sources of volts. But when tackling the potential gradients inside semi-conductors, next month, it will be an advantage to have some definite ideas about the meaning of the word "potential."

\* It was this curious fact that led Einstein to his General Theory of Relativity.

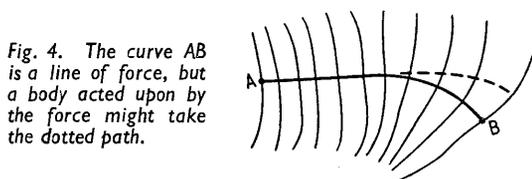


Fig. 4. The curve AB is a line of force, but a body acted upon by the force might take the dotted path.

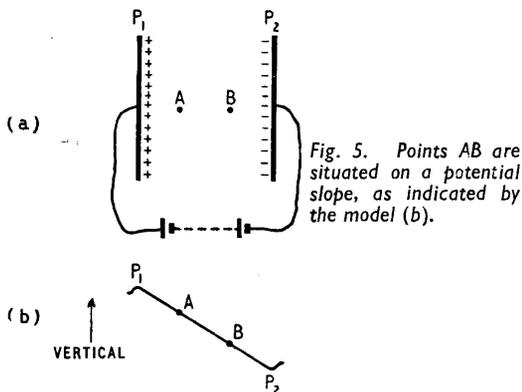


Fig. 5. Points AB are situated on a potential slope, as indicated by the model (b).

# Doppler Navaid for Civil Aircraft

Self-contained Air Navigational System Entirely Independent of Ground Station Co-operation

**M**ILITARY aircraft of the Royal Air Force have been using the Marconi Doppler Navigator for the past three years, but so far nothing quite comparable to it has been available for civil aircraft. All the existing airborne radio nav aids require the co-operation of one or more ground stations and failing this navigation in the air hitherto had to rely on old-fashioned systems. More important than this the pilots of civil aircraft flying to-day have no accurate knowledge of the actual ground speed, drift or prevailing wind velocity.

These points serve to underline the importance of the new Doppler Navigator, Type AD2300, specially designed for commercial aircraft and recently introduced by Marconi's Wireless Telegraph Company. The equipment operates as a self-contained system in the 8,000-Mc/s band and is entirely independent of any ground station.

The AD2300 provides the airline pilot with accurate indication of ground speed, drift-angle and distance flown, and used in conjunction with a computer, gives instantaneous and continuous information of the aircraft's immediate position in latitude and longitude, wind direction and wind speed. The distance to go along a "leg" of a pre-determined flight plan, or the distance to fly along a composite track to reach a destination, and also more accurate computation of ETA (expected time of arrival), than hitherto, comprise some, but by no means all, of the navigational information available with this new nav aid.

## Theory of Operation

The full equipment comprises an aerial system, a transmitter-receiver, a tracking unit, computer and display unit. The system is based on the phenomenon of the displacement in frequency which occurs at the receiving position when the transmitter and receiver are in relative motion to a fixed point of reflection of the waves. The basic principles were described in *Wireless World* recently.\* Two c.w. beams are radiated from the aerial one projecting forward and the other backward and both are depressed towards the ground. A small amount of the radiated energy is returned, by ground reflection, to the aircraft where analysis is made of the difference in frequency existing between the transmitted and received waves. This difference is directly related to the speed of the aircraft relative to the ground.

By displacing one beam to starboard and the other to port, and alternately switching their positions, the drift angle of the aircraft is found by comparing the Doppler frequency when the forward beam is displaced to starboard and the backward beam displaced to port, to the frequency derived when the beam positions are reversed. The aerial is then rotated until the two frequencies are equal and it is then aligned along the aircraft track.

The aerial system comprises four slotted linear arrays lying parallel to one another in a directional horn assembly with the axis of the aerial horizontal. The forward and backward beams are obtained by feeding from each slotted unit in turn, two waveguides being used for transmission and two for reception. At the half-power points the beam width is  $3\frac{1}{2}^\circ$ . A sample of the transmitted signal is extracted in a directional coupler and mixed with the received signal.

## Airborne Computer

The transmitter and receiver units and their associated power supplies are housed in a single unpressurized case with cooling complying with the American ARINC standard. The carrier wave is generated by a klystron and the transmitter output is one watt. The output from the receiver is fed to the tracking unit, which contains the frequency measuring circuits for determination of ground speed and drift angle, a.g.c. and automatic search circuits. Frequency measuring is effected in a discriminator, where the Doppler signal is compared with the tone generated by a phonic wheel. The resultant frequency is used to control integrator and azimuth drive circuits, the former controlling the speed of the phonic-wheel motor and the latter a motor situated in the aerial system which rotates the aerial for drift-angle measurement. The phonic-wheel speed is a measurement of aircraft ground speed.

The resultant speed and drift information is fed to the computer, an electro-mechanical type using analogue methods for solution of the trigonometrical equations concerned in the navigational problem. Inputs of compass heading and true air speed are also fed to the computer.

The display is capable of considerable variation to suit individual requirements. It may be embodied in the computer, or if the only information required is ground speed, drift angle and distance flown, these can be displayed by a small indicator unit which will in such cases replace the computer unit.

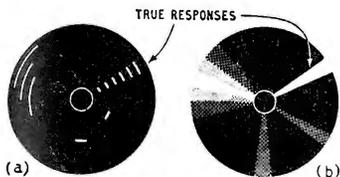
The Marconi AD2300 operates over an altitude range of 150 ft to 50,000 ft, at ground speeds of 80 to 900 knots, at drift angles up to  $\pm 45^\circ$ , up to  $10^\circ$  climb or descent and up to  $20^\circ$  of bank. The equipment will function in steeper angles of climb, descent and bank than given, but the accuracy may be degraded slightly.

A pilot's left-right indicator for steering the aircraft on a desired rhumb line, or great-circle course, can be included, also information of distance to destination and visual indication when the end of a "leg" of a pre-determined course has been reached. In addition the left-right course indication is available as a signal for feeding into an auto-pilot.

All units are for standard ARINC rack mounting and all valves have American equivalents. The total weight, including aerial system and computer, is 130 lb.

\*" Airborne Doppler Navigation " by G. E. Beck, *Wireless World* May 1957, p. 225.

**Helical-Scan E.E.G.** display described by H. W. Shipton in Vol. 7, No. 2, of the *Proceedings of The Electro Physiological Technologists' Association* uses a number of small c.r. tubes to give a topographic presentation of brain potentials picked up simultaneously from various parts of the patient's head. In an earlier "electrotoposcope" the c.r. tubes had a p.p.i. type of rotating radial timebase, as shown in (b), a stationary pattern being obtained when the rotational speed of the timebase was related to the frequency of the e.e.g. signal. When, however, a photographic record was taken, the light



integration made it difficult to distinguish the true responses, related to the timebase rotation (at "2 o'clock"), from others of short duration (4 and 6 o'clock), and those formed by overlapping when a signal was drifting slowly round the tube (at about 9 o'clock). With the helical scan, however, which increases in diameter during the camera exposure, the different types of responses can be clearly distinguished, as shown at (a). Signals related to the rotational speed appear at the same bearing on successive sweeps but with changing radius. Where there is not an exact relationship, a progressive displacement occurs on successive sweeps from which an estimate of frequency can be made.

**Grown Infra-Red Crystals**, for use as windows, lenses and prisms in this not-quite-optical part of the electromagnetic spectrum, are now being produced on a commercial scale with a purity and crystalline perfection superior to that of the natural material. Hilger and Watts, for example, are growing rocksalt (sodium chloride) crystals about 8 inches in diameter by 4 inches thick from which optical components can be cut. The polished surfaces can be aluminized if necessary. Rocksalt is transparent over the wavelength range 0.2 to 15 microns, but potassium bromide crystals of similar size can be grown to extend this to about 26 microns and caesium bromide crystals to go up to 40 microns. Where the infra-red components have to be used in extremes of temperature or with rapid heating and cooling rates, silicon crystals offer distinct advantages. These are being grown by the American firm Texas Instruments with impurities of less than 1 part in  $10^8$ . A silicon component 3mm thick will transmit

# Technical Notebook

over 50% of the incident radiation between 1.3 and 9 microns, but transmissions greater than 90% can be achieved at particular wavelengths within this range by applying a low-reflection coating to the material.

**Information-Theory Servicing** of electronic equipment is discussed by R. B. Miller, J. D. Folley and P. R. Smith in D.S.I.R. unpublished report PB118038. Methods of fault diagnosis using the "half-split" technique for eliminating alternatives leads to a consideration of the relationship between fault-finding, information theory and probability data.

**New Storage Ferroelectric** called triglycine sulphate has the same kind of rectangular voltage hysteresis loop as the well-known barium titanate but with a much lower coercive field, allowing it to be switched from one state to the other with potentials of only about 20 volts. This means that transistors can be used for driving purposes. Discovered by B. T. Matthias of Bell Telephone Laboratories, the new material is stable chemically and does not decompose when exposed to moisture or to the atmosphere. Large single crystals can be grown quite easily (see picture), and a number of large-area slices can be cut from each crystal. Repeated switching does not cause any fatigue in this material, as it does in barium titanate, and a given area will retain a given polarization in-



definitely without any deterioration. Although heating beyond 47°C (the Curie point) causes the material to lose its ferroelectric properties, these properties are regained in full when it is cooled. By replacing some of the hydrogen atoms with deuterium the Curie point can be raised to

60°C. Switching times of the order of 1-2  $\mu$ secs can easily be attained. A matrix store can be constructed with 30 or more electrodes to the inch evaporated on to each side of a thin slice of crystal. This means that 900 or more binary digits can be stored on a square inch of the material—a very compact form of storage compared with most other methods.

**Function Generator Tube** designed by L. S. Allard of G.E.C. Research Laboratories is a self-contained c.r.t. device which depends for its operation on the equal division of beam current between two target electrodes. Conventional c.r. tubes have been used as function generators in the past—the spot being made to follow the profile of an opaque mask stuck on the tube face—but these suffer from the disadvantages that the screen phosphor is very readily



burnt and that voltage fluctuations are introduced into the output by the granular structure of the screen. In the G.E.C. tube one of the two target electrodes is cut to give a profile of the required function while the other is a planar disc. As the electron beam is scanned across this assembly in the X direction it is constrained to follow the profile by a feedback voltage derived from the target electrodes, which is applied to the Y deflection plates so as to maintain the equal division of beam current between the electrodes. The voltage applied to the Y plates varies in accordance with the y ordinates of the profile electrode and so provides the required output.

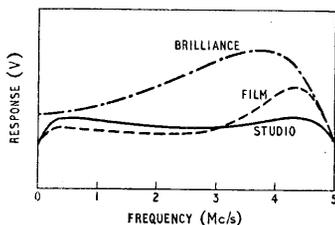
**Fast Kerr Cell**, using nitrobenzene, is being developed as a light shutter to give extremely short light pulses of the order of micro-microseconds. Some parts of the work are described in D.S.I.R. unpublished report PB118714, by G. L. Clark, D. K. Holshouser and H. M. Von Foester.

**Square-Law Thermocouple.** — A method of compensating a thermocouple to make it accurately follow a square law was shown at the recent N.P.L. Open Day. By joining a platinum wire of high tempera-

ture coefficient of resistance in series with the thermocouple an opposite deviation can be added to that of the thermocouple. In this way power measurements to within 0.25% can be obtained.

**C.R.T. Chronograph** has been built for measuring and recording a large number of consecutive time intervals. The signals appear as lines on a c.r. tube raster and are recorded photographically. Circuitry and possible extensions are discussed in D.S.I.R. unpublished report PB114757 by H. G. McGuire and K. A. Yamakawa.

**Video Response Control**, equivalent to the tone control of a sound broadcast receiver, is used in a recent German television receiver, the Nord-



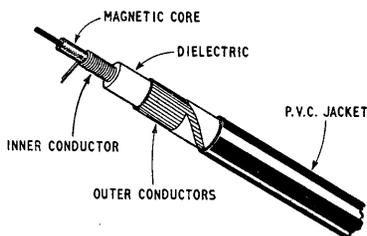
mende "Diplomat 58." Three conditions are available, "Studio," "Film" and "Brilliance," as shown in the accompanying sketch, and the circuit corrections to obtain them are selected by a piano-key switch. Appropriate compensation is applied automatically to the picture contrast as each key is depressed. A full description of the receiver appeared in the issue for the second half of March, 1957, (No. 6) of *Funk-Technik*.

**High-Power Microwave Frequency Doubling** in ferrites is reported by J. L. Melchor *et al.* in *Proc. I.R.E.* for May 1957. The frequency doubling arises from the generation of a double frequency component of magnetization along the direction of the d.c. magnetizing field. The efficiency depends markedly and in a complicated manner on the ferrite geometry. By careful attention to this point a conversion loss of only 6 dB has been achieved for doubling from 9 to 18 Mc/s. Peak and mean power levels can be as high as roughly 32 kW and 20 watts (at 9 Mc/s) respectively.

**Coaxial-Line Monitor Diodes** for the S, X and Q microwave bands are available from Elliott's. These consist of a length of evacuated coaxial line terminated in a dissipative load (iron-loaded resin). When an electromagnetic wave is propagated along the line the potential difference produced by the r.f. energy between the inner cathode and outer anode causes

electrons to flow between them. Owing to the short response time (less than 0.01 μsec), r.f. pulse envelopes can be directly viewed on a c.r.o.; the high output (of the order of 50 volts) being also useful for this purpose. Mixing and demodulation are, of course, also possible. High maximum mean and peak power inputs of at least 10 watts and 50 kW respectively can be accepted. Reflection coefficients of less than 0.09 over the band can be obtained in the tunable holders provided.

**Magnetic-Core Delay Cable**, produced by the Columbia Technical Corporation of New York, contains, inside the inductive winding, a continuous, flexible, low-loss magnetic core which serves to increase the impedance and the unit delay of the line. This kind of delay element is,



of course, a distributed-parameter type, and does not have the same sort of cut-off frequency as lumped-parameter lines. Rather the attenuation increases gradually with increasing frequency. Cables are available with delays ranging from 0.08 to 1.0 microsecond per foot and with impedances between 1,500 Ω and 3,900 Ω. They are intended mainly for pulse work in a frequency spectrum up to 30 Mc/s and have bandwidths ranging from 6 to 15 Mc/s. Any delay can be obtained by cutting off the appropriate length of cable, and the makers will supply calibrated lengths complete with terminations.

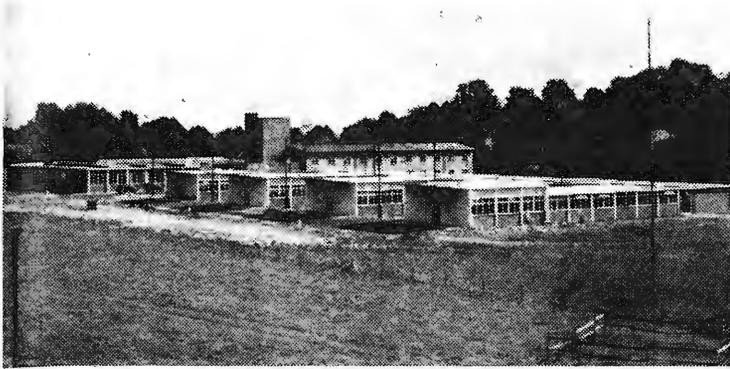
**R.F. Power Transistor**, capable of providing an output of 5 watts at 10 Mc/s either as an oscillator or an amplifier, has been developed at Bell Telephone Laboratories. Normally, of course, it is difficult to make power transistors work at even high audio frequencies because of their necessarily large dimensions. The Bell device, however, which is made from silicon, achieves the high frequency performance by using the diffusion method of forming, together with a p-n-i-p type of structure in which a "neutral" layer of silicon separates the collector from the other elements. Alpha cut-off frequency is about 100 Mc/s and some laboratory samples have apparently provided as much as 1 watt output in oscillation at this frequency. Another silicon power transistor of high performance has now been put into commercial

production by Texas Instruments in the U.S.A. This is the 2N389, with a power dissipation of 37.5 watts at 25°C and 15 watts at 100°C, and it is made by a diffusion process similar to that of the Bell Laboratories. It is intended for use in power circuits which have to operate at high temperatures.

**Transistors in Parallel** for obtaining greater power output from pulse amplifiers are used in a technique described in D.S.I.R. unpublished report PB111665 by J. F. Spades and A. W. Carlson. Parallel operation of the transistor regenerative pulse amplifier is achieved by means of common-base and common-emitter connections, but with each emitter returned through a separate path.

**Microwave Pulse Powers** can be measured from the perturbation of electron beams in a new technique described by H. Thomas in *Proc. I.R.E.* for February 1957. The beam is accelerated transversely through an evacuated section of waveguide carrying power in the TE<sub>10</sub> mode. To a first approximation, the electrons gain energy in one half cycle of the r.f. (when they are in phase with the r.f.), and lose it in the next (when they are out of phase). Thus, if the transit time is an odd number of half cycles, there will be a net gain or loss in the odd half cycle. The accelerating potential is adjusted so that the transit time is such that there is a maximum net gain. This gain is measured by a d.c. cut-off potential. It can be theoretically related to the Poynting vector of power flow. It is necessary to correct for the perturbations in the r.f. field produced by the holes in the waveguide through which the beam passes. This also can be done theoretically. Corrections due to standing waves in the guide can be made either from measurements of the phase and amplitude of these waves, or by using three separated beams. The thermal distribution of the electron's energy produces an uncertainty in the true current cut-off point which can lead to serious errors at low powers. However, by subtracting the apparent cut-off voltage without power flow from that with power flow, this uncertainty is eliminated. The directness of this method is of particular advantage in the measurement of peak pulse powers where the errors are normally about 30% or more. The fact that the power flow is not disturbed by the measurement may also be useful.

*Unpublished Reports mentioned above come from various sources but can be obtained from the Technical Information and Documents Unit of the Department of Scientific and Industrial Research, 15, Regent Street, London, S.W.1.*



Radio Research Station's new building at Ditton Park, showing the four laboratory units and the administration block in the background.

## New Building for Radio Research Station

IT is perhaps appropriate that the formal opening of the new building at Ditton Park for the Radio Research Station of the D.S.I.R. should take place on the eve of the International Geophysical Year, during which over 1,000 research stations throughout the world will be participating, with the Radio Research Station taking a leading part. The opening ceremony was performed by Sir Edward Appleton, F.R.S.

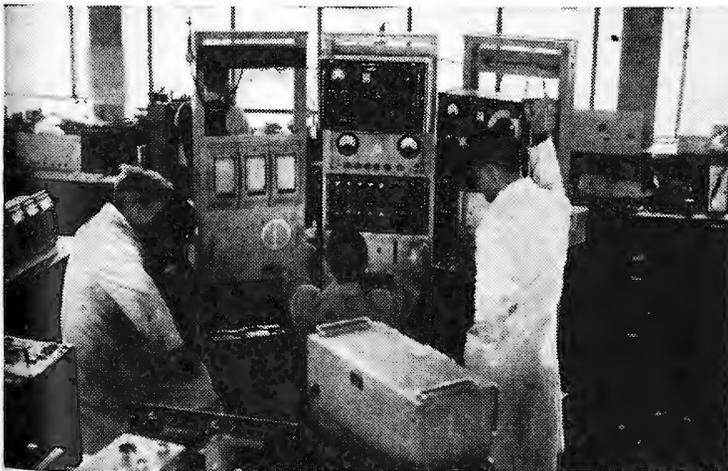
The new building has accommodation for a staff of 300 and much of the work hitherto carried out in wooden hutments scattered throughout the park, and at the N.P.L., will now be concentrated under one roof. The building consists of a central two-storey administration block with two single-storey wings, one containing laboratories and the other workshops and stores. The laboratories jut out into the field area of the park and have easy access for aerial lead-ins from the many diverse kinds of aerials on which much of the work at the station depends.

Radio wave propagation has always been one of the principal subjects for study at the station and a new development in this field is the utilization of back-scatter for determining skip distances on the short waves. Back scatter results where r.f. waves strike the ground after refraction in the ionosphere and some travel back to the transmitter over the same path as the waves that originated the echoes. Radar technique is used to plot, on a p.p.i. display, echoes from one- two- and sometimes three-hop transmission paths.

Study of the ionosphere has enabled D.S.I.R. to issue long-term forecasts, enabling all users of radio channels to plan their communications some six months in advance. Investigation into the causes of errors in radio direction finding at h.f., v.h.f. and u.h.f. occupies much of the time of the station.

Among the activities at the new laboratories is the study of the properties of ferrites and of semi-conductors.

Interior of one of the laboratories in the new Radio Research Station's Building.



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# RANDOM RADIATIONS

By "DIALLIST"

## Sound Sense About Aerials

THERE'S good sound sense in the recommendations on TV aerial and feeder installation recently issued by the R.E.C.M.F. From my window, for instance, I can see a horizontal array so erected that it overhangs a chimney pot and is less than a foot above it. One hates to think of the devastation when the sweep comes to do his stuff! Very rightly, this sort of thing is frowned on, as is the all-too-common practice of letting feeders straggle over roofs without tile clips to anchor them. As I watch some of these blowing about over slates and tiles I can't help wondering that breakages of feeder "inners" isn't a whole lot commoner than it is. Another useful point made is that feeders must not be taken over the outer edge of gutterspouts unless stand-off brackets are used. I wonder whether some of the makers of TV aerials could re-institute short courses for erectors. It would be a jolly good thing if they did, for careless, slovenly erection is often responsible for breakdowns for which the aerial makers are quite unjustly blamed.

## FM/DX

THE ranges at which reception from the B.B.C.'s f.m. stations has been reported are quite uncanny. Writing from Sidcot Heaton, near Bolton in Lancashire, a reader tells me that before the Holme Moss service started he had no trouble about getting Wrotham, though it is well over 200 miles from him. It was receivable with an improvised single dipole (lengths of brass wire fixed to a thin board with paper clips!). The signal was so strong at night-time that it came in loud and clear in no matter what direction the dipole was pointed—and even if it was turned from horizontal to vertical. Wrotham seems, for some reason which eludes me, to be pushing out the most far flung of the Band II transmissions. I've had reports of it from many parts of the country. In my East Anglian home town we normally get our v.h.f. programmes from Norwich. But these are the Midland programmes in the Home Service. If there's an item from London that we want to hear there's not the least

difficulty about doing so if you have an indoor aerial and can reorient it. Our friend has separate outdoor aerials for Norwich and Wrotham and can take his choice.

## Timeo Danaos

"I'VE my doubts about those Greeks though they come with gifts in their hands," as the Trojans had good cause to feel when they were offered the fatal wooden horse. Now it's the Irish Republic which is scratching its head over the offers made to it to put up a television transmitter free of charge in return for the sole use of it for some hours every day. As those hours would, one imagines, be used for advertising, it must be plain that the object of the would-be-benefactors can hardly be to serve only Southern Ireland with its rather small population. One feels that they'd like to build a station with a very high e.r.p. and capable of reaching Northern Ireland as well as considerable portions of this country. Mutual interference between TV transmitters has already become quite a big problem. The Irish station, if built, would presumably have to occupy a channel on Band I or Band III and those available are already pretty well booked up. It's quite understandable that such offers must be very tempting to a country which is

anxious to have a television service, but whose government has not the money to build the transmitter and run the programmes. If, though, any such offer is accepted, I hope there will be very strict provisions that no interference with other stations shall be caused.

## Matters of E.H.T.

IT has often puzzled me that it's almost (if not quite) universal practice to use miniature types for that hard-worked valve, the e.h.t. rectifier. In some cases it may be necessary for space-saving reasons; but there certainly are receivers with heaps of room for a full-sized valve, yet fitted with tiny e.h.t. rectifiers. These little valves are apt to break down more quickly than bigger types would. I know, in fact, of one case in which e.h.t. rectifiers seldom much outlasted their three months' guarantee until an expert friend installed one of larger size. Since then there's been no trouble. Another point which calls for attention is the regulation in some e.h.t. circuits. It can be very poor. You adjust, for example, height, width and focus on Test-card C and get them just to your liking. Now, the test-card contains a good deal more white than the average TV picture and the drain on the source of the e.h.t. can cause



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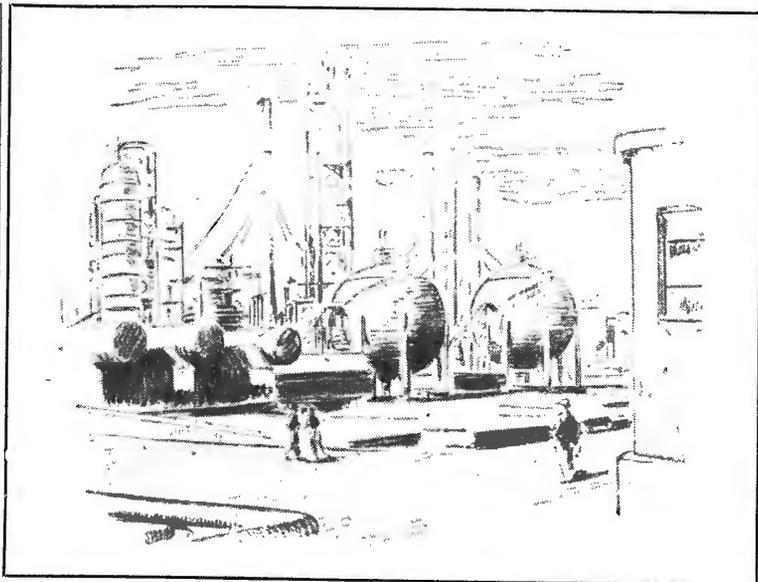
a voltage drop if the regulation is poor and increase the size of the image. Hence the test-card on which you've so carefully adjusted height and width is actually oversize on the screen and when an ordinary picture comes on you may find it adorned with unwelcome dark borders.

### The Two-in-one Valve

THE use of "compound" valves, such as double-triodes, triode-pentodes, diode-triodes and the like, has become so much standard practice nowadays that you find them in almost every kind of electronic apparatus except the very simplest affairs, or those using transistors throughout. They have many advantages, but those who benefit most largely from these are probably the manufacturers of such apparatus, to whom they mean smaller costs, reduced space requirements and things of that sort. But I'm not so sure that their user benefits to the same extent, particularly in the case of domestic equipment. Thanks to them this may be less bulky than it otherwise would be and the purchase price isn't so high, but when it comes to replacements he feels the draught. If one part of a double valve gives out, the whole thing becomes useless and must be renewed. And that costs more—sometimes a great deal more—than the replacement of the faulty one would come to, if they were two separate valves.

### Are You Earthed?

IT doesn't always pay to take earth connections for granted. I once buried a large biscuit tin with the idea of using it as a first-rate earth for a wireless set. Some months later I dug it up to see how it was getting on and found the whole thing destroyed by the action of acid soil. Not long ago a friend found his set "earthed" in a different way. He was using an indoor aerial in an upstairs room and had taken his earth wire through the floor to an ascending water main in a large cupboard below. It occurred to him one day to see that the connection to the pipe was as it should be: so down he went to have a look at it. He got a bit of a surprise when he found the wire cut and the two ends neatly rolled up. What had happened was that some weeks before the painters had been at work and that the one who was doing the cupboard found that the wire was in his way and took what seemed to him the best way out of the difficulty.



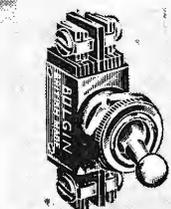
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## Telephilerers' Troubles

JUST lately we have read a lot in the press about telephone tapping and many of us who are not indulging in what the prayer book calls "seditious and privy conspiracy" cannot help feeling uncomfortable when using the phone to fix up a date with our respective blondes.

After all, even though we are not plotting to overthrow Queen and Parliament we do perhaps say some things to our blondes which sound unconvincing and even a little foolish when set down in cold print. Few of us can rise to the heights of Homer when we try to express our feelings over the phone, and even fewer of us attain to the simple dignity of Barkis when he sent his famous three-word proposal of marriage to Peggotty. Perhaps it is well we do not, for I feel sure that the stolid policeman licking his pencil at the phone-tapping table might easily read something sinister into such a cryptic phrase as "Barkis is Willing".

Naturally I have been hard at work trying to work out an electronic speech scrambler on the lines of the one used in the transoceanic radio-telephone. The difficulties that confront me are economic rather than technical. Each subscriber who desired to be immune from telephone tapping would have to have a scrambling and descrambling unit. But the cost of these devices puts them out of court and their absence is apt to put telephilerers into one even if only the divorce court.

The simplest and cheapest form of "scrambler" is the one the Germans used so successfully in the first World War to convey information and instructions to their agents in certain nearby neutral countries. In those far-off days anybody tuning in to Norddeich heard the station transmitting what appeared to be a continuous high note which in reality was a "scrambled" message.

The *modus operandi* was simple. In Berlin messages were recorded in the ordinary way on a wax cylinder of the type used on the old-fashioned cylinder phonograph and also, of course, on a well-known office dictating machine of those days. The record was then put on a special reproducer having a mandrel rotating at high speed. A primitive mike picked up the resultant high-pitched noise which, at the receiving end, was recorded on another high-speed machine. It was then only necessary for the record to be transferred to an ordinary cylinder reproducer and its message read in the ordinary way.

Surely one of your technological tycoons can think of a workable system lying somewhere between the crudities of the Germans' 1918 device and the prohibitively expensive transoceanic arrangement. At present my blonde and I are both learning Swahili but at any moment it may occur to the authorities to use a tape machine and send the record for translation to one of the big missionary societies, the officials of which might think it their duty to phone the Queen's Proctor at once.

## A Photoarchic Camera

I WAS delighted to see an advertisement in *W.W.'s* sister journal, *Amateur Photographer* (19.6.57) describing a 16mm cine camera in which a photocell is used to operate the iris diaphragm of the camera so that it is always opened to the correct aperture according to the varying conditions of light. Thus the lens is always opened to the correct aperture according to the varying conditions of light available even if a cloud momentarily passes over the sun while shooting.

This is indeed a praiseworthy application of electronics and the reason for my delight is the fact that I first described this type of photoarchic cine camera in this journal

some twenty years ago (20.6.34). It is gratifying to learn that all the big manufacturers of scientific apparatus keep a wary eye on these columns.

In the advertisement it is described as the first cine camera of this type. I have little doubt that the maker of this camera honestly believes this to be the case. After all, we all used to believe that Harvey discovered the circulation of the blood until it was revealed that he was anticipated, several centuries earlier, by an Arabic medical man. But this oriental sage's discovery was forgotten and Harvey made the discovery independently long afterwards. No doubt the camera has been re-invented and its progenitors owe nothing to my former description.

## Is Ernie Radioactive?

I AM very sorry to say that my attempt to use electronic techniques to influence Ernie in my favour, about which I wrote in June, proved a complete flop. At the same time I must take off my hat to the Post Office engineers for their very successful effort to outwit me and others like me. I was unaware of their precautions at the time and thought that my pulse generator had developed a fault.

However, the Editor has solved the mystery by forwarding to me a communication he has received from the Lead Development Association in which it is stated that the whole of Ernie's innards were encased in lead. This would, of course, effectively prevent any outside influence affecting his distributions of largesse.

I am astonished to realize from the wording of the bulletin sent out by the Lead Development Association that its public relations officer obviously does not realize the real reason for Ernie being provided with a lead casing. The P.O. engineering department seems to have informed him that the purpose of the lead casing is to contain the radiations from Ernie's neon tubes and so prevent interference with other parts of his anatomy.

If this be true I cannot for the life of me see why the screening metal had to be of lead and not of some non-plumbeous metal such as we use for screening in our radio sets. Could it be that the P.M.G. has not been as truthful as he might have been and that the real reason for Ernie's lead waistcoat is to shield his audience from harmful radioactivity? That would at least explain the presence of lead. Perhaps the P.M.G.'s technologists will write to the Editor and explain, and maybe the Lead Development Association will join me in this request for enlightenment.



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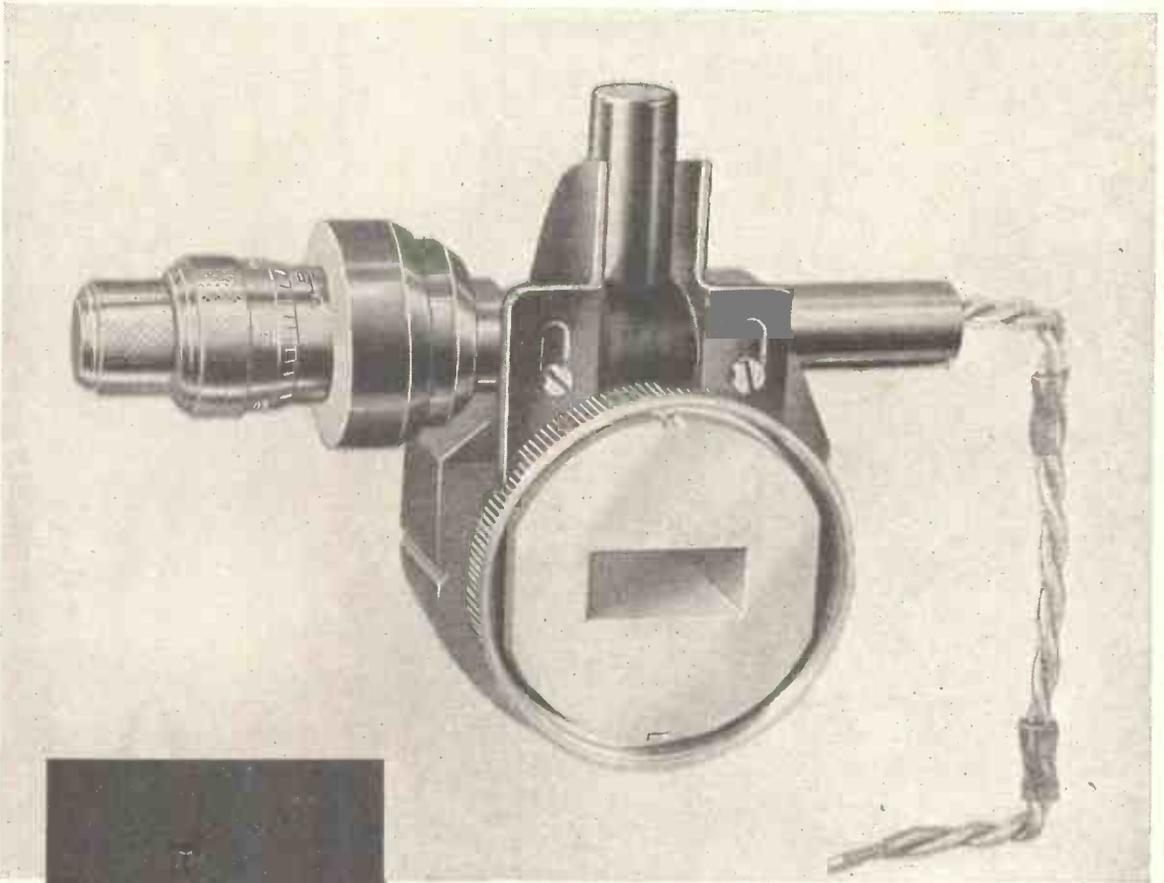
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## tunable magnetrons

These tunable X-band medium power magnetrons, developed by Mullard and produced in the new microwave valve factory, represent an important contribution to the field of microwave valves. They are particularly suited for use in microwave test equipment where c.w. power levels of a few watts are required.

**JPT9-01**

Tunable X-band magnetron with waveguide output. The valve delivers a c.w. output of 5 to 10 watts over a 450Mc/s band centred on 9375Mc/s. Tuning is by single-knob control, and has a total range of 800Mc/s, including the 450Mc/s band centred on 9375Mc/s.

**JPT9-02**

This is a similar valve intended for pulsed applications. It will deliver peak powers in excess of 20 watts over the 450Mc/s band at duty cycles up to 0.05.



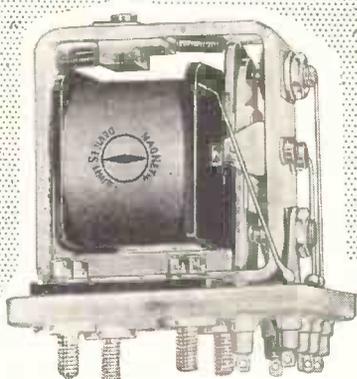
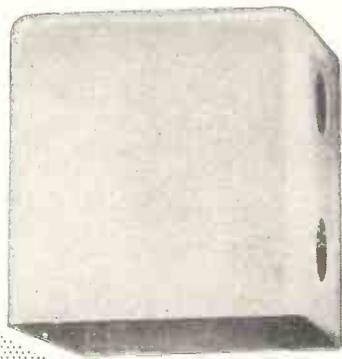
MULLARD LIMITED · MULLARD HOUSE · TORRINGTON PLACE · LONDON W.C.1

Experimental samples are available of another c.w. magnetron which gives a power output of several watts over the frequency range 5850 to 7300Mc/s.

## Mullard

COMMUNICATIONS AND  
INDUSTRIAL VALVE DEPARTMENT

# Voltage Regulating Relay



Two forms of the relay are available, either fully hermetically sealed or enclosed and tropicalised but unsealed. The inter-service reference numbers are as follows:—

**Unsealed**

ZA 44706 25.5V. make 23.5V. break  
ZA 44707 12.75V. make 11.75V. break

**Sealed**

ZA 44704 25.5V. make 23.5V. break  
ZA 44705 12.75V. make 11.75V. break



## MAGNETIC DEVICES LIMITED

A.I.D. & A.R.B. approved

EXNING ROAD, NEWMARKET, SUFFOLK  
Telephone: Newmarket 3181/2/3      Telegrams: Magnetic Newmarket

**ZA44704  
ZA44706**

**ZA44705  
ZA44707**

The Voltage Regulating Relay was designed in co-operation with S.R.D.E., to reduce voltage variations in certain essential circuits of radio sets and has many other applications of a similar nature.

This is particularly necessary in the case of vehicle-borne equipment, with power supplies consisting of lead acid batteries and a small charging generator.

The armature is balanced to withstand vibration, and the complete relay has been subjected to severe vibration testing.

Magnetic shielding is achieved by the iron case, enabling the relay to be used within reasonable proximity of transformers, chokes, etc.

The Voltage Regulating Relay complies with the stringent Ministry of Supply specification No. 166/1, to operate within tolerance, over a temperature range of  $-40^{\circ}\text{C}$ . to  $+85^{\circ}\text{C}$ .



*Loud-speaker manufacturers to the Radio Industry since 1930.*

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**WOLVERHAMPTON · ENGLAND**

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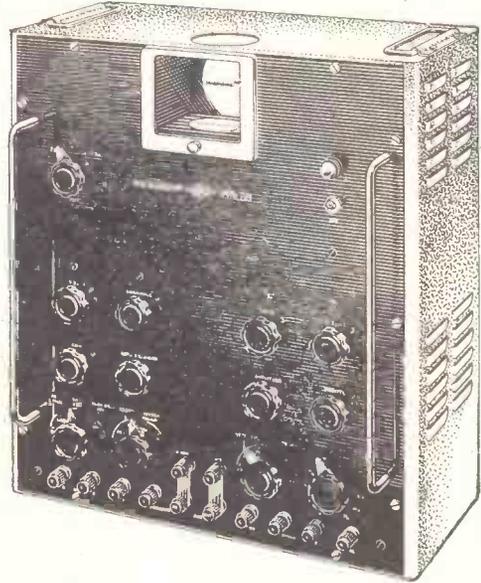


# OSCILLOSCOPE

## TYPE 723

### DC—5Mc/s

- Y Amplifier response flat from D.C. to 5 Mc/s.
- Sensitivity of 100 mV per cm. at 1 kV E.H.T.
- No overloading occurs with full screen deflection over the complete frequency range at 2 kV E.H.T.
- Variable E.H.T. voltage of 1, 2 and 4 kV.
- Automatic Brilliance Control Circuit.
- Time-base range from 0.5 seconds to 1 microsecond for full screen deflection.
- Versatile Auxiliary Amplifier incorporated.
- A deflection of 1 cm. ensures rigid synchronisation over the whole frequency range.
- Instantaneous shifts.



THE OSCILLOSCOPE TYPE 723 utilises a vertical cathode ray tube with a 4in. flat screen, which is viewed through a surface aluminised-mirror. This form of construction has considerable advantages. The instrument which is only 8in. deep, may be forward rack mounted on a 19in. rack, but when employed for bench use it takes up less room than a conventional oscilloscope. The screen is observable at a reasonable height from the bench without tilting, and an effective light shield is obtained without a projecting hood. The large front panel makes possible a clear and convenient layout of controls, and an Oscilloscope Camera Type 758 may be mounted permanently on the top of the instrument without interfering in any way with normal viewing.

IMMEDIATE DELIVERY

PRICE £160

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

# AIRMEC LIMITED

HIGH WYCOMBE, BUCKINGHAMSHIRE, ENGLAND

Telephone: High Wycombe 2060. Cables: Airmec, High Wycombe

# ***Distortion Detected - Transmission Perfected***



### **T.D.M.S. 5A**

*Sends an automatic test message, or characters, or reversals at any speed between 20-80 bauds with or without distortion. The CRO has a circular time base for distortion measurements on synchronous signals only, or relay adjustment. Weight 37 lb.*



### **T.D.M.S. 6A**

*For distortion measurements on working circuits without interrupting service. Each element of a start-stop signal appears separately on the spiral time base display. Adjustable speeds from 20-80 bauds. Weight 33 lb. Higher speed versions can be supplied to order.*



### **REGENERATIVE REPEATER TRR.1**

*is a start-stop, five unit code equipment, designed to correct distortion on long line or radio telegraph circuits. It covers the speed range 45, 50 or 75 bauds, and accepts signals with up to 49% distortion.*

**AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.**

RADIO AND TRANSMISSION DIVISION,  
STROWGER HOUSE, ARUNDEL STREET, LONDON, W.C.2  
TELEPHONE : TEMPLE BAR 9262. CABLEGRAMS : STROWGEREX LONDON.



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TRUVOX R1 Recorder



Tape Recording Amplifier



Tape Deck Mark IV.



Stereophonic Head



Telephone Attachment

Senior Radio Jack



Standard Radio Jack



Lightweight Headphones



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No other manufacturer can boast of so wide a range of components and accessories devoted to the perfect reproduction of taped speech and music. Designed and developed in our own laboratories by a team of highly skilled acoustical engineers, the Truvox range of equipment represents years of patient research which has now reached full fruition by the introduction of the Truvox R1 Recorder. The available accessories provide almost limitless applications for this truly high-fidelity equipment.

Detailed literature available on request from

# TRUVOX

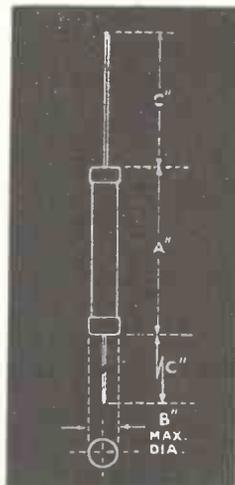
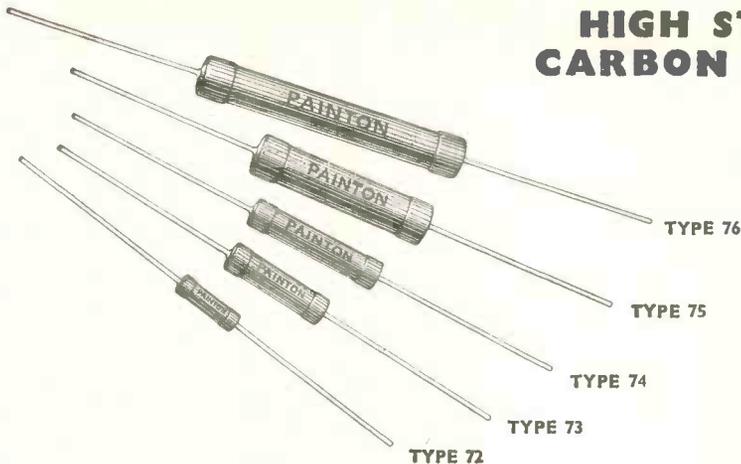
## TRUVOX LIMITED

Sales Office: 15, Lyon Road, Harrow, Middlesex. Tel: Harrow 9282  
Service & Technical Dept: 328 Station Rd., Harrow, Middx. Tel: Harrow 4455



*By Appointment to the Professional Engineer*

# HIGH STABILITY CARBON RESISTORS



### ELECTRICAL CHARACTERISTICS

The electrical characteristic of a High Stability Carbon Resistor depends upon the physical size of the units and upon the ohmic value. All the data given below relates to the Type 73 Resistor. To obtain the equivalent ohmic values to which the information is applicable in the other four sizes of Resistor the following factors should be applied:

- Type 72 x 3
- Type 74 x 2
- Type 75 x 4
- Type 76 x 8

### FULL LOAD STABILITY

Up to 100 K.ohms the resistance change at full load with an ambient temperature of 70°C. is less than 0.75% (average 0.25%) after 1,000 hours operation. At 1 Megohm the change is less than 1% (average 0.75%).

N.B. On D.C. loading the maximum voltages stated in RCL 112 should be observed.

### AGEING AND SHELF DRIFT.

Up to 100 K.ohms the average change is 0.25% in 12 months (never greater than 0.75%). For 1 Megohm resistors the average change is 0.6% in 12 months (never greater than 1.25%).

### CLIMATIC

Exposure to the two cycles of H.I. humidity as laid down in RCL 112 shows a change of less than 0.7% (average 0.4%) up to 100 K.ohms. At 1 Megohm the change is less than 1% (average 0.7%).

### TROPICAL EXPOSURE

Eighty-four days exposure to the standard 25°C./35°C. 100% humidity-cycling shows a change of less than 1% (average 0.5%) up to 100 K.ohms. At 1 Megohm the change is less than 2% (average 1.6%).

### TEMPERATURE COEFFICIENT

The temperature coefficient is less than 0.04%/°C. up to 100 K.ohms. At 1 Megohm the coefficient is approximately 0.055%/°C.

### NOISE

Noise which is generated in a resistor, as the result of a direct voltage applied across it, varies according to the ohmic value of the resistor, the noise decreasing as the ohmic value increases. The noise is also influenced by factors such as the size of the resistor.

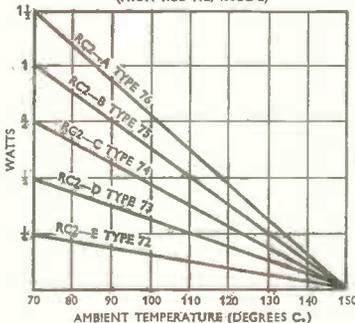
For noise which falls within frequency range of 0 to 10 Kc./sec., the Painton high stability resistors have noise levels which are between 0.05 and 0.4 microvolts of noise per applied direct volt, when the resistor is dissipating power at its maximum wattage rating.

### VOLTAGE COEFFICIENT

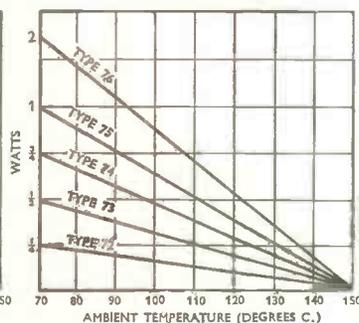
Not exceeding 0.002% per volt D.C.

### DERATING FOR AMBIENT TEMPERATURES EXCEEDING 70°C.

WATTAGE RATING/AMBIENT TEMPERATURE GRAPH (FROM RCL 112, ISSUE 2)

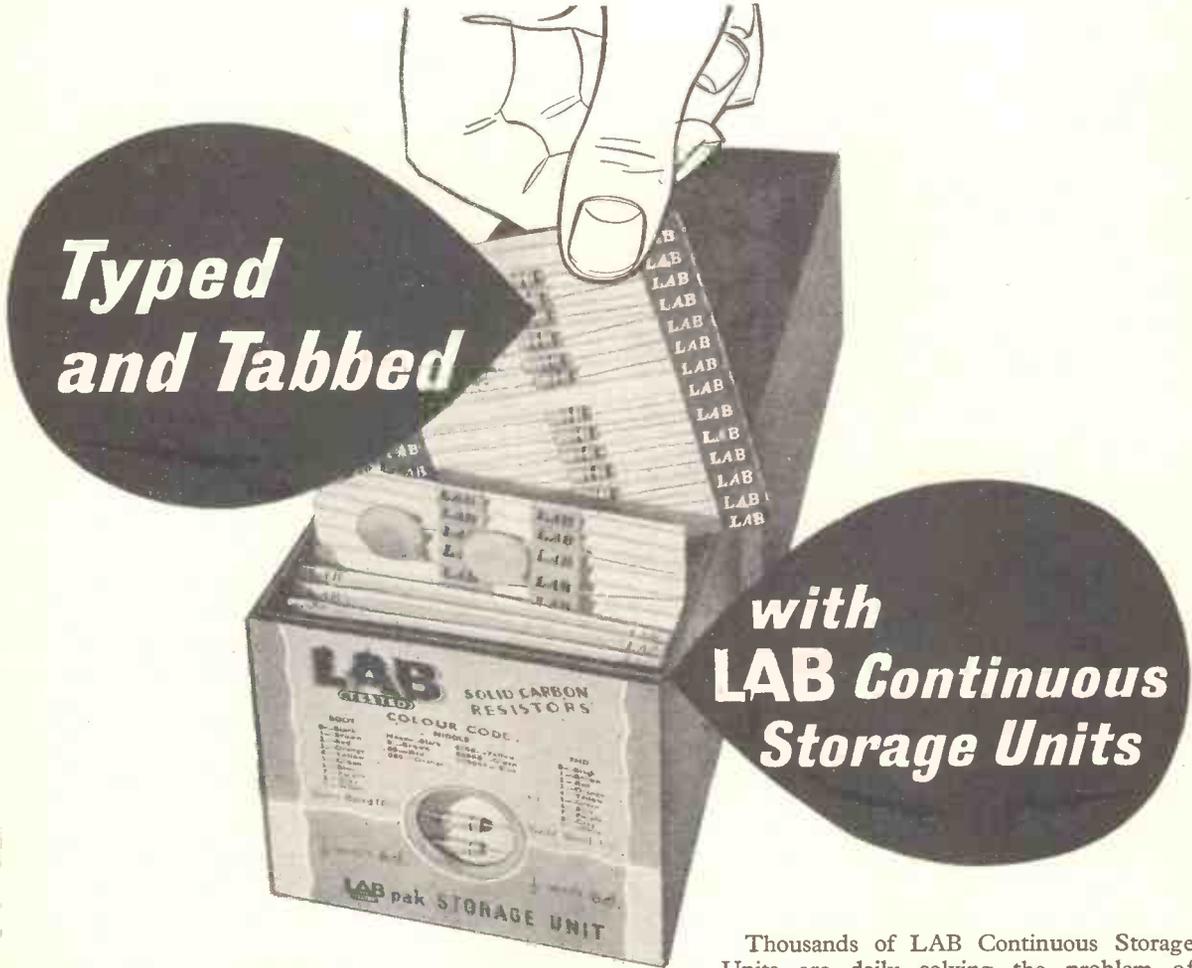


COMMERCIAL DERATING CURVE



TYPE	RESISTANCE RANGE (ohms)	VALUES OUTSIDE THIS RANGE MAY BE QUOTED FOR SEPARATELY.				
		72	73	74	75	76
72	±1% 4—700K	±2% 4—1.0M	±5% 4—2.5M			
73	±1% 4—1.0M	±2% 4—2.0M	±5% 4—5.0M			
74	±1% 20—2.0M	±2% 20—4.0M	±5% 20—10.0M			
75	±1% 20—3.0M	±2% 20—5.0M	±5% 20—10.0M			
76	±1% 20—5.5M	±2% 20—9.0M	±5% 20—50.0M			
TYPE		72	73	74	75	76
Normal Commercial Rating 70°C—watts		1	1	1	1	2
R.C.S.C. style		RC2-E	RC2-D	RC2-C	RC2-B	RC2-A
R.C.S.C. Rating at 70°C—watts		1	1	1	1	1 1/2
R.C.S.C. Rating at 100°C—watts		1	1	1	1	1
DIMENSIONS IN INCHES		A	B	C		
		1 1/2	1 1/2	1 1/2	1 1/2	2 1/2
		1/8	1/8	1/8	1/8	1/8
		1 1/2	1 1/2	1 1/2	1 1/2	1 1/2

**PAINTON**  
*Northampton England*



REF.	WATTS	MAX. VOLTS	OHMS	MIN. ORDER FOR FREE UNIT	UNIT STORAGE CAPACITY
<b>RESISTORS</b>					
T	½	250	10 to 10M	240	720
R	1	500	10 to 10M	180	500
Tolerances available ±20% 10% 5%					
<b>HIGH STABILITY RESISTORS</b>					
HS3	½	750	1 to 500M	93	500
Tolerances available ±5% 2% 1%					
<b>WIREWOUND RESISTORS</b>					
LM	5 & 10	—	5 to 100K	72	300
LP	5 & 10	—	5 to 100K	72	300
<b>CERAMICAPS</b>					
CER	Tubular	500	3 to 470pf	141	500
HK	Tubular	500	470 to 5000pf	141	500
HKD	Disc	500	470 to 5000pf	141	500
Tolerances available ±2% 10%					

Thousands of LAB Continuous Storage Units are daily solving the problem of control and storage of the great range of resistors. Compact, and capable of storing up to 720 separate resistors, LABpak make selection positive, simple and speedy. Now that Ceramicaps, Histabs and Wirewound resistors have been added to the carded range the usefulness of LABpak storage units is enhanced.

FREE with any purchase of the LABpak range, these units are the complete answer to the storage problems of small production units, laboratories, etc.

**MAKE UP YOUR ORDER TODAY — DELIVERY EX-STOCK**

All LABpak resistors are carded in ohmic value, rating and tolerance, colour indexed and tabbed for easy selection.

The LAB Continuous Storage Units are available from your normal source of supply, but more detailed information and literature can be obtained from

# THE RADIO RESISTOR COMPANY LIMITED

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Little fellows making

# POWERFUL HISTORY

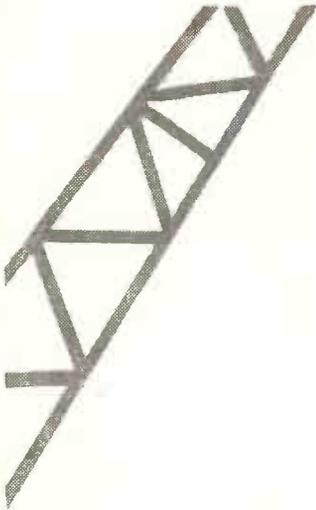
*Top manufacturers and designers have been quick to grasp the advantages offered by the recent introduction of the Ever Ready Power Pack range of batteries for transistor duties and are exploiting the enormous potential they offer in the design of portable transistor equipment. Have you considered how Ever Ready Power Packs might help develop new lines in your business?*

*Write or telephone today for comprehensive leaflet which gives full details, to: Sales Department (Technical Service) The Ever Ready Company (G.B.) Ltd., London, N.7. Tel: Archway 3030.*



**POWER PACKS** *EXTRA* **for life!**

\* The illustrations show only three of the new range of Ever Ready Power Packs.



It is gratifying to know that in a world of rising prices our policy of maintaining and, in many instances, reducing prices has resulted over the years, and especially at this period, in ever increasing sales.

We carry a stock of 2,000 types of receiving, transmitting and special purpose tubes, and invite your enquiries not only for commercial grade tubes but also for those tested to C.V., JAN and MIL specifications.



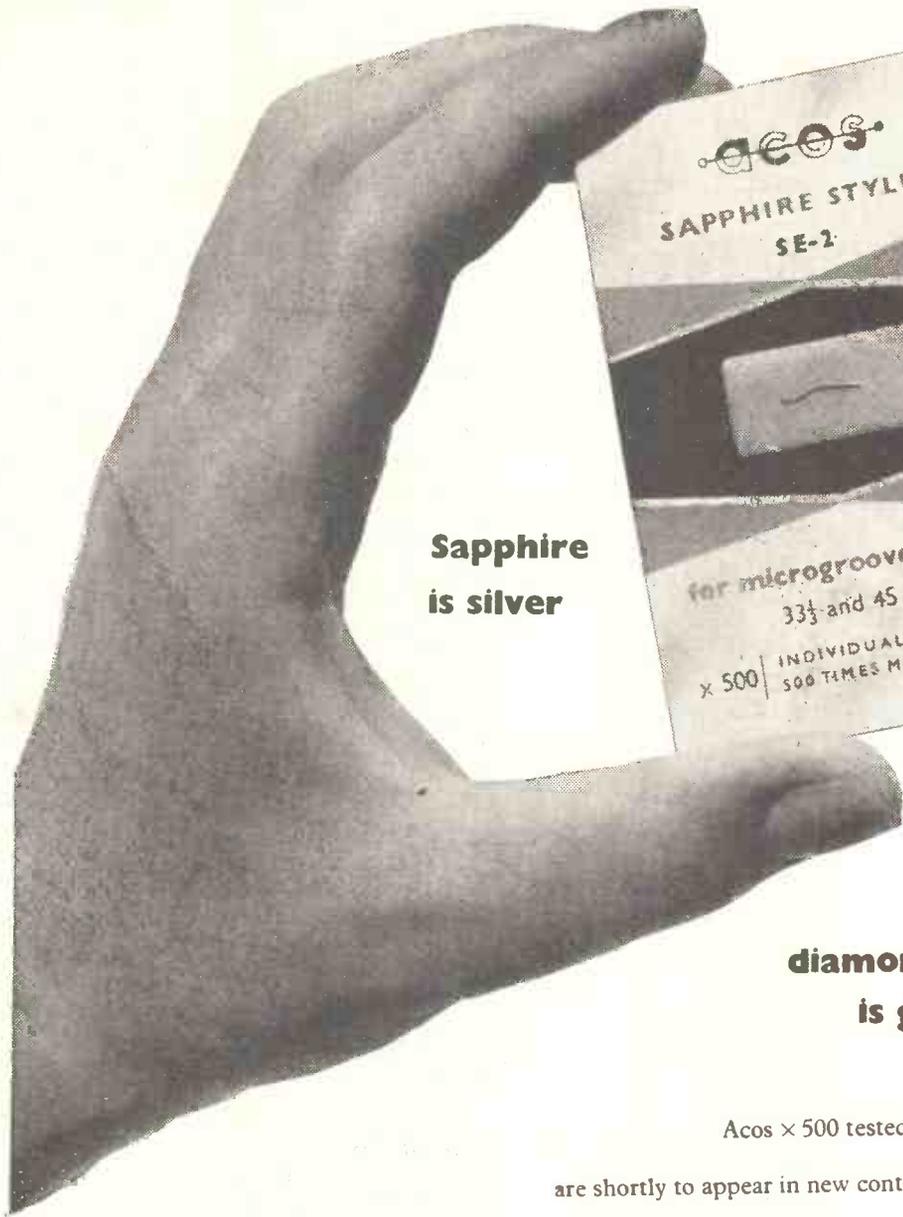
**Our Organisation is A.R.B. Approved.**

*If you are not already on our Mailing List, please send for latest Price and Stock Lists.*

# HALL ELECTRIC LTD

Haltron House, 49/55 Lisson Grove, London, N.W.1

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AMBassador 1041 (5 lines)  
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Hallectric, London  
TELEX 2-2573



**Sapphire  
is silver**

**diamond  
is gold**

Acos x 500 tested Replacement Styli  
are shortly to appear in new containers.

Sapphire styli in silver packs, diamond styli in golden packs.

These sealed envelopes will give added protection to the styli.

Also, their striking design will catch your eye  
in the shop to remind you: for your records' sake,  
fit Acos styli, and fit them in time.



**ARE DOING THINGS IN STYLI**

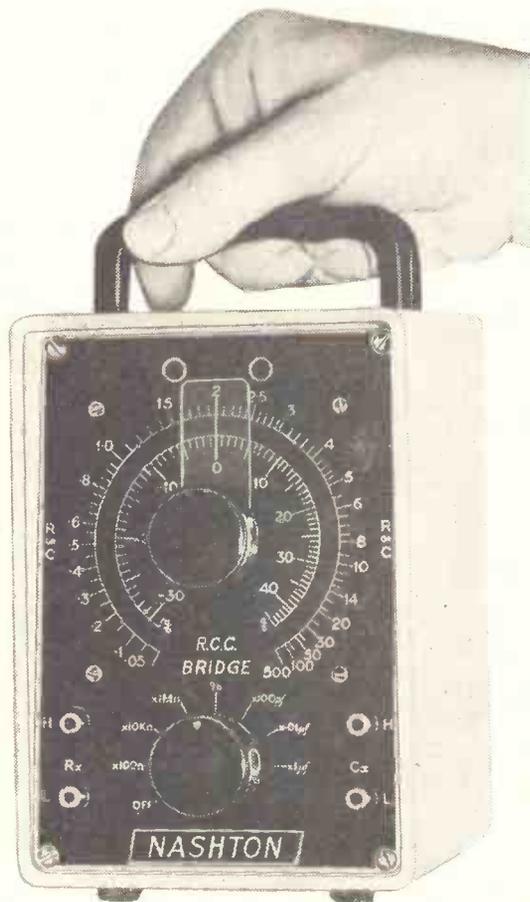
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**NASHTON**

INSTRUMENT RANGE

**R**esistance(5 $\Omega$  to 500M $\Omega$ )**C**apacitance(5pF to 500 $\mu$ F)**C**omparison

(-30% to +45%)

**B**RIDGE(1% mid-scale;  
2½% from 20 $\Omega$  to 20M $\Omega$ )

The Nashton R.C.C. Bridge is the first of a new range of electrical test instruments by Nash & Thompson, the Company specially selected to carry out the R.C.S.C. approval testing for the Ministry of Supply. The R.C.C. Bridge is precision-built of high stability 1% components

and incorporates a 0.1% linearity wire-wound cam-corrected balancing potentiometer.

Instruments in the new Nashton range, of which the R.C.C. Bridge is the first, will all be **Accurate • Low-priced • Reliable Compact**

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**Nash and Thompson**

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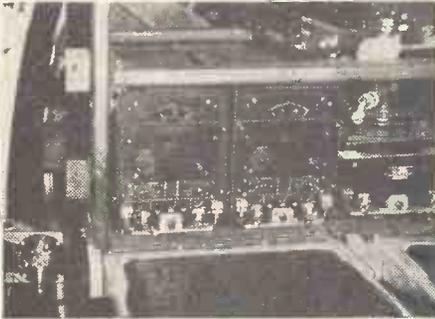
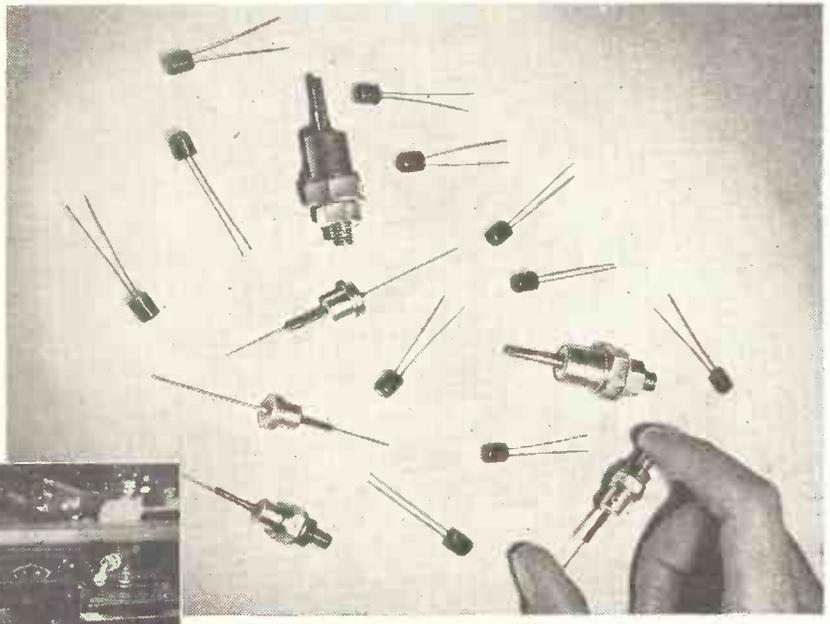
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*A wide range of applications*  
**FERRANTI SILICON JUNCTION DIODES**  
*and SILICON POWER RECTIFIERS*

Ferranti Silicon Junction Diodes are used in Smiths Flight System.



- LOW REVERSE CURRENT
- HIGH FORWARD SLOPE
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- SMALL PHYSICAL DIMENSIONS
- HIGH MECHANICAL STRENGTH



Ferranti Silicon Junction Diodes have been chosen for use in Smiths Flight System not only for their efficient operation, but also for their complete reliability, robust construction, small size and lightness in weight.

Ferranti Silicon Junction Diodes and Silicon Power Rectifiers have many applications in the aircraft, electronic, electrical and general engineering industries including aero engine controls, aircraft power supplies, radar systems, guided missiles, computers, indicating and recording instruments, process control and telephone equipment.

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# Voltage Reference and

This comprehensive range of Mullard gas-filled voltage reference and stabiliser tubes fulfils the needs of a variety of applications—both civilian and military.

The tubes are highly stable and mechanically strong. They have a long life and their operating characteristics are well defined.

Most of them are available to British Services CV Specifications and in Special Quality versions—both pinned and flying lead—for operation under rigorous conditions of shock and vibration.

Further information and data are readily available upon request at the address below.



## Voltage Reference Tubes

These tubes provide a constant voltage standard of extreme accuracy. They are normally operated at the optimum constant current.

### Abridged Data for Reference Tubes (Please send for details of Special Quality Versions)

Type No.	Equivalent U.S. Type	CV No.	Construction	Preferred Operating Current (mA)	Burning Voltage Range at Preferred Operating Current (V)	Min. Voltage for Ignition (V)	Max. Incremental Resistance (ohms)	Typical Drift in Burning Voltage per 1000 hrs. (%)	Max. Voltage jump of typical tube at preferred operating current (mV)
85A2	—	CV449	B7G	6.0	83 to 87	115	450	0.1	5
85A3 *	5783	—	Sub-min. flying lead	1.5 to 2.0	84 to 88	130	1000	0.5	5



Mullard Ltd., Mullard House,  
Torrington Place,  
London, W.C.1



# Stabiliser Tubes

**75C1**



This 75-volt stabiliser combines a good regulation voltage with long term stability and a wide range current of 2 to 60mA

**90C2**



90-volt subminiature voltage stabiliser tube equivalent to the 5644.

**90C1**



**150B2**



90-volt and 150-volt stabiliser tubes. These two tubes offer particularly good long term stability and close tolerance characteristics.

**108C1**



**150C4**



The most important feature of these 108-volt and 150-volt stabiliser tubes is their low regulation voltage. The 150C4 is an improved version of the 150C2.

## Voltage Stabiliser Tubes

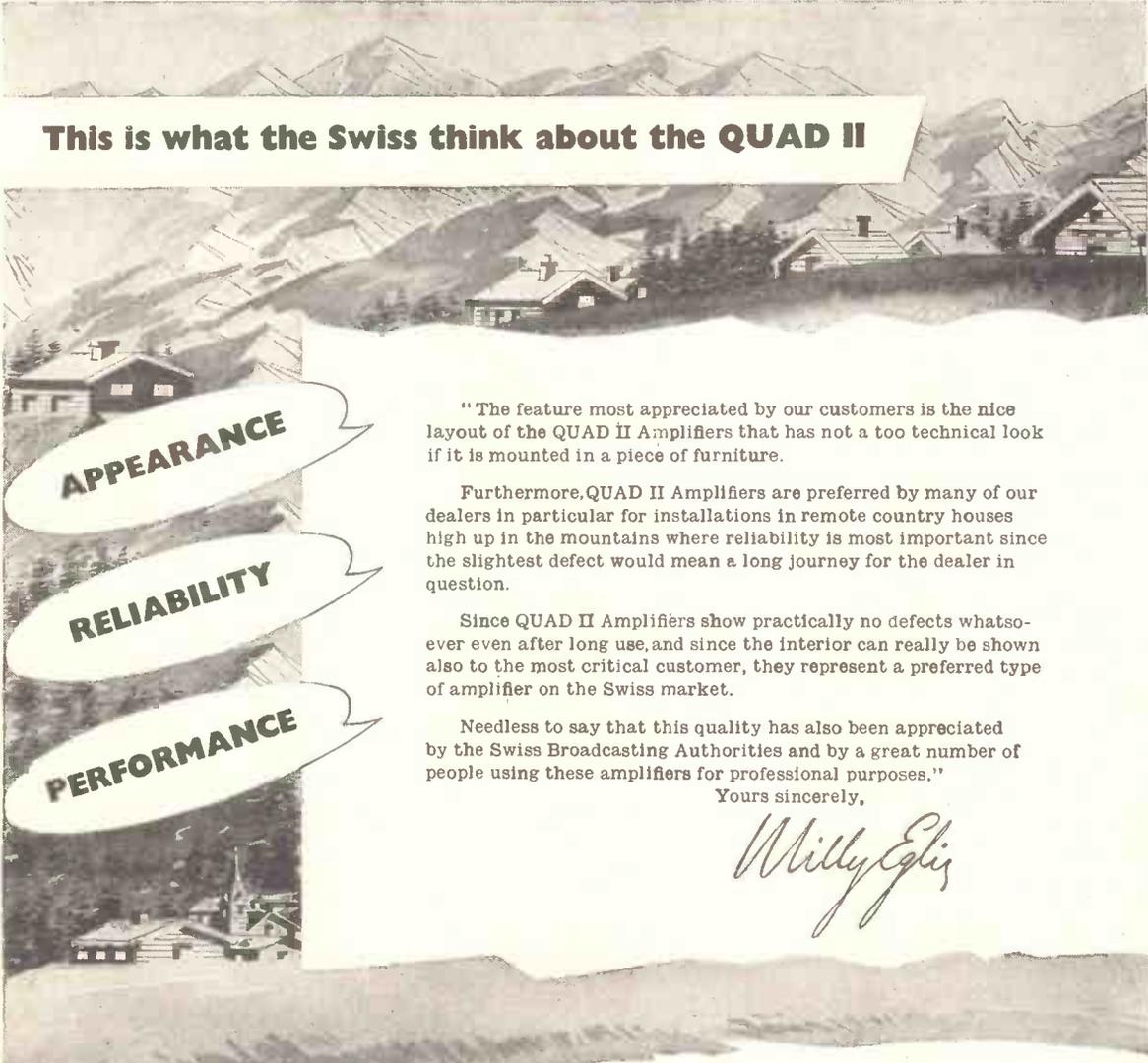
These tubes are designed to give a constant output voltage despite wide variations of input supply. They have a wide current range and good regulation.

### Abridged Data for Stabiliser Tubes (Please send for details of Special Quality Versions)

Type No.	Equivalent U.S. Type	CV No.	Construction	Nom. Burning Voltage (V)	Min. Ignition Voltage (V)	Current Range (mA)	Max. Regulation Voltage** (V)
75C1	—	—	B7G	75	115 †	2.0 to 60	8.0
90C1	—	—	B7G	90	115 †	1.0 to 40	14
90C2 *	5644	CV3987	Submin. flying lead	90	125 §	5.0 to 25	5.0
108C1	0B2	CV1833	B7G	108	133 §	5.0 to 30	4.0
150B2	—	CV2225	B7G	150	180 †	5.0 to 15	5.0
150C4	0A2	CV1832	B7G	150	185 §	5.0 to 30	8.0

- \* Preliminary information only.
- \*\* Measured over the range  $I_{min}$  to  $I_{max}$ , where  $I$  = Operating Current.
- † This voltage covers operation in daylight or complete darkness.
- § In total darkness a somewhat higher voltage is required for ignition.

THE QUAD II IN THE WORLD—No. 2



## This is what the Swiss think about the QUAD II

**APPEARANCE**

**RELIABILITY**

**PERFORMANCE**

"The feature most appreciated by our customers is the nice layout of the QUAD II Amplifiers that has not a too technical look if it is mounted in a piece of furniture.

Furthermore, QUAD II Amplifiers are preferred by many of our dealers in particular for installations in remote country houses high up in the mountains where reliability is most important since the slightest defect would mean a long journey for the dealer in question.

Since QUAD II Amplifiers show practically no defects whatsoever even after long use, and since the interior can really be shown also to the most critical customer, they represent a preferred type of amplifier on the Swiss market.

Needless to say that this quality has also been appreciated by the Swiss Broadcasting Authorities and by a great number of people using these amplifiers for professional purposes."

Yours sincerely,

*Willy Egli*

*An extract from a letter received from  
Willy Egli & Co. of Switzerland.*



**ACOUSTICAL**

**I**N like manner, enthusiasts the world over express their approval of the QUAD II — the best which present techniques can devise. The design of the QUAD II is simple and straightforward, without the sacrifice of a single refinement capable of contributing to the final objective — the closest approach to the original sound.

Send for full details & Brochure to Dept. W.W.

**ACOUSTICAL MANUFACTURING COMPANY LTD**  
HUNTINGDON, HUNTS. Telephone: HUNTINGDON 361

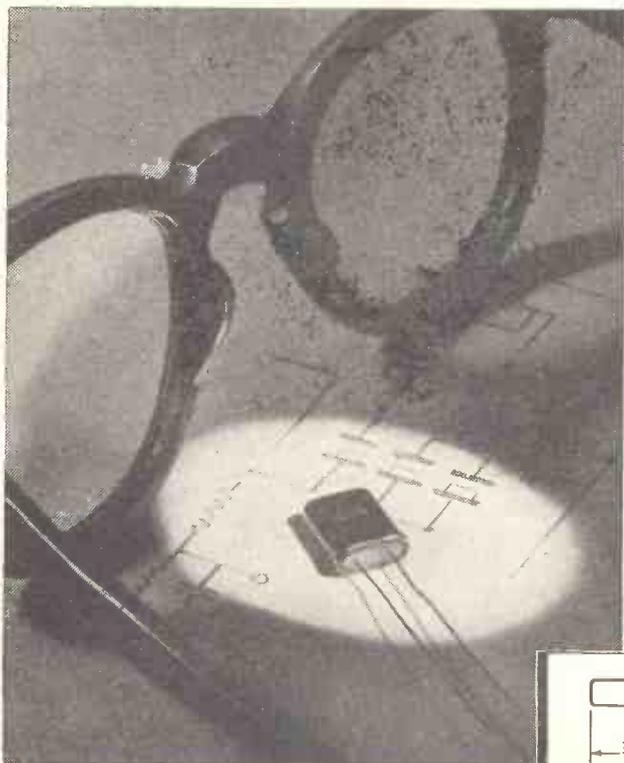
THE QUAD II IS AVAILABLE THROUGHOUT THE WORLD

*New!*



**The CATHODEON CUB**

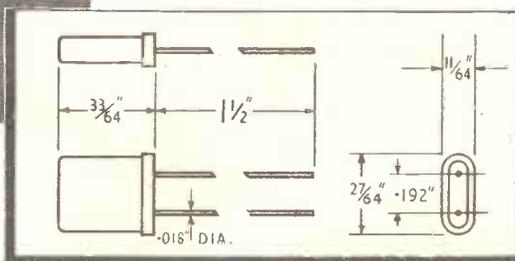
CRYSTAL UNIT



**Might in miniature**

- Precision frequency control from 5.0 Mc/s to 60.0 Mc/s.
- Above average frequency stability without oven control.
- Wide operating temperature range.
- Direct soldering to printed circuits or selector switches.
- Ideal size for packaged and transistorised circuits.
- Specially suitable for frequency synthesising as used in the latest transmitter-receivers.
- Fundamental 5 to 20 M/cs  
3rd Overtone 20 to 60 Mc/s.
- Frequency tolerance  $\pm 0.005\%$   $-55^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$ .
- 2MM holder equivalent to R.C.S.C. Style J and American type HC-18/U.

ACTUAL SIZE



**CATHODEON CRYSTALS LIMITED**  
**LINTON CAMBRIDGESHIRE**  
 TELEPHONE LINTON 223





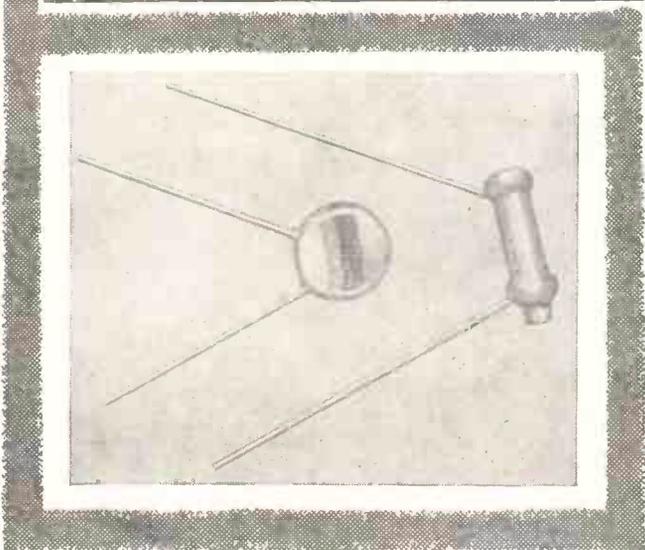
**NEW!**

# Tubular and Disc Ceramics

## HIGH-Q TUBULAR

List No.	Capacitance	List Prices			List No.	Capacitance	List Prices		
		±5%	±10%	±20%			±5%	±10%	±20%
<b>Type P100</b>									
CT10Q/2	1.5 pF	—	—	1/0d	CT10Q/2	75 pF	1/1½d	1/0d	10½d
CT10Q/2	2.2 pF	—	1/1½d	1/0d	CT12Q/2	100 pF	1/1½d	1/0d	10½d
CT10Q/2	2.7 pF	—	1/1½d	1/0d	CT15Q/2	150 pF	1/4½d	1/3d	1/1½d
CT10Q/2	3.3 pF	—	1/1½d	1/0d	CT20Q/2	200 pF	1/9d	1/7½d	1/6d
CT10Q/2	3.9 pF	—	1/1½d	1/0d	CT20Q/2	240 pF	1/9d	1/7½d	1/6d
CT10Q/2	5.0 pF	1/1½d	1/0d	10½d	CT25Q/2	300 pF	1/9d	1/7½d	1/6d
CT12Q/2	7.5 pF	1/1½d	1/0d	10½d	CT25Q/2	330 pF	1/9d	1/7½d	1/6d
CT12Q/2	8.2 pF	1/1½d	1/0d	10½d	CT30Q/2	390 pF	1/9d	1/7½d	1/6d
CT12Q/2	10.0 pF	1/1½d	1/0d	10½d	CT35Q/2	510 pF	1/9d	1/7½d	1/6d
CT15Q/2	15.0 pF	1/1½d	1/0d	10½d	<b>HIGH-K TUBULAR (Tolerance -20% +80%)</b>				
CT20Q/2	20.0 pF	1/1½d	1/0d	10½d	List No.	Capacitance	List Price		
CT20Q/2	22.0 pF	1/1½d	1/0d	10½d	CT10K/2	470 pF	10½d		
CT25Q/2	30.0 pF	1/1½d	1/0d	10½d	CT10K/2	680 pF	10½d		
CT25Q/2	33.0 pF	1/1½d	1/0d	10½d	CT10K/2	1,000 pF	10½d		
CT30Q/2	39.0 pF	1/1½d	1/0d	10½d	CT10K/2	1,500 pF	10½d		
<b>Type N750</b>									
CT10Q/2	10 pF	1/1½d	1/0d	10½d	CT10K/2	2,200 pF	10½d		
CT10Q/2	15 pF	1/1½d	1/0d	10½d	CT15K/2	3,300 pF	1/0d		
CT10Q/2	20 pF	1/1½d	1/0d	10½d	CT18K/2	4,700 pF	1/0d		
CT10Q/2	22 pF	1/1½d	1/0d	10½d	CT20K/2	5,000 pF	1/0d		
CT10Q/2	24 pF	1/1½d	1/0d	10½d	<b>HIGH-K DISC (Tolerance -20% +80%)</b>				
CT10Q/2	30 pF	1/1½d	1/0d	10½d	CD 8K/2	470 pF	10½d		
CT10Q/2	36 pF	1/1½d	1/0d	10½d	CD 8K/2	680 pF	10½d		
CT10Q/2	39 pF	1/1½d	1/0d	10½d	CD 9K/2	1,000 pF	10½d		
CT10Q/2	47 pF	1/1½d	1/0d	10½d	CD 9K/2	1,500 pF	10½d		
CT10Q/2	51 pF	1/1½d	1/0d	10½d	CD11K/2	2,200 pF	10½d		
CT10Q/2	68 pF	1/1½d	1/0d	10½d	CD12K/2	3,300 pF	10½d		
					CD14K/2	4,700 pF	10½d		

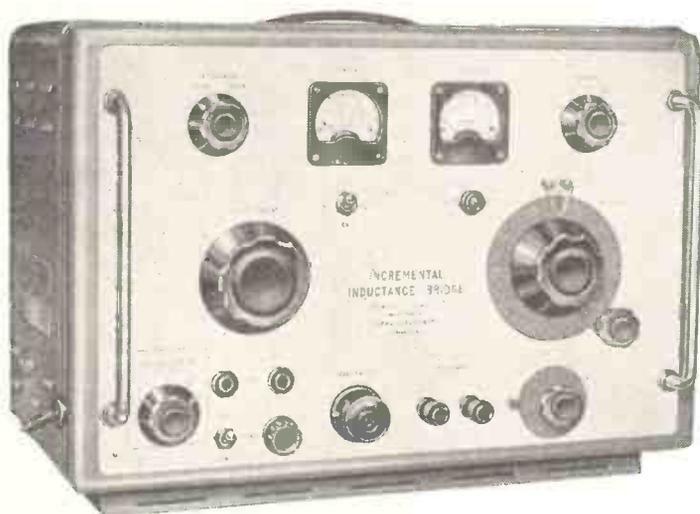
\* Hunts announce their new ranges of Tubular and Disc Ceramics. Precise in their characteristics and robust in design, these capacitors are available in High-K and High-Q Tubulars and in High-K Discs. Working Voltage 500 v D.C. or 300 v A.C. Minimum quantity 6 of any one capacitance.



**A. H. HUNT (Capacitors) LTD.**  
 WANDSWORTH, LONDON, S.W.18 BAT 1083-7

Factories also in Surrey and North Wales

## INCREMENTAL INDUCTANCE BRIDGE



*Designed to measure the value of iron cored chokes and similar inductors in the range 0.01H to 1000H of Q value not less than 2.*

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

*Full technical information is available on request.*

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A COMPANY WITHIN THE RANK ORGANISATION LIMITED

WORSLEY BRIDGE ROAD • LONDON • S.E.26  
HITHER GREEN 4600

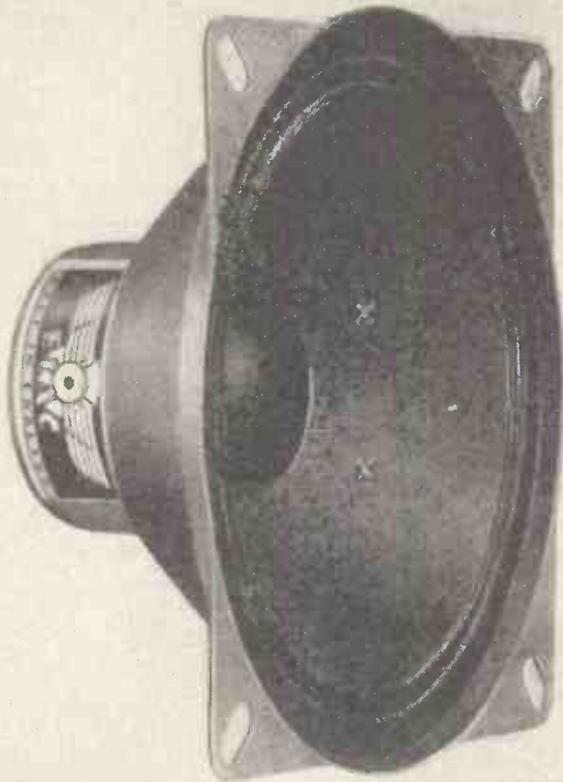
**SALES AND SERVICING AGENTS:**

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McKellen Automation Ltd., 122 Seymour Grove, Old Trafford, Manchester 16

Atkins, Robertson & Whiteford Ltd., Industrial Estate, Thornliebank, Glasgow

# The latest in the Hi-Fi range



## The Elac 4 inch Tweeter

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

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

Frequency response within 5 dB from 5,000-17,000 cps, only  $7\frac{1}{2}$  dB down at 20,000 cps.

OVERALL SIZE: 4in. DIA. x  $2\frac{5}{8}$ in. DEEP.

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

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

PRICE: 29/10 inc. P.T.

Trade Terms  $33\frac{1}{3}\%$

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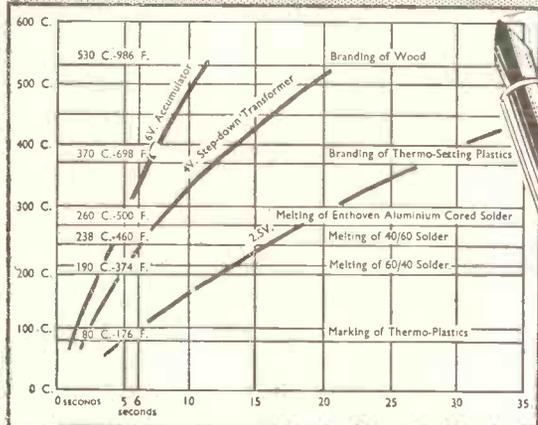
# The Superspeed

## SOLDERING IRON

heats up from cold  
in 6 seconds!

Manufactured for Enthoven Solders Ltd., by Scope Laboratories, Melbourne, Australia.

Designed on an entirely new principle, this light-weight, versatile iron is eminently suitable for soldering operations in the radio, television, electronic and telecommunication industries. For test bench and maintenance work it is by far the most efficient and economical soldering iron ever designed. Ideally suitable for use with Enthoven Aluminium Cored Solder (melting point 260°C. 500°F.).



**TIME/TEMPERATURE CURVE CHART from the SUPERSPEED SOLDERING IRON TIP/TEMPERATURE TIME CHECK**

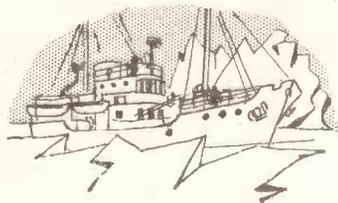
The effect of different voltages on initial heating-up time is shown. Whilst 4V is the standard voltage normally employed, 6V will cause no harm, and accumulators are a useful source of current supply.

- \* Activated by light thumb pressure on the switch ring. When pressure is released, current is automatically switched off—thus greatly reducing electricity consumption, wear on copper bit and carbon element.
- \* Length, 10"; weight, 3½ ozs.; can be used on 2.5 to 6.3 volt supply (4 volt transformer normally supplied) or from a car battery.
- \* More powerful than conventional 150-watt irons; equally suitable for light wiring work or heavy soldering on chassis.
- \* Simple to operate; ideal for precision work.
- \* Requires minimum maintenance—at negligible cost; shows lowest operating costs over a period.

For full particulars, including guarantee terms and free trial facilities, please write to the sole concessionaires in this country:—

**ENTHOVEN SOLDERS LTD.** (Industrial Equipment Division)  
Dominion Buildings, South Place, London, E.C.2. **MONarch 0391**

Switch to the  
**Superspeed**  
Soldering Iron

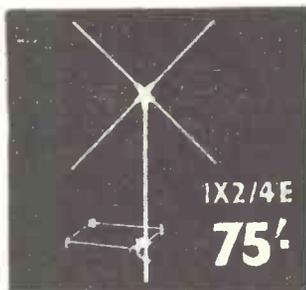


as being used by the  
Royal Society Antarctic Expedition  
for the International Geophysical Year.

LIST PRICES	
IRON	39/6
TRANSFORMER	35/6
All prices and trade discounts subject to revision	



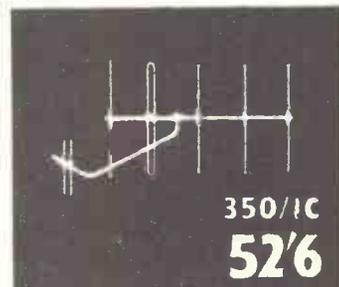
# ANTIFERRENCE aerials



**BAND I** A complete range of Antex (illustrated) Dipole, "H," Fringe and Indoor models is available. Outdoor models can easily be adapted for Band III by adding Band III Grip-on aerials.



**BAND II** Indoor and outdoor models to suit all conditions and to provide the very best results for VHF/FM equipment. Models for fitting to existing TV masts are available.



**BAND III** 3, 5, 8, 10 element and Stacked Arrays for outdoor installation and a comprehensive range of indoor models.

## Specially Designed EXPORT RANGE

Antiferrence offer a specially developed range of competitively priced Television and VHF/FM aerials for export including Horizontally or Vertically Polarised Single or Stacked Yagi Arrays, Broad-Band and All-Band types for International Frequencies including Continental (C.C.I.R.) and American channels. Full details of this specially designed Export Range on request from Export Department, ANTIFERRENCE LIMITED, AYLESBURY, BUCKS.



STANDARD  
**PLUG &  
SOCKET**

R.E.C.M.F. SPECIFICATION.  
Robust and simple to fit.

**PLUG TVP/1  
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Both **8<sup>D</sup>** Each



**"Y" BOXES**

For combining or dividing Band I and Band III Television Aerial down leads.

**Outdoor Model Y.1.— 16'6**

**Indoor Model Y.2.— 12'6**

Now **BAND III & HIL-O**  
**AUTOMATIC**  
WITH  
*Click-Mec*  
Far in advance of any other form of pre-assembly — "click" and they're fixed!

**HIL-O** 17 models to provide perfect Band I/Band III reception with only one aerial. All incorporate the patented Electronic Coupling exclusive to Antiferrence.



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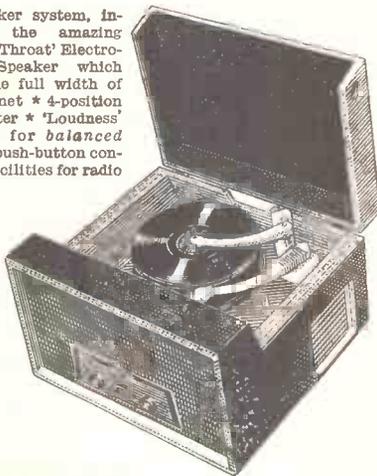
Antiferrence Aerials are supplied through Appointed Antiferrence Distributors to all leading Radio and Television Dealers. We regret that we cannot supply direct to members of the public.



# VIVACE

"Vivace" . . . with life . . . so vital to a musical performance. An ordinary record played on the Super Black Box becomes a thrilling musical experience . . . springing to life with all the feeling and beauty of the original performance. The Super Black Box gives a standard of performance unequalled by any other table record player (for the technical this means only 0.5% distortion at 8 watts output). Ask your Pye dealer for a demonstration.

\* 3-speaker system, including the amazing 'Infinite Throat' Electrostatic Speaker which spans the full width of the cabinet \* 4-position noise filter \* 'Loudness' control for 'balanced' sound \* push-button controls \* facilities for radio tuner



## SUPER BLACK BOX

4-speed record player for automatic or manual operation. In gay Contemporary or Traditional mahogany-veneered cabinets. A.C. Mains. 59 gns. tax paid



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This superb instrument is an impressive addition to the famous Pye "Black Box" range of high-fidelity record reproducers. For full details, fill in and post this coupon to PYE LTD., HI FI DIVISION, CAMBRIDGE.

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# A-M-P

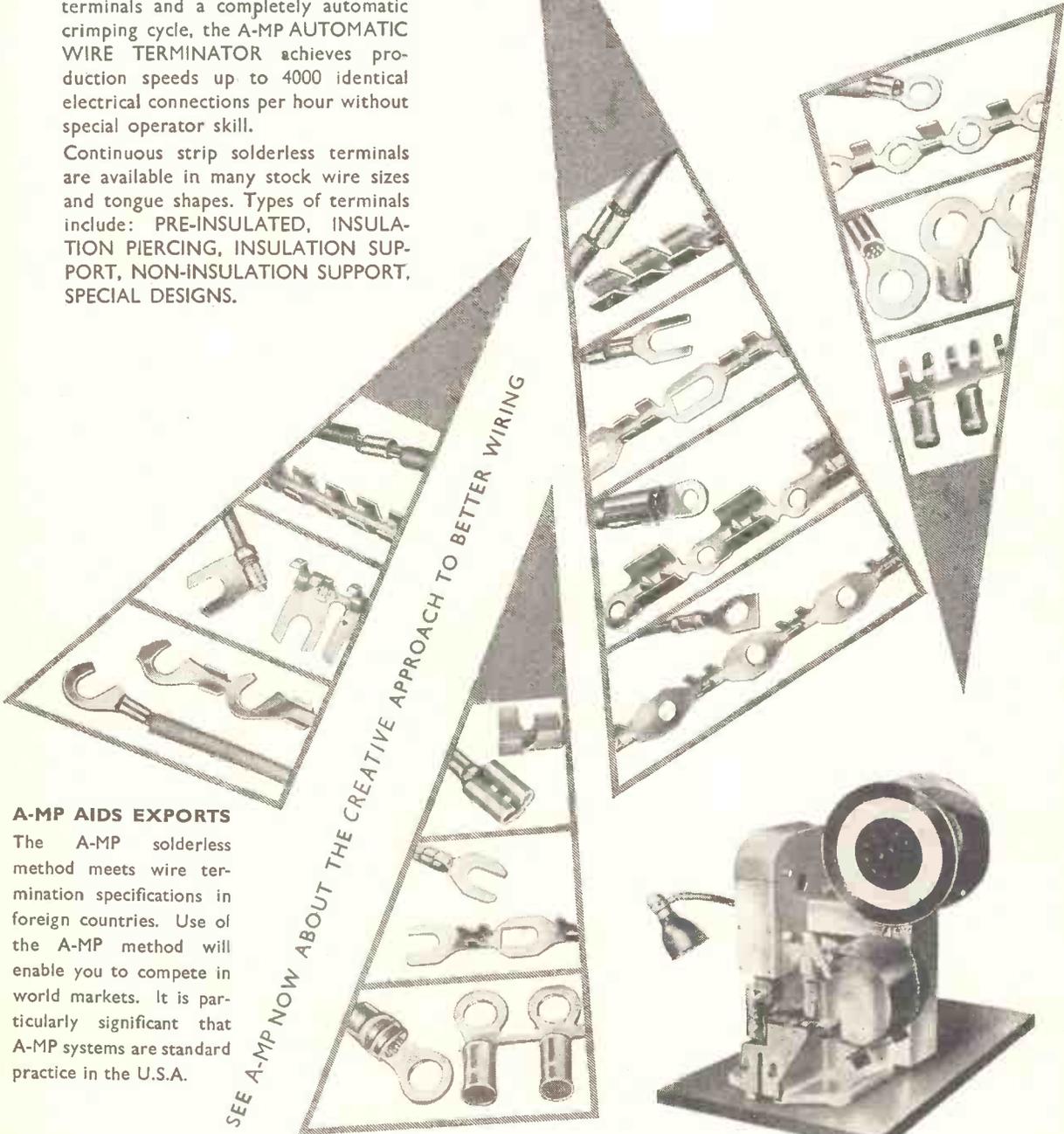
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TRADE MARK

## for the mass-production of electrically wired products

Using a continuous strip of solderless terminals and a completely automatic crimping cycle, the A-MP AUTOMATIC WIRE TERMINATOR achieves production speeds up to 4000 identical electrical connections per hour without special operator skill.

Continuous strip solderless terminals are available in many stock wire sizes and tongue shapes. Types of terminals include: PRE-INSULATED, INSULATION PIERCING, INSULATION SUPPORT, NON-INSULATION SUPPORT, SPECIAL DESIGNS.



### A-MP AIDS EXPORTS

The A-MP solderless method meets wire termination specifications in foreign countries. Use of the A-MP method will enable you to compete in world markets. It is particularly significant that A-MP systems are standard practice in the U.S.A.

SEE A-M-P NOW ABOUT THE CREATIVE APPROACH TO BETTER WIRING

# A-M-P

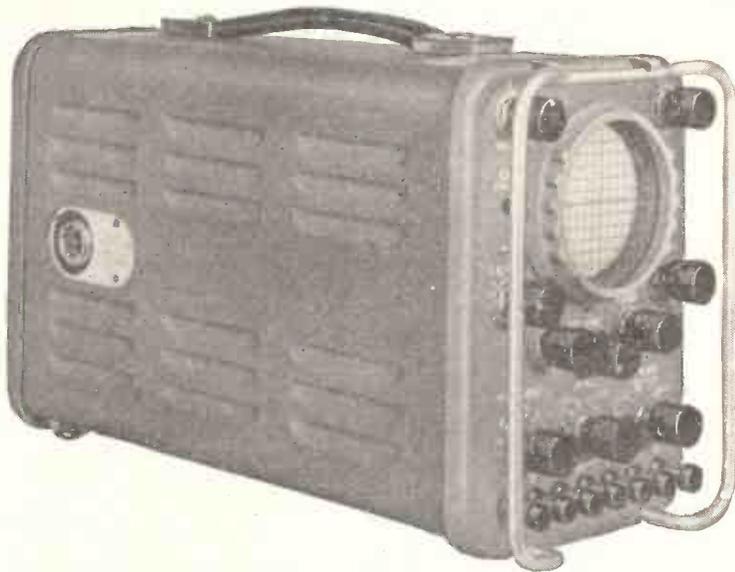
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Works: SCOTTISH INDUSTRIAL ESTATES, PORT GLASGOW, SCOTLAND.

# MINIATURE OSCILLOSCOPE



Type  
CT84

Type  
CT52

Weight—approx. 15 lb. Size— $13\frac{1}{2}'' \times 8'' \times 5\frac{1}{2}''$  approx. Finish—Dark Battleship Grey.

Designed as a general-purpose instrument, the Metrovick miniature oscilloscope is particularly useful for radar servicing. Its light weight and compact construction result in a portable and robust instrument designed to withstand rough use, so that it has now become standard equipment for the fighting services.

## SPECIFICATION

**SUPPLY:** With A.C. Power Pack (CT52)—100/125 v., 200/250 v., 50/60 c/s.; 180 v., 500 c/s. With D.C. Power Pack (CT84)—28 volts D.C. Power consumption 50 VA approx.

**CATHODE RAY TUBE:** Hard tube— $2\frac{3}{4}$  in. diameter screen. Standard tube fitted has Green screen with medium afterglow. Alternative tubes can be fitted.

**TIME BASE:** Free-running linear time base, paraphase amplifier and synchronising. Repetition range 10 c/s. to 40 Kc/s. Single-sweep linear time base with paraphase amplifier, triggered by 30-volt pulse. Repetition range—50 c/s. to 3,000 c/s. Sweep range—50 milliseconds to 3 microseconds.

**Y PLATE ATTENUATOR:** Resistance attenuator, capacitance compensated. Flat response—3 db. from D.C. to 100 kc/s. Fixed attenuation of 14 db. (5 times).

**Y PLATE CONNECTION:** Direct or series capacitor connection. Input resistance—2.5 megohms. Input capacitance—50 pf. approx.

**Y PLATE AMPLIFIER:** 1. Max. gain of 38 db. (80 times) flat to 3 db from 25 c/s. to 150 Kc/s. 2. Max. gain of 28 db. (25 times) flat to 3 db. from 25 c/s. to 1 Mc/s.

**CALIBRATION:** An internal supply of 50-volt peak  $\pm 10\%$ , sine wave, at the supply or vibrator frequency.

**DELAY LINE:** A delay network brought to the Y plate switch, and the displayed signal is delayed by approximately 0.5 microseconds, having its source impedance of 75 ohms.

**RATING:** Continuous operation at ambient temperatures between— $32^\circ\text{C}$ . and  $+50^\circ\text{C}$ .

*Write for leaflet 652/14-1 for technical details*

## METROPOLITAN-VICKERS

ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER 17

*An A.E.I. Company*

# NEW LOW-COST RADIO RELAY EQUIPMENT FOR DEPENDABLE, ECONOMICAL MULTICHANNEL COMMUNICATIONS

*RCA MM-2 provides  
multiplex telephone and  
telegraph circuits in 152 to 174 mc band*



RCA MM-2 radio relay equipment is ideally suited for private, commercial or governmental application where from 1 to 6 channels are needed for opening new radio communications. The modulation bandwidth, from 300 cps to 28 kcs, can provide up to five 3 kc carrier derived telephone-channels plus one voice frequency channel. Each channel may be further multiplexed for high speed voice frequency carrier telegraphed circuits, teleprinter or manual telegraph, telemetering and control circuits.

**Compact, Easy Access Design.** The entire MM-2 equipment, including multiplex equipment such as the RCA MV-124, can be mounted in one standard 19" width rack. All tubes, components and adjustment controls are readily accessible for maintenance and service purposes. The simplicity and dependability of the equipment reduce maintenance to a minimum.

The Transmitter unit, with built-in power supply, features crystal con-

trol and phase modulation, and provides a power output of 60 Watts. When used in conjunction with a directional type antenna, the effective radiated power may be increased.

The Receiver makes use of two crystal controlled local oscillators in a double conversion superheterodyne circuit. A Receiver Power Supply is also furnished as part of the basic equipment.

**Low Cost MM-2 Packages** are available to meet the needs of every user. RCA Communication specialists will study the system requirements, terrain, and other factors, to recommend the correct equipment package. Adaptions will be made to meet local power supply, or a power supply will be included in the equipment package.

For further information on this low-cost radio communications equipment see your local RCA Engineering Products Distributor or write to Dept. RR-491, RCA International Division, 30 Rockefeller Plaza, N. Y. 20, N. Y.

**TYPICAL MM-2 TERMINAL** rack shown here with transmitter, receiver, and power supply on upper half with multiplex equipment mounted below.



RCA INTERNATIONAL DIVISION

**RADIO CORPORATION of AMERICA**

RCA Building, 30 Rockefeller Plaza, New York, N.Y., U.S.A.

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# A NEW A.C. MILLIVOLTMETER BY BRITISH PHYSICAL LABORATORIES

MODEL NO.: VM 348D MK II.

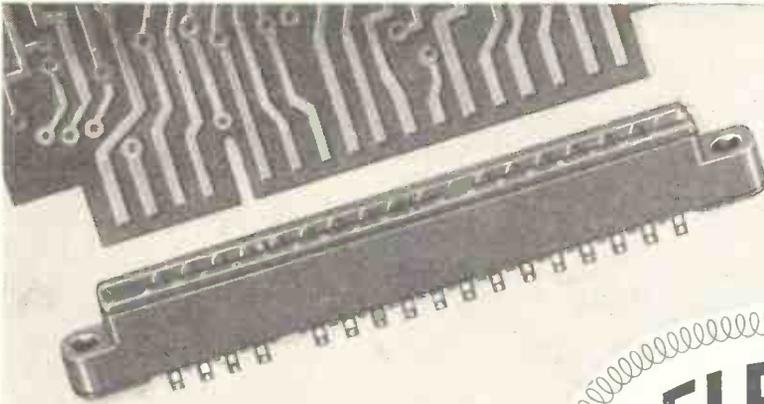
## POINTS TO NOTE.

- ★ 2mV F.S.D. at 10 MC/S,  $\pm 0.5$  dB.
- ★  $\pm 30$ dB AT 15 MC/S.
- ★ OPERATES UP TO 20 MC/S WITHIN  $\pm 6$ dB.
- ★ EIGHT RANGES UP TO 6 VOLTS. UP TO 00 VOLTS WITH PLUG IN MULTIPLIER.
- ★ 5 INCH SCALE METER, MIRROR SCALE, KNIFE EDGE POINTER.
- ★ INPUT VIA TERMINALS OR COAXIAL SOCKET.
- ★ ALTERNATIVE USE AS HIGH GAIN AMPLIFIER (X1000) FOR SINE, SQUARE AND PULSE WAVEFORMS.
- ★ IMMEDIATE DELIVERY—  
ASK FOR DEMONSTRATION.



FOR FURTHER INFORMATION ON THIS INSTRUMENT OR ANY OTHER ITEMS IN OUR RANGE OF INSTRUMENTS OR METERS, PLEASE CONTACT THE ADDRESS BELOW.

**BRITISH PHYSICAL LABORATORIES, RADLETT, HERTS.**  
TELEPHONE : RADLETT 5674.



This K-18 connector is  
ACTUAL SIZE  
—made under U.S. licence from  
Winchester Electronics Inc.



**DATA RELATING TO  
SERIES 'K'  
PRINTED-CIRCUIT  
CONNECTORS**

CURRENT CARRYING  
CAPACITY: 5 amps

BREAKDOWN VOLTAGE  
BETWEEN CONTACTS:  
3 kV (at sea level)

AVERAGE MATING  
AND UNMATING FORCE  
(per contact): 8 oz.

CONTACT CENTRES: .156"

FIXING HOLES: .125"

POLARISING KEYS  
fitted in any position

CONNECTIONS TO CONTACTS  
by rivets or solder-cups

**SERIES 'K'**  
with 6, 12, 18 & 22 contacts  
**NOW AVAILABLE  
FOR  
PROMPT DELIVERY**

— the foremost manufacturers of

*printed circuit  
connectors*

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

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

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12-36 Caxton Way, Stevenage, Herts.  
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## UNQUESTIONABLY . . .

*"The variable oscillator employs a triode in a modified Colpitts circuit comprising a split-stator capacitor and an appropriate tuning inductor which is selected by means of a range switch, the oscillator output being monitored by a crystal rectifier and indicating meter which are coupled to an 80dB resistive step attenuator."*



**W**HEN schoolboys are as interested in square-wave techniques as they are in square-leg tactics, it is advisable to know all about Marconi instruments.

It's not difficult. Take the Marconi TF 982A, for example, about which our young friend is so obviously well-informed. Here is a Marconi instrument that provides complete test facilities for mobile radio telephone sets. It combines, in one compact unit, a signal generator, a crystal-controlled auxiliary oscillator, a.f. and r.f. power meters, a local r.f. field detector, and an a.c./d.c. multi-range test meter.

Details of all this apparatus are given in a leaflet, full of technicalities, so that you, too, can discuss the V.H.F. Test Set authoritatively. You really should send for a copy.

**MARCONI  
INSTRUMENTS**



**MARCONI V.H.F. TEST SET  
Type TF 982A**

*Signal Generator Section*: 60 to 200 Mc/s; also eight bands centred on common i.f. values from 1.6 to 8.5 Mc/s; fixed depth 30% a.m. can be applied internally. Output 2 $\mu$ V to 2 mV at 52 and 75 ohms; higher outputs at 37.5 ohms. *A.F. Power Meter*: 30 mW full scale at 600 ohms; 1 watt full scale at 3 ohms. *R.F. Power Meter*: 20 watts full scale at 75 ohms. *Test Meter*: Five ranges covering from 100 $\mu$ A d.c. to 200 volts a.c. full scale.

AM & FM SIGNAL GENERATORS · AUDIO & VIDEO OSCILLATORS  
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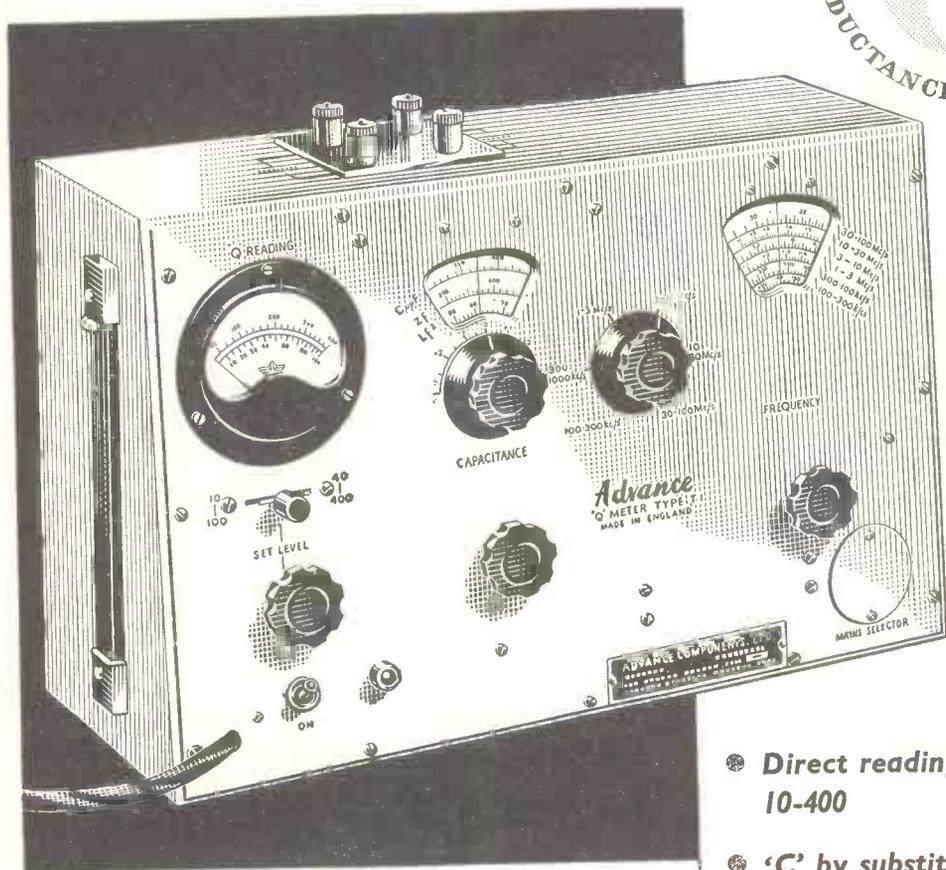
*North*: 30 Albion Street, Kingston-upon-Hull. Tel: Hull Central 16347

**WORLD-WIDE REPRESENTATION**

# Advance

## CIRCUIT MAGNIFICATION METER

INDUCTANCE CAPACITANCE



The "T1" is an easily operated and convenient instrument for making R.F. measurements of circuit magnification ('Q'), inductance, capacitance and power factor at frequencies between 100 kc/s and 100 Mc/s. Its portability and excellent specification make it a valuable addition to the electronic laboratory as well as for production testing.

Full technical details in Leaflet W31 available on request

### The MODEL T/2

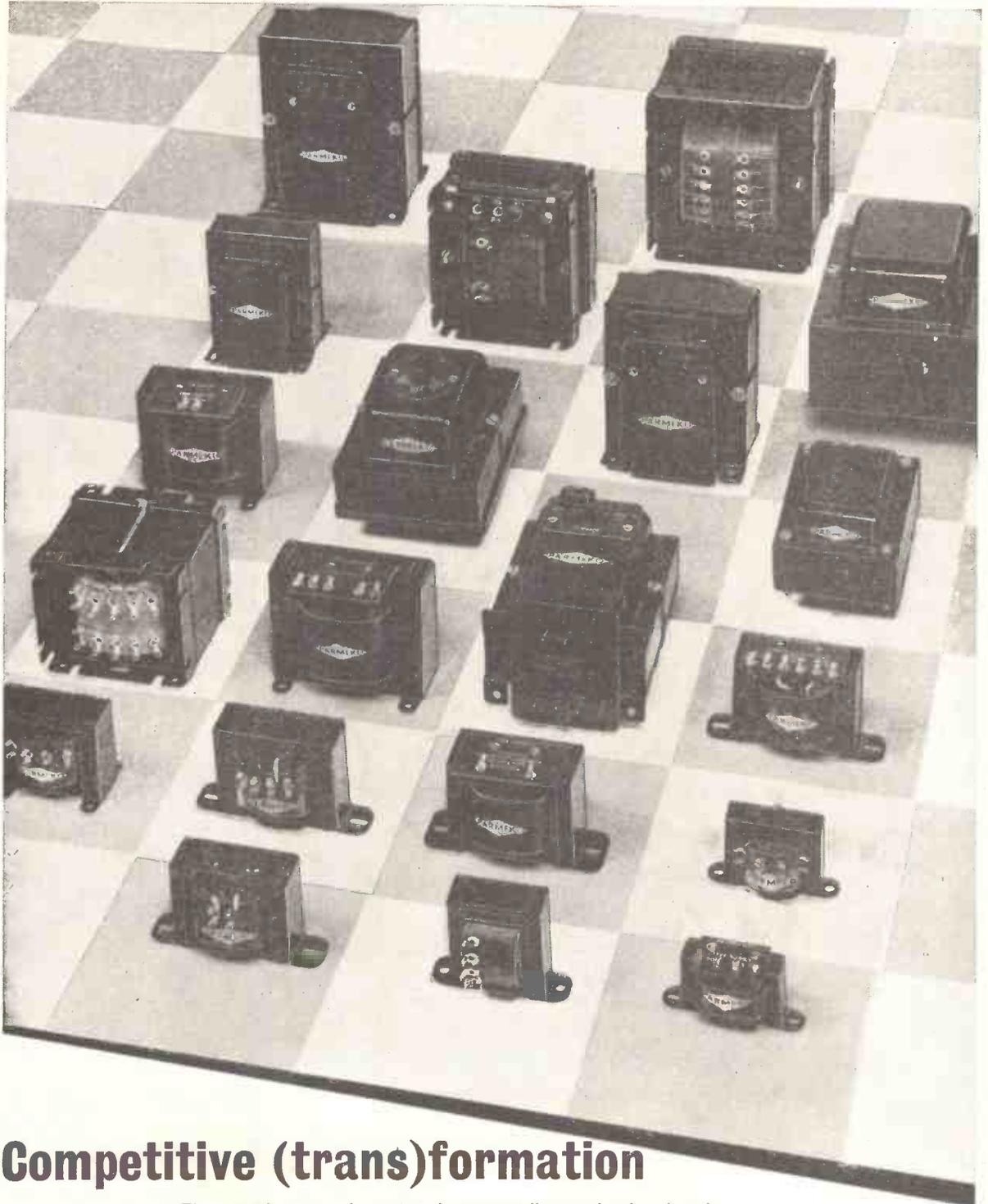
A new version of the Model T1 providing additional facilities for comparing 'Q', Inductance and Capacitance, and is most suitable for the production testing of coils.

Full technical details in Leaflet W44. **£70** Nett Price in U.K.

- Direct reading of 'Q' Range 10-400
- 'C' by substitution
- Rapid calculation of 'L' and 'Z'
- No 'Set-Zero' problems
- Small and portable  
(15½ x 10¼ x 6½ - 14lb)

**MODEL T1** NETT PRICE IN U.K. **£55**

Export enquiries welcomed.



## Competitive (trans)formation

There is value in numbers—in industry as well as on the chess board. Thanks to the factory extensions, Parmeko transformers are now being produced on a larger-than-ever scale, with resulting savings in time and unit cost. Prices are competitive; quality unsurpassed. If the transformer you want is not shown here, write for details of the complete and comprehensive Parmeko range.

# PARMEKO TRANSFORMERS

for the electronic and electrical industries  
PARMEKO LIMITED, PERCY ROAD, LEICESTER.

# ARCOLECTRIC SWITCHES & SIGNAL LAMPS



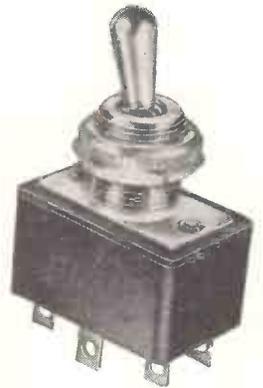
S.936: Normally off  
S.938: Normally on



T.600  
3-amp., 250v.



S.L.81  
Neon Signal Lamp  
1/2" hole fixing



T622. Toggle Switch  
D.P.C.O. 3.amp., 250v.



K.75: Small Pointer Knob



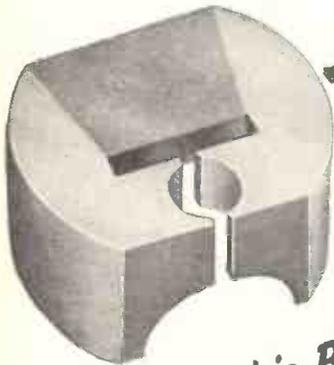
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Low Voltage,  
Signal Lamp  
for M.E.S. bulbs

Write for Catalogue No. 131



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TELEPHONE: MOLESEY 4336 (3 LINES)



**MUREX  
'SINCOMAX'  
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*are used in this B.P.L. TRANS RANGER*

A typical example of the use of Murex 'Sincomax' Magnets where a high energy product with high magnetic stability is essential. Murex 'Sincomax' Magnets with an alloyed bond between magnet and soft iron, continue to give accurate and reliable service in this and many other applications.



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MINIATURE CERAMIC CAPACITORS AND TRIMMERS for Radio, T.V., Electronic Appliances & Interference Suppression. MICRODISC TRIMMERS for printed circuits.

Vast range, new designs. Our Capacitors and Trimmers are of unsurpassed quality to build reliability that sets standard of long life and trouble free performance, and are used throughout the world by leading manufacturers.

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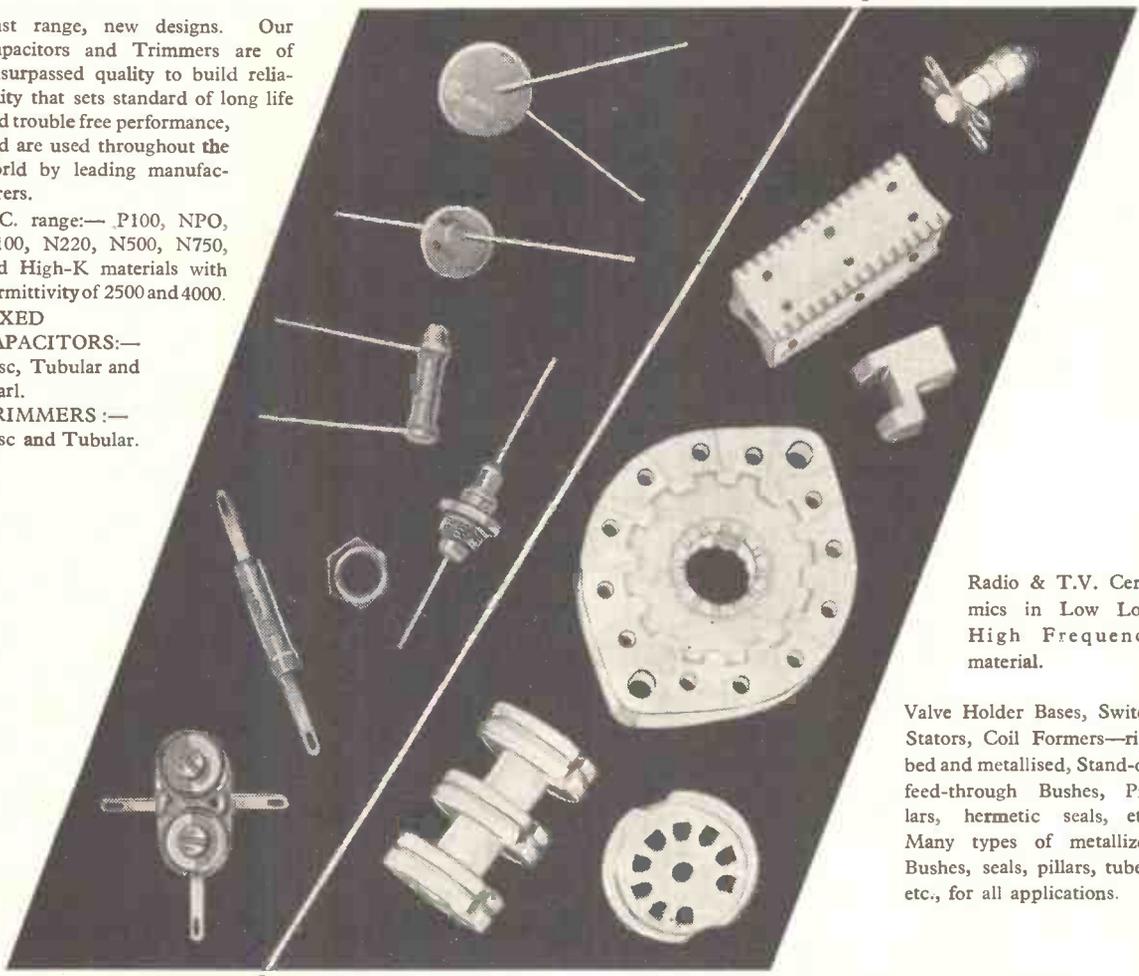
FIXED CAPACITORS:—

Disc, Tubular and Pearl.

TRIMMERS:—  
Disc and Tubular.

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Radio & T.V. Ceramics in Low Loss High Frequency material.

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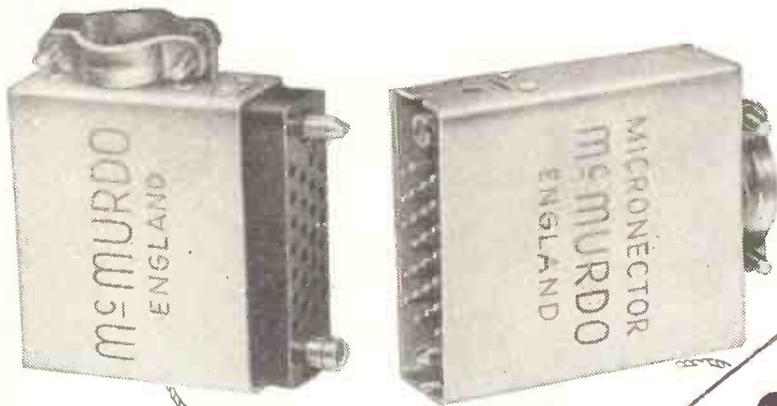
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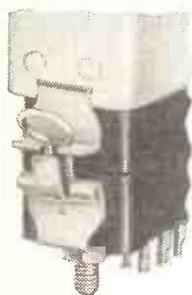
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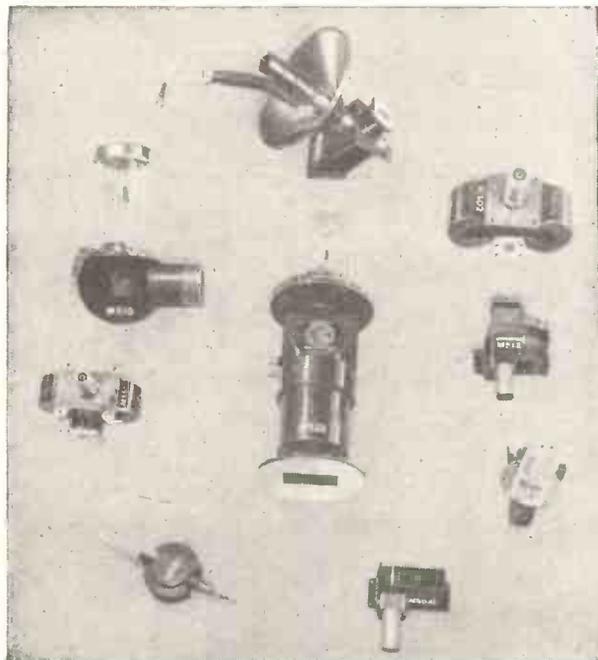
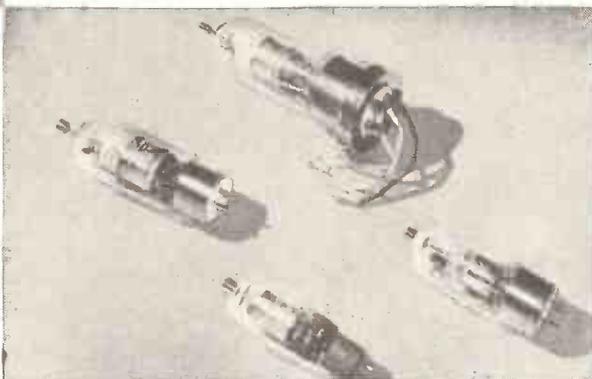
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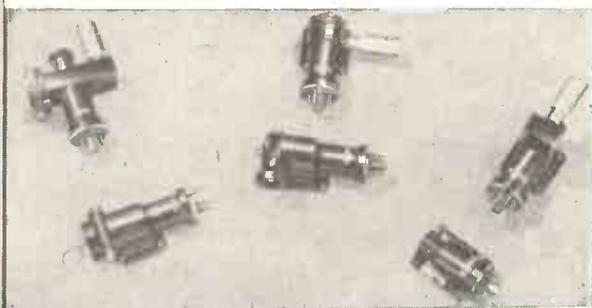
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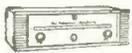
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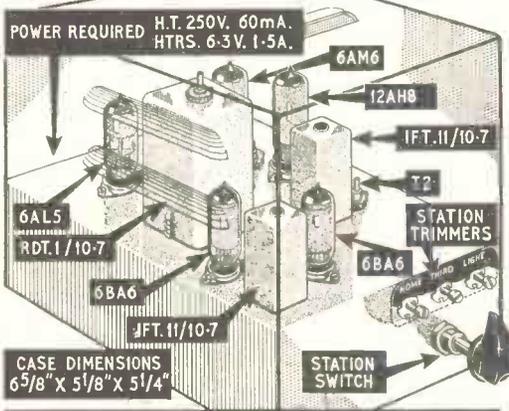


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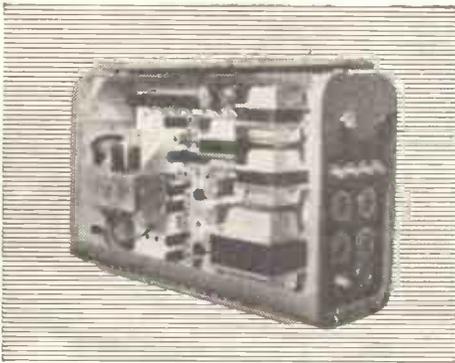
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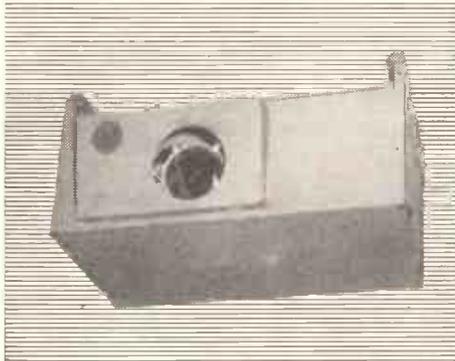
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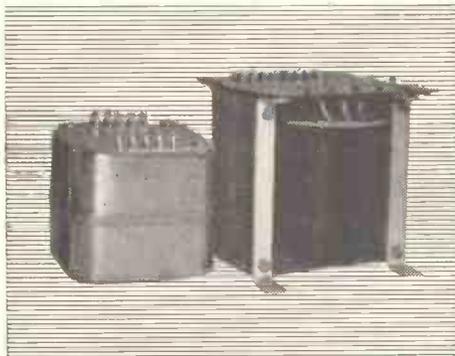
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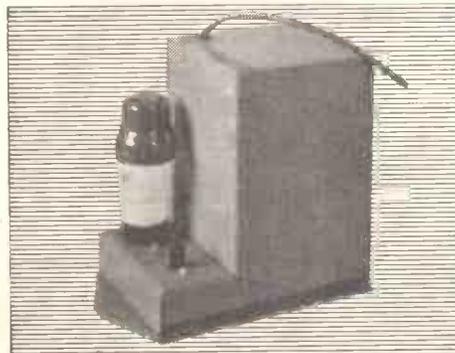
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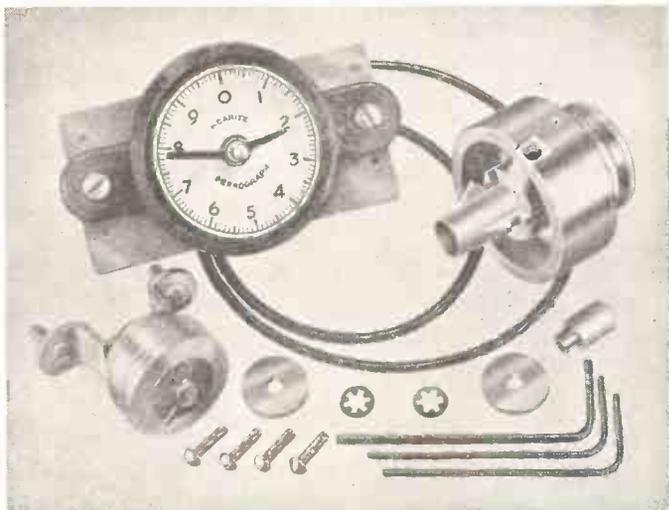
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## A clock-type Counter to fit all models of the Ferrograph

For Ferrograph users who want something more precise than the conventional scale, there is now available a clock-type zero-setting Counter which can be fitted to the Deck (between the two reels) to locate any required position on the tape track.

As can be seen, the traverse of the tape is continuously registered on a clock face scaled from 0-10 in tenths by a pair of hands. The Counter is belt driven through an intermediate pulley enabling the full length of an 8 1/4" reel of standard or long-play tape to be covered in one count.

Any Ferrograph or Wearite Tape deck owner can easily fit the Counter, which is supplied as a complete kit of parts with instructional booklet and a drilling template.



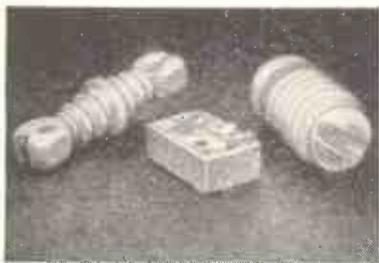
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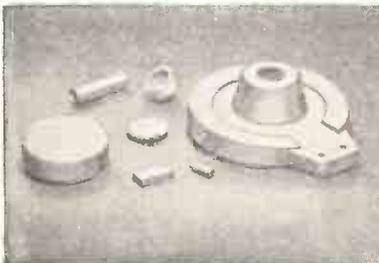
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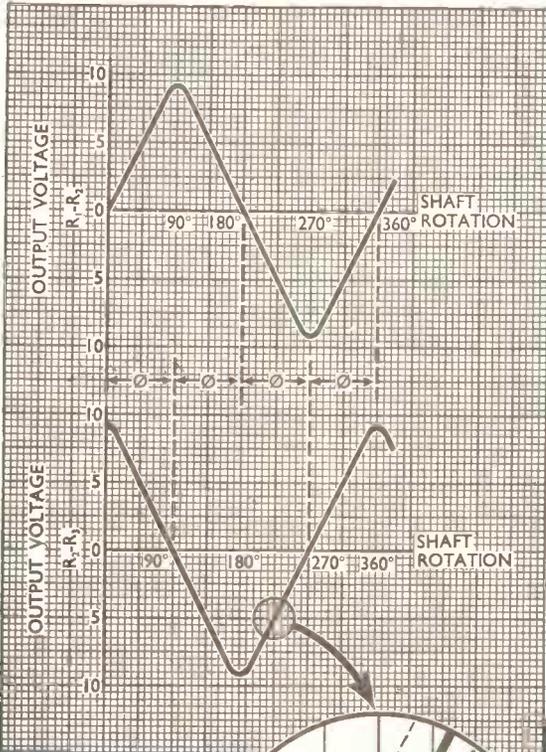
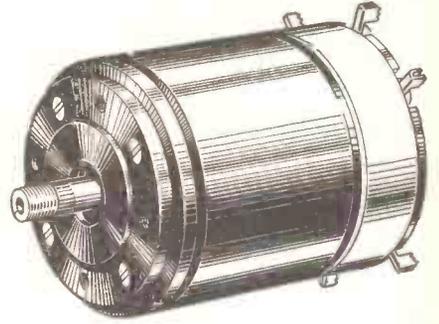
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The Sperry size 15 Variable Linear Transformer gives two output voltages whose amplitudes vary linearly with shaft rotation. It consists of a rotor with two windings at right angles which rotates in a stator having a single winding. If the Synchro is connected as shown, the voltages  $V_{R_1-R_2}$  and  $V_{R_2-R_3}$  vary linearly as shown in the accompanying graphs.

**SUPPLY:**— The unit is designed to work with a 1000 c.p.s. 10-volt signal applied to the stator, but will work at other frequencies including 400 and 50 c.p.s. with suitable adjustment of the signal level.

**TRANSFORMATION RATIO:**— The rotor output voltage, when the stator is excited at 10 volts 1,000 c.p.s., is arranged to rise to 5 volts when the rotor is displaced 45° from a null position. This transformation ratio of 2:1 varies  $\pm 0.2$  per cent between the windings in any one model and  $\pm 0.5$  per cent between models.

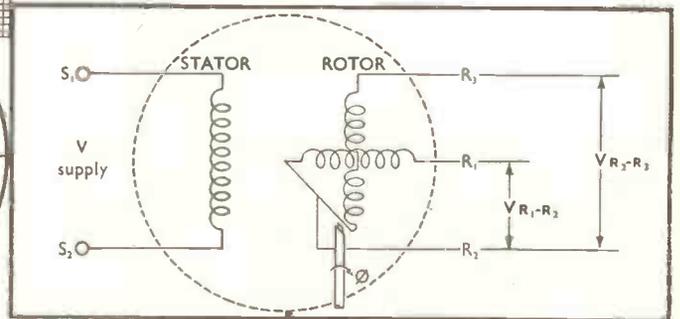
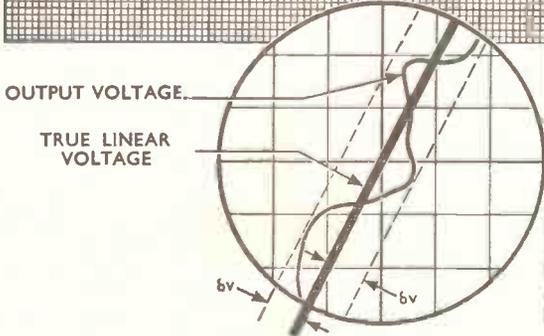
**NULL SPACINGS:**—  $\emptyset = 90^\circ \pm 4'$

**LINEARITY:**— The rotor output voltage rises linearly from the null position

- $\delta = \pm 0.4\%$   $0^\circ - 60^\circ$  displacement
- $\delta = \pm 0.5\%$   $60^\circ - 75^\circ$  displacement

Expressed as a percentage of the output voltage at 60°.

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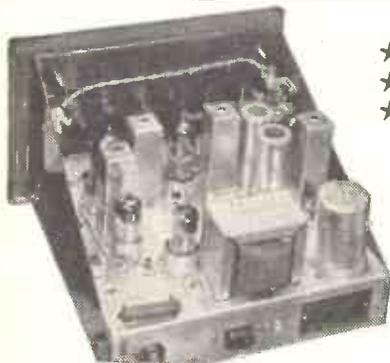
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(GRR Home Test No. 37 by Donald W. Aldous, M.Inst.E., M.B.K.S., G.R.R. March 1957).



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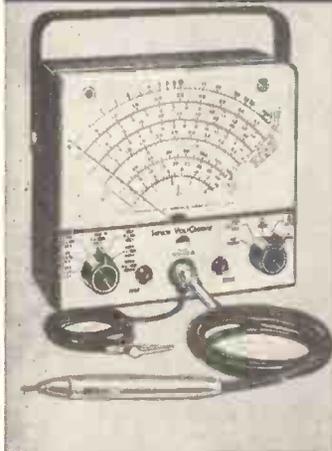
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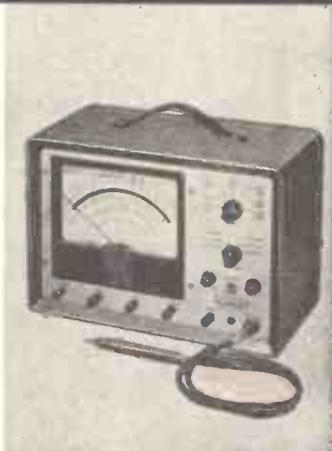
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AC (peak-to-peak) Voltage	0.2-4200v	0.2-4200v	—
Resistance	0.2-1000 meg.	0.2-1000 meg.	0.2-1000 meg.
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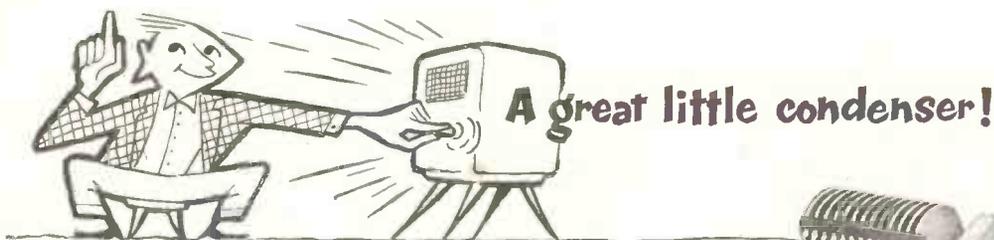
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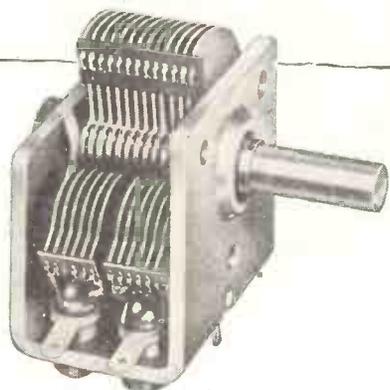


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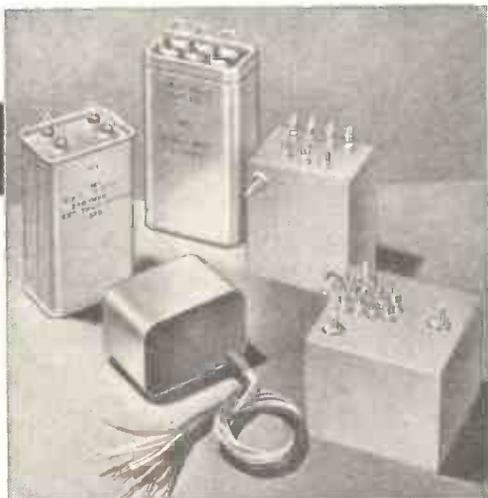
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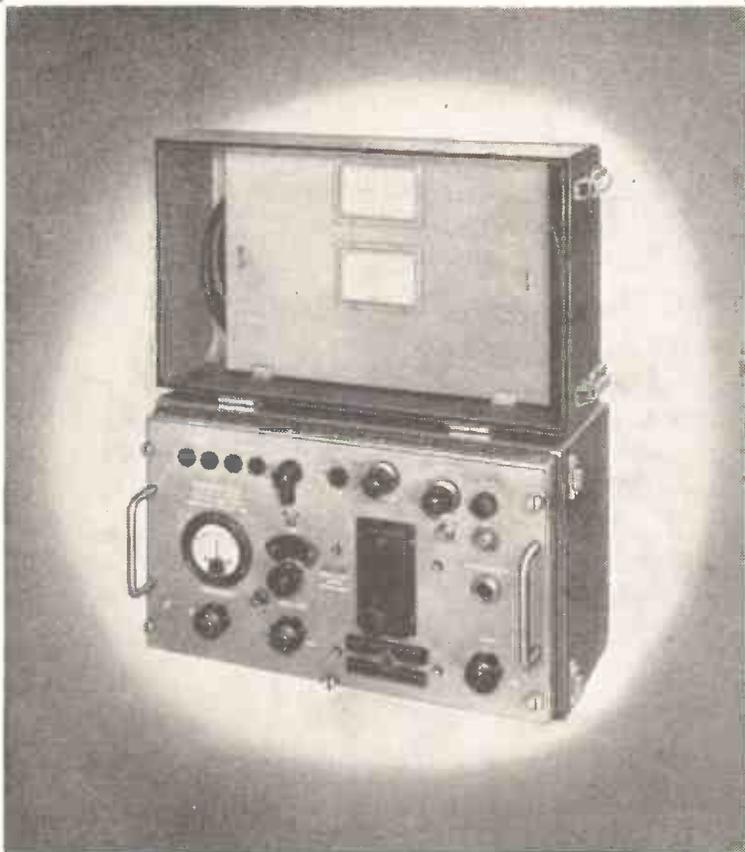
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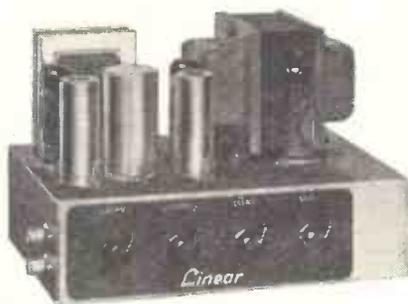
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Referred to maximum output and including integral pre-amp —60 d.b.

**HARMONIC DISTORTION**  
0.19% measured at 6 watts.

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offering facilities for making prototype flexible remote controls as required, without flexible casing.

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No. 130 (.130 in. dia.) for controls up to 4 inches long  
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Dia. of base.....	35in.
Fixing holes, No. and size as required, on a 33½in. P.C.D.	
Weight.....	1 ton 15 cwt. 10lb.
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Thrust .....	3,000lb. plc.
Excursion .....	0.500in. max.
Max. permitted acceleration 100 "G"	
Direct current force factor	36lb/amp.
Max. input.....	64 amps (r.m.s.)
Moving coil blocked impedance	
	1.5 ohms (est.)
D.C. resistance of moving coil	
	0.875 ohms.
Field coil current .....	4.6 amps.

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The new No. 1 "SYMPHONY" AMPLIFIER Mark III is a 3-channel 5-watt Gram/Radio Amplifier with astonishingly flexible tone control. You can lift the treble, the bass, or—and here is the unique feature—the middle frequencies to suit your own ear characteristics, and the record or radio programme being heard. Independent Scratch-cut is also fitted and special negative feedback circuit employed. The Amplifier can accommodate a wide variety of records from old 78s to new LPs. Input is for all types of pickup of 0.1 v. output or more and there is full provision for Radio Tuner Tape take-off and Playback. It is available to match 15 ohms or 2-3 ohms speakers. Price 12 gns. (carr. 7/6). Fitted in Portable Steel Cabinet 2 gns. extra.

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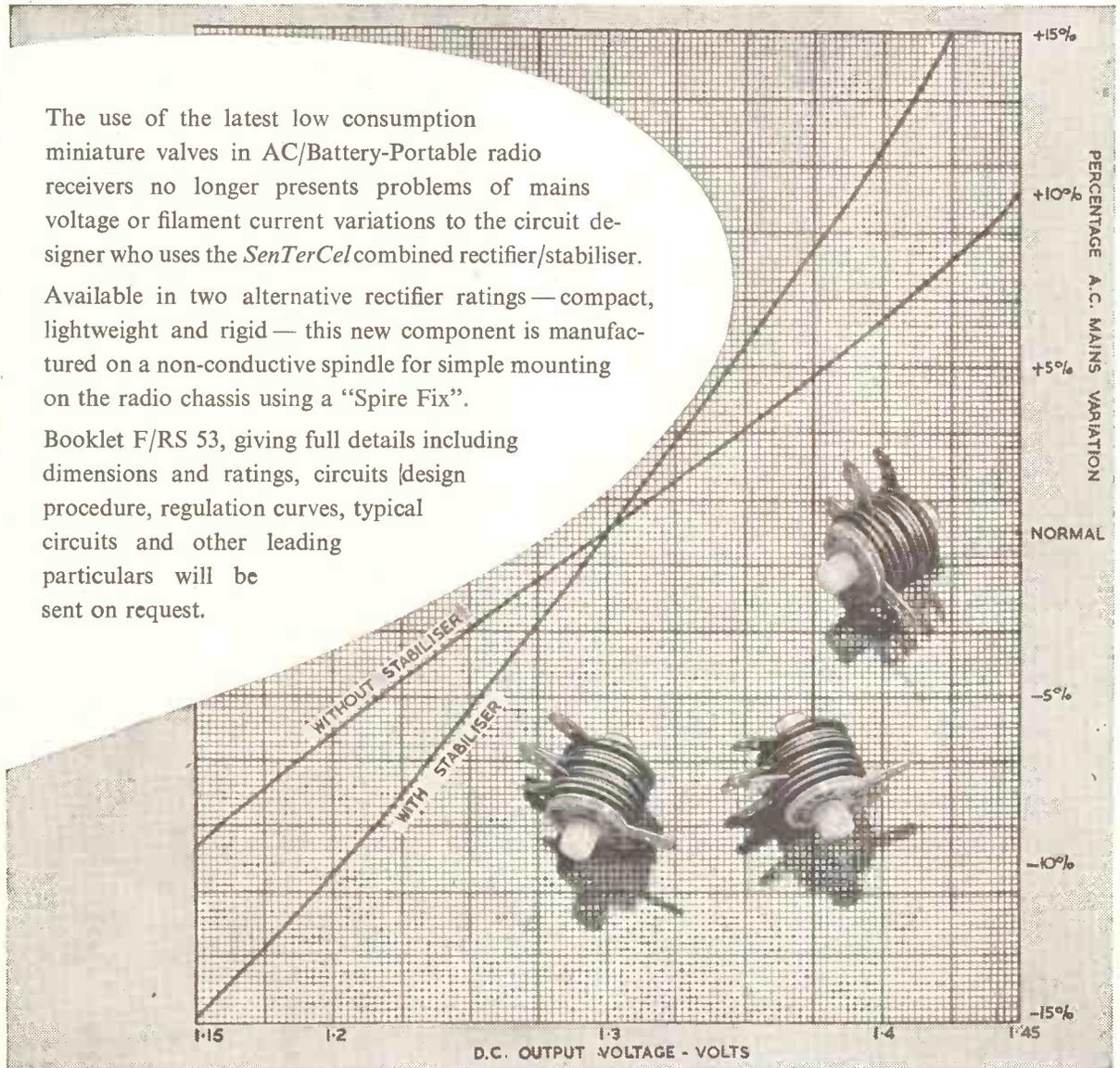
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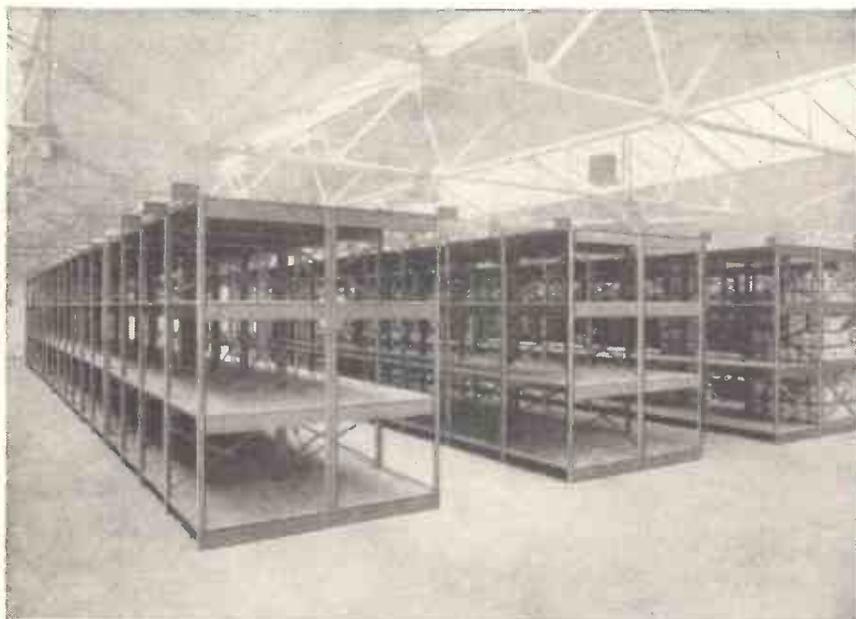
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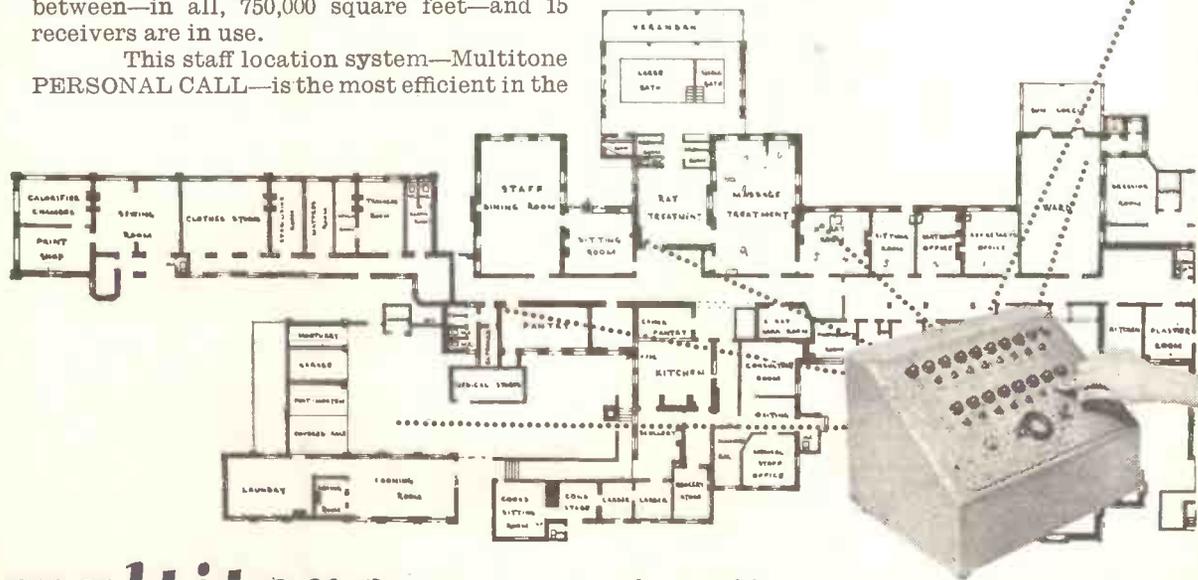


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This staff location system—Multitone PERSONAL CALL—is the most efficient in the

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**£39.10.0**  
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Tropical model made with resin-bonded plywood can be supplied at £2 extra.

Choice of Walnut, Oak, Mahogany and Maple Veneers.

When fitted with the WMT1 Matching Transformer (cost 13s. 6d.) this model will give full domestic volume from any good F.M. receiver.

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## MODEL SFB/3

After a long absence from the audio scene, the baffle re-enters the field with this wide-range, high quality three-speaker system. Low resonance foam surround units made it possible to design from first principles, and the result embodies most of the features required in a domestic loudspeaker.

- ★ Free-standing and easily moved.
- ★ Resonance free, sandfilled baffle.
- ★ Frequency range 30 c/s to 20,000 c/s.

Specification: Size 34" × 31" × 12". Weight 64 lbs. Bass Resonance 30/35 c/s. Impedance 8/15 ohms. Max input 15 watts.

Units: W12SFB, 10in. Bronze/SFB, Super 3. The 12in. and 10in. units are in parallel. The Super 3 is again in parallel via 4 mfd. capacitor and is mounted on a small baffle facing upwards. There is no cabinet resonance because there is no cabinet. The 12in. and 10in. units are specially built and matched for optimum results from this system. Baffles cannot be supplied separately.

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- 28 volts 0.04 amps
- 12 volts 0.1 amps
- 6 volts 0.1 amps

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### MINIATURE SEALED PANEL LAMPHOLDER—INDICATOR TYPE

Completely waterproof and will withstand conditions of constant vibration and shock, these lampholders are intended for installation on aircraft, armoured fighting vehicles, and marine equipment. They are sealed and insulated from the panel, the thickness of which can vary from 20 S.W.G. (.036") to 10 S.W.G. (.128"). Thicker panels can be counterbored. Rotation is prevented by flats on the body. Mounting is by a single hole. Access to the lamp, for replacement, is from the front of the unit by unscrewing the dome. Lamps may be renewed, without breaking the seal to the equipment. Weight: .420 oz. (11.6 grammes) with bulb. Electrical connections: Two solder tags. Catalogue No. MPL. 20 Red; MPL 21 Green. Catalogue No. MPL. 22 Amber; MPL 23 Opalescent Ivory.

### MINIATURE SEALED PANEL LAMPHOLDER—DIMMER TYPE

Identical to the Indicator type, except for the interchangeable cap. This is ribbed for grip, continuously rotatable and contains a light output control from bright to "blackout." Weight: .530 oz. (14.8 grammes) with bulb. Electrical connections: Two solder tags. Catalogue No. MPL. 10 Red (Translucent). Catalogue No. MPL. 11 Green (Transparent). Catalogue No. MPL. 12 Amber (Transparent). Catalogue No. MPL. 13 Clear (Transparent).

### THORN MIDGET PANEL LAMPHOLDER

This is the simplest and most economical lampholder designed to accommodate the Atlas Midget Panel lamp. It is extremely effective and easily installed. Available with its transparent top in a variety of colours. Weight: 8.4 gr. (0.3 oz.). Can be supplied with insulated washers and connecting tags where non-earth return is desirable.

### FLUSH OR RECESSED LIGHTING UNIT

This lampholder is used as a standard unit in the Plasteck Console panel. The body of the lampholder may be retained in a countersunk hole in the panel by a hexagonal backnut and lock-washer. A small projection under the collar prevents the fitting turning in the panel. The special coloured filter is contained in a moulded screw cap and a soft rubber sealing washer prevents any light from escaping round the edge. Filters in red, green, amber and clear. Weight: .31 oz. with bulb. Terminals: Solder tag and earth return. Catalogue No. PPL90. Catalogue No. PPL120 (with 6BA terminal screw and earth return, weight: .35 oz. with bulb).

Interservice ref: Type A, No. 1.  
Flush type—Solder connections. Ref. No. 5C/X. 5143.  
Type A, No. 2.  
Flush type—Screw terminals. Ref. No. 5C/X. 5144.  
Can be supplied with insulated washers and connecting tags where non-earth return is desirable.

### SURFACE TYPE LIGHTING UNIT

An alternative design to PPL90 for Plasteck and other control panels where no room exists immediately behind the metal panel. The bulk of the component projects above the face of the panel. A soft rubber sealing washer under the cap prevents the escape of light from the front of the panel. The lamp is inserted with the cap up. Weight: .49 oz. with bulb. Terminals: Solder tag and earth return. Catalogue No. PPL. 100. Interservice Ref: Type B, Surface type—Ref. No. 5C/X. 5145.

**Thorn**



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Type 1.K for 10in. diameter Loudspeakers .. ..	£8 10 0
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Type 3A for 10in. diameter Loudspeakers .. ..	£9 0 0
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The demand for a high quality **TAPE RECORD/PLAYBACK AMPLIFIER** of small size, to suit the Collaro Tape Transcriber, has encouraged us to design the "Miteamp."

Specification  $2\frac{1}{2}$  watts (max) output, with specially designed U./L. output transformer.

Sec. 3 ohms and 15 ohms.

Separate BASS and TREBLE controls on Playback.

5 latest type valves.

Optional monitoring via L/Speaker during Recording as well as by new EM840 strip type Magic Eye.

Igranic input and output jacks, and co-ax. head outlets.

As a high impedance outlet is provided for feeding larger Hi-Fi Amplifier, the "Miteamp" has all the advantages of the best Pre-Amps., plus audible monitoring, an output of its own (for portable recorder use) and, a lower price!

Frequency response. 45 c.p.s. to 12K c.p.s.  $\pm$  2.Dbs. at 7 $\frac{1}{2}$ in. per sec. (Via Hi-Fi Amp.).

Separate Power Pack with well smoothed output.

Good components employed. Neat tagboard construction.

Price 18 gns. or 15 gns. less P. Pack.

We can wire up your Collaro Deck to suit, free if purchased from us, or 17/6 otherwise. To suit Reflectograph, Bradmatic Decks, etc., the "Miteamp" costs 20 gns., and includes a Push-Pull Oscillator circuit. A Valvevoltmeter circuit instead of "Eye," 2 gns. extra. We are still continuing our 6 watt 25 gns. "Lodestar" type model, and the 4 watt, at 23 gns. 1 watt **TRANSISTOR AMPLIFIERS** for TAPE (playback only), to order, 6 volt. 16 gns.

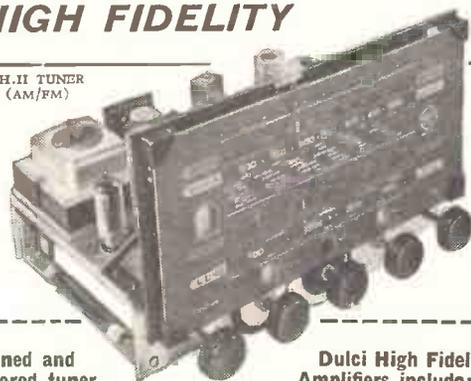
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D.P.4 (4 watts) Main Amplifier £7.10.0.

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D.P.A. 10 (10-14 watts) Main Amplifier. £12.12.0.  
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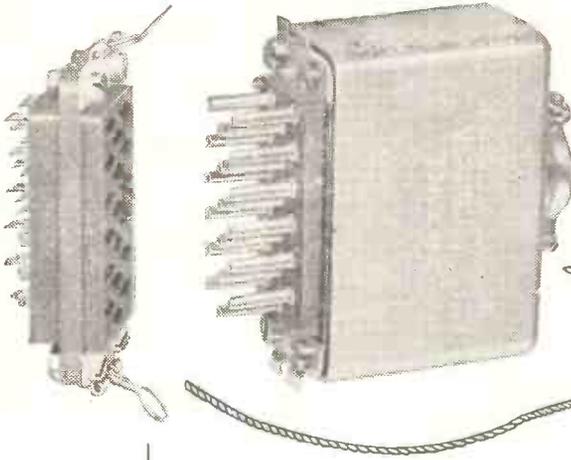
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BUSHES**



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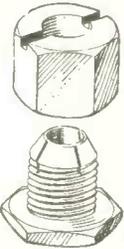
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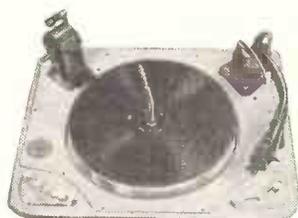
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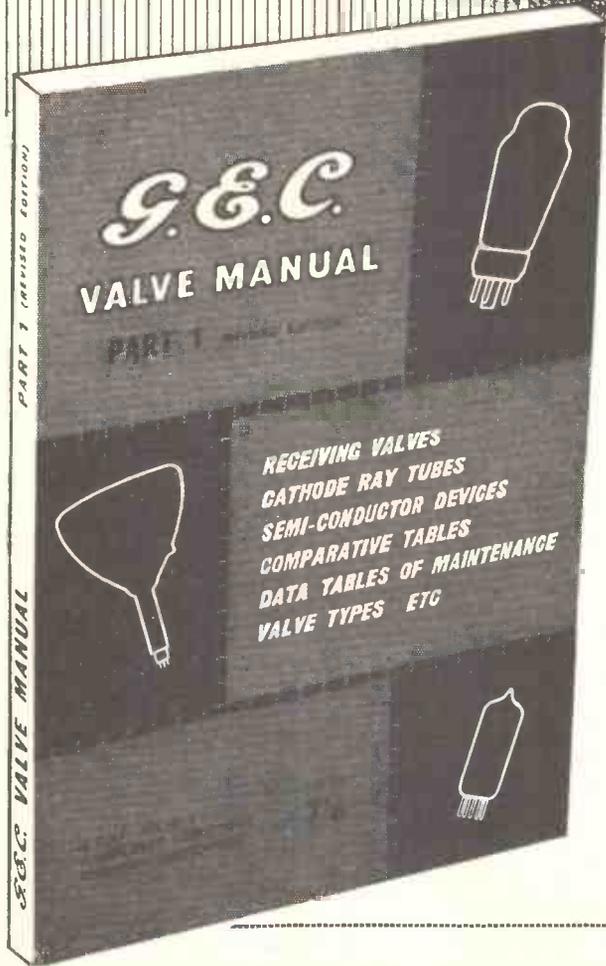
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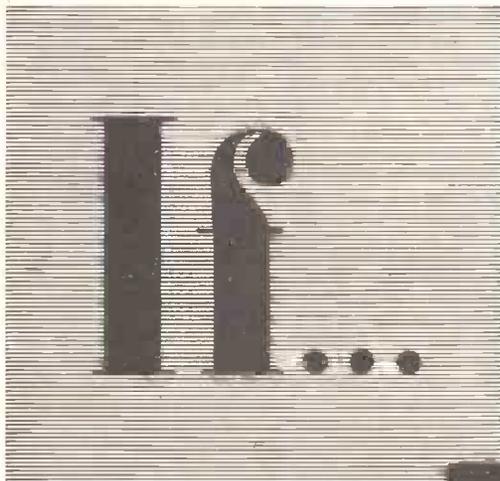
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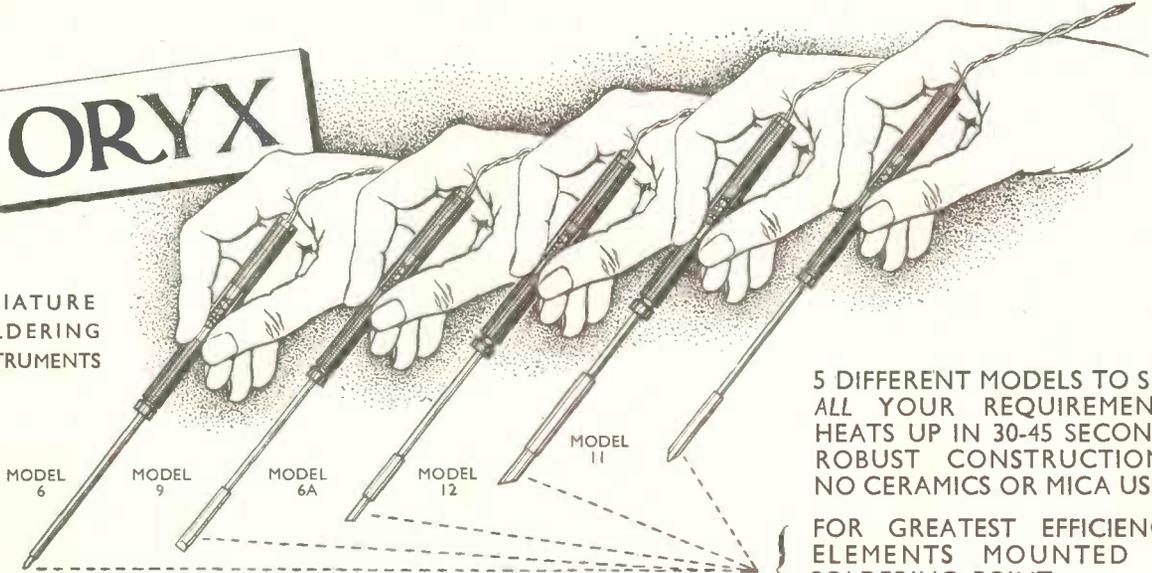
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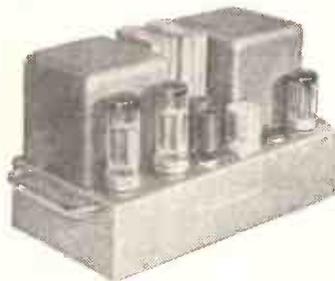
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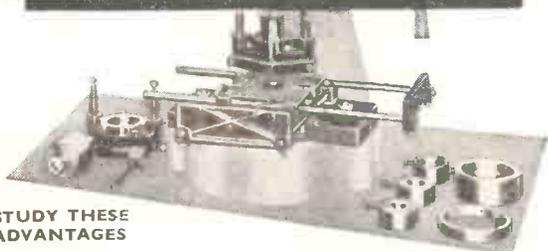
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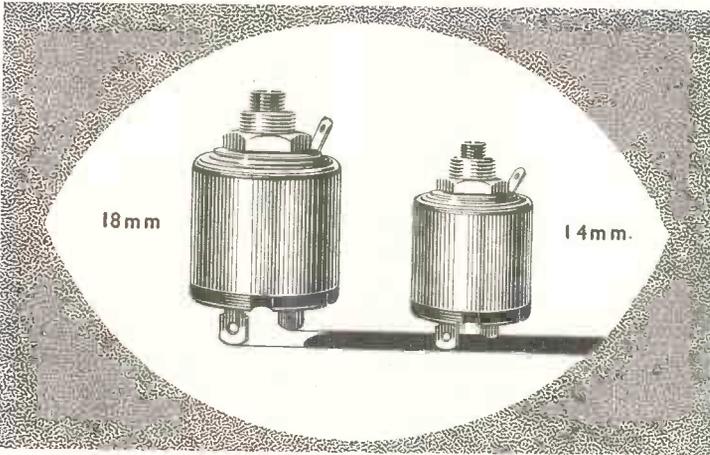
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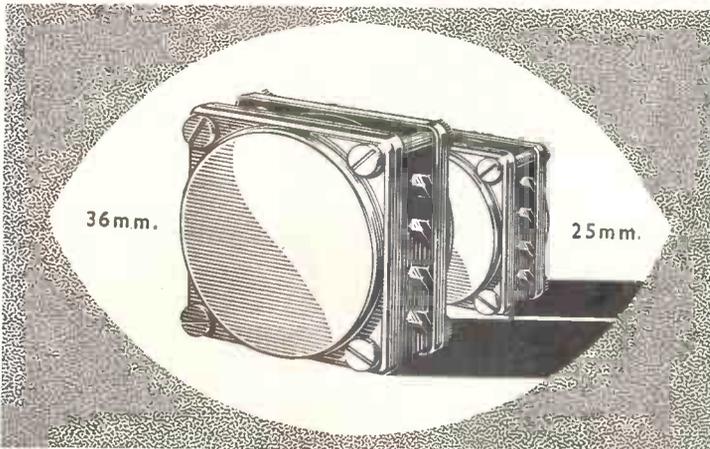
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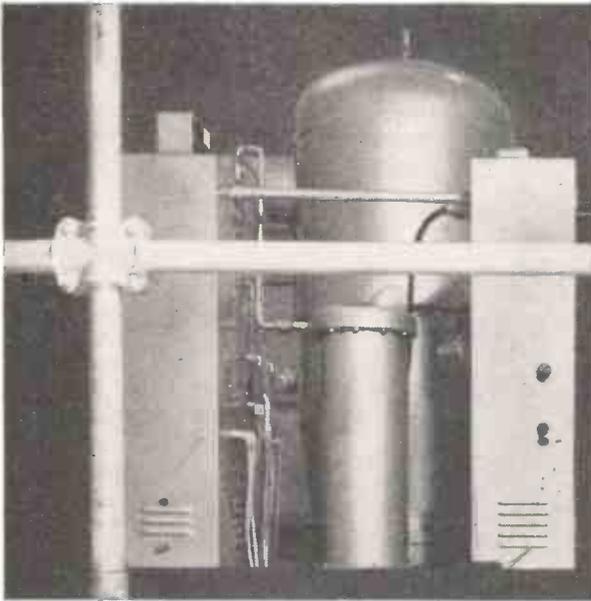
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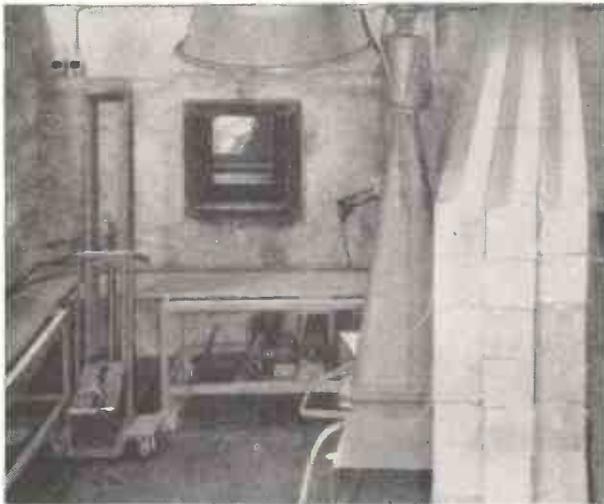
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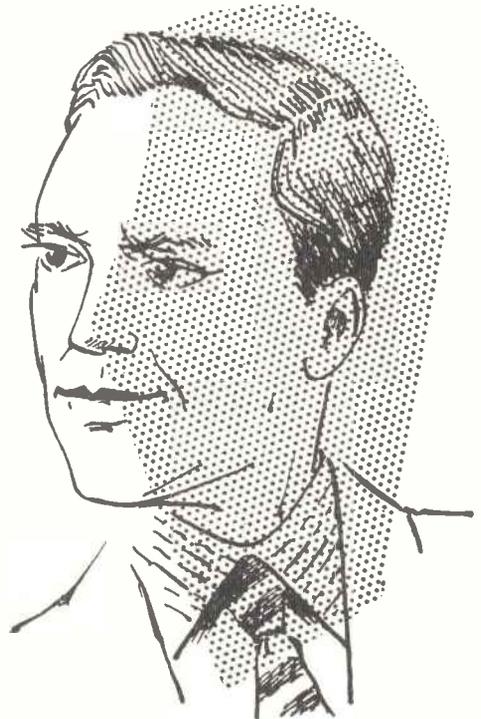


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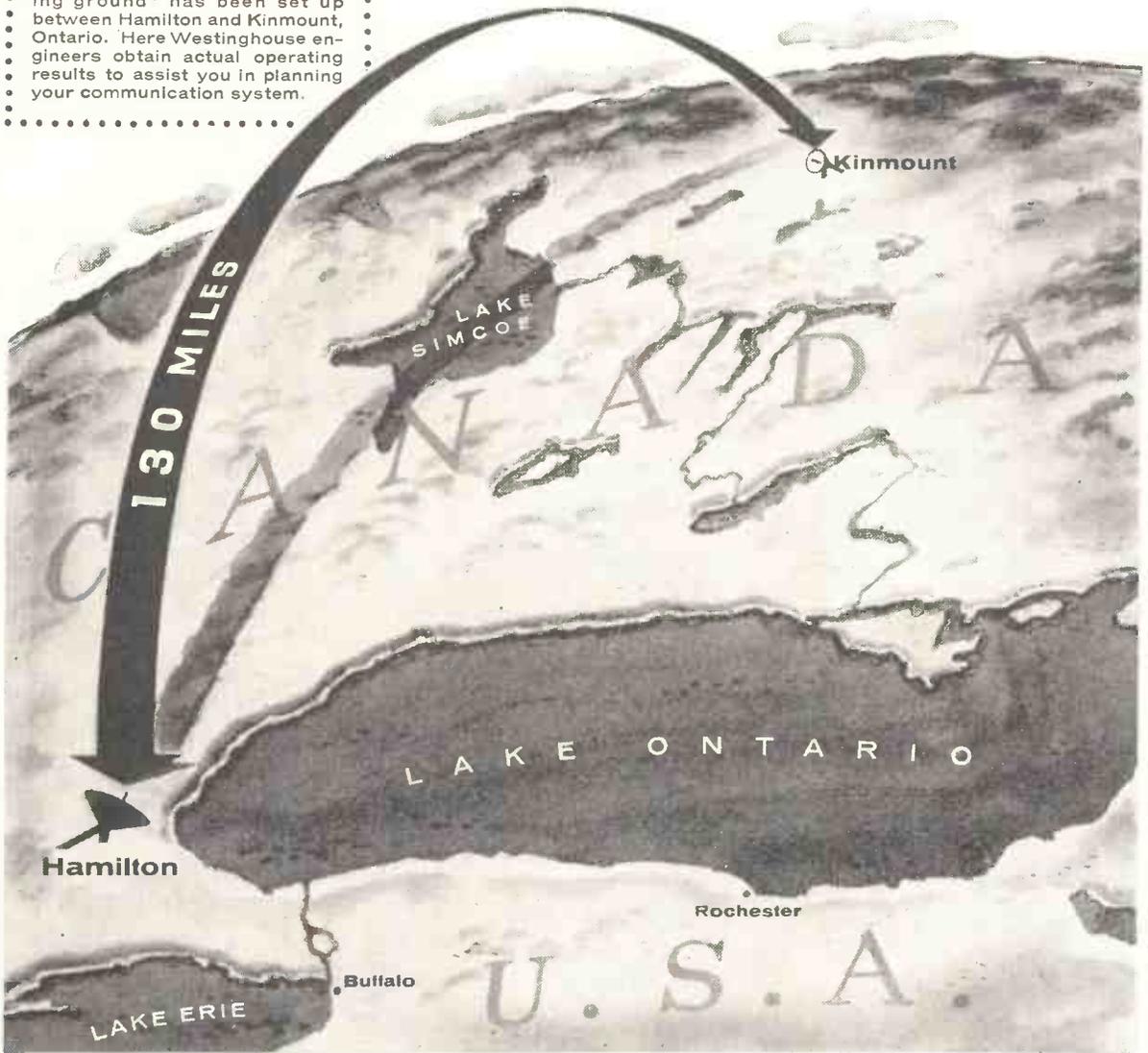
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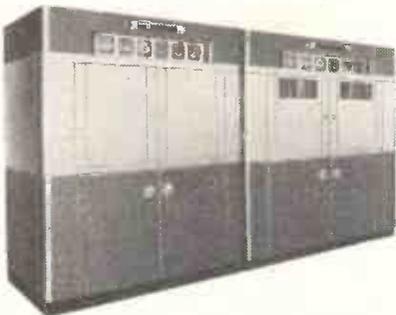
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Model	Cash Price	Deposit	8 Monthly Payments of
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870	£34 16 0	£4 1 6	£4 1 6
840A	£55 0 0	£6 8 4	£6 8 4
750	£78 0 0	£9 2 0	£9 2 0
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680X	£120 0 0	£14 0 0	£14 0 0

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Model 840A is for A.C. or D.C. 110/250 v.; 750 and 680X 110/240 v. A.C. These sets are the choice of the discerning professional and amateur users. Descriptive literature gladly forwarded.  
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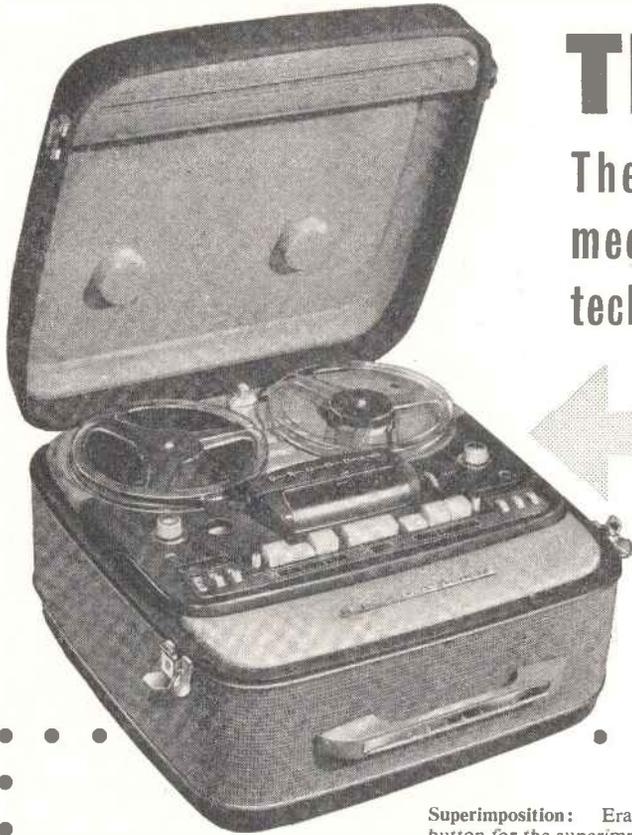
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**Mains Fuse:** 110-125V 1.25A. 140-160V 1A, 190-250V 0.8A.

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**Valves:** EF 86-ECC 81-ECC 83-3 x EL 95,-EM 71-4 Metal Rectifiers.

**Recording Level Indicator:** Magic Eye.

**Loudspeaker System:** Three 7" x 5½" Elliptical high flux permanent magnet moving coil units.

**Superimposition:** Erase cut-out button for the superimposition of a further recording on to previously recorded tape.

**Amplifier Output:** 6 watts approx.

**Sockets for:** Microphone, Diode, Radio L.S./Gram P.U. Inputs, High Impedance Output, Extension Speaker Output, Grundig Distributor Speaker, Grundig Remote Control, Earth Connection.

**Tape Speed:** 3.75 ins. per second and 7.5 ins. per second.

**Frequency Response:** At 3.75 ins/sec. 50-10,000c/s ± 3db. At 7.5 ins/sec. 40-15,000c/s ± 3db.

**Wow and Flutter:** 0.3% at 7.5 ins/sec. 0.5% at 3.75 ins/sec.

**Tape Length:** 1200 feet.

**Tape:** Grundig (M.S.S.) Tape fitted with Automatic Stop Foils.

**Automatic Stop Switch:** Electro Magnetic.

**Position Indicator:** Precision counter type position Indicator.

**Running Time Per Tape:** 30 minutes each track at 7.5 ins/sec. (1 hour total). 60 minutes each track at 3.75 ins/sec. (2 hours total).

**Fast Forward and Rewind Times:** Approx. 2 minutes.

**Recording Sense:** Top Track, left to right (British and International Standard) with immediate Track Change by press buttons.

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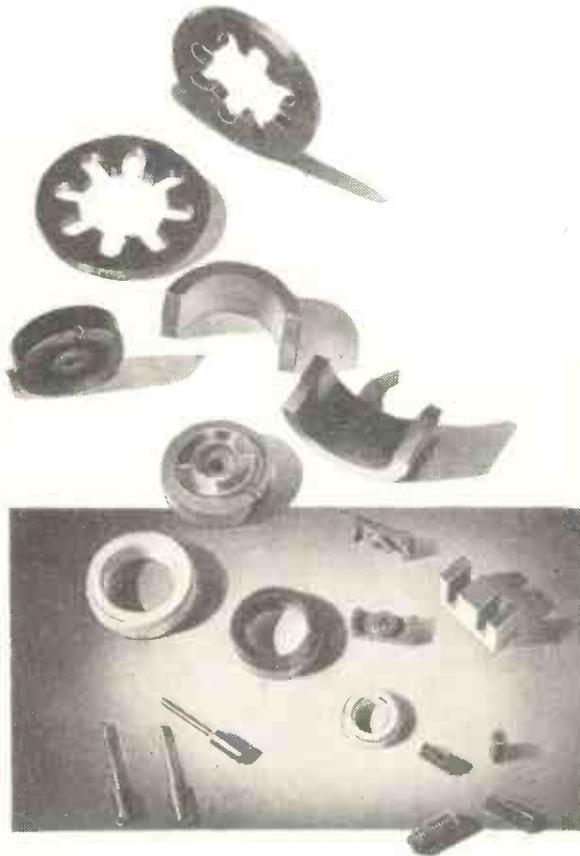
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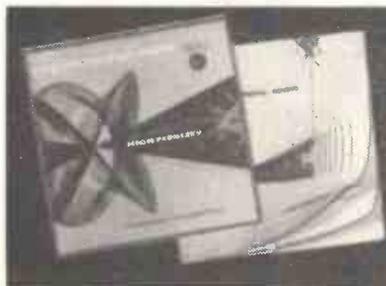
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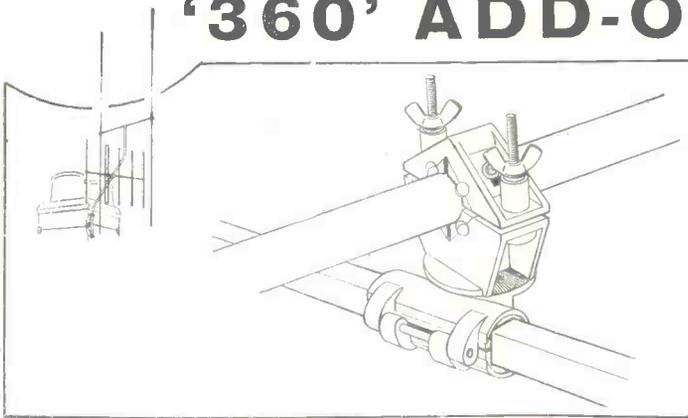
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- 3 Attaches aerial direct to stand-off arm or mast thus eliminating unnecessary sag (no extra arm required).
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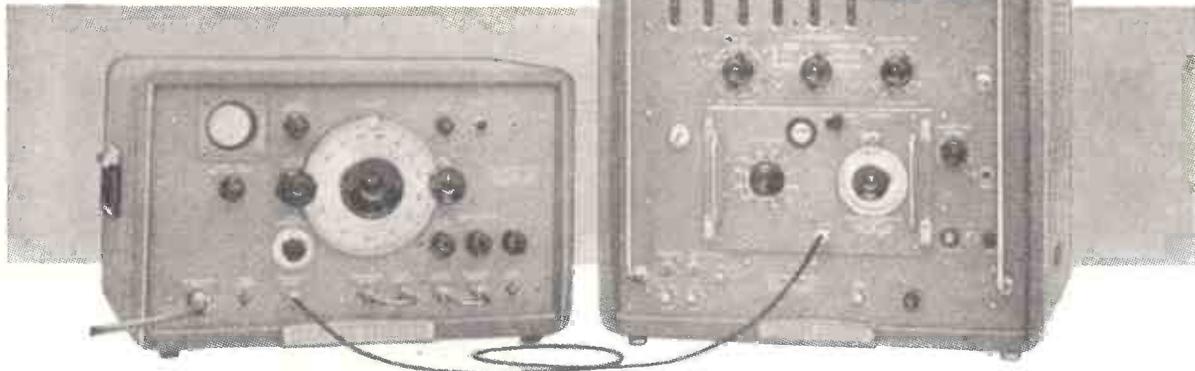
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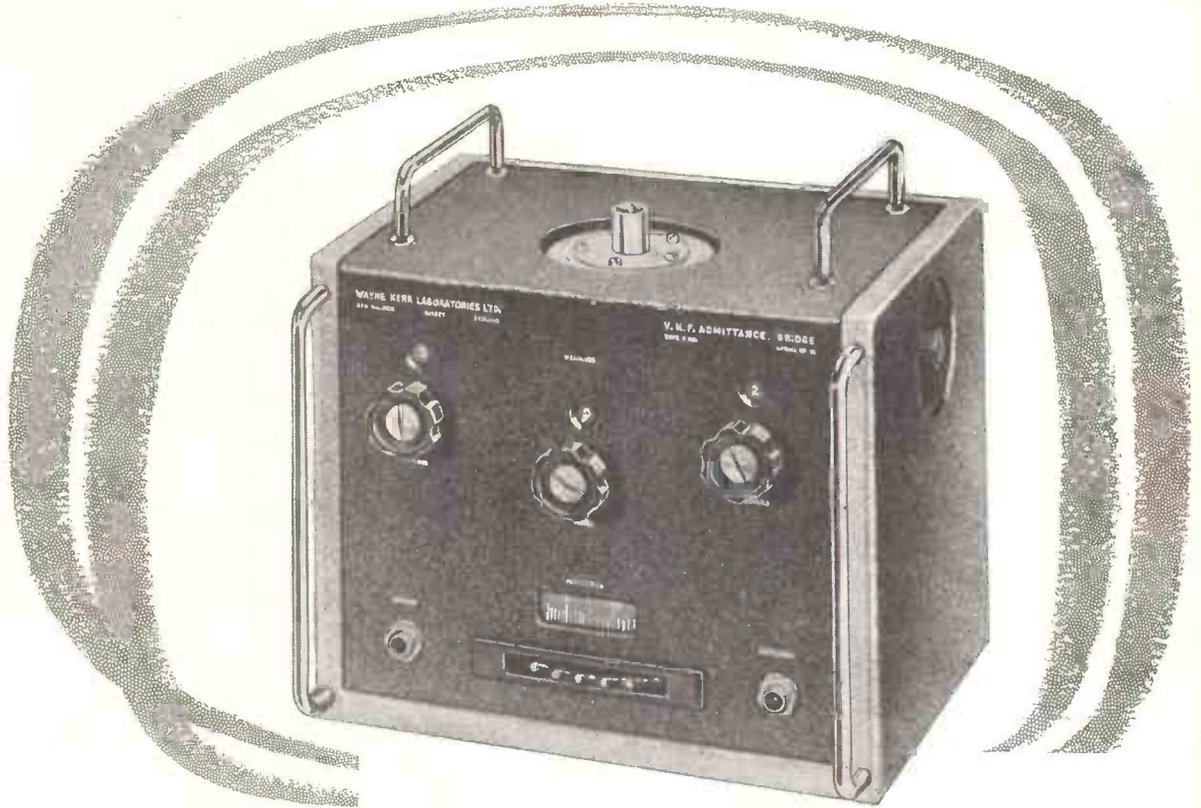
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 0-100 Millimhos in 3 ranges.  
 0-90 mmho in 10 mmho steps.  
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 $\pm 2\%$  or  $\pm 0.5\text{pF}$ ,  
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**FREQUENCY RANGE:** 50-250 Mc/s.  
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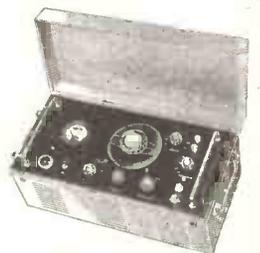


## WAYNE KERR



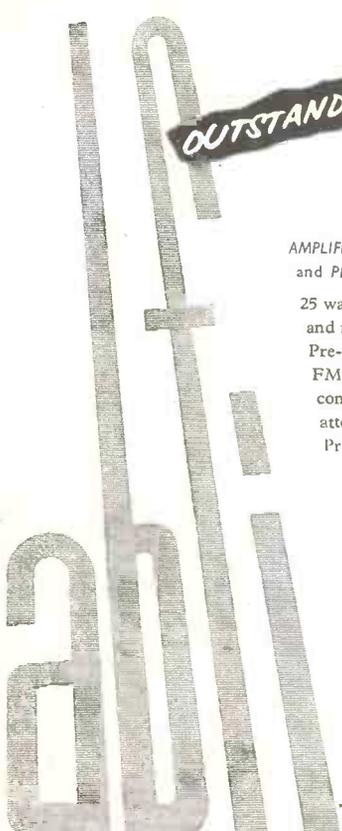
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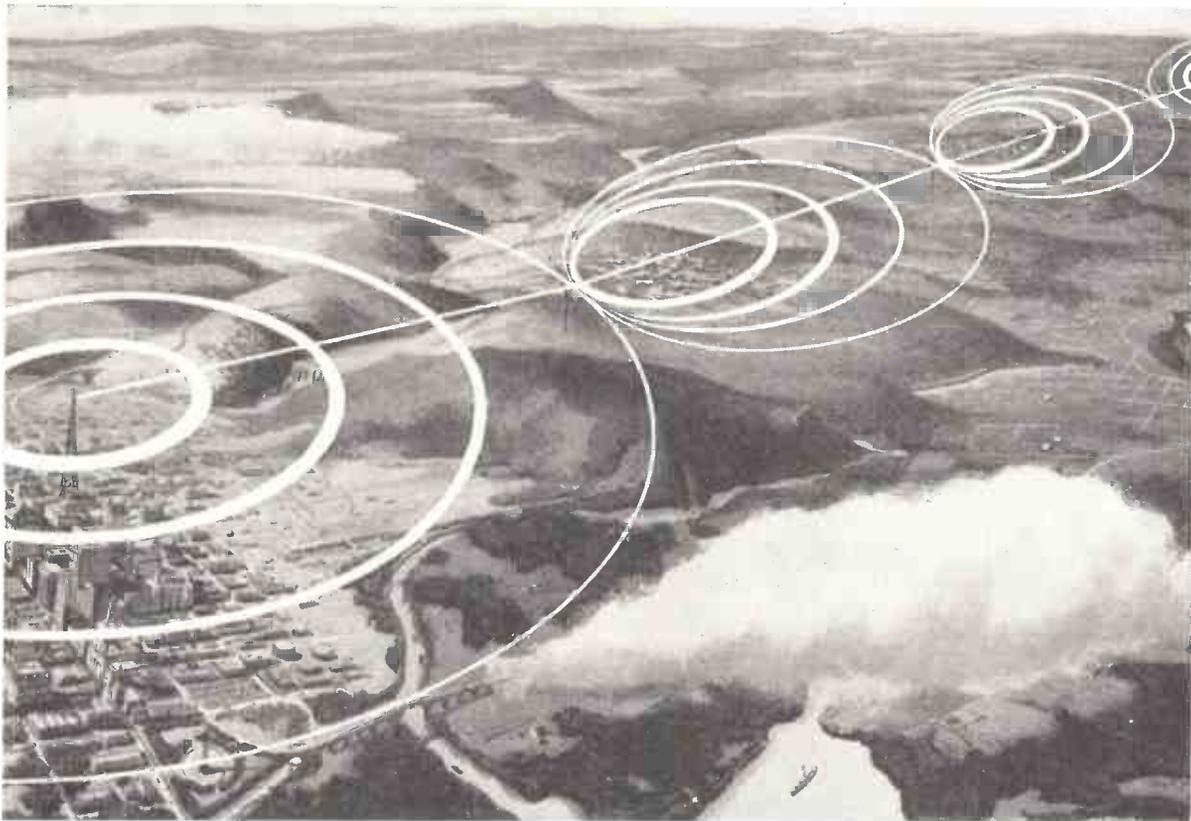
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# RCA's NEW TVR-1 RELAY REBROADCAST SYSTEM

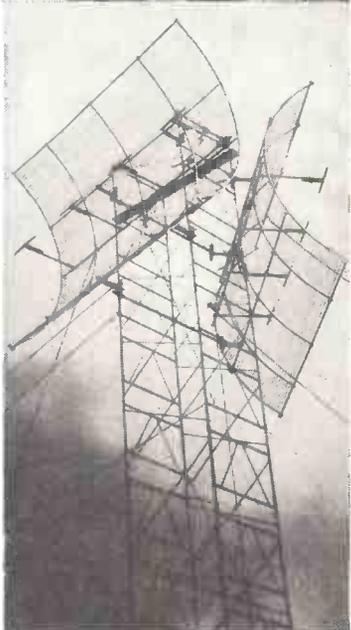
**Economically extends VHF TV Station Coverage**



Since the TVR-1 relay system uses standard TV frequencies, it enables those in its path to receive your station's broadcasts on their home receiver. Eight repeaters, or more, may be linked in tandem to relay television programs while providing home reception between repeaters.

The RCA TVR-1 offers the TV broadcaster an opportunity to extend economically the coverage of his stations, and provide inter-city television relaying. Communities which may not be receiving a sufficiently strong signal, or those small communities which are outside the station's service area and could not hope to have television, will now receive your broadcasts. Unlike conventional microwave re-

lay systems, the TVR-1 is capable of rebroadcasting at each relay station. Designed for unattended operation, each repeater is in essence an automatic station. Directional or non-directional antennas can be used, depending upon local coverage considerations. For full details on new RCA TVR-1 relay-broadcast system, contact your RCA Distributor or write Dept. TV-49-H at the address below.



Typical TVR-1 repeater antenna installation.



RCA INTERNATIONAL DIVISION

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# RELAYS

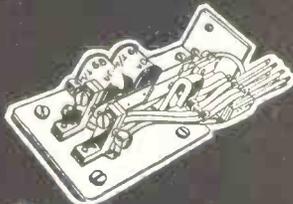
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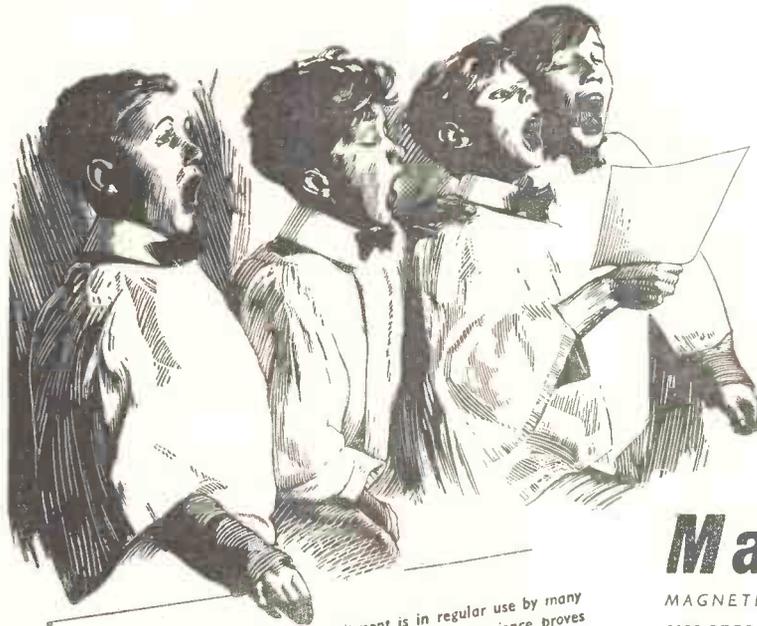
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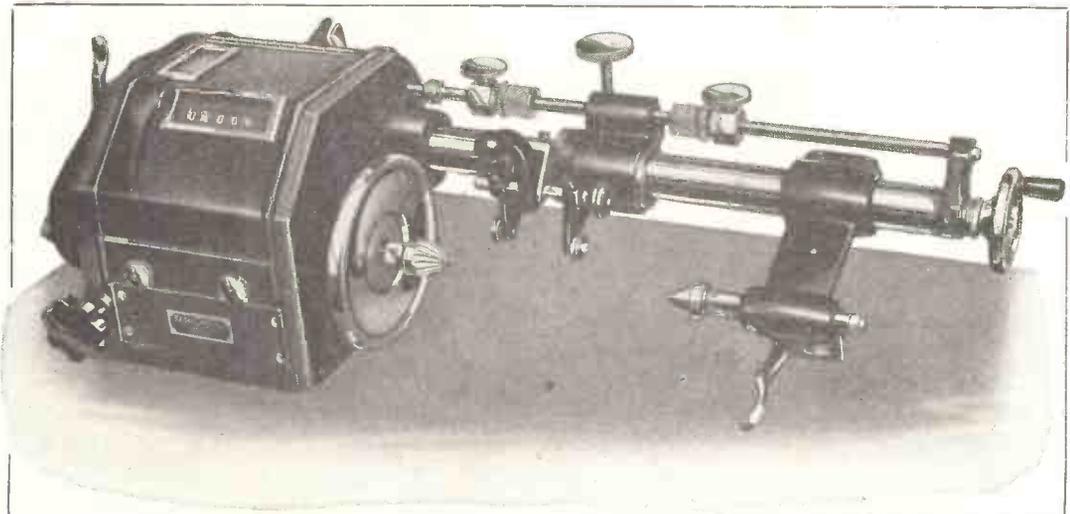
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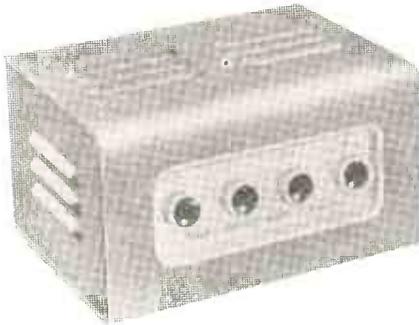
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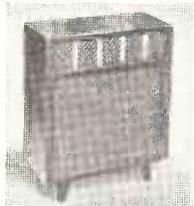


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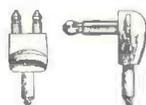
## Miniature Components



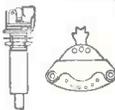
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F.M.  
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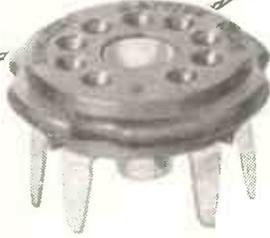
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FIVE - FIFTEEN

## AMPLIFIERS



The WINDSOR POWER AMPLIFIER with PRE-AMPLIFIER

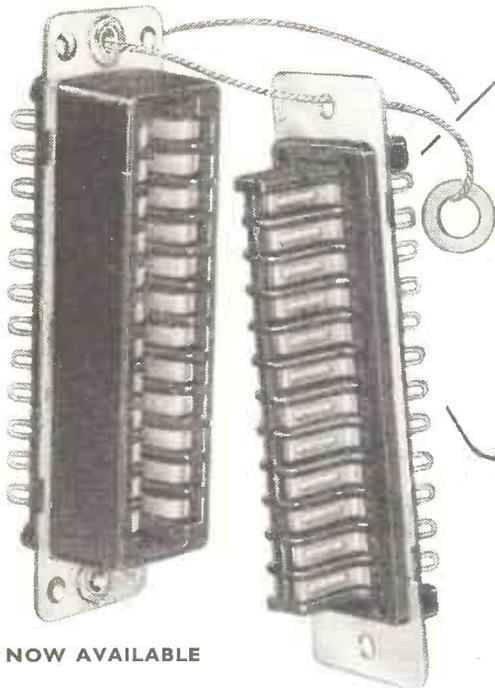
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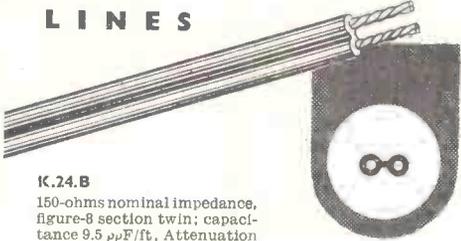
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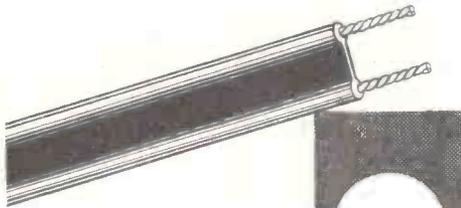
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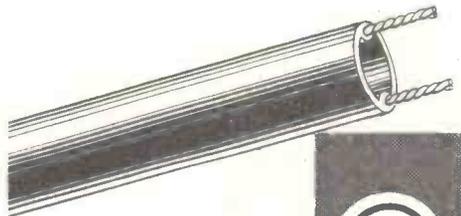
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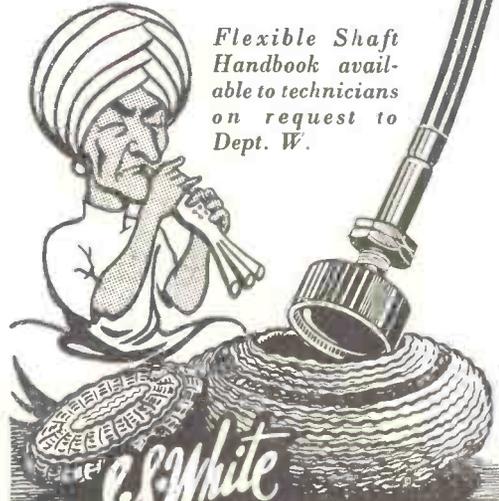
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We can operate from an accessible point, switches, valves and other electrical and mechanical devices located in inaccessible places.

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R.C.3

# The "Little Staar"

... battery operated player  
for single 45 r.p.m. records

★Size of unit base-board only 7½" x 6".

★Weight only 15½ozs.

★Powered by Staar Kinder motor. Operating voltage 6v., current consumption as low as 27 mA while playing.

★Ideal as the nucleus of a midget player, and amplifier of extreme portability.

The pickup of the Little Staar is fitted with a robust ceramic element transducer with two 1 mm. radius sapphire styli suitable for use in all climatic conditions. The cartridge can be withdrawn and replaced in a matter of seconds. The Staar Kinder Motor incorporates a centrifugal governor to ensure constant turntable speed within 2% whatever the applied voltage between 6.2v. and 3.5v.



A dual purpose turntable centre is available which allows for playing small or large centre-hole records.

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## Staar Electronics Ltd.,

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PRECISION HI-FIDELITY

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THE FOLLOWING RANGE OF MAGNETIC SOUND HEADS ARE NOW AVAILABLE

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An adequate signal level is assured even at relatively long distances from the transmitter, and in ordinary reception areas aerial complication and expense are reduced to a minimum.

**COMPLETE FREEDOM FROM DRIFT**

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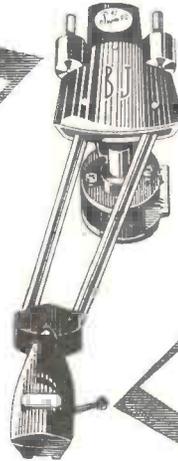
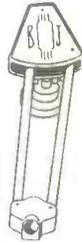
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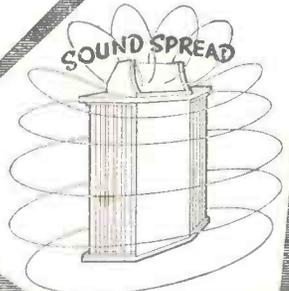
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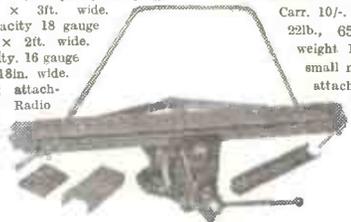
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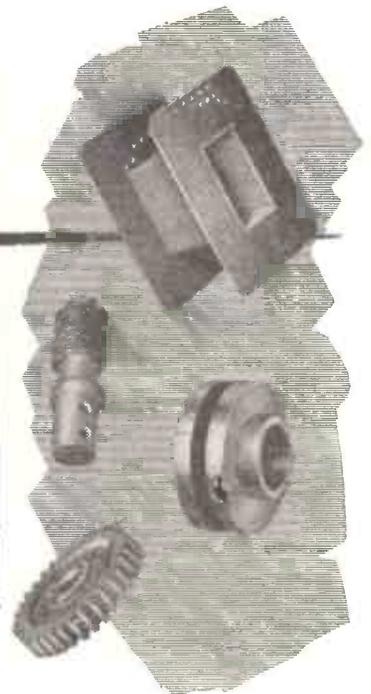
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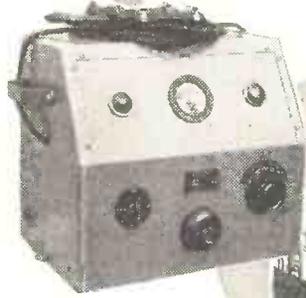


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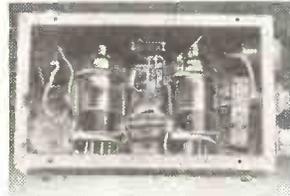
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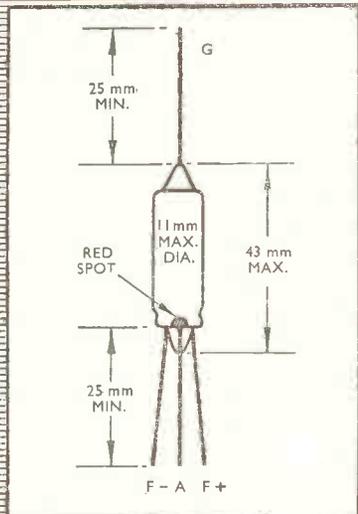
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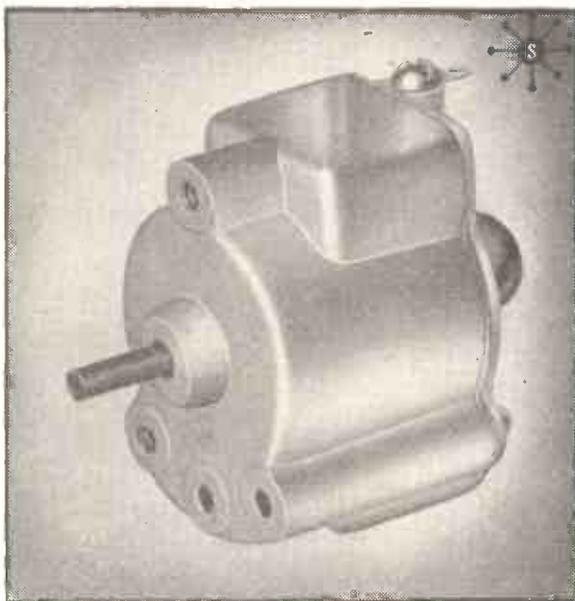
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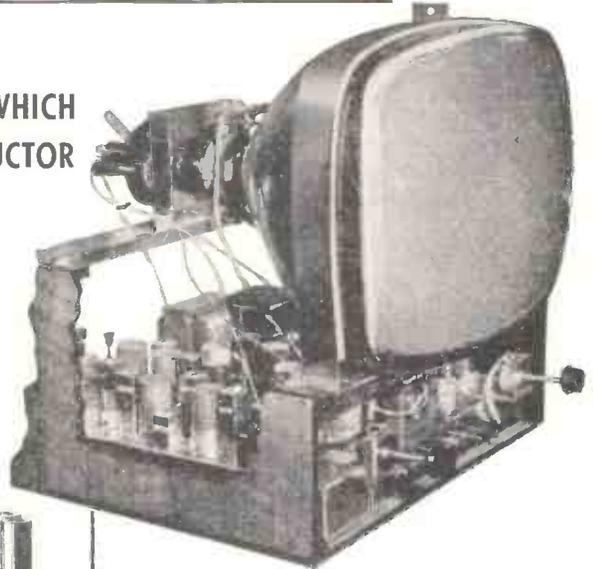
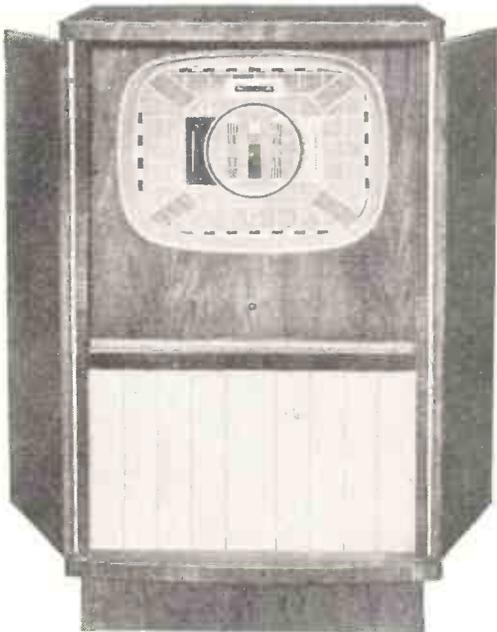
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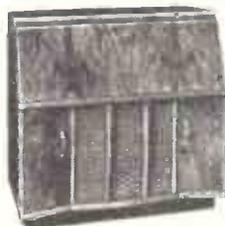


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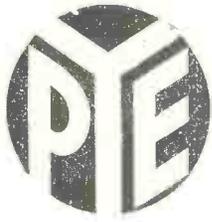
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AUGUST 1957

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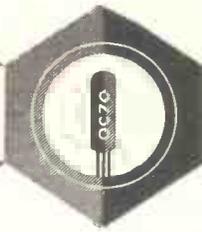
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# Transistor



# Base-to-Emitter Voltage Compensation

It is well known that satisfactory transistor performance can only be obtained by restricting the variation of collector current with temperature. Under the worst conditions of operation, stabilisation of the working point is also essential to prevent thermal runaway. The most widely used method of d.c. stabilisation consists in deriving the base bias from a potential divider connected across the base in conjunction with an emitter resistor. One possible refinement is to give the emitter resistor a positive temperature coefficient. This method is of particular importance in circuits using power transistors, such as the OC16, with low impedance bias supplies.

### Temperature Dependence of Base-to-Emitter Voltage

The increase in collector current with temperature arises in part from the temperature dependence of the base to emitter voltage. Under certain conditions, and particularly with power transistors, this increase may become more important than that produced by the temperature dependence of the collector leakage current. Referring to the figure, the base to emitter voltage which can be measured on an actual transistor exists between b and e, and itself depends on the internal base resistance,  $r_{bb'}$ , and the voltage between  $b'$  and e. This latter voltage,  $V_{b'-e}$ , changes with temperature at a rate which is theoretically the same for all transistors, and is equal to  $-2.5\text{mV}/^\circ\text{C}$ . The minus sign indicates that  $V_{b'-e}$  decreases with temperature.

### Emitter Resistors of Pure Metal

The change of  $V_{b'-e}$  with temperature can be compensated by using temperature sensitive elements in the circuit. Thermistors having a negative temperature coefficient can be used in the bias circuit, but as their temperature coefficient varies with temperature, it is not possible to obtain exact compensation. On the other hand, if the emitter resistor is wound from wire made of some pure metal, such as copper or nickel, it will have a positive temperature coefficient and compensation for changes in  $V_{b'-e}$  can be obtained over

the entire temperature range.

For exact compensation, the voltage across  $R_e$  should have an equal and opposite coefficient to  $V_{b'-e}$ , that is, the voltage across  $R_e$  should increase by  $2.5\text{mV}/^\circ\text{C}$ . Pure metals such as copper and nickel have temperature coefficients of about  $+0.004/^\circ\text{C}$ . If the value of  $R_e$  is chosen to give a voltage drop of about  $630\text{mV}$ , this voltage drop will increase by about  $630 \times 0.004 = 2.5\text{mV}/^\circ\text{C}$  as required.

If the drop is higher, or if in fact  $V_{b'-e}$  decreases by less than  $2.5\text{mV}/^\circ\text{C}$ , the circuit will be overcompensated. However, overcompensation is not a disadvantage as it helps to stabilise against the collector current changes produced by the temperature dependence of the collector leakage current.

### Advantages

In general, an emitter resistor having a positive temperature coefficient reduces variations in collector current but does not directly improve the stability of the circuit with respect to thermal runaway, because the emitter resistor reacts to changes in ambient temperature, not junction temperature.

Signal handling capacity is reduced to a smaller extent by any rise in ambient temperature.

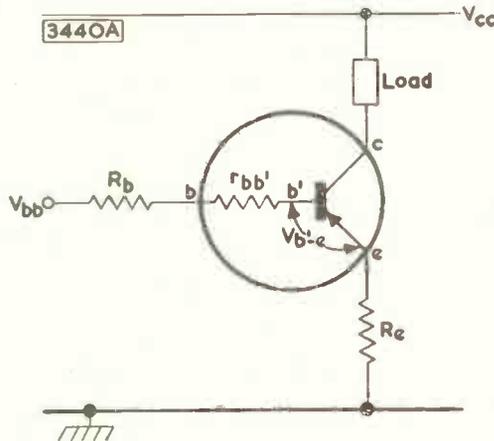
The collector dissipation does not rise so much with temperature. It is therefore possible to increase the dissipation by 10 or 15%, or to permit a higher ambient temperature, with any given heat sink: under these conditions the runaway stability remains unaltered. Alternatively, a somewhat smaller heat sink suffices: the runaway stability then deteriorates somewhat and better circuit stabilisation is required.

Mounting the positive temperature coefficient resistor on the heat sink makes only a negligible improvement to the runaway stability and may actually be inadvisable because of the heat dissipated in the emitter resistor itself. It would, however, reduce the current changes which occur when first switching on.

### Heat Sinks

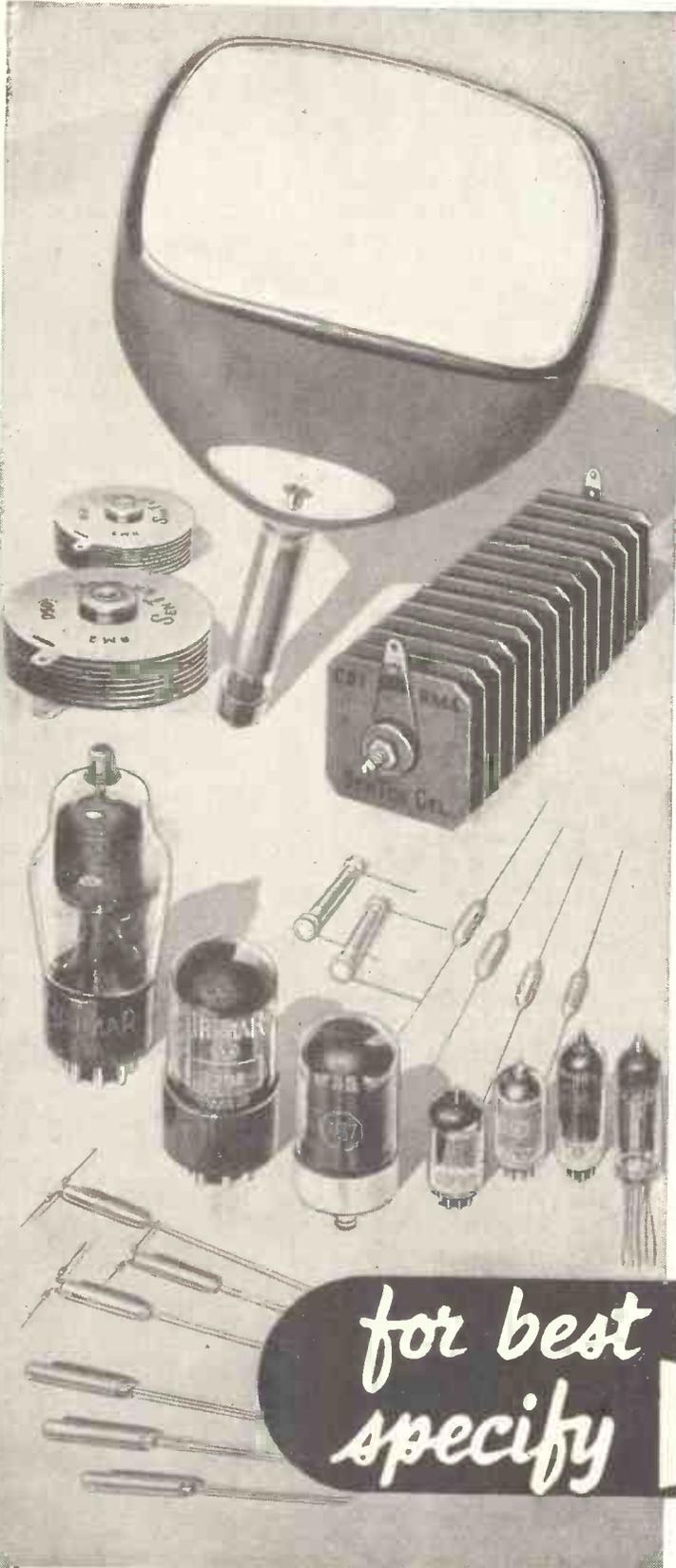
Transistors with higher dissipation ratings, such as the OC72 and OC16, have to be fitted with some sort of metal cooling fin or mounting plate which serves to conduct away, and radiate away, heat generated in the transistor itself.

Although these heat sinks operate on such a simple principle, it becomes necessary at the power rating of the OC16 to specify the dimensions, material, and the gauge and finish of the metal plate rather exactly. Usually the chassis can be designed to be the heat sink, but, if the chassis gets hot because of the presence of valves or other heat generating components, a separate sub-chassis may be necessary.



It is regretted that the circuit shown in Fig. 2 on this page of the July issue was incorrect. The electrolytic capacitor C should be omitted. There should be a single load resistance Z as shown in Fig. 1 and the top of the resistor  $R1'$  should be connected to the collector of  $Tr1$  (point X).





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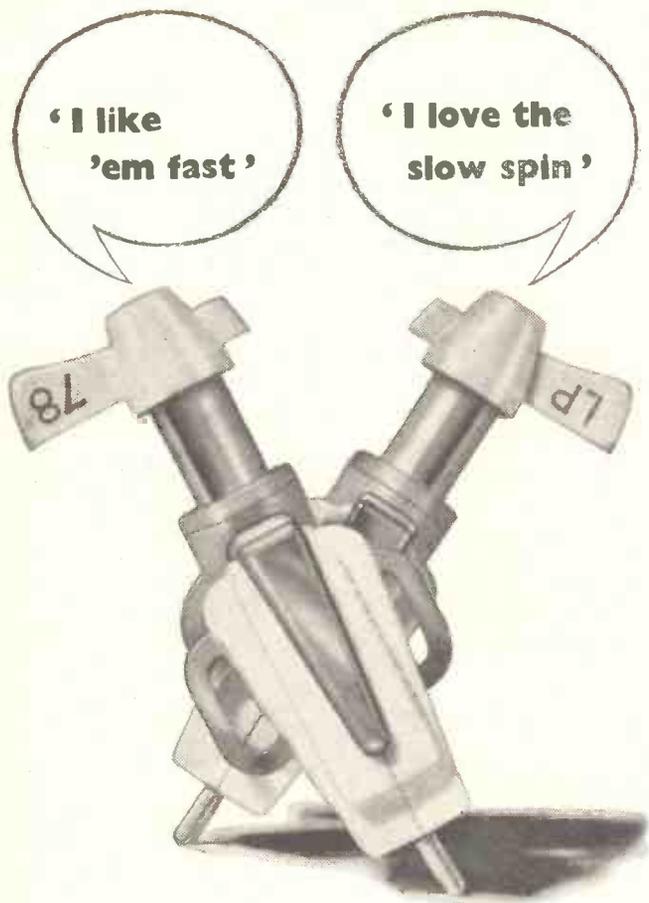
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# "BELLING-LEE" NOTES

## A CASE FOR THE INDOOR AERIAL

As far as we know, the first indoor television aerial ever invented, manufactured and sold, was the "Doorod." Even within the firm, the inventor had great difficulty in persuading the Directors and the Technical Manager to market his idea, because at that time it was known that to use an indoor aerial was bad technical practice. There were too many variables, beyond the control of the user. Hidden metal objects built into the wall such as girders, conduits, water pipes, etc., and in the case of semi-detached properties, portable metallic objects such as standard lamps, pianos, etc., just at the other side of a parting wall, which, to a radio signal, might as well not be there.

Individuals at the B.B.C. and the Post Office blamed us for setting a bad example, but, as we saw it, in the case of a difficult landlord, and a fairly strong signal, it was a case of an indoor aerial or no television.

The outcome is well known, "Belling-Lee" have sold nearly a million "Doorods," and competitors must have sold an additional number amounting to many tens of thousands.

There is little doubt that if it were possible to erect a well-situated outdoor aerial, still better results would be obtained in practically every case. But only too often there are already four multi-element aerials on the only available chimney.

In the meantime receiver manufacturers have improved the sen-

sitivity and automatic gain control of their sets, and the B.B.C. have increased the power of their transmitters.

Not to be outdone, I.T.A. are using very high power to overcome the propagational difficulties associated with the higher frequencies and so in a great many cases it is found that less sensitive aerials are required.

Many American viewers have several transmitters close to their homes and with high sensitivity receivers and high A.G.C. they have, for some time, had a choice of entertainment on much less efficient aerials than we have needed here.

Today, however, in this country, with increased transmitter powers, improved receiver sensitivity and better automatic gain control it can, in our opinion, now be regarded as reasonable technical practice to introduce a *broad band aerial* into the same room as the receiver, if signal strength is realistically high, interference levels low, and receivers reasonably modern.

The outcome is the "Golden V" for bands I, II and III. True, all is not gold that glitters, but the telescopic elements are genuine gold plated—and look it. Standing up from their highly polished black base and gilt bezel, overall appearance is one of quality. There is nothing cheap about it, although it is very good value for two guineas.

The "Golden V" is designed to stand on top of the receiver, which it cannot damage, because of its non-scratch, non-slip base, or on the corner of a nearby mantleshelf or table, or to hang on the wall.

"Wireless World" readers will appreciate that it would be unreasonable to expect such an aerial to give optimum results just by setting it up anywhere, anyhow. It should be moved about, and the angles and length of the elements should be adjusted until the best possible picture is obtained. If the signal is strong enough and the location relatively free of interference, there should be a combination of element lengths and angles and position to provide a reasonable reception from both B.B.C. and I.T.A.

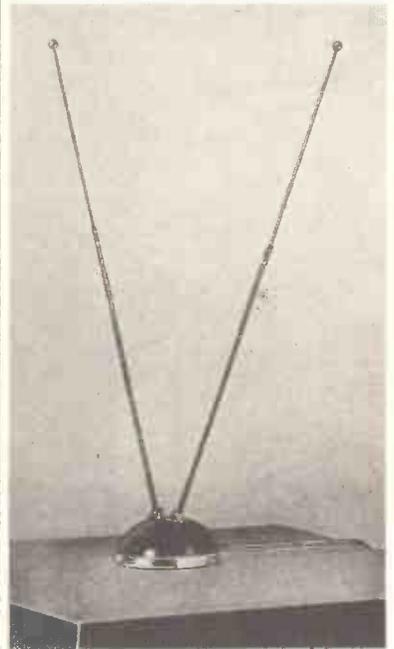
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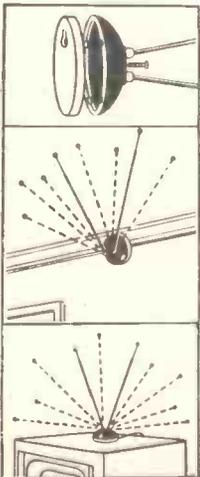
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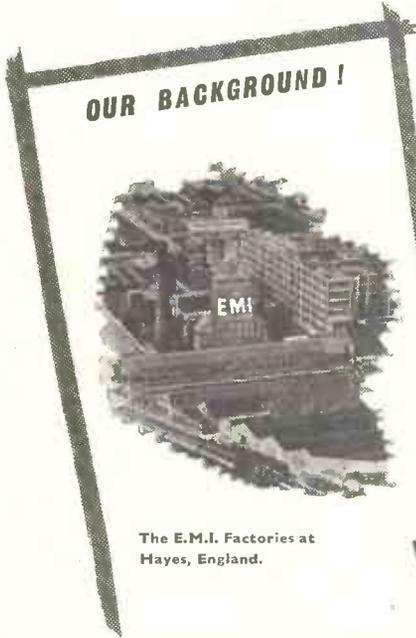
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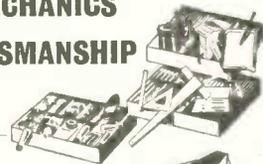
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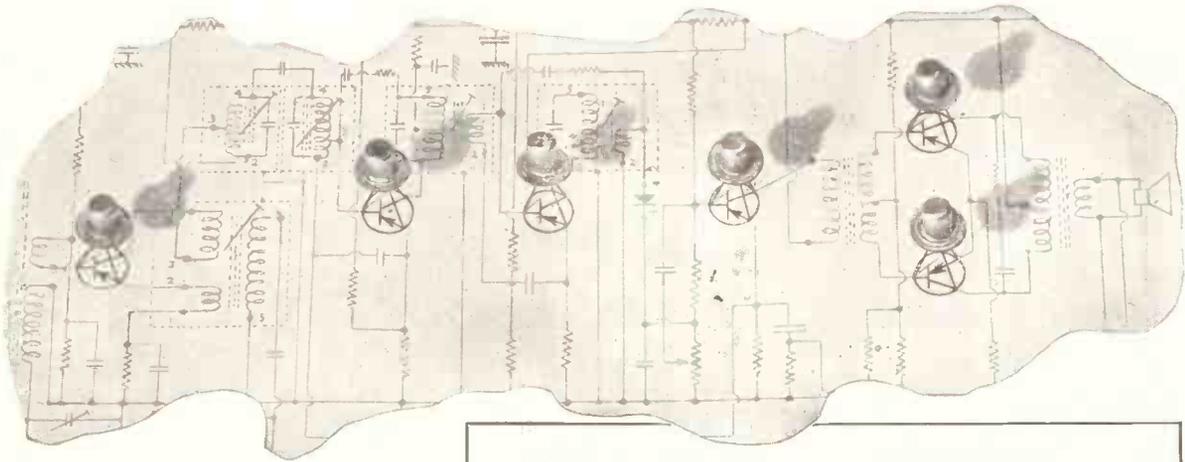
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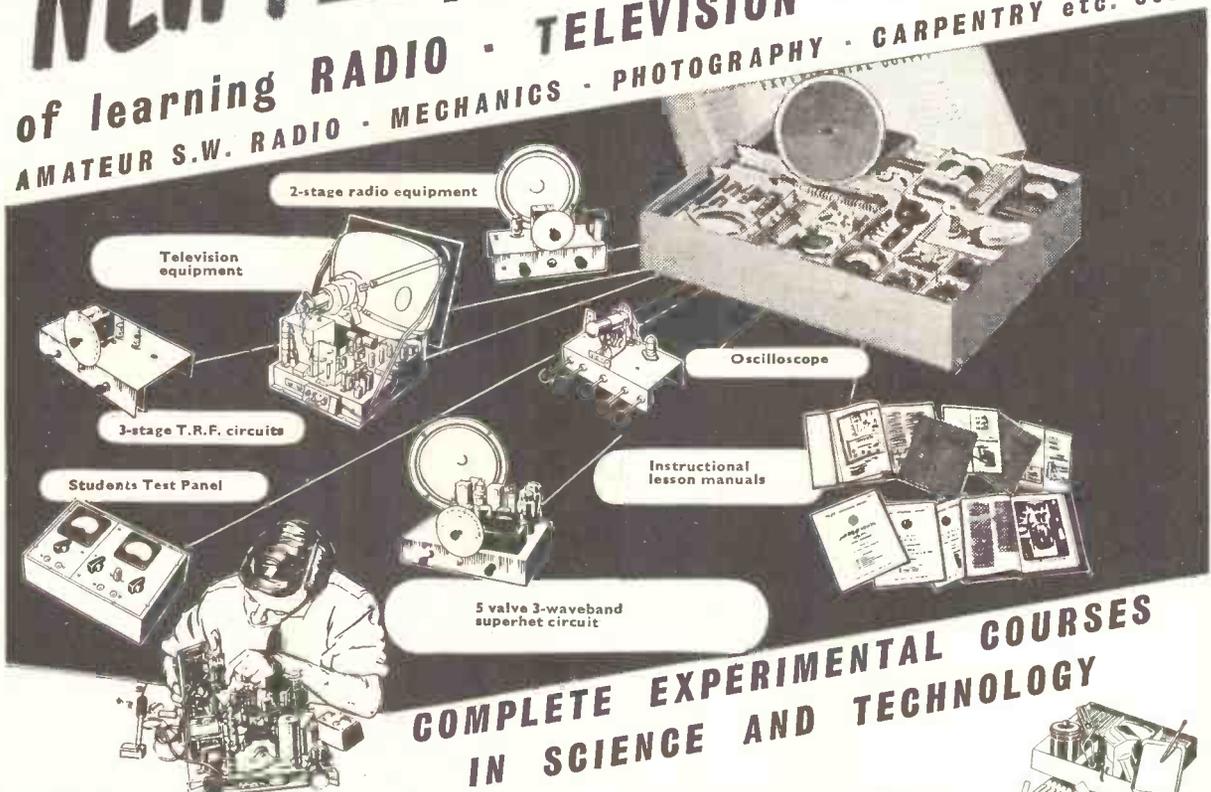
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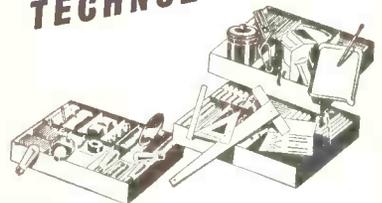
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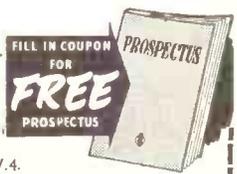
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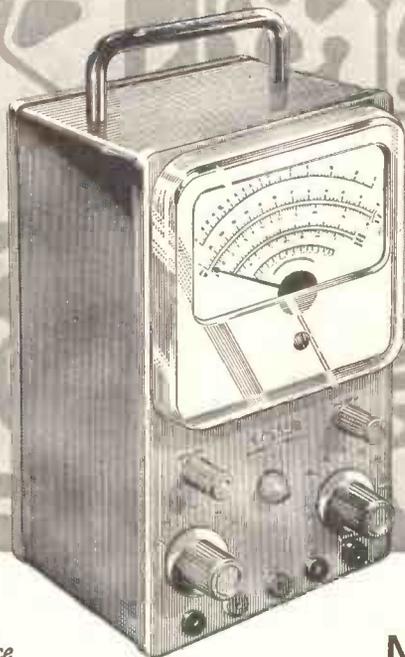
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Output (at 1,000 c.p.s.) at 1.2 cm/sec. .3 volts.



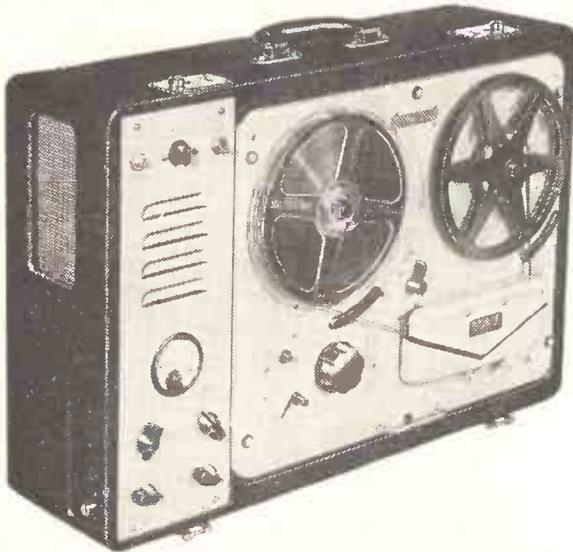
For use with low gain amplifiers, as fitted in the vast range of small record players.  
Has a flat response ( $\pm 3$  d.b.) up to 7,000 c.p.s.  
Output (at 1,000 c.p.s.) at 1.2 cm/sec. .9 volts.

Years of painstaking research have been devoted to perfecting the finest cartridge modern electronic experience and resources could produce. The Ful-fi satisfies the man who automatically listens for faults, it is the cartridge for the connoisseur—put it to the test! Designed to fit all standard pick-up arms, the Ful-fi is easily and instantaneously removed from snap-fork housing for examination, cleaning and replacement of styli. Turnover mechanism is exact and foolproof, styling is modern, streamlined and refreshingly practical. The precision-ground sapphire styli, can be quickly replaced when worn out. Ful-fi cartridges are individually packed in polystyrene containers and attractively cartoned.

*Fitted to the Monarch*  
**World's Finest 4-Speed Autochanger!**

**BIRMINGHAM SOUND REPRODUCERS LTD.,**  
**MONARCH WORKS, OLD HILL, STAFFS.**

# Vortexion



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

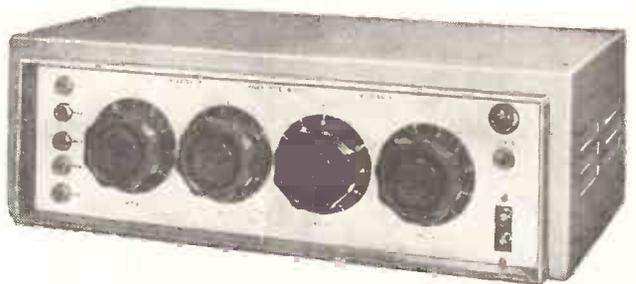
**T.R.G.10 MINIATURE AMPLIFIER AND VERSATILE PRE-AMPLIFIER.** A modern miniature amplifier, measuring only  $4\frac{1}{2}$  x 5 in. over front panel and projecting  $10\frac{1}{2}$  in. to the rear. Uses C core transformer material to obtain low external magnetic field and has less than 0.1% harmonic distortion at 10 watts output. The amplifier response is level 15 c/s. to 50,000 c/s. within 0.2 db. The 3-valve pre-amplifier will operate direct from recorder heads with correction networks for difficult tape speeds and switched inputs are provided for radio, microphone and gram. with correction for all recording characteristics.

**"SUPER FIFTY WATT" AMPLIFIER.** This heavy duty amplifier is available for long life under arduous conditions. The normal life being 5,000 hours without valve change.

## FOUR CHANNEL ELECTRONIC MIXER

An Electronic Mixer for four 30-50 $\Omega$  balanced line microphones or special to order. Normal output 0.5 v. on 20,000 $\Omega$  but 1 mW., 600 $\Omega$  balanced or unbalanced is available as an alternative.

The 3-CHANNEL MIXER and PEAK PROGRAMME METER is similar to the above but is fitted with a meter reading peak signals with 1 second decay time and calibrated in db. from zero level 1 mW., 600 $\Omega$  to +12 and -20 balanced or unbalanced output by means of switch.



*Full details and prices of the above on request*

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

Telephones: LIBerty 2814 and 6242-3

Telegrams: "Vortexion, Wimble, London."

## TAPE RECORDERS and AMPLIFIERS

★ The total hum and noise at 7 $\frac{1}{2}$  inches per second 50-12,000 c.p.s. unweighted is better than 50 db.

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

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

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

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

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

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

★ The power output is 4 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.

★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

**CP20A AMPLIFIER.** This standard amplifier for extreme tropical use will operate from 230 v. A.C. mains or 12 v. car battery and give 15 w. output for a consumption of 5.5a. Inputs for 30 $\Omega$  balanced microphones, M.I. P.U. and Cr. P.U.

**The first**  
**frequency**  
**changer valve**  
  
**pecially**  
  
**designed for**  
  
**printed circuit**  
  
**turret tuners**

The use of printed circuits in television turret tuners offers attractive advantages both from the quality and performance of the product and the reproducibility of performance. Printed circuits, however, limit the scope of wiring connections mainly to two dimensions instead of the three dimensional freedom of normal wiring and the existing connections of frequency changer valves are not very suitable for use with the existing cascodes. In order to realise the expected improvement in performance both the basing connections of the pins and the internal connections in the valve have to be optimised. The new Ediswan Mazda 30C13 has been specially designed to overcome these problems and give improved performance in gain and stability, particularly in Band III. Samples and preliminary technical information on the 30C13 will be available at an early date to Set makers only. Our Application Laboratories will be pleased to discuss your problems.

**EDISWAN**  
MAZDA

**valves and**  
**cathode ray tubes**

---

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VALVE AND CATHODE RAY TUBE DIVISION  
155 CHARING CROSS ROAD · LONDON · W.C.2

*An A.E.I. Company*

# Britain's best Hi-Fi Equipment

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

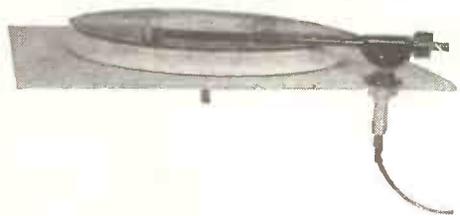
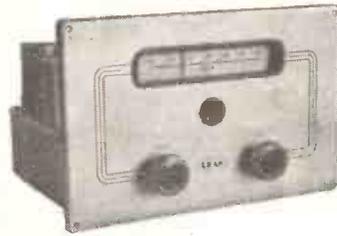
High engineering ideals have guided our efforts, and Leak Amplifiers have been the choice of the B.B.C., Commonwealth and foreign broadcasting authorities and Recording Studios. This acceptance by professional audio engineers has led to a demand for Leak equipment from music lovers throughout the world.

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

## An important Test Report . . .

*Independent laboratory tests of the Garrard 301 transcription turntable were recently carried out by Audio Instrument Company Inc., New York, U.S.A., under the direction of Mr. C. J. Lebel (Chairman of one of the groups which prepared the NARTB Standards). It was necessary that the pick-up and amplifier system should conform in response to the RIAA-New AES-new NARTB response curve within  $\pm 1$ db, and in the tests of this excellent transcription unit the components selected for use as complying with this requirement were a Leak tone arm fitted with Leak cartridge and a complete Leak pre-amplifier and power amplifier Model TL/10.*

*The full test report appeared in the February, 1957 issue of "Wireless World," pages 22 and 23.*



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SENSATIONAL REDUCTION  
THIS MONTH!**

**SUMMER SALE**

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SENSATIONAL REDUCTION  
THIS MONTH!**

- S.1. **Superhet 5v. AC/DC chassis.** Medium and two short. Unused. Less valves. Uses standard octal range. Coil pack worth more. 27/6. Carriage 6/6d.
- S.2. **Superhet 7 v. 5 waveband chassis.** h.f. stage. Unused. Less valves & power pack. Slightly soiled. Coil pack worth twice as much. £2/15/-, Carriage and insurance 7/6.
- S.3. **Rectifier Unit.** Ex Electric Supply Co. for working d.c. instruments, motorised equipment, etc. from a.c. mains. Input 200/240v. Output 200/240v. 3 amp. 35/-, carriage 7/6.
- S.4. **Rectifier Unit,** as item S.3. but 2 amp. 25/-, carriage 6/6.
- S.5. **Rectifier Unit,** as item S.3. but 40 m.a. 20/-, carriage 5/6.
- S.6. **Filament Transformer, 2v. 5 amp.** High voltage output. Secondary winding, so OK for tube isolation. 4/6.
- S.7. **Filament Transformer. 6-3v. 1-1½amp. 230v. primary. 5/9.**
- S.8. **Transistor new, tested. OK for LF 6/6.**
- S.9. **10v. Superhet 1½ Metre.** Ex Govt. but unused. Complete with valves. Easily converted for Band III. 39/6, carriage and packing 7/6.
- S.10. **Pyrex Aerial Insulator** complete with metal fixing flange. 1/6.
- S.11. **Germanium Diodes. BTH.** With wire ends. 10d. each or 9/- doz.
- S.12. **Perspex Escutcheon** for 12in. Tube, embodies mask for tube, suits our 12in. cabinet. 9/6, post and insurance 2/6.
- S.13. **12in. T.V. Cabinet** by famous maker. Cost over £4 to make. 12/6, carriage 4/6.
- S.14. **Metal rectifier. 200-250, 60-80 m.a.** Ideal for mains set or instrument or to replace that expensive valve. 3/9.
- S.15. **Superhet Coils.** Long and medium. Aerial and oscillator circuit included. Per set 3/6.
- S.16. **.0005 twin gang tuning condensers.** 4/9, post 9d.
- S.17. **Midget coils.** Ideal for formers in cans, with dust cores. 4/6 per doz.
- S.18. **Midget I.F. Coils,** dust cored, size 1¼in. x 1in., 465 Kc/s. 5/6 per pair.
- S.19. **Standard size I.F. Coil,** dust cored. 465 Kc/s. 4/6 pair.
- S.20. **Meter 0.9 amp hot wire.** Measures AC or DC current. 9/6.
- S.21. **Jumbo valve bases.** Ceramic for 805, etc. 3/6.
- S.22. **Moving coil meter. 2½in. flush mounting.** Scaled 0-30 m.a. 7/6 each.
- S.23. **Mullard 510. Output transformer.** 27/6, plus 2/6 post and packing.
- S.24. **Mullard 510. Mains transformer.** 29/6, plus 2/6 post and packing.
- S.25. **D.C. Rotary Converter.** Doubles or halves voltage, e.g. 24v. to 12v. or vice versa. 45/-, plus 3/6 carriage and insurance.

- S.26. **R.F. 25 Tuning Unit.** New, unused and complete with valves. 9/6, post 2/6.
- S.27. **Hand magneto generator,** as used on telephones. 9/6.
- S.28. **Powerful Blower** with motor, 24v. D.C. but can be operated off mains with rectifier. 15/-, post and packing 2/-.
- S.29. **As item S.28,** but with larger motor for 220v. 25/-, post and packing 3/6.
- S.30. **400 watt Step Down Transformer** tapped output, 110-155v. 37/6, carriage 6/6.
- S.31. **500 watt Isolation Transformer.** Mains in, mains out. (Make servicing safe.) 69/6, post 6/6.
- S.32. **Coil pack** for superhet 465 Kc/s I.F. Medium and 2 short waves. 9/6.
- S.33. **Fluorescent Tube 80 watt.** Standard in all respects. Callers only. 8/6 each.
- S.34. **Fluorescent Tube 40 watt.** See item S.33. 7/6 each.
- S.35. **Fluorescent Tubes 20 watt.** Standard in all respects. Callers only. 6/6 each.
- S.36. **Cathode Ray Tube. VCR 97.** Instrument type. 7/6 each, carriage 3/6.
- S.37. **Cathode Ray Tube. VCR 517.** 8/6 each, carriage 2/6.

Where the value of your order for small articles exceeds £2, these are post free. Under £2 add sufficient to cover, and where carriage or postage specifically mentioned add this in any case.

- S.38. **.1 mfd. 350v. small tubular metal cased type,** made by Dubilier. 2/6 per doz.
- S.39. **Loudspeaker. 5in. energised field 600 ohm.** 9/6, carriage 3/6.
- S.40. **Loudspeaker. 8in. energised field 500 ohm.** 12/6, carriage 3/6.
- S.41. **Welding Transformer. 12v. 50 amp.** Continuous rating. Intermittent rating for spot welding 500 amps. Price 45/-, carriage and packing 5/-.
- S.42. **Mains Lead.** Metal screened to stop interference. 9d. per yard.
- S.43. **10 core flexible cable. 230v. cores.** Price 1/6 per yard.
- S.44. **7 core flexible cable 230v. cores.** Price 1/3 per yard.
- S.45. **5 core flexible cable 230v. cores.** Price 10d. per yard.
- S.46. **3-valve superhet chassis.** Long and medium. Complete with valves. Unused but may need servicing. 25/-, post and insurance 3/6.
- S.47. **Thermometer Capillary Type. 0-100°C.** Price 9/6.

Many more bargains at all our branches. Please telephone before calling to pick up something special in case stocks have been cleared.

- S.48. **Mains Transformer 250-0-250.** 60-80 m.a. 6-3v. Standard mains input. Half shrouded. 12/6. post and insurance 2/6.
- S.49. **Precision Potentiometer 20k.** ohms 10 watt, with large instrument knob. Price 8/6.
- S.50. **Push Button Switch. 9 press.** 3/- per doz. 30/- per gross.
- S.51. **Paxolin panels. Size 8in. x 5in.** 3/- per doz. 30/- per gross.
- S.52. **High voltage condenser. .05 mfd. at 5KV.** Price 4/6 each.
- S.53. **50 assorted resistors.** Well mixed and useful values, ½ and ¼ watts. Price 5/- per 50.
- S.54. **50 assorted resistors.** Well mixed and useful values. 1 watt. Price 6/6 per 50.
- S.55. **Cut-out in bakelite case.** Suit 6-12v. or 24v. Price 7/6.
- S.56. **Automatic D.C. motor starter** for remote control of motors or D.C. gear between 1 to 3kw. 110v. or 230v. £4/-, carriage 7/6.
- S.57. **Check meter.** Movement only, made by Ferranti. New and unused. 7/6, post and insurance 2/6.
- S.58. **Wire welder.** Efficient hand grip tool with trigger switch, operates from 40a.c. Price 4/6.
- S.59. **Rotary switch,** as used for hair driers, etc., 10 amp. 1/9 each.
- S.60. **Bakelite 5 amp electric wall switch. "Hicraft".** 9d. each or 8/- per dozen.
- S.61. **As item S.60,** but two-way. Price 11d. each, or 10/- per doz.
- S.62. **Series, parallel and off-electric wall switch** made by Crabtree. Price 1/3 each or 13/6 per doz.
- S.63. **25 amp switch plug** made by Clix. Price 6/6.
- S.64. **5 amp 3 pin plug socket Hicraft.** 1/- each or 10/- per doz.
- S.65. **Vacuum pump,** makes good compressor. Price 22/6.
- S.66. **Hydraulic pump,** creates immense pressure, motorised but 24v. Price 35/-, carriage 7/6.
- S.67. **Amplifier ex-Government unit 1134** contains one double triode and one triode. 6/6, post and insurance 2/6.
- S.68. **Battery re-activator.** If you use a battery portable this will save you pounds, operates from AC mains. 25/-, post and insurance 2/6.
- S.69. **Fused knife switch** for isolating and switching, complete with fuses. 5 amp 2/6, 30 amp 3/6, 60 amp 4/6.
- S.70. **Thermo couple** mounted on valve base, useful for experiments and schools. 6/6 each.
- S.71. **Head-phones, lightweight American type HS 30.** 22/6 pair.
- S.72. **Clock case, modern flat type** (Movement exposed). 2/6.
- S.73. **Midge push-pull input transformer,** and push-pull output transformer to match. 8/- the pair.
- S.74. **Octagonal speaker enclosure** as specified by the G.E.C. for the metal cone, also suits any 8in. speaker, beautifully made but no polished. £5. Carriage and insurance 10/-.

DEFINITELY LAST MONTH — **SUMMER SALE** — DEFINITELY LAST MONTH

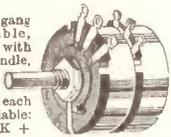
**14" T.V. CABINET**



14in. T.V. cabinet of the latest styling—beautifully veneered and polished—limited quantity—sale price 17/6 each. Carriage and packing 3/6 extra.

**MORGANITE POTENTIOMETERS**

Single and 2 gang types available, standard size with good length spindle, all new and boxed. Gang type 3/- each—values available: 5K + 5K, 100K + 100K, 1 meg. + 1 meg. Single types 1/- each, values available: 10K, 25K, 50K, 100K, 250K, 1 meg., 2 meg.



**CRYSTAL MICROPHONE**

Minature crystal type has high gain and is suitable for all purposes—tape recorder—amplifiers. Price 4/9, post and ins. 9d.



**VARIABLE RHEOSTAT**

This is a heavy duty slider resistor rated at 25 amps, but easily capable of twice this load. Basic resistance is .4 ohms but by the removal of one wire this becomes .8 ohms, alternatively it can be rewired to suit individual requirements. Adjustment is by rotating a Bakelite knob which couples to a heavy duty slider, ideal for dimmer circuit. Price 8/6, post and ins. 3/6.



**PORTABLE CABINET 19/6**

Product of a famous maker. Complete with top board. Sale price 19/6, carriage and ins. 3/6.



**TRANSISTOR RECEIVER 19/6**

Makes ideal bedroom radio, uses one transistor and one crystal diode. Complete less case 19/6, case 5/- extra, post and ins. 1/6.



**BLANKET ELEMENTS 15/-**

We are offering an out-of-season bargain—14 yards of waterproof electric blanket element, enough to make a full size blanket. Normally we sell at 20/-. Sale price is only 15/-, post free, complete with illustrated data.

**NOTE**  
Customers ordering small articles to the value of £2 or over need not add anything for postage—under £2 add sufficient to cover. Ask for Sale List.

**2 1/2" M/c METER**

500 micro. amp. Sale price 17/6. 250-0-250 micro. amp 22/6. 5-0-5 millamp. 17/6. Post and ins. 2/6



**MULTI TAPPED STEP DOWN TRANSFORMER**

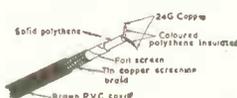
Rated at 250 watts continuous this transformer will easily carry twice this load for short periods. Primary: 200 v. to 250 v. in 10 v. steps, secondary: 115 v. to 155 v. in 3 v. steps. Robustly made (originally intended for Ministry), new and unused, sale price 37/6, carriage and ins. 7/6.

**CERAMIC SWITCHES**

By one of our best makers, 3 pole, 3 way, 2/6 each, also standard type switches 12 pole, 2 way, 1/3 each, 6 pole, 3 way, 1/3 each, 2 pole, 6 way, 1/6 each.



**TWIN FEEDER**



Ideal for FM down lead as a twin microphone lead, etc. Sale price 8d. per yard. 80 ohm co-ax. low loss for Band 3, 8d. per yard.

**HIGH NOTE BUZZER**

A.C. operated, tone can be varied. Sale price 2/6.

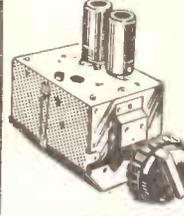
**SAPPHIRE NEEDLES**

Unrepeatable bargain—new and perfect—two types available: miniature E.M.I. and Standard (trailer). Sale price 1/- each or 10/- doz.



**THIS MONTH'S SNIP**

**TURRET TUNER**

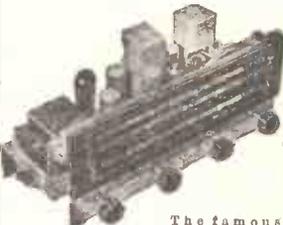


Brand new stock, not surplus, with coils for Band I and III, complete with valves PCC84 and PCF80—I.F. Output 33/38 Mc/s with instructions and circuit diagram 79/6. With knobs 3/6 extra, post and ins. 2/6.

**HALF PRICE OFFER**



PVC covered copper wire in 100ft. coils most colours. Sale price 2/6 per coil or 5 coils 10/-, post free.



The famous Cleveland "Windsor" 5"—5 valve A.C./D.C. superhet with a particularly fine performance and appearance. New, unused and ready to work, as illustrated but without knobs. Made to sell originally at 12 gns., sale price 6 gns. Callers only.

**SAVE £2. 10s.**

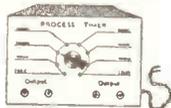
The Cleveland Band 3 converter is one of the best on the market and literally thousands are in use all over Britain. Original price £7/10/-. Sale price £4/19/6, carriage and ins. 5/-.

**THE "CRISPIAN" BATTERY PORTABLE**

A 4-valve truly portable battery set with very many good features as follows—  
● Ferrite Rod Aerial.  
● Low consumption valves (DK96 range).  
● Superhet circuit with A.V.C.  
● Ready built and signed chassis if required.  
● Beautiful two-tone cabinet.  
● Guaranteed results on long and medium waves.  
All parts, including speaker and cabinet, are available separately or if all ordered together the price is £7/15/- complete. £1/5/- deposit and seven monthly payments of £1. Post and insurance 3/6. Ready built chassis 30/- extra. Instruction booklet available separately 1/6.

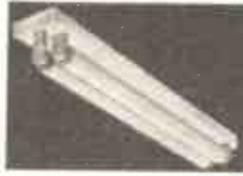


**PROCESS TIMER 15/-**



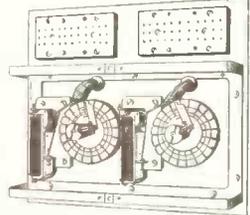
Make a useful time switch to work off mains (A.C. or D.C.), all the parts (less case). Sale price 15/-, post and ins. 2/6.

**FLOUORESCENT LIGHTS**



These are complete fluorescent lighting fittings. Built-in ballast and starters—stove enamelled white and ready to work. Ideal for the kitchen, over the work bench and in similar locations. Single 40, 4ft. 3in. long, uses a 40 watt tube. Sale price 35/-, complete with tube. Twin 20. Uses 2 20-watt standard tubes. Sale price 35/-, with tubes. Carriage and ins. up to 150 miles 5/6; up to 250 miles 7/6.

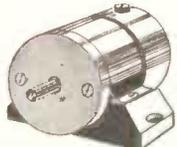
**TOWARDS AUTOMATION**



Rotary switch—Ministry Ref. No. AP37379, this is a motor-driven switch, the driving motor being a synchronous type for working on 110 volts 50 cycles. The two switches have 20 positions each and are enclosed by a Perspex fronted lid, separately operated relays providing interlocks. Sale price 27/6 each. Carr. 3/6.

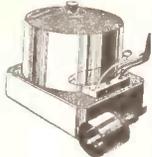
**MAINS MOTORS**

Powerful electric motor, size: 3in. long by 2 1/2in. diameter, with speed variator suitable for operation on/off standard A.C. mains. Ideal for driving fan, model, car heater, dryer, etc., etc. Don't miss this snip, 12/6, plus 2/-, post and ins. Stand not included.



**CLOCKWORK UNIT 9/6**

Contains a clock movement less hands and balance. Makes and breaks heavy duty contacts. Sale price 9/6, post and ins. 3/6.



**MANY OTHER BARGAINS**

There will be special bargains for callers at all branches and it will definitely be worth your while to pay each branch a visit.

**ELECTRONIC PRECISION EQUIPMENT LTD.**

266 London Road, Croydon. Phone: CRO 6558. Half-day Wednesday.  
249 Kilburn High Road, Kilburn. Phone: MAI 4921. Half-day Thursday.  
42-46, Windmill Hill, Ruislip, Middlesex. Phone: RUISLIP 5780. Half-day Wednesday.  
152-153 Fleet St., E.C.4. Phone: FLEET 2833. Half-day Saturday.  
29 Stroud Green Road, Finsbury Park, N.4. Phone: ARCHWAY 1049. Half-day Thursday.

Post orders should be addressed to E.P.E. LTD., Dept. 2, SUTTON ROAD, EASTBOURNE. All enquiries to Eastbourne address and please enclose S.A.E., terms are cash with order.

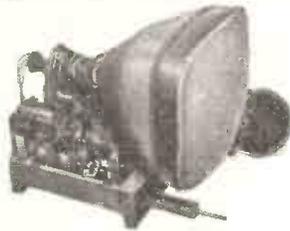
## SUMMER SALE CHASSIS BARGAINS

### LOOK! 17" T.V. CHASSIS £19.19.6.

**17" rectangular tube on adapted chassis**  
Any or all channels. The TURRET TUNER can be fitted later as an extra at our special price to chassis purchasers, 50/-.  
Valve line up (5 valves) 6SN7G, 6P25, EY51 & 2-6D2's. Others: 6L1B, EL38 & 7-6F1's. These may be on YOUR shelf.

### 14" T.V. CHASSIS, TUBE & SPEAKER.

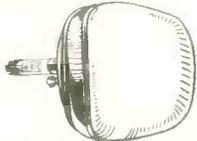
**£13.19.6.** As above, with 14" round tube, which you can convert later if you wish to a 17" rectangular tube. I.F.'s 10.5-14 Mc/s. Less valves. Chassis, tube and valves guaranteed for 3 months. Price with 5 of the valves £15.19.6 or complete with all valves £19.19.6. Ins., Carr. (incl. tube), 25/-.



Chassis size:— 11½" x 14½" x 11". 12 months' guarantee on the rectangular tube, 3 months' guarantee on the chassis and valves. All complete and working on any channel 1-5 but less valves. With 5 of the valves £21.19.6. Complete with all valves £25.19.6. Ins., Carr. (incl. tube) 25/- . Please state B.B.C. channel (& I.T.A. channel if turret tuner required).

A TURRET TUNER of famous manufacturer is fitted to either of the above chassis's, giving choice of channels at an extra charge of 50/- towards the cost of the tuner. Only available to chassis clients.

17"  
£7. 10. 0.  
**12 MONTHS' GUARANTEE**



T.V. TUBES. Used

14"  
£5. 10. 0  
**LATEST RECTANGULAR**

We are now able to offer this wonderful guarantee, 6 months' full replacement, 6 months' progressive. Made possible only by the improved high quality of our tubes. Carr., Ins., 15/6.  
As a SPECIAL OFFER we can now supply 14", 15" and 16" T.V. tubes at £5. These carry a 3 months' guarantee. N.B.—C.W.O. on all tubes.

**12" T.V. TUBES £6.** Shortage may cause delay, phone first, we may have alternative and can tell you delay if any. Ins., Carr. on all tubes 15/6. T.V. TUBES 30/- . With cathode to heater shorts. With burn 15/- . Please enquire. Give type and size required. Carriage extra.

**CONVERT THAT OLD 9", 10" or 12" T.V. SET TO 14", 15" or 17"**. See details in our FREE catalogue.

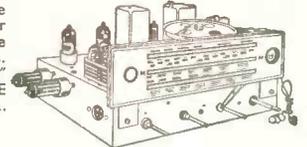
**8" P.M. SPEAKERS, 8/9.** Buy now while stocks last. Let the lady of the house listen to that radio programme. P. & P. 1/9. With O.P. transformer fitted, 10/- . Postage 2/3.

Send for FREE catalogue. Liverpool St. Stn. to Manor Park Stn. 10 mins. Open SATURDAY all day. Terms available.

**DUKE & CO. (W.W.) 621/3 ROMFORD ROAD, MANOR PARK, LONDON, E.12 Telephone: GRA 6677-8, 2791**

### ARGOSY PUSH PULL RADIOGRAM CHASSIS. 139/6.

8 wave latest models. 3/wave band and gram switched. Over 10 watts output. Full tone range included. 4-knob control Less valves. Chassis size:— 12" x 7½" x 7½". Drawings 3/6 or FREE with order. Valves 59/6 extra. Ins., Carr., 5/6.



### POPULAR RADIO or RADIOGRAM CHASSIS. 39/9.

3 w/band and gram. 5 valves, International octal. S/het. Ideal for table gram, but still giving high quality output. 4 knob control. 8" P.M. speaker 7/9 with order. Set of knobs 2/- extra. Chassis size 12" x 6" x 9". Less valves. Ins., Carr. 4/6. Valves 45/9 extra.

### T.V. CONSTRUCTOR CHASSIS

**SOUND & VISION STRIP 35/6.** Tested working, I.F.'s 16-19.5 Mc/s. Complete sound and vision strip. Less valves. Drawings 2/6 or free with order. P. & P. 2/6.

**POWER PACK 39/6.** R.F. E.H.T. unit included. Less valves. Tested working. Drawings free with order or 2/6. Ins., Carr. 5/-.

**RADIO-GRAM CHASSIS, 29/9.** 5 valve superhet. 8" speaker included. 3 w/bands. A.C. mains. Complete Less valves. Front drive, FREE printed dial. Chassis size: 12" x 10" x 8". Ins., Carr. 5/6.

Estd. **L.R.S.** 1925  
**EASY TERMS**

**LEAK** QUALITY EQUIPMENT  
*for the Connoisseur*

THE LATEST  
**"TL/12 PLUS" POWER AMPLIFIER**  
and the  
**"VARISLOPE III" PRE-AMPLIFIER**

are designed to give the highest possible fidelity from records, radio and tape.

**OTHER LEAK PRODUCTS** "Trough-Line" F.M. Tuner . TL/10 Amplifier . Point One Pre-amplifier . Dynamic Pickup

**TUNERS:** Chapman · Lowther  
**LOUDSPEAKERS:** Goodmans · Tannoy · Wharfedale  
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**EARLY DELIVERY OF HIGH STABILITY RECTIFIERS**  
to any rating.  
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## COMMUNICATIONS RECEIVER B28 (MARCONI CRI00).



- ★ Valve line-up: 2 R.F., Mixer, separate Local Osc., 3 I.F., Det./A.V.C./1st A.F., Output, B.F.Osc. and H.T. Rectifier.
- ★ Variable Selectivity (Crystal and Audio filters), of 6 Kc/s., 3 Kc/s., 1.2 Kc/s., 300 c/s and 100 c/s pass bands.
- ★ Built-in power supply operates from 200-250 V. 50 c/s.
- ★ Covers 60 Kc/s to 30 Mc/s. (5,000 to 10 metres) in 6 ranges, with small gap between 420 and 500 Kc/s (I.F. 465 Kc/s).
- ★ Precision geared drive with 2 logging scales gives an equivalent scale length of 18 feet for each range.
- ★ Sockets on front panel for headphones, terminals at rear for 3 ohms speaker or 600 ohms line.
- ★ Size 16in. x 12½in. x 16½in. deep. Weight 83lbs. nett.
- ★ Thoroughly checked and in beautiful condition.
- ★ Gladly demonstrated.

**PRICE — ONLY £21.**

Plus Packing & Carriage £2. U.K. only.  
(£1 refunded when packing case returned.)

### TRANSFORMER BARGAINS

Input 0-230/250 v. Output 240-0-240 v., 1.5 amps RMS, 5 v. 1.75 amps, and 5 v. 12.5 amps. 7 x 7½ x 10½in. high. Wt. 50 lbs. Potted, oil-filled, by Gresham. Gives 2.1 amp. D.C. when rectified, OR, as ISOLATING TRANSFORMER, to obtain two 240 v. 360 w. lines. Brand new. £3/10/-. Carr. 10/-. Input 0-110/120-200/250 v. Output 275-0-275 v. 100 mA, 6.5 v. 7 amps, 5 v. 3 amps (Govt. ratings). 4 x 4½ x 4in. high. Upright mounting. Brand new. 32/6. Postage 2/6.

U.S.A. potted type, input 210/220/230 v. 5 secondaries, 7.5 v. 4 a., 7.5 v. 4 a., 7.5 v. 8 a. and 2.5 v. 5 a., ALL centre tapped, and 6.3 v. 4a. These can be connected to give many useful voltages up to 31 v. 4 a. Size 6in. x 5in. x 4in. Wt. 16lb., price 35/-.

**HEAVY DUTY SLIDER RESISTORS.** 0.4 ohm, 25 amps, 250 watts, worm drive, 7/6-10 ohms, 3.5 amps, worm drive, 10/6. 1 ohm 12 amps, 150 watts, 7/6. 14 ohms, graded 1-4 amps, 7/6.

**MINIATURE STC RELAYS.** 250 ohm coil. DP C/O (double-contacts). 1½ x ¾ x ¾in. 7/6.

**OUTPUT POWER METERS.** Ex-W.D. No. 3, Mk. 2 (Windsor 150 A.). Impedance ranges 2.5 to 20,000 ohms in 40 steps. Power ranges 0-5, 50, 500 milliwatts, and 0-5 watts. Also scaled in dB, ¾in. M/C meter. In oak case, 10½in. x 8in. x 5½in. In good condition. Tested. £15.

**INSULATION TESTERS** by Record Electric. 0-50 Megohms. Test voltage 500. In perfect working order. Complete in leather carrying case. £9/19/6.

**AVO VALVE TESTERS.** Roller panel type, with cut-out. New purchase enables us to offer these in very good condition, in transit case and full working order for ONLY £7/19/6 carriage paid.

**JACK BOXES.** A small metal box fitted with 9 miniature insulated Igranic jack sockets. Brand new. SNIP. 12/6.

**HEAVY DUTY BLOWERS.** For 200-250 v. A.C./D.C. mains, 300 watts. With 1½inch diam. twin "V" shape outlets. 2 lengths of hose, 4 spare filters, and brushes. Suitable for industrial use, forges, etc. Brand new. £4/19/6.

**VIBRATOR PACKS.** Input 6 v. D.C., Output approx. 100 v. D.C. at 30 m/Amps, fully smoothed and R.F. filtered. Size 6½ x 5 x 2in. Fitted with Mallory 629C vibrator. Brand new. Boxed. 12/6.

**MOTOR ALTERNATORS.** Input 80 volt D.C. at 16 amps. Output 80 volt A.C. 2,000 c/s, at 8 amps (650 V.A.). Built-in voltage regulator. Brand new. Crated. £79/6. Carriage 15/-.

### METER BARGAINS

RANGE	TYPE	SIZE	PRICE
60 Microamp.	D.C. M/C	2½in.	59/6
100 Microamp.	D.C. M/C	2½in.	39/6
500 Microamp.	D.C. M/C	2in.	17/6
500-0-500 Micro-amp.	D.C. M/C	2½in.	25/-
1 Milliamp.	D.C. M/C	2in.	22/6
160 Milliamp.	D.C. M/C	2in.	7/8
200 Milliamp.	D.C. M/C	2½in.	10/6
1 Amp.	Thermo-couple	2½in.	6/9
4 Amp.	Thermo-couple	2in.	6/9
30-0-30 Amp.	D.C. M/I	2in.	5/-
15 Volts	A.C. M/I	2½in.	8/6
300 Volts	D.C. M/C	2in.	10/6
METER RECTIFIERS. Full wave bridge. Brand new, Salford 1/mA. 6/6. 5 mA, 6/6. STC 2 mA, 5/6.			

### WIRELESS SET No. 19, Mk. 2.

Two transmitter-receivers and an intercom. amplifier in one case. "A" set covers 2-8 Mc/s R/T and CV, and "B" set 240 Mc/s R/T only. Complete with dynamotor for 21 v. D.C. operation, 6 K7G, 2 6K8G, 2 6V6G, 6B8G, 807, E50, EB34, and 500 microamp check and tuning meter. S.A.E. full specification. Technical data supplied. Made in U.S.A. First-class condition. AIR TESTED £5/10/- plus 15/- carr. and pkg. Or less dynamotor, £4/19/6.



**RCA AMPLIFIER M1-11220.** Employs 2 6L6G, 4 6I7, 1 5U4G. Output 12 watts at 5, 7.5, 15, or 600 ohms. For 190-250 v. A.C. mains. In amber-grey crackled case, 17 x 11 x 9in. Wt. 38lbs. Brand new, boxed, less valves, £9/19/6. Circuit supplied. Set of new valves, 59/6. Converted for use with pick-up or microphone, with tone control, £2 extra. Spare O/P transformer for above, with NFB tertiary winding. BRAND NEW, 27/6, including amplifier circuit.

**HIGH VOLTAGE POWER UNITS** Input 200-250 v. A.C. mains. Output 1200v. D.C., 200 milliamps. Fully smoothed, Metal rectifiers, £5/10/-, plus 15/- carriage.

**RI09A RECEIVERS.** 8 valve superhet using 5 x ARP12's and 3 x AR8's covering 2-12 Mc/s. Contains vibrator pack and 3½in. speaker and operates from 6 volt battery, consumption 1½ amps. Housed in metal case 13 x 12 x 11in. Complete with valves and circuit. Very good condition. Tested. £4/7/6, carr. pd.

**SCR522 TRANSMITTER/RECEIVERS.** 100-150 Mc/s. Comprises BC624A rec., and BC625 trans. All complete with valves, and in first-class condition. BC624A, less relay, 39/6. With relay, 49/6. BC625, 49/6.

**RT37/PPN2 BEACON TRANSMITTER-RECEIVER.** 214-234 Mc/s. Size 13in. x 10in. x 5in. Contains 5 3A5, 3 1S5, 1 IR5 and 2 2 v. synchronous vibrators. Operates from 2 v. accumulator via 2 built-in vibrators. Complete with telescopic mast antenna system (9½ft.), lightweight headphones. Technical Manual, super quality carrying haversack, cords, co-ax cables, plugs, etc. Total wt. 28lb. BRAND NEW, boxed. American equipment, 72/6.

**PYE 45 Mc/s. IF STRIPS.** Complete with 7 valves and CIRCUIT. New. ONLY 39/6. **RF UNITS. ALL BRAND NEW AND BOXED.** RF24 7/6, RF 26 25/- Post 2/6.

**Two-Way MORSE TRAINING SETS,** W/P Mk. 3. Consists of 2 valve oscillators (ARP12's) (one with pitch control), for 1 or 2 operators. Has provision for creating "atmospherics." In polished oak case 12½in. x 10in. x 8in., wt. 16 lb. Complete with valves, leads, 2 keys, 7-way terminal board, circuit and instructions, but less batteries and phones. Ideal for Cadets, Scouts, etc. SNIP, 19/6, carr. 7/6.

**VARIAC TRANSFORMERS.** Semi-variable input 200-240 v. 50 c/s. Output 7.5 amps., 1.65 KVA. 8 x 4½ x 4 inches. Wt. 14lb., 89/6.

**MAINS DIMMERS.** 300 ohms, 1 amp, 300 watts, twin ceramic formers, 15/-.

**FIELD TELEPHONES.** Army type D, Mk. 5. Buzzer calling. Ideal for building sites, farms, workshops, etc. Complete with handset and batteries. Tested, 39/6 each. **CRYSTALS.** 200 Kc/s American GEC, 10/- each. 100 Kc/s R.C.A. bars, 19/6 each.

PLEASE ADD POSTAGE OR CARRIAGE ON ALL ITEMS

**CHARLES BRITAIN (Radio) Ltd.**  
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One minute from Leicester Square Station (up Cranburn Street)  
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# R.S.C. BATTERY CHARGING EQUIPMENT

## ASSEMBLED CHARGER

6 v. or 12 v. 2 amps.

Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads, Double Fused. **47/9** Only



Carr. 3/6.

## ASSEMBLED CHARGERS

- 6 v. 1 amp. .... 19/9
- 6 v. or 12 v. 1 amp. .... 25/9
- 6 v. 2 amps. .... 29/9
- 6 v. or 12 v. 2 amps. .... 38/9
- 6 v. or 12 v. 4 amps. .... 59/9

Above ready for use. Carr. 2/9.

## MISC. SPARES.

Bakelite Fuses 15a 1/9. Bakelite Terminals, 6d. ea. Multi-Position 15a Switches with Knobs 4/9. Rheostats 25μ 0.4 ohms. with worm drive 6/9.

Heavy Duty rectifiers can be supplied to customers specification. Please let us Quote you for your requirements.

## BATTERY CHARGER KITS

Consisting of Mains Transformer F.W. Bridge. Metal Rectifier, well ventilated steel case, Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.

- 6 v. or 12 v. 1 amp. .... 22/9
- 6 v. 2 amps. .... 25/9
- 6 v. or 12 v. 2 amps. .... 31/6
- 6 v. or 12 v. 4 amps. .... 53/9

## BATTERY CHARGER KIT

Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans., 0-9-15 v. 6 a. output, and ammeter. Only 49/9. Post 3/-.

All for A.C. MAINS 200-250v., 50 c/s. Guaranteed 12 months. Assembled 6v. or 12v. 4 amps.



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish.

Ready for use with mains and output leads. Carr. 3/9. Or Deposit 13/9 and five monthly payments 13/9.

## SELENIUM RECTIFIERS

- |                        |                        |                         |
|------------------------|------------------------|-------------------------|
| L.T. Types             | 6/12 v. 6 a. .... 19/9 | 6/12 v. 10 a. .... 25/9 |
| 2/6 v. 1/2 a.h.w. 1/9  |                        |                         |
| 6/12 v. 1/2 a.h.w. 2/9 | H.T. Type H.W.         |                         |
| F.W. Bridge Types      | 120 v. 40 mA. 3/9      |                         |
| 6/12 v. 1 a. .... 4/11 | 250 v. 50 mA. 5/9      |                         |
| 6/12 v. 2 a. .... 8/9  | 250 v. 80 mA. 7/9      |                         |
| 6/12 v. 3 a. .... 11/9 | 250 v. 150 mA. 9/9     |                         |
| 6/12 v. 4 a. .... 14/9 | 300 v. 250 mA. 12/11   |                         |

CO-AXIAL CABLE. 75 ohms 1/2in., 8d. yard Twin screened feeder 11d. yard.

5 CORE FLEX. Henleys circular rubber 14/36. Each lead colour coded. 1/6 yard.

DIAL BULBS. M.E.S., 8 v. 0.2 a., 6/9 doz. 6.5 v. 0.3 a., 5/9 doz. 2.5 v. 0.3 a. 3/9 doz.

ELECTROLYTICS (current production). NOT Ex Govt.

- | Tubular Types           | Can Types                    |
|-------------------------|------------------------------|
| 8 mfd. 450 v. .... 1/9  | 16μF 450 v. .... 2/9         |
| 8 mfd. 500 v. .... 2/6  | 16 mfd. 500 v. .... 3/9      |
| 16μF 350 v. .... 1/11   | 32μF 350 v. .... 2/11        |
| 16μF 450 v. .... 2/9    | 32 mfd. 450 v. .... 4/9      |
| 16μF 500 v. .... 3/9    | 100 mfd. 450 v. .... 4/9     |
| 8-16μF 500 v. .... 4/11 | 8-8μF 450 v. .... 2/9        |
| 25μF 25 v. .... 1/3     | 8-16μF 450 v. .... 3/11      |
| 50μF 12 v. .... 1/3     | 16-16μF 450 v. .... 3/11     |
| 50 mfd. 25 v. .... 1/9  | 32-32μF 350 v. .... 4/9      |
| 50μF 50 v. .... 1/9     | 32-32μF 450 v. .... 5/9      |
| 100 mfd. 12 v. 1/9      | 100-100 mfd. 350 v. .... 5/9 |
| 100 mfd. 25 v. 2/3      |                              |
| 3,000 mfd. 6 v. 3/9     | 64-120 mfd. 350 v. .... 7/6  |
| 6,000 mfd. 6 v. 3/11    | 100-200 mfd. .... 7/6        |
|                         | 275 v. .... 6/11             |

Many others in stock.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

EX GOVT. STEP UP/STEP DOWN TRANSFORMERS. Double wound 80/100 watts. 10-0-100-200-220-240 v. to 5-0-75-115-125-135 v. or Reverse. Only 11/9, plus 2/9 post. 10-0-100-200-220-240 v. to 9-0-110-122-136-148 v. or Reverse. 200 watts, 35/9 plus 7/6 carr.

EX GOVT. METAL BLOCK PAPER CONDENSERS

- 4 mfd. 500 v. .... 2/3
- 8 mfd. 500 v. .... 4/6
- 4 mfd. 1,000 v. .... 3/9
- 10 mfd. 500 v. .... 3/9

EX GOVT. VALVES. VR137, EA50, EB34, 11d.; SP61 2/3; VS110 1/11; 6J5 3/9; 6V6G, 5U4G 7/9; 3Z54, 6X4 5/9; EF80 7/9.

EX GOVT. UNITS, type RDF1 in original sealed cartons with 14 valves including 5Z4G, etc., trans., L.F. choke, Rectifier, etc., etc. We cannot enter into correspondence regarding these units which represent a really exceptional bargain at 29/9. Carr. 7/6.

## OIL FILLED BLOCK CONDENSERS

Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.

## THE SKY FOUR T.R.F. RECEIVER



A design of a 3 valve 200-250 v. A.C. Mains L. & M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated above or walnut veneered type. It employs valves 6K7, SP61, 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-Point wiring diagrams, instructions and parts list, 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

## EX GOVT. MAINS TRANSFORMERS

- All 230 v. 50 c/s. input
- 120-0-120 v. 40 mA. .... 5/9
- 250-0-250 v. 60 mA., 6.3 v. 3 a., 6.3 v. 1 a. Potted 4 1/2-3 1/2-in. .... 11/9

## HEAVY DUTY OIL FILLED MAINS TRANSFORMERS

Suitable welding or soil heating. With input of 200-250 v. 50 c.p.s., output is 12 v. 80-100 amps. Only £6/19/6, carr. 7/6.

## MANUFACTURERS SURPLUS TRANSFORMERS

Primary 200-240-250 v. Drop through type 250-0-250 v. 70 mA. 6.3 v. 3 a., 11/9. Post-age 2/9.

## R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5 1/2 x 4 1/2 x 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagrams, 39/9, or ready for use, 46/9.



Type BM2. Size 8 x 5 1/2 x 2 1/2in. Supplies 120 v., 90 v., and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp, fully smoothed THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions 49/9 or ready for use 59/6.

- JUNCTION TRANSISTORS for Audio stages. Only 7/6.
- MINIATURE MOTORS. 24/28 v. D.C. or A.C. Size only 2 1/2 x 1 1/2ins. Spindle 1 1/2ins. long, 1/2in. diam. Made by Hoover Ltd., Canada. Price only 9/9.
- VIBRATORS. Oak 2 v. 7 pin. synchronous, 7/9.
- M.E. SPEAKERS. 2-3 ohms R.A. 8in. Field 600 ohms, 11/9.

T.V. CABINETS. For 15 16 or 17in. tube. Table model with doors. 79/6 carr. 7/6.

## R.S.C. TRANSFORMERS

FULLY GUARANTEED, INTERLEAVED AND IMPREGNATED.

- | MAINS TRANSFORMERS   |      | FILAMENT TRANSFORMERS        |                                      |
|--|------|------------------------------|--------------------------------------|
| Primaries 200-230-250 v. 50 c/s.   |      | Primaries 200-250 v. 50 c/s. |                                      |
| <b>FULLY SHROUDED UPRIGHT MOUNTING</b>   |      |                              |                                      |
| 350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.  | 19/9 | 6.3 v. 1.5 a. .... 5/9       | 12 v. 1 a. .... 7/9                  |
| 250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a. .... 25/9  |      | 6.3 v. 2 a. .... 7/6         | 6.3 v. 6 a. .... 17/6                |
| 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.   | 23/9 | 0-4-6-3 v. 2 a. .... 7/9     | 12 v. 3 a. or 25 v. 1.5 a. .... 17/6 |
| 250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion .... 31/-   |      | 6.3 v. 3 a. .... 8/11        |                                      |
| 300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.   | 25/9 |                              |                                      |
| 300-0-300 v. 100 mA., 6.3 v. 4 v. 4 a. c.t., 0-4-5 v. 3 a. .... 26/9   |      |                              |                                      |
| 350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.   | 23/9 |                              |                                      |
| 300-0-300v. 130 mA., 6.3v. 4 a., c.t., 6.3v. 1 a., suitable for Mullard 510 Amplifier                                | 33/9 |                              |                                      |
| 350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t. 0-4-5 v. 3 a. .... 26/9   |      |                              |                                      |
| 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.   | 33/9 |                              |                                      |
| 350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. .... 33/9  |      |                              |                                      |
| 425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t., 5 v. 3 a., suitable Williamson Amplifier, etc. .... 49/9 |      |                              |                                      |
| 450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a. .... 69/6  |      |                              |                                      |
| <b>TOP SHROUDED DROP-THROUGH TYPE</b>  |      |                              |                                      |
| 260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.  | 16/9 |                              |                                      |
| 350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.  | 18/9 |                              |                                      |
| 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.   | 22/9 |                              |                                      |
| 300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a. .... 23/9  |      |                              |                                      |
| 350-0-350 v. 100 mA., 6.3 v. 4 a., c.t., 5 v. 3 a. .... 22/9   |      |                              |                                      |
| 350-0-350 v. 100 mA., 6.3 v. 4 a. 4 a. c.t., 0-4-5 v. 3 a. .... 23/9   |      |                              |                                      |
| 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.   | 29/9 |                              |                                      |
| <b>E.H.T. TRANSFORMERS, 2,500 v.</b>   |      |                              |                                      |
| 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517 .... 36/6   |      |                              |                                      |

## CHARGER TRANSFORMERS

All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1 1/2 a., 11/9; 0-9-15 v. 3 a., 16/9; 0-3.5-9-17 v. 3 a., 17/9; 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9.

## ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s. 120 v. 40 mA., 5-0-5 v. 1 a. .... 14/9 90 v. 15 mA., 6-0-6 v. 250 mA. .... 9/11

## OUTPUT TRANSFORMERS

- Midget Battery Pentode 66:1 for 3S4, etc. 3/6
- Small Pentode 5,000Ω to 3Ω .... 3/9
- Standard Pentode, 5,000Ω to 3Ω .... 4/9
- Standard Pentode, 8,000Ω to 3Ω .... 4/9
- Push-Pull 8 Watts 6V6 to 5 ohms. .... 8/9
- Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω 15/9
- Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω .... 16/9
- Push Pull EL84 to 3 or 15 ohms. .... 16/9
- Push Pull 15-18 Watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms. .... 21/9
- Push-Pull 20 Watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω 47/9

## SMOOTHING CHOKES

- 250 mA., 5 H., 100 ohms. .... 11/9
- 150 mA., 7-10 H., 200 ohms. .... 11/9
- 100 mA., 10 H., 200 ohms. .... 8/9
- 80 mA., 10 H., 350 ohms. .... 5/6
- 60 mA., 10 H., 400 ohms. .... 4/11
- 1 amp. 0.5 ohm. L.T. type .... 6/6

# R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

NEW 1957 DESIGN. HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 12 millivolts minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc. etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams.



Cover as illustrated 17/6 extra. Only **10** car. 10/- GNS. Or Factory built with 12 months' guarantee. £12/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 28/11 and 9 monthly payments of 28/11.

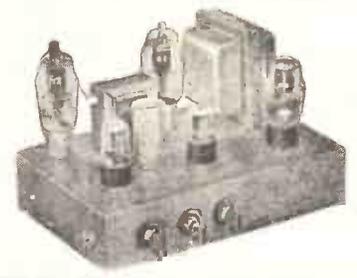
Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response  $\pm 3$  D.B., 30-20,000 c/s., Tone Controls  $\pm 12$  D.B. at 50 c/s.,  $\pm 12$  D.B. to  $-6$  D.B. at 12,000 c/s., Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12x9x9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc. etc.** We can supply Microphones, Speakers, 12 v. Rotary Converters, etc., at best cash prices or on terms with amplifiers.

## LT/45 HIGH QUALITY TAPE DECK AMPLIFIER

COMPLETE with POWER PACK and OSC. STAGE. Suitable for Collaro, Lane, Truxox, Aspin, Brennel, etc. etc. State make of Deck when ordering. Chassis size 12-7-3in. Overall size 12-7-6in. For 200-250 v. 50 c/s. A.C. mains. Output for standard 2-3 ohm speaker. Only 15 millivolts input required for full recording. Only 2 millivolts minimum input required for recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Negative feed-back equalisation. Linear frequency response  $\pm 3$  D.B. 50-11,000 c/s. Facilities for recordings at 15in., 7in. or 3in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. Separate gain and output controls. Mullard valves ECC83, ECC83, EL84, E280, EM34. Output 4 watts. Unit supplied with makers' 12 months' guarantee. We know of no other make which represents the same exceptional value. We can supply Decks and microphones with above at a special inclusive price.

12 Ready for use GNS. Carr. 7/6.

## R.S.C. ULTRA LINEAR 12-WATT AMPLIFIER



## LINEAR LG3 MINIATURE 3 WATT GRAM. AMPLIFIER

For 200-250 v. 50 c.p.s. A.C. Mains. Chassis and P.U. connections fully isolated. Fitted vol. (with mains switch) and Tone Control. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker. Guaranteed 12 months (valves 3 months). Only 69/9 carr. 3/9.

## R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only 24/15/-, or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

## R.S.C. A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only 23/15/-, carr. 3/6 or factory built 22/6 extra. Or Deposit 18/6 and five monthly payments of 18/6 for assembled unit.

P.M. Speakers recommended for use with A7, A5 or L45 amplifiers.

Plessey 12in. 3 ohm, 29/11. 6in. Celestion and Goodmans with high flux density magnet 19/8.

## COLLARO RC456 4 SPEED AUTO-CHANGERS

With studio pick-up with turnover head. BRAND NEW. Cartoned, latest model. For 200-250 v. 50 c.p.s. A.C. mains. Very limited number at only £8/19/6. Carr. 5/6.

## COLLARO RC54 3 SPEED AUTO-CHANGERS

As above unit but for normal 3 speed requirements. Brand new cartoned but for 110 v. 50 c.p.s. A.C. mains. So that the unit can be operated from normal, 200-250 v. A.C. mains we are supplying free with every changer a suitable auto-transformer with input and output voltages clearly marked. Limited number only. £7/19/6. Carr. 5/6.

## LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER.

Suitable for use with Garrard, B.B.R. or any other record playing unit, and most microphones. Total negative feedback 12 db. Separate Bass and Treble Controls. For convenience when mounted in cabinet, mains switch is incorporated in control. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves used. Size of unit only 6x5x5in. high. Chassis is fully isolated from mains. Guaranteed 12 months. Only 25/19/6. Or Deposit 22/- and five monthly payments of 22/- . Send S.A.E. for leaflet.

## PLESSEY DUAL CONCENTRIC 12 in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker, of orthodox design, supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A8 or any similar amplifier. Rating is 10 watts. Price only £5/17/6. Or Deposit 13/- and nine monthly payments of 13/-.



## NEW 1957 MODEL A8 HIGH-FIDELITY PUSH-PULL AMPLIFIER WITH "BUILT-IN" TONE CONTROL, PRE-AMP. STAGES

High sensitivity. Includes 5 valves (807 outputs), High Quality sectionally wound output transformer, specially designed for Ultra Linear operation, and reliable small components of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut" Frequency response  $\pm 3$ db. 30-30,000 c/s. Six negative feedback loops. Hum level 71 db. down. ONLY 70 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and practically all microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. FOR MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 20 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx 12-9-7in. For A.C. mains 200-230-250 v. 50 c/s. Output for 3 and 15 ohm speakers. Kit is complete to last out. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied.

Unapproachable value at £7/15/- or factory built 45/- extra. Carriage 10/- . If required louvred metal cover with 2 carrying handles can be supplied for 17/6. Where an extra input socket with associated volume control is required for mixing purposes this can be provided for 13/- extra. TERMS OF ASSEMBLED UNITS with extra input as mentioned above. DEPOSIT 25/6 and nine monthly payments of 23/4.

LINEAR "DIATONIC" 10-WATT HIGH FIDELITY AMPLIFIER. Incorporating pre-amp. For A.C. Mains input 200-230-250 v. 50 c.p.s. A compact attractively finished unit with two separately controlled inputs, and outputs for 3 and 15 ohm speakers. Separate Bass and Treble controls. Five latest type miniature Mullard valves. Only 12 Gns. Send S.A.E. for leaflet and credit terms.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012, 10 watts, 15 ohm (or 8 ohm) speak coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. 24/10/9. Please state whether 3 ohm or 15 ohm required.

P.M. SPEAKERS. 2-3 ohm 5in. Goodmans 17/9. 7x4in. Elliptical. Delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. Incorporates Gram. position. Controls are Tuning, W., Ch., and Vol. output will load most Amplifiers requiring 500 M.V. input depending on Ae. location. Only 250 v. 16 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is 24/15/- . Point-to-point wiring diagrams and instructions, 2/6.

## SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/Changer is used. Pentode I.F., and double Diode Second Detector. Delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. Incorporates Gram. position. Controls are Tuning, W., Ch., and Vol. output will load most Amplifiers requiring 500 M.V. input depending on Ae. location. Only 250 v. 16 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is 24/15/- . Point-to-point wiring diagrams and instructions, 2/6.

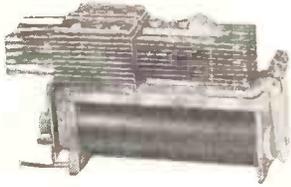
RECORDING TAPE. 1,200 ft. Reels, Puretone, Medium Coercivity, 15/9.

**Radio Supply Co. (LEEDS) LTD.**

**32 THE CALLS. — LEEDS, 2.**

Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 5d. Open to Callers: 9 a.m. to 5.30 p.m. Saturday until 1 p.m., S.A.E. please with all enquiries.

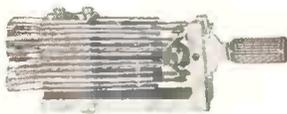
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BUILT TO YOUR SPECIFICATION  
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PROMPT DELIVERY ALL TYPES  
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### METERS GUARANTEED

F.S.D.	Size	Type	Price
100 Microamp	2 1/2 in.	MC/FR	50/-
250 Microamp	3 1/2 in.	MC/FR	55/-
Multi Sc.			
500 Microamp	2 in.	MC/FR	18/6
Sc. 15Kv.	2 in.	MC/FS	27/6
30 "	2 1/2 in.	MC/FR	12/6
100 "	2 1/2 in.	MC/FR	12/6
25 Amp.	2 1/2 in.	MI/FR	25/-
25 "	2 1/2 in.	MI/FR	7/6
50 "	5 in.	MI/PR	60/-
50-0-50 Amp.	2 in.	MC/FS	12/6
15 Volt	2 1/2 in.	MI/FR	15/6
20 "	2 in.	MC/FS	10/6
40 "	2 in.	MC/FS	10/6
300 "	2 in.	MC/FS	10/6
300 "	5 in.	MI/PR	60/-



**GROSS POINTER METERS.** With 2 separate 100 microamp movements. Brand new. 22/6, post 2/-.

**METER RECTIFIERS.** Full wave bridge 1 m/a or 5 m/a. 7/6 each. 50 m/a 5/- each, post 6d.

**CIRCUIT TESTER** in wood case 9in. x 6in. x 4in. 2 1/2 in. Flush Round meter, 50 milliamps, basic movement 10 M/A with leads, 10Ω pot. provision for 1.5 v. batt. Ideal for conversion, 17/6, post 2/6.

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**P.M. SPEAKERS.** 12in. Plessey 3 ohms. Special price 32/6, post 2/-.

**P.M. SPEAKERS.** 10in., in portable case with flex and plug, 50/-, carr. 5/-.

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**CONDENSERS, METALMITE.** 350 vt. wkg., .001, .002, miniature, 12/- doz., .005, .01, .02 10/- doz., .05 12/- doz., .1 13/6 doz., .25 Metalpack 16/- doz., 1.0 Metalpack 24/- doz. Post 1/-.



### BATTERY CHARGERS

Output up to 22 v. 10 amps., controlled by two 4-position rotary switches for fine and coarse control. Input 200/250 v. A.C. 50 cy., fused for A.C. and D.C. Brand new, £17/10/-, Carr. 15/-.



### JACK PLUGS.

Cylindrical bakelite screw on cover. 2 Contact. Ideal for amplifiers etc. 2/6 each, 24/- doz., £9 per 100.

### GLASS DOME INSULATORS.

2 1/2 in. with flange. 3/- each. Post 9d.

**PORTABLE BLOWERS.** 200/250 v. AC/DC 300 watts with switch and leads, 1 1/2 in. outlet. £5, carr. 7/6.

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**RECKS—POST OFFICE STANDARD.** 8ft. high with U-channel sides drilled for 19in. panels, heavy angle base. 4ft. 10in. also in stock.

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**RADIO ACTIVITY MEASURING INSTRUMENTS.** Philips Type 1092c. A portable self-contained unit in haversack. Scaled 0 to 10 millirontgens per hour, using Mullard Geiger Counter MX115. £25.

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**HEADPHONES.** High resistance 4,000Ω Type CHR, new. 12/6 pair, post 1/6.

**VENT-AXIA FANS—EXTRACTION OR INTAKE.** 230/250 volts A.C. 6in. diam. blades 130/-, 12 volt D.C. 90/-, post 2/9.

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## TURNTABLES AND TUNERS

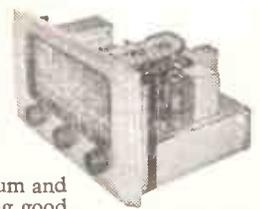
We stock many makes of turntables and tuners among our range of HI-FI equipment. This month we feature one of the best of each of them.

The Lenco GL50/4—this is a four-speed turntable with "click-in" positions for the four standard speeds. A control is also fitted to allow for continuously variable speeds between 29 r.p.m. and 86 r.p.m. Complete with Goldring variable reluctance No. 500 pick-up and automatic stop. £21/17/10 including tax.



Outstanding among AM/FM Tuner Units is the FM 85 by Chapman. This model is the economical answer to most radio needs of the Hi-Fi enthusiast.

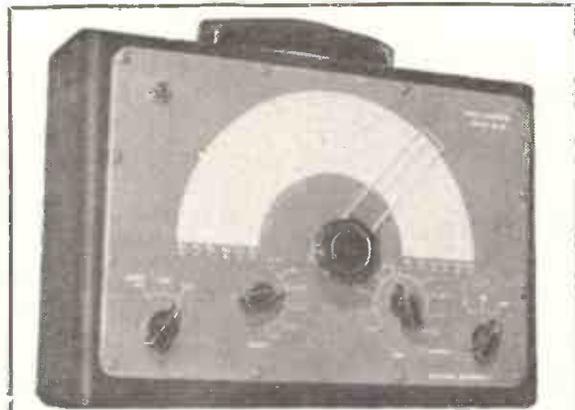
The tuner covers the FM band as well as medium and long wave bands providing good reception on Continental Stations as well as Home transmissions. Unpowered model 24 gns. Powered model 28 gns.



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Further details sent by return of post on receipt of self addressed, stamped envelope. Trade supplied direct.

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JUNCTION TYPE P-N-P  
(British Manufacture)

RED-SPOT 800 kc/s Audio Frequency.....	10/-
BLUE-SPOT 1.6 Mc/s Mixer and Frequency Changer	15/-
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All Transistors are Tested and Guaranteed  
**N.B. The Red-Spot is similar to Mullard OC71**

### "EAVESDROPPER"

**THREE-TRANSISTOR POCKET RADIO**  
(No Aerial or Earth required)

Pre-selected to receive the Light and Home Stations. Total cost, as specified, including Transistors, Transformers, Coils, Condensers and Battery, etc., with circuit and plastic case.

**77'6** POST FREE

All items sold separately.  
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Push-pull Portable Superhet

Can be built for £11/10/-

This Portable 8 Transistor Superhet is tunable for both Medium and Long Waves and is comparable in performance to any equivalent Commercial Transistor Set. Simplified construction enables this set to be built easily and quickly into an attractive lightweight cabinet supplied.

**TEN STAR FEATURES**

- ★ 8 Specially selected Transistors
- ★ 250 Milliwatts Output Push-Pull
- ★ Medium and Long Waves
- ★ Internal Ferrite Rod Aerial
- ★ 7 x 4 Elliptical High Resistance Speaker
- ★ Drilled Plastic Chassis 8½ x 2½ in.
- ★ Point to Point wiring and practical layout
- ★ Economical. Powered by 7½ v. battery
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- ★ Attractive lightweight contemporary case

We can supply all these items including Cabinet for **£11/10/-**  
All parts sold separately

Send for circuit diagrams, assembly data, illustrations and instructions, and full shopping list 1/6.

N.B. Pair of OC72's supplied at additional cost of 40/-  
Call & hear demonstration model.  
Further details in the August issue of "Radio Constructor."

## TRANSMITTER/RECEIVER

ARMY TYPE 17 MK. II

Complete with Valves, High Resistance Headphones, Hand-mike and Instruction Book and Circuit.

Frequency Range: 44.0 to 61 Mc/s.  
Range approximately: 3 to 8 miles.  
Power requirements: Standard 120 v. H.T. and 2 v. L.T.  
Ideal for Civil Defence and communications.

BRAND NEW **59'6**

Calibrated Wavemeter for same 10/- extra

### CATHODE RAY TUBES

VCR139A	£1 15 0
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### TRANSMITTER/RECEIVER SCR 522

Comprising the well known BC625 and BC624A Units. The complete unit is in very good condition having very useful parts including Relays, Transformers, Condensers, etc.  
Less valves 45/-, carr. 5/-.

### TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

(200 MILLIWATTS OUTPUT)

Build this Push-Pull Amplifier which is ideal for Crystal or Magnetic Pick-up Amplification, Baby Alarm, Microphone Amplifier, etc.  
Powered by 6-volt Dry Battery lasting for months.  
Complete Kit of Parts including 4 Transistors and all Components with Circuit (less Speaker) and plastic case, £4/10/-.

## THE TELETRON "COMPANION"

**THREE-TRANSISTOR POCKET RECEIVER**  
MEDIUM AND LONG WAVES. NO AERIAL OR EARTH

Tuned R.F. Circuit. Ardente Transformers. 3 Transistors. Drilled Plastic Chassis and Cabinet, size 4½ x 3 x 1 in., and all Components. Balanced Armature Output. Total cost

**89'6**

ALL PARTS SOLD SEPARATELY

### COLLARO RC456

4-speed auto-changer. Latest type with crystal turnover pick-up. £9/15/-.

### TRANSISTOR SIGNAL TRACER

Complete Kit with 2 Transistors, Components, Phones with Circuit and plastic case. 42/6

### TRANSISTOR SQUARE WAVE GENERATOR

Complete Kit with 2 Transistors. Components, Circuit and plastic case. 25/-

### DIODES

B.T.H. GERMANIUM	1/6
MULLARD OA74	2/6
IN21	3/6
IN22, IN23, IN21A	5/-

### MODEL-MAKERS' MOTORS

Two types available 12 or 24 v. with ½ spindle ..... 10/- each.

### 6 v. VIBRATOR PACKS

Output 180 v. 40 m/a., 15/- Brand new.

### "HOMELIGHT" ONE-TRANSISTOR RECEIVER

Build this pre-selected set which is powered by No. 8 battery. Total cost including Transistor, Coils, Diode, Plastic Case and H/R single 'phone. 32/6.

### "HOMELIGHT" 2-TRANSISTOR PERSONAL PORTABLE

No Aerial or Earth Required  
Pre-selected 2 Stations Receiver  
We can supply all components including 2 Transistors, Diode, Resistors, Condensers and Miniature Hearing Aid and Plastic Case size 4½ x 2½ x 1½ and 1½ v. Battery FOR 55/-.  
All items sold separately.

R.F.24. 10/- R.F.25 12/6 R.F.26 25/-  
Brand new with valves, carr. 2/6.

### COLLARO RC/3554

3-speed single player with crystal turnover pick-up type "T." £6/19/6. carr. 3/6. Brand new in original carton.



# Stern's introduce...

## A "fidelity" TAPE RECORDER WITH EVERYTHING—EXCEPT A HIGH PRICE TESTED AND APPROVED AT THE TRUVOX LABORATORIES

IT INCORPORATES: The NEW TRUVOX Mk. IV TAPE DECK together with the "fidelity" MODEL HF/TR2 TAPE AMPLIFIER (both fully described on this page), and a Rola 10 x 6in. P.M. speaker.

● BEFORE CHOOSING YOUR TAPE RECORDER YOU SHOULD HEAR THIS MODEL—TRULY "Hi-Fi" RECORDINGS ARE OBTAINABLE and it is comparable to much higher priced Recorders.

Alternatively send S.A.E. for ILLUSTRATED LEAFLET.

PRICE... Including CRYSTAL MIKE and 1,200ft. reel of PLASTIC TAPE.

**£49.10.0.** (OR £3 EXTRA WITH REV. COUNTER.)

(Plus £1/10/- carriage and insurance, of which £1 is refunded on return of Packing Case.)

CREDIT SALE: Deposit £12/6/- and 9 monthly payments of £4/10/8.

HIRE PURCHASE: Deposit £24/15/- and 12 monthly payments of £2/5/11.

## Home Constructors! YOU CAN BUILD A PORTABLE TAPE RECORDER OR INCORPORATE "TAPE" IN YOUR RADIOGRAM.

WE MAKE SPECIAL PRICES TO PURCHASERS OF TAPE EQUIPMENT (i.e. buyers of Deck and Amplifier together, etc.). SEND YOUR ENQUIRY TO US. H.P. and CREDIT SALE TERMS ARE AVAILABLE.

A COMPLETE KIT OF PARTS TO BUILD

The "fidelity" TAPE AMPLIFIER Model HF/TR2 including POWER SUPPLY UNIT FOR ONLY **£12.0.0.** (Plus 6/- carr. and ins.)

This amplifier has been expressly designed to meet the requirements of the enthusiasts for High Fidelity reproduction. It is based on a new design, completed by the Mullard Technicians and only really high grade components are incorporated, truly HIGH FIDELITY Recordings are obtainable whilst "Hi-Fi" reproduction is assured by use of a high quality Output Transformer by Gilson. It incorporates a "magic eye" Recording Level indicator, a two position equaliser for 3 1/2 in. and 7 1/2 in. speeds, and an effective Tone Control arrangement. Monitoring and Extension Speaker Socket are incorporated and in addition a position is provided to enable it to be used as an independent Amplifier for Gramophone Records or Radio Tuning Unit. Overall size: 11 in. x 6 in. x 6 in. high. Suitable for nearly all makes of Tape Decks. When ordering, please advise make of Deck in use. THE ASSEMBLY MANUAL, PRACTICAL DIAGRAMS, etc., are available for 2/9 or send S.A.E. brief details.

WE ALSO SUPPLY THE HF/TR2 ASSEMBLED AND READY FOR USE FOR £16.0.0. (Plus 6/- carr. & ins.) H.P. TERMS: Deposit £3 and 9 monthly payments of £1. CREDIT TERMS: Deposit £4 and 9 monthly payments of £1/9/4.



## THE NEW TRUVOX MkIV TAPE DECK

THIS IS UNDOUBTEDLY ONE OF THE BEST TAPE DECKS ON THE MARKET. WE HAVE A FEW ONLY AVAILABLE

PRICE **£27.6.0** (Plus 10/- carr. and ins.)

CREDIT TERMS: Deposit £8/17/- and 9 monthly payments of £2/10/-.

H.P. TERMS: Deposit £13/13/- and 12 monthly payments of £1/5/4.

SPECIFICATION—● 3 B.T.H. shaded pole motors with silent friction drive eliminating wow and flutter. ● Push button controls, electrically and mechanically interlocked (patented). ● Patented electric type push button controlled brake. ● Inching to assist editing; tape loading on the drop-in principal accommodation for reels of 7in. diameter. ● Tracking sense. To British and American standards. ● Playing times: Up to 3 hours with L.P. Tape or 2 hours with Standard Tapes. ● Two tracks side by side, with safety gap. ● Playing time indication by precision revolution counter or large visual type indicator plate, according to choice. ● Positive Azimuth adjustment of Record/Player Head. ● High Impedance Heads. ● The metal work is Gold Hammered finish. ● Overall size 14 1/2 in. x 12 1/2 in., from top of face of panel, overall depth 5 in.

THE MK. IV DECK CAN ALSO BE SUPPLIED INCORPORATING PRECISION REV. COUNTER for £30/9/- H.P. TERMS: Deposit £15/4/6 and 12 months of £1/8/3 CREDIT SALE: Deposit £7/12/3 and 9 months of £2/15/-.



## STERN'S "COMPACT 5" AMPLIFIERS



The "Compact 5-2"

EXPRESSLY DEVELOPED FOR VERY HIGH QUALITY REPRODUCTION OF GRAM. RECORDS AND PARTICULARLY SUITABLE FOR HIGH QUALITY REPRODUCTION OF THE F.M. TRANSMISSIONS.

A 2-stage high sensitivity amplifier having SEPARATE BASS and TREBLE CONTROLS and designed to give up to approx. 5 watts with very pleasing quality. PRICE £9/3/-.

The "Compact 5-3" A 3-stage version of the "5-2" model but in this case having an additional stage and incorporating negative feedback. PRICE £8/16/-.

POWER SUPPLY. Is obtainable from a small separate Unit which apart from supplying power to either Amplifier, also has additional supply available for a Radio Tuning Unit. PRICE (additional to above), £2/10/-.

## Stern's "fidelity" F.M. TUNING UNIT

A 5-Valve Tuner incorporating the latest Mullard Permeability Tuned Unit. Price assembled less Power Supply: **£14.10.0**

(Plus 7/6 carr. and ins.)

TERMS: (a) H.P. Deposit

£7/5/- and 9 monthly payments of 18/4;

(b) Credit Deposit £3/12/6 and 9 monthly payments of £1/6/7. Provides "Hi-Fi" reproduction with any make of Amplifier and many Radio Receivers. It incorporates:

- The latest Valve line-up—ECC85, 2 type EF85, EF91 and EM80. ● A "Magic Eye" Indicator. ● Power consumption is 1.7 amps at 6.3 volts and 25 ma/ at 250 volts.

## STERN'S "fidelity" COMBINED A.M. and F.M. TUNING UNIT

This is IDENTICAL to the Stern's F.M. Tuner illustrated above, but in addition incorporates the MEDIUM WAVE BAND and thereby also provides a selection of foreign stations. Price **£18.18.0.** (Plus 7/6 carr. and ins.)

TERMS:—(a) H.P. Deposit £9/9/- and 10 monthly payments of £1/1/-; (b) Credit Deposit £4/15/- and 9 monthly payments of £1/14/7. Send S.A.E. if further data required.



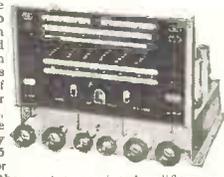
## THE ARMSTRONG MODEL AF105 AM/FM RADIOGRAM CHASSIS

Developed to meet the needs of those who require really high quality radio and record reproduction but who, for reasons of expense or lack of room in existing or proposed cabinets, cannot consider the normal high-fidelity system. The A.F.105 is as good as, or better than, all but the most expensive Amplifiers, and Associated units. Independent and continuously variable Bass and Treble controls give a wide range of control. SEND S.A.E. FOR DETAILS.

PRICE **£37** (Plus 7/6 Carr and Ins.)

CREDIT SALE TERMS: Deposit £9/5/- and 9 monthly payments of £3/7/10.

HIRE PURCHASE TERMS: Deposit £18/10/- and 12 monthly payments of £1/14/4.



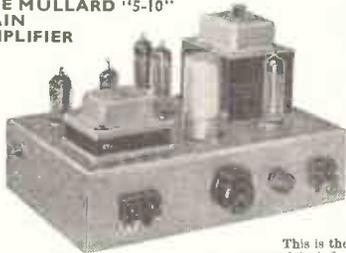
Open Monday to Friday 9 a.m.—6 p.m. Saturday 9 a.m.—1 p.m.

# STERN RADIO LIMITED

**AMPLIFIERS PRE-AMPLIFIERS HIGH FIDELITY FOR THE HOME CONSTRUCTOR TUNING UNITS RADIO RECEIVERS**  
**—COMPLETE KITS OF PARTS FOR THE "Hi-Fi" ENTHUSIAST—**

QUALITY OF THIS NATURE HAS NEVER BEFORE BEEN OFFERED AT SUCH LOW COST.

**THE MULLARD "5-10" MAIN AMPLIFIER**



This is the very latest design and needs no recommendation from us. Our Kit is complete to Mullard's specification, including the latest GILSON ULTRA LINEAR OUTPUT TRANSFORMER and the entire MULLARD Valve line up. ALL SPECIFIED COMPONENTS are supplied.  
**PRICE OF COMPLETE KIT OF PARTS £11/11/0** (Plus 5/- carr. and ins.).

THE full SPECIFICATION and BUILDING INSTRUCTIONS for these two Units are available for 1/6 each. THEY include COMPONENT PRICE LISTS and simple "wire-to-wire" PRACTICAL DIAGRAMS.

**STERN'S "fidelity" PRE-AMPLIFIER TONE CONTROL UNIT**

"A design for the music lover"



Briefly it has inputs for all types of MICROPHONES, HIGH and LOW GAIN PICK UPS and a RADIO TUNING UNIT. It incorporates (a) GRAM EQUALISING CONTROL, (b) STEEPCUT FILTER, (c) Continuously variable BASS and TREBLE CONTROLS and a variable OUTPUT CONTROL which enables its use with any type of Amplifier.

PRICE OF COMPLETE KIT OF PARTS **£6/6/0** WE ALSO OFFER IT ASSEMBLED READY FOR USE, **£8/-** (Plus 5/- carr. and ins.).

**A COMPLETE KIT OF PARTS, STERN'S "HIGH QUALITY" 8-10 WATT AMPLIFIER**



Has power supply available for Radio Tuning Unit. Price of COMPLETE KIT OF PARTS (plus 5/- carr. and ins.) **£7/10/0**

WE ALSO OFFER IT ASSEMBLED and READY FOR USE for **£9/10/0** (plus 5/- carr. and ins.).

This amplifier has proved one of the most popular models yet offered to the HOME CONSTRUCTOR. It provides really excellent reproduction up to 8 watts, employing 6V6's in push-pull and incorporating negative feedback. Provides for the use of both 3 and 15 ohm Speakers. The complete SPECIFICATION and BUILDING INSTRUCTIONS are available for 1/6. "Wire-to-Wire" Diagrams are included and all Components are available separately.

**SPECIAL PRICE REDUCTIONS . . . FOR PURCHASERS OF A COMPLETE "Hi-Fi" AMPLIFIER**

WE WILL SUPPLY (a) COMPLETE KIT OF PARTS to build THE MULLARD "5-10" MAIN AMPLIFIER and the STERN'S "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for **£16/16/-** or we will supply THE TWO UNITS MADE UP and READY FOR USE for **£19/19/-** Terms: Deposit **£9/19/6** and 12 monthly payments of **18/7**, or **£5** Deposit and 9 monthly payments of **£1/16/7**.

**"MODERNISE YOUR OLD RADIOGRAM" IT IS MUCH CHEAPER THIS WAY!!**

THE LATEST DESIGN OF COMBINED AM/FM REPLACEMENT RADIOGRAM CHASSIS and a NEW 4-SPEED RECORD PLAYER  
**STERN'S NEW "Fidelity" COMBINED AM/FM RADIOGRAM CHASSIS**      **THE NEW ARMSTRONG P.B.409 AM/FM RADIOGRAM CHASSIS**

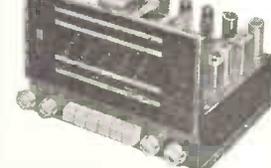
A genuinely hand-made chassis providing really high quality on both Radio and Gram.



**PRICE £26/15/0** (Plus 7/6 carr. and ins.).  
 TERMS: Credit Deposit **£8/14/-** and 9 monthly payments from **£2/9/-** H.P. Deposit **£13/7/6** and 12 monthly payments of **£1/4/10**.

BRIEFLY IT HAS—  
 An 8 valve line up incorporating the latest MULLARD preferred-type valves. ● Provides complete coverage of the VHF/FM waveband plus the SHORT, MEDIUM and LONG waves. ● Has EL84's in Push-Pull, with negative feedback of 6 watts output. ● Employs "Piano Key" Selector Switch and a Variable Tone Control. ● Contains Gram input socket for both Crystal and Magnetic Pick-ups ● Provides for use of either 3 or 15 ohm Speakers. ● Has "Magic Eye" Tuning Indicator. ● Dimensions 13in. x 9 1/2in. x 8in. high, Dial size 1 1/2in. x 5 1/2in.

A "de luxe" Chassis for those who want the highest possible quality



**PRICE £29/8/0** (Plus 7/6 carr. and ins.).  
 TERMS: Credit Deposit **£7/7/-** and 9 monthly payments of **£2/14/-** H.P. Dep. **£14/14/-** and 12 monthly payments of **£1/7/3**.

BRIEF SPECIFICATION—  
 A 9 valve line up employing the latest MULLARD preferred-type valves. ● Provides complete coverage of the VHF/FM Transmissions, plus the SHORT, MEDIUM and LONG waves. ● Has Push-Pull output, with negative feedback, for 6 watts Peak output. ● Quick action "Piano Key" Selectors and separate Bass and Treble Controls. ● Has "Magic Eye" Tuning Indicator. ● Two Gram Inputs are provided, one for Crystal Pick-ups and the other for Magnetic types. ● Dimensions 13in. x 9 1/2in. x 8in. high. Dial size 1 1/2in. x 5 1/2in.

**STERN'S "SUPER 31X" 6 Valve 3 Waveband Superhe:**



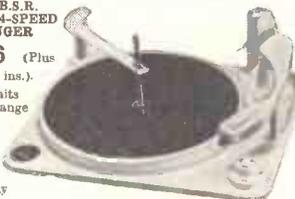
Provides good selection of stations and really good reproduction on both RADIC & GRAM  
**PRICE £14/0/0** (Plus 7/6 carriage and ins.)  
 CREDIT TERMS: Deposit **£3/10/-** and 9 monthly payments of **£1/5/8**. H.P. TERMS: Deposit **£7** and 10 monthly payments of **16/-**.  
 BRIEF SPECIFICATION  
 ● Delayed AVC on all wavebands  
 ● Preselection feedback  
 ● Modern valve line-up: 12A8S, 6BA6, 6AT6, two 6AQ5 and 5Z4 (or OCTAL VALVE equivalent)  
 ● Push-pull output gives approx. 6 watts  
 ● Connections on chassis for extension speaker, gram and mains supply to gram  
 ● Coverage 18-50 metres, 190-500 and 800-2,000  
 ● Overall size 11 x 7 1/2 x 8 1/2in. high, dial 8 1/2 x 4 1/2in.  
 ● A bronze dial escutcheon is available for 4/6.

SEND S.A.E. IF FURTHER INFORMATION IS REQUIRED ON THESE CHASSIS. . . . we recommend THE NEW COLLARO MODEL 456 4-speed Autochanger and if a LOUDSPEAKER is required (and SPEAKER if required), SEND S.A.E. FOR DETAILS.

**CASH ONLY OFFER!!**

**THE LATEST B.S.R. MONARCH 4-SPEED AUTOCHANGER**

**£7/19/6** (Plus 5/- carr. and ins.).  
 ● These units will autochange on all four speeds, 7in. and 12 in.



● They play MIXED 7in., 10in and 12in. records of same speed.  
 ● They have separate sapphires for L.P. and 78 r.p.m. which are moved into position by a single switch.  
 ● Minimum baseboard size required 14 x 19 1/2in. with height above 5 1/2in., and height below baseboard 2 1/2in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.



**RECORD PLAYERS THE VERY LATEST MODELS ARE OFFERED AT GREATLY REDUCED PRICES**

Send S.A.E. for ILLUSTRATED and DESCRIPTIVE LEAFLET which also contains details of:—  
 (a) A PORTABLE CASE to accommodate an Amplifier—Speaker and autochanger. **£3/17/6**  
 (b) A 2-STAGE GRAM AMPLIFIER having separate BASS and TREBLE CONTROLS. Suitable for use with all modern Record Players. **£4/0/0**

**WE HAVE THE FULL RANGE OF DULCI CHASSIS IN STOCK**

THE MODEL H.4 is illustrated but all Chassis and Tuners are similar—send S.A.E. for leaflets. H.P. and CREDIT SALE TERMS are available.

**RADIOGRAM CHASSIS**  
 These two Chassis are really well designed and reproduce most excellent quality on both Radio and Gram.  
 Model H.3—A 3 Waveband AM/FM chassis **£20/17/0**  
 Model H.4—A 4 Waveband AM/FM chassis **£24/6/6**

**TUNER UNIT CHASSIS**  
 The FM/VHF TUNER CHASSIS with self-contained Power Supply. **£17/10/3**

MODEL H4/T—A 4-Waveband AM/FM TUNER with self-contained Power Supply. **£20/17/0**  
 MODEL H.11—A combined 4-Waveband AM/FM Tuner incorporating a "Hi-Fi" Control Unit—Audio Pre-amplifier which has switching and connections for Tape Reply, Gram equalising, Bass and Treble Controls, etc. **£29/3/10**

**"Hi-Fi" AUDIO AMPLIFIERS**  
 MODEL G.A.4—A self-contained 4 watt Amplifier with adjustable Tone Control Box. **£9/9/0**  
 MODEL D.P.A.LO—A 10 watt Amplifier with separate Tone-Pre-amplifier Unit incorporating Bass and Treble Controls and Gram. equalising. **£19/19/0**

**109-115 FLEET ST., LONDON, E.C.4.**

Phone: FLEet Street 5812-3-4.

**FOR CALLERS ONLY** We have in stock various KITS OF PARTS including F.M. Tuners, AM/FM Tuners, Midget Battery Portable and Mains Units, etc. etc. We also have the most comprehensive stock of WIRELESS and ELECTRICAL COMPONENTS.

# LASKY'S RADIO

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

## AUTO-CHANGERS

Our stocks are constantly changing. See us for your requirements or send for our list of 3-speed and 4-speed Auto-changers, including RC80, RC88, etc., post free.



### COLLARO 4-SPEED AUTO-CHANGER

Latest model RC.456 incorporating auto and manual control enabling records to be played singly or automatically. Complete with Studio crystal pick-up and sapphire stylus. List £13.17.0  
**LASKY'S PRICE £9.15.0**

B.S.R. 4-speed with t.o. crystal pick-up. £8/15/-, post 5/-.

## SINGLE PLAYERS

Collaro 3/554 3-speed Single Player with Studio T p.u., crystal cartridge and stylus.  
**LASKY'S PRICE £6.19.6**

Collaro 4/456 4-speed Single Player £7/19/6. Carr. 3/6.

## CABINETS AND CASES

Large selection for TV sets, radiograms, record players, tape recorders, etc. At attractive prices. Your enquiries invited.

## BAND III CONVERTERS

Large stocks. We have just what you require. Call and select.  
**Prices from £3.16.6**

## REALLY SUPERB TV CABINETS



## LASKY'S F.M. TUNER

PRINTED CIRCUIT VERSION OF G.E.C. 912 F.M. TUNER FOR HOME CONSTRUCTION

- Note these star features:—
- ★ HIGH SENSITIVITY.
  - ★ T.C.C. PRINTED CIRCUIT.
  - ★ NEW T.C.C. CONDENSERS.
  - ★ AERIAL COIL AND R.F. COUPLING COIL PRINTED ON CIRCUIT.
  - ★ 5 VALVES AND 2 GERMANIUM DIODES.
- By the use of a printed circuit the I.F. and R.F. amplifiers are extremely stable at maximum gain and results are consistent on all tuners. Valve line-up:—
- R.F. Amplifier, Z719 or EF80.  
 Mixer and Osc., B719 or ECC85.  
 1st I.F. amp., W719 or EF85.  
 2nd I.F. amp., W719 or EF85.  
 2 Germanium Diodes GEX34.  
 Driver Limiter, Z719 or EF80.

CAN BE BUILT FOR **8 Gns.** (including valves)

G.E.C. F.M. Tuner Book plus our full data and shopping list 2/6 post free. All parts available separately.

### LASKY'S PORTABLE GRAM AMPLIFIER

4 watt. Will suit any type of crystal or magnetic pick-up. Uses 3 valves.—EL84 output, L63 and EZ80 rect., 7×4in. elliptical speaker. Speaker and controls are separate and can be mounted in cabinet where most suitable. COMPLETE with 3 valves, knobs and speaker, ready for use. Carr. 5/-.  
**£5.9.6**

Details and circuit diagram on request.

### LASKY'S PORTABLE GRAM AMPLIFIER KIT

For construction on printed circuit. 2 watts. Note small size:— approx. 6½×3½in. Maximum height 5in. Uses EL84 output and 6X4 rectifier, double-wound trans., tone control, output trans., and 7×4in. elliptical speaker. COMPLETE KIT including valves, T.C.C. printed circuit, speaker and full instructions.  
**77/6**

## ALMOST HALF PRICE

Dimensions: 36in. high, 19in. deep, max. width 26in. Constructed of finest laminated wood with straight grain walnut veneer, inlaid maple. Fitted two full-length doors. Has cut-out for 21in. projection TV but can easily be adapted for any size c.r. tube. Also can be adapted to house hi-fi equipment or a radiogram. A really handsome cabinet which cost £20 to manufacture.

**LASKY'S PRICE £10.19.6**

Carr. 21/- extra.

Strictly limited number, unrepeatable once sold

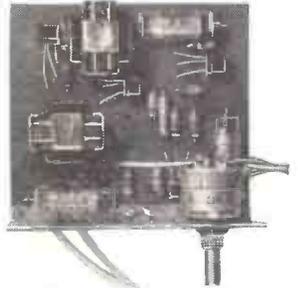
## NEW MINIATURE 200 milliwatt TRANSISTOR AMPLIFIER KIT

for construction on a Printed Circuit

Size: 3½×3½in. Height can be under 1in. Uses our new hermetically sealed Transistors and operates from 6-volt battery. Output impedance 3 ohms.

FULL DETAILS, CIRCUIT DIAGRAM AND SHOPPING LIST 1/- post free.

COMPLETE KIT including 4 Transistors, all brand new components, latest T.C.C. miniature condensers, printed circuit and full instructions. **86/6** Post 2/-.



DEMONSTRATIONS AT EITHER OF OUR ADDRESSES

All components available separately.



## TRANSISTORS AT A REASONABLE PRICE

R.F. P.N.P. Junction type, suitable for medium and low frequency oscillators, frequency changers and I.F. amplifiers 1.5 to 8 Mc s.  
 (double spot—yellow and red) **21/-**

AUDIO P.N.P. Junction Type, suitable for high gain and low frequency amplifiers, and for output stages up to 250 milliwatts.  
 (double spot—yellow and green). **10/-**

SPECIAL PRICES FOR 6 AND OVER

- ★ TESTED AND GUARANTEED EFFICIENT
- ★ HERMETICALLY SEALED and unaffected by temperature variations.

Full operating data and circuit diagrams for a simple receiver superhet, T.R.F. multi-vibrator, relaxation oscillator, audio amplifier, oscillators, signal tracers, etc., supplied with each Transistor.

MULLARD TRANSISTORS		
OC70 21/-	OC71 24/-	OC72 30/-

BRIMAR TRANSISTORS		
TS1 15/-	TS2 21/-	TS3 24/-
TP1 or TP2 40/-		TJ3 40/-
TJ1 30/-	TJ2 35/-	

**BAND I-III CONVERTERS**  
 Covering Channels 8-4 or 1-9. Complete with valves and power supplies. **£5/17/6**.  
 See our advt. in June issue.

**20,000 VALVES IN STOCK**  
 Brand new surplus and imported valves, also full stock B.V.A. valves and C.R. Tubes. List Post Free.

## NEW BRENELL MARK IV DECK

Now available! Entirely redesigned to permit of conversion to stereophonic sound with 4 heads for dual channel operation when required.



DECK only ..... **22 gns.**  
**DECK WITH PRE-AMP. UNIT** and magic eye indicator ready for use with any standard amplifier **38½ gns.**  
**COMPLETE MARK IV TAPE RECORDER**, as illustrated **53 gns.**

Come and inspect the new Brenell Mark IV and have a demonstration. Full details post free on request.

## TAPE DECKS

Collaro "Tape Transcriber," Mk. III, **£22.**  
 Truvox Deck, Mk. III, **23 gns.**  
 Truvox Deck, Mk. IV. **£27/6/0.**  
 Lane Deck, **£18/10/-.**  
 Wearite Decks, **£35** and **£40.**

## TAPE RECORDERS

Leading makes — Elizabethan, Truvox, Sound, Vortexion, etc. All leading makes of Recording Tape in stock. Also all types of Spools.

## TRUVOX 'SENIOR' SPEAKER DRIVING UNIT (pressure type)

Power handling cap. 15 watts peak. With 12ft. cinema horn reproduces down to 17 cps.  
 List **£7/15/-.** Carr. 5/-.  
**LASKY'S PRICE 59/6**

**MAGNETIC RECORDING TAPE**, kraft base, on Oyldon metal spool, 1,200ft. 10/6. 600ft. 7/9. Post 1/-.

**PURETONE** Tape on plastic spool, 1,200ft. 12/11. Post 1/-.  
 All makes of tape stocked.

**RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS**

**LASKY'S RADIO**

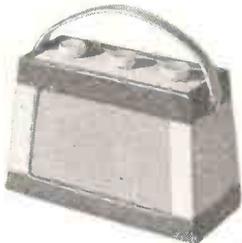
**JASON F.M. TUNER**  
Special parcel containing data book, chassis, front panel, dial, drive, tuning condenser, full sets of coils, I.F.'s ratio detector, etc. Post 2/6.  
**DATA BOOK** with price list 2/-. Note: This tuner uses 4-6AM6 and 2 crystals and can be built for £6/15/-, plus 3/6 post.

**JASON "ARGONAUT"**  
Super-sensitive Tuner for F.M. and medium waves. Complete parcel with power supplies. Post 3/6.  
**£13.19.6**

**DATA BOOK** 2/- post free.  
Chassis Assembly 57/9 post 2/6.  
I.F. and Coil Set 78/- post 1/6.  
All components available separately

**OTHER F.M. TUNERS**  
TSL F.M. TUNER..... £17/10/-  
DULCI F.M. TUNER £17/10/-  
DULCI AM/FM TUNER £20/17/-

**LASKY'S BATTERY PORTABLE FOR HOME CONSTRUCTION ON PRINTED CIRCUIT**



Can be built complete with valves and case for only

**£7.7.0**

Post 3/6 extra.

Combines simplicity of construction with high quality performance. In particular, the **PRINTED CIRCUIT** greatly simplifies construction and eliminates the possibility of wiring errors. Build it NOW ready for your holidays!

**10 STAR FEATURES**

- ★ PRINTED CIRCUIT, size 7½ x 2½in.
- ★ 4-valve Superhet, med. and long waves.
- ★ Low consumption Valves, Double Battery Life.
- ★ Ferrite Rod Internal Aerial.
- ★ 5in. P.M. Moving Coil Speaker.
- ★ Brand New T.C.C. Capacitors.
- ★ Automatic Volume Control.
- ★ New Style Contemporary Case.
- ★ Lightweight and Handsome Appearance.
- ★ Every Component available separately.

**DEMONSTRATION MODELS AT BOTH OUR ADDRESSES**

CIRCUIT DIAGRAM, data, instructions, and shopping list, 1/6 post free.

POWER UNIT for above, also suitable for other battery portables. For 200-250 v. A.C. mains. Complete Kit including printed circuit, 45/-.

**LASKY'S RADIO CONSTRUCTOR PARCELS**



**PARCEL No. 1**  
Contains everything to build a 4-valve 3-wave superhet for 200/250 A.C. mains. Uses 6K8, 6K7, 6Q7, 6V6 valves. Attractive wood cabinet, walnut veneer, or plastic cabinet as illustrated. Size 12x6½x4½in. deep. **CAN BE BUILT FOR £7.19.6**  
Carr. and packing 2/6.

**PARCEL No. 2**  
Contains everything to build a T.R.F. 3-valve set for 200/250 A.C. mains, medium and long waves. Uses 6K7G, 6U7, 6V8 and metal rectifiers. Neat plastic cabinet, walnut or ivory finish, or wood cabinet. Size 12x6½x4½in. deep.  
**CAN BE BUILT FOR £5.10.0**  
Carr. and packing 2/6.

**INSTRUCTION BOOK** for either above sets 1/- post free.  
**CABINETS ONLY**, plastic or wood, 17/6. Post 2/6.  
All components available separately.

**5-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES**

3-wave superhet, 16-50 m. 200-250 m. 1,000-2,000 m. Brand new Mullard and Mazda valves—6C9, 6F15, 6LD20, N108, U107. Overall dim. 13in. long, 6in. deep, 7in. high approx. for A.C. mains 200/250 v.  
**LASKY'S PRICE, £7.19.6**  
complete with all valves.  
Carr. & Pkg. 7/6 extra.  
Price without valves, £5/4/-.

**MOVING COIL P.M. SPEAKERS**

2½in. 3in. and 3½in. .... 19/6  
5in. 19/6. 6½in. 17/6. 8in. 21/-  
10in. 29/6. 12in. 29/6.  
6½in. with transformer ..... 21/-  
7x4in. Elliptical ..... 19/6  
10x6in. Elliptical ..... 32/6

**FEW ONLY 17IN. C.R. TUBES**

Type C17FM, rectangular, alum. inised, 0.3 heater. **£14.19.6**  
Brand new and unused. Carr. and Insur. 22/6.

**HI-FI ELECTROSTATIC SPEAKERS ("TWEETERS")**

Easy to fit to any radio, TV receiver or amplifier. Full data and circuit diagram supplied.  
LSH75. For outputs up to 6 watts, 8/-.  
LSH518. For outputs of 10-12 watts, 12/6.  
LSH100. For outputs up to 20 watts, 14/-.  
LPH65. MOVING COIL TWEETER. Imp. 5.5 ohms, freq. range 2,000-2,200 50 c/s. For outputs up to 6 watts. 2½in. diameter, 39/6. All post free.

**HI-FI EQUIPMENT**

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**SELECTIVE DEMONSTRATIONS OF ALL HI-FI EQUIPMENT AT OUR TOTTENHAM COURT ROAD BRANCH.**

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Write stating your requirements.

**MAKERS' SURPLUS TV COMPONENT BARGAINS**

- WIDE ANGLE 38 mm.**
- Line E.H.T. trans., ferrox-cube core, 9-16kV. .... 25/-
  - Scanning Coils, low imp. line and frame ..... 25/-
  - Ferrox-cube cored Scanning Coils and Line Output Trans., 10-15 kV. EHT winding. Line Trans. Complete with circuit diagram, the pair ..... 50/-
  - Frame Output Transformer ..... 6/6
  - Scanning Coils, low imp. line and frame ..... 17/6
  - Frame or line blocking osc. transformer ..... 4/6
  - Focus Magnets Ferrox-dure ..... 19/6
  - P.M. Focus Magnets, Iron Cored ..... 19/6
  - Duomag Focallisers ..... 22/6
  - 300 m/a. Smoothing Chokes ..... 15/-
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- STANDARD 35 mm.**
- Line Output Transformers 6.9 kV. E.H.T. and 6.3 v. winding. Ferrox-cube winding. .... 19/6
  - Scanning coils. Low imp. line and frame ..... 12/6
  - Idto by Igranic ..... 14/6
  - Frame or line blocking oscillator transformer ..... 4/6
  - Frame output transformer ..... 7/6
  - Focus Magnets. Without Vernier ..... 12/6
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**COMING SOON! LASKY'S FULLY TRANSISTORISED PORTABLE FOR HOME CONSTRUCTION**

- Note these Star features.
- ★ Unit construction on Printed Circuit
  - ★ 200 milliwatts push-pull output
  - ★ Uses 7 Transistors and 1 germanium diode
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  - ★ Fully tunable
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  - ★ Choice of 7 x 4 elliptical or 3½in. P.M. Speaker
  - ★ Choice of cabinet
  - ★ Most important — a keen price!
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**ALL-DRY POWER UNITS**  
By Decca. Suitable for any battery radio using IR5 IT4 etc., 67½ volts H.T., 1½ volts L.T. Mains input 200-250 adjustable. In metal chassis with rubber feet and black plastic cover. Size: 7 x 5 x 1½in. Mains lead and on/off switch. Complete with two metal rectifiers, ready for use. List £14/15/-.  
**LASKY'S PRICE 35/-**  
Post 3/6  
If too large to fit into your portable, stand it on or by it.

**MAINS TRANSFORMERS**  
All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.  
MBA/3. 350-350 v. 80 m.A. 6.3 v. 4 a. 5 v. 2 a. Both filaments tapped at 4 volts. 19/6  
MBA/7. 250-0-250 v. 80 m.A. 6.3 v. 3 a. 5 v. 2 a. Both filaments tapped at 4 volts. 19/6  
AT/3. Auto trans. 0-10-120. 200-230-240 v. 100 watts ..... 19/6  
MT/340. Tapped input 200-250 v. 300-0-300, 100 m.A. 5 v. 3 amp., 6.3 v. 1.5 amp. 18/6  
MT/341. Tapped input 250-0-250, 120 m.A. 6.3 v. 5 amps., fully shrouded ..... 27/6

**FILAMENT TRANSFORMERS**  
All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.  
6.3 v. 1.5 amp. .... 5/11  
6.3 v. 3 amp. .... 9/6  
6.3 v. 1 amp. .... 4/6  
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**GERMANIUM CRYSTAL DIODES**  
GEX.00 1/6. GEX.34 3/6. W05 3/6. GEX.04 and QA74 5/-. GD3 3/6, GD4 3/6. CC12E 5/-.

**FERRITE ROD AERIALS**  
Med. and long waves, wound ready for use. Each 6/9, post 1/-.

**FERRITE ROD**  
6in. long, ½in. diam., with full instructions for making a Ferrite rod aerial 2/6, post 1/-.

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**SPEAKER COVERINGS.** Large stock of Tegan and "Some-weave" Speaker Coverings. Any size piece cut. Send for sample and prices.

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Few only left. Let us have your enquiry. Prices from £4/19/6.

**NEW AND PERFECT 16" METAL CONE G.R.T.**  
Type T901. Note: Not "seconds" but perfect tubes in original cartons. Gives large 11 x 14½ in. picture. Guaranteed by us for 3 months. See our previous adverts in "W. World" or send for details.  
Carr. and Insur. 22/6 extra.  
Masks, Anti-Corona, Bases and Ion Traps available.

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## ARR 2 RECEIVERS

Covering 235 to 358 Mc/s. Containing 3 6AK5's, 7 9001s, 1 12A6. Good condition. Price 25/-, plus 3/- post and packing. Circuit supplied. Size: 10 1/2 in. x 4 1/2 in. x 5 1/2 in., black crackle finish.

## STUD SWITCHES

20 segment 5/16 in. studs, base 5 in. square with handle and housing. New and boxed, 5/- each, plus 1/6 p.p.



## BEACON RECEIVER BC1206A

Covering 200-400 kc/s. Valve line-up: 6K7 RF; 6SA7 frequency changer; 6SK7 I.F. amplifier; 6SQ7 det; 28D7 O/P.

This was designed to run on 24/28 v. D.C. HT/LT. Excellent basis for car radio; size 6 x 5 x 4 in. Good working order. £3/5/- each, plus 5/- carr.

## DESYNN TYPE Antenna or Beam position indication system

This comprises a transmitter unit and Indicator which will operate on 12 or 24 volts D.C. and will indicate with instantaneous and smooth pointer movement. The Transmitter is a specially designed potentiometer and will operate the Receiver on a simple three-wire system and the receiver in this instance is calibrated in Gallons but dial could be easily altered to indicate a 360 deg. sweep. Transmitter and Receiver with full instructions. Price 12/6, plus 2/- p.p.

## GYRO UNIT AND INVERTER

Inverter: 12 volt D.C. input, 3 phase 190 cycle output. (These inverters can be used successfully as 12 v. D.C. Motors for Models.)

Gyro Unit: operates on 3 phase output from Inverter. Peak speed 11,400 r.p.m. Caged. Precision made equipment. These units are ideal for experimenting and demonstration purposes. Size: Inverter 4 x 3 x 3 in.; Gyro 4 in. dia. incl. cage. Price 12/6 per pair, plus 3/- p.p.

## RADIO ALTIMETER

5 mA. panel mounting meter, 3 in. dia., 8 in. circular scale. Large magnet. Scale easily removable, leaving finished faceplate for recalibration. Basis for sensitive portable multimeter. Brand new. Boxed. 7/6 post free.



## BATTERY INTERCOM-AMPLIFIER

Type A1368 A.M. REF. 10U/13025. Using 1 VR35 and 1 VR21. Power Req. 120 v. H.T. 2 v. L.T. Size 7 in. x 4 1/2 in. x 4 in. Fully valved, in good condition, £1 each, post paid.

## COMMUNICATIONS RECEIVER CG.46116

(General Electric U.S.A.). Highly sensitive receiver 1500 to 9000 kc/s. (200-232 metres) continuous coverage with overlaps in 4 channels. 3 I.F. stages, 2 R.F. stages and I.F. break-through trap. B.F.O. and O/P. Valve line up: 5 12SK7s, 12K8, 12SR7, 12A6. Neon static in antenna circuit. Fully valved £8/10/-, plus 10/- pack. and carr.

## VALVES

	s.	d.		s.	d.		s.	d.
6SH7	3	3	12SC7	6	0	6G6	3	0
3A5	5	6	OZ4	5	0	6SN7	6	6
6V6M	8	6	6AC7	6	0	954	1	9
VR56	5	0	VR54	2	0	12Y4	1	0
VT501	2	6	6H6	2	0	VR91	5	0
12H6	2	0	12SH7	2	9	(EF50)		
6L7	5	6	VT52	2	6	VR136	5	0
12A6	5	0	6J6	3	6			

On orders up to 4 please allow 3d. postage on each. On quantities of 5 or over 1/- up to 12.

## B.C. 610 TUNING UNITS

2.2. 5 Mc/s. 10/- post paid.

## BENDIX INVERTER

Type 12123-1-A. 24 volt D.C. input. 115 volt 3 phase 400 cycle .5 amp. Size: 9 in. long, 4 in. dia., 6 in. high including connector box and voltage regulator. Price £4 each, plus 5/- p.p.

## RECEIVER UNIT Ex 1143A

10.72 Mc/s. I.F.s. Frequency 100-120 Mc/s., suitable for conversion to 2 metres and Wrotham.

Owing to a large purchase we can offer these units fully valved, with circuit diagram at 25/- each, plus 3/- post/pack. Valve line-up: (4) EF50, (1) EL32, (2) EF39, (1) EBC33, (1) EA50.



## VIBRATOR PACK

12 volt, fully smoothed 150 volt 80 mA. output. 2-50 volt bias packs. Screened lead and clips for battery; completely enclosed in black crackle metal box measuring 6 in. x 7 in. x 4 in. Price 25/-.



## AN/APN.1 TRANSDUCER

This Unit consists of Magnet and Coil which is attached to an aluminium diaphragm suspended freely and perforated to prevent air damping. Mounted on a Ceramic cover which sits over the diaphragm is a form of 2-gang capacitor which has a swing from 10-50 pF.

The above unit is used as part of Wobblulator described on page 252 of the June 1956 "Wireless World." Price 7/6 p.p.

## MORSE KEYS No. 2

Mk. 3, 8 amp. ZA.16929. New and boxed. Size 3 1/2 in. x 1 1/2 in. Price 2/6 post paid.

## TOGGLE SWITCHES

Double pole on-off 230 v. 6 amp. Panel fitting. Size: 2 in. x 3/4 in. x 1/4 in. depth behind panel REF 64/14. Price 2/6 each, post paid. New in packets.

## CO-AXIAL CHANGE-OVER RELAY

Type 77A. Size: 2 in. x 4 in. x 5 1/2 in. Price 15/- post paid.

## NICKEL IRON CELLS

1.2 volt size 3 1/2 in. x 2 1/2 in. x 1 in., unfilled 5/- each, plus 1/- p.p.



## R.F. UNITS

R.F.24 20-30 Mc/s. Switched Tuning. Valved ..... 9/6 each  
 R.F. 25 40-50 Mc/s. Switched Tuning. Valved ..... 9/6 each  
 R.F.26 50-65 Mc/s. Variable Tuning. Valved. Damaged dials ... 20/- each  
 Perfect dials ..... 25/- each  
 Packing and postage 3/- each type.

## BLOCK CONDENSERS

10 mfd. 500 v. wkg. Size: 3 in. x 4 1/2 in. x 2 1/2 in. Base mounting. 7/- post paid.

## CARBON HAND MICROPHONE

Type 4 with lead. New and boxed, 7/6 each plus 1/- post.

## SLIDE RULES

10 in. carrying A, B, C, D, and Log-Log scales on face, with centimetre and inch scales on edges. Price 9/-, post paid, with instruction booklet.

## INVERTERS

Miniature 3-phase (ex-compass unit) 24 v. input with 17 v. 3-phase-400 c/s. output. These have been used by model makers as motors and are known as the "5/- Motor." Will run quite successfully on 12 volts. 5/- plus 2/- p.p.

## BOOST GAUGES

2 in. dia.; suitable after minor adjustment as car induction manifold meter, 2/6 p.p.

All offers on display at **PROOPS** BROS. LTD.

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*The Walk-around Shop***MAINS CHANGING TRANSFORMER**

(Admiralty Pattern) 230/100-110-130 v. Separate primary and secondary with earthed screen winding between. Totally enclosed in 7in. x 6in. x 8in. black steel case with detachable lid exposing terminal block and tapping link. Secondary very conservatively rated at 0.44 amps. (core size 3 sq. in.). Tested to 2,000 v. Weight 19 lb. Price £1 each, packing and postage.

**TRANSFORMERS****HEAT TRANSFORMERS**

6.3 volt, 1½ amps.; brand new, 6/6, plus 1/- p.p.

**SMALL MAINS TRANSFORMERS**

Input 230 v. 50 cycles, output 250 v. 40 mA., 6.3 v. 1.5 a. Size 3.9in. x 2.4in. x 2in. Ideal for TV converters. Price 12/6 each, plus 1/- p.p.

**CHARGER TRANSFORMERS**

For 6 or 12 volt; 230 volt 50 cycles input, 9 and 17 volt 3 amp. output. Price 15/6 each, plus 1/- p.p.

**'S' BAND PRECISION WAVEMETER**

2,900 to 3,150 Mc/s. TEST SET 288 A.M. Ref. 10SB/6161.

Comprising exceptionally rugged silver-plated Wavemeter Type 1665, resiliently mounted and directly tuned by 1½in. dia. calibrated micrometer with 6½in. thimble scale. Temperature correction for micrometer attached. Resonance indicated on 100 microamp meter. Equally suitable for laboratory using milliwatt power or, with loose coupling, for high powers. UR21 connecting cable and coupling probe supplied. Brand new in robust moisture-proof case with jacking-off screws and tool. Price £15, plus £1 packing and carriage.

**REMOTE CONTACTOR**

Type 4.24 volt. Solenoid Ratchet action giving 120 pulses to 1 complete rotation of indicator arm. Contacts are cam operated and in its present state make for 270 degrees and open for 90 degrees. These could be altered to suit any sequence in the 360 degree sweep by changing cam. On and off switch and dial is re-settable. In metal case 4in. dia. x 2in. deep. New and boxed, 6/- each, post paid.

**DYNAMOTOR**

(U.S.A. Manufacture) 28 volts input, 330 volts 170 mA. output. 3½in. dia. x 6in. long, mounted on base containing smoothing choke, condenser, etc.; black crackle finish. New and boxed. Price 17/6, post paid.

**I.F. AMPLIFIER UNIT**

460 kc/s. with IT4. Brand new and boxed. Fully screened in plug-in box. Size 2½in. x 1in. x 4½in. Price, with circuit, 10/- each, plus 1/- p.p.

**BENDIX INVERTER**

Type 12123-1-A. 24 volt D.C. input. 115 volt 3 phase 400 cycle 5 amp. Size: 9in. long, 4in. dia., 6in. high including connector box and voltage regulator. Price £4 each, plus 5/- p.p.

**RELAYS**

Sensitive Single Pole changeover 2,000 ohm Coil. 10 volt D.C. Mounted on insulated base 2½ x 2½ x ½in. American manufacture. New and boxed. Price 12/6, p.p.  
4 Pole changeover. Miniature Relay 200 coil. 24-27 volt D.C. Size 1½ x 1½ x 1½in. American manufacture. Price 7/6, p.p.

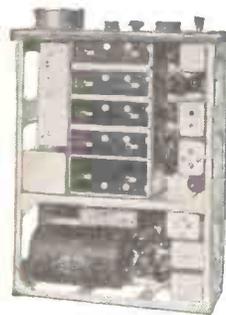
**RECEIVER M.N. 26C****BENDIX COMMUNICATIONS**

A superb 12 valve receiver covering 150-1500 kc/s in 3 bands 150-325, 325-695, 695-1500 kc/s. I.F. frequency 112.6 kc/s. Valve line up: 6K7 1st and 2nd R.F. Amplifier. 6B8 1st and 2nd Det and A.V.C. 6J5 B.F.O. 6F6 Audio Output. Also Radio Compass output stage; 6N7 Compass Modulator. 6N7 Audio Oscillator. 6K7 Loop Amplifier. 6K7 Compass Output.

Power Supply 28 volt D.C. 1.6 amps to internal Motor Generator, which can be easily changed for 12 volt Generator as unit was designed for both supplies.

(Details available). THE PERFECT CAR RADIO size 15½in. x 11½in. x 6in. For A.C. mains operation, supply required: 6.3 v. and 230 v. 100 mA. Circuit diagram and connection chart free with each unit. Price £32/10/- plus 10/- carriage.

12 v. DYNAMOTORS available (U.S.A.) at 30/- each.

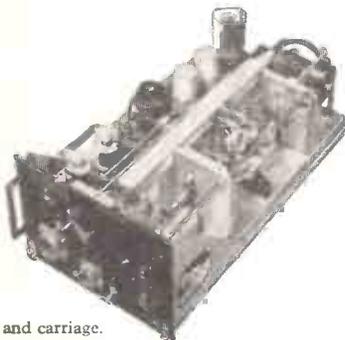
**BENDIX RADIO COMPASS**

Azimuth indicator, for use with D.F. loop on manual operation. Flexible cable entries on both sides of unit. Dial face calibrated in degrees and adjustable for corrections. Small dial lamps are fitted for night use and unit is supplied with plug for input. Size 6in. dia. 2½in. deep. Grey crackle finish. Brand new and boxed. Price 15/-, plus 2/6 p.p.

**A.P.Q.9 RADAR JAMMING UNIT**

Containing 913A Photo Multiplier Cell, complete with resistance network and lightproof box. Wide band amplifier (2) 6AC7 and 6AG7, driving a pair of parallel 807s which Grid modulate a pair of 8012s in push pull. Lecher lines, these cooled by blower motor. Cathode loaded by co-axial stubs which simultaneously guillotine tune anode and grid lines with a counter mechanism. Output is matched to aerial by a matching stub. Suitable for use in centimetric bands. Brand new.

Price £5, plus 10/- packing and carriage.

**AVAILABLE FROM STOCK**

T.S./184, Echo box, 400-430 Mc/s. New, £5/10/-.

Details available for conversion to 420/430 mc/s wavemeter.

T.S./61AP "S" band cavity. New, £15/10/-.

T.S./70AP. As new, £25.

T.S./92A.P. New, £20.

T.85/APT.5 "L" Band New, £20.

Carriage Paid U.K.

**ABSORPTION WAVEMETER**

Easily converted to 2 metres or 70 cm. In Copper-plated metal case 3½ x 4½ x 5½in. with dial calibrated 0-100 and 80 v. Neon tube. Coverage approx. 190-210 Mc/s. New 6/6 each, post paid.



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## TRAWLER BAND R1155s.

The latest version of this famous Communications Receiver to be released by the Air Ministry. Covers 5 wave ranges: 18 5-7.5 Mc/s., 7.5-3.0 Mc/s., 3.0-1.5 Mc/s., 1.5 Mc/s.-600 kc/s., 500-200 kc/s. As used by Coastal Command, Air-Sea Rescue Launches, etc. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Have had slight use, but are in excellent condition. ONLY £12/19/6.

**A.C. MAINS POWER PACK OUTPUT STAGE**, in black metal case, enabling the receiver to be operated immediately, by just plugging in without any modification. Can be supplied as follows: WITH built-in 6 $\frac{1}{2}$ in. P.M. speaker, £5/5/-, LESS speaker, £4/10/- With 8in. P.M. speaker, £6/10/- DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver.

Add carriage; 10/6 for Receiver, 5/- for Power Unit

**R1155 SUPER SLOW-MOTION TUNING ASSEMBLY.** As used on all late model 1155s. Easily fitted to "A" sets, etc. ONLY 12/6.

**RF UNITS TYPE 26.** For use with the R.1355 or any receiver with a 6.3 v. supply. This is the variable tuning unit which uses 2 valves EF54 and I of EC52. Covers 65-50 Mc/s. (5.6 metres). Complete with valves, and BRAND NEW IN MAKER'S CARTONS. ONLY 25/- each. BRAND NEW Type RF 24, 5 positions covering 15-30 Mc/s., ONLY 7/6 (postage 2/6).

**MARCONI BAND III CRYSTAL CALIBRATORS.** Frequency range 170-240 Mc/s. Incorporates 5 Mc/s crystal for better than .001 per cent. accuracy. Directly calibrated dial, internal A.C. mains pack. Complete with spare set of valves and instruction manual in maker's transit cases. BRAND NEW. ONLY £4/19/6.

**CLASS D WAVEMETER.** Another purchase of this famous crystal-controlled wavemeter which has been repeatedly reviewed and recommended in the "R.S.G.B." Bulletin as being suitable for amateur transmitters. Covers 1.9-8.0 Mc/s., and is complete with 100/1,000 kc/s. crystal, 2 valves ECH35, two 6-volt vibrators and instruction manual. Designed for 6 v. D.C. operation, but simple mod. data for A.C. supplied. BRAND NEW IN MAKER'S TRANSIT CASES. ONLY £5/19/6. Transformer for A.C. modification, 7/6.

**A.C./D.C. BLOWERS.** 220/250 volts, 300 watts. 1 $\frac{1}{2}$ in. diam. outlet. Complete with filter pads. BRAND NEW. ONLY £4/19/6.

**INSULATION TESTERS (MEGGERS).** Read up to 20 megohms at 500 volts pressure. Overhauled, and in perfect order. With leather carrying case. ONLY £9/19/6, OR less case £8/10/-.

**POWER UNIT TYPE 3.** Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 mA. and 6.3 v. 4 amps. Fitted with H.T. current meter, and voltmeter. For normal rack mounting and has grey front panel size 19in. x 7in. ONLY 70/- (carriage, etc., 7/6).

**EHT TRANSFORMERS.** 5.5 kV. (Rect.) with 2 v. 1 a., 79/6. 7 kV. (Rect.) with 2 v. 1 a., 89/6. 2.5 kV. (Rect.) with 2-02 v. 1.1 a., 2-02 v. 2 a. (for VCR 97 tube, etc.), 42/6 (postage 2/- per trans.).

**6 v. VIBRATOR PACKS.** Output approx. 130 v. at 30 mA., fully filtered and smoothed. Complete. ONLY 12/6.

**MARCONI SIGNAL GENERATOR TF144G.** Frequency coverage 85 kc/s. to 25 Mc/s., and known as a Laboratory Standard. For normal A.C. mains, and complete with all leads. Reconditioned AS NEW. ONLY £75.

**AMERICAN COMMAND RECEIVERS.** A few still available. Top band model (1.5-3.0 Mc/s.). Used, good condition, 65/-, OR BRAND NEW IN CARTONS, 75/- BC453 Model, the famous "Q Fiver" (190-550 kc/s.). Used, good condition, 59/6.

**MARCONI SIGNAL GENERATORS TF-390G.** Frequency coverage 16-150 Mc/s. BRAND NEW IN MAKER'S ORIGINAL TRANSIT CASES, with instruction manual. For normal A.C. mains operation. A unique opportunity to acquire Laboratory Equipment at a fraction of original cost. ONLY £27/10/-.

**AVO ALL WAVE OSCILLATORS.** A few only of these famous Signal Generators in first-class order. Covers 95 kc/s. 80 Mc/s., and has large directly calibrated dial. For normal A.C. mains use. ONLY £8/10/-.

**L.T. HEAVY DUTY TRANSFORMERS.** Ex-Admiralty, with 230 v. 50 cycles primary. 1. Secondaries 5, 10, 15, 20, 25, 30 volts at 5 amps. ONLY 29/6. 2. Secondaries 7, 14, 21, 28 volts at 12 amps. ONLY 42/6. (Postage on either 2/9).

**12-WAY SCREENED CABLE.** In 10ft. lengths, fitted with plugs, originally made for use with the 19 Set. UNUSED. ONLY 17/6 per lead.

**POCKET VOLTMETERS.** Not ex-Govt. Read 0-15 v. and 0-300 v. A.C. or D.C. BRAND NEW AND UNUSED. ONLY 18/6.

**WALKIE TALKIE TYPE 18.** Covers 6.0-9.0 Mc/s. Transmitting and receiving units in metal case, complete with valves. In excellent condition. ONLY 79/6.

**CRYSTALS.** British Standard 2-pin 500 kc/s 15/- Miniature 200 kc/s and 465 kc/s. 10/- each.

**AMERICAN 14 v. DYNAMOTORS.** Output 225 v. 60 mA. Ideal for car radio or running electric shaver from car battery. ONLY 45/-, CHOKES. 10H 60 mA., 4/-; 5H 200 mA., 7/6.

Cash with order please, and print name and address clearly

PLEASE ADD POSTAGE OR CARRIAGE COSTS ON ALL ITEMS

**U.E.I. CORPORATION** Radio Corner, 138 Gray's Inn Road, London, W.G.1. Phone: TERMINUS 7937

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## EDDY'S (Nottm.) LTD.

(DEPT. W.W.)

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### THIS MONTH'S SPECIAL OFFERS

**CAR RADIO AERIALS 26/11.** Postage 1/6 each. Brand new, best quality chrome. Please state side or wing fitting. Co-ax. lead with terminals for above 6/- extra.

**MU-METAL SCREENING CANS** for mike transformers 5/6 each. 6d. extra post.

**RECORDING TAPE.** 1,200ft. reels. Good quality. 9/11 each. Postage 1/- each.

Any parcel insured against damage in transit 6d. EXTRA.	NEW & VALVES		Postage and Packing 6d. per valve extra. OVER £2 free.		
	GUARANTEED	NEW & VALVES			
AZ1	12/11	EZB1	9/11	688G	3/6
CY31	12/11	GZ32	12/6	615M	3/11
DAF96	9/6	MS-PEN(7)	9/6	6K7G	2/11
DF96	9/6	MSP41(7)	9/6	6K8G	9/6
DK96	9/6	MU14	8/11	6Q7G	8/3
DL96	9/6	PCC84	10/11	6V6GT	5/11
DM70	7/11	PCF80	9/11	6V6M	7/11
EABC80	7/6	PCL83	11/9	6X4	6/11
EB91	6/11	PL82	8/11	6SK7	4/11
ECC83	8/3	PL83	11/6	6U4GT	13/11
ECC84	10/11	PY80	8/11	12AH8	10/6
ECC85	9/-	PY81	8/3	12J7GT	9/6
ECH35	9/-	PY82	8/3	12K7G	8/11
ECH42	9/11	UBF80	9/6	12Q7G	9/3
ECH81	8/11	UBC41	8/11	12SJ7	7/11
ECL80	8/11	UF42	13/6	12SK7	5/11
EF39	5/11	UL41	9/11	12SH7	5/6
EF40	10/11	UL84	9/6	1457	12/11
EF41	9/6	UY41	7/11	19AQ5	11/6
EF50(R)	6/11	VU111	1/6	25Z4G	8/11
EF80	8/3	1R5	7/6	35A5	10/6
EF85	10/6	1S5	7/3	35Z4G	8/3
EF89	9/6	1T4	7/3	35W4	8/11
EP91	7/11	3V4	8/6	80	8/6
EL32	5/11	5Z4G	8/3	954	1/6
EL84	10/3	5Y3GT	7/6	955	3/11
EY51	9/6	6AT6	7/11	956	2/6
EY86	10/3	6BA6	7/3	958	3/11
EZ80	8/3	6BJ6	7/11	807	3/11

## ADAPTATAPE

is the name of the new SONOMAG Pre-Amplifier recommended on page 238 of the November "Hi-Fi News" to those already owning Hi-Fi equipment and wishing to add tape reproduction of the same quality.

This is the ONLY pre-amp. at present available designed specially for the new Collaro Transcriber and rigidly fixed as a unit to it.

Demonstrations to all Hi-Fi enthusiasts of our pre-amp. used in conjunction with the Collaro Transcriber Tape Unit, Collaro Transcription Motor, Leak Dynamic Pick-up and Diamond stylus, Leak Trough-line F.M. Tuner, Wharfedale Baffle 3-speaker system and Leak main amplifiers, will convince you of the fine standard of recording possible. Day, or evening (by appointment).

Price 34 gns.

(Power pack, if required, 4 gns. extra).

Fitted into Fireside Console cabinet, oak, walnut, or mahogany finish, 42 gns.

Your own Collaro Unit fitted, aligned, tested and guaranteed (at our factory only) for 19 gns.

Complete Tape Recorders, including Collaro Microphone and 1,200ft. tape. Portable 52 gns. Console (with extra large speaker) 60 gns.

Leaflet on request.

Credit facilities from:

H. C. Harridge, 8, Moor Street, Cambridge Circus, W.1.  
Hollies Radio, 315, Camberwell Road, Camberwell Green, S.E.5.  
Jackson Radio, 163, Edgware Road, W.2.

London Radio Supply Co. Ltd., Balcombe, Sussex.  
Readings Music Stores, 11, Station Approach, Clapham Junction, S.W.11.

Sound-Tape-Vision, 71, Praed Street, Paddington, W.2.  
Woods Radio, 198, Lavender Hill, Clapham Junction, S.W.11.

## SONOMAG Ltd.,

2 St. Michael's Road, Stockwell, S.W.9

(Minute from Stockwell Tube)

Telephone: BRI 5441

## INDICATOR UNIT

SLC No. 5



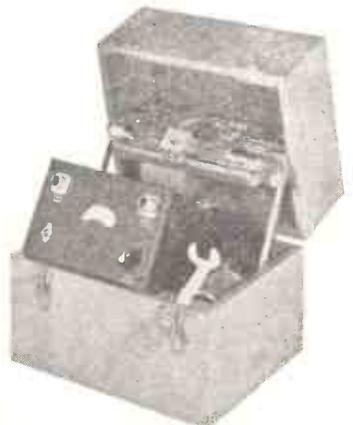
(Illustrated with cover removed)

Consisting of VCRI39A with mumetal H.T. band. Time base with 2-SP61, 1-VR66. Electrolytic condenser 24 MFD 550 V. PK. WKG. Test point for each stage. Completely enclosed in steel cabinet with lift-up front window. Chassis dimensions 11 x 6 x 3in., cover dimensions 11 x 6 x 5 1/2in., total height 8 1/2in. This unit is easily converted at a cost of a few shillings to an oscilloscope for modulation monitoring or linear sweep generator and horizontal amplifier. Brand new in original cartons. Price, complete with suggested modification circuit, only 65/- plus carr. 7/6.

## WHY SUFFER STANDING WAVES? COMPLETE STANDING WAVE RATIO METER

110 V. A.C. operated. From 60 c/s-1,000 c/s with all coax coupling and probe finder. To match all feeder line impedances and lengths Calibrated matching bar. Direct standing wave ratio readings are shown on meter 50 micro amp movement. This magnificent instrument is precision built, complete with all spares and housed in oak carrying case. Brand new in original packing.

£14 each. Plus carriage 10/-.



**MINIATURE I.F. STRIP TYPE "373"** 9.72 Mc/s. Valve line up 3-EF 91, 2-EF 92 1-EB 91. Size 10 1/2in. by 2 1/2in. by 3 in., completely valved with screening cans. 8-way Jones socket 50 K output potentiometer coax output socket. Ideal for modification to F.M. Tuner as described on page 107 of the April "Practical Wireless." Price 45/-. Less valves 8/6.

**DIPOLE AERIAL No. 4A.** 52in. hard drawn 7/22 copper wire with centre insulator, fitted with feeder sockets. Both ends have 3-link insulators and slotted wire adaptors. Brand new. Price 9/- P. & P. 2/-.

**BENDIX 12v RECEIVER.** Covering 8.4-7 Mc/s, 325-895 Kc/s, 150-325 Kc/s. Valves used 5-6K7, 2-6N7, 2-6J7, 1-6L6, 1-6F6. Complete with switching motor and 12v Dynamotor. Only 65/- Carr. 8/6.

**A.F. AMPLIFIER.** An Audio Frequency Amplifier in a sub-chassis 5in. x 3in. x 3 1/2in., R/C coupled, using 2 — 12SH7 and 1 — 12SJ7 valves; and can be used for Telephone Intercom., Pre-Amplifiers, etc. Price 12/- P. & P. 2/-.

**AMERICAN GEARED MOTOR.** 24 v. D.C. with built-in precision gearbox. No. 1 drive 24 R.P.M. No. 2 drive 6 R.P.M. On 12 v. No. 1 drive 16 R.P.M. No. 2 drive 4 R.P.M. Overall size of motor and gearbox 7 1/2in. x 3 1/2in. x 3in., weight 1 lb. 14 ozs. Brand New. Only 29/6. P & P. 2/-.

**EE-8 FIELD PHONES.** Talk as far as 17 miles! Dependable 2-way communication at low cost! Ideal for home, farm, field, etc. Up to six phones can be used on one line. Each phone complete with ringer. Excellent condition. Our price £7 0 0 each.

**INDICATOR UNIT TYPE 182A.** Unit contains VCRI 517 6in. cathode ray tube with mumetal screen, 1 5U4G, 3 EF50, and 4 SP61, 9 wire-wound volume controls, H.T. mains transformer, numerous resistors, condensers and other components. Fully smoothed. Brand new, 65/-. Plus carriage 7/6.

**HOVER ROTARY TRANSFORMERS.** 11.5 v. input, 490 v. output at 65 mA, and 6 v. input, 300 v. output at 75 mA. Guaranteed and tested, only 27/6. P. & P. 2/6.

**VIBRATOR POWER PACK.** Input 12 V., output 150 V. at 100 milliamps 2 bias packs 50 V. each. Complete with screen lead for battery. Completely smoothed. Brand new. Price 25/-. Postage and packing 3/-.



## ★ THIS MONTH'S BARGAIN ★ AMERICAN 829B VALVES Brand New & Boxed. ONLY 40/- P. & P. 1/-.

**R109A RECEIVER**

8 valves: 5 ARP 12's, 3 AR 8's, covering 2-12 Mc/s on two frequency bands. Contains 6 v. Vibrator Pack and built-in 3 1/2in. Goodman speaker, operates from 6 v. battery, consumption 2 amps. Housed in metal case 13 x 12 x 1 1/2in. Designed for Mobile or Ground station. Operates with any normal aerial. Complete, guaranteed and tested, including circuit. Very good condition. Only 85/-. carr. paid.

**Save £££'s on your Beam Antenna**

Aerial whip antenna sections. 4ft. lengths can be utilized for beam antenna construction. Brand new. Six for 12/6. Plus carriage 2/-. Twelve for 24/-. Plus carriage 3/-.

**LOUD HAILER SPEAKERS**

Sound powered with output transformer, impedance of speech coil 7 ohm, handling capacity 8 watts. Ideal for inter-communication. Complete with carrying strap. Price 25/-. Packing and carriage 5/-.

2 for 45/-. Carr. 7/6.

**COMMAND TRANSMITTERS**

2.1-3 Mc/s	valved less crystal	17/-
3-4 Mc/s	valved with crystal	25/-
4-5.3 Mc/s	valved less crystal	17/-
5.3-7 Mc/s	valved less crystal	17/-

P. & P. 3/- each.

**GRAND OPENING**

Visit our newly opened BARGAIN STORE in our own warehouse. SEE FOR YOURSELF!! Three thousand square feet of warehouse space loaded with a tremendous variety of resistors, condensers, chokes, transformers, valves, headsets, microphones, test sets, receivers, transmitters.

**EVERYTHING IN ELECTRONICS.  
ROCK BOTTOM PRICES !!**

**FM WOBLULATOR CAPACITOR**  
Excellent for Sweep Generator. Frequency modulation unit permanent magnetic field and a moving mechanism driving a metal diaphragm supported at its rim. This diaphragm acts as a moving plate of the frequency modulator capacitor. Tested. Price 7/- each

**R.F. UNITS**

R.F. 24. 20-30 Mc/s, 8/6 each  
R.F. 25. 40-50 Mc/s, 8/6 each  
R.F. 26. 50-65 Mc/s, 25/- each  
R.F. 27. 65-85 Mc/s, 25/- each

All valved. Brand new in original cartons. Postage 3/- on each.

**WESTERN ELECTRIC SHUNT MOTORS**

27v 1 1/2 amps giving 3000 R.P.M. Continuous duty, rated 1/50 H.P. works off 12v and 6v at reduced R.P.M. length of shaft 1 1/2in. Motor 3 1/2 x 2 1/2in. Brand new and boxed. Only 17/6. P. & P. 1/6.

24v giving 6000 R.P.M. continuous duty. Shaft 1 1/2in. x 2 1/2in. works off 12v at reduced R.P.M. Brand new. Only 12/6. P. & P. 1/6.

**TUNING UNITS**

TU-6-B 3000-4500 KC  
TU-7-B 4500-5200 KC  
TU-8-B 6200-7700 KC  
TU-10-B 10,060-12,500 KC

These well known units have Micro Meter dials with 2,500 divisions over 180 degrees rotation. Giving plenty of mechanical bandspread. Velvet vernier drive, high Q tank circuit and heavy duty 6-way ceramic switch and variable transmitting condensers. Price 14/- each. P. & P. 3/-.

**LOW IMPEDANCE PADDED HEADPHONES TYPE D.L.R. 3.** Complete with cord and plug. Brand new. Price 9/-. Post & packing 1/6.

**U.S.A. INTERPHONE AMPLIFIER.** This unit uses 2 6V6's. Includes Microphone Transformer, output Transformer, Sidetone Transformer, 600ma choke, Fuse holders and double pole 10 amp switch. DYNAMOTOR 12v INPUT 250v OUTPUT AT 50 mA. Size 9in. x 9in. x 5in. Brand new (less valves) only 55/-. Carriage 5/-.

**PARMEKO C CORE TRANSFORMER.** Intervalve Transformer. Ratio 4/1 600 ohms CT. 1 1/2in. x 1 1/2in. x 2in. Original cartons 6/- post paid.

**AMERICAN THROAT MICROPHONES Type T. 30.** Complete with elastic strap, lead with 2 pin plug PL291. New and boxed 2/6 each.

**AMERICAN ROTARY CONVERTERS**

With cooling Fan input 12 V. D.C. Output 300 V. at 90 mA

Completely suppressed. Brand new 19/- each. Plus P & P. 3/-.

Hours of business:  
8.30 a.m. to 6 p.m.  
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MUSEum 5929/0095  
(50 yards only from Tottenham Court Road Tube)

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EUSton 5533/4/5

## TRANSISTORS!!!

SURPLUS—P.N.P.	
RED SPOT (Audio/Experimental Applications) . . . . .	10/- ea.
BLUE SPOT, R.F. up to 1.5 Mc/s. . . . .	15/- ea.
WHITE SPOT, R.F. up to 2.5 Mc/s. . . . .	20/- ea.
STANDARD—	
BRIMAR . . . . .	
T.S.I. . . . .	18/- ea.
MULLARD	
OC70 . . . . .	21/- ea.
OC71 . . . . .	24/- ea.
OC72 . . . . .	30/- ea.
(ALL POST FREE)	

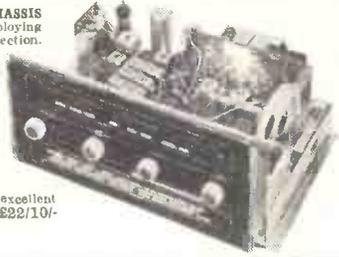
**RC7, F.M.** A most attractive AM/FM chassis employing 9 valves with Push-Bull output. Covers Long, Medium, Short and P.M. wavebands. Valve line-up; 5Y3, 2-6BW6, 12AU7, EAB080, EP89, EC881, EC085 and 6EM8. Built-in Ferrite Rod Aerial for A.M. reception. Controls; 2 dual, Tuning/Wavechange and Volume ON/OFF/Tone. 6-8 watts output. Very attractive easily read dial in BLACK and GOLD. Size (overall) 16in. x 6in. Chassis dimensions: (overall) 16in. x 6in. x 7 1/2in. Indoor Aerial for F.M. provided. For use on A.C. mains 200/250 v. 50 cycles. Brand new and fully guaranteed. PRICE 26 gns., plus 7/6 c. & p.

H.P. Terms; Deposit £13/13/- and 12 months at £13/4/.

**RC5 F.M. AM/FM CHASSIS.** This is a most attractive chassis employing the very latest circuitry and highly efficient miniature valves. Waveband selection by means of a piano-keyboard type push-button control—separate bass and treble controls are provided also a built-in Ferrite Aerial which automatically comes into operation on all A.M. Bands and is rotatable by means of a knob situated on the front panel. This Chassis is supplied complete with two dermo-dynamic 10in. x 7in. elliptical speakers and one high-frequency tweeter unit (cross-over network is incorporated in Chassis wiring). Valve line-up: BC086, EC881, EP89, EAB080, EL84, EM80 and C100 metal rectifier. Overall dimensions: 20 1/2in. x 8in. x 6 1/2in. high. For use on A.C. Mains 110/250 v. PRICE: £25, plus 7/6 carr. and pkg. H.P. terms: £12/10/- deposit and 12 monthly payments of £12/11/.

### RC4 F.M. AM/FM RADIOGRAM CHASSIS

A new style AM/FM Chassis employing a printed circuit F.M. Tuner section. Valve line-up 8 valves: EC085, 6BA6, 12A8, 6BA6, 6AL5, 6AT6, EL84, 5Y3. Most attractive dial 12 x 5 1/2in. fully illuminated, with figures in green, red and white on black background. Four controls: Tuning, Volume, Wavechange and Tone/On/Off. Dimensions (overall): 13 x 9 x 6 1/2in. Frequency coverage (four wavebands): 1,000-2,000 m., 300-550 m., 15-30 m., 85-100 mc/s. This is an excellent and very efficient chassis. Price £22/10/- plus 5/- P. & P.



### SWITCH TUNED FOUR STATION RECEIVER CHASSIS (Manufacturers' Surplus).

A most attractive unit covering 4 pre-set stations in the medium waveband. A complete receiver (less cabinet) including built-in good quality 5in. loudspeaker, and frame aerial. Employs Universal Superhet circuit and miniature valves—UCH42, UAF42, UL41, UY41. Dimensions (overall):—5 x 9 x 8in. For use on A.C./D.C. mains 200/250 v. 50 cycle brand new. Few only at £5/5/- plus 2/6 P. & P.

### SPECIAL PURCHASE: MANUFACTURER'S SURPLUS

Owing to favourable purchase we can offer strictly limited quantity of these handsome chassis. AC/DC 200/250 v. for Medium and Long Waves, plus gram position. Incorporates own frame aerial. Valve line up: U107, N108, DH107, W107 and X109. Overall chassis size 12 x 5 1/2 x 7 1/2in. high. Attractive bronze dial with gold and cream lettering. Dial size 11 1/2 x 4 1/2in. Scale length 7 1/2in. Logging scale provided. Price £7/19/8 only, tax paid, plus 3/6 P. & P. H.P. terms. 44 deposit plus four monthly payments of 22/-



### DULCI F.3 RADIOGRAM CHASSIS.

Last few of these fine chassis. 3 waveband, 5 valve superhet with built-in ferrite aerial. Brand new, fully guaranteed only, £10/5/- plus 3/6 P. & P.

### DULCI

All Dulci products available ex stock. Illustrated leaflets and H.P. terms available.  
Dulci F.M. Tuner at £16/18/-  
AM/FM Tuner type H4T at £20/17/-  
AM/FM Chassis H4 at £24/6/-  
Each plus 5/- p. & p.  
Demonstrating at Tottenham Court Road!

### TELEVISION TURRET TUNERS 12 CHANNEL—"BRAYHEAD"

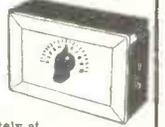
We have five types now available from stock, to cover Bands I and III—fully illustrated and descriptive leaflet available on request. Each unit is fully aligned and thoroughly tested before despatch. Valves employed are PCF80, PC084 for AC/DC and EC080 and EC084 for A.C. Price complete £77/12/6 P. & P. All channels available.

Type	Sound MC/s	Vision MC/s	Series	Heater
353	38.0	34.5	Series	
163	19.5	16.0	Series	
103	10.5	14.0	Parallel	
10P	10.5	14.0	Parallel	

We have a large selection of in-built converters for all areas from 92/6; also aerials, low-loss co-axial cable at 10d. per yd. Are you on our mailing list?

### JUST RELEASED!!! THE NEW R.C. TRANSISTOR/RECEIVER KIT

This receiver, covering medium waveband, can be assembled in about 1 hour, will give amazing volume and tonal quality when used in conjunction with a good aerial and earth. Incorporating PNP Transistor and Germanium Diode. For headphone reception. Included with the kit of parts is a handsome plastic case in black and white, measuring 4 1/2 x 2 1/2 x 1 1/2in. This case accommodates the complete receiver, including battery. PRICE OF COMPLETE KIT: 25/- plus 1/3 P. & P. (Light weight high resistance headphones can be supplied separately at 15/- pair. If, however, the kit is purchased complete with headphones this will be supplied at a SPECIAL INCLUSIVE PRICE OF 37/6 plus 1/6 P. & P. Optional extra. 100ft. coil single 7/36 coloured P.V.C. covered wire, suitable for both aerial and earth. 2/6 only.



## THE JASON FM TUNER

Based on the booklet by Data Publications Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive, free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes dried chassis with tuning condenser, scale calibrated in mc/s, and attractive bronze stove-enamelled front plate already mounted (illustrated). Front plate size 8in. x 5in. Chassis 7in. x 4 1/2in. x 1 1/2in. Complete standard kit £6/15/- plus 2/6 P. & P. Fringe area kit £7/15/- plus P. & P.

**FM POWER PACK KIT.** We can now supply complete kit for power pack suitable for the above F.M. tuner or any other similar type. Price for the complete kit is £7/6 only or 52/6 for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6X4 and built on chassis size only 6 x 4 x 1 1/2in. Optional extra for power pack. Bulgin Octal Plug 2/3.

### AM/FM KIT

Introducing the JASON AM/FM KIT or medium waves and F.M. As illustrated this is a very high quality chassis incorporating 8 of the latest miniature valves, plus DM70 magic eye. Kits are available for chassis complete with output stage at £15/5/-. Also less output stage but with own built-in power pack at £13/10/6 only. These are high fidelity units and exceptional value at these prices which include all required components and full constructional details. Fully illustrated Data Booklet with full construction details, plus individually priced component list, available per return of post 2/- post free. Both plus 3/6 P. & P.

### THE T.S.L. FM TUNER!

We can now supply this FM/VHF adaptor either in kit form or fully assembled, wired and tested. Our price for the ready-built unit, which incorporates its own power supply, is £13/15/- only, tax paid, plus 5/- P. & P. or H.P. terms. Magic eye tuning indicator, 19/- extra. Or the kit complete as specified £10/19/6 plus 3/6 P. & P. The booklet "FM TUNER CONSTRUCTION" (32 pages) with full technical data and point-to-point wiring diagrams, together with our separately priced parts list, is available at 2/6, post free.

### ANNOUNCING OUR NEW F.M. TUNER KIT! (printed circuit)

This is our printed circuit version of the Osram 912 F.M. Tuner—using T.C.C. printed circuit and condensers, incorporating 5 valves and two germanium diodes. Attractive black and gold dial, with gold escutcheon plate. Dial aperture only 5 x 2 1/2in. Osram F.M. booklet, plus our additional instructions and individually priced components list—2/6 post free or the kit absolutely complete at £8/8/- plus 2/6 P. & P. Alignment service available if required. We are demonstrating at 18 Tottenham Court Road.

### SPEAKERS & ENCLOSURES

Full range in stock by WHARFEDALE, W.B., T.S.L., etc. Your enquiries welcomed.

### JUST ARRIVED. Further limited stocks of Acos HGP37 crystal pick-up insert complete with sapphire stylus, suitable for B.S.R. Monarch, etc. Brand new, only 18/6 and 9d. P. & P.

### VALRADIO T/V TUNER

Limited stocks of this well-known unit available at much reduced price. An ideal pre-fabricated front end for any superhet T/V receiver with 16 mc/s I.F. Continuously variable tuning covering ALL bands, from 40-100 mc/s and 170-225 mc/s. Valve line-up: PC084, PCF80 (series heaters). Whilst stocks last only £3/19/6 plus 2/- P. & P.

Our advantageous H.P. terms are available on any single item over £5. Let us have your enquiries.

Please add postage under £1, or Cash with order. C.O.D. charge extra—open 9 a.m. to 6 p.m. Monday to Friday. Sorry but we close 1 p.m. on Saturday.

THE FIRST AND STILL THE BEST !!

**THE "SUPERIOR FOUR" KIT**  
Our superior four-valve receiver A.C. mains 200/250 v. M. and Long waves. As with our very successful "Economy Four" all the required components are supplied. Valve line-up: 2 6SG7, 6 X5GT and 6 VOGT. Chassis ready drilled. Cabinet size 10 1/2 in. x 10 in. wide. Max 1 in. depth at base 5 in. tapering to 3 1/2 in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6 post free. Our price for complete kit, £8/9s. 6d. Please add 2/6 P. & C. If preferred, we can supply Cabinet Assembly only, comprising cabinet and bracket, wave-change switch, dial, pointer, drum pulleys drive spindle, drive spring and knobs, at 4/5- plus 2/6 P. & C. N.B.—Our kits are even supplied with sufficient solder for the job.



**CONSTRUCTORS NOTE !!**  
RADIO DATA BOOKS AVAILABLE, i.e. Valve guide, Colour code, etc. Send stamp for list.

**VALVES.** We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list of brand new imported valve types, fully guaranteed. P.T. paid. Also all usual surplus types available such as 6V5GT, etc.

**THE R.C. RAMBLER ALL-DRY PORTABLE KIT**  
Full assembly details with practical and theoretical diagrams, 1/6 post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. Cream plastic top panel, with dial engraved in red and green adds to the very imposing appearance of this model which is housed in attractive cream and grey leatherette covered attaché-case type cabinet, measuring only 9 in. x 7 in. x 6 1/2 in. Weight less batteries 4 1/2 lb., with batteries 6 1/2 lb. This set really has everything. Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up 3V4, 1R5, 1S5, 1V4. The required components, exactly as specified, including cabinet can be supplied from stock at the special inclusive price of £7/7- plus 2/6 p. and p. (less batteries). Uses Ever-Ready 90 v. H.T. type B125 at 1 1/2". Also 1.5 V. A.D. 35 at 1 1/2".



**N.B.—All our T.R.F. Kit circuits include specially wound Denco "Max Q" coils on polystyrene formers, improved performance. Price remains the same.**

**THE R.C. 2 AMP. BATTERY CHARGER KIT**  
Includes handsome well-ventilated black stove-enamelled steel box, size: 7 1/2 in. x 3 1/2 in. x 3 1/2 in. Fully shrouded first quality transformer, brand new G.E.C. rectifier. Mains fuse, etc. For charging 6 or 12 batteries at 3 amp. Absolutely complete kit with full practical and theoretical instructions. Price 3/6 plus 2/6 P. & C. Can be supplied assembled and tested at 4/1/6 plus P. & P. Heavy duty crocodile clips suitable for ear battery lugs, optional extra at 1/6 per pair.

**THE R.E.P. 1-Valve RECEIVER.** All dry battery operation, for use with head phones. The complete kit is available at 4/2-, less batteries plus 2/- P. & P. or full instructions at 9d. post free.

**RC2.A. Small Portable Gram Amplifier.** This little Amplifier is built around a Printed Circuit and employs the very latest highly efficient valve type ECL82. It is ideal for use where space is limited. Although of such small size 7 in. x 5 1/2 in. x 2 in. (overall) with a control panel 3 1/2 in. x 1 1/2 in., reproduction is excellent. A wide range tone control is provided. Output approx. 3 watts max. For use on A.C. Mains 200/250 v. NOTE THE PRICE 5/9/6, plus 2/- P. & P.

**RC1.A. AMPLIFIER.** A small high quality gramophone amplifier employing the latest circuitry and highly efficient miniature valves. Very neat chassis finished in bronze stove enamel. Size (overall) 6 1/2 x 4 x 5 1/2 in. Valves: 6X4, ECL82. Output 3 watts max. Controls: Volume, Tone/On/Off. For use on AC mains 200/250 v. & P.

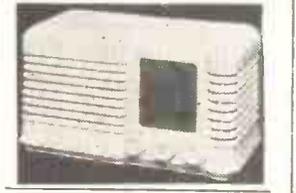


**RC3.A. Small 3-Valve Portable Gram Amplifier.** An excellent little amplifier for portable gram, giving high quality output. Separate Bass and Treble controls. 2-3 watts output. Valve line-up: E280, EL84, ECC83. Provision for mounting 6 in. loudspeaker. Fully isolated from mains 200/250 v. A.C. Overall size: 6 1/2 in. L. x 5 1/2 in. H. x 2 1/2 in. D. PRICE £3/19/6 (less Speaker and Output Transformer), plus 2/6 P. & P.

**RC4.A. (STALLION)** This is supplied complete with high flux 9 in. P.M. Speaker and Baffle. Incorporating three actual type valves 6Q7, 6V6 and 6X5, this robust and well-made unit is ideal for use in the larger type of record player and is equally suitable for use in conjunction with a radio feeder unit. Separate bass and treble controls are provided; also provision is made for an extension speaker and mains supplies to gram. motor. Output approx. 4 watts. Size overall 18 in. x 4 in. x 9 in. high. For use on A.C. Mains 100/200/250 v. PRICE £5/19/6 plus 2/6 P. & P. H.P. terms £2/19/6 deposit and four monthly payments of 16/6 per month. Fits our portable cabinet "G" at 85/- without modification.

**RECORD PLAYER CABINETS**—to suit all types of single record and auto-changer units. Priced from 4/5-. Send stamp for fully illustrated list.

**THE "ECONOMY FOUR" T.R.F. KIT.** A three-valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up 6K7, 6J7, and 6V6 Chassis ready drilled. Cabinet size 12 1/2 in. long by 6 in. high by 5 in. deep—Choice of Ivory or brown Bakelite, or wooden walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price is £5/10/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/6 post free. This is allowed if kit is purchased later. Plus 2/6 packing and carriage for complete kit.



**GRAMOPHONE MOTORS are in SHORT SUPPLY!**

**COLLARO AC 3/554:** Three speed, single player for A.C. mains 200/250 v. cream finish, complete with turn-over crystal pick-up incorporating the well-known high output "T" type head. Strictly limited quantity at £6/19/6 plus 3/6 p. and p.

**FOUR-SPEED CHANGERS**  
Collaro RC456 Mixer Auto-Changer in cream with Studio "O" insert. £9/15/-.  
B.S.R. Monarch Mixer Auto-Changer, in cream and gold. £9/15/-.  
Both plus 3/6 p. and p. H.P. Terms available. Stocks rapidly diminishing.

**RECORDER AMPLIFIER**  
(Well known manufacturer's surplus.)

This is a brand new amplifier designed for use with a famous wire recorder. A simple modification is all that is required to make this unit ideal for use with any Tape Deck.

Specifications: Valve line-up 7C5, 12AU7, 6BR7, 6BR7, 6X4. Neon Record Level Indicator. Controls: Volume/Record Level, Tone Control, Record/Playback Switch. High and Low level inputs for Mike and Radio. External Speaker Socket. Built-in 5 in. Loudspeaker with High Flux magnet. Separate Power Pack. Dimensions: Amplifier 6 1/2 in. H. x 11 in. W. x 2 1/2 in. D. Power Pack 6 in. x 6 in. x 8 in. High (overall). Full modification details are supplied. Price £8/19/6, P. & P. 3/6.



**10in. CABINET SPEAKER.** Ideal for P.A. etc. Comprises solid wood cabinet complete with carrying handle. Painted dark brown; with built-in good quality 10in. P.M. speaker, 3 ohm speech coil, complete with lead and Igratec Jack plug. Brand new. Price only 4/5-, plus 3/6 P. & P.

**SURPLUS BARGAINS—METERS**

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 4in.	M.C.	Rectangular	110/-
50 microamp	D.C. 3 1/2 in.	M.C.	F.R.	95/-
100 microamp	D.C. 2 1/2 in.	M.C.	F.R.	45/-
200 microamp	D.C. 3 1/2 in.	M.C.	F.R.	65/-
500 microamp	D.C. 2 1/2 in.	M.C.	F.R.	18/6
1 mA.	D.C. 2 1/2 in.	M.C.	F.Sq.	17/6
1 mA.	D.C. 3 in.	M.C.	P. Sq.	22/6
1 mA.	D.C. 2 1/2 in.	M.C.	F. Sq. (1954 by Elliott)	25/-
50 mA.	D.C. 2 1/2 in.	M.C.	Desk type	30/-
50 mA.	D.C. 2 1/2 in.	M.C.	F. Sq.	8/6
100 mA.	D.C. 2 1/2 in.	M.C.	F.R.	10/6
5 amp.	R.F. 2 in.	Thermo	F. Sq.	6/6
1 amp.	R.F. 2 in.	M.C.	F.E.	10/-
120-0-120 amp.	D.C. 2 in.	M.C.	F. Sq. (shunt required)	15/-
130 amp.	A.C. 4 in.	M.I.	R.E.	35/-
1 amp.	R.F. 2 1/2 in.	Thermo	R.P.	7/6
3 amp.	R.F. 2 in.	Thermo	F. Sq.	6/-
20 amp.	D.C. 2 in.	M.L.	R.P. (with shunt)	10/6
30 amp.	D.C. 2 1/2 in.	M.L.	F.R.	12/6
15 volt	A.C. 2 1/2 in.	M.I.	F.R.	10/-
15-0-15 volt	D.C. 2 1/2 in.	M.O.	F.R.	17/6
300 volt	A.C. 2 1/2 in.	M.C.	F.R.	35/-

SPECIAL U.S. 0-1 mA. 2 1/2 in. taken from equipment out perfect, 22/6 each. R.P. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.R. = Flush Round. M.I. = Moving Iron.

**METER RECTIFIERS.** 1 mA. by G.E.C. at 6/6, also 5 mA. by G.E.C. at 6/6.

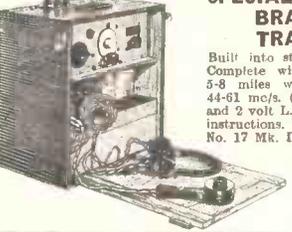
**THE R.C.3/4 WATT AMPLIFIER KIT.** Compare the advantages. Treble, Bass AND middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250 v. Valve line-up: 6V6GT, 63G7 metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8 in. x 4 in. x 1 1/2 in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at £4/5- only, plus 2/6 packing and post or instruction Book fully illustrated for 1/- post free. This amplifier can be supplied assembled, tested, and ready for use at £5/5- plus P. and P. Hearing is believing.

**PRE-SET TUNER UNIT.** (Manufacturers surplus.) A two valve (TH41, VP41) superhet tuner unit covering two pre-set stations: Light and Home services, for feeding direct into any suitable amplifier. Power requirements: 200 volt at 20 ma. D.C. and 4 v. at 2 amps. Built-in power supplies may be added if required. Dimensions: 9 in. x 3 1/2 in. x 7 1/2 in. overall. Unit only, 4/5- plus 2/6 P. & P. All components for built-in power supplies with full modification details available for 20/- extra.

**SPECIAL PURCHASE from Ministry BRAND NEW No. 17 Mk. II TRANSMITTER/RECEIVER**

Built into strong wooden cabinet 15 in. x 14 in. x 9 in. Complete with headphones and microphone. Range 5-8 miles with simple aerial. Frequency coverage, 44-61 mc/s. (6-7 metres). Uses standard 120 v. H.T., 6-3A5, 3-1S5, 1-1R5, 2-2V, vibrator packs, also comprehensive illustrated manual. Frequency coverage, instructions: 59/6, plus 3/6 P. & P. No. 17 Mk. II, as above, but secondhand, in good condition and complete, 45/- plus 3/6 P. & P.

**MAINS TRANSFORMER—SPECIAL**  
Removed from chassis but clean and guaranteed. 200/240 v. input. 350-0-350 or 250 m/f. 6.3V. 3 amps. 6.3V. at 8 amps. 5 at 3 amps. Only 30/- plus 1/6 P. & P.



**BEACON TX/RX.** (Mint condition.) Comprising: Transmitter/receiver unit, telescopic antenna, pair lightweight headphones, co-ax. cable, connecting leads, plugs, etc., contained in excellent quality haversack. Supplied complete with valves 6-3A5, 3-1S5, 1-1R5, 2-2V, vibrator packs, also comprehensive illustrated manual. Frequency coverage, 214-234 Mc/s. Size: 13 in. x 10 in. x 5 in. Weight: 28 lb. Limited quantity only at 72/6, plus 2/6 P. & P.

**CLYNE RADIO LTD.**  
18, Tottenham Court Road, London, W.1

# G.W. SMITH & CO

## (RADIO) LIMITED

Phone: GERRARD 8204/9155

Cables: SMITHEX LESQUARE

3-34 LISLE STREET, LONDON, W.C.2

### AMERICAN LIGHTWEIGHT HEADPHONES H-30-R

Magnetic type, resistance 50 ohms. Fitted with rubber earmoulds to fit inside the ear. Best quality, ideal for communication receivers, etc., supplied with lead, brand new, 15/- each. P.P. 1/6.

**BENDIX COMMAND TRANSISTERS**  
Complete with all valves and crystal. Coverage 2.1 to 3 Mc/s., 29/6 each. P.P. 3/-.

**HEAVY DUTY L.T. TRANSFORMERS.**  
Input 230 volt 50 cycles. Output 17.5 volts 35 amps. (service rating, OK 50 amps). Brand new, 72/6 each. P.P. 5/-.

### 0-1 MA. METERS



Brand new moving coil meters, round flush mounting with 2½ in. scale, calibrated 0/300 volts, complete with rectifier. Price 25/- each. P.P. 1/-.

**8 MFD. PAPER CONDENSERS.** Brand new T.C.C. Visconol type, 750 volts working, 5/6 each. P.P. 1/-.

**COPPER AERIAL WIRE.** Ex-U.S.A., 300ft. reel, 3/6. P.P. 1/-.

**HEAVY DUTY SLIDER.** 1 ohm 12 amps. Brand new, 6/6. P.P. 1/9.

### HEAVY DUTY MAINS ISOLATING TRANSFORMERS

Specification:—Primary 230 volts 3 amps. Secondary 230 volts 3 amps. (Service rating, OK 5 amps.). Ideal for laboratory or workshop use. Supplied brand new in original transit cases, £6/10/- each. P.P. 10/-.

**INSTRUMENT POTENTIOMETERS.** Brand new Colvern type. 100,000 ohms. 10 watts, 3½ in. dia. Ideal for bridges, etc., 10/6 each. Ditto, twin gang, 5,000 ohms, 10/6 each. P.P. 1/6.

**460 KC/S B.F.O. UNITS.** Brand new and complete with 155 valve, fully screened in aluminium case, only 8/6 each. P.P. 1/-.

### ROTARY CONVERTORS

Input 24 volts D.C. Output 230 volts 50 cycles, 100 watts. Supplied brand new, 92/6 each. P.P. 5/-.

### ALUMINIUM CHASSIS

Best quality, 18 s.w.g. Four sided, reinforced corners.

6 × 4 × 2½ in. ... 3/6    10½ × 7½ × 2½ in. ... 5/3  
7½ × 5½ × 2½ in. ... 4/6    13½ × 9 × 2½ in. ... 6/9  
11½ × 7½ × 2½ in. ... 6/-    Postage 1/- all sizes.

**POST OFFICE RELAYS AND KEY SWITCHES.** Extensive stocks available at "CHEAP" prices. All enquiries welcomed.

**MAINS NEON PANEL INDICATORS.** Chrome escutcheon. 200/250 v. Red, amber or clear, 3/9 each. P.P. 6d.

### A.C. MAINS BLOWER MOTORS

220/230 volts 300 watts 1½ in. diameter outlet. Housed in metal box and fitted with dust filter pads. Supplied complete with 4 spare filters, 2 way outlet adaptor and 2 lengths of hose. Brand new only £4/19/6 each. P.P. 7/6.

### EX-NAVY SOUND POWERED TELEPHONES



This type requires no batteries to operate and can be fitted in moments. Uses hand generator for calling, giving an extremely loud buzzing note, and also a neon indicator. Ideal for field activities, factories, office, etc. Only 45/- each. P.P. 4/6.

### AMERICAN MULTI-RANGE TESTMETERS

1,000 ohms per volt, 400 microamp basic movement. Ranges as follows: A.C. and D.C. volts, 0 to 5,000 volts in 6 switched ranges. D.C. current, 1 mA., 10 mA., 100 mA., and 1 amp. Resistance measurement from .1 ohm to 1 megohm. Decibels from -10 db. to +15 db. The instrument is housed in a polished wood case, complete with leather carrying handle, test prods and battery. Guaranteed perfect order and tested before despatch. Price £5/19/6 each. P.P. 3/-.

### MODULATOR 67



These bargain instruments contain a COMPLETE A.C. MAINS POWER PACK. Input 230 volts 50 cycles. Output 350 volts. 120 mA. and 6.3 volts 5 amps. Choke and condenser smoothed and uses 5Z4 rectifier. (Transformer actually 200 mA.). Also included in the unit are 11 other valves, 5 SP61, 1 VR116, 2 EB34 and 3 EA50, and many other useful components, pots, resistors, switches, etc. Size of case 18 × 9 × 7 in., which is finished in grey. Supplied brand new, 49/6 each. P.P. 7/6.

### COSSOR DOUBLE BEAM OSCILLOSCOPE, TYPE 339A

Operation 110/200/250 volts A.C. Ten time base positions, 6 cps. to 250,000 cps. Input frequency range, 10 cps. to 2 Mc/s. Offered in perfect operational condition, fully tested, £27/10/- each. P.P. £1.

### AMERICAN GEARED MOTORS



American 24 volt D.C. motor with built-in precision gearbox giving twin outputs 20 r.p.m. and 6 r.p.m. Will also operate on 12 v. giving reduced outputs. Size 7 in. × 1½ in. Shaft dia. ½ in. Supplied brand new

### MARCONI SIGNAL GENERATORS TYPE 390-G

Frequency coverage 16 to 150 Mc/s in switched ranges. 200/250 volt A.C. mains 50 cycle operation. Supplied brand new in original transit cases complete with calibration charts, instructions and complement of leads. £25 each. P.P. £1. Other types in stock.

### AMERICAN ROTARY GENERATORS

Input 12 volt D.C. Output 250 volts 80 mA. Fitted with blower attachment which can be easily removed if desired. Brand new 22/6 each. Ditto with 6 volt input 22/6 each. P.P. 3/-



### AMERICAN BEACON TRANSMITTER RECEIVERS

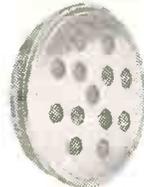
RT 37/PPN-2. Brand new and boxed, complete with instruction book. Equipment comprises transmitter/receiver with 9 valves (5 3A5, 3 1S5 and 1 IR5), with built-in 2 v. vibrator power pack, spare vibrator, head-set, connector leads and 10ft. collapsible aerial. Frequency coverage 214/238 Mc/s. Price 72/6 each. P.P. 6/-.

**L.T. TRANSFORMER BARGAIN.** Input 200/250 volts. Output tapped, 3, 6, 9, 12, 24 or 36 volts 5 amps., 35/- each. P.P. 3/-.

### A.R.88 WAVECHANGE SWITCHES

Ceramic, 8 bank, 6 position, complete with screens. Brand new and boxed 17/6 each. P.P. 2/6.

### CRYSTAL MICROPHONE INSERTS



Sensitive, ideal for amplifiers, tape recorders, etc., 4/6 each. P.P. 6d.

**SMOOTHING CHOKE SNIP.** Brand new pameko chokes. 5 henry, 200 mA., Res. 50 ohms. Only 5/6 each. P.P. 1/6.

### WESTON DUAL RANGE OHMMETERS

American test instruments by two famous manufacturers. Incorporates a 2½ in. moving coil meter, ranges 0-2,000 and 0-200,000 ohms. Price 39/6 each, brand new with leads and leather carrying case. P.P. 2/6.

**INSTRUMENT TRANSFORMERS.** Type 1.—Pameko. Input 230 volts. Outputs 195 volts 85 mA. tapped 130 v. and 65 v. 6.3 volt 5 amp., 6.3 volt 3 amp. Price 14/6. P.P. 1/6. Type 2.—Midget. 220/240 volt input. Output 200 volts 25 mA. and 6.3 volt 1 amp. Price 10/6. P.P. 1/-.

**6 VOLT VIBRATOR PACKS**  
6 volt D.C. input. Output 120 volts 30 mA. Fully smoothed, uses standard Mallory 4-pin vibrator. Compact in size. Supplied brand new and boxed, 12/6 each. P.P. 2/6.

**JACKSON SHORT WAVE VARIABLES.** 75 pF. with twin ended spindle, 2/- each. Twin gang 100 pF., 3/6. P.P. 1/-.

### HALLICRAFTER S.36A RECEIVERS

Frequency coverage 27 to 143 mc/s. A.M. or F.M. Built in "S" meter, operation 110/230 volt A.C. Supplied brand new with handbook, £45 each. P.P. 15/-.

**POST OFFICE JACK LEADS**  
4ft. twin screened lead fitted with two standard jack plugs, brand new, 3/- each. P.P. 6d.

### 50 MICROAMP METERS

A 2½ in. flush mounting meter housed in a grey instrument case, complete with a chrome handle. Resistance 800 ohms. Supplied brand new and tested, 59/6 each. P.P. 3/-.

**HOURS OF BUSINESS:** 9 a.m.-6 p.m. Thursday 1 p.m. Open all day Saturday.

Please print name and address clearly.

**WANTED. ALL TYPES OF COMMUNICATION RECEIVERS, TEST EQUIPMENT AND VALVES. HIGHEST CASH PRICES PAID.**

**MINIATURE REVERSIBLE MODEL MOTORS**

Size only 2in. x 3in. Will operate from 4.5 to 24 volts D.C. Ideal for launches etc., 8/6 each. P.P. 1/-.

**6FT. POST OFFICE RACKS.** Standard 19in. U channel type, 79/6 each. P.P. 12/6.

**CHARGING AND MODEL TRANSFORMERS**

1. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 1 amp., 9/9.
2. Pri. 200/250 v. Sec. 3.5, 9 of 17 v. 2 amp., 14/3
3. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 4 amp., 16/6
4. Pri. 200/250 v. Sec. 6.3 v. 3 amp., 8 v. 1.5 amp., 9/6.
5. Pri. 200/250 v. Sec. tapped, 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 v. 2 amp., 18/6. P.P. 1/6 all types.

**PANORAMIC ADAPTORS**

Brand new and boxed Ex-U.S.A. For use with receivers having an I.F. of 455/475 kc/s., giving a bandwidth of 200 kc/s., 110/230 volt A.C. operation. Price £30 each. P.P. £1.

**ELECTROLYTIC CONDENSER BARGAINS**

All new stock.

- |                         |                       |                        |                      |                       |
|-------------------------|-----------------------|------------------------|----------------------|-----------------------|
| 8 m. 450 v. 1/9         | 30 m. 450 v. 3/8      | 18 x 16 m. 450 v. 2/-  | 40 m. 450 v. 3/8     | 450 v. 3/6            |
| 16 m. 450 v. 2/9        | 8 x 8 m. 450v. 3/8    | 16 x 16 m. 500 v. 4/3  | 8 x 16 m. 500 v. 4/3 | 32 x 32 m. 450 v. 3/6 |
| 450 v. 4/6              | 50 x 50 m. 350 v. 4/3 | 25 m. 25 v. 1/9        | 275 v. 3/9           | 100 m. 25 v. 1/8      |
| 250 x 250 m. 6 v. 1/9   | 50 m. 50 v. 1/9       | 6000 m. 6 v. 3/6       | 6 v. 2/6             | 500 m. 12 v. 1/3      |
| 1000 x 2000 m. 6 v. 3/6 | 8 x 16 v. 6d.         | P.P. on all 4/3 types. |                      |                       |

**ADMIRALTY REFLEX RE-ENTRANT P.A. LOUDSPEAKERS**

Two units. Impedance 3 ohms. Extremely sensitive and directional. Ideal for all outdoor work. Complete with 600 ohm line transformer. Price 32/6 each. P.P. 5/-.

**MINIATURE SLOW MOTION DRIVES**

Dia. 1 1/2 in. Scale 0-100, for 1/2 in. spindle. Complete with locking device. Brand new, 7/6. P.P. 1/-.



**L.T. METAL RECTIFIERS**

Full wave and bridged. 12 v. 1 amp., 6/3; 12 v. 2 amp., 9/3; 12 v. 4 amp., 13/9; 24 v. 4 amp., 22/6; 1/- P.P. all types.

**METER BARGAINS**

- |                                    |      |
|------------------------------------|------|
| 0/50μ amp. 2 1/2 in. Pj. MC        | 49/6 |
| 0/100μ amp. 2 1/2 in. F.M.M.C.     | 39/6 |
| 0/150 M/amps. 2in. F.M.M.C.        | 6/9  |
| 0/200 M/amps. 2 1/2 in. F.M.M.C.   | 9/6  |
| 0/1 amp. R.F. 2 1/2 in. Pj. T.C.   | 5/-  |
| 0/4 amp. R.F. 2in. F.M.T.C.        | 5/-  |
| 0/300 volt A.C. 2 1/2 in. F.M.M.I. | 25/- |
| 0/1.5 amp. A.C./D.C. 2in. F.M.M.I. | 6/6  |
| 20/0/20 amp. Lucas arc type        | 8/6  |
| 500/0/500μ amp. 2 1/2 in. F.M.M.C. | 25/- |

**ALL NEW AND UNUSED**

2 m/a meter rectifiers S.T.C. .... 5/6

**R.1155 COMMUNICATION RECEIVERS, MODEL L**



Latest issue by the Ministry. Similar to the model N, incorporating the trawler band. Frequency coverage, 200-500 kc/s., 600-1500 kc/s., 1.5-3 mc/s., 3-7.5 mc/s., 7.5-18.5 mc/s. Supplied as new, aerial tested and complete with illustrated descriptive leaflet. Price £12/19/6 each. P.P. 10/-.

**R.1155 SUPER SLOW MOTION DRIVES**

Improved version as fitted to model L and N. Supplied brand new and boxed, 12/6 each. P.P. 1/6.

**POWER UNIT TYPE 3**

A complete A.C. mains power pack, input 200/250 volts. Output 250 volts D.C. 100 m/a, and 6.3 volts 4 amps. Fitted with H.T. voltmeter and current meter. Fully smoothed, choke and paper condensers. Housed in grey case for 19in. rack mounting. Supplied in brand new condition. 72/6 each. P.P. 7/6.

**L.T. TRANSFORMER BARGAIN**

Input 200/250 volts. Output 12 volts 5 amps. Brand new 12/6 each. P.P. 2/6.

**FIELD TELEPHONES**

Type Don Mk. 5. Buzzer calling. Ideal for inter office or house communication.

Supplied complete with two 1.5 volt cells, tested and ready to operate. Price only 39/6 each. P.P. 3/-.

**RCA AR.88 COMMUNICATION RECEIVERS**

Model L.F. Frequency coverage 75-550 kc/s. and 1.5-30 mc/s. on 6 bands. Operation 110/230 volt A.C. Supplied in perfect condition, aerial tested, £45 each. P.P. 30/-.

**RCA OUTPUT TRANSFORMERS**

Completely potted. Centre tapped primary, 10,000 ohms. Secondary tapped. 3, 7.5, 15, 500 or 600 ohms. Supplied brand new.

**MARCONI CRYSTAL CALIBRATORS**

Frequency coverage 170/240 mc/s. Directly calibrated, accuracy .001%. Operation 200/250 volts A.C. Supplied complete with 5 mc/s. crystal and spare set of 5 valves in original transit case, brand new with instructions. £4/19/6 each. P.P. 10/-.

**TRANSMITTER/RECEIVER No. 19, Mk. II**



Equipment comprises 3 separate units built into one chassis and separate power pack. Specification: "A" set. Transmitter/receiver. Frequency coverage 2-4.5 mc/s. and 4.5-8 mc/s.

For R.T., C.W. or M.C.W. Range on R.T. 15 miles, C.W. 50 miles. Superhet receiver, 465 kc/s. I.F. B.F.O., etc. R.V. Valve line-up: 6K7, RF, 6K8 mixer, 2 6K7 I.F., 6B8 det. A.F. phone output. Tx: 6K8 mixer, VFO, EF50 buffer, EB34 ADC. 807 P.A. "B" set. Transmitter/receiver 229/241 mc/s. Local use up to 1 mile. Valve line-up: CV6, 2 6K7 and 6V6. Inter Com. set, 2 valve A.F. amplifier for vehicle crew inter-communication. Valve line-up: 6K7 and 6V6. A 2 1/2 in. meter is built in reading L.T. and H.T. voltages, drive, etc. POWER UNIT. 12 volt D.C. input. Output 275 volts 110 m/a., and 500 volts 50 m/a. Equipment is of American manufacture and is supplied in good condition. Price, complete with power pack only 25/10/- each. P.P. 15/-.

**POWER UNIT 234**

A complete A.C. mains power unit in grey metal case for 19in. rack mounting. Input 200/250 volts A.C. Output 250 volts 150 m/a. and 6.3 volts 6 amps Double choke and condenser smoothed. Fitted with 2 1/2 in. moving iron meter for measuring A.C. input and D.C. output volts. Price 69/6 each. P.P. 8/6.

**VARIAC TRANSFORMERS.** Input 220 volts 50 cycles. Output variable from 200-240 volts 7.5 amps. Price 87/6 each. P.P. 5/-.

**SOUND POWERED EARPIECES.** Can be used as a two-way communication, no batteries required. New, 3/6 each. P.P. 1/-.

**DYNAMO EXPLODER UNITS**

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All new and unused  
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ALL NEW AND UNUSED  
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Size only 2 1/2 in. x 1 1/2 in. x 3 1/2 in. Will operate from 4.5 to 24 volt D.C. Fitted with reduction gear. Supplied brand new, 12/6 each. P.P. 1/-.

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5V4 8/6, 6AG5 3/6, DK96 9/6, EY51, 10/6, EF86 12/6, 6V6 6/6, DL96 9/6, EF80 9/6, EL84 12/6, 5U4 8/6, 6X5 7/6, PX25 15/6, DF96 9/6, ECF80 12/6, E281 10/6, 6H6 1/9, 6SN7 5/11, DAF96 9/6, ECF82 12/6, ECC83 9/-, 6J6 3/6, KT66 12/6, DF31 7/6, ECC84 12/6, ECL80 11/6, 2D21 8/6, VU111 1/9, EF39 5/6, ECH42 10/6, ECH81 10/6, EF37A 10/6.  
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**ALL ORDERS FOR RESISTORS C.O.D. PLEASE, AS WE CANNOT GUARANTEE TO STOCK ALL VALUES.**

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200 Assorted Moulded Mica Condensers, popular values..... £2 10 0  
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150 v. H.T. Size 2 3/8 x 5 1/2 x 1 1/2 in.	5/6
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60 v. H.T. 1.5 v. L.T. 3 1/2 x 3 3/8 x 1 1/2 in.	4/6

All batteries sealed and unused. All plus 1/6 post and pkg. Special reduction for quantities.

4-way Push Button Units 2/6 each. Knobs for same 3/- per doz.

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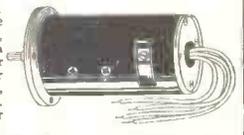
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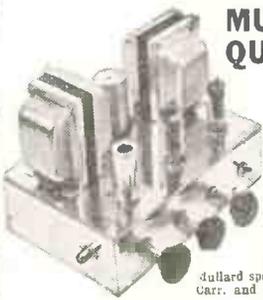
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1H6GT	10/6	6AM6	6/6
1L4	6/6	6AQ5	7/6
1LD5	3/6	6AT6	8/6
1N5	10/6	6AU6	5/6
1R5	8/6	6B4	10/6
1R4	10/6	6BR6	4/6
1R5	7/6	6BA6	7/6
1T4	7/6	6BE6	8/6
2A2	4/6	6BR6	9/6
2A4	7/6	6BS7	13/6
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3V4	9/6	6C6	8/6
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5Y3G	8/6	6F13	14/6
5Y3GT	8/6	6F33	5/6
6Z4G	10/6	6F16	14/6
6A7	13/6	6GG6	4/6
6AG8	10/6	6H6	2/6

6J5G	5/6	7H7	9/6	12Q7	9/6	EABC80	10/6	EZ80	10/6	PY80	10/6	VR65A	
6J5GT	5/6	7Q7	9/6	12SC7	9/6	EAC91	7/6	EZ90	9/6	PY81	10/6	(8P41)	3/6
6J5M	6/6	787	9/6	12SH7	7/6	EAF42	12/6	E1148	12/6	PY82	8/6	VR66	
6J6	6/6	7Y4	3/6	12SHT	6/6	EBC41	9/6	G232	2/6	PY83	12/6	(7P1)	3/6
6J7G	6/6	75	11/6	12SJ7	8/6	EBC41	10/6	H1231D	8/6	QF84	7/6	VR91	
6K6GT	7/6	77	8/6	12SK7	6/6	EBF80	11/6	H80	5/6	R19	13/6	(EF50)	4/6
6K7G	5/6	80	8/6	12SL7	8/6	EC91	9/6	KBC32	8/6	SP220	3/11	VR91	
6K7M	6/6	807	6/6	12SQ7	7/6	ECC84	12/6	KT24	4/6	U10	10/6	(SYL)	7/6
6K8G	8/6	8D2	2/6	12SR7	7/6	ECC85	10/6	KT3	5/6	U22	8/6	VR92	
6L6G	9/6	9001	5/6	12SRT	13/6	ECC91	6/6	KT33C	10/6	U25	13/6	(EA50)	1/6
6L7	7/6	9002	5/6	14ZBT	3/6	ECC91	14/6	KT66	15/6	U45	13/6	VR105/30	6/6
6L8	11/6	9003	5/6	15D2	7/6	ECC82	15/6	KTW61		UC29	13/6	VR116	4/6
6N7	7/6	9004	5/6	20P5	11/6	ECH35	11/6	(KTW62)	8/6	UBA42	11/6	VR136	6/6
6Q7G	9/6	9006	5/6	25L6GT	9/6	ECH42	10/6	KTW63	8/6	UBF1	9/6	VR137	5/6
6R4GT	7/6	954	2/6	25Y3G	9/6	ECH51	11/6	KTZ41	6/6	UBC41	10/6	VR130/30	8/6
6S6	8/6	955	4/6	25Z4G	9/6	ECL80	10/6	LP220	5/6	UBC43	11/6	VP23	6/6
6S7	8/6	956	3/6	25Z6GT	9/6	ECL82	9/6	MH4	7/6	UBF80	12/6	VP41	6/6
6S8	8/6	12A6	6/6	30P1L	12/6	EP80	7/6	MH41	7/9	UCH42	12/6	VS70	3/6
6S9	8/6	12AH7	8/6	35L6GT	9/6	EP22	8/6	N78	12/6	UCH81	12/6	VT52	
6S17	8/6	12A83	11/6	35V4	9/6	EP40	12/6	P61	3/9	UF41	10/6	(EL32)	6/6
6S27	9/3	12A76	10/6	35W4	9/6	EP85	12/6	P15	3/11	UL41	11/6	VT501	5/6
6U4GT	14/6	12A77	9/6	35Z4GT	9/6	EP86	12/6	PEN4	15/6	UY41	10/6	VR91	
6U5G	8/6	12A78	9/6	50L6GT	9/6	EP89	12/6	PEN25	5/6	UY85	10/6	(MU12/14)	8/9
6U7G	8/6	12AX7	10/6	510DDT	5/6	EP92	8/6	PEN46	7/6	VR21	2/9	VR64	
6V6G	7/6	12BA6	9/6	210VPT	9/6	EP92	8/6	PC28A	10/6	VR33		(UF59)	6/6
6V6GT	7/6	12BE6	10/6	AC6/PEN	6/6	EP41	10/6	PCF80	11/6	VR34		(EB34)	2/6
6X4	7/6	12C8	7/6	AT4	3/6	EL42	11/6	PCF82	12/6	VR55		(EBC33)	7/6
6X5G	7/6	12H6	3/6	DAF96	10/6	EM34	10/6	PL31	13/6	VR66		X79	11/6
6X8GT	7/6	12J5	4/6	DF96	10/6	EM80	11/6	PL82	10/6	VR67		(EF36)	6/6
6Y30L2	12/6	12K7	10/6	DH73M	9/6	EY51	11/6	PL83	12/6	VR57		Z001	10/6
7B7	8/6	12K7	9/6	KD96	10/6	EY86	12/6	PL83	10/6	VR57		(EK32)	8/6
7C5	8/6	12K7	9/6	D186	10/6	EY91	6/6	PP225	3/11	VR65		Z359	14/6
7C6	8/6	12K8	13/6	DM70	8/6	EZ40	10/6	PR25	2/6	VR65		(8P61)	3/6

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RF for use up to 1.6 mc/s. blue spot ea. 15/-  
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TT2 2nd IF Transformer (315 Kc/s) 5/-  
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**ELSTONE INTERVAL TRANSFORMERS**  
LF.35 Ratio 1-3.5 Primary 40-60H Parallel feed only Coupling condenser, 25mfD 2in. x 1.2in. high ..... each 10/-  
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4 speed automatic record changer unit plays 7in, 10in, and 12in. records automatically with "MAGIDISK" Selector. Unit plate 12 1/2 x 10 1/2in. £8 15s. Od. each. Carriage 3/-.

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Plessey 12in. units PM. .... 35/-  
BOLA 6in x 4in. Elliptical Unit PM. .... 19/6  
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S.A.E. FOR FREE LIST OF CLEARANCE OFFERS.  
Postage 1/- in £1 (1/9 in £1 Speakers/Trans.) Min. 6d. No C.O.D.  
100 TELEVISION SET BARGAINS TO CALLERS AT—

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PORTSMOUTH'S RADIO, TV AND TOOL SHOP



### COMMERCIAL TELEVISION CONVERTER

#### SUITABLE ANY T.V.

using lower side band

NO ALTERATIONS TO SET

Complete with built-in power supply, 230-250 v. A.C. mains. Case 3 1/2 in. long, 3 1/2 in. wide, 4 1/2 in. high. Incorporating gain control and band switch.

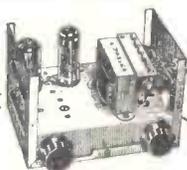
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Plus Post & Packing 2/6.

3 element foiled dipole I.T.A. loft AERIAL, 15/- P. & P. 2/-.

Co-ax cable 6 ft. yard.

Illustrated with cover removed.

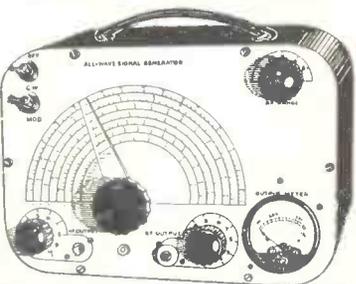


### COMPLETELY BUILT SIGNAL GENERATOR

Coverage 120 Kc/s.-250 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-66 Mc/s., 24 Mc/s.-84 Mc/s. Metal case 10 in. x 6 1/2 in. x 4 1/2 in. Size of scale, 6 1/2 in. x 3 1/2 in. 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation 400 c.p.s. to a depth of 80 per cent., modulated or unmodulated R.F., output continuously variable 100 milli-volts; G.W. and mod-switch, variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%.

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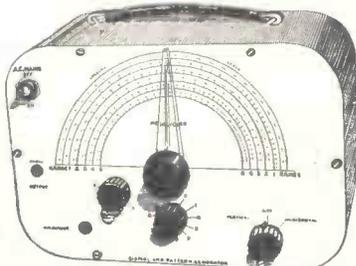
### SIGNAL & PATTERN GENERATOR

Coverage 7.6 Mc/s.-210 Mc/s. in five bands, all on fundamentals, slow motion tuning, audio output, 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ± 1%. A.C. mains 200-250 v.

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P. & P. 5/6.

Or £3 deposit, P. & P. 5/6 and 3 payments of 30/-.



### COMPLETELY BUILT PORTABLE AMPLIFIER

approx. size 6 1/2 x 2 1/2 incorporating 3 valves, contact-cooled metal rectifier, bass and treble lift controls and double wound mains transformer 39/6 Plus P. & P. 230-250 v. 3/6.

6 1/2" P.M. SPEAKER AND O.P. TRANSFORMER

If purchased with the above 18/6. Plus P. & P. 1/8.

### COLLARO 4-SPEED AUTOMATIC CHANGER

Model 456. A.C. Mains 200/250v. Turnover crystal head. Brand new. Fully guaranteed. (Suitable for use with above amplifier.) P. & P. 5/-.

£8. 19. 6

### AC/DC MULTI-METER KIT

Comprising 2 in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-10, 0-100 and 0-500. Milliamps 0-10, 0-100; ohms 0-10,000. Front panel, range switch, wire wound pot (for ohms zero setting), two toggle switches, resistors and meter rectifier.

Complete in case, grey hammer finish. 19/6 P. & P. 1/6. Point to point wiring diagram 1/-, free with kit.

### 4 VALVE ALL-DRY SUPERHET PORTABLE KIT

incorporating ferrite rod aerial

Medium and long waves. In grey leatherette. Size 9 in. x 7 in. x 6 in. Valve line up IT4, IR5, IS5, 3V4. Complete kit of parts (less batteries).

£5/19/6 Plus 3/6 Post and Packing.



### RADIO AND T.V. COMPONENTS (ACTON) LTD.

23, ACTON HIGH STREET, LONDON, W.3

GOODS NOT DISPATCHED OUTSIDE U.K.

## DESIGN DRAUGHTSMAN

A vacancy exists at Plessey Nucleonics for a Senior Design Draughtsman to become responsible for the design of electronic equipment. Applicants should have had several years' experience in this field and be familiar in designing such equipment to Ministry specifications, where sound methods of design and construction are most important. The successful candidate will be expected to operate with very little supervision and lead a small team on the design of electronic devices in the nuclear energy field. Promotion prospects are good, and this small team will be expanded during the next two years. Applications in writing should be sent to the Chief Engineer, Plessey Nucleonics Ltd., Weedon Road, Northampton.

## TRANSISTORS HAVE A FUTURE

We require engineers to work on all aspects of transistor circuit applications. We do not expect to find people with appreciable experience in this field, but we are willing to train energetic intelligent applicants provided they have previous electronic development experience and sound industrial and technical training.

Applications, quoting reference 'TA,' will be welcomed by the Chief Engineer, Pye Limited, St. Andrew's Road, Cambridge.

## MECHANICAL LABORATORY

requires a Technical Assistant of O.N.C. standard for work of a MECHANICAL and ELECTRONIC nature as applied to Environmental Testing. Duties include the preparation of instrumentation for tests and recording the results. Write stating age and experience to Personnel Manager,

### THE GENERAL ELECTRIC CO. LTD.

Applied Electronics Laboratories, Brown's Lane, Allesley, COVENTRY

## APPLICATIONS ARE INVITED

for employment as Technical Assistants, Test Engineers and Testers on Radar and Guided Weapon equipments. The work is varied and interesting and offers opportunities for advancement.

Applications should be made to the Personnel Manager

### THE GENERAL ELECTRIC CO. LTD.

Applied Electronics Laboratories, Brown's Lane, Allesley, Coventry quoting Ref RG/RRB

## PYE LIMITED

have vacancies at their new factory at:  
**ROYSTON, HERTFORDSHIRE**  
 for first class

- (1) **SENIOR DESIGN DRAUGHTSMEN**  
 (2) **SENIOR ELECTRONIC ENGINEERS**

The work covers a wide range in the servo-mechanism and power control field and offers considerable scope to persons desiring to use their design ability and initiative to the fullest advantage.

Applicants must possess at least the H.N.C. or equivalent in mechanical or electrical engineering, have served a recognised apprenticeship and have considerable experience in one or more of the following fields:—

- (a) Instrument and precision engineering.
- (b) Medium mechanical engineering including welded aluminium and steel structures.
- (c) Hydraulic systems and hydraulic servo mechanisms.
- (d) Sheet metal and chassis design for electronic equipment.
- (e) General electronic engineering.
- (f) Instrumentation and data transmission engineering.
- (g) Power and instrument servo systems.
- (h) High speed tape storage equipment.

Excellent working and canteen facilities are being provided and pension and superannuation schemes exist for established employees.

Applications, stating salary required, should be addressed to:

**The Chief Engineer,**  
**Pye Ltd., St. Andrews Road, Cambridge,**  
 quoting reference "RPC."

## MURPHY RADIO LIMITED

have vacancies for

### EXPERIENCED ENGINEERS

in their domestic receiver design laboratory to work on receivers and radio-gramophones for home and export markets covering transistor, valve, and hybrid circuitry and for both amplitude and frequency modulation reception. Good conditions of employment including pension scheme and active sports club, catering for many different sports and hobbies. Welwyn Garden City offers pleasant surroundings and successful applicants from the Greater London area would qualify for housing after a period. Applications giving full details of age, experience and qualifications should be addressed to Personnel Department (R.8),

**Murphy Radio Limited,**  
**Welwyn Garden City, Hertfordshire.**

## BELLING & LEE RESEARCH LABORATORIES

want keen, enthusiastic engineers to fill the following vacancies in a progressive and expanding Research department:

**ELECTRICAL ENGINEER** to work on Aerial development in the range 30 Mc/s to 200 Mc/s.

This is a senior appointment and applications are invited from graduate engineers although consideration will be given to all applicants with suitable experience.

**ELECTRICAL ENGINEER** to investigate problems associated with interference suppression. Knowledge of filter networks is necessary.

**PROJECT ENGINEERS** required for:

- (a) development and design work in connection with high grade electronic components.
- (b) design of V.H.F. aeriels and accessories from experimental stage to prototype. For these posts a knowledge of materials and finishes is essential.

Attractive commencing salaries are offered which will be based on experience, qualifications and age in each individual case. A Pension Scheme is in operation and all applications, giving full details of career so far, should be sent to the Secretary,

**BELLING & LEE LTD.,**  
**GREAT CAMBRIDGE ROAD, ENFIELD,**  
**MIDDLESEX.**

## ENVIRONMENTAL RESEARCH

### THE ENGLISH ELECTRIC COMPANY LTD.

**STEVENAGE, HERTFORDSHIRE,**

has a number of vacancies in the Department concerned with vibration problems and ground simulation of guided missiles flight conditions. In particular this Department is looking for:—

**An Electronic Engineer** who is capable of designing and carrying through development of circuiting for special purposes. H.N.C. qualifications preferred.

**Laboratory Technicians,** who have an electrical/electronic background together with O.N.C. standard. Successful candidates would make up teams carrying through various test programmes.

Applications giving details of previous experience should be sent to Dr. D. A. Layne, c/o Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. WW 1306D.

## PYE TELECOMMUNICATIONS LTD., HAVERHILL, SUFFOLK

require Junior Engineers for design and development work on (a) transistor circuitry and (b) all wound components related to communications equipment.

Applicants must possess a thorough knowledge of basic electronic theory preferably with O.N.C. or an equivalent standard of technical education.

Apply giving full details of qualifications and experience to the Personnel Manager.

## ENGINEERS AND TECHNICAL WRITING

Descriptive and instructional literature concerning propellers and guided weapons must be prepared by men with sound knowledge of electrical, electronic or mechanical engineering and the ability to write clear factual English. Engineers who feel they have these qualifications are offered senior positions by this leading company. Please write, in confidence, to the Personnel Manager (Ref. 18b),

**DE HAVILLAND PROPELLERS LIMITED,**  
Manor Road, Hatfield, Herts.

## DEVELOPMENT ENGINEER INTERESTING U.H.F. PROJECT

Degree or equivalent. U.H.F./  
V.H.F. experience essential

Apply Box No. 0059 c/o W. World.

### Solid State Computer Component Research

The Nelson Research Laboratories of the English Electric Co., Ltd., have vacancies for Physicists at Stafford. The work involves research into the design and development of new components for use in digital computers. Previous experience of semiconductor, magnetic or vacuum work would be an advantage.

Please write to Dept. C.P.S.,  
336/7 Strand, W.C.2., quoting  
Ref. W.W. 913F.

## AUTOMATION

Elliott Bros. (London) Ltd., have openings for **JUNIOR** and **SENIOR DEVELOPMENT ENGINEERS** to design Automatic Weighing Systems. Prospects in this new field are excellent. H.N.C. standard required and some previous electronic development experience is desirable, although the Company is prepared to train suitable applicants.

Vacancies also exist for **JUNIOR TEST ENGINEERS**, who are about O.N.C. standard.

Please apply by letter to:—

**Personnel Officer,**  
Century Works,  
Conington Road, Lewisham, S.E.13

## Television Development and Test Equipment Engineers

A well known West London manufacturer requires Engineers for the development of black and white and colour television receivers and associated test equipment.

Vacancies exist for both Senior and Junior Engineers in the Television Development Department and for Junior Engineers in the Test Equipment Department.

Senior Engineers should have academic qualifications and several years' development experience. Junior Engineers require either academic qualifications or experience in development or equipment calibration and maintenance.

Progressive salary policy ensures rapid advancement for Engineers who show exceptional initiative and responsibility. All posts are permanent and carry the benefit of the Firm's Pension Scheme.

Please write fully, in confidence, stating age, qualifications and experience to Box No. 7441.

### THE POLYTECHNIC 309, REGENT STREET, W.1 ELECTRICAL ENGINEERING DEPARTMENT

Head of Department: D. O. Bishop, Ph.D., M.I.E.E.

**FULL-TIME DAY COURSES** are held for a Diploma in Electrical Engineering (Power and Telecommunications) extending over a period of three to four years. Courses are also held for the B.Sc.(Eng.) Degree of the University of London (External).

Session 1957-58 begins on September 17th, 1957.

**EVENING COURSES** in the above subjects and also in Radio and Television Service Work commence on Monday, September 23rd. The courses prepare for the Ordinary and Higher National Certificates and for the City and Guilds of London Institute examinations. New students will be enrolled on September 18th, 5-8 p.m.

Prospectuses may be obtained on application to the **DIRECTOR OF EDUCATION**.

### UNIVERSITY OF SOUTHAMPTON Technical Department FULL-TIME COURSE IN TELECOMMUNICATIONS ENGINEERING

A two year full-time day course in Telecommunications Engineering is now available. The course prepares candidates for the Intermediate, Final, and Full Technological Certificate Examinations of the City and Guilds of London Institute. It includes Physics for candidates who wish in addition to obtain full exemption from the Graduateship Examination of the British Institute of Radio Engineers.

The next course commences in September, 1957, and early application for entry is desirable. Application forms and further particulars may be obtained from the Technical Officer, the University, Southampton.

## RADIO TECHNICIANS IN CIVIL AVIATION

A number of appointments are available for interesting work providing and maintaining aeronautical telecommunications and electronic navigational aids at aerodromes and radio stations in various parts of the United Kingdom.

Applications are invited from men aged 19 or over who have a fundamental knowledge of radio or radar with some practical experience. Training courses are provided to give familiarity with the types of equipment used.

Salary £561 10s. at age 25 rising (subject to a practical test) to £671. The rates are somewhat lower in the Provinces and for those below age 25. Prospects for permanent pensionable posts for those who qualify.

Opportunities for promotion to Telecommunications Technical Officer are good for those who obtain the Ordinary National Certificate in Electrical Engineering or certain City and Guilds Certificates. The maximum salaries of Telecommunications Technical Officers are Grade III £790, Grade II £925, Grade I £1,160.

Apply to the Ministry of Transport and Civil Aviation (ESB1/RT), Berkeley Square House, London, W.1, or to any Employment Exchange (quoting Order No. Westminster 2109)

## FERRANTI LIMITED, EDINBURGH

require a

### SECTION LEADER

to take charge of their  
**AIRCRAFT RADIO  
SERVICING WORKSHOP**  
at our Flying Unit based at  
Turnhouse Airfield. Applicants should hold current "A" and "B" Licences and have wide experience of V.H.F., H.F., and GEE overhauls, repairs and modification to A.R.B. and A.I.D. Specifications. Staff position with membership of Pension Scheme and an appropriate salary will be offered. Please apply to the Personnel Officer, Ferranti Ltd., Ferry Road, Edinburgh, 5, quoting Ref. 59/SLTID.

## MUIRHEAD & CO. LTD., BECKENHAM, KENT, REQUIRE DEVELOPMENT ENGINEERS

for interesting work on development of Synchros and Facsimile equipment. In particular the vacancies require:—

(a) Qualified Engineers with Honours Degree. Industrial experience not essential.

(b) H.N.C. with practical experience; or without academic qualifications but having a good engineering background.

Salaries commensurate with qualifications and experience. A Pension Scheme is in operation and the Company has its own Sports Ground. Please write giving full particulars to the Personnel Manager.

**LICENCED RADIO ENGINEER**  
required  
for **D. H. Heron & Dove Fleet**  
Apply:  
**MORTON  
ENGINEERING SERVICES LTD.,**  
Croydon Airport, Surrey.

## UNILEVER LIMITED

The following staff are required at the London Headquarters for the development and application of electronic and other process control devices and for the application of automation techniques:—

**JUNIOR ENGINEERS** with University degree or equivalent, graduate membership of the I.E.E., I.Mech.E., or Inst. Physics, and some industrial experience—preferably a recognised apprenticeship.

**TECHNICAL ASSISTANTS** with O.N.C. in Electrical Engineering, Inter B.Sc. Physics or Engineering, or equivalent C. & G. Certificate. Some experience in constructing and testing electronic and other light current equipment is essential.

**DRAUGHTSMEN** with experience in designing and developing electronic and electromechanical process control devices, light mechanisms and other automation equipment.

Starting salaries according to qualifications. These posts are permanent and pensionable. Apply in the first instance to:

**Head Office Staff Dept. (WF 8),  
Unilever House, Blackfriars,  
London, E.C.4.**

## MURPHY RADIO ELECTRONICS DIVISION

ENGINEERS are required in the design laboratories to work in the following fields:—

**SPECIAL PURPOSE TELEVISION  
EQUIPMENT**

**MOBILE COMMUNICATION SYSTEMS**

**POINT TO POINT TELEPHONE RELAYS**

**TELEMETER DEVICES**

**RADAR NAVIGATIONAL AIDS**

**AIRCRAFT AND GROUND AERIALS**

Both Senior and Junior engineers are required and there is ample opportunity for advancement to staff with energy and initiative who are willing to accept responsibility.

Location of laboratories allow easy access to both London and open country and Sports Club and other recreational facilities are available locally. Good conditions of employment including a Pension and Life Assurance Scheme.

Apply in writing initially giving full details of age, experience and qualifications to:—

Personnel Department (E38),  
Murphy Radio Limited,  
Welwyn Garden City,  
Herts.

## VACANCIES IN GOVERNMENT SERVICE

A number of vacancies, offering good career prospects, exist for:—

**Radio Operators — Male**

**Cypher Operators—**

**Male & Female**

Apply, giving details of education, qualifications, and experience, to:—

Personnel Officer,

G.C.H.Q. (FOREIGN OFFICE),  
53 Clarence Street,  
Cheltenham.

## ELECTRONICS IN SCOTLAND

**BARR & STROUD LTD., ANNIES-  
LAND, GLASGOW, W.3.** have vacancies in their Research and Development Department for:—

**ELECTRICAL ENGINEERS  
AND APPLIED PHYSICISTS**  
to engage in work on

1. Micro-wave circuit and aerial development.
2. Servo-mechanisms.
3. Guided weapons projects.

The laboratories and works are modern, well equipped, and pleasantly situated on the outskirts of Glasgow. Applicants should write to Managing Director, giving details of qualifications and experience.

## R. B. PULLIN & CO. LTD.

have vacancies to offer in their steadily expanding organisation for **ELECTRONIC DEVELOPMENT ENGINEERS** to be concerned with the design of a variety of equipment including specialised instruments and **TELE-COMMUNICATIONS SYSTEMS.**

The appointments offer various degrees of seniority, and, therefore, qualifications ranging from O.N.C. to Degree standard are acceptable; applicants should have had appreciable previous experience of valve circuit design. For some of the appointments experience of transistor circuit techniques is also an advantage.

All appointments are permanent and carry attractive salaries. To engineers of ability and initiative they offer excellent prospects and the opportunity to work in a very well-equipped Laboratory on a variety of interesting long-term projects which involve considerable technical responsibility.

A comprehensive pension scheme is in operation; Canteen and Social Club facilities are available.

Existing Holiday arrangements will be respected.

Applications will be treated in strict confidence and should be made to:

**THE SUPERINTENDENT,  
ELECTRONIC DEVELOPMENT  
DIVISION,  
R. B. PULLIN & CO. LTD.,  
GREAT WEST ROAD,  
BRENTFORD, MIDDLESEX.**

## FERRANTI LIMITED, EDINBURGH

### REQUIRE ADDITIONAL PERSONNEL

for important work in connection with the testing of electronic equipment and the design and manufacture of production test equipment. The vacancies require men of ability and experience, preferably with some radar knowledge. Graduates, or engineers of equivalent status will be given preference, but persons with practical experience are also invited to apply. Staff status, with membership of pension scheme, and appropriate salaries will be paid.

Please send full particulars of experience to date to the Personnel Officer, Ferranti Limited, Ferry Road, Edinburgh 5, quoting Ref. ETD.59.

## MULTITONE ELECTRIC CO. LTD.

invite applications from  
Intermediate and Junior

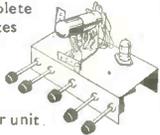
### ELECTRONIC ENGINEERS

for work on the development and testing of an interesting range of new electronic projects. There are vacancies for engineers with a wide range of qualifications and experience up to and including H.N.C. standard. Experience of development work or fault-finding advantageous. Preferred age range 20/30 years but applications will also be considered from young men who have recently left school with Higher School Certificate in Science. Apply stating age and giving particulars of education, training and experience to 12/20, Underwood Street, London, N.1.

## OSCILLOSCOPE

(MINIATURE TYPE—1" C.R.T.)

Supplied in kit form complete with full instructional notes for radio & T/V servicing. Operates from power supply of most AC domestic radio receiver equipment or from power unit supplied as an extra.



**Cash £10** (inc. post/pkg.) or 30/- down and 9 monthly payments of £1 (Total Price £10.10.0.) (Power unit, if required, £3 extra)

Order now or send for further details to:—  
E.M.I. INSTITUTES, Dept. S.C.127, London, W.4

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## COUNTY BOROUGH OF BOLTON EDUCATION DEPARTMENT BOLTON TECHNICAL COLLEGE Full-time Course in Electronic Engineering

A three-year full-time course in Electronic Engineering is now available. Candidates should be in the age range of 16 to 18, and have taken, or be taking, General Certificate courses at the Ordinary level in Mathematics or Physics, or equivalent courses in technical institutions.

This rapidly developing industry offers new and attractive openings to qualified men, and students who have passed through the course are readily absorbed by industry.

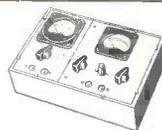
Application forms and particulars may be obtained from the Principal, Technical College, Manchester Road, Bolton.

Education Offices, W. T. SELLEY,  
Nelson Square, Chief Education Officer.  
BOLTON.

## PORTABLE TEST PANEL

for workshop  
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Two separate moving coil meters for voltage, current and resistance measurement. In wooden case with metal front and test prods.



Ranges (AC & DC)  
0-30mA  
0-10v, 0-25v  
0-500v  
0-10,000 ohms  
Size 8½" x 5½" x 2½"  
light and portable.

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Order now from:—  
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## PHYSICISTS AND ELECTRICAL ENGINEERS

Progressive positions are open to qualified people of degree standard for work on development and manufacture of special radio valve and microwave devices.

Initial training at the Research Laboratories of the G.E.C. will be available for certain selected candidates.

Canteen, pension fund and social club.

Apply quoting T/1 to:—

**Personnel Officer, THE M.O. VALVE CO. LTD., Brook Green, Hammersmith, W.6.**

MANUFACTURERS OF VALVES for G.E.C.

Electrical and electronic engineers are required for interesting work concerned with calculating machines and digital computers. Vacancies exist in the electrical laboratory and engineering department of our Scottish Factory and the work consists of:

- (1) Detailed investigation into the quality of electrical/electronic components for computers.
- (2) Design of electronic test equipment for computers production tests.
- (3) Study of newly developed computers circuitry and the introduction of new computers to production.

Qualifications for these vacancies are University Degree in electrical engineering or equivalent and at least two years experience in electronic development or production work. Application forms can be obtained from Personnel Manager, I.B.M. United Kingdom Ltd., P.O. Box 30, Greenock. Quote reference F.B.I.

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# Bridge Meggers

Series 2 250 volt £25.  
500 volt £45.  
1,000 volt £55.

Packing and carriage 12/6.

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Evershed and Vignoles Wee Megger

500 volt £12.10.0.

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All with leather cases.

WESTON Multirange tester model 785.  
20,000 ohms per volt, from £12.10.0.

## METERS

4" sq. 0-50 microampere, £5.10.0. p.p.

A.C. current, any size single or up to 8 ranges. 1 mA.-10 A. F.S.D. with current transformer.

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All types and makes of single and multi-range meters repaired and converted to your requirements.

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# Heterodyne Frequency Meters

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- Navy version of BC221, modulated
- Frequency range 125-20,000 kc/s.
- Overall accuracy: 0.01% from -32 to +65°C.

# UNIVERSAL ELECTRONICS

22 LISLE STREET, LONDON, W.C.2

## LYONS RADIO LTD.

**WAVEMETERS TYPE W1810.** Frequency range 155 to 230 Mc/s. Contain their own built-in power pack for operation from 200/250 v. 50 cps. A.C. mains. Beautifully made and housed in copper lined wooden instrument cases 18x11x10in. Complete with valves and test prod. Can also be adapted for use as a signal generator. A most useful addition for any laboratory or test room and a good buy as a breakdown for parts alone. In good condition and working order. PRICE ONLY £37/7/6, carriage 6/6.

**RECEPTION SETS R.109B.** Frequency range 3 to 12 Mc/s (25 to 100 metres). Ex Army 8-valve superhet receivers for operation from 6 v. motor cycle or car battery. In good condition and working order. For fuller details see last month's W.W. page 138 or send S.A.E. PRICE ONLY with valves 85/-, less valves 45/-, Carriage 8/6.

**METERS.** A.C. Voltmeters, m/c rectifier type (1,000 ohms/volt), 3 1/2 in. dia. 0/100 volts. PRICE 15/- Selected resistor to extend range to 300 v. 1/6. D.C. Voltmeters, m/c type, 2 1/2 in. sq. 0/40 volts. PRICE 7/8. Microammeters, m/c type, 2 1/2 in. dia., 0/500 micro-amps. PRICE 17/8. Post all types 1/3.

**VALVE SPECIALS.** CV173 (EF55), 12/6. CV7 35/6. D63 3/6. VE503 (KT33C) 9/6. VU508 9/6. 6V6G or G.T. 8/6. 807 5/-, Post 9d.

**2MFD. HIGH VOLTAGE CONDENSERS.** Working 5,000 v. D.C. Test 10,000 v. D.C. Overall size 9in. high x 1 1/2 in. long x 6in. PRICE 12/6. Carriage 5/6.

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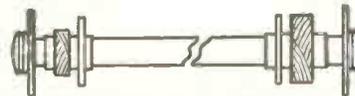
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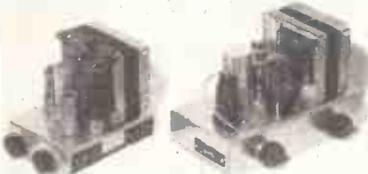
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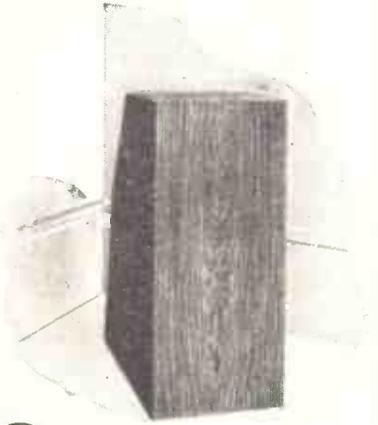
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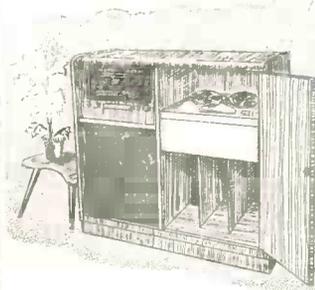
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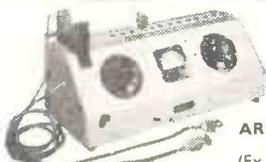
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WANTED, BC610 Hallicrafters, E.T.4336  
transmitters, BC321 receivers, BC221  
frequency meters and spare parts for all above;  
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URGENTLY required, scrap platinum wire,  
contacts, etc.; spot cash for any quantity;  
£30 per oz tray.—The Scientific Metal Co., 50,  
Old Brompton Rd., London, S.W.7. Tel. Kni.  
2534. [7009]

URGENTLY wanted, manuals or instruction  
books, data, etc., on American or British  
Army, Navy or Air Force radio and electrical  
equipment.—Harris, 93, Wardour St., W.1.  
Gerrard 2504. [16993]

WANTED.—Surplus and redundant stock  
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ent equipment; details to—Stewart Aeronau-  
tical Supply, Co., Ltd., Adastral House, Low-  
field Heath, Crawley, Sussex. [6997]

WANTED, tape recorders, domestic radios,  
amplifiers, record players, communications  
receivers; also the above taken in part ex-  
change for new equipment; call, send or phone  
Gerrard 2613.—Radio Exchange, Newport Place  
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ALL U.S.A. V.H.F. test and communication  
equipment; TSI74, TS175, TS47, B.C.221  
freq. meters; receivers 1294, 1359; Hallicrafters  
S.27, S27CA, U.S.A. APR4 and tuning units  
T.N.17, 18 and 19, S.C.A. AR88-D.L.F. Hal-  
licrafters SX28; valves 707A-707B, 2K28, 2K39,  
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Ger. 8410 and 4447.—Universal Electronics, 22,  
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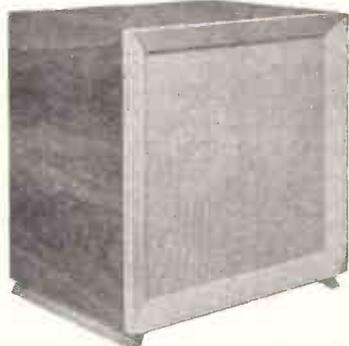


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**BRITISH SOUND RECORDING ASSOCIATION.** Details of membership, open to the professional sound recording engineer and all others interested in recording high quality reproduction and other branches of audio engineering, together with details of the London lecture programme and the Manchester, Portsmouth and Cardiff Centres, may be obtained from the Hon. Membership Secretary, H. J. Houlgate, A.M.I.E.E., 12, Strongbow Rd., Eltham, S.E.8. [0031]

**BUSINESS OPPORTUNITIES**

**ITALIAN** firm interested in importing English radios, televisions, tape recorders and related electronic equipment.—Please send literature and prices to: C. A. Posnansky, Casella Postale No. 38, Bari, Italy. [7169]

**WELL-KNOWN** firm of precision engineers and instrument makers (London area) are desirous of entering into a licence agreement or purchasing outright patents relating to electrical and/or mechanical devices of a precision instrument character, or of a consumer goods nature; adequate capital and production facilities are available to develop, produce and market suitable devices.—Communications should be addressed, in the first instance, to Box 7247. [7146]

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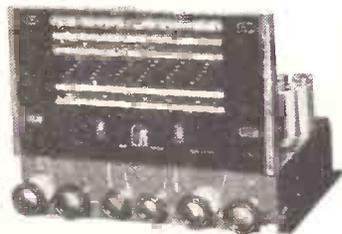
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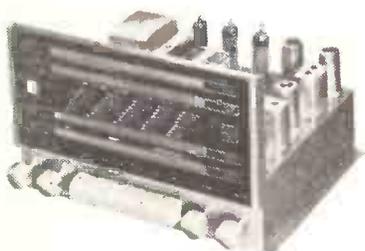
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- Independent and Continuously variable Bass and Treble Controls with visual setting indicators.
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A FULLY experienced man is required by The British Tabulating Machine Co., Ltd., Letchworth, Herts to lead a small section preparing circuit diagrams of electronic computers and the like at their Essex premises.

Much more than a knowledge of symbols and first-class draughtsmanship is required; the successful applicant should be able to prepare lucid circuit diagrams from engineers' rough drawings, in which causes and effects are immediately apparent. The opening is likely to interest those with experience in circuit delineation.

WRITE, giving full particulars, to the Personnel Officer, quoting reference W/783. [7171]

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APPLICANTS must have had a sound training and practical experience in the installation, maintenance and repair of various makes of radio and television sets.

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CANDIDATES should be Members, or Associate Members, of the British Institution of Radio Engineers, hold the Final Certificate of the Radio Trades Examination Board for Television and the City and Guilds Certificate in Radio and Television Service.

SALARY—N.J.B. Class K, Grade 10. £935/20/95 per annum.

APPLICATIONS, giving full details of age, qualifications and experience, together with the names of two referees, should be forwarded to the Manager, No. 6 (Hall) Sub-Area, Yorkshire Electricity Board, Queensway, Kingston-upon-Hull, not later than August 6th, 1957. [7193]

## ASSISTANT Controllers of Telecommunications.

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APPOINTMENTS on contract/gratuity terms with salary according to qualifications and experience in the range \$818 to \$1,699 (£1,145 to £2,378 per annum). Variable Cost of Living Allowance. Single candidates: minimum gross emoluments £1,218 maximum £2,120; married, no children, minimum £1,440 maximum £2,499; married with children, minimum £1,531 maximum £2,750. Substantial gratuity; free passages' quarters available, at reasonable rentals; generous leave.

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MAN with some experience of television testing for work in our Weybridge factory. ALSO: Wiring Inspectors (female), 44-hour, 5-day week; top rates of pay; clean and pleasant working conditions; canteen, social club, etc. APPLY:—Personnel Officer, Peto Scott Electrical Instruments, Ltd., Addlestone Rd, Weybridge, Surrey. [7158]

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CAR RADIO (Command Receiver, Medium wave), circuit and modification data, 1/6. HRO Vibrapacks 6 v. D.C. to 180 v. 50 mA., smoothed, cased, 22/6 (post 3/-). Bendix Rxs. RA-10/DA Med., Long and 2 Short w/bands, new, 90/- (car. 7/6). Accumulators, Varley Dry 2 v. 15 AH, 12/6, wet 14 AH, 7/6. Metro-sils 1 1/2. Carbon Potentiometers, 20 spindles, 20 k. 1 meg. range, 10/6 doz. Switches Arrow DPST, 1/6; Diamond SPDT 1/6; G.P.O. type push-pull DP c/o, 1/-; H.F. Chokes (Bulgin), SW69 or SW144, 1/-; Indicator Units, new, with VC97, 3/VR91, 2/ CV18, 2/VR54, 2/- (car. 6/-). Responder ZC8931/190 220 mos., with valves, 17/6 (car. 6/-). VIBRATORS, Mallory G629C 12 v. 4 pin, 7/6. THERAT MICS., new, 2/6. SUPPRESSORS, radio interference, ex-A.M., 5/6 (post 2/-). BRAND NEW RF.28, 27, 25/- (post 2/6); RF.25, 10/6. RF.28/27, damaged dials, 15/-; CONTROL UNITS with 6 G.P.O. Key switches, 15/- (p.p. 3/-). DYNAMOTORS (post 3/-); 12 v. to 230 v. 65 mA., and 6.3 v. 2.5 A., 10/6; 6 v. to 250 v. 80 mA., 12/6. EDDYSTONE, 12 v. to 190 v. 75 mA., cased, 15/-; Input 24 v., outputs 475 v. 210 mA. or 360 v. 20 mA., 22/6. METAL RECTIFIERS: 750 v. 80 mA., 7/6; 500 v. 300 mA., 10/-; 240 v. 30 mA., 3/6; 140 v. 30 mA., 7/6. 6 v. 13 A., 25/-; 90 v. 30 mA., 1/-; 120 v. 2 A., Bridge, 30/-; R155 coil packs, used, 9/6. R155 S.M. Tuning DRIVES "N" type, brand new, 10/6. CHOKES, L.F., Ferranti, 10H, 120 mA., Screened, 7/6. 10H, 200 mA., 5/6; 10H, 400 mA., 12/6. 5H, 200 mA., 4/6. "C" core 10H, 130mA, 12/6. SWITCHES, wafer: 1 pole 6 way, 1 bank, 1 p 11 w 1b, 1p 8w 1b, 1p 3w 3b, 2p 5w 2b, 4p 2w 1b, 1p 6w 5b, 1p 6w 2b, 2/6; 1p 11w 2b, 6p 2w 4b, 3/6. Stud type, 1p 9w 2b, 4/6. Winker-Falton type 1P24W2B, 7/6. TRANSFORMERS: "C" core 230 v. in.; outputs: 315-0-315 v. 60 mA., 5 v. 2 A., 6.3 v. 1.5 A., 25/- (p.p. 3/-). 285/315 v. 350 mA., 790/850 v. 480 mA., 40/- (car. 7/6). Open 230 v. to 50 v. 3 A., 22/6 (post 3/-). Potentiometers, w. wound 20 k., 3 1/2 inch dia., ceramic, 4/6. KEY ELBOWS or sockets, 8d. each. Transmitter/Receivers: No. 18, with valves, 50/-; No. 19, with valves, 70/- (each less attachments, car. 7/6); No. 46, with attachments, and 2 xtals., 65/- (car. 7/6). List and enquiries, S.A.E. please! Terms, C.W.O. Postage extra. Immediate despatch.

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YORKSHIRE Division.

APPLICATIONS are invited for the following appointments in the Technical Department (Communications Section):

**THIRD Assistant Engineer**—based near Leeds. COMMENCING salary within the range £1,055-£1,180 per annum, Grade 3, Class AX, National Joint Board Agreement (Schedule "B"), according to qualifications and experience, rising to an ultimate maximum of £1,320 per annum (Class EX).

**THIRD Assistant Engineers**—based on various locations in the Division.

COMMENCING salary within the range £695-£1,020 per annum, Grade 4, Class AX, National Joint Board Agreement (Schedule "B"), according to qualifications and experience, rising to an ultimate maximum of £1,140 per annum (Class EX).

APPLICANTS should possess technical qualifications leading to Corporate Membership of the Institution of Electrical Engineers and have had experience in various applications of communication and electronic technique, e.g., telemetering, supervisory control and automatic exchanges.

**FOURTH ASSISTANT ENGINEER**—based near Leeds.

COMMENCING salary within the range £810-£935 per annum, Grade 5, Class AX, National Joint Board Agreement (Schedule "B"), according to qualifications and experience, rising to an ultimate maximum of £1,035 per annum (Class EX).

**FOURTH Assistant Engineers**—based on various locations in the Division.

COMMENCING salary within the range £710-£835 per annum, Grade 4, Class AX, National Joint Board Agreement (Schedule "B"), according to qualifications and experience, rising to an ultimate maximum of £935 per annum (Class EX).

APPLICANTS should possess or be completing technical qualifications as above and should have some experience in applications of communications and electronic technique.

APPLICATION forms obtainable from the Divisional Secretary (Establishments), Central Electricity House, St. Mary's Road, Leeds. To be returned within 14 days of the appearance of this advertisement. [7168]

**DIRECTOR** of Electricity and Telephone: To Department, Antigua, Leeward Islands.

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CONTRACT appointment for three years in first instance; salary £1,500 p.a.; contract gratuity—12% of salary; free passages for officer wife and up to three children; unfurnished quarters at rental of 10% of salary; generous leave.

CANDIDATES must be A.M.I.E.E., under 45 and have had considerable experience in installation and running of diesel-operated generating stations, construction and maintenance of both overhead and underground H.V. and L.V. lines, the installation and maintenance of distribution transformers, the testing and maintenance of consumers' meters, the installation and maintenance of C.B. and magneto telephone exchanges including subscribers' P.B.X.s, the construction and maintenance of overhead and underground telephone lines, the installation and maintenance of subscribers' services, etc.; knowledge of refrigerating plants desirable. WRITE Director of Recruitment, Colonial Office London, S.W.1, giving age, qualifications and experience, quoting BCD 145/34/01. [7170]

**NORTHERN POLYTECHNIC,** Holloway, London, N.7.

THE Governing Body invite immediate applications for appointment as full-time Assistant Lecturer Grade "B" in the Department of Telecommunications; the duties will include teaching in telecommunications engineering and in radio and television servicing; a knowledge of electronic instrumentation is desirable; salary scale: £650-£225-£1,025, together with allowances in accordance with the Burnham Award; commencing salary according to age, qualifications and experience. [7160]

**REQUIRE** for interesting research development work on electro-acoustic devices, an Engineer up to B.Sc. standard.—Apply Box 8273.

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**RADIO Engineer,** first-class required for approx. 12 months service overseas; large firm engineers; excellent opportunity; write experience, age, references.—Box 8576. [7098]

**AUDIO and television engineer** required by a leading manufacturer, applicants to submit full details of qualifications and experience; all applications treated as strictly confidential.—Box 0505. [7187]

**TRANSFORMERS**—Small manufacturer, Oxford, seeks young man with good theoretical knowledge as design engineer for coupling transformers; salaried superannuated appointment with good prospects.—Box 0140. [7166]

**SALESMAN** required with ability to sell television aerials and components to the wholesale trade in the North-West; preferably resident in Manchester or Liverpool.—Applications in strict confidence to: General Sales Manager, Labgear (Cambridge), Ltd., Willow Place, Cambridge. [7182]

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THE work embraces acoustics and electronics and involves the application of the basic physical principles underlying ultrasonics, telecommunications and computers. Some knowledge of these fields would be an advantage.

THE initial salary will be in accordance with experience and qualifications within a scale which allows ample scope for future development. A contributory pension scheme is available and assistance in housing or removal expenses may be given in suitable cases.

APPLICATIONS, which may be made in strictest confidence, should give full details of qualifications, previous experience, age and salary required, and be addressed to Box 0353.

A.B.C. television require experienced television studio engineers for their Manchester studios.—Application should be made in writing to A.B.C. Television Studios, Manchester 20. A.B.C. Television Studios, Manchester 20. [7185]

SUPERVISOR required by leading manufacturer of high-quality loudspeakers and microphones; experience in this field and ability to control female staff essential. Full particulars and wages required.—Box 8847. [7159]

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DRAUGHTSMEN.—E. K. Cole, Ltd., South-end-on-Sea, have vacancies for draughtsmen for the design and production drawing of electronic apparatus or radio and television for mass production.—Write, stating age, qualifications and experience, to Personnel Manager

RADIO engineer.—A vacancy occurs in small, active manufacturing company in the Home Counties for a man with a sound knowledge of L.F. amplifiers to undertake development work on sub-miniature units. First class progressive appointment for young man with suitable experience; write details.—Box 0141.

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ELECTRONIC Engineers required for work on Transistor and other electronic projects. The minimum qualification for senior post H.N.C. or equivalent. For junior post, O.N.C., but consideration would be given to advanced student of special ability. North London district.—Box 8125. [7043]

KELVIN & HUGHES (AVIATION) require Field Service Engineers for work on production of new aircraft instrumentation systems. Practical work on aircraft, instrument and electronic equipment is essential and applicants should possess Higher National Certificate in Electrical or Mechanical Engineering or equivalent.

SALARY will be paid according to qualifications, experience and ability, but is based on generous scales, and adequate payment during illness and contributory pension scheme, etc., are in operation. Canteen, medical services, sports and social facilities are also provided.

APPLICATIONS should be made in writing giving full details of age, qualifications, experience, etc., to the Personnel Manager, Kelvin & Hughes, Ltd., Winchester Road, Basingstoke. [7200]

MARINE Radar Instructor required at Leicester factory for instructing ship officers and servicing personnel in the operation and maintenance of Marine Radar equipment; occasional visits to ship are a part of the duties; previous radar servicing experience desirable.—Apply Construction Department, The British Thomson-Houston Co., Ltd., Rugby.

AN experienced inspector with considerable practical knowledge, mechanical and/or electrical is required for site work; applicants must be prepared to travel and be away from home for periods of several months at a time.—Letters of application to be addressed to Chief Inspector, Scanners, Ltd., Woodskippers Yard, Bill Gussy, Gt. Gheens, 10. [7151]

ELECTRONIC engineers required at N.C.B.'s Mining Research Establishment, Worton Hall, Isleworth, Middlesex, to assist in the design and development of mechanical, electro-mechanical and electronic instruments used in mines and laboratories. Occasional underground may be necessary. O.N.C. or H.N.C. in Applied Physics or Electrical Engineering is required.

APPOINTMENTS (superannuable), variously graded, within inclusive scales from £492-£1,069, according to qualifications and experience—5-day week, staff canteen and good prospects of promotion; for junior grades there are facilities for further education.

WRITE, stating age, education, qualifications and experience, to the Personnel Officer at the above address, marking envelope X.784/C.

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36in. wide, 35in. high, with choice of Motor Boards either (A) 35 x 14in., as shown, or (B) 17 x 14in. and control panel 15½ x 12½in. Amplifier compartment and L.P. record storage in lower section. Price £15/15/- or 47/- Deposit and 9 payments of 32/1 monthly. Supplied in Oak, Walnut and Mahogany veneers finished to required shade. Delivery England and Wales 12/6 (Scotland, N. Ireland and Channel Isles 25/-).

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- All post extra from 1/6-3/-. E.H.T. Rects. 14D134, 25/-; 36EHT60, 35/10, post 4d. 1 m.a. A.C./D.C. meter-rects., 14/6.

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## SITUATIONS VACANT

**ASSISTANT to Chief Inspector** required for work in quality control laboratory of Electronic Component Manufacturer (E. London); applicant should be interested in electrical measurements.—Write Box 0354. [7191]

**PROFESSOR RADIO & TELEVISION, Ltd.**, require Development Engineers for Commercial Television projects; senior and junior positions available; previous experience essential for senior positions; excellent salaries and usual large company advantages, pension scheme, etc.—Write to the Technical Director, Cossor Radio & Television, Ltd., Cossor House, Highbury Grove, N.5. [7190]

**INSTRUCTORS** required by Posts and Telegraphs Department, Nigeria Federal Government on contract for one tour of 12/24 months in the first instance. Commencing salary according to experience in scales set out below. Outfit allowance £60. Gratuity at rate of £150 a year. Free passages for officer and wife. Assistance towards children's passages and grant up to £150 annually towards maintenance in P.M. technique. Liberal leave on full salary.

**INSTRUCTOR, Grade I (M2C/42120/WF)**. Candidates, preferably under 40 years of age, should have had experience in the installation or maintenance of multi-channel radio telephone systems and be conversant with V.H.F. and P.M. techniques. They should have had at least 3 years' teaching experience and possess C. & G. certs. in Telecomms. Principles III and Radio III or equiv. Salary scale (including Inducement Addition) £1,556 rising to £1,674 a year.

**INSTRUCTOR, Grade II (M2C/42145/WF)**. Candidates preferably under 35 years of age, should have had practical experience in the installation and maintenance of radio telephone systems. They should have had recent teaching experience and possess appropriate C. & G. certs. or equiv. Salary scale (including inducement Addition) £1,170 rising to £1,488 a year.

**WRITE to the Crown Agents, 4, Millbank, London, S.W.1** State age, name in block letters, full qualifications and experience, and quote the reference number shown against the post applied for.

**CHIEF of Test** required for the Weapons Research Division (Guided Missiles) of A. V. Roe & Co., Ltd., Woodford; applicants should have experience of testing prototype and production electronic apparatus and instruments; familiarity with A.I.D. requirements would be an advantage.—Applications to Personnel Manager, A. V. Roe & Co., Ltd., Greengate, Middleton, Manchester, quoting reference WRD/MJC/R.1/W. [7177]

**RADIO technicians** required by International Aeradio, Ltd., for overseas service; permanent and pensionable positions; inclusive salary from £894 per annum to £1,373 per annum, tax free, according to marital status; free accommodation; kit allowance; free air fares; generous U.K. leave.—Qualified candidates, to whom replies only will be sent, please write, quoting RT to Personnel Officer, 40, Park St., W.1. [0262]

**TEST engineer:** we have a number of vacancies in our final test room, which offers a prospect of interesting jobs in this rapidly expanding company; candidates should either have had considerable previous experience in the electronic industry or to be at least O.N.C. standard, 5-day week, contributory pension scheme, staff clubbing.—Call or phone Electronic Instruments Ltd., Lower Mortlake Rd., Richmond, Richmond 5656. [7176]

**SKYWAYS, Ltd.**, require the following experienced radio mechanics: 1, at Lympne airport, to work on ground and aircraft equipment; 2, at Stansted airport, for employment in workshops and on maintenance of aircraft in aircraft; applicants must be fully experienced particularly in workshop practice; good rates of pay and conditions of service.—Apply with full details to Personnel Manager, Skyways, Ltd., Stansted Airport, Essex. [1559]

**ELECTRONIC inspector** required for site work; experience on centimetric radar equipment is necessary, and applications will be considered from ex-service technicians or men with similar experience who are prepared to travel and be away from home for periods of several months at a time.—Letters of application to be addressed to Chief Inspector, Scanners, Ltd., Woodskippers Yard, Bill Quay, Gateshead, 10. [7150]

**ENGINEERS** with experience of Gyroscopes are offered careers by a leading company in the field of Guided Weapons; applicants will find that experience is just as valuable as academic qualifications; the work concerns the design, development and testing of weapon components; please write, in confidence, for further details, to the Personnel Manager (ref. 20B), De Havilland Propellers, Ltd., Manor Rd., Hatfield, Herts. [7174]

**SIGNAL Technician** required by Kenya Government, Police Force on probation for pensionable employment, salary scale (including inducement addition) £813 rising to £1,341 a year, commencing salary according to age and experience; outfit allowance £40, free passages for officer and wife and assistance towards cost of children's passages, liberal leave on full salary; candidates, preferably not over 40 years of age, must have a wide knowledge of the installation, running and maintenance of H.F. communications equipment, fixed and mobile V.H.F. equipment and installation and maintenance of artillery equipment; experience with V.H.F. multi-channel equipment, teleprinters, facsimile equipment would be an advantage.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/42335/WF. [7188]

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Capable of full output of 50 watts from 25~ to 35,000~

- PRIMARY**  
6,000Ω C.T. tapped 43% and 25%.
- SECONDARY**  
0.45Ω, 1.8Ω, 4Ω, 7Ω, 11Ω, 16Ω  
22Ω and 30Ω to handle 50 watts

**Approximate characteristics:**  
Primary resistance: 50Ω+50Ω.  
Primary inductance: 50 hys

**Leakage Reactance:**  
Primary to secondary: 6 m/Hys.  
Half primary to secondary: 3 m/Hys.  
Half primary to half primary: 6 m/Hys.

**Open type:**  
5 1/2 in. x 4 1/2 in. x 5 3/4 in. high.  
Fixing Centres: 4 3/8 in. x 3 3/8 in.  
Weight: 14 1/2 lbs.

**Potted type (Hammer Grey finish):**  
5 in. x 5 1/2 in. x 6 1/2 in. high.  
Fixing Centres: 3 3/8 in. x 5 in.  
Weight: 15 lbs.

Transformer type 4N1 is designed to handle 50 watts in the Ultra Linear Circuit where cathode bias is employed

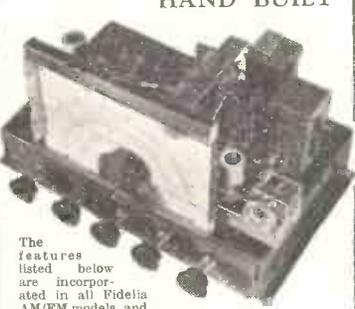
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VHF/FM reception with low noise R.F. stage, variable selectivity, medium and long wavebands, negative feedback tone control circuit, having separate bass and treble controls. Triode output stages. Tuning indicator. High quality gramophone amplification. Audio response not less than 20-20,000 cycles.

Fidelia AM/FM De-Luxe, 11 valves, 7 watt push-pull output. **£33/12.**

Fidelia Major, 12 valves. Tuned R.F. stage on all wavebands. VHF, S, M, and L wavebands. Gram. pre-amplifier, input corrector for all pick-ups. Separate 9 watt power amplifier. **£44.**

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Full details of these and our other models willingly on request.



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**SITUATIONS VACANT**

**D**RAUGHTSMAN required to join a team working on the design and development of high-power audio amplifiers for specialised applications; enthusiasm, initiative and a sound appreciation of practical problems are more important than formal qualifications; experience on electronic equipment is highly desirable.—Write, in confidence, giving brief details of qualifications and experience, to Goodmans Industries, Ltd., Axiom Works, Wembley, Middlesex. [7143]

**E**LECTRONICS Technician.—Department of Biochemistry, University of Oxford, require an electronics technician to construct and maintain electronic apparatus for research; the post requires a man who is keen and willing to use his initiative; some knowledge of workshops practice an advantage but not essential; salary on University scale according to age and experience, 54-6 weeks' paid holiday per year.—Applications in writing to Administrator, Department of Biochemistry, South Parks Rd., Oxford. [7156]

**A**n interesting position for an electronic development engineer occurs in a laboratory engaged in a large variety of original work. The field covered includes: industrial instrumentation, servo, audio circuits, pulse work; experience in one or more of these is desirable. Academic qualification up to H.N.C. would be an advantage, but the relevant experience will be taken into account.—The replies should be addressed to: Chief Engineer, Winston Electronics, Ltd., Govett Ave. Shepperton, [7152] Utesex.

**A**n engineer with sound knowledge of light and electro-mechanical engineering material and/or finishes required to advise on existing and new materials and processes, and to assist with general engineering development and the preparation of specifications. Interesting work, good salary and conditions with an A.E.I. company. Opportunity for responsibility and progress for the right man.—State qualifications, experience and salary required, to Staff Officer, ref. 744/80, Siemens Brothers & Co. Ltd., Woolwich, S.E.18. [7145]

**SENIOR** Mechanical Design Draughtsmen are required by the Design Department of Murphy Radio, Limited, to work on radio and television; experience of similar work is essential and preference will be given to applicants between the ages of 25 and 35; this affords an opportunity to join a successful and expanding design team providing excellent scope to men of initiative and originality; Welwyn Garden City is most pleasantly situated within easy reach of London, and applicants from the London area would be eligible for housing after a period; apply by letter initially, giving details of age, experience, and qualifications, to Personnel Department (R.9), Murphy Radio, Ltd. Welwyn Garden City, Herts. [7162]

**SENIOR** Assistants (Scientific)—The Civil Service Commissioners invite applications for pensionable posts: (a) Admiralty, 20; (b) Royal Mint, 1; (c) Department of Scientific and Industrial Research, 5; (d) War Office, 5 (men only); (e) Ministry of Supply, 10. Age at least 27 on 31st December, 1957. Candidates must have reached school certificate credit standard in mathematics or a science subject, or have other approved qualifications (e.g., O.N.C.), but candidates otherwise well qualified by experience may be admitted. Every candidate must have had thorough experience in the duties of the class, and appropriate to the type of work to be gained by service in a Government department or elsewhere.

**UNDER** (a) 10 posts are for electrical engineers, including communication engineers, 2 mechanical engineers, 1 marine engineer, 2 mathematicians, 2 chemists, 1 physicist, and 2 for general duties. The posts are at naval establishments in London, and the South of England.

**THE** post under (b) requires knowledge of the processes of producing metallic silver.

**UNDER** (c) 1 post is at the National Physical Laboratory and calls for a good knowledge of thermometry; 2 posts are for electronic engineers at the Mathematical Engineering Research Laboratory, East Kilbride, near Glasgow; 1 post is at the Building Research Station, Garston, near Watford, Herts; 1 post is at the Pest Infestation Laboratory, Slough, Bucks, for work on problems of grain storage.

**UNDER** (d) 2 posts are at the David Bruce Laboratories, East Eyeleigh, near Marlborough, Wilts.—1 for a bacteriologist and 1 for a physicist; 3 posts at the Royal Army Medical College, Millbank, London, S.W.1—1 in the Serological Department, 1 in the Pathological Museum and 1 in the Virology Laboratory.

**UNDER** (e) the posts are classified: Glass blowing (1), Mathematics and Physics (4), Electronics (3), Engineering (1), Chemistry (1). FULLER information about the duties and the kind of experience expected is given in the memorandum.

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**APPLICATION** forms and memorandum from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting S 4712/57/13. Applications to be returned by 12th August, 1957. [7172]

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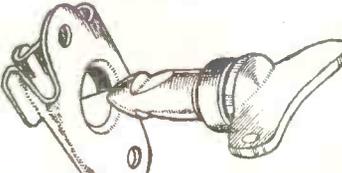
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**THE General Post Office** has vacancies for Radio Operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster General's First Class Certificate of Proficiency in Radiotelegraphy or an equivalent certificate issued by an Administration of the Commonwealth or of the Irish Republic; selected candidates will be considered later for permanent pensionable posts.—Applications should be made to the Inspector of Wireless Telegraphy, Radio Services Department, Wireless Telegraphy Section, Union House, St. Martins-le-Grand, London, E.C.1. [7100]

**RADIO** Technicians required for the Ocean Weather Service; duties include maintenance of radio and radar equipment and radar operation; experience in servicing radio and/or radar required; technicians from 30 to 36 days at sea followed by 9 to 22 days in harbour (Greenock); leave, 82 days a year, granted during harbour periods; pay, including additional allowances, at age 25 or over, £506 10s rising by annual increments to £716; food and accommodation free on board ship; prospects of promotion and pensionable employment.—Apply to Shore Captain, Ocean Weather Ship Base, Air Ministry (W.S. 12), Great Harbour, Greenock. [7165]

**ELECTRONIC** engineers, senior and junior, required for design and development work on high-power audio amplifiers for specialised applications; notification for consideration for senior position are a University Degree, City & Guilds Technological Certificate, or equivalent qualifications, together with experience on high-power amplifiers at the design stage. The junior post requires either B.Sc. or equivalent qualifications. Suitable applicants should have enthusiasm and initiative with a keen appreciation of the importance of the practical aspect of their work.—Write in confidence, giving brief details of qualifications and experience, to Foodways Industries, Ltd., Axton Works, Wembley, Middlesex. [7149]

**WIRELESS** operator mechanics required by Falkland Islands Dependencies Survey for service at isolated British bases in Antarctic; must be able transmit and receive morse at 20 words a minute and be capable elementary maintenance wireless transmitting and receiving equipment. Salary according to age in scale £230 rising to £420 a year with all found, including clothing and canteen stores. Keep young men between 20 and 30 years required, preferably single, of good education and high physical standard, with genuine interest in polar regions, and travel and willing to spend 30 months under conditions testing character and resource.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/4227/WF. [7165]

**RADIO** engineers required by Trinidad Government Wireless Branch, Works and Hydraulics Department for one tour of two years in first instance. Salary scale (including present temporary allowance of £30) equivalent to £780, rising to £1,250 a year. Commencing salary according to qualifications and experience up to maximum of scale. Gratuity rate equivalent £100/£150 a year. Oufit allowance £60. Free passages. Liberal leave on full salary. Candidates should be A.M.(Brit.), or holding examination or possess C. & G. Full Technological Cert. in Telecomms. Engineering. They should have had experience in wireless station management and maintenance and in the organization and operation of communication services. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2C/41953/WF. [7184]

**TELECOMMUNICATIONS** Research Staff (Engineers and Technicians) are required at our London Research Centre (Blackheath, S.E.18) for interesting and important new work in well-equipped and up-to-date laboratories; opportunities for original thinkers seeking experience, advancement and responsibility exist in the following fields: (a) Electronic switching and computer techniques. (b) Telecommunication transmission. (c) Transistor circuit applications; candidates expressing a preference may also be considered for engineering vacancies on closely allied development projects; engineers should have a degree, or H.N.C., plus previous practical experience in industry or research; technicians should have O.N.C. or G.C.E. at advanced level, and a definite interest in this type of work; as the research laboratories and main works are in London, technical staff can participate in the activities of professional institutions and attend a wide range of lectures and courses; attractive salaries, liberal pension scheme; assistance with housing difficulties, if required, may be available in approved cases; excellent sports club and canteen facilities; applications giving preliminary outline of qualifications should be sent to the Staff Officer, ref. 744/77, Siemens Brothers & Co. Ltd., Woolwich, S.E.18 (an A.E.I. company). [7070]



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9 x 8 x 2 1/2	7/6	12 x 9 x 2 1/2	8/11	17 x 9 x 3	11/6
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**THE SYSTEMS GROUP** of Elliott Bros. (London), Ltd., has vacancies for two Junior Electronics Engineers; this Group is concerned with system engineering and automatic process control and covers a very wide field of activities involving process instrumentation, telemetering, computing, data handling and control engineering; successful applicants will be required to carry out experimental investigations under the direction of senior engineers and will be given a first-class opportunity to gain experience in this new and vital field; in addition to work carried out in the laboratory, opportunities will arise for gaining experience on process plant, both in this country and abroad.—Applications giving details of qualifications and experience should be addressed to: Personnel Officer, Century Works, Conington Rd., Lewisham, S.E.13.

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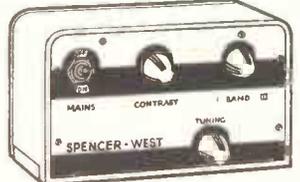
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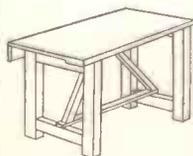
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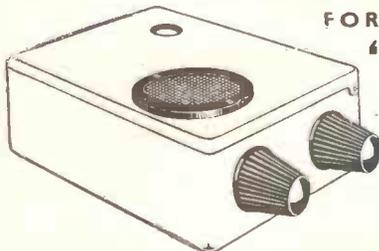
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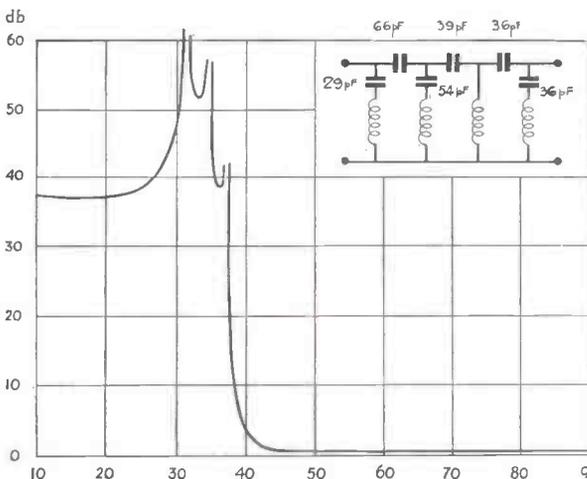
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