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# Wireless World

## ELECTRONICS

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# Wireless World

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JUNE 1960





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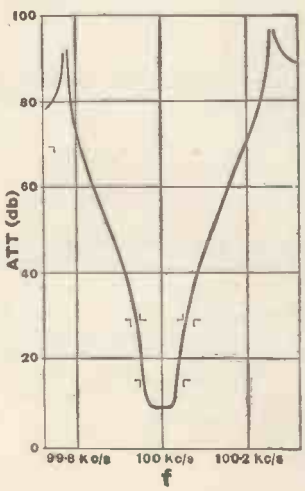


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JUNE 1960
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Wireless World

# The Universal Language

IF circuit diagrams are the universal language of electronics it is only right and proper that they should have a standardized grammar. Without this, communication becomes difficult. On the other hand, it is unreasonable to expect all who use the same grammar to speak with the same accent.

We are delighted with the lively discussion in our correspondence columns resulting from L. H. Bedford's letter on circuit conventions in the April issue. It is a subject on which everyone feels justifiably entitled to express an opinion, and on which the views of the young technician can be as sensible and worth-while as those of the experienced and highly qualified engineer. But in all these letters there does not seem to be any serious disagreement on the basic grammar of circuit drawing—only on such things as wiring cross-overs and junctions, valve envelopes and resistor "squiggles". Whether one would describe these as matters of grammar or of accent is open to question. They are certainly important to the easy reading of circuit diagrams, but not so important, we feel, as the general layout, the spacing and grouping of component symbols, the use of easily recognized configurations—and even the relative thicknesses of lines.

Several correspondents have reminded us that there is a British Standard on circuit conventions. We agree that these recommendations are an excellent guide to the draughtsman. But it is unreasonable to expect that everyone should follow B.S.530 slavishly and make all circuit diagrams look alike—just as it is unreasonable to expect a Mancunian to sound like a Londoner. The point is, surely, that circuit diagrams are drawn for very different purposes and on very different media—technical reports in laboratories, servicing manuals for technicians, wiring diagrams for the work bench, technical journals for general publication—and each of these has its own particular requirements and limitations. For practical reasons, then, the actual techniques of presentation must differ also.

In our own case (and we are often under fire on this subject), besides the general requirement of clarity and easy reading we have problems of sizing, space limitation, balance of diagrams to text and making our diagrams acceptable to people who cannot be expected to know anything about B.S.530—Continental readers, for example. To cover new developments without delay it is often necessary to design new symbols: we cannot wait for the standardizing committees. In this way, in fact, *Wireless World* played a considerable part in developing the actual grammar of modern circuit symbolism from the old pictorial diagrams used in the early days of radio. We say this, not to pose as grey-beards, but to show that we have had a good deal of experience in evolving a system to suit the purposes of technical publication. We do not wish to impose this system on anybody else and we may well change it to keep in step with changes in electronics or technical journalism. A case in point is the transistor symbol (e.g., March, 1960, issue, p.110) on which one correspondent accuses us of being "the odd-man out". Even if we are the odd-man out, we feel quite justified in departing from the present convention (junction transistors looking like the now-obsolete point transistors) if it helps our readers and possibly has other advantages (e.g., May, 1960, issue, p.228).

Our critic on transistor symbols has a very good point, however, about the usefulness of redundancy in communicating information. This fact, if not already understood, has certainly been brought to attention by modern Communication Theory. We in the radio and electronics field therefore ought to take note of it, not only when providing the means of communication for other people, but when communicating amongst ourselves.

## Third-party Messages

HAS the time come for a change in the regulations which the P.M.G. is empowered to make to protect the telecommunications monopoly which prohibits a listener, radio amateur or radio operator from passing on a message for a third party?

Legally, Bill Hayes, of the B.B.C.'s Aerial Radio Club, was breaking the law when he passed on to the police an appeal from a Moroccan amateur for drugs for the Agadir earthquake victims. So was the driver of a radio-equipped taxi who, seeing some act of violence, called his control room to notify Scotland Yard. Such acts should be not, even technically, against the law.

# hi-fi

By P. P. ECKERSLEY, M.I.E.E., F.I.R.E.

*He knows what's what, he knows hi-fi;*
*Is not a true Fidelity.*
(Adapted)

WHAT a term! How can fidelity be high? Lack of it can stink to high heaven but that hardly justifies an opposite. Perhaps it is something raised up, usually in volume! But let that pass, "we know what we mean". In my young day we used to speak of quality, good and bad, or, if faithful is the code word, of faithful reproduction.

But do we know what we mean? I know that perfect reproduction would be that which caused a loudspeaker to create a field of sound around a listener's ear identical to that existing around the ears of an individual situated in the auditorium, studio, or whatever, where the reproduced sound originated.

The diagram of Fig. 1 helps the understanding of the definition and is an aid to an explanation why truly faithful reproduction, according to any means known to me, cannot be achieved.

For the sake of example we postulate an orchestra spread around one end of the auditorium and a microphone (M) facing it. This microphone is connected by a single channel to a loudspeaker (L) placed opposite to the listener, in the room where he listens.

Apart from any distortion that may be created by the transducers and in the channel connecting them the principle inherent artificialities, which militate against perfect reproduction (hi-fi to you) are:

1. The acoustics of the room in which the loudspeaker is situated are superimposed on those of the auditorium.
2. The source of the sounds impinging on the listener's ears is a point source, the sources of sound in the auditorium are spread over a relatively wide area.
3. A minor cause of distortion is produced because the microphone, not being the shape of a human head (and not having two ears) must in some degree alter the composition of the sound field from its form as it would be created around the ears of one listening in the auditorium.

Neglecting for a while the problem of superimposed acoustics (paragraph 1 foregoing) the artificialities of a point source of reproduction and a single microphone (as distinct from two ears) it has been suggested (and the suggestion taken up in modern equipment) that more faithful reproduction would arise by the use of so-called stereophony, consummated by the use of, typically, two microphones, two channels and two loudspeakers. Dr. Leakey has more than adequately discussed the possibilities in a recent article (April and May issues).

While it may be, and often is, claimed that two-channel reproduction is an improvement we must nevertheless appreciate that it cannot achieve the ideal of true fidelity.

I recollect, and this, though it is related to "binaural" rather than "stereophonic" listening, may be of some academic interest, that in the very early days of broadcasting, when we transmitted opera from Covent Garden, H. J. Round set up two microphones spaced feet apart, among the footlights, and connected each one to each earpiece of a two-earpiece headphone. It was remarked that as a singer moved across the stage parallel or at some angle to the line joining the microphone he (or she) appeared to us wearing the headphone to move not from side to side but in an arc above our heads. Thus if one kept one's eyes shut one looked upwards!

One of the more dramatic effects of stereophony is the verisimilitude of movement of a sound source. Properly located in relation to the loudspeakers the listener hears an aeroplane flying over his room diagonally or a speaker appears to move from side to side. Orchestra players, however, sit still, but it is claimed that two-channel broadcasting adds realism in the sense that, for instance, the fiddlers do appear to play to one side, the wood wind to another; is there a claim for depth?

## Stereo Assortments

An American friend of mine, writes to me and starts a paragraph with the words "Why Stereo?" and goes on "Dr. Harry Olson wrote an interesting paper . . ." on "the psychological response to monaural" (sic Mr. Editor) "low-fi" (sic), "monaural hi-fi" (he is unrepentant) "with several spaced speakers . . . playing the same record; binaural fringe-channel two-speaker reproduction and "filled-in" binaural hi-fi, three channel, with speakers respectively playing the left-ear channel, the right-ear channel, and (at intermediate position for the speaker) the mixed left and right-ear channels.

"The results indicate successive improvements between each of these and the preceding but very unequal steps. The big jumps were to hi-fi and spaced speakers whether two . . . or single channel."

I envy Dr. Harry Olson, he must have had a lot of fun; I would join in it more thoroughly, however, were I better acquainted than I can be, without a sight of his paper, with the meaning of some of the terms he uses.

It is time for a confession—quite simply I do not find any real improvement between any single- and any multi-channel reproduction I have heard demonstrated and I hasten to say that many, whose powers of observation and whose integrity in expressing their opinions I respect, hold different views;

I must add that some equally competent people agree with me. There is, without doubt, a difference between the two systems but to me it is no more than a difference; it is not an improvement.

I would characterize this difference as giving one a feeling that the sound from two-channel reproduction is more diffused, it is fuller than when the single channel system is compared. But, with a limited number of observations, I have remarked this same improvement when two or more loudspeakers are energized from a single-channel source. Moreover I would say that those loudspeakers which are designed to be facing the corner of a room and are responsive to single channel energization give much the same effect. It is, I repeat, a difference that I observe, and a pleasing one in some instances, but it is still artificial, reminding one of reality rather than copying it.

No! What I believe is that the primary need in improving reproduction is not so much a perfect copy of the original but rather a result, limited in certain respects as it may be, which pleases because it is free from the intromissions of the several types of non-linearities, and is unaccompanied by extraneous noise.

## Art and Artificiality

This is where I mount my hobby horse and discuss art and artificiality. There is some rather involved phrase implying that the object of the artist is to conceal art. It is doubtful if artists are objective, but if the sense of the statement is that art produces emotion in those who appreciate it without the means to this end being obvious (and certainly being artificial and distinct from realism) then one can agree with a supposed meaning.

When it is seen how a two-dimensional picture can represent a three-dimensional subject, or how in statuary without loss of the value as art, dimensions are shrunk or expanded below or above those of reality then the artificiality of these forms of art are its obvious characteristics. The artist paints not what he sees but from a sub-conscious which tells his hand to register the emotion a scene conjures in it. This is not realism but it can be good art. I must say, in passing, that it would help if some painters would issue a guide to the operation of their sub-conscious; it is not always easy to join in as it were. Is it, as a final example, necessary to call attention to the artificiality of the theatre and to its impact as an art?

This may seem to have wandered a long way from hi-fi, but surely not. Surely in broadcasting there is on the one hand an artist creating a programme and upon the other the person upon whom an effect is produced and between the two a medium, a means, indeed, an artificiality, namely the technique of "reproduction." In television, as in the film, it is again the two-dimensional image that creates a three dimensional impression; in sound it is more usually the point not the diffused source which stimulates the listener's sensibilities. And provided always that these artificialities are such as to convey reality without precisely reproducing it, and provided in so doing at least some of those who look or listen are moved, and provided, in other words, their sensibilities are awakened, what more is required?

But if the artificiality of reproduction has added to it the distractions of dissonances and the peevish introduction of irrelevant noise then its value as an art is at least reduced, in some cases destroyed. So in discussing hi-fi, I would count it of greater importance to consider chiefly the effect of the generation of harmonics, and combination tones and the presence of noise than what, in a cynical mood, I describe as the sales gimmick of stereophony.

In discussing the kind of distortion I have in mind it helps to consider the graphs of Fig. 2*. In this figure the ordinate represents pressure (a scale of decibels is also shown) and the abscissæ frequency on a log. scale. The upper full-line graph shows sound intensities at which the ear experiences pain, or "which stimulate the sensation of feeling"; the threshold of feeling is therefore the intensity at which the listener starts to experience painful sensations.

The lower graph delineates the threshold of audi-

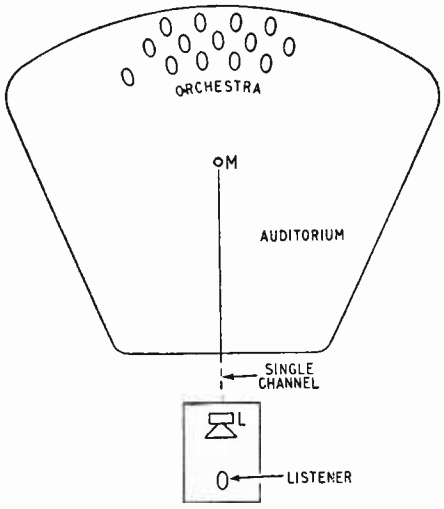


*Fig. 1. Illustrating the obstacles to fidelity of reproduction.*

bility, intensities less than those shown by the graph are inaudible. It is remarkable that the maximum pressure at the threshold of feeling is some 130dB greater than the minimum of audibility. The ratio of fortissimo to pianissimo of a symphony orchestra is of the order of 80dB. The contrast ratio of hi-fi reproduction is of the order of 40dB at maximum; if it were more faithful to the original with respect to contrast ratio pianissimo passages would be masked or spoiled by noise. Fi cannot be so hi as some would believe.

The upper broken-line graph in Fig. 2 is drawn to illustrate the performance of a poor quality receiver; typically one designed for medium wave reception or perhaps one of those little snarlers that use transistors and pick up anything anywhere without visible means of aerial.

In drawing the graphs of Fig. 2 we have assumed "attenuation distortion," i.e. "distortion due to variation of loss or gain with frequency"; in jargon terms the frequency characteristic is not "flat." Another assumption, alas by no means unjustified, is that there is considerable mains hum (frequency 100c/s).

The lower dotted graph illustrates a contrast ratio

* Based on Fig. 70, p. 141 of "Speech and Hearing"—Harry Fletcher, (Macmillan and Co., 1929).

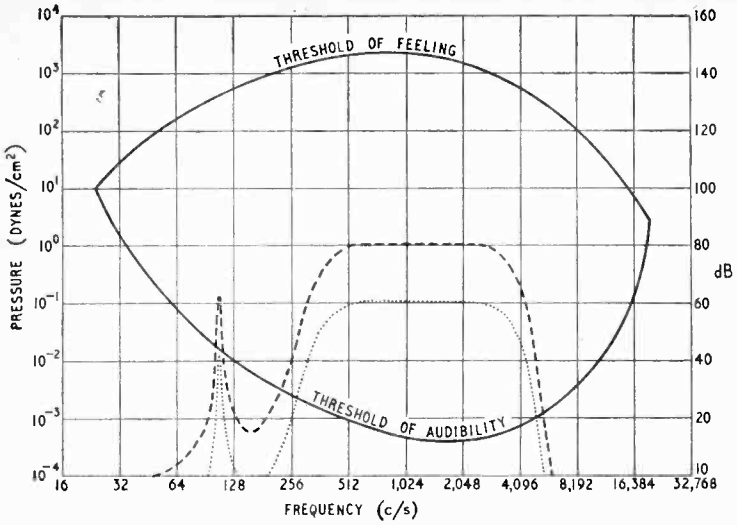


*Fig. 2. Fletcher-Munson curves of the upper and lower limits of hearing, with superimposed (dotted) response curves of a poor-quality receiver at two different volume levels.*

of 20dB, may be a pessimistic value, but not greatly so for medium-wave broadcasting.

We notice that the reproduction of the upper and lower frequencies varies with the volume knobs and this may explain, if it does not excuse, why the user of an inferior type of set turns up his volume. It is seen from Fig. 2 that as volume is increased so the frequency gamut is increased but now the middle frequencies must approach nearer to sensation level. The result may well be to overload the audio amplifiers with a consequent introduction of amplitude distortion "the lack of constancy of the r.m.s. value of the output of the system to that of the input at different amplitudes of the input," also of harmonic distortion "the production of harmonic frequencies at the output by the non-linearity of a network when a sinusoidal voltage . . . is applied at the input." In other words turning up the volume produces a harsh and unpleasing result marred by the introduction of spurious frequencies not existing in the original.

## Noise and Bandwidth

It is also remarkable that as the volume is increased the bandwidth of reception is also increased and so any noise picked up is also increased—"the wider you open a window the more dirt that comes in." Maybe this noise is masked by the greater intensities of speech or music, while this is transmitted, but during quiet passages or during pauses noise is annoyingly audible.

Perfect quality would be represented by points lying within the lozenge-shaped area, indicated by the full lines of Fig. 2; it would demand a frequency characteristic, including the loudspeaker, which was flat between, say, 30 to 16,000c/s, freedom (to, say, 80dB) from harmonic or amplitude distortion and a contrast ratio without the introduction of noise of, say, 80dB.

There is another form of distortion which may or may not be audible, namely, phase distortion "distortion due to variation of the group velocity of the system with frequency" and, as explained later on, a distortion associated with a Doppler effect in the loudspeaker. There is also the effects due to hangover of oscillation of the loudspeaker diaphragm. We know that if the frequency characteristics of a system is flat then the group velocity of waves transmitted through it is constant; phase change is then proportional to frequency. If, however, the effects of reactance are present, causing a variation of the ratio of the output to the input of the system with frequency, then inevitably phase distortion appears. This is why some argue that the frequency characteristic of the amplifiers in a receiver should extend to, say, 100,000c/s and then fall off gradually. In common practice cut-off is allowed just above the highest frequency it is desired to reproduce. Whether this effect, other distortions being eliminated, is audible, I do not know.

The Doppler principle is that which makes the frequency of waves appear to change when there is a relative velocity between the wave source and the observer. Thus if a loudspeaker diaphragm is moving as a piston at a low frequency, and if it is simultaneously reproducing a higher frequency than there is, so far as the higher frequency is concerned, relative velocity between observer and source; the higher frequency is thus frequency-modulated by the lower. The degree to which the effect is audible is not known to me; it may well be negligible.

But there are more things in transducers and amplifiers than are dreamed of in some philosophies; flattening the frequency characteristic, as judged by audio oscillator and output volt-meter (electrical or acoustical) is a step on the way, but there are other side effects which this simple test cannot remark. For example, there is the hang-over of the diaphragm of a loudspeaker which, given a steep wave front, continues to oscillate long after the impulse which sets it in motion has died away. By the same token it will not immediately and therefore properly respond to a steep wave-front. These are effects which subtract from good quality by robbing music of its attack, its crispness, which when present is an engaging characteristic of good reproduction.

## Obscure Distortions

There are other distortions which defy analysis; recounting an experience may illuminate my meaning.

A friend, whose judgment of quality is of a very high order, installed an allegedly hi-fi single channel radio-gramophone which, at first hearing, pleased him. The same impressive housing beautiful wood, discreet lid cushioning into place, contained tuner and turntable while a set of loudspeakers, contained in what might be described as a cupboard, radiated their output through an elegant grill.

As time passed my friend's satisfactions diminished until, thoroughly disillusioned, he decided to install a separate loudspeaker in substitution for those boxed in what I have described as a cupboard.

A change-over switch allowed a comparison. It only needed to be operated once to demonstrate excellent as compared with indifferently good quality. Incidentally, the single loudspeaker which gave the improved quality was one which faced into the corner of the room.

What can one conclude and what more when it is recounted that the substitution of the tuner and the gramophone pickup by others of different design made a further improvement? Perhaps all is not fi which is described as hi; except the latter abbreviation did truly qualify the cost of my friend's set.

I can hear my critics saying, "What after all have you said, that the elimination of harmonic, amplitude and phase distortion is essential? We hi-fi experts are quite aware of that."

I reply "Yes! But if you are why can someone buy an expensive hi-fi equipment and find it lamentably wanting and why do I and others feel that stereophony is no more than a gimmick, not a fundamental improvement?"

Another critic might exclaim, "Are you so simple as to neglect the cost factor? It's all very well to ask for a wide frequency gamut, amplifiers free from distortion, elimination of mains hum, but have you considered the cost?"

"I am," I reply, "quite aware of the cost factor and that is one reason why I have continuously and persistently (without making much impression) argued the merit of wire-broadcasting." Let me once more, in the light of the foregoing, point out its advantages with respect of reproduction.

Essentially, given a conductor, joining programme source and loudspeaker, the receiver can be simpler than when radio is used. In audio frequency technique the receiver is no more than a loudspeaker; if a carrier frequency method is essential, then the received level is not a few, but hundreds of millivolts and the receiver is consequently cheaper and gives better reproduction in spite of its decreased cost.

In sum, while I respect those who believe that stereophony represents a major advance in the art of reproduction, my own ears fail to notice more than a difference, not an improvement. I am not alone in this belief.

The greatest step towards hi-fi would be that which concentrated on removing distortions due to non-linearities and the effects of noise from the average receiver.

A wider application of wire broadcasting would be a major advance towards hi-fi. It would also perhaps be easier, because of its facility to provide more channels, to introduce stereophony with wire rather than radio broadcasting.

## Excessive Volume

As a final and possibly "tantrumistic" contribution to the subject I must air a grievance. What is it that turns ordinary decent folk, once they get their hands on the steering wheel of a motor car or the volume knob of a loudspeaker into sadists demonstrably hating their fellow men? As one who suffers from my neighbour's ever-louder speaker, I pray that the designers of reproduction equipment should limit volume output and should not give the user the excuse to increase it by the limitation of the frequency characteristic. If I were in charge of a wire broadcasting system I would deserve the thanks of many, because I would make it impossible for the reproduced sounds to exceed a certain level. I am aware that a reduced level may subtract from realism, but then I deny the need for realism. I would and do accept limitations both of contrast level, frequency characteristic, and volume, but I cannot abide the invasion of spurious tones; I want clean reception and the crisp reproduction of transients.

Good quality, as I define it, at a lower volume than may be theoretically desirable is, as I prove whenever I listen, satisfactory, but the quality must be good quality, and the operator of the set, like me, a good neighbour.

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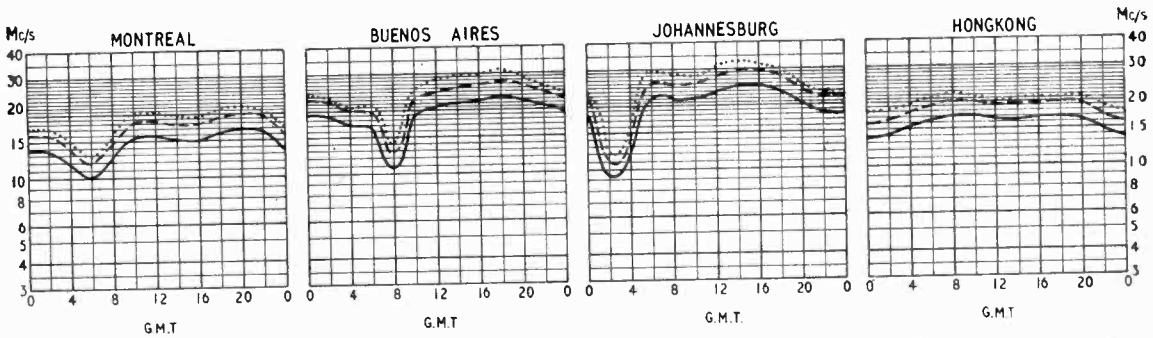
# SHORT-WAVE CONDITIONS

*Prediction for June*




THE full-line curves 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 June.

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

# Noise Level Measurement in Television

## Method for Use When the Video Signal is Present

By L. E. WEAVER,* B.Sc., A.M.I.E.E.

THE following method of measuring the level of random fluctuation noise in a television signal was originally developed in response to a request within the BBC for an accurate and completely objective procedure for use with camera tubes, and in particular image orthicons. It has proved to give very consistent and accurate results, and for this reason it has for some time past been adopted as the standard method of test for the acceptance and maintenance checking of these tubes.[1]

Although such a measurement may seem to concern only a comparatively few specialists, in fact the manner in which the method operates, by taking advantage of certain characteristics of a television signal, is of much wider interest. It can also be applied to other random noise measurements in the television field.

### Difficulty of Measurement

For the present purpose it is only necessary to explain that the principal difficulty in measuring this random noise level arises because these camera tubes can only operate while being scanned, so that their output signal always contains both scanning and random noise components. Even in the extreme case where the lens is capped and the synchronizing pulses are removed, the output signal still contains enough energy from the line and field components to frustrate any attempt to estimate the random noise by a direct measurement of the output level of the tube.

Evidently what is needed is some means for distinguishing clearly between the random noise and the signal components. The standard method hitherto achieves this by making use of the storage property of the eye and its ability to interpret patterns. The signal is displayed on a waveform monitor and the apparent or quasi peak-to-peak noise voltage is measured separately from the signal voltage by recognizing the difference in waveform. Unfortunately there is a degree of uncertainty inherent in this method which makes it inadvisable for the present purpose. For example, the conversion factor from quasi peak-to-peak to r.m.s. noise voltage, which is the quantity required for the signal-to-noise ratio, is given values ranging from 14 to 18 dB by various authorities.

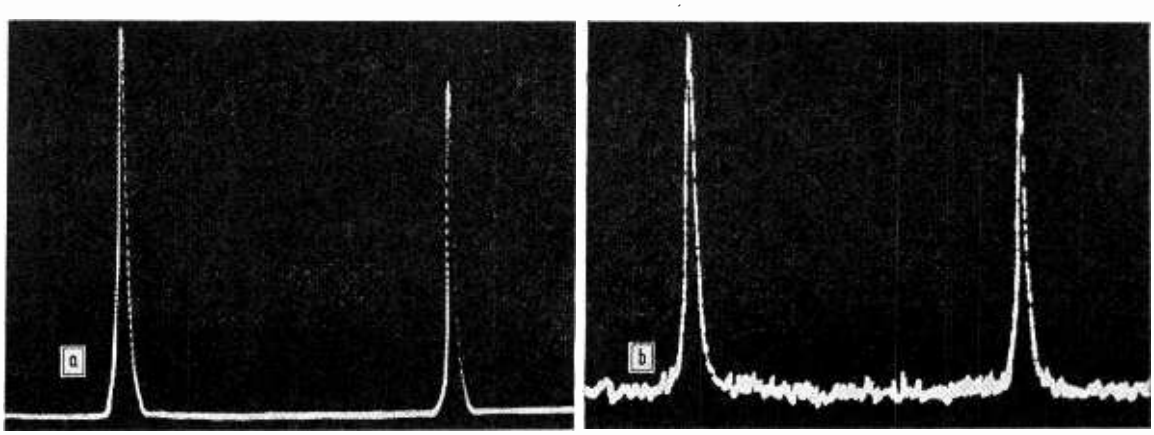
* British Broadcasting Corporation.

### Nature of the Video Spectrum

The preferred method takes advantage of the difference in spectrum between the signal and the random noise components. It was shown by Mertz and Gray[2] more than a quarter of a century ago that the spectrum of a television signal is basically discontinuous, that is, in general the energy is almost entirely concentrated in the area immediately surrounding each line-frequency harmonic in the form of a rapidly decreasing series of sidebands, which originate from both the synchronizing information and the picture content. On the other hand, the spectrum of random fluctuation noise is inherently continuous, with the energy, on an average, distributed evenly over the spectrum.

This is well illustrated by Fig. 1, which shows two photographs of the same portion of the spectrum of a television signal comprising two adjacent line-frequency harmonics in the neighbourhood of 600 kc/s. Fig. 1 (a) corresponds to the original, almost noise-free, signal and (b) to the same signal but with added white noise. The resolving power of the apparatus was not sufficient to show the sidebands in detail, but their presence is indicated. The apparent erratic nature of the noise spectrum

*Fig. 1. Portion of the spectrum of a television signal comprising two adjacent line-frequency harmonics: (a) original noise-free signal, (b) the same signal with added white noise.*



between the harmonics is due to the fact that the sweep shows the conditions existing at a series of successive instants, and not the average condition over the area concerned.

This leads one to suppose that if it is possible to measure the energy in a narrow frequency band situated midway between two such line-frequency harmonics, the reading will be independent of the signal content and will, in fact, represent the noise power distribution with frequency in that region of the spectrum.

The simplest satisfactory way of making use of this principle in practice is shown in Fig. 2. A more refined version has already been described elsewhere[3] and an improved form of this is at present under investigation.

In the "measure" position of the switch the incoming video signal is connected through a fixed attenuator pad to the input of a communications receiver, which covers the video band down to 60 kc/s and is provided with a choice of bandwidths between 6 kc/s and 100 c/s. The input circuit has been modified to provide a good 75-ohm impedance, and the pad serves to prevent overloading the receiver. The audio output terminals are connected

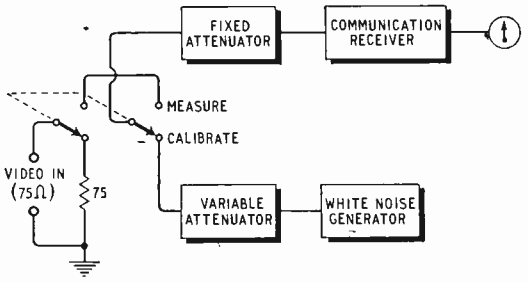



*Fig. 2. Simplest technique for measurement of random noise level.*

to a meter which reads a close approximation to r.m.s. values.

In the "calibrate" position of the switch the incoming signal is terminated and at the same time the receiver with its input pad is connected through a variable attenuator to a standard white-noise generator. This generator furnishes an accurately known and constant random noise power per unit of bandwidth.

## Use of the Apparatus

With the switch in the "measure" position, the receiver is set to a convenient bandwidth, say 600 c/s. When it is tuned slowly through the region where a reading is required a series of sharp maxima corresponding to the line-frequency harmonics are shown on the output meter. The receiver is then tuned accurately to the exact minimum point midway between two such maxima, and the gain is adjusted until a convenient output reading is obtained.

The switch is next placed in the "calibrate" position and the setting of the fixed attenuator is varied until precisely the same reading is given by the output as in the previous instance.

When this has been achieved, the noise power per unit of bandwidth from the generator has been made the same as that existing at the point in the video spectrum where the measurement was made. If the random noise has a flat spectrum, then a knowledge of the generator constant and the attenuator setting are sufficient to enable one to calculate the total noise power in a 3-Mc/s band, and hence the r.m.s. noise voltage. If the noise spectrum is not constant a few more readings must be taken, in most instances three or four are sufficient, and the calculation is just a little more complicated but nevertheless still very simple.

The great advantage in calibrating the receiver with the standard white-noise generator lies in the removal of two important sources of error, the variations in the pass-band of the receiver and the behaviour to noise voltages of its diode detector. The adjustment to equality of output meter reading means that the noise powers per unit bandwidth are the same in the two instances, and the shape of the receiver pass-band is therefore quite immaterial. At the same time the detector is operating at the same level with applied voltages of the same nature, and consequently no correction is needed for this effect.

## A Practical Example

Suppose that when noise with a flat spectrum is measured, the attenuator reading for equality of output level is found to be 20 dB. The reference generator furnishes a noise power of 20 $\mu$W per Mc/s. Now for a picture signal amplitude of 0.7 volt peak-to-peak in a 75 ohm circuit and 3 Mc/s bandwidth the random noise power distribution corresponding to a signal-to-noise ratio of 0 dB is easily found to be 220 $\mu$W per Mc/s. The actual ratio is therefore $20+10 \log_{10} 220/20$ dB$=$ 30 dB to the nearest 1 dB. In practice the added 10 dB constant would be known in advance, so that the answer would be obtained without the necessity of calculation.

When the measured spectrum is not flat a small number of readings is taken. The fact that these are expressed in power per unit bandwidth makes it possible to use immediately one of the rules for approximate integration such as the trapezoidal rule, and the calculation then reduces to a quick and simple arithmetical operation. The details, if required, are given in reference[3].

This series of readings at different frequencies also gives the shape of the noise spectrum, which is a further useful piece of information. For example, when testing image orthicon tubes it is usual to present the camera with a standard test scene and to adjust the overall resolution of the camera with its control unit in a standardized manner. Since the noise spectrum of an image orthicon should itself be flat, the measured deviation from flatness is an accurate measure of the resolution of the tube itself under working conditions[1].

A small correction to the overall signal-to-noise ratio has to be made when the signal is blanked, since this process reduces the total random noise power without changing the noise voltages which are superimposed upon the unblanked portions of the waveform. With 405-line signals, 1 dB must be subtracted from the measured value.

There is a limit to the lowest signal-to-noise ratio which can be measured, which arises from the fact that the energy from the signal components in the region of measurement, although normally extremely small, is not in fact absolutely zero. The exact

amount is a function of the subject matter of the picture signal, the frequency of measurement, and the time stability of the waveforms composing the synchronizing signal, so that it is impossible to give a single figure for the limiting signal-to-noise ratio measurable to a certain degree of accuracy. Further information and a curve are given in reference[3]. Very broadly, however, it can be stated that this limitation has not been found at all restrictive for the type of measurement for which the method is intended.

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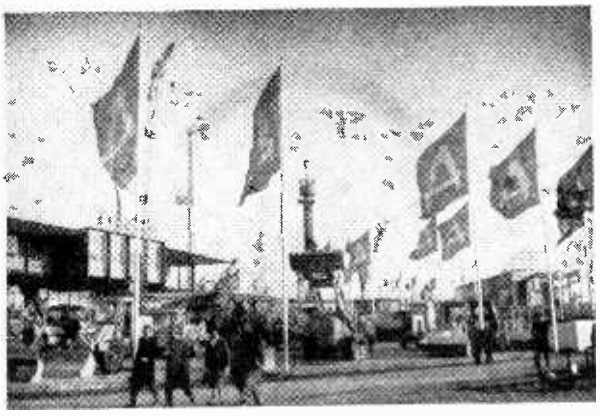
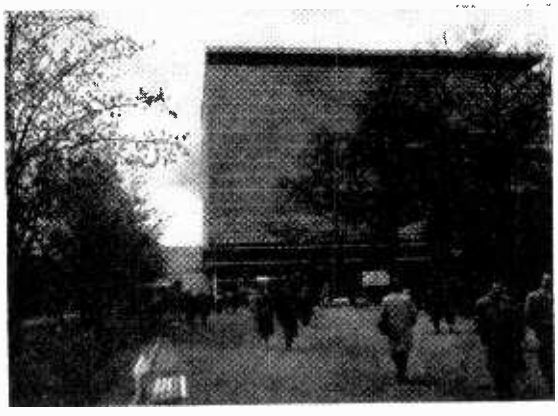
1. "The Testing and Operation of 4½-in. Image Orthicon Tubes." D. C. Brothers, *Jour. Brit. I.R.E.*, December 1959.

2. "A Theory of Scanning and its Relation to the Characteristics of the Transmitted Signal in Telephotography and Television." P. Mertz and F. Gray, *Bell System Technical Journal*, Vol. 13, p. 464, July 1934.

3. "The Measurement of Random Noise in the Presence of a Television Signal." L. E. Weaver, BBC Engineering Division Monograph No. 24, March 1959.



# HANOVER FAIR

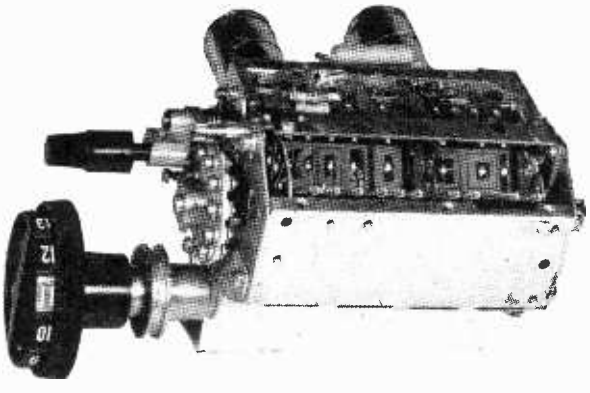
IF the radio and television sections seem to occupy an insignificant part of the 7 million square feet of this vast exhibition, they are nevertheless comparable in size with our annual and the German biennial special radio shows. Indeed, Hanover is regarded by many of the German radio manufacturers and their customers as the most important event of the year, and this applies particularly to those interested in portable and car radio receivers, for the Fair is invariably held at the beginning of the summer season.

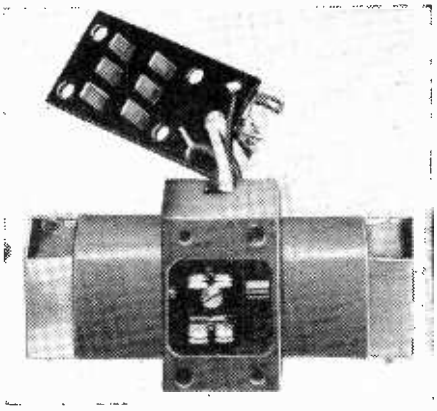
The valve has virtually disappeared from portable receivers and most of the new all-transistor models have provision for v.h.f. as well as medium and long waves. The introduction of a v.h.f. band has spread even to some personal portables, e.g., the Telefunken "Partner" (v.h.f. and medium waves) and Siemens RT10 (the latter with three wavebands). Although operating on medium waves only, the new Grundig "Mini-Boy" is the smallest transistor pocket receiver at present on the German market; it weighs 250gm (10oz) and measures 104×65×27mm.

The vogue of the dual-purpose car-radio/independent

*Deutsche Philips "Memomatic" tuner with printed inductances and independently adjustable trimmer stops on each channel.*

*Band switching in some Nordmende sets is effected remotely by a miniature switch operated by an electromagnet, shown open to reveal sliding contacts.*





battery portable first noted last autumn in London and Frankfurt is well established and has been strengthened by the introduction of the "Westerland" combination by Blaupunkt. In this an independent transistor portable with self-contained batteries is designed, as usual, to fit neatly into a recess in the car dashboard. When the set is pushed home an additional 4-watt output stage, feeding a larger loudspeaker also permanently installed in the car, is brought into operation. This auxiliary reproducer has its own separate bass and treble tone controls.

Although the promised second television programme in Germany is still delayed by organizational questions, for which satisfactory answers have not yet been found, it is confidently expected at the turn of the year (1960/61). One consequence of the delay is that set manufacturers have had to produce sets with provision for Band IV tuners which can be bought and fitted later on by customers who are reluctant to spend money so far in advance of fulfilment. To ensure that realignment will be unnecessary when the u.h.f. units are added, Blaupunkt are using a non-reactive bridge filter in the output from the mixer. This causes some loss of gain, so all new Blaupunkt models have 4-stage i.f. amplifiers.

"Fully automatic" operation is still obligatory in television sets which hope to sell in Germany, and contrast control by ambient light, as well as "automatic fine tuning" on both v.h.f. and u.h.f., are now common. The method adopted by Deutsche Philips in their "Memomatic" tuner for Channels 2-11 is to pay particular attention to oscillator stability and then to provide independently adjustable trimmer stops for each channel on the selector switch mechanism. These determine the setting of the trimmer through a rocker arm.

A neat method of band switching is used by Nordmende in some of their television sets, which not only eases design problems in the layout of the tuner unit but also provides for simple remote control. The switch slider is actuated by the armature of a solenoid in which there are two windings connected in series in the valve heater circuit. One or other of these coils is short-circuited by push buttons on the front panel or by switches in a cable-connected remote control unit.

*The inexpensive Grundig television camera, mentioned last autumn in our report of the Frankfurt radio show, can now be obtained with a portable battery-operated radio link, working on 440-460 Mc/s. The range is stated to be 2km average.*

Considerable prominence is being given in Germany at the present time to *störstrahlung*—radiated interference from TV tuner units, timebases, etc. With the coming of the second programme on Band IV the problem is appreciated as a serious one and is being so treated by the manufacturers, who are giving particular attention to the design of screening in tuning units and to the establishment of radiation measuring laboratories in order to be able to meet the requirements laid down by the German Post Office.

Television sets capable of receiving the four standards at present in use in Europe are now offered by Blaupunkt, Graetz and Telefunken.

Although the Hanover Fair is predominantly the shop window of German industry it is open to all and is gaining in international significance. It is gratifying to record that many British radio and component manufacturers were represented, either as individual exhibitors or as participants in the British Electronics Centre.


*Nordwest Deutsche Rundfunk television studio and O.B. equipment installed adjacent to Hall 9 for the broadcast of special programmes relating to the Fair. These and other programmes were distributed by cable to exhibitors' stands.*

# Using the Simple Analogue Computer

## SETTING UP THE INSTRUMENT TO REPRESENT A MECHANICAL SYSTEM

By G. B. CLAYTON*, B.Sc.

LAST month the author described the design and construction of a simple analogue computer that could be used for demonstration purposes in educational and other training establishments. As a suitable exercise in connecting up the computer to represent a physical system, consider the mechanical arrangement in Fig. 1. This consists of a mass M suspended in a viscous liquid by a light spiral spring.

It is required to determine the subsequent motion of the mass if it is displaced from its equilibrium position and then released. Let S represent the force required to produce unit extension of the spring (S being a measure of the "stiffness" of the spring) and let D be the viscous force per unit velocity acting on the mass. Let $y$ measure the displacement of the mass from its equilibrium position.

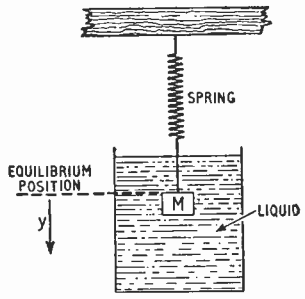



*Fig. 1. Mechanical system to be represented on the analogue computer.*

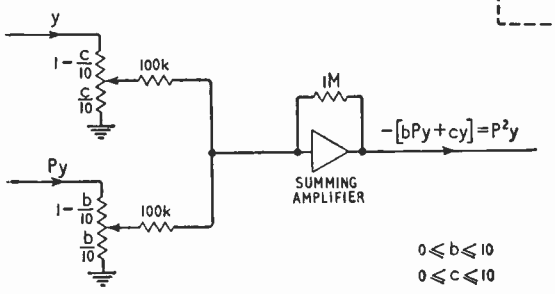



*Fig. 2. The summing operation necessary in solving the equation for Fig. 1.*

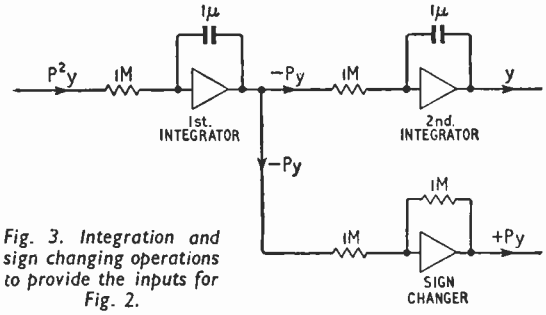



*Fig. 3. Integration and sign changing operations to provide the inputs for Fig. 2.*

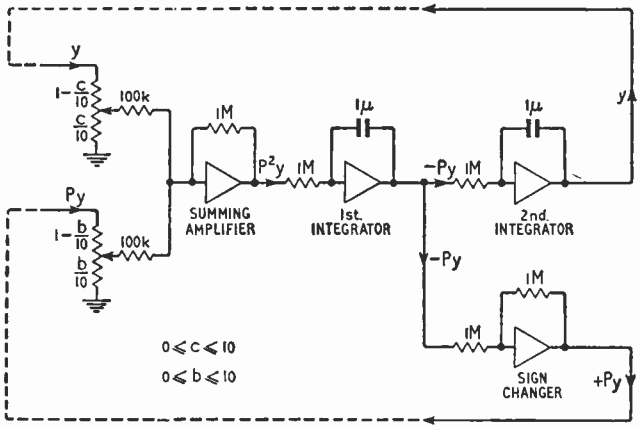



*Fig. 4. Combination of Fig. 2 and Fig. 3 to form the complete computer set-up for solving the equation for Fig. 1.*

The force acting on the mass will be

$$F = -Sy - D\frac{dy}{dt}$$

and the equation of motion of the mass will thus be

$$M\frac{d^2y}{dt^2} = -Sy - D\frac{dy}{dt}$$

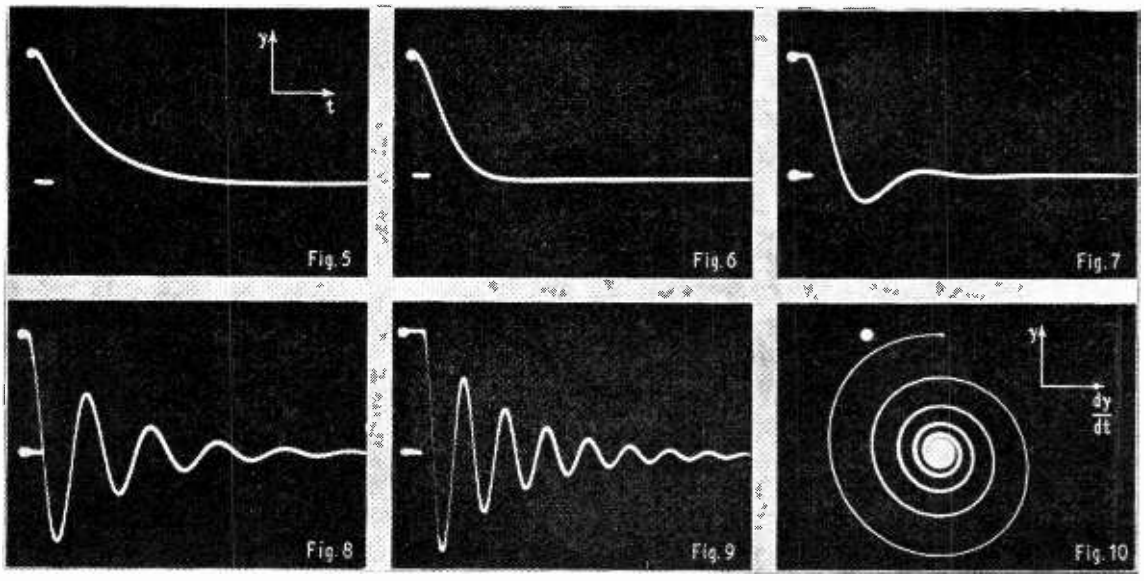
Rearranging this gives

$$\frac{d^2y}{dt^2} + \frac{D}{M}\frac{dy}{dt} + \frac{S}{M}y = 0 \text{ or } P^2y + bPy + cy = 0$$

where $P = \frac{d}{dt}$., $b = \frac{D}{M}$, and $c = \frac{S}{M}$. Many physical systems may, in fact, be represented by a second order differential equation of this type, e.g. a damped galvanometer movement, or an LCR electrical circuit.

In order to solve the above equation it is first rearranged: $-(bPy + cy) = P^2y$. Terms $bPy$ and $cy$ are represented by voltages which are applied to the input terminals of a summing amplifier. This performs the operation of addition and multiplication by $-1$, and its output must therefore represent

* Liverpool College of Technology.




*Figs. 5—10. Oscillograms of solutions of equations obtained using the analogue computer arrangement in Fig. 4.*

$P^2y$ (Fig. 2). The voltages representing $Py$ and $y$ are dependent on the value of $P^2y$ and are obtained from $P^2y$ by successive integrations.

$P^2y$ is assumed to be known and is applied to the input of an integrator. The action of an integrator being essentially that of multiplication by $-1/P$, the output of this integrator gives $-Py$. A second integrator changes $-Py$ to $+y$ and a sign changing amplifier changes $-Py$ to $+Py$ (Fig. 3). The voltages representing $Py$ and $y$ are now available for application to the summing amplifier of Fig. 2, and the complete computer set up for the solution of the equation is shown in Fig. 4.

This circuit causes the variable voltages to change in exactly the same way as the physical variables that they represent. At the start of a computer run the integrator control switch is put in the "reset" position and a voltage representing the initial value of the displacement $y$ is put across the capacitor of the second integrator. On switching to the "compute" position the integrators are placed in circuit and the computer run commences.

The oscillograms above are a record of some solutions obtained using the circuit of Fig. 4. Figs. 5 to 8 show the displacement $y$ as a function of time for a constant value of the coefficient $c$ but successively smaller values of the coefficient $b$. The coefficient $b$, which depends on the viscosity of the liquid, controls the damping of the motion; Fig. 6 corresponds to critical damping. Figs. 8 and 9 are solutions for the same value of $b$, but in 9 the coefficient $c$ has been increased. This corresponds to an increased spring "stiffness" with a consequent increase in the frequency of oscillations, the damping remaining the same. Fig. 10 shows the displacement $y$ as a function of the velocity $\frac{dy}{dt}$ for a damped oscillation. The recordings were made using an oscilloscope with d.c. coupled amplifiers, slow sweep facilities and a long-persistence screen.

Thanks are due to D. L. McCluskey who did most of the constructional work on the apparatus described last month.

# B.B.C. HANDBOOK

WITH the object of giving "a comprehensive and up-to-date picture of what the B.B.C. is and what it does," the Corporation publishes each year a handbook. The 1960 edition, like its predecessors, does just that. Although a considerable part of its 270-odd pages is devoted to programme matters, there is much of technical and general interest in the Handbook. Here are some points of interest culled from the section devoted to engineering activities.

"Approximately 50% of the programme output is recorded in advance. . . . During the year recordings were made on 108,000 disks and 24,000 miles of magnetic tape. . . . B.B.C. tape recording facilities include 241 static, 88 mobile and over 225 midget machines. There are also 68 static and 29 transportable disk-recording machines."

"While it may well be possible to build at great cost a loudspeaker or combination of loudspeakers, which in a specially arranged setting will be the ultimate in performance in the light of present knowledge, this is of little use to a broadcasting authority [for monitoring]. Here the need is for some hundreds of high-quality loudspeakers, all of which must have an identical performance within normal manufacturing limits. Since nothing meeting these requirements is available commercially, the B.B.C. has designed and produced its own loudspeaker system, including the design of a suitable cabinet."

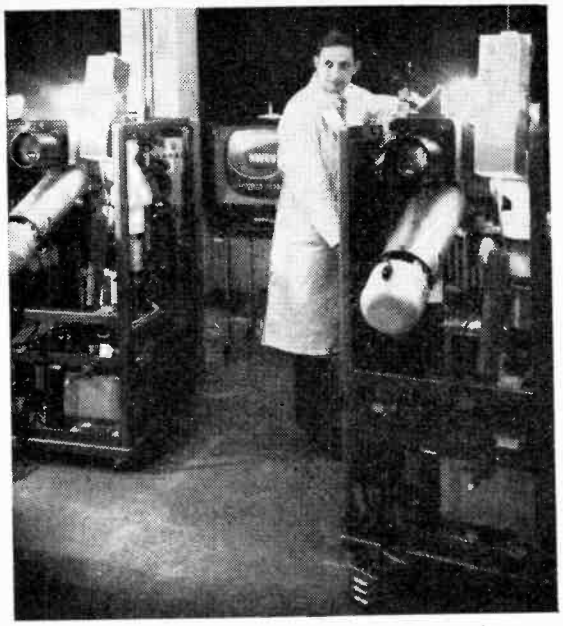
It is interesting to see that the cost of running the television service in 1958/59 was £14M as against £11.1M for the domestic sound service and £5.9M for the external services. The percentage of each of these figures attributed to "engineering" is 33, 23 and 25, respectively. Of the total of £4.6M for television engineering, £775,086 was for the rental of Post Office lines.

# LARGE SCREEN COLOUR TV

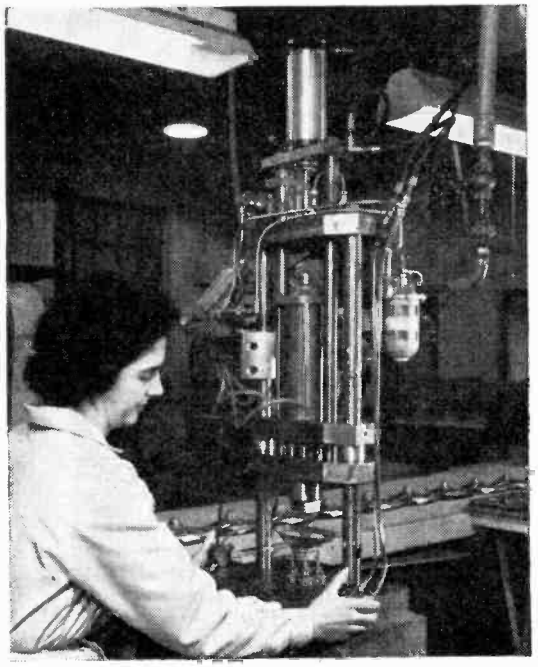
THE Eidophor system for projecting television pictures on large screens has now been adapted for colour television, and recently we saw a demonstration of its capabilities for closed-circuit work at Belle Vue, Manchester, given by CIBA Clayton Ltd., the dye manufacturers. In the Eidophor projector (made in Switzerland by Gretag A.G., with the backing of CIBA, the Swiss chemical combine) light from a powerful xenon arc lamp is modulated by means of an oil film which is electrostatically deformed in the pattern of the television picture by a scanning electron beam. The deformations in the film actually modulate the light by refraction—by altering the angle at which the light is reflected from a concave mirror behind the oil film. An optical interception system (Schlieren system) in the path of the reflected light then causes the beam-angle variations to produce corresponding beam-intensity variations in the light emerging from the projector.

Adaptation to colour television has been achieved by using the frame-sequential system with synchronized rotating colour filters in front of the camera and projector. For the demonstration three image orthicon cameras were set up at CIBA Clayton's Technical Service Laboratories in Manchester and the signals were transmitted 1½ miles by microwave link to Belle Vue for projection on a screen measuring 10ft×7ft. The cameras were American types and the 525-line standard was used.

The advantage of the Eidophor system over c.r. tube projection systems is, of course, the greater brightness obtained by modulating a normal light source. This was very evident at the demonstration, although the pictures suffered a certain amount of spasmodic flicker. Definition was excellent for a large screen (there are no image registration problems with the frame sequential system) and the colour rendering was as good as the quality of the rotating colour filters.



*Eidophor projectors in process of manufacture.*



# Multi-Riveting Machine

A DOUBLE-ACTING air-operated press tool especially suitable for radio assembly work involving riveting of any kind has been introduced by Rhoden Partners Ltd., design and development engineers of 19, Fitzroy Square, London, W.1. It is shown in the illustration in use in the production of loudspeakers.

A feature of this machine is that it automatically feeds and punches a whole pattern of rivets in one operation and it is claimed that the squeezing action of the air-operated punches is less violent than mechanical impact operation as it produces little or no distortion in the immediate vicinity of the riveted parts.

The working cycle is as follows: the operator loads the parts to be riveted together on to the spring-tensioned location pins in the bottom bolster, then releases compressed air to the upper ram punch holder. For this latter operation two press buttons have to be operated simultaneously, one by each hand. This is a safety precaution. After the riveting operation is completed the rams rise automatically to the "ready" position. This sequence of operations takes about three seconds.

Power for the press is a single-phase (230-250V) a.c. supply for the rivet vibratory-bowl feeder, and an air supply of preferably 80lb sq in.

*Rhoden multi-riveting machine.*

# WORLD OF WIRELESS

## *Trade and Production*

FIGURES contained in the twenty-seventh annual report of the Radio and Electronic Component Manufacturers' Federation show that production of components during 1959 increased by over 20% compared with 1958. Total production for 1959 was about 2,400M components, worth £120M. On average this represents an output of one million components for each working hour.

Domestic equipment manufacture absorbed 43% of the total, an increase of 1.4% over 1958, professional equipment took 30.4% and 14.6% (– 0.9%) was exported. The remainder comprised a.f. equipment and military use, retail sales, etc. Exports of components returned £21.5M, compared with £20M in 1958.

The total value of parts and assembled equipment exported was £53.4M (+17.5%), the most significant increase being in professional equipment, which rose by 35% to £21M. The largest individual markets (up to November) for components continued to be Australia (£1.34M) and India (£0.96M) and for a.f. equipment the U.S.A. (£5.03M); but the largest increase, 50%, in sales over £0.5M was in Italy. Total exports to America top the list at £5.6M, a rise of 28.2% over 1958. Total audio exports, however, fell.

Imports to the U.K. rose to £20.3M from £13.5M in 1958. Biggest increase here was £2M, to £5.7M, for valves, tubes and parts; but imports of domestic receivers nearly trebled to £0.61M. Tape recorder imports were three times our exports and Great Britain now has an adverse balance of £3.8M with the Netherlands and W. Germany. The total deficit with the Common-Market countries was £2.7M and the credit with Outer Seven £1.2M.

## *New Post Office Director General*

On June 1st Sir Gordon Radley, K.C.B., first engineer to be director general of the Post Office, retires after five years in office. He joined the Post Office in 1920 and was controller of research before being appointed engineer-in-chief in 1951. Sir Gordon, who was knighted in 1954 and was for some time chairman of the technical sub-committee set up by the Television Advisory Committee, was awarded the I.E.E. Faraday Medal in 1957 for his "outstanding contributions in the field of international communications and particularly in the development of long-distance, deep-sea telephone cables and their repeaters."

The new director general is Sir Ronald German, C.M.G., who entered the Post Office in 1925 and left in 1950 to become Postmaster General in East Africa, where he did much to develop the telephone service in that area. He returned to the British Post Office in 1959 as a deputy director general. Sir Ronald is succeeded as deputy director general by W. A. Wolverson, C.B., who entered the Post Office in 1928. In 1951 he was appointed commandant of the Post Office Residential Management Training Centre. He was more recently in charge of the Radio Services Department and since 1955 has represented the Post Office on the Council of the International Telecommunication Union.

## *Data Processing Expansion*

THE Electronic Engineering Association, which represents the capital goods side of the industry and is now separated from the Radio Industry Council, is setting up more groups to deal with electronic data processing matters. The 1959 Annual Report of the E.E.A. reveals that in addition to the data processing executive committee formed in 1956 there are now two technical committees, on digital and analogue data processing respectively, with working parties on coding of punched paper tape, storage systems, input and output equipment, international data transmission, core stores, magnetic tape, single-purpose computers and on transistors and semiconductor devices for computers. In 1959 exports of electronic computers amounted to £1.75M, the total exports in the field of the E.E.A. being £28M. Recent achievements of the capital goods section of the industry are described in an illustrated annual review obtainable from the E.E.A.

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**Servicing Examination Problems.**—The practical tests for entrance for the sound radio servicing certificate examination of the Radio Trades Examination Board on May 21st had to be postponed. This was because of "the difficulty of concluding a satisfactory arrangement with the patent holders" of the trainer-tester system introduced last year. This test has been deferred until the autumn when actual receivers will be used. Because of the problem of securing the necessary number of receivers, which are lent by manufacturers, it has been decided to restrict the practical course to candidates who succeed in the written papers.

**The Paul Instrument Fund Committee** have awarded a grant of £2,500, with the probability of further grants totalling up to £3,000, to Dr. J. H. Sanders, university lecturer and demonstrator in physics, Clarendon Laboratory, Oxford, for the construction of an optical maser; and another of £3,000 to H. W. Gosling, lecturer in the department of engineering, University College of Swansea, for the construction of an instrument for checking the stability of the standard ampere.

**Institution of Electronics** 15th annual electronics and instruments exhibition and convention is to be held at the Manchester College of Science and Technology from July 7th to 13th. It is again being organized by the northern division of the Institution and will include a manufacturers' section and a section devoted to scientific and industrial research. Complimentary tickets of admission to the exhibition and also details of the convention are obtainable from W. Birtwistle, 78 Shaw Road, Rochdale, Lancs.

**Electronic Organs.**—The first general meeting of the recently formed Electronic Organ Constructors' Society, of which Alan Douglas is president, will be held on May 28th at 2.30 in Room 45, Northern Polytechnic, Holloway Road, London, N.7. The secretary of the society, which has a membership of nearly 80, is A. Le Boutillier, 26 St. Catherines Road, London, E.4.

**R.E.C.M.F.**—At the annual general meeting of the Radio and Electronic Component Manufacturers' Federation on April 22nd, the following member firms (whose representatives' names are in parentheses) were elected to the council: Belling & Lee (N. Dundas Bryce), Garrard (H. V. Slade), A. H. Hunt (S. H. Brewell), Multicore Solders (R. Arbib), Painton & Co. (C. M. Benham), Plessey (P. D. Canning), S.T.C. (L. T. Hinton), Telcon Metals (G. A. V. Sowter) and Bakelite (G. J. Taylor). In addition Texas Instruments (D. Saward), Reliance Cords & Cables (C. H. Davis), and Morganite Resistors (J. Thomson) were subsequently co-opted to the council. Hector V. Slade and Dr. G. A. V. Sowter were re-elected chairman and vice-chairman, respectively, of the Federation.

**B.R.E.M.A.**—The new council of the British Radio Equipment Manufacturers' Association elected at the annual general meeting on April 29th consists of the following member firms whose representatives' names are in parentheses: A. J. Balcome (E. K. Balcombe), British Radio Corp. (F. W. Perks), Bush Radio (G. Darnley-Smith), E. K. Cole (W. M. York), Ferguson Radio Corp. (S. T. Holmes), G.E.C. (M. M. Macqueen), Kolster-Brandes (L. R. Tyne), Philips (A. L. Sutherland), Radio & Allied Industries (R. H. W. Pengelly), Rediffusion Vision Service (M. Exwood), Roberts Radio Co. (H. Roberts), and Ultra Radio & Television (E. E. Rosen). The new chairman of the association is A. L. Sutherland with W. M. York as vice-chairman.

**Channel Islands TV.**—The Television Act, which governs the I.T.A.'s operations, does not at present apply to the Channel Islands, but provision is made in the Act for its operation to be extended by Order in Council. If this is done, the I.T.A. plans to build a station, probably in Jersey, which will receive some of its programmes *via* the Authority's Devonshire station, due to be opened early next year. It is announced by the I.T.A. that if the Act is extended to the Channel Islands, they will offer the programme contract to Channel Islands Communications (Television) Ltd., which has recently been formed in Jersey.

"**Designers Guide**" is the title of an information sheet introduced by Mullard's Semiconductor Division to assist industrial designers to plan equipment in the knowledge that the semiconductors they specify will continue to be available when the equipment comes into production. It gives essential data on every Mullard transistor, rectifier and diode available. Readers wishing to receive "Designers' Guide", which will be issued three times a year, should write on their organizations' letter heading to: Semiconductor Division, Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

**A radar training school** is being established by Decca at the recently acquired site at Cowes Airport, Isle of Wight. Technical training courses of eight or ten months will be provided for the staffs of overseas Governments and authorities installing Decca civil or military radar systems. There will also be shorter courses of about six weeks for service engineers. The company already operates a technical training scheme at its service headquarters in London and a marine operational school at Blackfriars Pier, London.

"**Engineers in Communications**" is the title of a half-hour film surveying the research and development in telecommunications undertaken by Post Office engineers, which is now available for hire from the C.O.I. Central Film Library, Government Building, Bromyard Avenue, London, W.3. It costs 15s to hire and is considered particularly suitable for students.

**Apprenticeship schemes** offered by E.M.I. are outlined in a well-illustrated 32-page book "A Career in E.M.I. Electronics," which also deals with the group's various products. Career masters and others concerned with young people leaving schools and colleges may obtain copies of the book from the Group Personnel Department, E.M.I. Ltd., Hayes, Middx.

**The Orkneys** v.h.f. sound broadcasting station at Netherbutton, near Kirkwall, was brought into full-power service on May 2nd. Its directional aerial, giving a maximum e.r.p. of 25kW, radiates the B.B.C.'s three sound services on 89.3, 91.5 and 93.7Mc/s. A single-programme low-power transmitter has been in service on the site since December, 1958. Netherbutton picks up its programmes direct from the v.h.f. station near Wick, which in turn receives the programmes from the v.h.f. station at Meldrum, Aberdeen.

**15,000,000** broadcast receiving licences were in force in the U.K. at the end of March. During the month the number of combined television/sound licences increased by 101,430 to 10,469,753. Sound only licences totalled 4,535,258, including 427,491 for sets fitted in cars. During the same period television licences in Holland rose to 640,000 and sound licences to 2,621,000.

**H.P. and Hiring Restrictions.**—Under new restrictions imposed by the Board of Trade on April 29th on the initial deposit and repayment period for hire-purchase and credit sales agreements (S.I. 1960, No. 762) a deposit of 20% of the cash price is now required on sound radio and television sets and gramophones. The period for repayment is limited to two years. Another Order (S.I. 1960, No. 763) stipulates that the initial payment on hiring agreements for these equipments is a quarter's hire charge.

**Norway.**—The official opening of the Norwegian television service has now been fixed for August 20th. At present experimental transmissions are radiated by a transmitter in the Oslo area, where some 14,000 licences have been issued. A second station, in Bergen is being introduced.

**Armour Research Foundation** of the Illinois Institute of Technology is acting as host for the fourth annual Joint Military-Industrial Electronic Test Equipment Symposium which will be held in Chicago on September 14th and 15th.

**Two-year sandwich course** in telecommunications, providing alternate 6-monthly periods in college and industry, commences at the South East London Technical College, Lewisham Way, London, S.E.4, on October 3rd. The London fee is £17 per year. C. W. Robson, head of the electrical engineering department, has also sent us details of a four- or five-year engineering sandwich course in which provision is made for specialization in communication engineering.

**Technical books** to the value of £200 are to be provided during each of the next seven years to the Holborn (London) Central Library under a deed of covenant presented by Philips Electrical Ltd.

**Valve Dimensions.**—Two new sections of BS448, specifying the base and bulb dimensions of the B5G/F and B7E/F sub-miniature valves with flexible connecting leads, have been issued by the British Standards Institution. They cost 2s each.

"**Hardwood Instrument Cases.**"—Because of the misspelling of the name of a resin glue in the footnote on p. 178 of our April issue some confusion might arise with Casein type glues which are not so suitable for hardwood gluing. The correct name is Cascamite.

"**Dynamic Side Thrust in Pickups.**"—Owing to a typographical error in this article in our May issue, the steady stylus displacement was given on p. 215, column 2, line 30, as $25 \times 10^{-3}$cm; it should, of course, be $2.5 \times 10^{-3}$cm. On page 216, column 2, at the end of line 39, "other" should read "outer."

**Advance Components Ltd.** have asked us to point out that the price of their TC1 transistorized counter, which was quoted on page 254 of our May issue as £425, is now £335.

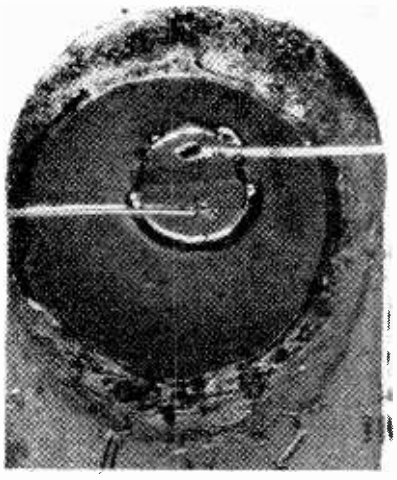
**Heathkit Ham Transmitter Kit.**—We regret that the price of the Model DX-4OU on page 24 of the advertisements in our May issue, was given in error as £12 10s. The correct figure is £29 10s.

**Royal Signals Institution.**—Membership of the Royal Signals Institution, which has in the past been restricted to Officers of the Royal Corps of Signals, is now open to all ranks of the Corps, both past and present. Its object is to foster the professional and technical interests of the Corps by publishing a journal (at present bi-annually), arranging lectures, maintaining the Royal Signals museum and conducting an annual essay competition. Details of membership, for which the fee is 15s a year, are obtainable from Brigadier W. T. Howe, Royal Signals Institution, 88 Eccleston Square, London, S.W.1.

**Twelve Scholarships** to men wishing to study for the Radio Amateurs' Examination are being offered by 404 Signal Squadron (Press Communications), Army Emergency Reserve. The scheme is open to fit men between the ages of 18 and 40 who are prepared to enlist in the Squadron for three years. When they attend the annual 15-day camp (the only peace-time training) they will be given intensive courses in basic theory and morse. At home they will continue their theory studies by means of a free correspondence course in preparation for the 1961 radio amateur examination. Details are obtainable from Major J. A. Bladon (G3FDU), 28 Jack Lane, Davenham, Northwich, Cheshire.

**I.E.E. On The Pipe.**—The Institution of Electrical Engineers building is now permanently connected by a 5-Mc/s wide-band coaxial cable to the Post Office distribution network for television or other wide-band signals. The cable, which goes to the Gerrard exchange, was actually put in for the colour television relay from Paris reported on p. 287.

**Stereophonic broadcasting** using a time-multiplex pulse-amplitude modulation system for the transmission of two channels from one transmitter has been developed by Siemens & Halske AG., of West Germany. The system, which is compatible, is one of several being tested in Germany.



**Portrait of a Mesa.**—*The central section, to which the two wires are attached, is the raised plateau of semiconductor material which is characteristic of a mesa transistor. This specimen, magnified 53 times, is the Ferranti double-diffused silicon transistor ZT20, which has a cut-off frequency of 80 Mc/s. Its construction was described and illustrated in the March issue, p. 127. The two gold wires, one mil in diameter, are pressure-bonded to the base and emitter, while the metal tab supporting the main body of the semiconductor forms the collector connection. By mid-1960 production of these transistors is expected to be 25,000 per year.*

# Personalities

**J. A. Saxton,** D.Sc., Ph.D., A.R.C.S., M.I.E.E., head of a division of the D.S.I.R. Radio Research Station at Slough for the past five years, has been appointed deputy director of the station. Dr. Saxton has been in the scientific civil service since 1938, when he joined the staff of the N.P.L. Radio Division. As already announced, the present director, **Dr. R. L. Smith Rose,** retires on September 30th, and is succeeded by **J. A. Ratcliffe.** Dr. Saxton has been responsible for carrying out a considerable programme on research in the propagation of microwaves over the ground and through the troposphere. He has twice served in the U.K. scientific mission in Washington and has been a U.K. delegate at many international scientific meetings. He is chairman of the U.K. national study group of the C.C.I.R. covering groundwave and tropospheric propagation.

*Dr. J. A. Saxton*

*Prof. C. W. Oatley*

**C. W. Oatley,** O.B.E., M.A., M.Sc., M.I.E.E., who since 1945 has been a Fellow of Trinity College, Cambridge, and University lecturer in electrical engineering, has been elected Professor of Electrical Engineering by the University. He will succeed **Professor E. B. Moullin,** who, as announced in our January issue, is retiring in October after occupying the chair since it was established in 1945. For twelve years prior to the war Professor Oatley was a member of the staff of the physics department of King's College, London, and for some time during the war was in charge of basic work on radar transmitters and receivers at the Radar Research and Development Establishment of the Ministry of Supply. He was chairman of the Radio Section of the I.E.E. in 1954/55 and is a member of the measurements and standardization committee of the International Scientific Radio Union.

**J. Bell,** B.Sc., F.Inst.P., deputy director of the G.E.C.'s Research Laboratories at Wembley, Middx., which he joined in 1929, has been appointed a director of the M.O. Valve Co., a subsidiary of the G.E.C. Mr. Bell, whose scientific work has been largely in the field of radio and radar transmitting valves, has been manager of telecommunications division of the laboratories since 1953.

**P. J. Walker,** president of the British Sound Recording Association for 1960/61, is managing director of Acoustical Manufacturing Co., of Huntingdon, which he formed in 1936. Mr. Walker, who has been responsible for most of the design and development of audio equipment made by his company, is also very well known as a lecturer on loudspeakers and high-quality reproduction. Readers will recall his articles in *Wireless World* on the electrostatic loudspeaker.

**A. L. Sutherland,** director of Philips Electrical, which he joined in 1933, and of Cossor Radio and Television since its acquisition by Philips, is the new chairman of the British Radio Equipment Manufacturers' Association. After war service in the Royal Artillery, in which he rose to the rank of major, and the Air Branch of the General Staff, Mr. Sutherland rejoined Philips in 1946 and managed the tungsten lamp department until being appointed commercial manager of the television and radio division in 1950. Six years later he was appointed to the board. Mr. Sutherland has represented Philips in B.R.E.M.A. for some years and has been vice-chairman of the council since 1957.

*A. L. Sutherland.*

*J. F. Winterbottom.*

**J. F. Winterbottom,** M.Sc., A.M.I.E.E., A.M.Brit.I.R.E., has been appointed chief engineer of Data Recording Instrument Co., of Ashford, Middx., which is associated with International Computers and Tabulators Ltd. Mr. Winterbottom was previously with the Motor Industry Research Association.

**P. A. Charman,** who joined Semiconductors Ltd. on its formation in 1957, has been appointed sales development manager and will be concerned with the company's technical information service. After ten years in the Electrical Branch of the Royal Navy and of the Royal Canadian Navy he was for two years with Philco (Great Britain), Ltd., where he set up a training equipment division.

**Joseph Samuels,** purchasing director of Winston Electronics, Ltd., Shepperton, Middx, for several years, has been appointed works director in charge of production. Before joining Winston Electronics in 1954, Mr. Samuels, who is 49, was for several years with Standard Telephones & Cables and later Sunvic Controls of A.E.I., Ltd.

**V. P. Cole,** who joined Grundig (Great Britain) Ltd. as sales manager in 1955, has been appointed sales director to the board. He started his career in 1917 as a wireless operator with Marconi's and during the last war he was with the Radio Production Executive of the Ministry of Aircraft Production.

**James C. Pledger** has been appointed technical director and chief engineer at the Coventry factory of Lexor Electronics Ltd. He succeeds **R. Grey,** who has taken an overseas appointment.

**E. G. Wakeling,** who joined Advance Components, Ltd., as general manager in February last year, has been appointed a director. He was formerly manager of the servo division of Elliott Brothers, Lewisham.

**A. B. Clarke** has joined Cossor Instruments Ltd. as sales manager. He was previously instrumentation sales manager of J. Langham Thompson Ltd., which he joined from the G.E.C. Applied Electronics Laboratories.

**Cecil Dannatt,** O.B.E., M.C., D.Sc., M.I.E.E., has been appointed vice-chairman of Associated Electrical Industries Ltd., with the special responsibility of coordinating both commercial and technical policy. Dr. Dannatt, formerly group managing director of Metropolitan-Vickers, has been group managing director of Associated Electrical Industries (Manchester) since it was formed earlier this year. He joined the board of Metro-Vick in 1947 as director and chief electrical engineer. Four years later he became assistant managing director and director of research and education. Dr. Dannatt, who is 63, and a director of a number of companies in the A.E.I. Group, was professor of electrical engineering at Birmingham University from 1940 to 1944.

**H. West,** M.Sc., M.I.Mech.E., M.I.E.E., assistant managing director of A.E.I. (Manchester) since last January, succeeds Dr. Dannatt as managing director. He joined Metropolitan-Vickers as an apprentice in 1918. In 1946 he was appointed assistant to the chief electrical engineer of the company; three years later he became chief electrical engineer, and was appointed to the board in 1951.

**Peter Axon,** O.B.E., Ph.D., M.Sc., A.M.I.E.E., managing director of Ampex Electronics Ltd., is now also managing director of Redwood City Engineering Ltd., the U.K. marketing subsidiary of Ampex International, S.A., of Fribourg, Switzerland. Dr. Axon joined Ampex Electronics Ltd., the organization's U.K. manufacturing subsidiary, last year from the Research Department of the B.B.C. where he had been engaged mainly in magnetic recording research and development since joining the Corporation in 1947.

**D. H. Follet,** M.A., Ph.D., F.Inst.P., keeper of the Department of Electrical Engineering and Communications in the Science Museum, London, since 1957, has been appointed director of the Museum. He succeeds Dr. T. C. S. Morrison-Scott, who has become director of the British Museum (Natural History). Dr. Follett joined the museum in 1937 as an assistant keeper in the department of physics. He was previously an industrial physicist.

## OUR AUTHORS

**D. Saull,** who on page 306 discusses mains transformer design, is on the development engineering staff of a firm of instrument manufacturers, where he is mainly concerned with the design of a wide variety of transformers. Following war-time military service in radar, he served for eight years in the Police Force and then entered the Diplomatic Wireless Service in which he was engaged on technical security work. For several years immediately prior to joining his present company he was in the Plessey applications laboratory at Towcester.

**L. E. Weaver,** B.Sc., A.M.I.E.E., author of the article on the measurement of random noise in television receivers, is head of the measurements group of the B.B.C.'s Designs Department which he joined in 1955. Prior to joining the B.B.C. he was with Standard Telephones and Cables where in the transmission laboratory he was engaged on the design of multi-channel telephone systems and networks and was for some time leader of a group specializing in the design of terminal equipment.

**John E. Robson,** B.Sc., A.M.I.E.E., senior development engineer of Redifon's Communications Laboratory, Crawley, Sussex, contributes an article on the calculation of standing-wave ratio to this issue. After serving in Royal Signals from 1940 to 1946 he studied at King's College, Newcastle, where he graduated in electrical engineering in 1948 and then went into industry. For seven years prior to joining Redifon in 1959 he was with Waymouth Gauges, Ltd. He is 39.

# V.H.F./F.M. Car Radio

By R. V. TAYLOR,
Assoc. Brit.I.R.E.

USE OF F.M. TUNER, A.F. AMPLIFIER AND POWER SUPPLY UNIT FOR MOBILE BROADCAST RECEPTION

THE B.B.C.'s v.h.f./f.m. services now cover all the major populated areas, and the greater part of the country is served by the 20 transmitting stations. In many areas medium and long-wave reception is not as satisfactory as v.h.f and, of course, the relatively short car-radio aerial is very inefficient at low broadcast frequencies. Many listeners now use v.h.f.-only receivers in their homes and would, no doubt, be satisfied with restriction to B.B.C. only on their car radios; especially in view of the freedom from interference given by f.m. Thus it seems only logical to use a v.h.f./f.m car-radio receiver.

Two difficulties arise when considering such an installation. The first, common to most car radios, is the provision of power supplies. Many modern cars use 12-volt positive-earthed batteries; thus valves must either have 12-volt heaters or be connected in series pairs. Also the positive earth may limit the choice of vibrator units.

The second apparent difficulty concerns the aerial. Only a vertical aerial could be kept reasonably clear of the car body and one would expect reception of horizontally-polarized transmissions on a vertical aerial to be unsatisfactory. Fortunately this is not so; a vertical quarter-wavelength rod fitted to the car roof (which will serve as a ground plane) has been found to provide a good signal in the service area of a v.h.f station. Such an aerial is usually omni-directional and is also suitable for direct connection by coaxial cable to the receiver input.

The principal requirements for a mobile v.h.f./f.m. receiver are met by most good f.m. tuners at present available, so the simplest method of obtaining v.h.f. car radio is to use a "standard" tuner and add a.f. stages and a power unit.

## Tuner Requirements

The principal requirements of the tuner are:—

*Sensitivity.*—A figure of the order of 10$\mu$V input for effective limiting has been found to be adequate in most areas. Greater sensitivity is not an advantage, as in places where it would be warranted for domestic use a moving vehicle would pass through rapid variations of signal strength, the minimum values of which might be too low for satisfactory use. A tuner of 10$\mu$V sensitivity normally gives good reception or no reception at all, an ideal state of affairs where borderline operation may distract a driver.

*Frequency Stability.*—Naturally, retuning during the warm-up period is undesirable and automatic frequency control is a useful "extra." However, despite the variations of temperature and supply voltage which arise in a car, many tuners seem to be stable enough to operate satisfactorily.

*Good a.m. rejection.*—It is vital where signal levels are low and ignition interference, vibrator hash, and generator "whine" abound, that a good a.m. rejection factor should be achieved. Tuners having a limiter stage preceding a ratio detector, or two limiters and a Foster-Seeley discriminator, should be suitable.*

*Automatic Gain Control.*—Good a.m. rejection can be achieved by "dynamic" limiting, but a limiter of this type is not able to compensate for variations in signal strength. Thus a.g.c. is necessary and this may also help to hold constant the a.f. level when using a static type of limiter.

*Free Tuning.*—Switched tuning is unsuitable unless the receiver is to be used in the service area of only one station. A large-reduction tuning drive is, naturally, an aid to tuning.

*A.F. Gain Control and Switch.*—Some v.h.f tuners incorporate an a.f. gain control and a power switch. This is desirable as then only the tuner need be accessible from the driving position and the power supply and amplifier can be mounted elsewhere.

Many of the kits and ready-assembled tuners on the market satisfy these requirements with little modification, so the choice of "front end" for the receiver is largely a matter of size (both in regard to the pocket and the tuner).

## Preparing the Tuner

For a 12-volt supply the valve-heater circuit will have to be re-arranged unless 12-volt valve equivalents are available. The simplest method is to connect the valves in series pairs, remembering that a shunt resistor will be necessary across the lower-current heater if valves of different heater-current rating are connected in series.

The heaters of the local oscillator and discriminator valves (if germanium diodes are not used for the latter) should be at the "earthy" side of their pairs. The extra wiring involved may cause instability. New leads should be run close to the chassis and kept away from signal wiring: extra decoupling may be necessary. Microphony, too, can be a problem, so this should be eliminated from the tuner before installation. Any leads or components likely to move under vibration should be secured. To ease servicing problems plug-and-socket connections for aerial, power supply, switch and a.f. output are desirable.

## A.F. Stages

Most tuners provide an a.f. output of at least 0.3 volts at high impedance and the author finds that a power output of one to two watts is ample for use in a car—in most modern cars no more than 0.5W will be required. Thus a single-ended two-stage amplifier is adequate. Where space is limited a single triode-pentode valve (an ECL80 or ECL82, for example) could be used.

* *Editorial note.*—Readers are reminded of the excellent and simple limiter/discriminator described by J. G. Spencer on p. 492 of our November 1959 issue.

**TABLE: SUITABLE OUTPUT VALVES**

| Valve | Bias Resistor (ohms) | Output Transformer Ratio for 3-Ω Load | Heater Rating | | H.T. Current (mA) |
|---|---|---|---|---|---|
| | | | V | A | |
| 6BW6, 6V6 | 270 | 40 : 1 | 6.3 | 0.45 | 50 |
| 6J5, 6C4 | 470 | 50 : 1 | 6.3 | 0.3 / 0.15 | 15 |
| EL91 | 680 | 75 : 1 | 6.3 | 0.2 | 19 |
| EL32 | 470 | 50 : 1 | 6.3 | 0.2 | 37 |
| 12A6 | 330 | 50 : 1 | 12.6 | 0.15 | 33 |

Transistors could be used with advantage in both the a.f. amplifier and power supply units. However, the intention was to keep down costs by using components available either from the "junk" box or the surplus market. Kits for both transistor amplifiers and power units are available, though, and the saving in battery drain through the use of transistors may be thought worthwhile. Also data sheets giving details of suitable 12-volt power units and a.f. amplifiers are obtainable from some transistor manufacturers.

Fig. 1 shows a circuit in which various combinations of valves may be used—a 6BR7 voltage amplifier and 6BW6 output stage are indicated. The a.f. input, from the tuner gain control (a screened lead is necessary), has connected across it a 1MΩ resistor to prevent the grid circuit becoming "open"

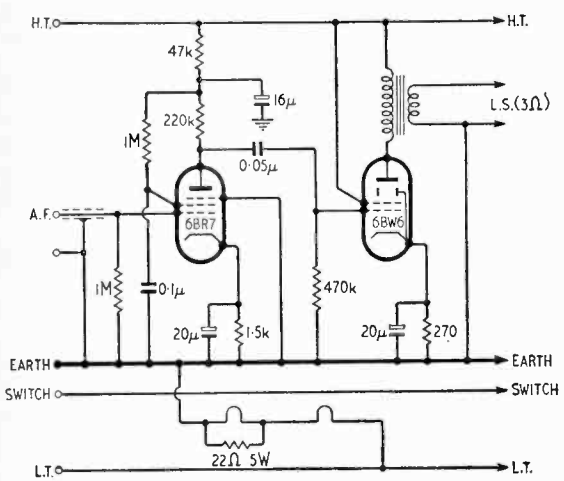



*Fig. 1. Audio amplifier showing heaters connected for operation from 12-V battery. On 6V, heaters should be connected in parallel and 22-Ω shunt resistor omitted.*

if the lead is disconnected. This first stage provides a voltage gain of about 140; it is thus capable of driving fully the least-sensitive output valve listed in the Table from a tuner output of as little as 0.15V. Octal-based near equivalents of the valves shown are 6SJ7 (V1) and 6V6 (V2) but a 43-Ω 2-W heater shunt will be required for the 6SJ7 instead of 22Ω.

An "economy" version of the a.f. unit, given in Fig. 2, is intended for use where space is limited and battery drain must be kept at a minimum. An output of over one watt is available, but distortion is higher than in the first circuit.

**Other Possibilities.**—If battery drain is the only consideration, a 6J5 or 6C4 may be used as an output valve. No heater shunt resistor is required with a 6SJ7/6J5, or 6BR7/6C4 combination.

Other pairs not requiring a shunt resistor for 12-V operation are EF86/EL32 and EF86/EL91. No change in component values, except heater shunt, need be made for any of the voltage-amplifier valves mentioned. Of course, a 12A6 and 12SJ7 or 12AT6 could be used with parallel-connected heaters on a 12-V supply. The Table gives further details of the valves suggested.

Layout of the a.f. stages is not critical; normal precautions should be taken to keep input leads away from the output and heater wiring.

## Interconnections

The connection between tuner and a.f. unit will carry a.f., h.t., l.t. and leads to the switch thus, for convenience, plug and socket connections are a good idea, although it would be unwise to add a bulky socket to a compact tuner. Multiple earthing should be avoided and the outer braid of the screened a.f. lead must be connected to earth only at one point. It will thus require a separate pin on the plug. L.T., earth and, possibly, the switch leads carry high currents, and need conductors thick enough to keep the total potential drop within bounds—say a maximum of half a volt with a six-volt supply, and double that on 12V.

Connections from the a.f. unit to the power supply

*Fig. 2. "Economy" a.f. amplifier requiring only 19mA at 220V h.t. Heaters shown wired for 12-V operation.*

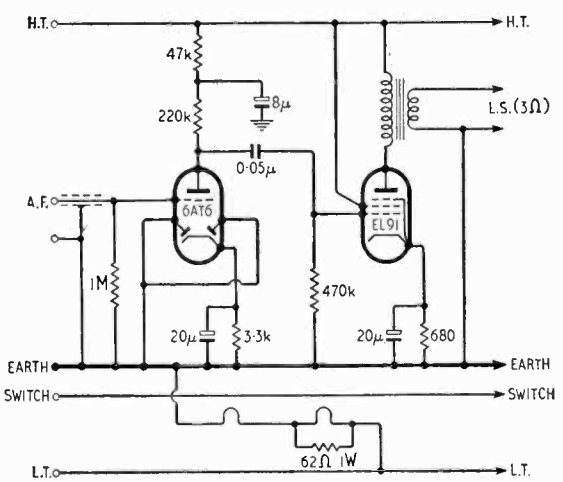
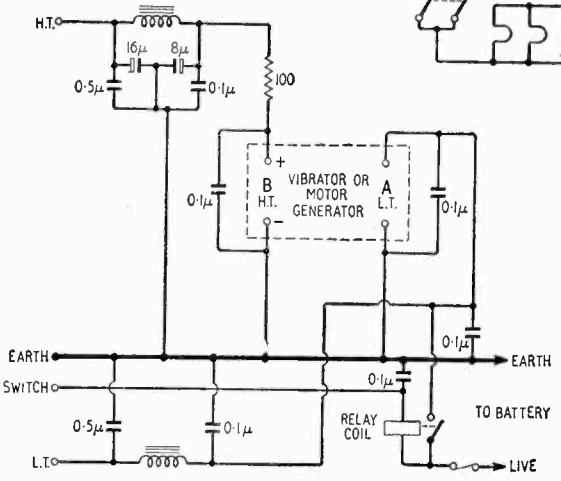


*Fig. 3. (Below) Filter and switch circuits added to vibrator or motor-generator h.t. supply. If the h.t. unit has only three terminals its input polarity should match that of the car supply. Switch on volume control connects switch lead to earth in the "on" position.*



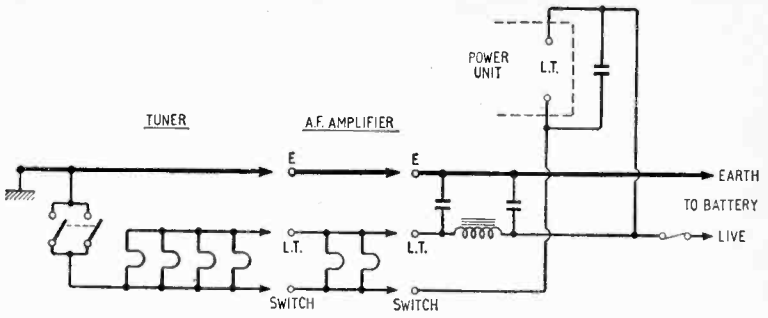




*Fig. 4. Power switching without relay. The h.t. unit must be isolated from earth: i.e. there must be no d.c. earth connection in the unit. Switch lead may require filtering similar to l.t. lead.*

should be made in the same way and a screened lead should also be used for the loudspeaker. The loudspeaker should be earthed only at the amplifier chassis (the earthy connection of the cathode-bypass capacitor for V2 seems to be the best place). All these measures are taken to avoid noise pick-up from the electrical-system currents flowing in the body of the vehicle; these may reach the loudspeaker, even when the receiver is switched off, if earth connections are made at several points on the car body.

## Power Supplies

A variety of vibrator and motor-generator units are available on the surplus market. A vibrator is more efficient than a motor generator and is therefore kinder to the battery. Care must be taken to check that the polarity of the supply acceptable by the vibrator unit is the same as that used on the car, although some units are designed to be compatible, usually by a simple modification, with either polarity of supply. The h.t. current of both the tuner and the a.f. unit (see Table for values at 220V) must be added to give the total power required from the h.t. supply.

Fig. 3 shows the connections for a typical vibrator or motor-generator unit. The filters shown in the h.t. and l.t. leads should not be necessary where the unit has its own filters, but the additional capacitors will generally be required to reduce radiation or pick-up of noise by the leads. The l.t. choke may be made by winding about three yards of 14-s.w.g. enamelled-copper wire on to a 1-in long by $\frac{1}{2}$-in diameter former. An ordinary smoothing choke rated at the full h.t. current is suitable for the h.t. filter.

The contacts of the switching relay must be capable of carrying in the region of 12A for 6-V operation or 5A on a 12-V supply. If a suitable type cannot be found on the "surplus" market a horn relay from a motor-accessory dealer would be suitable.

If the space available allows a compact layout, and leads between battery and power unit (via the tuner power-on/off switch) can be kept short (less than about six feet total) the relay can be dispensed with and the alternative circuit of Fig. 4 may be used. If the switch is incorporated in the tuner volume control it is advisable to connect in parallel the two halves of a double-pole type.

The lead from the power-supply unit to the car battery should follow the most direct route possible, passing through grommets where necessary to avoid chafing. Remember that the movement of the car may damage a heavy cable that is not securely fixed. The fused lead may be connected directly to the battery terminals; but if an "auxiliary" connection is provided (usually on the cut-out panel) this should be used in preference to the direct connection.

The author used a 7×4-in elliptical loudspeaker as space was available. Generally, the largest-possible loudspeaker with the highest-flux magnet will give the best results; but avoid damp or hot places or its life may be shortened. A large baffle area also helps.

## Aerials

At v.h.f. a resonant aerial can easily be used. A quarter-wavelength vertical whip mounted at the centre of a sheet of metal is a simple and effective aerial. As long as the metal sheet extends for more than a quarter wavelength in all directions from the base of the aerial it will behave as a ground plane and the aerial will have an impedance of about 50Ω at its base (but 75-Ω coaxial cable is suitable). For Band II the sheet of metal must be at least five feet across its smallest dimension; a car roof is obviously ideal.

A 2-ft 6-in whip in the centre of a car roof thus makes a simple and effective aerial. Despite the apparently incorrect plane in which it is mounted, it will operate because the signal at or near ground level will have a considerable vertically-polarized component.

Details of easily constructed or adapted aerials are given in Fig. 5. Where a quarter-wave whip and ground plane cannot be used (for example, on a sports car) a coaxial dipole (each element 2ft 6in long) may be suitable. In most cases the lower ele-

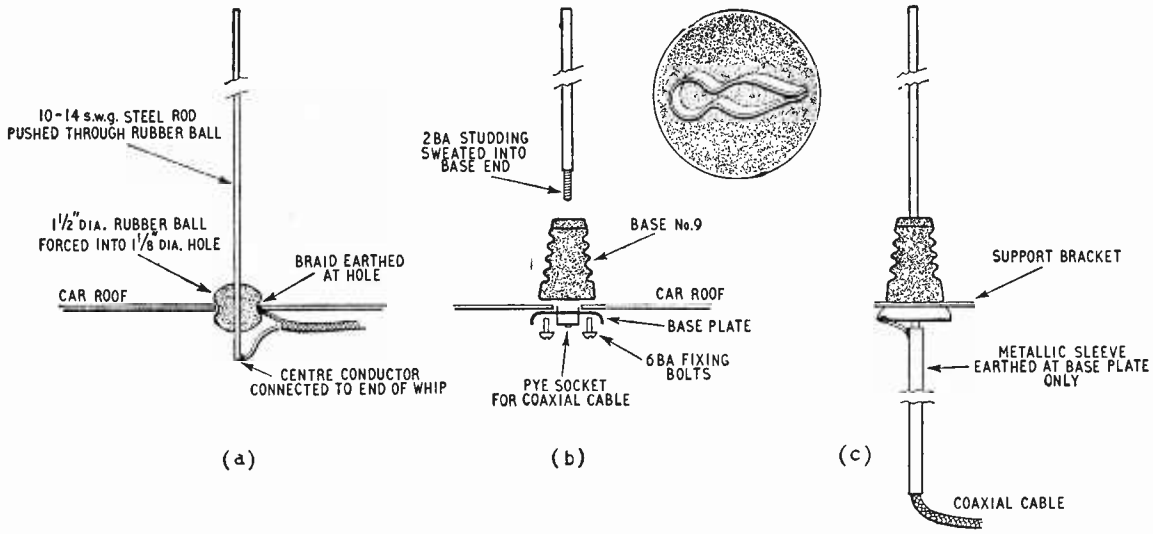



*Fig. 5. Some methods of mounting the aerial: (a) uses rubber ball as insulator and (b) employs ex-Govt. aerial base. For cars with non-metallic bodies (c) shows a coaxial dipole. Sleeve can be formed from outer covering and braid from large-diameter coaxial cable. Aerial elements are about 2ft 6in long. (Inset). Cable clip to secure aerial feeder. Springy clip material enables " legs " to enter slot in bodywork, then open out to hold cable firmly.*

ment will be close to the bodywork, reducing the efficiency of the aerial, but a good signal should still be obtained.

Feeder losses are negligible on the short run required in a car and the unbalanced aerial is better suited to connection to a coaxial cable than a balanced dipole. The normal telescopic car-roof aerial may be used as long as the outer braid of the coaxial cable is earthed effectively to the car roof at the aerial base.

The inset in Fig. 5 shows a cable clip for use in a slot in the bodywork. To avoid a loop in the receiver earthing it may be necessary to isolate the aerial-feeder "outer" at the tuner-input socket. This can be done by using a coaxial socket of the type employed on live-chassis television receivers. The sleeve (outer braid connection) of this socket is connected to the chassis through a 1,000-pF capacitor shunted by a 1-MΩ resistor. The resistor provides a leakage path for any "static" charges picked up by the aerial.

## Mounting the Units

Of course, the tuner chassis must be insulated from the car body—if the tuner has rubber feet it may be stood on the parcel shelf. Strips of plastic-foam draught excluder stuck to the bottom of the tuner make a good substitute for rubber feet. Some form of insulated resilient retaining clips are also advisable. For the a.f. unit the same considerations apply as far as vibration and earthing is concerned—the units should be placed rather than mounted, but must be restrained from "wandering" due to the movement of the car.

The power-supply unit, as it is much heavier than the other units, must be firmly anchored. The vibrator or generator is likely to be noisy acoustically so it is best placed outside the passenger compartment, either in the boot or in the engine space. To prevent the transmission of noise by the bulkhead or body work, the unit should be fixed by bolts, passing through rubber grommets in its chassis and in the mounting holes in the car.

## Conclusion

A receiver made up on the lines suggested should give good results in almost any part of the country. However, many apparently small points may have a noticeable effect on performance and a certain amount of trial and error is inevitable if the best results are to be obtained. A last word—don't forget that a separate licence is required for a car radio!

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**Foreign Body Locator,** *developed by the University of Birmingham Department of Physics, will detect an object of about 1 cu. mm size at a distance of 1cm with an accuracy of better than 1mm. It uses a search coil in one arm of an R-L bridge, and the presence of a magnetic or metallic object causes an impedance change which unbalances the bridge (indicated by a meter reading and a variation in pitch of an audible note). A phase-sensitive detector indicates whether the object is magnetic or not.*

# LONDON AUDIO FAIR

## SELECTED EXHIBITS OF INTEREST

"THE mixture as before," only more so, might be said to describe the recent Audio Fair, since most of the changes from last year were continuations of trends which were already noticeable then.

One trend which had perhaps hardly begun last year but which was very noticeable this year was an increase in the number of imported foreign (and in foreign we hope we are allowed to include U.S.A.) exhibits.

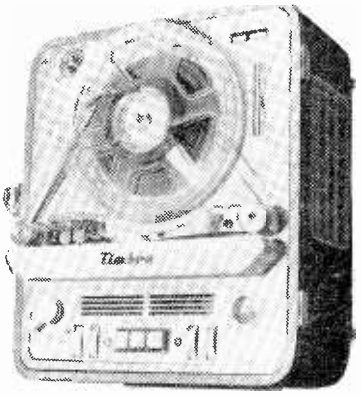
As before, while the main emphasis was on stereo, the main developments were in tape recording. This year, however, stereo has well and truly invaded the tape recording field, with stereo recording as well as replay facilities being offered in many of the new models and with the introduction of several new stereo microphones. Stereo microphones and tape recorders which can both record and replay stereo are thus now no longer the rarities they once were.

Four-track tape recorders are also now no longer a rarity, many of the new models coming into this category. As many as three such models were introduced by T.S.L.—the Harting HM8, the Korting and the Electron 9S/4K. All of these can also record stereo (as well as mono). Both the Korting and Harting HM8 use a transistor in the pre-amplifier to reduce hum and noise. In the Harting HM8 this transistor is not in its usual position before the first valve, but rather after it, this latter arrangement being claimed to allow better matching to the tape head.

Four- and two-track recorders, both of which used the same deck, were introduced by Multimusic (Reflectrograph). One unusual feature of this deck is that variable-speed fast forward and fast rewind are provided by a single control. This control consists of a potentiometer. The ends of the element are connected to the fast forward and rewind motors while the slider is connected to one side of the mains supply: the other side of the mains supply is connected to the other inputs to the motors. In this deck no idler wheels are used to drive the tape, the capstan being directly attached to the spindle of a synchronous "inside-out" motor. The rotor of this motor then acts as a flywheel to reduce fluctuations in the tape speed. Speed change is effected electrically. No pressure pads are used, the required close contact between the head and tape being produced by means of fingers bearing on the tape at each side of the head: a method being increasingly used nowadays. The signal-to-noise ratio is quoted as 50dB for the two-track model A; for the four-track model B this ratio is reduced to 45dB because of the narrower track width.

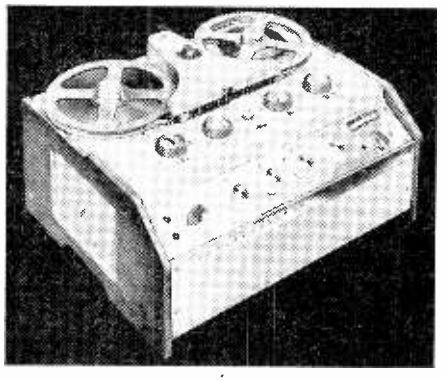
A stereo recorder shown by Ampex —the 970—has several unusual features. One of these is that the numbers of tracks used on record and replay can be different, since two-track heads are used to record and four-track heads to replay. Thus, while only two-track tapes can be recorded, both four- and two-track tapes can be replayed. Since the tape track positions are different for two- and four-track stereo tapes, and since the replay head gaps should lie centrally across each track for minimum crosstalk, the optimum head positions for minimum crosstalk are also different for replaying two- and four-track stereo tapes. This factor is allowed for in the Ampex 970 by making the position of the four-track replay head adjustable relative to the tape width—another unusual feature.

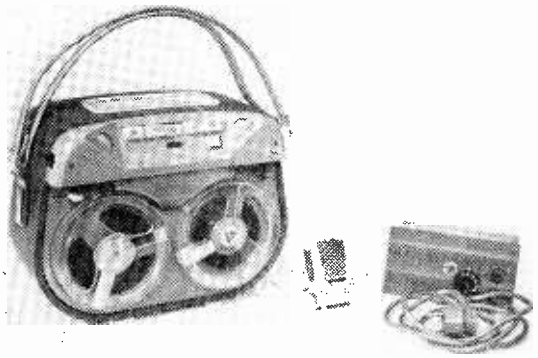
A very unusual feature of the two-track Timbra recorder shown by T.S.L. is that the two tape reels are placed one on top of the other. To raise the tape from one reel to the other it is first twisted through a right angle until it lies horizontally, then raised, and finally twisted back through a right angle. Impressive performance figures are quoted for this recorder: at the two provided



*Timbra recorder showing reels in playing position one on top of the other.*

*Multimusic Reflectograph 4-track recorder*





*Butoba battery/mains transistor recorder showing mains converter on right.*

tape speeds of 3¾ and 1⅞in/sec the frequency responses are stated to be within ±2dB from 30 to 18,000c/s and 30 to 12,500c/s respectively, and the total wow and flutter less than 0.05% and 0.1% respectively.

An unusual facility of the Vollmer 120 tape deck shown by Chitnis is that the tape speed can be continuously varied from 1⅞ to 7½in/sec. This variable speed is obtained simply by driving the capstan flywheel by means of a rubber wheel which can be shifted along a shaft perpendicular to the flywheel axis. Even at the slowest tape speed of 1⅞in/sec, the wow and flutter is quoted as less than 0.1%. Space for up to six miniature Bogen heads is available on this deck.

Two new two-track transistorized battery tape recorders were shown—the German Butoba MT4 (distributed in England by Denham and Morley) and the Challen Minivox. In the latter recorder, although the high-frequency recording bias is provided by the transistors, permanent magnets are used for erasing the tape. Two magnets are used in an arrangement which is claimed to result in much less tape noise than is produced by a single magnet. The fast forward and rewind motors are designed so that the battery current does not increase when the tape is fast wound (at about 40in/sec). The tape is capstan driven in the usual way in both this and the Butoba MT4 recorder. In this latter recorder the tape drive motor speed is kept constant as the battery voltage falls by means of a transistor switched by a centrifugal governor. The wow and flutter is quoted as 0.3% at a tape speed of 3¾in/sec. Both high-frequency bias and erase are provided by two OC74 transistors in push-pull. A converter for operating this recorder from the mains is available.

## TAPE

American Irish (Orr) tape was shown by Wilmex. The recording surface of this tape is polished so as to produce closer contact between the head and tape and thus improve the high-frequency response.

Pre-recorded four-track 7½in/sec stereo tapes produced by the United Stereo Tape group of American manufacturers were demonstrated by Ampex.

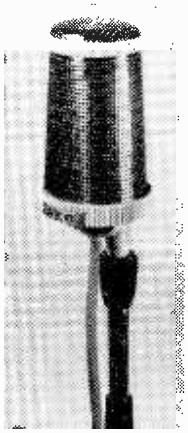
## MICROPHONES

Stereo twin moving-coil cardioid microphones were shown by the Austrian firm A.K.G. (distributed in England by Politechna (London)), Chitnis, T.S.L. and Telefunken. In the Telefunken model the two moving-coil units can be rotated relative to one another or even separated altogether: in the other models the units are fixed at right angles to each other.

A close-talking high-quality ribbon microphone—the 4104—was shown by S.T.C. A ribbon microphone normally responds to the sound pressure gradient or sound velocity and the low-frequency response rises for close sound sources. In the S.T.C. 4104, however, for a person speaking from a controlled standard distance from the microphone set by a mouth guard, this rise in the low-frequency response has been eliminated to give an output which is flat within ±3dB from 60c/s to 10kc/s. Distant sound sources will then appear to have their lower frequencies attenuated by amounts which range from about 5dB at 1000c/s to 25dB at 60c/s. Since these lower frequencies form an important part of most background noises, the response to such noises is considerably reduced. Another feature of this microphone is that the responses to sounds from the mouth and nose have been carefully equalized.

A number of useful facilities are offered with Austrian A.K.G. moving-coil and condenser microphones (distributed in England by Politechna (London)). For example, in several of the moving-coil units the bass response can be usefully reduced to eliminate the normal rise when close talking. This reduction in the low-frequency response is usually produced simply by connecting a choke across the microphone. A variable polar response is offered for both the D30 and D36 moving-coil and C12 condenser microphones. Essentially this variable polar response is obtained by mounting two cardioid units back to back and combining a varying proportion of their outputs in or out of phase—in the case of the condenser unit by altering the relative magnitudes and polarities of the two polarizing voltages. Omni-directional and figure-of-eight responses, for example, are then obtained by combining the two cardioid responses in or out of phase respectively.

Many of the moving-coil units in the A.K.G. range have been given a cardioid response. This is done by combining the omni-directional sound pressure response of a diaphragm exposed on only one side to sounds with the figure-of-eight pressure-gradient response of a diaphragm exposed on both sides to sounds. Basically these microphones are thus constructed with the diaphragm enclosed on one side except for a release tube.



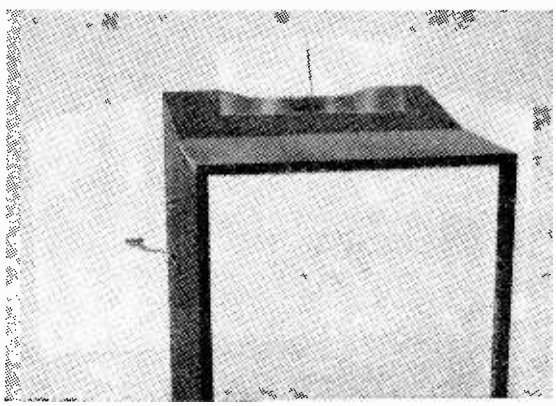
*Above: A.K.G. stereo moving-coil cardioid microphone.*

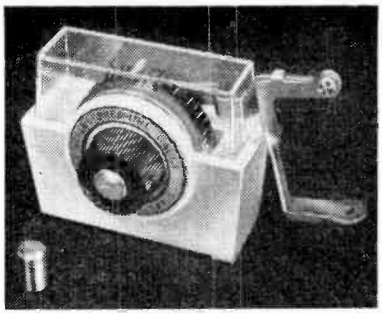
## LOUDSPEAKERS

An interesting single-cabinet stereo loudspeaker system—the Acousta-Twin—was demonstrated by Lowther. In this system frequencies below 200c/s—which convey only a small part of the directional information—are combined together by loading the rear of each of the two loudspeakers via a cavity (to cut off frequencies above 200c/s) with two folded horns having a common mouth. Frequencies above 200c/s which are radiated from the front of the speakers are reflected both sideways and upwards by wedges at the top of the cabinet. Further reflections at the room walls and ceiling then produce apparent sound sources much further apart than the speakers themselves. The separation and height of the sound sources produced by the upward-directed portion of the sound can be modified if desired by tilting a Perspex reflector on top of the cabinet. When the speaker system is used for reproducing mono sound this reflector is turned round through 180° and can then be raised or lowered to reflect a variable proportion of the upward-directed sound forwards. A variable proportion of the sideways-directed sound can also be reflected forwards by rotating two hinged Perspex panels at the side of the cabinet. For reproducing stereo, these hinged panels should be flat against the wall.

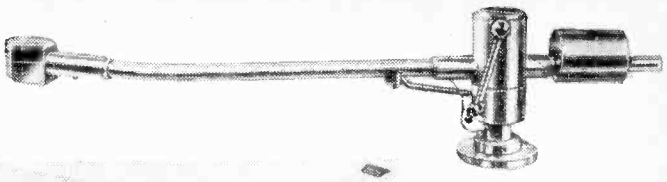
A number of unusual loudspeakers and loudspeaker mounting arrangements were shown by the French

*Below: Lowther Acousta-Twin stereo loudspeaker system.*

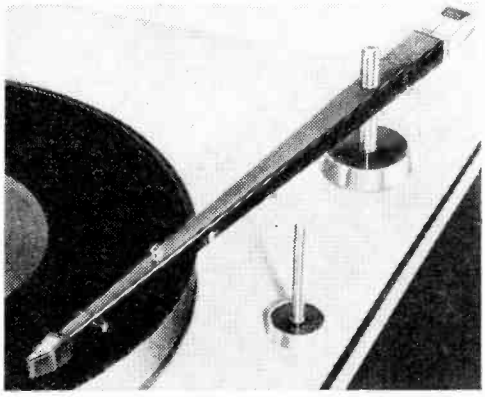




*Garrard stylus pressure gauge showing check weight at front left.*



*Above: H.M.V. pickup arm and stereo cartridge.*



*Left: Shure pickup arm and stereo cartridge.*

firm Teppaz whose equipment is distributed in England by Selecta Gramophones. For example, in their portable record players high-impedance crystal loudspeakers are used to reproduce frequencies above 3000c/s, and, in order to save space, the lower frequencies are reproduced by inside-out loudspeakers—i.e., loudspeakers in which the magnet is inside rather than outside the cone angle. These inside-out loudspeakers are mounted on flat lid baffles with the mounting deliberately made non-rigid. Moreover, both the front and back of these speakers are covered by grilles which are deliberately designed to impede the free flow of sound. The Teppaz Duo Dynamic enclosure has a long slit opening at its rear which leads to two expanding chambers terminated by hinged doors. By adjusting these doors the bass response of the system can be varied.

A recent modification to the Stantel column loudspeakers made by S.T.C. for sound reinforcement purposes is that they have been given a slight curvature in the vertical plane. This widens the high-frequency vertical polar response to the same width as the low-frequency vertical polar response.

A 10-in version of their well-known Dual Concentric loudspeakers—the IIILZ—was shown by Tannoy. In this new unit the high-frequency response can be altered by using a capacitor to shunt a variable fraction of a resistor in series with the horn-loaded high-frequency unit. Alternative speaker impedances of 4, 8 or 15Ω can be selected by means of an auto-transformer.

High-quality moving coil headphones with quoted responses from 30c/s to above 15kc/s were shown by A.K.G. (distributed by Politechna (London)) and Chitnis (the Beyer DT48). The low-frequency response of course depends on how airtight the earpiece to head joins can be made.

## PICKUPS

A rather unusual arm is used in the American Shure Studio Dynetic pickup (distributed in England by Maunder). In this arm the vertical- and lateral-motion pivots are well separated rather than close together. The two vertical motion point pivots, being only about an inch from the head, carry little more than the head and head counterweight. The arm is balanced about the point and sleeve pivots for lateral motion so as to reduce interference by external vibrations and to avoid the need for levelling. The main arm counterweight is attached by means of a vertical strip embedded in a special damping material to reduce the effects of the low-frequency arm resonance. A magnet in the arm attaches it to its rest. This arm is straight, the offset angle necessary to reduce tracking error being provided in the head itself. This head uses a moving-magnet system, both mono and stereo versions being available. For the stereo or mono cartridge respectively the effective mass at the stylus tip is quoted as 1.3 or 1.25mgm and the compliance as $9\times10^{-6}$ or $7\times10^{-6}$cm/dyne.

A high-quality stereo pickup and arm were shown by H.M.V. The pickup uses a variable-reluctance vertical-lateral motion system, the correct outputs for the standard 45/45 recording system being obtained by the usual method of summing (adding) and differencing (subtracting) the vertical and lateral outputs. The effective mass at the stylus tip is quoted as about 1mgm vertically or laterally, and the vertical and lateral compliances as $3.5\times10^{-6}$ and $7\times10^{-6}$cm/dyne respectively. The arm is suspended on a single pivot, movement being damped by a viscous fluid. The counterweight is mounted asymmetrically to provide the sideways balance necessitated by the head offset. The head offset angle is adjusted to minimize the distortion produced by the angular tracking error rather than to minimize the tracking error itself. Minimizing the tracking error will not necessarily minimize the distortion since this is not only proportional to the tracking error but also inversely proportional to the distance from the record centre. A raising and lowering mechanism is also incorporated in this arm.

In the Mark II version of the Tannoy Vari-Twin stereo cartridge an extra pair of pole pieces has been added. These are cross-connected to the bottom two pole pieces so that any hum picked up by either of the bottom two pole pieces and induced in the coil wound on it is cancelled by the hum induced via one of the extra pole pieces. A hum reduction of the order of 20dB has been obtained in this way.

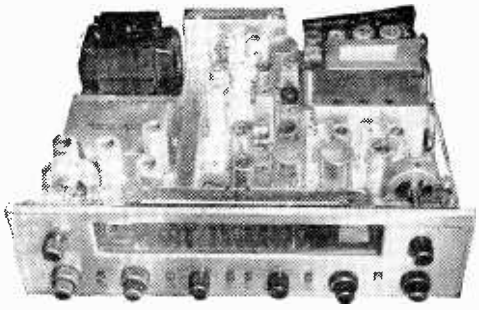
A new stylus force gauge—the SPG3 —was shown by Garrard. This is graduated in ½gm intervals from 0 to 12gm. A 5gm check weight is provided. The stylus force is balanced via a lever against that of a spiral spring.

## RECEIVERS

Two American models consisting of independent a.m. and f.m. tuners mounted on the same chassis for receiving suitable stereo transmissions were shown by Ampex and Wilmex. The Wilmex unit—the Fisher 202-T —is claimed to effectively limit f.m. inputs below 1μV, four i.f. and limiter stages being used. A stereo pre-amplifier and tone control unit is incorporated on the same chassis.

A new Chapman tuner—their S6BS/FM—is a combination of their older FM91 f.m. and S6BS a.m. tuners. Nine a.m. bands are provided, six being bandspread.

The range of Goldhorn transistor sets shown by Denham and Morley

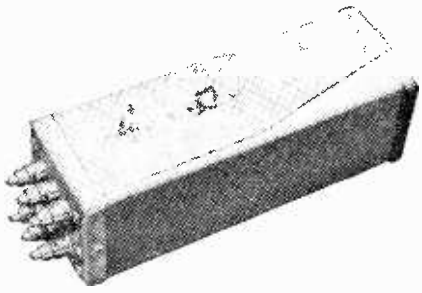


Rogers stereo tone control unit.

includes the TK110 which can receive short waves down to 16 metres.

S.T.C. were showing a relatively inexpensive triple-crystal unit for use in f.m. receivers.

Above: Fisher a.m./f.m. stereo tuner and tone control unit.



Right: Wellington Acoustic Laboratories transistor stereo pickup pre-amplifier.

## AMPLIFIERS & PRE-AMPLIFIERS

Transistorized units seemed to be more common this year. Pre-amplifiers were shown by Cintel, Wellington Acoustic Laboratories, and Reslosound. The Reslo Transistor Coupler is designed for microphones with impedances from 30 to 1,000Ω and uses a common-base transistor circuit. Wellington Acoustic Laboratories showed two units for use with both high and low impedance pickups—one unit for mono and the other for stereo. The crosstalk on the latter—the Stereo Wal Gain—is claimed to be as low as −60dB at 1,000c/s and better than −50dB at 10kc/s. (Any capacitive coupling would tend to make crosstalk increase with increasing frequency.) Special features of the Cintel prototype unit are high- and low-pass filters cutting off at 18dB/octave from 30c/s and 7kc/s respectively.

A transistorized combined pre-amplifier and 15W (5% distortion) power amplifier on the same chassis—the BCS2429—was shown by G.E.C. In the pre-amplifier mixing of the signals from two 15 to 30Ω microphones and a high-impedance crystal pickup is possible. In the power amplifier the base bias of the driver and two output transistors can be adjusted to obtain the optimum performance. A prototype power amplifier shown by Cintel gave an output of 10W at less than 0.5% distortion.

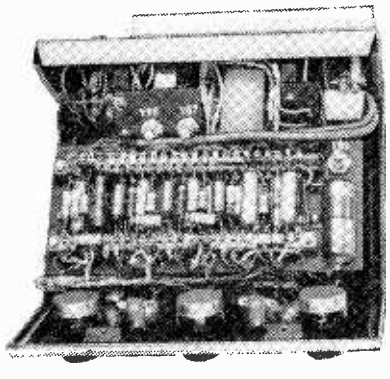
Turning now to valve amplifiers, for reducing stereo "hole in the middle" a variable output proportional to the sum of the two stereo signals and designed for feeding a central third speaker (third channel) is provided in the American Fisher X202 combined stereo pre-amplifier, tone control unit and 2×25W power amplifier shown by Wilmex. Variable crosstalk between the two channels can be artificially introduced in this unit so as to reduce the width of the overall sound field. Other unusual facilities in the Fisher X202 are controls for adjusting the bias and d.c. balance to optimum.

An unusual feature of a range of 30W (1.5% distortion) and 60W (3% distortion) portable combined pre-amplifiers and amplifiers designed by S.T.C. for use in public address systems is the provision of cathode-ray output level indicators. The output impedance is 333Ω for the AP30/2IP and AP30/3IP 30-W amplifiers and 166Ω for the AP60/3IP 60-W amplifiers. The signal-to-noise ratio for these amplifiers is as high as 54dB even at the maximum input sensitivity of 0.5mV (at 600Ω).

Special features of a very comprehensive stereo pre-amplifier and tone control unit shown by Rogers are a maximum sensitivity of 2mV, provision of as many as 18 inputs, 10 of which can have their sensitivities varied, a low-pass filter with variable slope and choice of three alternative cut-off points, a high-pass filter with two alternative cut-off points, and coarse and fine balance controls.

An American stereo amplifier balance indicator using a meter—the Kinematix SB-1—was shown by Wilmex. If an acoustic balance different from the amplifier balance is required and obtained, the indicator can be adjusted to re-indicate balance, and the same acoustic conditions for balance can then be readily reproduced.

A 25-W guitar amplifier combined with a 12-in loudspeaker—the Vibromajor—was shown by Grampian. A special feature of this is an amplitude modulation vibrato variable both in frequency and depth. The very high peak to mean ratio of the input signal necessitates an amplifier specification somewhat different from that for normal high fidelity. For example, the power requirements are somewhat higher, although a higher distortion—up to about 2%—is quite acceptable. The amplifier should have a smooth overload characteristic (i.e. less feedback than is usual can be employed) and not block or oscillate when overloaded.



Left: Underneath view of G.E.C. transistor combined pre-amplifier and power amplifier.

Right: S.T.C. triple-crystal unit for use in f.m. receivers.

# Self-Balancing Push-Pull Circuits

## 2.—Practical Design Considerations

By D. R. BIRT*

(Concluded from page 221 of the May, 1960 issue)

FROM the discussion of general principles in last month's article, the requirements for the first stage of a practical amplifier are now fairly clear. We have seen that for good balance and low push-push gain, $V_1$ and $V_2$ should have a high $g_m$ and large anode impedance. This suggests the use of pentode valves. However, there is an attendant disadvantage associated with the screen grid supply in this type of circuit, which may be of importance in the most critical applications. As may be seen from Fig. 8, the screen grids of $V_1$ and $V_2$ must be held at cathode potential as far as a.c. signals are concerned, and not at earth, to avoid application of one half the input signal to the common screen junction. This may be accomplished by decoupling the screen grids to cathode. However, when this is done, the screen dropping resistor appears effectively in shunt with the cathode impedance. A better plan is to substitute cascode stages for $V_1$ and $V_2$[12]. It is generally possible to achieve a higher gain in this way, and a screen grid supply is not required.

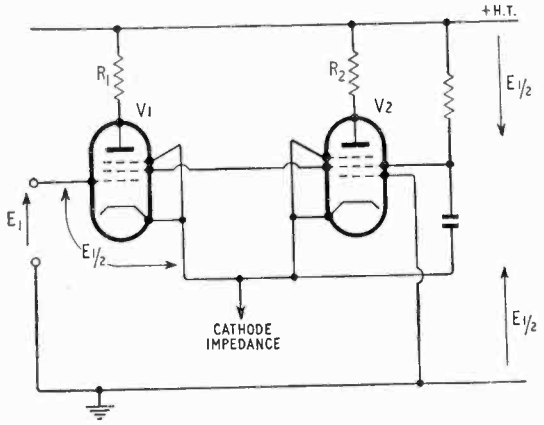



*Fig. 8 Long-tailed pair using pentodes.*

The grids of the upper triodes of the cascode pair require ideally to be at a constant potential relative to cathode. This is not a difficult problem, as we may decouple the grids to cathode, and make the grid feed resistor large.

Alternatively, a cross coupling arrangement can be used as shown in Fig. 9. The operation of this circuit is rather interesting. When a push-pull signal is applied, it can be seen that the drive to the upper triodes of the cascode pair is applied to both the grid and cathode, in antiphase. As far as the cathode circuit is concerned, this turns out to be equivalent to doubling the $g_m$ of the upper valve, and therefore the cathode impedance is halved and the voltage

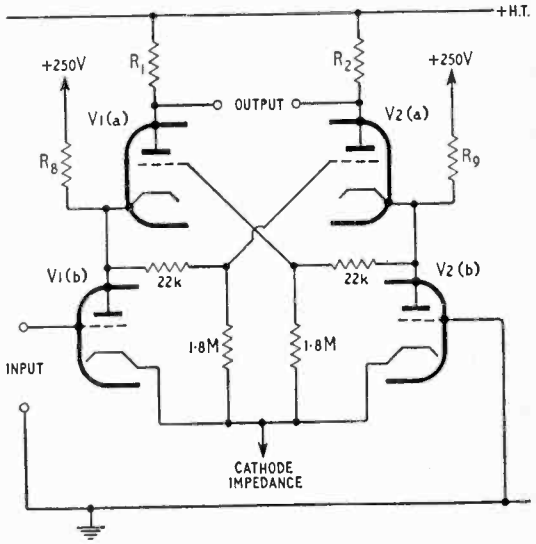



*Fig. 9 Long-tailed pair using cascode stages with cross coupling.*

gain to this point is halved. However, the grid-to-cathode voltage of each upper triode is the same as it would be in a conventional cascode amplifier, and the overall gain is similar.

If we now consider a push-push signal, we find that the signal voltages at the grid and cathode of the upper triodes are in phase, and of almost equal amplitude, so that the amplifier has less gain in this case.

The basic cascode amplifier may be improved by the addition of two resistors, $R_8$ and $R_9$ in Fig. 9[13]. This modification promotes a higher $g_m$ in the lower triodes by reason of the additional anode current bled through $R_8$, $R_9$. The gain of each cascode stage is the product of the $g_m$ of its lower valve and the anode load resistor of its upper valve. It would appear advantageous to operate the lower triode over the region of its characteristics where the $g_m$ is highest. This implies working at a high anode current. In a conventional cascode amplifier, an increase in lower triode anode current increases the voltage dropped across the upper triode anode load resistor. In a driver stage, where we want a large output, we cannot tolerate this reduction of anode voltage as it reduces the available output voltage. Therefore we have to reduce the anode load resistance, and we find that what we gained on the "swings" of higher $g_m$ we have substantially lost on the "roundabouts" by reducing the load resistance. In the modified circuit, however, current fed to the anode-cathode junction allows the anode current (and hence the $g_m$) of the lower triode to be greater

* Mullard Research Laboratories.

than that of the upper triode. The effective $g_m$ is increased by this means without affecting the current in the load resistor, and it follows that there is an increase in gain over the conventional form of circuit.

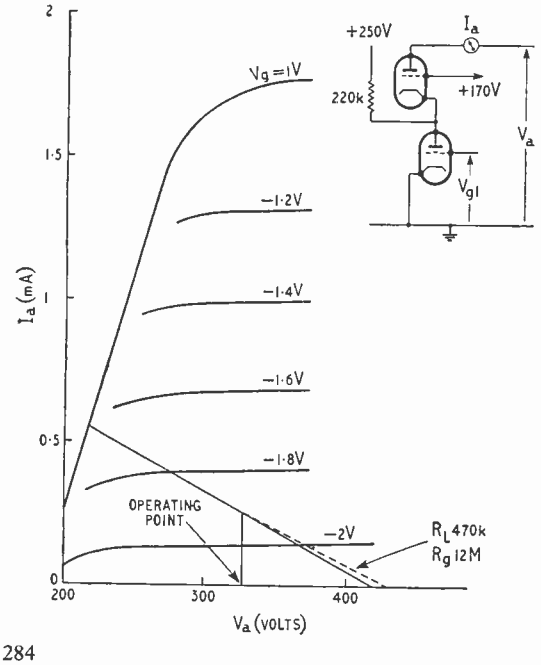
Having considered the general requirements of the circuit, it is now appropriate to consider particular requirements with respect to valve operating conditions. The first step is to plot the cascode characteristics of the double triode to be used. Fig. 10 shows the characteristics of an ECC83 plotted for an upper valve grid voltage of 170 volts. The characteristics are similar in form to those of a pentode, and it is a useful rule of thumb to take the knee voltage at a practical working current as being approximately equal to 120% of the potential of the upper triode grid. It is emphasized that, although these characteristics represent a fair average in respect of valves measured by the author, they are not necessarily those of a nominal valve.

The value of the anode load resistor may now be chosen. A high value will give a large gain, and the first limit is often set by the bandwidth requirements of the amplifier. It is necessary to ensure that the load is such that the operating point does not move into the knee region or beyond cut-off, under normal operating conditions.

In determining the operating conditions, one must bear in mind the fact that grid current may begin to flow at about $-1.3$ volts $V_g1$, and one must therefore ensure that the grid voltage does not normally approach this value. If supply voltages are subject to variation, allowance should be made to prevent an increase in distortion with a low h.t. voltage.

As an example, suppose the bandwidth required is 20 kc/s, and that the load presented by the following stage is 10 pF in parallel with 2MΩ. A load resistor of 470kΩ is suitable, and a loadline of the appropriate slope is drawn in Fig. 10. Fig. 11 shows

*Fig. 10 Cascode characteristics of the ECC88 double triode.*



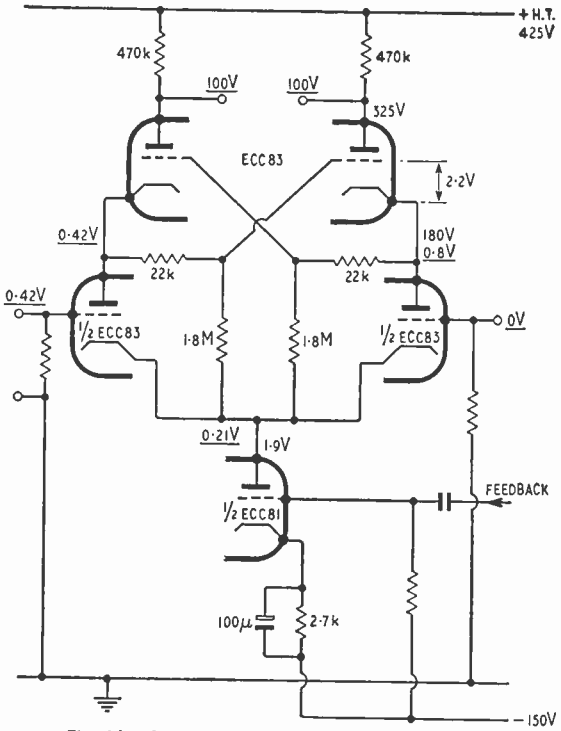




*Fig. 11 Operating potentials of the cascode pair.*

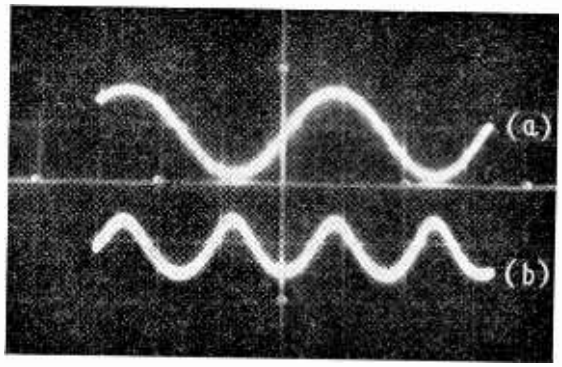



*Fig. 12 Degree of balance in an experimental audio amplifier is shown by these oscillograms: (a) amplifier output voltage, (b) output stage cathode current.*

the operating voltages. Figures underlined are peak-to-peak a.c. voltages relative to earth for a push-pull output of 200V peak-to-peak. The measured push-pull gain is some 500 times, and with feedback taken from a resistive divider connected between the output terminals, the push-push gain is −88 dB relative to the push-pull gain. Although a pentode is the ideal cathode impedance, the above figures demonstrate that it is frequently possible to obtain the required characteristics with a triode.

## Experimental Audio Amplifier

An experimental 10-watt audio amplifier which utilizes overall push-push feedback has been built (and it is hoped to describe a development of this amplifier in a future article). The amplifier embodies

a modified cascode phase splitter of the type described above. The phase splitter precedes a Class A pentode output stage, and the push-push feedback loop is taken from the common cathode bias resistor of the output stage to the grid of a pentode forming the cathode impedance of the cascode pair. The degree of balance obtained with components of 20% nominal tolerance may be seen from Fig. 12. The upper trace displays the output waveform at an output of 11 watts. The lower trace shows the residual voltage across the output stage cathode resistor. This represents an alternating h.t. current which is predominantly second harmonic and which has an r.m.s. value of 500$\mu$A. This compares favourably with the peak anode current per valve, which is 120mA. Practical advantage of this feature is reflected in an extremely simple RC power supply, which may be used to feed a high-gain preamplifier simultaneously, without risk of instability; and a signal/hum ratio in excess of 60 dBm.

Finally, the author would like to thank many of his colleagues, and in particular K. W. Moulding and P. L. Mothersole, for encouragement and help in the preparation of this article.

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# Causes of Low Outputs*

## WHY AUDIO OUTPUT STAGES OFTEN DO NOT ACHIEVE THE EXPECTED PERFORMANCE

In some valve manuals the data for most types of output pentode include a figure for the output power available at 10% total harmonic distortion. It is not always realized that this figure represents the power available *at the valve with the values of voltages, current and external anode resistance quoted.* Consequently, the values of output power actually obtained in practical equipment are often lower than those which seem, from the data, to be available.

The values of output power quoted in the manuals are usually given for fixed bias and screen-grid voltages because these closely represent the values actually available for speech or music reproduction. Where a cathode-bias resistor and/or a series screen-grid resistor are used, measurements with a continuous sine wave will show lower output powers than those obtained with fixed voltages. At full drive, the screen-grid current will be appreciably higher than without the signal. Therefore, if the signal is a sustained sine wave, the valve operating conditions will readjust themselves to an increased bias voltage and/or a reduced screen-grid voltage. During the reproduction of speech or music, the waveforms are complex and the sine waves are never sustained at full-drive amplitudes for a long enough time to affect the valve operating conditions.

If it is desired to know how much power is available at a certain level of distortion under speech or music conditions, the direct voltages between the various electrodes and the cathode can be measured and can then be maintained at these values by auxiliary supplies. As a rough guide, the output power measured with a sustained sine wave under cathode-bias conditions is approximately 10% less than that measured with a fixed bias voltage. A simple correction allowing for the effect of a screen-grid resistor cannot be given—it depends both on the value of the resistor and on the ratio of screen-grid current at zero signal to that at full drive.

The voltages quoted in the valve manuals are usually given with respect to the cathode, and should not be confused with the voltage between the h.t. line and the chassis. Usually, the actual anode voltage will be the h.t. line voltage less the voltages dropped across the primary winding of the output transformer and the cathode resistor.

Valve manuals usually give an optimum value of effective external anode load resistance, and the output power quoted is for this optimum value. At all other values of resistance, the output power will be lower. For single-valve operation, if the effective anode load resistance $R_a$ is greater than the optimum value $R_{a(opt)}$, the anode voltage swing at a given distortion is almost independent of the value of $R_a$.

For a resistance less than the optimum, the anode current swing is roughly independent of $R_a$.

Therefore, for $R_a > R_{a(opt)}$:

$$P_{out} \simeq \frac{R_{a(opt)}}{R_a} \times P_{out(opt)}$$

and for $R_a < R_{a(opt)}$:

$$P_{out} \simeq \frac{R_a}{R_{a(opt)}} \times P_{out(opt)}$$

where $P_{out}$ and $P_{out(opt)}$ are the values of output power corresponding to $R_a$ and $R_{a(opt)}$ respectively.

One of the most common causes of mismatching is that the resistances of the primary and secondary windings of the output transformer and of the leads to the loudspeaker have been neglected. The effect of the resistance of the secondary winding and the speaker leads is to increase the secondary load resistance. The effect of the primary resistance $R_a$ is twofold: it increases the external anode load resistance, and it influences the valve operating conditions in that it lowers the anode voltage and, hence, the optimum anode load resistance. The effective external anode load resistance $R_a$ is given by:

$$R_a = R_p + n^2 (R_s + R_L)$$

where $n$ is the transformer turns ratio, $R_s$ is the

*This article is based on a report in **Mullard Technical Communications**, Vol. 4, No. 40 (August 1959).

resistance of the secondary winding and $R_L$ is the secondary load resistance (including the resistance of the leads). Corrections to the optimum value of anode resistance can be made if it is assumed that the optimum value is roughly proportional to the anode voltage and the reciprocal of the anode current.

**Practical Example.**—Some time ago it was found that, in an amplifier which incorporated a single-ended EL84 audio output stage, the anode current was low with many samples of the valve and the output power delivered to a 7.5Ω secondary load was only 2W instead of the 4.2W indicated in the valve manual. The h.t. line voltage in the amplifier was 250V, and the current in the output stage was 36mA. The relevant data, abstracted from the valve manual, are given below:—

| | |
|---|---|
| $V_a$ | = 250V |
| $V_{g2}$ | = 250V |
| $R_a$ | = 7kΩ |
| $R_k$ | = 210Ω |
| $V_{g1}$ | = − 8.4V |
| $I_a$ | = 36mA |
| $P_{out}$ ($D_{tot}$ = 10%) | = 4.2W |

It was found that a cathode resistance of 210Ω was used in the output stage of the amplifier. The actual screen-grid voltage (with reference to the cathode) was therefore only about 242V, which explained why the anode current was often low.

However, the loss in power resulted mainly from mismatching and the resistance of the windings of the output transformer. Measurements showed that the turns ratio of the transformer was 30.5 : 1, which transforms 7.5Ω connected to the secondary winding into 7kΩ across the primary. However, the primary resistance was 700Ω and the resistance of the secondary winding was 0.9Ω.

The current of 36mA through the primary winding caused a voltage drop of 25V, so that the actual anode-to-cathode voltage was only 217V. At this voltage, the optimum anode resistance for an EL84 is approximately (217/250) × 7, or 6.1kΩ, and at this optimum value the output power would be (217/250) × 4.2, or 3.65W. However, the transformer, with its winding resistances and a secondary load of 7.5Ω, presented to the valve an effective anode resistance given by:

$$R_a = 700 + (30.5)^2 (7.5 + 0.9)\Omega.$$

That is, the effective anode resistance in the amplifier was 8.5kΩ. The output power available from the valve at this optimum value is approximately (6.1/8.5) × 3.65, or 2.63W. There is, however, a loss of power of 0.47W in the resistances of the primary and secondary windings, so that the useful power delivered to the load is about 2.2W instead of the expected 4.2W.

Because the calculation of output power at an anode resistance different from the optimum is only approximate, and also because the transformer resistances were measured on a cold transformer, this value of 2.2W is in reasonable agreement with the output of 2W obtained with the amplifier. A small reduction in the cathode resistance, and the use of a different, though somewhat larger, output transformer ($R_p$ = 305Ω, $R_s$ = 0.2Ω, $n$ = 28.3) resulted in an increase in output power to 3.5W delivered to a secondary load of 7.5Ω.

# Phonetic Alphabet

IT is understood that many hours were spent during the Geneva Conference discussing the merits and demerits of the various phonetic alphabets now in use, before adopting the one which has been used by N.A.T.O. forces and civil airlines since March 1st, 1956. It is a great improvement on the alphabet incorporated in the Atlantic City Regulations (1947), and will be used in international radiotelephony from May 1st next year when the Geneva Regulations come into force. However, even after that date stations of the same country may continue to use when communicating between themselves any other phonetic alphabet recognized by their own administration.

| | | | |
|---|---|---|---|
| A | **Alfa** | Able | Amsterdam |
| B | Bravo | Baker | Baltimore |
| C | **Charlie** | Charlie | Casablanca |
| D | **Delta** | Dog | Danemark |
| E | **Echo** | Easy | Edison |
| F | **Foxtrot** | Fox | Florida |
| G | Golf | George | Gallipoli |
| H | **Hotel** | How | Havana |
| I | **India** | Item | Italia |
| J | **Juliet** | Jig | Jerusalem |
| K | **Kilo** | King | Kilogramme |
| L | **Lima** | Love | Liverpool |
| M | Mike | Mike | Madagascar |
| N | **November** | Nan | New York |
| O | **Oscar** | Oboe | Oslo |
| P | **Papa** | Peter | Paris |
| Q | **Quebec** | Queen | Quebec |
| R | **Romeo** | Roger | Roma |
| S | Sierra | Sugar | Santiago |
| T | **Tango** | Tare | Tripoli |
| U | **Uniform** | Uncle | Upsala |
| V | **Victor** | Victor | Valencia |
| W | **Whisky** | William | Washington |
| X | X-ray | X-ray | Xantippe |
| Y | **Yankee** | Yoke | Yokohama |
| Z | **Zulu** | Zebra | Zurich |

We give in the table first the N.A.T.O./I.C.A.O. phonetics adopted at Geneva (with the syllables to be emphasized in heavy type), then the well-known Able-Baker-Charlie list, which is still used for working between British ships and British coast stations, and finally the cumbrous words approved at Atlantic City which will continue to be used for international working until the Geneva Regulations are introduced.

The first ten words of the new alphabet are also to be used for verifying the numerals 1 to 0 respectively, and the following four words for a comma, fraction bar, break sign and full-stop. When transmitting figures or marks they must be preceded and followed by the words "as a number" or "as a mark" spoken twice, e.g., the number 1960 will read: "as a number, as a number, Alpha, India Foxtrot Juliet, as a number, as a number."

This method of verifying numerals is not used by operators in British ships and coast stations. The G.P.O. "Handbook for Wireless Operators" gives the following rules for the pronunciation of numerals: 0, zero; 1, wun; 2, too; 3, thuh-ree; 4, fo-wer; 5, fi-yiv; 6, six; 7, seven; 8, ate; 9, niner. Each transmission of figures is preceded and followed by the words "as a number" spoken twice.

# COLOUR TELEVISION FROM PARIS

## DEMONSTRATION OF FRENCH SYSTEM AT THE I.E.E.

TECHNICAL history was made in a small way on the evening of 27th April, when colour television pictures were relayed for the first time from Paris to London. The occasion was a lecture at the I.E.E. on the Henri de France system of colour television, by R. Chaste and P. Cassagne of, respectively, the Compagnie Générale de Télégraphie Sans Fil and the Compagnie Française de Télévision, in which organizations the system has been under development. (C.F.T. is a subsidiary of C.S.F.) After the formal paper a demonstration was given, on colour and black-and-white receivers, of compatible colour pictures transmitted on the Henri de France system over a special relay network from the C.F.T. laboratories in Paris. The 625-line television standard was used and the programme material consisted of colour slides and colour films.

A 500-km television relay system was specially arranged for this occasion as a joint effort by the French P.T.T., British Post Office and B.B.C., and was described by W. J. Bray of the Post Office. It used a number of existing installations and some temporary stations. A temporary microwave link connected the C.F.T. laboratories to the P.T.T. establishment at the Tour de Meudon in Paris, from which the signals passed to Loos (near the town of Lille) on the permanent P.T.T. microwave relay system. From Loos they were transmitted to the Post Office radio station at Tolsford Hill, near Folkestone, by the permanent G.P.O./P.T.T. microwave link which normally serves for Eurovision and multi-channel telephony circuits.

The connection from Tolsford Hill to London was not made by the existing cables because these can only handle a bandwidth of 3Mc/s, whereas the 625-line colour signals require their normal 5Mc/s. Two temporary microwave links, connected in tandem, were therefore set up by the B.B.C., terminating at the Crystal Palace television station. From Crystal Palace the rest of the link-up to the I.E.E. was made by coaxial cable via Broadcasting House, the Post Office switching centre at the Museum telephone exchange and the Gerrard telephone exchange.

### Characteristics of the System

Some readers may recall that the Henri de France system of colour television* has certain features in common with the American N.T.S.C. system, now operating in the U.S.A., but is distinguished by the sequential method of transmitting the chrominance (colour without brightness) information. It is a compatible system which transmits the brightness information in a wide band on the main carrier, so that it can be picked up by existing monochrome receivers as a black-and-white picture, and the chrominance information on a narrow-band subcarrier. As in the N.T.S.C. system, the colour subcarrier conveys two sets of chrominance information (called colour difference signals), but sequentially, on alternate lines, rather than simultaneously by an amplitude- and phase-modulation multiplexing process.

At the colour receiver the sequential colour information is turned into simultaneous form for display by a storage system based on a delay line. Thus the complexity of the synchronous detectors and associated circuits of the N.T.S.C. receiver is avoided, but a somewhat expensive delay line is required. The whole transmission system, unlike the N.T.S.C. one, is insensitive to spurious phase delays (as was demonstrated at the I.E.E. by the deliberate introduction of 40° of phase change in the incoming cable) and the receivers are inherently stable. On the other hand there is a loss of vertical colour definition, due to the line sequential method of transmitting the colour information, and a slight misregistration of displayed colour information, due to the fact that the storage causes colour information belonging to one line to be presented also on the next line of the frame (next-but-one of the picture).

### Colour Receiver Design

Such points were brought out at the discussion following the lecture by various speakers, the majority of whom were critical of the Henri de France system but at the same time expressed their appreciation of the excellent demonstration and their admiration for the French authors' presenting a paper in a foreign country and in a foreign language. Regarding the receiver problem—which is certainly the main stumbling-block in the adoption of any system of colour television—it was generally felt that although the Henri de France receiver had the advantage over the N.T.S.C. receiver in fewer valves and less complexity, this was partly offset by the price of the delay line (about £6). In any case the price of receivers was largely controlled, not by these factors, but by the price of the colour c.r. tube.

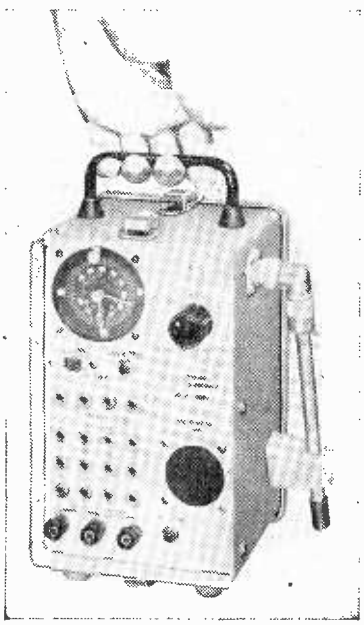
Recent work at C.F.T. has been aimed at reducing the cost and bulk of the delay line. Whereas it was originally a length of special coaxial cable, the present receiver uses a compact acoustical system based on multiple reflections inside a block of quartz to get the required path length. Other developments mentioned by the authors have been concerned with the reduction of noise visibility on the colour picture by the use of frequency modulation of the colour sub-carrier instead of amplitude modulation. With a.m. the system is somewhat worse than the N.T.S.C. system in this respect, having a threshold of noise visibility of about 7-8dB lower (both systems being worse than monochrome television). Demonstrations of pictures using the f.m. subcarrier were in fact given at the I.E.E. Unfortunately the visibility of the f.m. sub-carrier on the picture is greater than that of the a.m. sub-carrier, but experiments are in progress to reduce this by trying sub-carrier frequencies specially related to the line scan frequency.

On the question of standards, one speaker reminded any members of the Television Advisory Committee present (in fact there were several) that the French had shown us colour television on 625 lines. Representatives of the B.B.C. and the French Centre National d'Etudes des Télécommunications put in heartfelt pleas for common international standards for colour television, saying that they had suffered enough already from different standards in monochrome!

* As described in our September 1957 issue, under the title "Sequential Colour Again."

# Technical Notebook

**Portable Time Standard,** controlled by standard time transmissions, has been developed by Zenith in the U.S.A. It is a transistorized, battery-powered instrument, and is accurate to approximately ±16 seconds per year. A possible



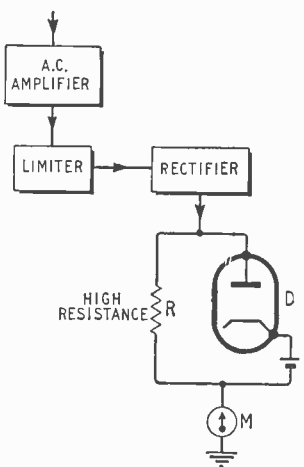
application is for precise time switching of recording instruments, telemetering transmitters, etc., in isolated areas. The instrument uses a transistor receiver—a crystal-controlled a.m. circuit—and is designed to receive the National Bureau of Standards station WWV, and other accurate sources of "seconds tick," at any of three frequencies, 2, 5 and 10Mc/s. The receiver output is fed to a circuit which filters out all information except the one-second "tick." This "tick" is applied to a pulse generator which gives a pulse of the required amplitude and duration to synchronize the electric clock (a type in which the balance wheel operates contacts for pulsing the mechanism). A "programme matrix," comprising a set of contacts utilizing the clock hands, is capable of providing a variety of switching time intervals for controlling external apparatus. An aural check of WWV signals is also incorporated.

**Polymerization of Propylene** (formula $C_3H_6$—the "next one up the chain" from ethylene, $C_2H_4$) by methods similar to those used to produce polyethylene, or polythene, result in a substance of very variable and not very useful properties. This variability is caused by the random placing of the "extra" $CH_3$ groups along the polymer molecule. However, research undertaken in Italy has resulted in the discovery of a new catalyst for the polymerizing process, a catalyst which enables the $CH_3$ groups to be aligned in a regular fashion. The result is a polymer of propylene with consistent and useful properties; in fact, it seems to possess most of the advantages of polythene and few of its disadvantages. Most valuable features of polypropylene for electronic purposes are its high melting point (170°C approx. compared with 108°C approx. for polythene), its hardness (Rockwell 90 to 95), small linear coefficient of expansion ($11 \times 10^{-5}$cm/cm/°C) and high tensile strength (4,000lb/in$^2$). In other respects it is broadly similar to polythene. Polypropylene is made in this country by the Telegraph Construction and Maintenance Company in the basic form of sheets from 0.020in to 0.375in thick, and it may be processed by all methods at present used with polythene (higher processing temperatures must, of course, be used).

**Minute Sealed Switch,** only 0.32in diameter by 0.44in long, has a breaking capacity of 3A at 28 volts (resistive load). Of welded stainless-steel

construction, the switch has a snap-action W-shaped blade operated by a push button, and the casing, before being hermetically sealed, is filled with an inert gas. The photograph shows the switch (made by Spencer Products Group, Texas Instruments, U.S.A.) against a background of aspirin tablets.

**Balance Indicating** non-linear amplifier forms part of audio-frequency current and voltage standardizing equipment developed by the Electrical Inspection Directorate. The standardization is carried out by means of thermo-junctions working at a fixed input current level. To avoid damaging or altering the characteristics of these thermo-junctions, the level must be set close to the fixed value before they are connected. This initial level setting is achieved to within 0.2% by means of a non-linear amplifier whose output is arranged to vary rapidly with the input when this input is near the required fixed value, but only slowly with the input otherwise. The output of the non-linear amplifier thus




provides a sensitive indication of when the input is near the required fixed value. The non-linear amplifier consists basically of an ordinary a.c. amplifier followed by a limiter and rectifier; across the rectifier output is connected a biased diode (D) in parallel with a high-value resistor (R) and in series with the output meter (M). At low input levels to the non-linear amplifier the biased diode does not conduct so that the output meter is fed from the high resistance. Thus the output meter reading increases only slowly with the input level at low input levels. Just below the fixed input level the biased diode suddenly starts to conduct and short circuits the high resistance feeding the output meter. Thus the output meter reading increases rapidly with the input near the fixed input level. At still higher input levels the limiter ensures that the meter reading again increases only slowly with the input level.

# Elements of Electronic Circuits

## 14.—THE MILLER TIMEBASE

By J. M. PETERS, B.Sc. (Eng.), A.M.I.E.E., A.M.Brit.I.R.E.

ONE of the most widely used linear timebase generators depends for its action on the Miller integrator circuit, in which negative feedback is introduced by an externally coupled capacitor between anode and grid. A single valve is used to control the charging and discharging of the timebase capacitor, which is initiated by switching pulses applied to the suppressor grid. It may be noted here that variations of this circuit (such as the "phantastron") differ in respect of the method of switching and the complexity of the associated amplifier circuit.

Before attempting to describe the operation of the circuit shown in Fig. 1 it will be necessary to

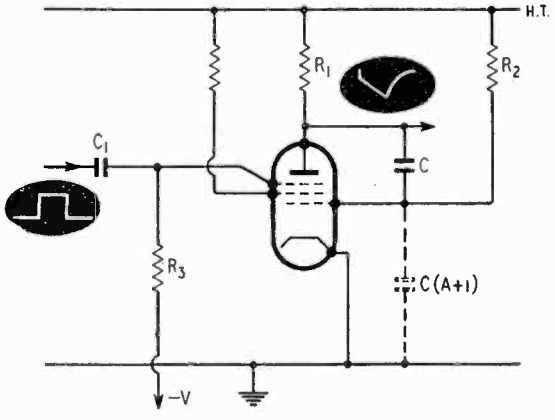



Fig. 1

understand what is meant by the Miller effect. First, let us consider a triode amplifier with gain=A, the valve developing its output voltage across a resistive load. As the anode voltage is 180° out of phase with the input voltage it can be shown that feedback to the grid is introduced by the inter-electrode capacitance $C_{ga}$. This has the effect of modifying the input capacitance of the valve, which can be written $C_{input}=C_{gk}+C_{ga}(1+A)$, the suffixes representing the respective inter-electrode capacitances. This increase in input capacitance, i.e., $A.C_{ga}$, is due to the Miller effect (named after its discoverer, J. R. Miller, in 1919).

A capacitor connected externally between the anode and control grid of a pentode amplifier will modify the input capacitance in a similar fashion, and this is the basis upon which the circuit shown in Fig. 1 operates. In this circuit the control grid is connected to a positive voltage source through a high-value resistor, $R_2$, and it is also connected to the anode via a capacitor, C. The grid circuit can therefore be regarded as consisting of a resistor $R_2$ in series with a capacitor C (A+1).

Referring to the waveform diagram in Fig. 2, the action of the circuit is as follows:—

**Stage (a)**

The suppressor is biased to a negative voltage via $R_3$ sufficient to prevent the flow of anode current, so that initially the valve is cut off as far as the anode is concerned, and $V_a$ is at h.t. voltage. Grid current flows since $g_1$ is just above cathode potential (a few volts positive). C is charged practically to h.t. voltage.

**Stage (b)**

The action starts with the application of a positive-going square pulse to $g_3$. This is sufficient to cause anode current to flow. $V_a$ falls and this drop in voltage is applied via C to $g_1$. As $g_1$ goes negative, less anode current flows; therefore $V_a$ tends to rise. A state of equilibrium is eventually reached when

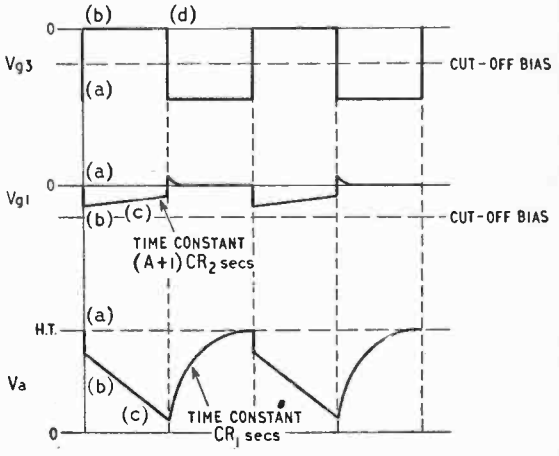



Fig. 2

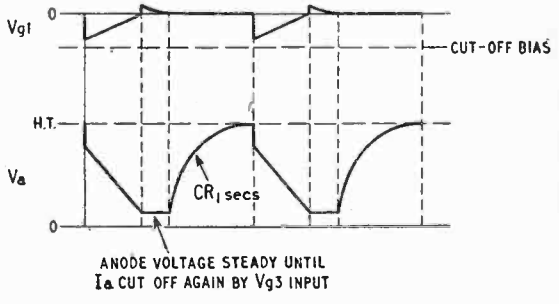



Fig. 3

the anode current is only just sufficient to cause a voltage drop in $R_1$ equal to the amount $g_1$ has gone negative from its original potential. $V_{g1}$ is now negative and $I_{g1}$ ceases.

**Stage (c)**

The side of C connected to $g_1$ is negative and as it is tied to h.t. via $R_2$ the h.t. voltage tries to charge it in the opposite direction through $R_2$. The voltage across C gradually falls. $V_{g1}$ gradually rises and $V_a$ consequently falls. The rate at which $V_{g1}$ rises (V/CR volts/second in a CR circuit) is $\frac{V}{C(A+1)R_2}$ volts/second, where V is the h.t. voltage. The time constant is $(A+1)CR_2$ seconds. Note that C becomes (A+1)C due to the Miller effect described above. $V_a$ changes at A times the rate of change of grid voltage; therefore $V_a$ falls at

$$\frac{V}{C(A+1)R_2} \times A \text{ volts/sec}$$

This can be written

$$\frac{V}{CR_2} \times \frac{A}{A+1} \text{ volts/sec}$$

Now if A is large (pentode amplifier) $A/(A+1) \simeq 1$. Therefore the rate of fall becomes $V/CR_2$ volts/sec, which is independent of the valve characteristics—an important attribute of this circuit. This is therefore the timebase sweep voltage.

**Stage (d)**

When the input square pulse ends, the suppressor voltage again cuts off the anode current and $V_a$ rises, carrying $V_{g1}$ with it until $I_{g1}$ flows. C charges exponentially in the opposite direction through $R_1$ with time constant $CR_1$ (not $C(A+1)R_1$ as the Miller effect is now absent since the valve is not amplifying during this period). $V_a$ finally reaches h.t. and the cycle of operation ceases.

If we make $R_2$ a smaller value, or if the square pulse which starts the action lasts long enough, the grid current region will be reached before the end of the period. This is illustrated in Fig. 3. $V_a$ remains steady until the pulse on the suppressor ends and the recovery phase begins. Thus the slope of the timebase waveform can be altered by varying $R_2$.

Provided that A is large, the slope has been shown to be independent of the valve characteristics and also of the anode load $R_1$. The output impedance of the circuit is therefore low (approximately $1/g_m$). This means that the Miller timebase can develop its waveform with negligible distortion across quite low impedances.

# Calculation of Standing Wave Ratio

## Effects of the Terminating Load on Line of Known Characteristic Impedance

*By JOHN E. ROBSON*, B.Sc., A.M.I.E.E.*

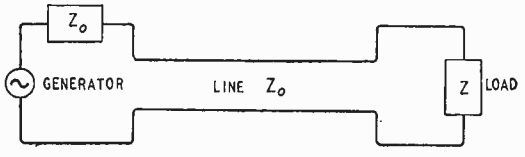
IT was the author's original intention to sub-title this article, " or how to do without a Smith Chart," but this would have seemed ungracious in view of R. A. Hickson's excellent series of articles on the subject.[1] However, the problem does arise in practice, and the main result obtained here is the outcome of a frequently recurring situation.

The essence of the problem is shown in Fig. 1. A transmission line of given characteristic impedance $Z_o$ is being driven by a generator, whose output impedance is taken as $Z_o$ also for the sake of simplicity, and is terminated in an impedance of value Z. What effect will this have on the performance of the system?

In an actual case, which does occur in practice, the generator of Fig. 1 is a source of signals in the frequency range 3 to 10Mc/s, the line is a coaxial cable for which $Z_o$ is 75 ohms resistive, and the terminating impedance Z is the input impedance of a level indicator or a receiver. The expression " the effect on the system " comes down to mean " the standing wave ratio," or " the return loss " caused by the impedance.

**The Importance of Standing Wave Ratio.**—In some previous treatments of the problem, the existence of standing waves was taken merely as an indication that all was not well at the far end of the line. Most probably, there was an amount of mismatch between the line and the load: in other words, the load was not exactly a pure resistance in value equal to that of the characteristic of the line. In fact, Hickson showed how a measurement of the magnitude and spatial distribution of the standing wave could be manipulated to provide a value for the terminating impedance. It is the purpose of this article to look at the problem from the other side; that is, to take a given impedance, and determine the standing wave ratio caused by it on a line of given characteristic impedance. This is the viewpoint of the transmission line engineer, who regards a standing wave as a bad thing in itself, being caused as it is by reflected power. The line has to be made " flat," and there are in general, many more than one

*Fig. 1. Transmission line of characteristic impedance $Z_o$ driven by a generator and terminated in a load of value Z*




*Redifon Ltd., Crawley.

junction at which reflection can take place. It is for this reason that the transmission line engineer works in terms of return loss, and here the author can do no better than refer to an earlier series of articles.[2] Another situation in which a high standing wave ratio is an inherently bad thing is that of a transmitter feeding an aerial via a transmission line. If the transmitted power is large, then dangerously high voltages can be developed across the line conductors, or even within the transmitter. Again, long before the danger point has been reached, the attenuation, or power loss in the line, has begun to rise quite steeply. In brief, the extra power losses at the high-voltage points on the standing wave pattern are not made good by the reduced losses at the low-voltage points.

**Determination of Standing Wave Ratio.**—Several measurement techniques have been evolved to determine the standing wave ratio, either by direct measurement or by calculation from a measurement of a related quantity. Thus, by means of a slotted line and probe, the electric field distribution along a line under given conditions of termination may be explored, and this will give the required quantity directly. Unfortunately, the line needs to be at least one half-wavelength long at the frequency of interest, and at 10Mc/s that would mean a line of some 47ft long.

Then the power flow in each direction along the line can be sampled, and two readings obtained which are proportional to the forward and to the reverse power flow. This technique is that of the Reflectometer, and " Cathode Ray " has recently illuminated it for us[3].

Finally, a kind of radar method can be used, in which signal pulses are sent off up the line, and the returns are displayed on a cathode-ray oscilloscope. This method is of wide application, though obviously the technique is fairly sophisticated.

A method will now be described in which a single impedance measurement is sufficient to allow of calculation of standing wave ratio.

**Calculation from Impedance Measurement.**—If the terminating impedance is purely resistive, and equal in value to the characteristic impedance of the line, then it is well known that no reflection of power will take place at the load. Everywhere along the line, the relationship $V = Z_o I$ will hold, including at the load itself. Now if the load is not equal to $Z_o$ then that relationship cannot hold, and so some power is sent back. It is easy to see that if the load is purely resistive and of a different value from that of $Z_o$ then there will be no phase change in voltages or currents, and the standing wave ratio will be given by $S = Z_o/R$ or $R/Z_o$. That fraction is chosen which makes S greater than unity, as the use of this convention appears to be increasing.

The next step is to consider the effect of a loading impedance which includes some reactance. For even if the resistive part of the load is equal to the $Z_o$ of the line, the relationship $V = Z_o I$, which holds good for either wave on the line, cannot hold equally for a load in which $Z = R_o + jX$.

Consider now the situation as shown in Fig. 2. This illustrates part of the complex plane of impedance: in other words, two axes are drawn at right angles, the real, or resistive, and the imaginary, or reactive. With reference to these axes, points may be plotted which represent impedances. The two impedances actually shown are the terminating impedance $Z_1 = R_1 + jX_1$ and the characteristic impedance of the line $Z_o$. This is purely resistive, and so is represented by a point on the real axis.

Now the value of standing wave ratio at the load, due to the particular value of Z, can be denoted by $S_1$, and the question arises, do any other values of terminating impedance give rise to this same value, $S_1$? This question can be put another way; given any value of standing wave ratio, what shape will the curve be which passes through all the points on the plane with that value? The answer is, interestingly enough, a circle, and a quick derivation of this result is now given.

By definition, the standing wave ratio is:—

$$S = \left|\frac{1 + K}{1 - K}\right|$$

where K is the ratio of reflected voltage to forward voltage. Recalling that a phase change occurs for a

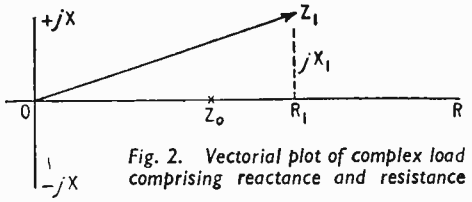



*Fig. 2. Vectorial plot of complex load comprising reactance and resistance*

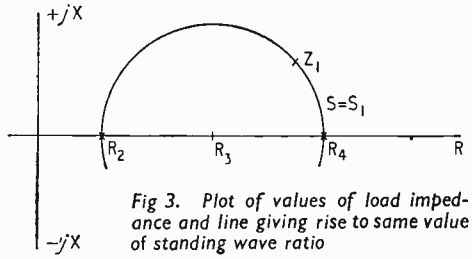



*Fig 3. Plot of values of load impedance and line giving rise to same value of standing wave ratio*

reactive load, it can be seen that K in general will be complex, that is, of the form $x + jy$.

This leads to:— $$S = \left|\frac{1 + x + jy}{1 - x - jy}\right|$$

and so:—

$$S^2 = \frac{(1 + x)^2 + y^2}{(1 - x)^2 + y^2}$$

After a little algebra this comes out to be:—

$$y^2 + x^2 - 2x\,\frac{S^2 + 1}{S^2 - 1} - \frac{1}{S^2 - 1} = 0$$

which is the equation of a circle.

Fig. 3 shows part of one such circle passing through the point representing the particular impedance $Z_1 = R_1 + jX_1$. In order to be able to describe this circle we need to know its centre and its radius, that is, to be able to determine the points $R_2$, $R_3$ and $R_4$ along the real axis. The points $R_2$ and $R_4$ are given by terminating loads of those values, and, it is to be noted, purely resistive in nature. Thus an earlier result can be used, and the value of standing wave ratio written at once as:—

$$S = \frac{R_4}{Z_o} \text{ and } S = \frac{Z_o}{R_2}$$

The reason for the inversion of one fraction is that

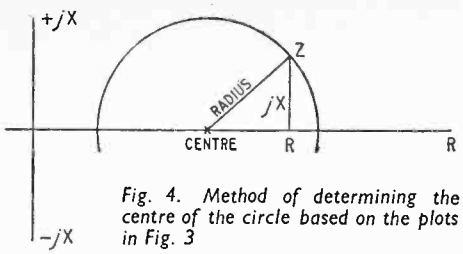



*Fig. 4. Method of determining the centre of the circle based on the plots in Fig. 3*

one value of resistance is greater than $Z_o$, and one smaller. Thus:—

$$R_1 = SZ_o \text{ and } R_2 = Z_o/S$$

The centre of the circle is $R_3$, and this is given by:—

$$R_3 = \frac{R_2 + R_1}{2}$$

which means that the circle has its centre at the point:—

$$\frac{SZ_o + Z_o/S}{2}$$

Again, the radius of the circle is given by:—

$$\frac{R_1 - R_2}{2} = \frac{SZ_o - Z_o/S}{2}$$

Finally, the line is terminated in any impedance $Z = R + jX$, and so the circle of constant standing wave ratio must pass through this point. This means that the distance from the centre to the point Z is equal to the radius of the circle. Thus there is a right-angled triangle shown in Fig. 4 whose sides are:—

$$X,\ R - \frac{SZ_o + Z_o/S}{2} \text{ and } \frac{SZ_o - Z_o/S}{2}$$

Applying Pythagoras gives:—

$$X^2 + \left[R - \frac{SZ_o + Z_o/S}{2}\right]^2 = \left[\frac{SZ_o - Z_o/S}{2}\right]^2$$

or

$$4X^2 + 4R^2 + S^2Z_o^2 + \frac{Z_o^2}{S^2} + 2Z_o^2 - 4RZ_o\left(S + \frac{1}{S}\right) = S^2Z_o^2 + \frac{Z_o^2}{S^2} - 2Z_o^2$$

and, on solving for S, we have:—

$$S^2 - S\left[\frac{R}{Z_o} + \frac{Z_o}{R} + \frac{X^2}{RZ_o}\right] + 1 = 0$$

**Applications of the Result.**—The equation just arrived at is of great interest, and the author believes it to be original, never having seen that result stated in the literature. Its interpretation is straightforward: given a line of characteristic impedance $Z_o$, and a terminating load Z, whose components as measured on an impedance bridge are R and $jX$, then a value of standing wave ratio at the load will be observed, as given by the expression for S.

It would appear that, as the equation is quadratic in S, the two roots will give two differing values of S. That this is not so can be seen by noting that the equation is of reciprocal type, which means that if $S = \alpha$, say, is one root, then $S = 1/\alpha$ is the other. This follows from the well-known point in the theory of equations that the constant term is the product of all the roots taken singly, and the fact that the constant term in the equation for S is unity.

This result can perhaps be expressed more fancifully by saying that one root of the equation gives S in its British form, and the other root in American.

As an interesting check on the correctness of the approach, set the reactance term equal to zero; in other words, consider a purely resistive load of value R. Then the equation reduces to:—

$$S^2 - \left[\frac{R}{Z_o} + \frac{Z_o}{R}\right]S + 1 = 0$$

Here again the theory of equations helps, for the sum of the roots is the negative of the coefficient of S, and so the roots are obviously $R/Z_o$ and $Z_o/R$ Which is the correct value for the standing wave ratio under that circumstance.

Reverting to the general equation, it may well be that the measurement of the termination is in the form of parallel admittance components, and over the radio frequency range under consideration this is the more likely case. Then the unknown will be stated as $Y = G + jB$, and the line will have a characteristic admittance of $Y_o$. The equation then becomes:—

$$S^2 - \left[\frac{G}{Y_o} + \frac{Y_o}{G} + \frac{B^2}{Y_oG}\right]S + 1 = 0$$

and the conclusions are unchanged.

There is one particularly useful feature of the equation whenever normalized impedances, or admittances, are employed. The termination will then be written as:—

$$\frac{Z}{Z_o} = \frac{R}{Z_o} + j\frac{X}{Z_o}$$

or

$$Z' = R' + jX'$$

the primes denoting normalized values. With this in mind, the basic equation may be written at once as:—

$$S^2 - \left[R' + \frac{1}{R'} + X'\left(\frac{X'}{R'}\right)\right]S + 1 = 0$$

owing to the fact that the various ratios within the bracket are already normalized.

One final point concerns the actual solution of the equation. No explicit solution for S has been exhibited, as the author feels nothing is gained thereby. It is best to substitute actual measured values, and solve the resulting simple quadratic equation.

As an example; the normalized form of an impedance is:—

$Z' = 0.6 + j0.4$. Thus we have $R' = 0.6$; $X' = 0.4$ and $X'/R' = 2/3$. Substituting in the basic equation gives:—

$$S^2 - \left[0.6 + \frac{1}{0.6} + 0.4 \times \frac{2}{3}\right]S + 1 = 0$$

$$S^2 - 2.53S + 1 = 0$$

and

$$S = 2.04 \text{ or } 0.49$$

and it can be checked that these are reciprocal values.

## REFERENCES


1 R. A. Hickson: "The Smith Chart," *Wireless World*, Jan., Feb. and March, 1960.

2 Thomas Roddam: "Return Loss": *Wireless World*, Nov. and Dec., 1957.

3 "Cathode Ray"; "The Reflectometer": *Wireless World*, March, 1960, p. 137.

# LETTERS TO THE EDITOR

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

## Negative Impedance

IN your May issue Mr. D. L. Clay has responded to my request to explain what he means by negative impedance, but he has still not convinced me that anything but confusion is to be gained by the concept. In an attempt to avoid the confusion invited by using "negative" in two different senses with reference to the same thing, he rules out the combination of a positive resistance and the reactance of a negative component, because it is unstable. On the same ground he must rule out the combination of a negative resistance and the reactance of a positive component. Since the latter is a commonly occurring one, its exclusion to suit Mr. Clay would be inconvenient.

He also appears to confuse dissipative losses due to the resistance of a reactor with the energy taken in by its reactance and returned in full during the same cycle.

Again, his use of the word "complex" in connection with impedance leaves one in doubt whether it is to be interpreted in its usual mathematical sense in that context or just as meaning "not simple."

I hope I am correct in interpreting his further remarks on phase difference as illustrating the worthlessness of any attempt to apply this concept to dissimilar waveforms.

Regarding Ohm's law and negative resistance: Mr. Clay said in his first letter "further explanation is wanted here." His second letter has convinced me that it is. But if I tried to compress it into a letter the confusion I appear to have created already might be worse confounded.

"CATHODE RAY"

## Circuit Conventions

THE letter from Mr. Bedford (April issue) and your own comments on circuit conventions were interesting. The function of a circuit drawing is to convey information to the reader "unambiguously and without interference to thought sequences" of that reader. Is not the draughtsman's liability to error—on which the Editor appears to base his opinion—of very secondary importance?

On the other hand Mr. Bedford's mixing of X junctions (with a dot) and cross-overs (without) is indefensible. A dot omitted, or a slight merging of two ink lines and the whole meaning is changed.

In the diagrams in his letter in the April issue the loops may be acceptable to some, but more complex circuits may involve dozens—even hundreds— of "little bridges." They then become tedious to read and equally tedious and expensive to draw.

What is wrong with the recommendations of B.S.530? No X junctions, use only T junctions, and no looped cross-overs. If these sound conventions are followed the correctness of the drawing does not depend upon the presence or absence of dots and semicircles; it is more quickly drawn and traced and—most important—more easily read.

East Barnet, Herts. V. L. BUTCHER

WHILST congratulating Mr. L. H. Bedford on his prodigious achievements between the ages of four and five (April issue), may I, as a struggling technical author, advise him not to attempt any questions on circuit drawing which may crop up in his eleven-plus examination.

The recommendations of B.S.530 are not the perfect guide by any means but, if intelligently applied, they could make a very noticeable improvement to Mr. Bedford's Fig. 3.

However, I must side with Mr. B. (and with the B.S.I.) in deprecating the looped crossing, partly because of the time involved in drawing the wretched things.

To return to B.S.530, the requirements concerning T-junctions and crossovers are so sensible (even to a child of five), that it seems pointless to deviate from them. You see, Mr. Bedford, most diagrams have to be reduced photographically, and printed—often on inferior-quality paper—with ink which tends to spread. (Look what happened to your capacitors, Mr. B.!) It is thus quite possible to produce an accidental blob at an X junction.

I think most users of circuit diagrams would support my next point, namely that the inclusion of valve envelopes is of considerable value in identifying the separate stages in a complex circuit diagram. (How would you draw a gas-filled valve, Mr. B.?)

The following points come under the heading of "delicate points of style."

(1) If the Ω symbol is redundant in resistor values, the letter "F" is equally redundant in capacitor values (see B.S.530).

(2) The comma, such as appears in "5,000 pF" should *never* be used in circuit diagrams.*

(3) Those diodes are not "D," but "MR."

(4) Potentiometers are not "R," but "RV."

(5) If C26 is an electrolytic capacitor (as seems likely since the polarity is shown) it should be drawn as an electrolytic capacitor.

It would be interesting to submit Mr. Bedford's diagram to the Admiralty department which recently told me that resistors have four wiggles on one side and three on the other, and that anything else is not a resistor. (Probably Nelson drew his resistors that way.)

In conclusion, it may be relevant to point out that the majority of people concerned with the presentation of electronics diagrams blunder on, using B.S.530 as a guide, and (you may not believe this, Mr. Bedford), our readers understand us!

Belfast, 5. L. DENNIS

* We accept responsibility for this "error"—Ed.

YOUR correspondent, Mr. Bedford, seems to have forgotten that some degree of redundancy is essential to good communications. Looped connections, giving an absence of information, prevent the mind from wandering. In his diagram, Fig. 3 (April issue), is the cross at R23, R24, R26, C23, D2 really a junction, or did the ink flow? I stop to find out and communications are interrupted.

Similarly with the valve "bottle." The valve is the centre of a stage of the circuit; the circle is a spot-light and helps in rapid assimilation.

Adding pin numbers to valves has been tried and discarded: they clutter the diagram. If numbers for valves, why not for transformers and other sub-assemblies which cannot be found in a book?

The circuit is only of interest to the man who has never seen the junk before and has to find trouble quickly and to the engineer who has to make time to read the article. Anything to help and not hinder their efforts is worth while.

While I am writing, may I ask the *W.W.* not to be the odd-man out when drawing transistors (as, for example, in the March, 1960, issue, p. 110). Also, though a circuit

with a negative supply at the top makes the transistor easier to us poor valve technicians, ought we not to start right with the positive at the top? Just one argument: with the negative supply at top, is a positive going pulse drawn downwards?

Bracknell, Berks. WALTER DALTON

## "Ring Angels"

I SHOULD like to comment on "Diallist's" note on "Ring Angels" in the April, 1960, issue of *Wireless World*.

Expanding ring echoes of this kind were recorded as early as 1956 on radar equipment operated by the Meteorological Office at East Hill in Bedfordshire. They were recognized as being caused by birds. At various times since then seven different centres of ring echoes were recorded within a radius of 15 miles of the radar installation, and each one was found to be the site of a starling roost.

It is not difficult to see why these movements are seen as expanding rings. Starlings leave their roosts at around dawn in a series of "explosions," and the echoes appear as rings because their flight paths to their feeding grounds radiate outward in almost every direction from the roost with a surprisingly uniform flight speed. Sometimes the directions of flight are more limited, and then the echoes expand as arcs rather than as rings. A description and explanation of ring echoes were given by me in *Ibis*, the journal of the British Ornithologists' Union (Vol. 101, 1959, p. 201).

I think that few meteorologists will find support for the view that ring echoes are caused by "rapidly expanding thermal fronts in the upper atmosphere."

Meteorological Research Unit, W. G. HARPER
Great Malvern, Worcs.

[Since receiving the above letter from Mr. Harper, an article by E. Eastwood, G. A. Isted and G. C. Rider, of the Marconi Research Laboratories, Great Baddow, has been published in *Nature* (April 9th) describing further work to establish the correlation between "ring angels" and starling flights.—ED.]

## Increasing Video Gain

FOR some time past I have felt dissatisfied with the performance of the single v.f. stage fitted to television receivers. In a fringe area, the low gain obtained is a serious disadvantage.

In my efforts to obtain an image free from "ringing" and "smearing" I have evolved the accompanying circuit for a high-gain v.f. amplifier.

The exact gain *in situ* proved unexpectedly difficult to measure, but appears to be of the order of volts × 120, and peak-to-peak output is 150 volts max. The cathode follower is connected in a manner calculated to give maximum d.c. protection to the c.r.t. in event of valve failure. The noise suppressor is highly efficient and does not affect the d.c. restorer.

The picture obtained is really beautiful, showing the 3 Mc/s (Test Card "C") lines with a minimum of ringing. (The exact amount of ringing is determined by the 500pF cathode bypass capacitor in the first stage.)

Peacehaven, Sussex. R. G. YOUNG.

## Deeper Amplitude Modulation?

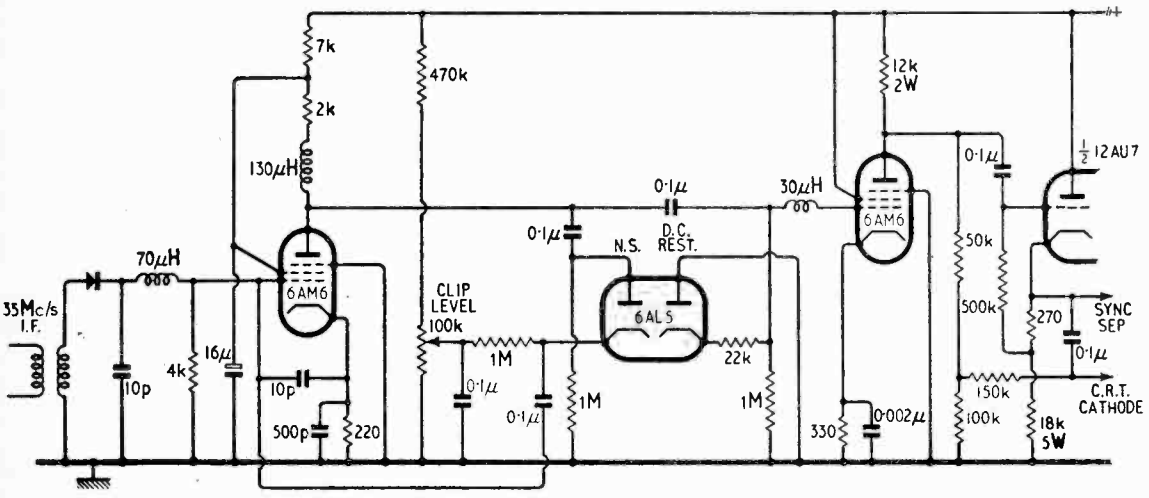
SOME time ago, when listening on my car radio in the London area, I noticed that the French 164-kc/s transmission appeared to be louder than the B.B.C. on 200 kc/s, but a check on the receiver a.g.c. showed that the B.B.C. had the stronger carrier. I assumed that the French were using more modulation than the B.B.C., and this was confirmed recently when I had a look at both carriers on a "panadaptor," which showed quite clearly that the French modulation, besides being considerably deeper than the B.B.C.'s, was also slightly clipped. The difference in quality was not immediately noticeable on a car radio, although it could be heard on hi-fi equipment, but this very slight loss of quality was easily offset by the great gain in intelligibility, and it occurred to me that now that the v.h.f./f.m. broadcasts are available to anyone expecting high-quality reception, the B.B.C. should adopt a higher percentage of modulation in its medium and long-wave transmissions and make them a little easier to listen to under marginal conditions, in a car or otherwise. From the amount of sideband splatter to be heard on the medium waves at night, most of the Continentals are already doing this without troubling unduly about their filtering! Another possibility is the adoption of single-sideband with carrier transmission, as used by the Voice of America on 173 kc/s.

I feel that the B.B.C. should make some sort of effort in this direction, since I find that more and more of my acquaintances, having good v.h.f. installations at their homes, listen on the medium- and long-wavebands only while in their cars.

Chichester. W. BLANCHARD

## Economical High-gain A.F. Amplification

IN reply to Mr. Short's letter in the May issue, I would first like to apologise to him for quoting a gain of less than 200 for a "straight" pentode 6BW7 amplifier. The error arose due to having just written a reply to another correspondent who was contemplating using an EF86.



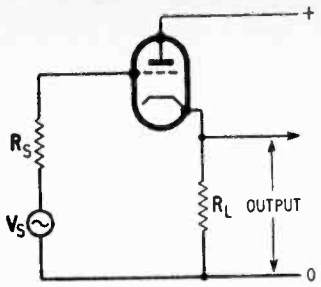


Fig. 1

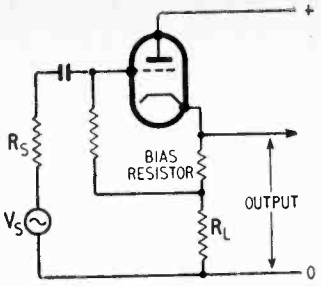


Fig. 2

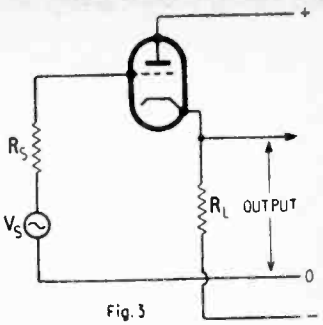


Fig. 3

I still feel, however, that 6dB loss in gain is a small price to pay in return for a stable high-gain amplifier which is not fussy about circuit layout.

With regard to Mr. Short's second point, I agree that the circuit that he shows (Fig. 1) has an output impedance that is independent of the input impedance for most practical purposes. It should be noted, however, that the output voltage is limited to a small amount due to the voltage drop across $R_L$ providing the valve bias. For a 12AT7 valve operating with 250 volts on the anode at an anode current of 10 milliamperes, the correct operating bias is about 2·5 volts. This makes $R_L$ equal to 250Ω. The peak output voltage will be in the region of 2·5 volts also and the output impedance will be less than $1/g_m$ ohms (180Ω) as $R_L$ is in parallel with the output impedance of the valve itself. To give increased output voltage the circuit shown in Fig. 2 is normally used, this providing bias by feeding back only a small amount of the d.c. voltage across the cathode load. This, however, makes the output impedance of the cathode follower vary with the input impedance.

To overcome both difficulties, the circuit shown in Fig. 3 can be used if a negative supply is also available. This has the same advantage as Mr. Short's circuit in being d.c. coupled but can give a much greater output as the valve bias is developed automatically and is much less than the voltage drop in the load resistor $R_L$.

ARTHUR R. BAILEY,
Bradford, 7. Bradford Institute of Technology.

# News from the Industry

**A.E.I.**—The consolidated profit and loss account of Associated Electrical Industries and its subsidiaries for 1959 shows an excess of income over expenditure of £16,972,609; just over £1M more than the previous year. After setting against this figure various charges, including nearly £5M taxation, the profit was £6,489,807 compared with £5.1M in 1958.

**T.C.C.** announce a group trading profit for 1959 of £769,980 which is a 45% increase on the preceding year. At the board meeting which followed the annual general meeting D. W. Aldridge resigned from the chairmanship and his place has been taken by W. C. Handley. The vacancy on the board has been filled by Dr. L. G. Brazier who is also director of research and education of B. I. Callender's Cables the parent company of T.C.C.

**Ekco** airborne weather radar is being fitted in the fifteen Boeing 707 airliners on order for British Overseas Airways Corporation. All B.O.A.C. Britannia and Comet 4 airliners are already equipped with Ekco radar.

**Ampex.**—According to figures issued by Ampex International, of Switzerland, there are now 65 of the corporation's Videotape recorders in use in Europe. Of this total 42 are in the U.K.

**Fraser Electronics and Communications Ltd.** has been set up by J. Fraser (until recently with Land, Speight and Company), and W. O. Buchanan, to act as Scottish agents for electrical and electronic manufacturers. They have premises at 1103 Argyle Street, Glasgow C.3 (Tel.: Central 9301).

**Reynolds (Packaging) Ltd.**, of Alfred's Way, Barking, Essex, have constructed a dust-free air-conditioned room for the cleaning and packing of specialized equipment including electronic gear for guided weapons.

**Mills & Rockleys (Production) Ltd.** have announced three appointments in their printed circuits division. J. R. Atkinson has taken over production from A. K. Bullock who will concentrate on planning. T. L. Harcombe has joined the company from the G.E.C. and will be responsible for development and application engineering.

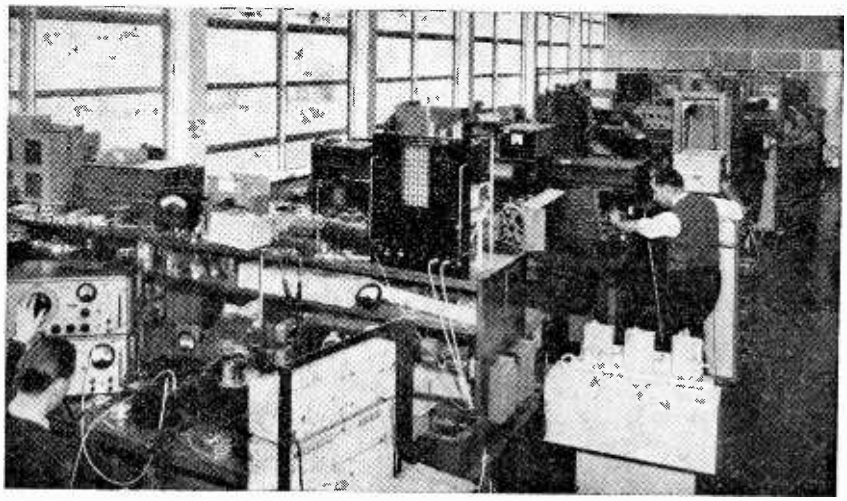
**Transitron Electronic Corp.**, of Wakefield, Mass., have set up a European sales subsidiary, Transitron Electronic S.A., with its headquarters in Zug, Switzerland, and Offices in London, Paris and Münich. The London offices will be run by a new company, Transitron Electronic Ltd., of which D. P. O'Connell, formerly with British Electric Resistance Co., is manager.

**Ferranti Ltd.** have signed an agreement with Bendix Aviation Corporation for them to sell in the U.S.A. Ferranti machine tool control systems. Bendix, who made the initial move in the negotiations, will set up a computer centre in Detroit to supply magnetic tapes for the equipment.

**Amplivox Ltd.**, of Wembley, Middx., has been awarded contracts by the General Post Office for the supply of miniature magnetic microphones and earphones for the new transistorized hearing-aid issued under the National Health Scheme.

**Swiss made** apparatus for the speedy insertion of soldering tags into printed circuit boards is being handled in this country by R. H. Cole (Overseas) Ltd., of 2 Caxton Street, London, S.W.1, who are agents for Kumag, of Zürich.

**Grundig (Great Britain) Ltd.** have extended the guarantee period for their tape recorders from six months to one year. This will apply to all guarantees registered on or after January 1st this year.



*Communication systems laboratory at the new establishment of Standard Telecommunication Laboratories, at Harlow, Essex. This particular laboratory is used for investigations into television transmission by pulse code modulation. S.T.L., a wholly owned subsidiary of Standard Telephones & Cables, was formed in 1945 with laboratories at Enfield, to take over the advanced research and development work of S.T.C.*

**Direct TV Replacements,** of 138 Lewisham Way, London, S.E.14 (Tel.: Tideway 6666) are now manufacturing their own replacement transformers for Ferguson television models 306T and 308T. This component is also used in H.M.V. models 1865 and 1869 and Marconiphone model VT153.

**Miniature Electronic Components, Ltd.,** of St. Johns, Woking, Surrey, are producing under licence from Con-Elco, of California, a range of miniature trimmer potentiometers specially designed and developed for the guided weapon and aircraft industries. The range extends from 10 ohms to 50kΩ.

**Precision Components (Barnet) Ltd.** have moved from Barnet to Kabi Works, Cranborne Road, Potters Bar, Middx. (Tel.: Potters Bar 3444).

**Precision Jigs Company Ltd.,** of 79 Caterham Avenue, Barkingside, Essex, has acquired a factory on the new industrial estate, Thetford, Norfolk.

**Hagan Controls, Ltd.,** a member of the Plessey group, has moved to 14, Grosvenor Place, London, S.W.1 (Tel.: Belgravia 6382).

## EXPORT NEWS

**Tropospheric** scatter link equipment is being supplied by Marconi's to Cable & Wireless (W.I.) Ltd. to establish a quadruple diversity u.h.f. link between the West Indies islands of Barbados and Trinidad. The system will carry six telephone speech channels and will be capable of enlargement to twelve channels.

**Closed-circuit television** equipment manufactured by E.M.I. Electronics has been installed in a Wall Street stockbrokers' office. The television system relays to large-screen monitors in seven offices a continuous picture of moving ticker-tapes giving stock market movements.

**H.F. telecommunications** equipment is being supplied to Turkey and Iran by Marconi's under a £225,000 order placed by H.M. Government as part of its programme of technical assistance to member countries of the Central Treaty Organization. The contract calls for the supply and installation of independent sideband telephone and multichannel telegraph circuits between Istanbul, Ankara, Teheran and London.

**Telemechanics Ltd.,** who recently moved into new premises at Brokenford Lane, Totton, Southampton (Tel.: Totton, Southampton 3666), have appointed Conway Electronic Enterprises Reg'd., of Toronto, as their Canadian agents, and M. Rietveld, e.i., of Rotterdam, as agents in Holland.

**Milan's** first radio taxi service, comprising a fleet of 250 vehicles, is fitted with Pye equipment. The service was introduced at the opening of the Milan Fair at which the theme of the Board of Trade exhibit was "British electronics in the service of mankind."

**Weather radar** has been supplied by Decca to several U.S. television stations for their weather forecasting services. The radar pictures are transmitted to viewers while an announcer interprets the information.

**Indian Agents.**—Capital Industries, of 8, Kapurthala Road, Jullundur City, who have been established since 1925, want to represent a British manufacturer of radio equipment.

**I.L.S. equipment** is being supplied by Pye for Nairobi's new international airport.

*The "Automorse" machine illustrated enables anyone without knowledge of the Morse Code to operate a telegraph communications system of either the wire or radio type. On depressing a key on the typewriter-like keyboard the machine automatically selects the correct Morse sequence of dots and dashes relevant to the figure, letter or other character marked on the key. Cams are not employed, the selection of dots and dashes being effected by an ingenious system of wiping contacts. The machine has a capacity of 180 characters per minute and it operates normally from 6V d.c. consuming 3A. It was demonstrated recently at the Norwegian Export Centre, 20 Pall Mall, London, S.W.1, and the makers are Automorse Ltd., Näktergalsgatan 6, Gothenburg, Sweden.*

# THE COSH AT WORK

By "CATHODE RAY"

## PRACTICAL USE OF A HYPERBOLIC FUNCTION

LAST month we saw that plotting the equation $y = \sqrt{r^2 - x^2}$ gives us a circle of radius $r$, so long as $x$ is confined to the range of values from $-r$ to $+r$. Certain ratios in this graph are very well known and useful; for example, $x/r$ is called $\cos\theta$, $y/r$ is $\sin\theta$, and $y/x$ is $\tan\theta$, where $\theta$ is the angle of the radius from any point $x$, $y$, relative to the "3 o'clock" radius. Directly $x$ goes beyond $\pm r$, $y$ is the square root of a negative quantity, described by mathematicians as imaginary. An alternative form of the same equation, $y = j\sqrt{x^2 - r^2}$, is then more convenient. Just as in a.c. vectors we interpret

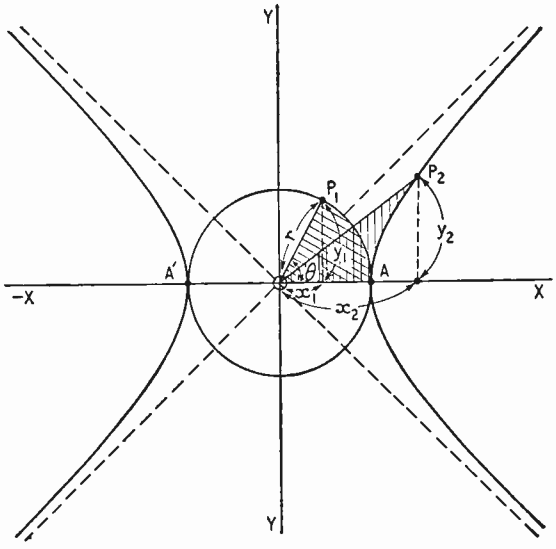



*Fig. 1 Believe it or not, this graph all arises from Pythagoras— $x^2 + y^2 = r^2$. The circle part is mathematically real, and comes from values of x between $-r$ and $+r$. The hyperbolic parts can be plotted only after the factor j has been introduced, so are (by comparison) imaginary.*

$j$ as an instruction to break away at right angles into a new world that can only be imagined by single-dimensional $x$-axis beings, now we can interpret it as a break away from the two-dimensional plane of the paper on which our circle is drawn into a plane at right angles. Continuing to plot the equation there, we find the graph takes the form of a rectangular hyperbola. The complete graph of the equation therefore consists of the circle and two-part hyperbola, shown (without distinction between real and imaginary) in Fig. 1. $P_1$ is a typical point on the circle, $x$ being less than $r$; namely, $x_1$. $x_1/r$ is $\cos\theta$. To distinguish the ratios in the hyperbolic world, "h" is added to their names; so $x_2/r$ is cosh $\eta$. And if you ask to be shown $\eta$ on the diagram, the best that can be done is to note that it is proportional to the shaded area $AOP_2$, just as the angle $\theta$ is proportional to the shaded area $AOP_1$. Although $\theta$ is the angle $AOP_1$, $\eta$ is definitely not the angle $AOP_2$ or any other angle visible as the inclination of one line to another. It was to emphasize this very important point that I used separate symbols, $\theta$ and $\eta$; but both just stand for a number, and it may often happen that they are the same number.

Because both sets of ratios are derived from the same equation, requiring only $j$ as a key for passing from one set to another, we have

$$\cos A = \cosh jA \qquad \cosh A = \cos jA$$
$$j \sin A = \sinh jA \qquad j \sinh A = \sin jA$$

Consequently the trigonometrical formulae for circular angles all have their hyperbolic counterparts, differing only by the appropriate power of $j$ ($j^2$ being of course $-1$). For example:

$$\cos A = \frac{e^{jA} + e^{-jA}}{2} \qquad \cosh A = \frac{e^{A} + e^{-A}}{2}$$

$$e^{jA} = \cos A + j \sin A \qquad e^{A} = \cosh A + \sinh A$$
$$\cos^2 A + \sin^2 A = 1 \qquad \cosh^2 A - \sinh^2 A = 1$$
$$\cos (A + B) = \cos A \cos B - \sin A \sin B \qquad \cosh (A + B) = \cosh A \cosh B + \sinh A \sinh B$$

Now circles, and angles thereof, are involved in a great variety of practical activities, so we are familiar with the circular side of the picture. The very name hyperbola suggests something much more academic, and it is certainly not familiar to the great non-technical public. So the usefulness of hyperbolic functions is much less obvious than that of circular functions. Another thing: we usually have some warning, in the shape of an angle, that circular functions may soon appear; but hyperbolic functions have a way of cropping up suddenly and apparently inconsequentially, to the dismay of the reader. Last month's effort was intended to make clear what hyperbolic functions are, and we have just recapitulated. The next thing is to show how they can be used, by taking a simple example.

It is the familiar ladder arrangement, Fig. 2, in which the impedances $Z_1$ and $Z_2$ can be of any kind, usually pure resistances and/or pure reactances (or as close approximations to them as practicable). If both $Z_1$ and $Z_2$ are resistances—or both reactances of the same kind—we have an attenuator, treating all frequencies alike; if they are a mixture, we have a filter, the purpose of which is to discriminate between frequencies. When the number of stages or sections is even as few as two, it becomes a little

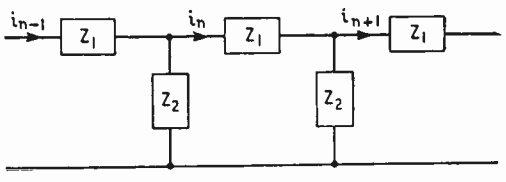



*Fig. 2 General form of ladder network, made up of impedances in two sizes.*

complicated to calculate it by ordinary circuit methods, and above two the paper work rapidly gets out of hand. However, if one can assume that the number of sections is unlimited—or alternatively that the chain is terminated by an impedance equivalent to an unlimited sequence—it becomes quite simple. The other necessary assumption is a signal source —a.c. or d.c.—somewhere to the left, to make current flow. The currents through the three $Z_1$ elements shown in Fig. 2 are named thereon. The current downwards through the left-hand $Z_2$ is obviously $i_{n-1} - i_n$, and that through the right-hand $Z_2$ is $i_n - i_{n+1}$.

The total voltage around any complete loop being necessarily zero, apply this principle to the loop formed by the two $Z_2$s and the middle $Z_1$. The clockwise voltage across the first $Z_2$ is $(i_{n-1} - i_n)\ Z_2$; across the $Z_1$, $-i_n Z_1$; and across the second $Z_2$, $-(i_n - i_{n+1})\ Z_2$. So

$$(i_{n-1} - i_n)\ Z_2 - i_n Z_1 - (i_n - i_{n+1})\ Z_2 = 0 \qquad (1)$$

Since every section is exactly the same as every other, the ratio of $i_{n+1}$ to $i_n$ is the same as that of $i_n$ to $i_{n-1}$. Call it $a$, so that $i_{n+1} = ai_n$ and $i_{n-1} = i_n/a$. Substituting this in (1) we get

$$(i_n/a - i_n - i_n + ai_n)\ Z_2 - i_n Z_1 = 0$$

which can be divided throughout by $i_n$ and $Z_2$ giving

$$a + \frac{1}{a} - 2 - \frac{Z_1}{Z_2} = 0 \qquad .. \qquad .. \qquad ... \quad (2)$$

We are interested in $a$, because it is the input/output current (and voltage) ratio of each section; and the attenuation of any number of sections, $m$, is $a^m$. So the natural thing is to lick equation (2) into a shape giving $a$ directly. It turns out to be a quadratic, and the answer is in the usual rather untidy form of the solution of a quadratic:

$$a = \frac{Z_1}{2Z_2} + 1 \pm \sqrt{\frac{Z_1}{Z_2}\left(\frac{Z_1}{4Z_2} + 1\right)} \qquad .. \qquad ..(3)$$

There is nothing actually wrong with that, and it can be used for computing $a$, given the ratio $Z_1/Z_2$ and a good deal of time and patience if it varies with frequency and $a$ is required over a wide band. The more sophisticated worker, being $e^x + e^{-x}$ conscious, notices with interest the $a + 1/a$ in (2) and wonders if there would be any advantage in putting $a$ into the form e to the something. He, of course, is of the type who would in any case require attenuation to be specified in decibels or even nepers (which are to decibels as natural (base e) logs are to common (base 10) logs).* Now the attenuation in nepers is defined as the natural log of the input/output current ratio. If this attenuation per section is denoted by $\alpha$, then, $\alpha = \log_e (1/a)$, which can also be written $1/a = e^{\alpha}$, or $a = e^{-\alpha}$. Substituting $e^{-\alpha}$ for $a$ and $e^{\alpha}$ for $1/a$ in (2), and dividing throughout by 2, our smart worker gets

$$\cosh \alpha = 1 + \frac{Z_1}{2Z_2} \qquad .. \qquad .. \qquad .. \qquad (4)$$

a decidedly neater result than (3) and one that gives him the answer direct in nepers instead of needing a separate operation to convert into them from the plain ratio $a$. The coshes can simply be looked up in a table.

If you are thinking that seems too dead easy you may be partly right. Some queries can arise when the values of $Z_1$ and $Z_2$ have been filled in. So let us look into the various possibilities.

When $Z_1$ and $Z_2$ are both resistances, the procedure really is as simple as it looks. To convince the sceptics, let us work an example out both ways. Suppose $Z_1$ is 100Ω and $Z_2$ is 250Ω (or any two values in the same ratio, 0.4). Using equation (3) first, we find $a = 1.862$ or 0.538. As we are assuming the only source is on the left, $i_n$ must be less than $i_{n-1}$, so $a$ is less than 1, and the solution 1.862 can be eliminated. As one might reasonably expect, 1.862 is the answer for signals coming from the right, so for left-coming signals it is $1/a$, which may actually be a little more convenient for calculating the decibels. Either way, the impedance of every section being the same, this current ratio is equivalent to 5.4dB; and as 8.686 dB = 1 neper, that is 0.62 neper.

Now try equation (4). The right-hand side is clearly 1.2 and a table of coshes (or Fig. 3) shows that if cosh $\alpha = 1.2$, $\alpha$ is 0.62. It's as easy as that.

Strictly, because of the symmetry of the cosh hanging-chain curve, $\alpha$ is $\pm 0.62$, but since we know our attenuator can't amplify the signals put into it our common sense again tells us which answer is right: $-0.62$, denoting a loss.

Next, suppose $Z_1$ and $Z_2$ are reactances of the same kind—both inductors or both capacitors. The $j$ and $\omega$ $(=2\pi f)$ cancel out in $Z_1/Z_2$, so we are left with the ratio of inductances or capacitances, which is a real number just like the ratio of resistances in the previous case. So it is just as easy, except that the impedance of the ladder varies with frequency, which is the reason that this kind of

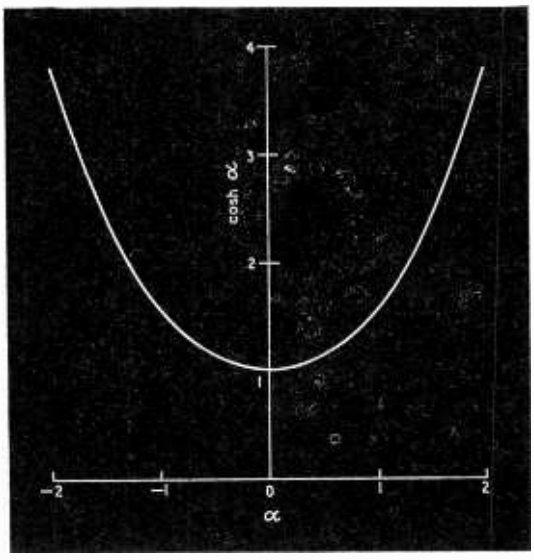



*Fig. 3 Here, repeated from last month, is a cosh curve.*

*Whereas decibels are power ratios expressed as common logs, nepers are current ratios expressed in natural logs. Current (or voltage) ratios can only be stated in dB on the understanding that both currents (or voltages) are in (or across) the same impedances. While the number of dB is correctly 10 $\log_{10}$ ($P_2/P_1$) where $P_2$ and $P_1$ are two powers being compared, powers in equal impedances are proportional to current (or voltage) squared, so the number of dB is then 20 $\log_{10}$ ($I_2/I_1$). The number of nepers is defined as $\log_e$ ($I_2/I_1$), and as $\log_{10} x = \log_e x/2.3026$, the number of dB is 20/2.3026 = 8.686 times the number of nepers (always assuming the equal-impedance clause applies).

attenuator is seldom seen. The only example I can think of is the capacitance potential-divider sometimes used in the probe of a valve voltmeter, where a main object is to minimize the input capacitance.

We enter much the largest division of the subject when we pass on to reactances of opposite kind. Most filters use them. The vital feature is that $a$ and $\alpha$ vary with frequency. So they have to be computed not once per filter but many times, and any short cut is that number of times more helpful.

Suppose $Z_1$ is an inductor and $Z_2$ a capacitor, both assumed devoid of resistance, as in Fig. 4. Then $Z_1/2Z_2$ in (4) is $j\omega L \times j\omega C/2 = -\omega^2 LC/2$. This not only varies as the square of the frequency, but is invariably negative, which will make us think a bit. For a start, it means that (except at zero frequency, when the filter does precisely nothing) according to (4) cosh $\alpha$ is always less than 1. But if we search Fig. 3 for a typical (or any) example we might as well look for an atheistic Pope.

For a hint of an escape from this impasse we can turn back to Fig. 1, where we see that $x/r$ is a cosh when it is 1 or more and a cos when it is 1 or less. We know that a cos is a cosh of an imaginary quantity. There is no real value of $a$ that makes $\frac{1}{2}(a + 1/a)$ less than 1; if one of the two terms in the brackets is less than 1, the other exceeds 1 by a greater margin, so their average is more than 1. But if instead of assuming $a$ is equal to $e^{\alpha}$, $\alpha$ being a real number, we consider the possibility of the index being imaginary, we can try $e^{j\beta}$. Since $\frac{1}{2}(e^{j\beta} + e^{-j\beta}) = \cos\beta$, we have as an alternative form of (4), for use when cosh $\alpha$ is "off the map,"

$$\cos\beta = 1 + \frac{Z_1}{2Z_2} \quad .. \quad .. \quad .. \quad (4a)$$

Until we are used to switching back and forth between a real world and (relative to what we have just left) an imaginary one, the transition may make us a little dizzy and in need of recovering our sense of direction. Fortunately there is always one point common to both worlds (A in Fig. 1), so let us pause on that threshold for a moment. From the hyperbolic point of view, it means that $\alpha$—the attenuation in nepers—is zero. That is what we would expect, because cosh $\alpha$ can (from (4)) only be 1 when $Z_1/2Z_2$ is zero, which in our Fig. 4 case means zero frequency and a perfect straight-through connection. From the circular point of view, $\cos\beta = 1$ means $\beta = 0$. We could have chosen to call it cos $\alpha$, to emphasize that it is basically the same quantity in both worlds, but it is rather more convenient to use a different symbol to indicate that in the circular world it is a circular angle. The physical interpretation of this is that instead of the attenuation, $\alpha$, we are now going to have a phase shift, $\beta$. Our Fig. 4 filter at zero frequency obviously causes no attenuation and no phase shift, so is aptly represented by the common point A.

As the frequency rises, $-Z_1/2Z_2$ rises and makes cos $\beta$ fall. That clearly indicates an increasing phase shift, which is what we get in an actual filter.

You will remember that there were two possible answers to the attenuation question, one representing movement away from the signal source and the other towards it, the first being a loss and the second an equal gain. In the same way there are two solutions to equation (4a); one a positive angle and the other an equal negative angle. Again, these represent what we find when we move away from or towards the source. Meanwhile, there is no attenuation. Two months ago we checked that $e^{j\theta}$ and $e^{-j\theta}$ represent vectors of variable angle but constant (unit) length.

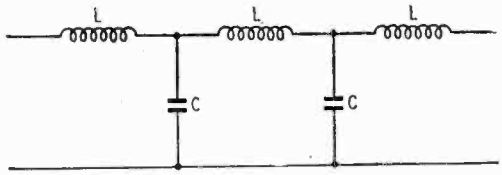



*Fig. 4 A particular variety of Fig. 2—a low-pass filter.*

The picture, then, is one of steadily increasing phase shift per section as the frequency of the signal entering the filter rises. Does it keep on doing this?

When the frequency is high enough to make $\omega^2 LC/2 = -1$, this cancels the 1 in (4a), so $\cos\beta = 0$ and $\beta = \pi/2$, or 90°. We are now half-way across Fig. 1, moving left. Doubling the frequency makes $\cos\beta = -1$, so $\beta = \pi$, or 180°. That brings us to A′ in Fig. 1. What next? Do we keep on going round the circle, or is this another threshold to an imaginary world (for now we are in the circular world. it is the hyperbolic one that seems imaginary)? We can soon find out by increasing the frequency another step, making $\omega^2 LC/2 = 3$, for $1 - \omega^2 LC/2$, is then $-2$, and this is certainly not to be found in the table of cosines. Neither is it to be found in a cosh table or in Fig. 3. So where are we now? Completely lost, it seems!

Our mistake was being in too much of a hurry to get past A′. We should have paused there for a moment's reflection like we did at A. So let us go back to it. At that point there is still no attenuation, but a 180° phase shift, which means that the signal loses no strength in its progress down the filter but does reverse its polarity at every section. So, changing over once more to the hyperbolic or attenuation viewpoint, we can say that $a$ is $-1$, which modifies (4) to

$$-\cosh\alpha = 1 + \frac{Z_1}{2Z_2} \quad .. \quad .. \quad .. \quad (4b)$$

This puts us back on to Fig. 3, and we can stay there indefinitely as the frequency rises. If you object that an infinitely large piece of graph paper would be needed, and that even cosh tables don't go to infinity, I would point out that if $a$ is very large then $1/a$ is very small and can be neglected, simplifying (4b) to

$$a \simeq 2 + \frac{Z_1}{Z_2}$$

which in our example is $2 - \omega^2 LC$. The phase shift vector meanwhile sticks at 180°, represented by the minus sign in (4b).

Corresponding, then, to the abrupt mathematical change from circular to hyperbolic world as we pass through A′, there is an abrupt physical change in the performance of the filter. At frequencies from zero to there, it doesn't attenuate the signal at all, but it does introduce an increasing phase delay.

Directly that delay equals 180° per section it sticks at that and attenuation begins, increasing with

frequency. The change-over point is, understandably, called the cut-off frequency, usually denoted by $f_c$. We can easily find it for our simple Fig. 4 low-pass filter by remembering that the transition occurred when $\omega^2LC/2$ was equal to 2:

$$\frac{4\pi^2 f_c^2 LC}{2} = 2$$

$$\therefore \quad f_c = \frac{1}{\pi\sqrt{LC}}$$

Just for the fun of it let us plot the attenuation curve from (4b), choosing our frequency scale in multiples of $f_c$ so as to make it applicable to any Fig. 4 filter. The result is Fig. 5. To put it in the

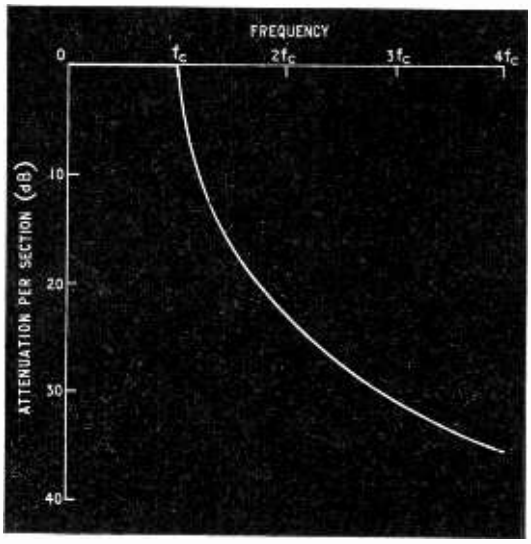



*Fig. 5 Attenuation/frequency characteristic curve of Fig. 4, the frequency scale being in terms of the cut-off frequency $f_c$. From 0 to $f_c$ there is a phase delay increasing from 0° to 180°; above $f_c$ it remains constant at 180°.*

form we expect for a filter curve I have drawn it upside down, and with $\alpha$ in dB rather than nepers.

We could do a high-pass filter in much the same way; the difference is that zero frequency is out at minus infinity on Fig. 1, and A is only reached at infinite frequency. And band-pass filters, with both $Z_1$ and $Z_2$ comprising both kinds of reactance as tuned circuits, are the same in principle, but of course $Z_1/2Z_2$ is a more complicated expression.

Having followed us so far, the earnest but inexperienced student may be disappointed, if not actually aggrieved, on being informed that the filters we have been considering are never used, or alternatively if they are used they don't work as hereinbefore described, because the conditions cannot be fulfilled. Quite apart from the inevitability of resistance, which smooths the sharp cut-off in Fig. 5, there is the awkwardness of having to provide an infinite number of sections, or an impedance equivalent thereto. This characteristic impedance $Z_o$, as it is called, has to vary in an extremely awkward manner with frequency. We went into the matter just over 10 years ago, and if you weren't with us then you can look it up somewhere, because it is outside our scope at present. To calculate it, the filter sections must be made symmetrical by dividing them either half-way along $Z_1$ to form Ts or down the middle of $Z_2$ to form $\pi$s. The $Z_o$/frequency curve for the Fig. 4 filter in T sections begins at zero frequency with a pure resistance equal to $\sqrt{L/C}$, curves downwards in a semicircle to reach zero at $f_c$, and after that is a pure reactance which rises indefinitely in a hyperbola. In fact, the curve is the same as $P_1AP_2$ in Fig. 1. The $\pi$ form is even more awkward, going to plus and minus infinity at $f_c$. No practical load behaves like this.

If an ordinary resistance or reactance termination is used, the performance of the filter naturally departs considerably from that worked out here, and as one would expect from the general cussedness of things it is worse. So in high-class practice somewhat elaborated forms of filter are used.

The only simple basic combination of $Z_1$ and $Z_2$ we have not yet considered is resistance *and* reactance. There are practical examples in almost every radio receiver, $Z_1$ being resistance and $Z_2$ capacitive reactance. If we put $Z_1 = R$ and $Z_2 = 1/j\omega C$, equation (4) becomes

$$\cosh\alpha = 1 + \frac{j\omega CR}{2}$$

In this, the 1 is real and the $j\omega CR$ is imaginary. In other words, the total is complex. Switching over to cos avails nothing, because making the imaginary part real makes the real part imaginary and one is no better off. Neither cosh $\alpha$ nor cos $\beta$ is sufficient by itself. There is both attenuation and phase shift at all frequencies, instead of these effects being segregated into their own frequency bands.

By means of a rather tricky bit of work, formulae have been found for cosh $\alpha$ and cos $\beta$ separately, when $Z_1/2Z_2$ is complex and therefore has the general form $a + j\beta$:

$$\cosh\alpha = \tfrac{1}{2}\sqrt{(a+2)^2 + b^2} + \sqrt{a^2 + b^2})$$

$$\cos\beta = \tfrac{1}{2}\sqrt{(a+2)^2 + b^2} - \sqrt{a^2 + b^2})$$

These equations can obviously be used to calculate LC filters, taking account of resistance. But in our particular example, $a = 0$ and $b = \omega CR/2$, so the equations simplify to

$$\cosh\alpha = \sqrt{p+1} + p$$

$$\cos\beta = \sqrt{p+1} - p$$

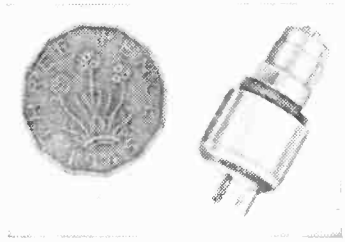
where $p$ is short for $\omega CR/4$.

Since $1 + Z_2/2Z_2$ can't be fully expressed as either cosh $\alpha$ or cos $\beta$ (= cosh $j\beta$) when it is complex, you may be wondering what it *is* equal to. Cosh $\alpha$ + cosh $j\beta$? One can soon find, from the above equations, that that doesn't work out. Actually it is cosh$(\alpha + j\beta)$. The combination $(\alpha + j\beta)$ is known as the propagation constant, the $\alpha$ part being the attenuation constant and $\beta$ the phase constant. Or, if you rightly object that these things are not constant at all but vary with frequency, you will call them coefficients.

When one turns to transmission lines, hyperbolic and circular functions of complex variables arrive in a big way. That subject would be rather too much to bite off at this stage, but perhaps the foregoing introduction will help to make it more digestible when it does come.

## *Very Small Potentiometer*

IN response to the growing demand for miniaturized components of all types, Plessey have introduced the Type L potentiometer. Measuring only 0.5in in diameter, it is housed in an aluminium case and the construction follows the well-tried Plessey practice of using a moulded carbon track with, in this case, a concentric metal track (silver loaded), the two being bridged by a moving contact mounted on an insulated carrier arm.



*Plessey miniature Type L pre-set potentiometer.*

Rating of the new potentiometer is 0.25W and the current range covers resistance of from 1kΩ to 2.5MΩ. A pre-set type only, with screw-driver slotted spindle, is available at present. The temperature range is −55°C to +85°C and a voltage limitation of 350 is imposed.

The makers are The Plessey Co. Ltd., Vicarage Lane, Ilford, Essex.

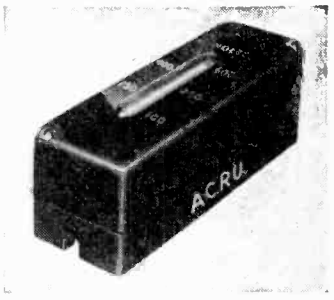
## *Transistorized V.H.F. Generators*

R.E.E. TELECOMMUNICATIONS have recently introduced three new transistorized sine wave oscillators. Model A covers 40 to 70Mc/s and Model B 100 to 150Mc/s; Model C was developed for servicing v.h.f. mobile radio receivers and covers both 70 to 72Mc/s as well as 85 to 87Mc/s. In all three models the output can be amplitude modulated at 400c/s with a depth variable from 0 to 100%. Each model also contains attenuators which allow a maximum output level variation of 90dB down to approximately 1μV. An internal 6-V battery supply is used. Models A and B, which both cost £65, and Model C, which costs £70, are made by R.E.E. Telecommunications Ltd., Market Square. Crewkerne, Somerset.

*R.E.E. Telecommunications single-band transistorized v.h.f. signal generator.*

## *Potential-Indicating Lamps*

THE Acru Electric Tool Manufacturing Co. Ltd. have introduced two neon lamps in which the length of the glow column depends on the current flowing through the lamp. Thus, with the normal high-value series resistors the lamps may be used to indicate applied potential. In the $\frac{1}{8}$in diameter, $1\frac{7}{8}$in long Type 93 (of "festoon" form) one electrode is in the form of a button at one end of the tube and the other extends along the tube: this is available also with a moulded housing containing either resistors appropriate for potentials from 60 to 250V (Type 103L) or 100 to 600V (Type 103H) a.c. The lamp is viewed through a calibrated slot in the cover. In another lamp (Type 98) the glow starts at the centre of the tube and extends towards the ends as the current increases.




*Acru potential-indicating neon lamp and housing for 100-600V.*

Other lamps in Acru's range include a snap-in one - hole - fitting type moulded in polystyrene and fluorescent-green types (only 7160V).

The address of the manufacturers is Acru Works, Demmings Road, Cheadle, Cheshire.

## *Printed Resistors*

A FURTHER development in the printed circuit technique is a new printed resistor made as a separate component on a base material of paper. The specification of the paper used is; breakdown voltage 1.5kV, tensile strength 45lb/in; thickness 0.006in and upper temperature limit 150°C.

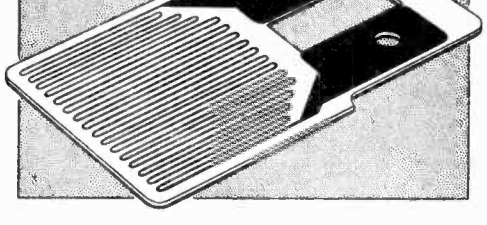
The resistance material can be either cupro-nickel, nickel-chrome or certain other alloys and the bond with the paper base is said to be so secure that it cannot be peeled off without destroying the component. Where complete insulation of the resistance is required the paper base can be bonded across the exposed face of the element.

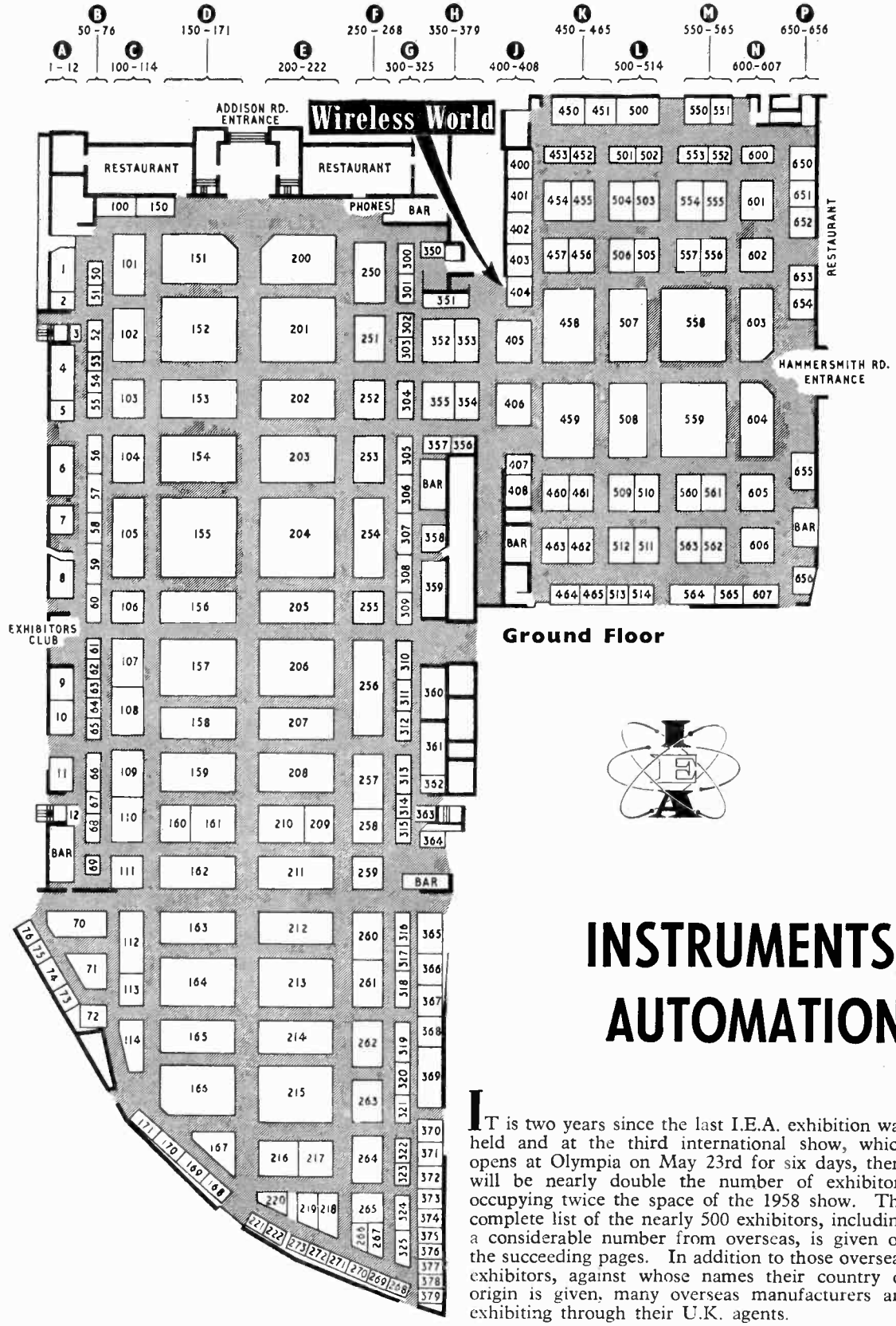
Among the applications for these resistors is where good heat dissipation is required in a restricted space, such as, for example, a contact-cooled mains dropper in radio and TV sets using the chassis as a heat sink.

These resistors are made to customers' requirements and the range of resistance can be anything up to 100Ω/sq in.

Further details can be obtained from Mills and Rockleys (Production) Ltd., Printed Circuit Division, Swan Lane, Coventry.

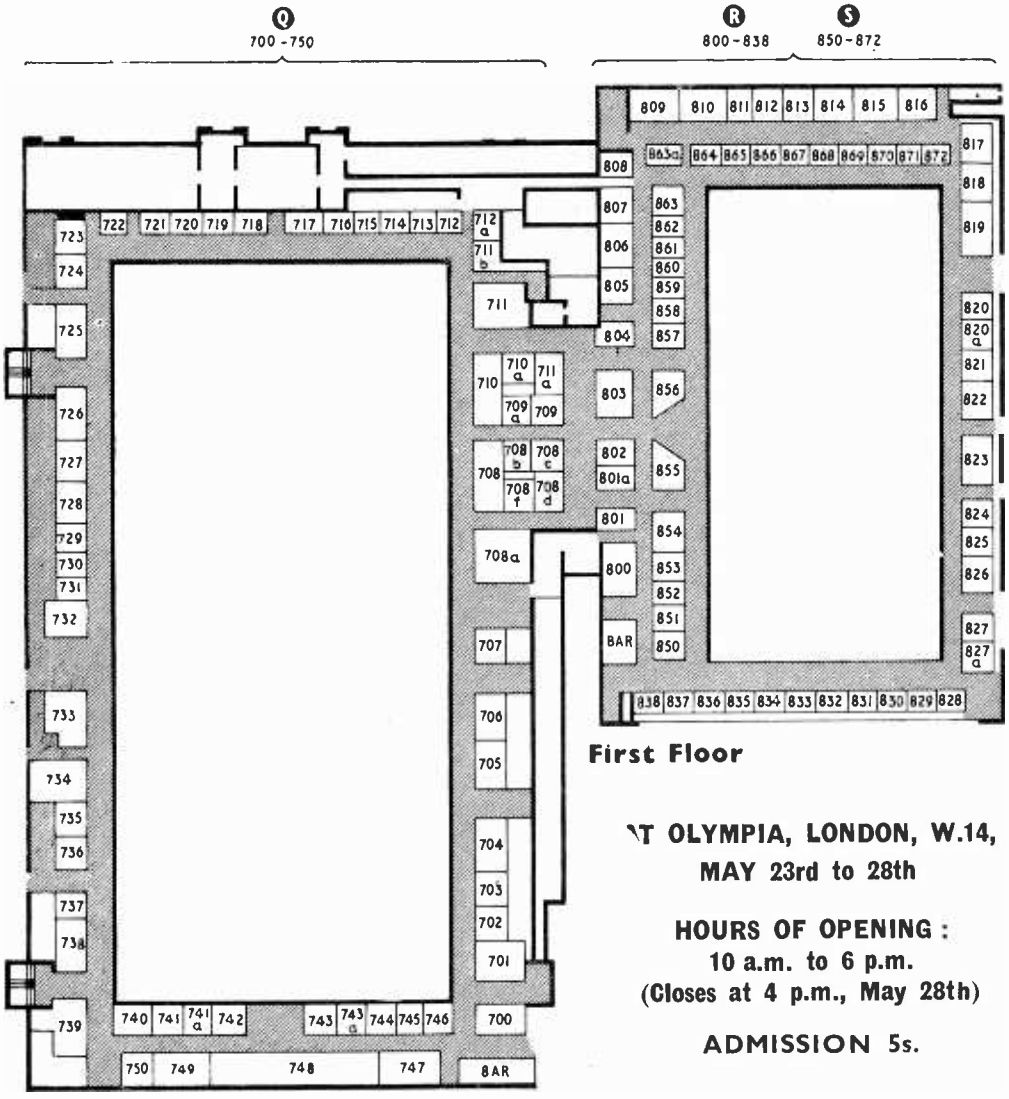
*One of Mills and Rockleys' printed resistors. This resistance element measures approximately $\frac{3}{8}$in square.*






# INSTRUMENTS, AUTOMATION

IT is two years since the last I.E.A. exhibition was held and at the third international show, which opens at Olympia on May 23rd for six days, there will be nearly double the number of exhibitors occupying twice the space of the 1958 show. The complete list of the nearly 500 exhibitors, including a considerable number from overseas, is given on the succeeding pages. In addition to those overseas exhibitors, against whose names their country of origin is given, many overseas manufacturers are exhibiting through their U.K. agents.




# ELECTRONICS, AND EXHIBITION

In our next issue we hope to review some of the outstanding equipment shown at the exhibition which is promoted by the six industrial organizations listed below*.

Admission to the exhibition costs 5s. It will be opened by the Rt. Hon. Lord Mills at 11.30 on May 23rd, but on succeeding days will open at 10.0. The closing time is 6.0 except on Saturday when it will close two hours earlier.

For three days during the exhibition the Electronic Forum for Industry (E.F.F.I.) is holding a conference on "User Experience of Electronics." Each of the three sessions will cover a different field of application of electronics in industry. On the 24th the theme will be electronics in data processing; on the 25th, factory applications of electronics (chairman, Lt. Col. Sir John Eldridge) and on the 26th electronics in instrumentation and control (chairman, Viscount Caldecote). Each day's programme begins at 2.30.

This is the first full-scale conference organized by E.F.F.I., which consists of nine associations of manufacturers in or pertaining to the electronics industry, and the object quoted in the prospectus of the conference is: "To project to all users and potential users of electronics equipment the wide and varied scope of the electronics industry, and

* British Electrical and Allied Manufacturers' Association; British Industrial Measuring and Control Apparatus Manufacturers' Association; British Lampblown Scientific Glassware Manufacturers' Association; Drawing Office Material Manufacturers' and Dealers' Association; Electronic Engineering Association; and Scientific Instrument Manufacturers' Association.

to receive from them inspiration and guidance on new uses, and the improvement or modification of established application."

A fee of £1 11s 6d is being charged for each session of the conference and this includes admission to the exhibition and a report of the proceedings. Details are obtainable from the Honorary Secretary, E.F.F.I., c/o The Electronic Engineering Association, 11 Green Street, London, W.1. (Tel.: Mayfair 7874).

# LIST OF EXHIBITORS

| | STAND NO. |
|---|---|
| AAP-Allgemeiner Apparatebau GmbH, *W. Germany* | M565 |
| A.B. Metal Products | F267 |
| A.D.S. Relays | Q728 |
| A.F.S. Developments | S861 |
| A.K. Fans | S872 |
| A.O.I.P. Mesures, *France* | R831 |
| A.P.T. Electronic Industries | P650 |
| A.T.E. (Bridgnorth) | F261 |
| Advance Components | C107 |
| Aircraft-Marine Products (G.B.) | N602 |
| Airflow Developments | B66 |
| Airmec | D162 |
| Alexander Controls | G318 |
| Allspeeds | R810 |
| Alma Components | F268 |
| Alto Instruments (G.B.) | R816 |
| Ampex International S.A, *Switzerland* | S863a |
| Amphenol | K453 |
| Analytical Measurements | G303 |
| Anderton Springs | S850 |
| Antiference | G321 |
| Ardente Acoustic Laboratories | S865 |
| Arrow Electric Switches | Q738 |
| Associated Automation | D155 |
| Associated Electrical Industries | D152 & E213 |
| Astralux | Q711b |
| Audley Engineering Co. | K454 |
| Aumann, Willy K. G., *W. Germany* | B73 |
| *Automation Progress* | G314 |
| Autronic Developments | Q715 |
| Aviation, Ministry of | J406 |
| Avo | D156 |
| B & K Laboratories | E203 |
| B & R Relays | R824 |
| B.O.B. (Arundel) | R817 |
| Bailey Meters & Controls | L507 |
| Baird & Tatlock (London) | N603 |
| Baldwin Industrial Controls | K463 |
| Beckman Instruments | R805 |
| Belling & Lee | D165 |
| Bellingham & Stanley | G315 |
| Beulah Electronics | S852 |
| Black Automatic Controls | H359 |
| Blackburn Electronics | Q710 |
| Blakeborough, J. & Sons | F265 |
| Boulton Paul (Aircraft) | B72 |
| Bradley, G. & E. | Q743 |
| Brannan, S. & Sons | B52 |
| Braun, G., Publishers, *W. Germany* | F269 |
| Bray, Geo. & Co. | Q731 |
| Bribond | H368 |
| Bristol Aircraft | B58 |
| Bristol's Instrument Co. | D155 |
| British Arca Regulators | R807 |
| British Electric Resistance Co. | R801 |
| B. I. Callender's Cables | R813 |
| British Physical Laboratories | H351 |
| British Power Transformer Co. | R801 |
| British Rototherm Co. | Q729 |
| British Sarozal | Q712a |
| British Scientific Instrument Research Assoc. | Q744 |
| Brookhirst Igranic | D156 |
| Brown, Neville, and Co. | H377 |
| Brown, S. G. | H366 |
| Bruce, Peebles & Co. | R802 |
| Brush Crystal Co. | Q704 |
| Bryans Aeroquipment | J400 |
| Budenberg Gauge Co. | A4 |
| Bulmers Business Machines | S864 |
| Burndept | B68 |
| Bush Beach & Segner Bayley | M561 |
| Cambridge Instrument Co. | F259 |
| Camlab (Glass) | G322 |
| Carlo, Erba S.p.A., *Italy* | Q709 |
| Carr Fastener Co. | R814 |
| Casella, C. F., & Co. | K460 |
| Cathodeon Crystals | G311 |
| Cementation (Muffelite) | R838 |
| Chapman & Hall | S862 |
| Chemical Cutting Co. | R817 |
| Clarke, H., & Co. (Manchester) | Q732 |
| Cole, R. H. (Overseas) | B73 |
| Coley Thermometers | Q708f |
| Colvern | Q723 |
| Colyer & Southey | B75 |
| Communication Systems | F261 |
| Compagnie Francaise Thomson-Houston, *France* | Q708c |
| Connollys (Blackley) | R834 |
| Constructors John Brown | H361 |
| *Control* | A8 |
| Correx Communications Equipment | R817 |
| Cossor | E212 |
| Coulter Electronics | Q743a |
| Counting Instruments | Q717 |
| Coventry Controls | E222 |
| Crompton Parkinson | C104 |
| Crosby Valve & Engineering Co. | F253 |
| Crouzet & Company, *France* | S861 |
| Croydon Precision Instruments Co. | Q716 |
| Cu-Ni-Craft | L500 |
| Cuthbert, Ralph | G320 |
| Data Recording Instrument Co. | G325 |
| Dawe Instruments | Q727 |
| Day, J., & Co. | B53 |
| Daystrom | S852 |
| DEAC (Great Britain) | R816 |
| Decker's, R., Verlag, G. Schenk, *W. Germany* | F269 |
| Degussa Hanau, *W. Germany* | M561 |
| De Havilland Propellers | R730 |
| Department of Scientific and Industrial Research | E214 |
| Deutscher Innen-und Aussenhandel Elektrotechnik, *E. Germany* | Q748 |
| Dewrance & Co. | M554 |
| Diamond H. Switches | B64 |
| Direct TV Replacements | S852 |
| Dobbie McInnes (Electronics) | K452 |
| Doran Instrument Co. | S858 |
| Drayton Regulator & Instrument Co. | K455 |
| Dubilier Condenser Co. | K461 |
| Dynatron Radio | E208 |
| E.M.I. Electronics | D166 |
| E.M.O. Instrumentation | F251 |
| Ekco Electronics | E208 |
| Electran Coil Co. | Q711a |
| Electrical Development Association | F250 |
| Electrical Remote Control Co. | F266 |
| Electro Automat | S851 |
| Electroflo Meters Co. | D155 |
| Electrolube | S871 |
| Electro-Mechanical Systems | D167 |
| Electro Mechanisms | M563 |
| Electronic Associates | R825 |
| Electronic Components | Q714 |
| *Electronic Engineering* | L502 |
| Electronic Instruments | Q711 |
| Electronic Machine Co. | R818 |
| *Electronic Technology* and *Data Processing* | J404 |
| Electronic Tubes | H373 |
| Electronics & Automation (London) | R816 |
| Electrothermal Engineering | G319 |
| Elga Products | G304 |
| Ellenberger & Poensgen, GmbH, *W. Germany* | Q746 |
| Elliott-Automation | D155 |
| Emeco Electronics Co. | R816 |
| Enalon Plastics | H372 |
| Endecotts (Filters) | B69 |
| Engelhard Industries | N606 |
| Engis | R819 |
| English Electric Co. | E215 |
| English Electric Valve Co. | E215 |
| English Numbering Machines | H370 |
| Epsylon Industries | D167 |
| Equipment & Services | F266 |
| Ericsson Telephones | D153 |
| Erie Resistor | D169 |
| Ether & Electro Methods | E205 |
| Evans Electroselenium | A11 |
| Everett, Edgcumbe & Co. | Q747 |
| Ever Ready Co. | K465 |
| Evershed & Vignoles | K450 |
| Fairey Aviation | L503 |
| Faraday Electronic Instruments | D154 |
| Farris Engineering | D155 |
| Ferranti | N604 |
| Fielden Electronics | C110 |
| Filhol, J. P., | R829 |
| Fireye Controls Co. | Q726 |
| Firth Cleveland Instruments | H353 |
| Fischer & Porter | A10 |
| Fisher Governor Co. | D155 |
| Fleming Radio (Developments) | P652 |
| Flexonics | M563 |
| Floform Parts | F264 |
| Formica | J403 |
| Fortiphone | Q741a |
| Foster Instrument Co. | C111 |
| Fox, P.X. | L514 |
| Foxboro-Yoxall | E202 |
| Furzehill Laboratories | Q721 |
| General Controls | H375 |
| General Electric Co. | E211 |
| General Post Office | R823 |
| General Precision Systems | M560 |
| General Radio Co., *U.S.A.* | Q733 |
| General Radiological | E209 |
| Geyer, Christian, *W. Germany* | Q746 |
| Gilbarco | G302 |
| Glass Developments & Ultrasonoscope Co. | A3 |
| Gloster Aircraft Co. | L508 |
| Goodman, George | F264 |
| Goodmans Industries | K462 |
| Gordon, James & Co. | D155 |
| Goring Kerr | Q736 |
| Graticules | B62 |
| Graviner Manufacturing Co. | R827 |
| Griffin & George | R803 |
| Grubb, Sir Howard, Parsons & Co. | P651 |
| Grundy & Partners | S868 |
| Guest Keen & Nettlefolds | F264 |
| Guyson Industrial Equipment | Q742 |
| Haddon, Thomas & Stokes | F264 |
| Haddon Transformers | D170 |
| Halden, J., & Co. | Q701 |
| Hallam, Sleigh & Cheston | J408 |
| Hall Harding | F256 & L505 |
| Harper & Tunstall | M551 |
| Harris Plating Works | H379 |
| Harwin Engineers | L513 |
| Hassett & Harper | R832 |
| Hatfield Instruments and Balun | G305 |
| Hawker Siddeley Group | L508 |
| Headland Engineering Developments | Q745 |
| Heathway Machinery Co. | H367 |
| Heidenhain, Dr. Johannes, *W. Germany* | E218 |
| Hendrey Relays | C113 |
| Henry & Thomas | S869 |
| Herbert Publishing Co. | D150 |
| Heywood & Co. | N600 |
| Hivac | F261 |
| Holmes Bros. (London) | R806 |
| Honeywell Controls | E200 |
| Hughes International | G310 |
| Hunt, A. H. (Capacitors) | M562 |
| Hunt & Mitton | H357 |
| Hunting Engineering | R830 |
| Ide, T. & W. | H350 |
| Ilford | B70 |
| Imhof, Alfred | H360 |
| Industrial Pyrometer Co. | L509 |
| Inertia Switch | Q722 |
| Infra Red Development Co. | P654 |
| Institution of Electrical Engineers | R827a |
| Instron Engineering Corp., *U.S.A.* | Q705 |
| Integra, Leeds & Northrup | D163 |
| International Electronics | R811 |
| International Rectifier Co. (G.B.) | Q739 |
| Ionic Plating Co. | F264 |
| Jobling, James A., & Co. | C112 |
| K.D.G. Instruments | K457 |
| K.L.G. Sparking Plugs | Q735 |
| Kelvin & Hughes | F257 |
| Kent, George | D159 |
| Kovo-Foreign Trade Corp., *Czechoslovakia* | G306 |
| Krizik n.p., *Czechoslovakia* | G306 |
| Kumag A.G., *Switzerland* | B73 |
| Kynmore Engineering Co. | R801a |
| Labgear | D154 |
| Laboratory Equipment | G313 |

| | STAND NO. |
|---|---|
| Lancashire Dynamo Electronic Products | E205 |
| Langham Thompson Group, J | H364 |
| Langley London | N601 |
| Laurence, Scott & Electromotors | L510 |
| Leach Corp., *U.S.A.* | D167 |
| Leeds Meter Co. | J401 |
| Leevers-Rich Equipment | R837 |
| Levell Electronics | H363 |
| Lewis Spring Co. | S867 |
| Lintronic | B55 |
| Lion Electronic Developments | L500 |
| Livingston Laboratories | F254 |
| Lloyds Bank | A9 |
| Lodge Plugs | M553 |
| London Electric Wire Co. and Smiths | B71 |
| Loughborough Glass Co. | M556 |
| Lucas, Joseph (Electrical) | Q743 |
| Lyons, Claude | Q733 |
| M.B.C. (Office Systems) | R822 |
| M.C.P. Electronics | Q708c |
| M-O Valve Co. | E211 |
| MSS Recording Co. | Q712 |
| Magnetic Devices | J407 |
| Mallory Batteries | P656 |
| Marconi Instruments | D157 |
| Markem (U.K.) | R835 |
| Marrison & Catherall | R812 |
| Marshall of Cambridge Electronics | B63 |
| Mason, E. N., & Sons | E201 |
| McMurdo Instrument Co. | D168 |
| Measurement | E221 |
| Mec-Test | Q740 |
| Metaducts | R820a |
| Metal Detection | G233 |
| Meterflow | D167 |
| Metrix Instruments | E219 |
| Micanite & Insulators Co. | L512 |
| Microcell Electronics | C108 |
| Midland Bank | Q734 |
| Mine Safety Appliances Co. | Q718 |
| Minerva Detector Co. | G309 |
| Miniature Electronic Components | S854 |
| Moncrieff, John | H356 |
| Morbank | S860 |
| Morgan Crucible Co. | K456 |
| Muirhead & Co. | E207 |
| Mullard | C102 & M559 |
| Murphy Radio | E209 |
| NSF | B57 |
| Nagard | G312 |
| Nalder Bros. & Thompson | C109 |
| Nash & Thompson | F258 |
| Negretti & Zambra | C105 |
| Neoflex | F270 |
| New Western (Eng.) | A6 |
| Newmark, Louis | B74 |
| Newmarket Transistors | G307 |
| Newport Instruments | Q715 |
| Nicolson, W. B. (Scientific Instruments) | N603 |
| Norgren, C. A. | B61 |
| Normalair | R826 |
| Nottingham Thermometer Co. | L509 |
| O.M.I. Instruments (G.B.) | R816 |
| Oldenbourg, R., Verlag, *W. Germany* | F269 |
| Oliver Pell Control | R809 |
| Opancol | Q708b |
| Optical Works | H362 |
| Otter Controls | Q741 |
| Ozalid Co. | D151 |
| P. & H. Engineering Co. | S866 |
| Packaging Centre | Q749 |
| Painton & Co. | B60 |
| Palmer, G. A. Stanley | R816 |
| Panax Equipment | S870 |
| Panellit | D155 |
| Parmeko | R804 |
| Payne & Griffiths | H358 |
| Peel, H. W., & Co. | H374 |
| Pergamon Press | H378 |
| Perkin-Elmer | J405 |
| Permali | Q702 |
| Phoenix Telephone & Electric Works | R817 |
| Photoelectronics (M.O.M.) | A2 |
| Planche, M., *France* | S861 |
| Plannair | K464 |
| Platon, G. A. | G317 |
| Plessey Group | M558 |
| Polypenco | Q709a |
| Precision Tool & Instruments Co. | M552 |
| *Process Control and Automation* | G308 |
| Pullin, R. B., & Co. | C103 |
| Pye | D154 |
| Pye, W. G., & Co. | D154 |
| Quickfit & Quartz | C112 |
| RCA Great Britain | Q708a |
| Racal | F260 |
| Radiochemical Centre U.K.A.E.A. | H355 |
| Radiometer, *Denmark* | J402 |
| Rank Cintel | N605 |
| Recorder Charts | A5 |
| Reliance Cords & Cables | Q724 |
| Reliance Manufacturing Co. (Southwark) | H376 |
| Research & Control Instruments | D164 |
| Richard Allan Radio | H371 |
| Rivlin Instruments | R815 |
| Roband Electronics | R808 |
| Robinson D., & Co. | B76 |
| Robinson, F. C., & Partners | B51 |
| Rola Celestion | F271 |
| Rotameter Manufacturing Co. | E210 |
| Royal Worcester Industrial Ceramics | B54 |
| Royston Instruments | R821 |
| Rumburske Kovozavody, *Czechoslovakia* | G306 |
| S.E. Laboratories | D167 |
| SFIM (Great Britain) | M563 |
| Salford Electrical Instruments | E211 |
| Samson Controls (London) | E220 |
| Sanders, W. H. (Electronics) | L506 |
| Sangamo Weston | F263 |
| Saunders-Roe | R826 |
| Saunders Valve Co. | R828 |
| Savage, W. Bryan | D154 |
| Sciaky Electric Welding Machines | R833 |
| Scott, James & Co. | Q703 |
| Servomex Controls | E255 |
| Shaw Moisture Meters | S856 |
| Short Brothers & Harland | M557 |
| Short & Mason | G301 |
| Siemens & Halske AG., *W. Germany* | B73 |
| Sierex | G324 |
| Sifam Electrical Instrument Co. | S855 |
| Smith & Nephew | L501 |
| Smiths Aircraft Instruments | F257 |
| Société D'Applications des Machines Motrices, *France* | B72 |
| Solartron Electronic Group | E206 |
| Southern Instruments | D158 |
| South London Electrical Equipment Co. | B56 |
| Sovirel, *France* | Q710a |
| Spear Engineering Co. | D171 |
| Sperry Gyroscope Co | C101 |
| Standard Telephones and Cables | K459 |
| Stanley, W. F., & Co. | Q706 |
| Stanton Instruments | G316 |
| Stevens Manufacturing, Co., *U.S.A.* | Q746 |
| Stonebridge Electrical Co. | S859 |
| Stratton & Co. | K450 |
| Submarine Signal Co. (London) | H366 |
| Swartwout Co. | D155 |
| Swift Levick & Sons | F273 |
| Taylor Electrical Instruments | P655 |
| Taylor Controls | D161 |
| Techna (Sales) | Q746 |
| Technicon Instruments Co. | P653 |
| Technograph Electronic Products | K451 |
| Telcon Metals | B59 |
| Teledictor | C114 |
| Telegraph Condenser Co. | L511 |
| Telephone Manufacturing Co. | H352 |
| Telequipment | S853 |
| Tesla n.p., *Czechoslavakia* | G306 |
| Texas Instruments | E216 |
| Thermal Syndicate | C106 |
| Thorn Electrical Industries | H369 |
| Tinsley, H., & Co. | N607 |
| Tintometer | A12 |
| Torsion Balance Co., *U.S.A.* | Q719 |
| Trist, Ronald & Co. | F262 |
| Trumeter Co. | R836 |
| Turner, Ernest, Electrical Instruments | C100 |
| Turton Bros. & Matthews | Q720 |
| 20th Century Electronics | Q713 |
| Tylers of London | A1 |
| Ultra Electronics | H364 & R820 |
| Unicam Instruments | D154 |
| United Trade Press | G300 |
| Vactric (Control Equipment) | M555 |
| Veb Elektro-Apparate-Werke, *E. Germany* | Q748 |
| Veeder-Root | S857 |
| Venner Electronics | Q737 |
| Vieweg, Friedr. & Sohn, *W. Germany* | F269 |
| Walker, Crosweller & Co. | Q700 |
| Waveforms | M550 |
| Wayne Kerr Laboratories | E217 |
| Webb, William A. | B50 |
| Welwyn Electrical | S863 |
| West, A., and Partners | F252 |
| West Instrument | H354 |
| Westinghouse Brake and Signal Co. | Q707 |
| Westminster Bank | Q708 |
| Westool | Q725 |
| Whiteley Electrical Radio Co. | R800 |
| Willy, Aumann K.G., *W. Germany* | B73 |
| Williams & James (Engineers) | D160 |
| Wilmot Breeden | Q708d |
| Winston Electronics | M564 |
| Wire Products & Machine Design | B65 |
| *Wireless World* | J404 |
| Woden Transformer Co. | A7 |
| Wolsey Electronics | S863a |
| Worcester Royal Porcelain Co. | H356 |
| X-Lon Products | B67 |
| Zeal, G. H. | L504 |
| Zenith Electric Co. | F272 |

# BOOKS RECEIVED

**Basic Electronics,** by Bernard Grob. Vol. 1 follows the order of topics presented in the first term's work of the technicians' training course at RCA Institutes, starting with elementary electricity and magnetism and ending with a brief insight into valves, transistors and radio frequency losses. It is to be followed by a second volume on Applied Electronics. Pp. 524; Figs. 383. Price 50s 6d. McGraw-Hill Publishing Co., Ltd., 95, Farringdon Street, London, E.C.4.

**Proceedings of the National Electronics Conference,** 1958 (Vol. 14). Illustrated record (99 papers) of the annual conference held at Hotel Sherman, Chicago, Illinois, covering all aspects of radio and electronics from antennas to automatic navigation and from audio to computers. Pp. 1074, profusely illustrated. Price $7.50. National Electronics Conference, Inc. 228, N. La Salle Street, Chicago 1, Illinois, U.S.A.

**A Quality-Checking Receiver for V.H.F./F.M. Sound Broadcasting,** by C. G. Mayo, M.A., B.Sc., M.I.E.E., B.B.C. Engineering Division Monograph No. 25, gives circuit diagrams and performance details of two alternative prototype receivers, designed, without compromise to give a high standard of performance. Pp. 15; Figs. 13. Price 5s. B.B.C. Publications, 35, Marylebone High Street, London, W.1.

**Testing of Screened Enclosures,** by J. Miedzinski, B.Sc., A.M.I.E.E. Methods of measuring insertion loss and its dependence on the details of experimental arrangements as well as on frequency and the construction of the enclosure. Pp. 27; Figs. 19. Price 24s. The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

**Insulation for Small Transformers,** by J. H. Mason and C. G. Garton. Handbook for designers reviewing the factors influencing electric strength and life of insulation, methods of non-destructive testing and data on new materials. Pp. 93; Figs. 33. Price 37s 6d. The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

# Power Trans ormer Design

## With Special Reference to Paper Interleaved Windings

*By D. SAULL*

THE development engineer in the electronic industry requires, from time to time, to design a power transformer for the equipment he is developing. The number of transformers he designs in the course of a year is usually relatively few; consequently it is necessary for him to become familiar with the "know how" of space factor, compensation, winding resistances, etc., each time.

In various technical journals are published graphs and charts for establishing space factor and gauges of wire, etc., but to date the writer has not come across any data which does not require some preliminary digesting before a start can be made.

The most common need in this industry is for relatively low-power mains transformers usually not in excess of 150VA. The writer's aim is to present a really easy, straight-forward method of design to cover six VA ratings, the first four applicable to equipment requiring valve heater supplies, and the remaining two for transistor power units of smaller physical size. The factors presented in the design data contained in this article are based upon practical results obtained from more than a hundred experimental transformers wound with terminal voltages to M.O.S. specification (± 2½% below 100V and ± 5% above 100V).

The VA ratings referred to are 150VA, 100VA, 60VA, 35VA in the first group, and 20VA and 10VA in the second group.

The development engineer in the first instance requires to produce a transformer that will function in the equipment he is designing. His second need is to produce this transformer as a practical production winding which may be passed on to the drawing office without further modification. It must, therefore, be electrically and constructionally sound. It must not be a tight wind but must possess sufficient space tolerance to allow for variation in wire sizes (± 10% diameter = 20% cross-sectional area—wire manufacturers' tolerance).

Transformer windings may be layer wound on formers with end cheeks, or paper interleaved and wound on cheekless formers. This article is based upon the latter method. Cheekless-former windings lend themselves to better inspection during the winding process, it being very easy to detect a dropped down turn, which in the end cheek variety could not be detected and might result in a shorted

**TABLE I—PRIMARY RATINGS**

| | 100-150VA | 60-100VA | 35-60VA | 25-35VA | 10-25VA | 8-10VA |
|---|---|---|---|---|---|---|
| Laminations (M.E.A.: Silcor 25) | 60A | 75A | 75A | 24A | 101A | 68 |
| Stack size | 1½in | 1¼in | 1in | 15/16in | 1 1/32in | 7/8in |
| Window area | 2.75 sq. in | 2.375 sq. in | 2.375 sq. in | 1.42 sq. in | 0.84 sq. in | 0.644 sq. in |
| Primary turns per volt | 3.56 | 4.42 | 6.68 | 7.83 | 7.4 | 10.5 |
| Secondary turns per volt | 3.81 | 4.76 | 7.15 | 8.4 | 7.9 | 11.2 |
| Overall space factor | 44% | 46% | 46% | 48% | 50% | 50% |
| Area occupied by 250V primary winding | 0.585 sq. in | 0.624 sq. in | 0.65 sq. in | 0.363 sq. in | 0.267 sq. in | 0.194 sq. in |
| 250V primary (Turns and wire gauge) | 890t: No. 23 s.w.g. | 1104t: No. 24 s.w.g. | 1670t: No. 26 s.w.g. | 1960t: No. 30 s.w.g. | 1850t: No. 32 s.w.g. | 2620t: No. 36 s.w.g. |
| Remaining area for h.t. and l.t. windings | 0.955 sq. in | 0.656 sq. in | 0.63 sq. in | 0.365 sq. in | 0.153 sq. in | 0.128 sq. in |
| 6.3-V winding to fill layer | 3.6A—7.2A 24t. 2×18 s.w.g. | 4A—8A 30t. 15 s.w.g. | 1.8A—3.6A 45t. 18 s.w.g. | 0.5A—1.2A 51t. 22 s.w.g. | 1A—2A 50t. 20 s.w.g. | — |
| 5-V winding to fill layer | 19t. 2×16 s.w.g. | 24t. 2×19 s.w.g. | 36t. 17 s.w.g. | 42t. 21 s.w.g. | — | — |
| Former length | 2 3/32in | 2 1/32in | 2 1/32in | 1 19/32in | 1 3/32in | 1 7/32in |

turn, or worse, a failure occurring early in the life of the transformer.

L.T. windings should be wound on first for two reasons:—

(1) They are wound with the thickest wire, and therefore form a good base on which to wind the thinner wire of the remaining windings.

(2) The l.t. windings carry the heaviest current, thus putting these windings on first results in a shorter mean-turn length. They consequently have a lower d.c. resistance and a better regulation percentage figure.

The l.t. winding should completely fill the available width, a bifilar wind can be used if a single winding at the required current capacity does not fill the layer. Current densities of these windings may be 1,500A or 2,000A per square inch.

A transformer design may call for four or more separate l.t. windings, perhaps two at 4A and two at 2A with a primary rating of the order of 150VA. In this case the 4-A winding should be wound on first, and the two 2-A windings wound side by side as a single layer with ¼in spacing at the centre between them. This saves valuable space which might well be required to allow a more generous wire gauge on the h.t. winding.

Where the occasion arises calling for a l.t. winding of low-current capacity (e.g. order of ½A) difficulty might be experienced in choosing a wire gauge to fill the layer. In this case, this winding may be wound on last, and placed centrally on the windings. Due to the low current value the voltage regulation would not be effected by the increased length of wire, and it would be convenient to operate the winding with a current density not greater than 1,000A per square inch.

The primary winding is wound on next with voltage taps as required, followed by the h.t. windings.

The choice of wire gauge for the h.t. winding should be as generous as possible to keep its d.c. resistance as low as possible. With full-wave rectification a good practical rule is to assume that each half winding will carry not less than an average of 0.7 of the d.c. output current, at a current density of 1,000A per square inch (this is not strictly true because a.c. current surges are in excess of the d.c. current and dependent on the rectifier used and the value of the reservoir capacitor—the 0.7 factor is a practical compromise).

Windings throughout the transformer should be in order of wire gauges, that is, the heaviest wire nearest the core, the lightest wire on the outside winding.

Table I sets out for easy reference the information required when designing a transformer. The space factor given is an overall figure and takes into account the former, insulation and wire tolerances. The space factor for a given lamination will remain reasonably constant for any gauges likely to be used at the respective VA rating.

Insulation throughout the transformer is as follows:—

(1) Three layers of Britain's (0.002in) tissue on the former.

(2) 2 layers of Symax (0.005in) between windings.

(3) One layer of Britain's tissue (0.002in) interleaving between layers throughout primary and h.t. windings.

(4) Two layers of Symax (0.005in) between layers of l.t. windings occupying more than one layer.

**TABLE II**

| Dia. | T/in | T/in² | Current at 1,000A/in² | S.W.G. |
|---|---|---|---|---|
| 0.131 | 7.6 | 57.8 | 12.9 | 10 |
| 0.119 | 8.4 | 70.6 | 10.6 | 11 |
| 0.107 | 9.3 | 86.5 | 8.5 | 12 |
| 0.095 | 10.5 | 110 | 6.65 | 13 |
| 0.083 | 12.0 | 144 | 5.03 | 14 |
| 0.0745 | 13.4 | 180 | 4.07 | 15 |
| 0.0665 | 15.0 | 225 | 3.22 | 16 |
| 0.0586 | 17.0 | 289 | 2.46 | 17 |
| 0.0505 | 19.8 | 392 | 1.81 | 18 |
| 0.0422 | 23.6 | 557 | 1.26 | 19 |
| 0.0382 | 26.1 | 681 | 1.02 | 20 |
| 0.0340 | 29.4 | 864 | 0.804 | 21 |
| 0.0300 | 33.3 | 1,110 | 0.616 | 22 |
| 0.0257 | 38.9 | 1,520 | 0.452 | 23 |
| 0.0237 | 42.1 | 1,770 | 0.380 | 24 |
| 0.0217 | 46.0 | 2,120 | 0.314 | 25 |
| 0.0197 | 50.7 | 2,570 | 0.255 | 26 |
| 0.0179 | 55.9 | 3,120 | 0.211 | 27 |
| 0.0163 | 61.3 | 3,760 | 0.172 | 28 |
| 0.0151 | 66.2 | 4,380 | 0.145 | 29 |
| 0.0136 | 73.5 | 5,400 | 0.121 | 30 |
| 0.0128 | 78.1 | 6,100 | 0.106 | 31 |
| 0.0120 | 83.3 | 6,940 | 0.0916 | 32 |
| 0.0112 | 89.2 | 7,960 | 0.0785 | 33 |
| 0.0102 | 98.0 | 9,600 | 0.0665 | 34 |
| 0.0094 | 106 | 11,200 | 0.0554 | 35 |
| 0.0086 | 116 | 13,500 | 0.0454 | 36 |
| 0.0078 | 128 | 16,400 | 0.0363 | 37 |
| 0.0070 | 143 | 20,400 | 0.0283 | 38 |
| 0.0059 | 169 | 28,600 | 0.0212 | 39 |
| 0.0055 | 182 | 33,100 | 0.0181 | 40 |
| 0.0051 | 196 | 38,400 | 0.0152 | 41 |
| 0.0047 | 212 | 44,900 | 0.0126 | 42 |
| 0.0043 | 233 | 53,300 | 0.0102 | 43 |
| 0.0039 | 256 | 65,500 | 0.0080 | 44 |

Table II sets out details of characteristics of enamelled copper wire for use with the design data given here.

*Example of Practical Design*———

(*a*) Tabulate the secondary VA ratings required:—

| | | |
|---|---|---|
| *LT*1. | 5.0V at 2.5A | = 12.5VA |
| *LT*2. | 6.3V at 3A | = 18.9VA |
| *HT*. | 250–0–250V at 60MA | = 15.0VA |
| | Total | = 46.4VA |

Primary VA at 86% efficiency = 46.5/0.86 = 54VA.

(*b*) From Table I No. 75A laminations and a 1in stack is required.

(*c*) Windings (from Table I)

*LT*1. 36 turns of 17 s.w.g. En Cu wire.

*LT*2. 45 turns of 18 s.w.g. En Cu wire.

Space remaining for l.t. and h.t. = 0.63 sq in.

*LT*1. = 36/216 = 0.167 sq in.

*LT*2. = 45/392 = 0.115 sq in.

Total = 0.282 sq in.

Space remaining for h.t. winding = 0.348 sq in.

(*d*) Turns required for h.t. winding at 7.15 turns per volt = 7.15 × 500V = 3,576 turns.

(*e*) Choice of wire gauge $= \frac{\text{Number of turns}}{\text{Space available}} =$ T/in² (turns per square in) = 3576/0.348 = 10,800 T/in²

(*f*) From Table II nearest gauge = 35 s.w.g. (55.4mA)
or even gauge No. 36 s.w.g. (45mA).

(*g*) Winding details would then be:—
*LT*1. 36 turns No. 17 s.w.g. En Cu wire.
*LT*2. 45 turns No. 18 s.w.g. En Cu wire.

Primary 230V, 1,533 turns
240V, 1,602 turns
250V, 1,671 turns
} No. 26 s.w.g. En Cu wire.

*H.T.* 3,576 turns No. 36 s.w.g. (or 35 s.w.g.) En Cu wire tapped at 1,788 turns.

It will be seen that the time required to design a transformer from the given data should not be more than half an hour.

After the prototype has been tested in circuit, and any necessary modifications due to circuitry changes have been made the transformer is ready to be placed in production.

# Nuclear Explosions and Radio Noise

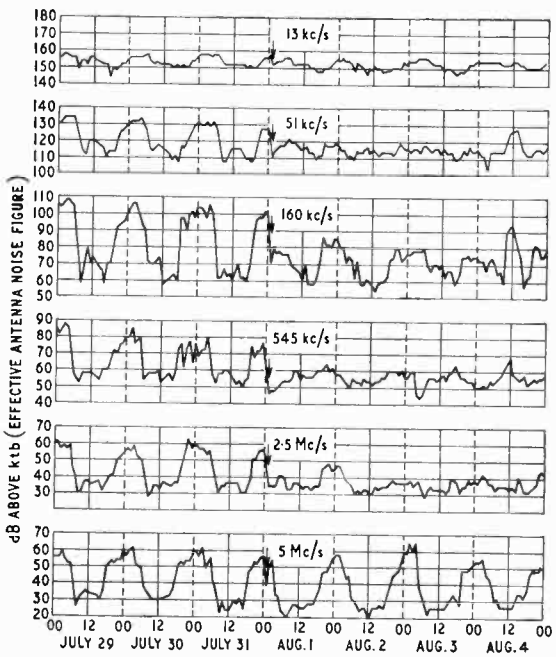
## EFFECT OF HIGH ALTITUDE BURSTS ON RADIO PROPAGATION

**By MICHAEL LORANT**

THE U.S. National Bureau of Standards recorded the changes in radio noise power that occurred when two high-altitude atomic explosions were set off over Johnston Island in the Pacific Ocean in August, 1958. The explosions appear to have had a pronounced effect on the radio noise as recorded at Kekaha, Hawaii. This recording station, located on the south-west coast of the island of Kauai, about 700 miles north-east of Johnston Island, is part of a world-wide chain of noise-recording stations supervised by the Bureau's Boulder (Colorado) laboratories.

Two bomb bursts occurred shortly after midnight on August 1 and August 12 at elevations estimated to be from 25 to 100 miles. Recordings were made of the received atmospheric radio noise power for a period before and after the first explosion. The usual diurnal pattern is evident on the graphs* during the three days prior to the blast, with the highest noise levels recorded at night and a rapid decrease in level between 0400 and 0800 local time. In the hour following the blast, however, the noise decreased by as much as 32dB (at some frequencies) at a time of day when it would normally be rising or holding steady. Recovery apparently occurred in a matter of hours at 13kc/s and 5Mc/s, but from 51kc/s through 2.5Mc/s a changed pattern is evident for several days, and records for August 5-11 indicate that a disturbed condition persisted until the second test on August 12. The after-blast effects on this date were similar to those on August 1, with abnormal noise conditions continuing on some frequencies until about September 1.

Because of the very low incidence of thunderstorms in Hawaii, most of the received radio noise is believed to be propagated from storms at a considerable distance. Thus, changes in propagation conditions are reflected more on the Kekaha noise records than at stations situated on large masses, where local and short-distance storm effects tend to mask changes in propagation.




*Graphs of radio noise power recorded at Kekaha, Hawaii, July. 29 to August 4, 1958. Time of nuclear explosion on August 1 indicated by arrows.*

It would appear likely that a highly ionized region was formed by the bomb explosions over Johnston Island and that this ionized region persisted for a period of at least several days after each test, causing greatly increased ionospheric absorption.

* The "effective antenna noise figure" is the mean noise power averaged over several minutes and is defined as the noise power available from an equivalent lossless antenna in decibels above the thermal-noise power available from a passive resistance. See "N.B.S., Radio and Ionospheric Observations During the I.G.Y." David M. Gates, *J.Res. N.B.S.* **63D**, July-August, 1959. p. 11.—ED.

### REFERENCE

"Effects of High-Altitude Nuclear Explosions on Radio Noise," by C. A. Samson, *J. Res. N.B.S.* **64D** p. 37 (Jan.-Feb. 1960).


*Kinetrol "Magi-Dor" mechanism for opening garage doors. A, "chopped" light-source; B, transistor amplifier and relay; C, latch solenoid; D, control spring and damper.*

# TRANSISTORIZED DOOR CONTROL

IN a light-controlled garage door opening mechanism developed by Kinetrol Ltd., Trading Estate, Farnham, Surrey, the use of a photo-transistor followed by a transistor a.c. amplifier ensures that the device operates only with light interrupted within a specified range of frequency; it cannot be triggered by steady light or even by headlamps switched on and off by hand. The high-speed chopped light source necessary to actuate the mechanism is provided by a rotating shutter driven by a small d.c. motor incorporated in the transparent plastic lens of a small spot light mounted on the front of the car and controlled from the dashboard.

The photo-transistor is housed in a black moulding about 1 inch in diameter, screwed to the garage door frame. Saturation by ambient light is avoided by restricting the aperture of exposure. The alternating component resulting from illumination by the car's special lamp is amplified, rectified and applied to a P.O.-type relay with mains contacts which energizes a solenoid and releases the bolt latch. The doors, which are spring loaded, then open at constant speed under the control of a linear damping device.

We have had an opportunity of examining one of these installations, which operated reliably under daylight conditions at a distance of 20ft or less and seemed to us to be soundly designed and made.

The complete installation costs £39 10s.

## CLUB NEWS

**Birmingham.**—John Savage, director of engineering of Collins Radio Company of England, is to give a lecture-demonstration on the new Collins series of s.s.b. equipment at the meeting of the Slade Radio Society on June 17th at 7.45 at The Church House, High Street, Erdington. Admission is by ticket only obtainable from the secretary, C. N. Smart, 110, Woolmore Road, Erdington. The subject to be discussed at the June 3rd meeting is entitled "Technical problems in sound and vision."

**Bristol.**—The third mobile rally to be organized by the Bristol Group of the Radio Society of Great Britain will be held on June 26th at Longleat House, near Warminster, Wilts. Details of the day's programme are obtainable from the secretary, D. F. Davies (G3RQ), 51, Theresa Avenue, Bishopston, Bristol, 7.

**Mitcham** & District Radio Society, which meets every Friday at 8.0 at The Canons, Madeira Road, now has four slow-morse tapes available for loan to members.

**Prestatyn.**—At the June 6th meeting of the Flintshire Radio Society, J. Thornton Lawrence (GW3JGA), secretary of the society, will give a talk on audio amplifiers. The meeting will be held at 7.30 at the Railway Hotel.

# RANDOM RADIATIONS

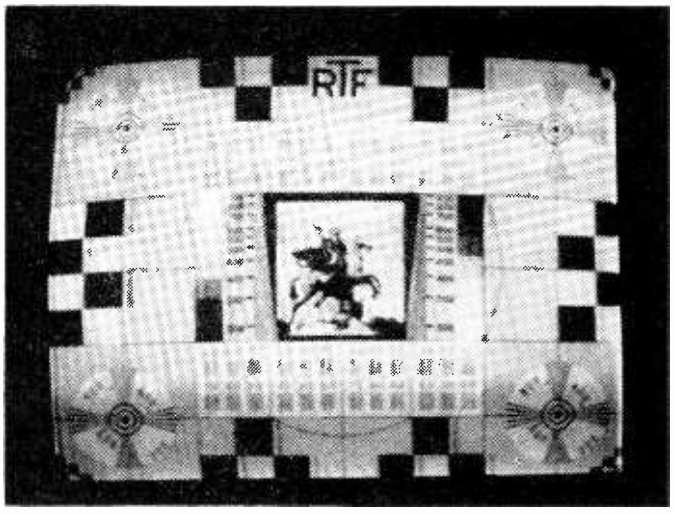
By "DIALLIST"

## "Things Great and Small"

THE National Bureau of Standards and the International Committee on Weights and Measures of the U.S.A., have, I see, approved for general use four numerical prefixes which have been used for some time in Europe. They are tera (symbol T) = $10^{12}$, giga (G) = $10^{9}$, nano (n) = $10^{-9}$, and pico (p) = $10^{-12}$. Their adoption is most welcome, for it should help to clear up the confusion which terms such as billion ($10^{12}$ with us, $10^{9}$ with the Americans) and trillion ($10^{18}$ and $10^{12}$ respectively) have long been causing. I do think, however, that the names might have been more happily chosen. In the metric system the terms are based on Greek and Latin numerals; Greek as you go up from unity (deca-, hecto-, kilo-, etc.) and Latin as you go down (deci-, centi-, milli-, etc.) though there's a slip-up over micro-. The system worked splendidly until vey in fact vague suggestions of the enormous, gigantic, the dwarfish and the tiny. I can't see why terms such as hectomega ($10^{8}$), kilomega ($10^{9}$) and megamega ($10^{12}$) shouldn't have been chosen, with symbols hM, kM and MM, for the big numbers. As micro and micromicro have already made their Greek appearances among the tinies why not millimicro (m$\mu$) for $10^{-9}$? These prefixes would anyhow show definitely what they mean without any sort of vagueness.

## 819-line DX

FROM a Harrow, Middlesex, reader comes a most interesting account of a deliberate attempt made to receive French television programmes here. That it was a success you'll gather from the accompanying photograph of the R.T.F. test card on his screen. His firm, he writes, when faced with some knotty problems brought about by their expanding export market,




words for very large numbers had to be found.

## Could be Better

The trouble is that neither the Greeks nor the Romans had any definite single words for quantities above 1,000 or for very small quantities. Hence names for the enormous and extremely minute numbers in use today had to be invented. The four prefixes in question aren't very good inventions because they don't suggest anything definite; they con-

decided to try to obtain direct reception from Lille. A modified British television receiver was used, with an 11-element Yagi mounted on the factory roof some 260-feet above sea level. I congratulate my correspondent most heartily and I hope that his success will induce others to try their hands at long-distance TV reception. In the U.S.A. and Canada it's quite a popular hobby—but the would-be DX-er is more luckily placed as all north American stations use the same standards.

## Medium Waves Too

MY recent note on long-distance v.h.f. reception has also brought forth a letter from an enthusiastic night-owl reminding me that there are still those who are interested in long-distance medium-wave reception. Time was when there was no more enthusiastic night prowler on this band than myself and this sort of reception as a hobby is most rewarding in the way of thrills. I recall, for example, hearing a mysterious heterodyne on a German station at about 9.30 p.m. one winter's night. I left the tuning as it was and switched off, for I'd an idea about that heterodyne. At 2 a.m. or thereabouts, I switched on again and there almost on the same frequency was an American station. There can't be much doubt that its carrier had caused the heterodyne on Hamburg. If any readers who haven't gone in for this kind of exploration care to try it out on a good night, I'm sure they'll be rewarded. There is, of course, the Medium-Wave Circle, which publishes its own duplicated monthly newsletter "Medium Wave News." The January issue had a 6-page supplement of western hemisphere m.w. stations logged in the U.K. since 1951.

## Entertainment by Line

THOUGH, as stated in the May *Wireless World*, the relaying of broadcast programmes by wire is nearly as old as broadcasting itself (relaying started in 1927 and broadcasting in 1922) there was in London and possibly in some other cities a wired entertainment service long before that. It was run by a company called, I think, Electrophone, Ltd. and I first came across it when shortly after the end of the first war (possibly in 1919) I was invited as a youngster to stay with some friends of my father's in London. To make use of the service you had to be on the G.P.O. telephone and to subscribe to Electrophone, or whatever its name was. This company paid half a dozen theatres and other places of entertainment, fees for the right to relay their entire programmes for a week or more. The subscriber's home was provided with a small square-topped table, at each side of which hung a set of ear-

phones. You consulted the list for the current week supplied by the company, then called exchange and asked to be connected to the theatre of your choice. That done you turned a switch which connected the telephone wires to a small distributor box on the table. Four people could then listen to their hearts' content. There was, I recall, an arrangement, whereby, should a call come through for you, the operator at the exchange could break in and inform you. You then switched back to the telephone and took the call, returning when it was finished to the theatre.

## *V.H.F./F.M. Goes Ahead*

WITH the opening of the Orkney v.h.f. sound transmitter on May 2nd, the B.B.C. completed one of the last stages necessary for full country-wide coverage by its three-programme network. Just how wise the B.B.C. was after the war in deciding to plump for v.h.f. for sound broadcasting is very clear to those who live near the south and east coasts and in other places where heterodyning, sideband splutter, and even virtual jamming too often occur on the medium and long waves. One's experience in East Anglia, for instance, is that with a moderately good receiver no station is of much use on the long waves except at odd times. On the medium waves the only B.B.C. programme fairly well received is the Home. Turning to v.h.f. is like going into another world—no interference, no fading, and always clear steady Home, Light or Network Three signals.

## *Electron Welding and Cutting*

THE electron has long proved itself a useful ally when harnessed by the ingenuity of man to perform tasks for him. We're all familiar with its work in the valve and the c.r. tube. But recently new applications have been found for sharply focused, high-velocity electron beams. Two firms, in W. Germany and Switzerland, have, it is reported, developed methods of electron-beam welding for use on metals ordinarily very difficult to join satisfactorily. A similar beam is being used successfully for drilling tiny holes in metals and for cutting slots in steel plates up to one fiftieth of an inch in thickness. The metal pieces that can be welded, drilled or cut must, one imagines, be very small, for an electron-beam can't be sharply focused except in a vacuum chamber.

# UNBIASED

By FREE GRID

## *Audio Fair*

THE most obvious new thing at this year's Audio Fair was the presence of stereo tape recorders whereby you could make your own stereo recordings as well as play commercial tapes. Last year there was one such instrument shown but it was a prototype and not actually on sale.

Stereo tape recorders have, of course, been with us for some years but only very expensive super ones not normally intended for home recording.

There is one thing about these new instruments which was not stressed and which I think ought to have been, as several non-technical people to whom I spoke were under quite a false impression about the instruments. They imagined that by using one of them they would be able to "bottle" their favourite broadcast programmes *stereophonically*.

I had quite an argument with some people about it who imagined that it was only necessary to stand the two mikes in suitable positions in front of their sets or to take two feeds from the set to the "radio" input of the recorder. I explained that this would be quite impossible until the B.B.C. starts regular stereo broadcasting.

All this made me rather wonder if the new machines will be used as *recorders* for few people nowadays make their own music at home, although those that do will, of course, be able to record it stereophonically. Also, it will be possible for them to record the amateur theatrical performances in the village hall.

There was also one complete stereo machine which operated at the two speeds of $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s. I know that there are some commercial tapes recorded at $3\frac{3}{4}$ i.p.s., but most of them are $7\frac{1}{2}$ i.p.s. I think that if I were paying 89 guineas—the price of this recorder—I should expect to have the $7\frac{1}{2}$ i.p.s. speed. It would, in fact, seem to me to be rather a waste of money to buy a stereo machine at all if I could not have this "hi-fi" speed.

The Fair seemed as crowded as ever on the day I visited it. I understand the total attendance was approximately 32,000.

All the demonstrations at the Fair were as good, or bad, as might be expected when a couple of dozen perspiring people are packed in an hotel bedroom. But quite frankly I don't see what the industry can do about it short of building an exhibition centre incorporating demonstration halls.

The stereo demonstrations did, however, make me realize that listening conditions in the average home leave much to be desired. My suggestion is that the garages in new houses should be built primarily as listening rooms with soundproof walls and built-in loudspeakers. Then, when it is desired to do some serious listening, the family limousine could be backed out and some chairs taken in.

My suggestion is primarily made because of the terrific volume which, judging by the demonstrations, it is necessary to have nowadays. The neighbours simply would not stand for it. The size and shape of the garage would also enable domestic listeners to sit far enough back from the loudspeaker to get a proper perspective of sound if that is the correct expression to use; more especially for stereo listening.

## *Fiat Lux*

IN the May issue, "Cathode Ray" tells us that he has forgotten the reason why a complete turning of an angle—or in other words a circle—is divided into 360 degrees. So have I, but I believe I am right in saying that the 60-cycle a.c. frequency in the U.S.A. is based on it. If so, maybe some American reader can lighten our darkness.

## *Bridal Larinometry*

WE have all heard that "gentlemen prefer blondes" but this obviously cannot refer to Africa where blondes are conspicuous by their absence; at any rate among the native population. But even there men have their preferences, and it is a matter of common knowledge that among certain tribes "gentlemen prefer fat girls," in fact for a really outstanding specimen a father can command a price of many head of cattle from his would-be son-in-law.

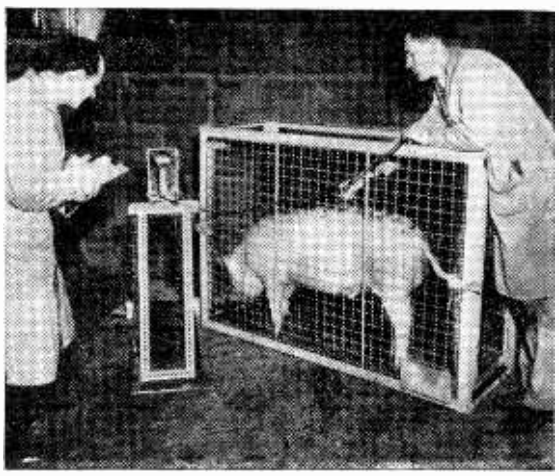
Hitherto a prospective African bridegroom has had to use the necessarily rather crude method of visual inspection when deciding whether one girl was fatter than another. But science has changed all that, as I have been reading in *Pulse*, the bulletin of technical development published by Kelvin & Hughes. An ultrasonic flaw detector is now being used to measure with great accuracy the thickness of body fat. It is true that the technique has not been developed specifically for the African marriage market, but for measuring the thickness of fat on a pig's back, such thickness being, strangely enough, important also in the porcine marriage market.

For this purpose, ultrasonic waves at a predetermined frequency of between 0.5 and 5 Mc/s are transmitted through the fat, and are reflected back at the boundary between the backfat and the lean muscular tissue. The time taken depends on various factors including the thickness of the fat. The measurement is read directly on the graduated scale of a cathode-ray tube.

This technique has, so it is said, already been used to obtain a "photograph" of a man's back muscles and vertebræ, and it is obviously but a step to apply it to performing a similar service in the fatty areas of a female African matrimonial candidate. One can visualize the live-wire salesmen of the firm hastily packing their bags and their portable larinometers.

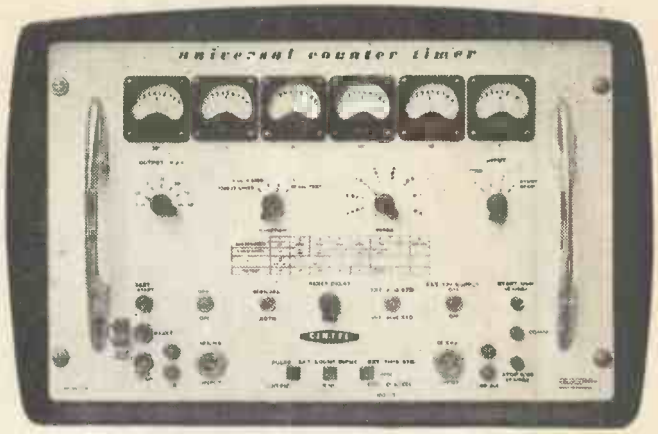
It won't be long before a prospective African bridegroom will be able to demand the production of an ultrasonic chart by any girl offered to him; and double-crossing fathers-in-law will no longer be able to practise any Laban-like tricks in getting rid of their less attractive daughters.

It is obvious that there are many other uses for this fat-measuring set-up, not the least being to let the surgeon know exactly the amount of fat he has got to cut through before he reaches the seat of the trouble.



*An unusual use for a Kelvin Hughes flaw detector.*

# Transistorized UNIVERSAL COUNTER TIMER

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3 *Attenuator* **balanced or unbalanced**
*range* 65*dB in* 1*dB steps*

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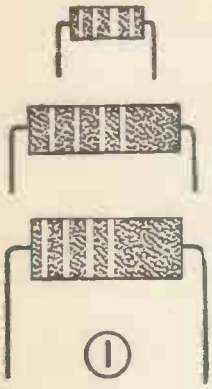


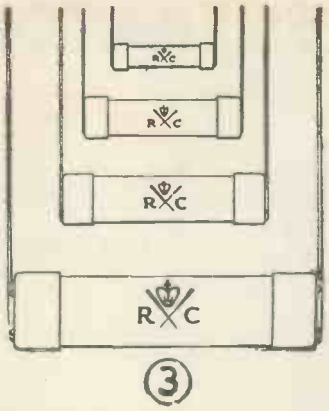


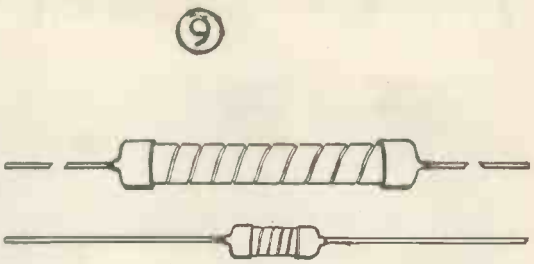



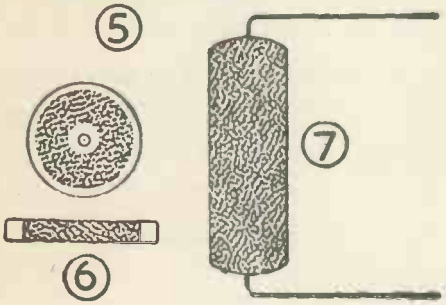


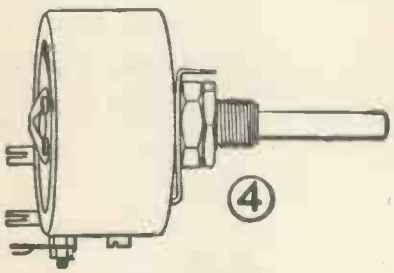


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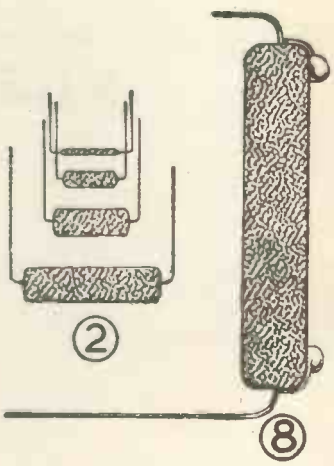


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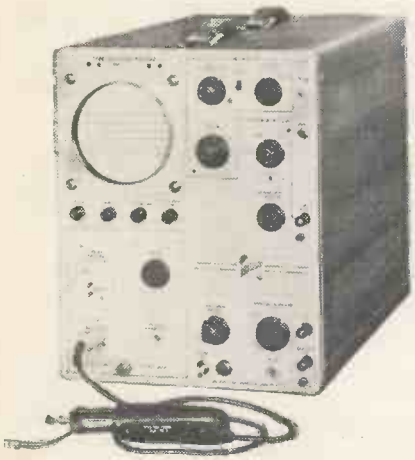

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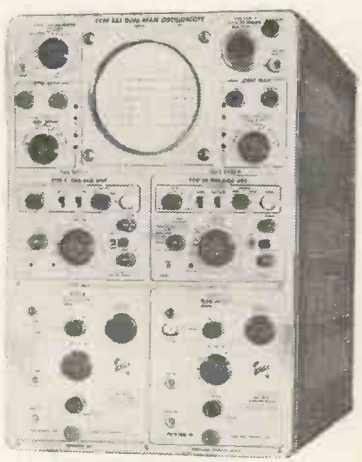
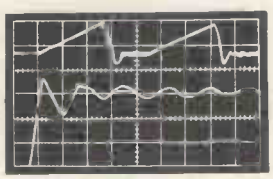
### *NEW* DC to 30 MC

### Dual - Beam Oscilloscope

**Type 555.**



Two electron beams, each with its own X and Y deflection systems, help make possible a highly versatile dual-beam oscilloscope. Either of the two time-base generators in the Type 555 can deflect either beam for dual and single displays, and either can deflect both beams for a dual display on the same time base. Time-base units are the plug-in type to facilitate instrument maintenance and the sweep speed is variable between 0.02 $\mu$sec/cm and 12 sec/cm. This new oscilloscope will accept the standard range of plug-in pre-amplifiers.



Same signal displayed simultaneously on slow sweep (upper beam) and fast sweep (lower beam) shows both coarse and fine structure of waveform. Delay range—0.5 $\mu$sec. to 50 secs.

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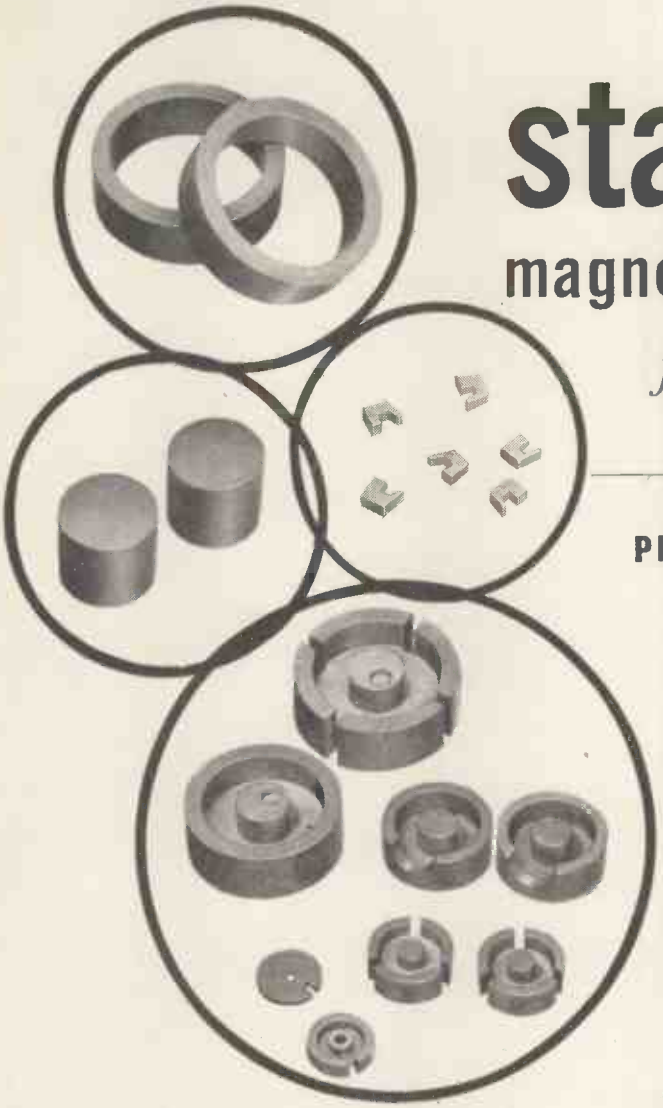

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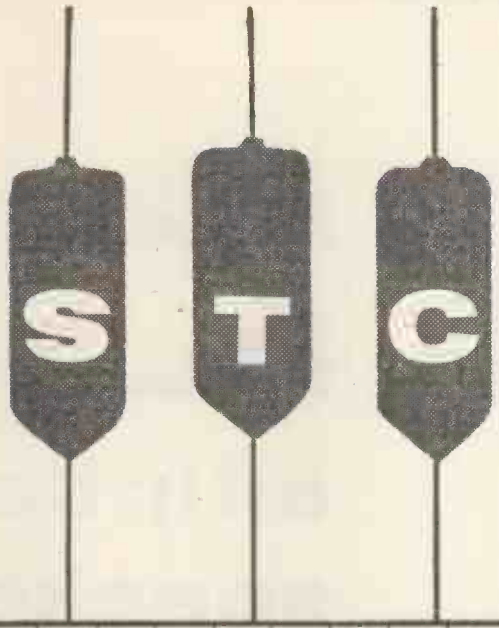


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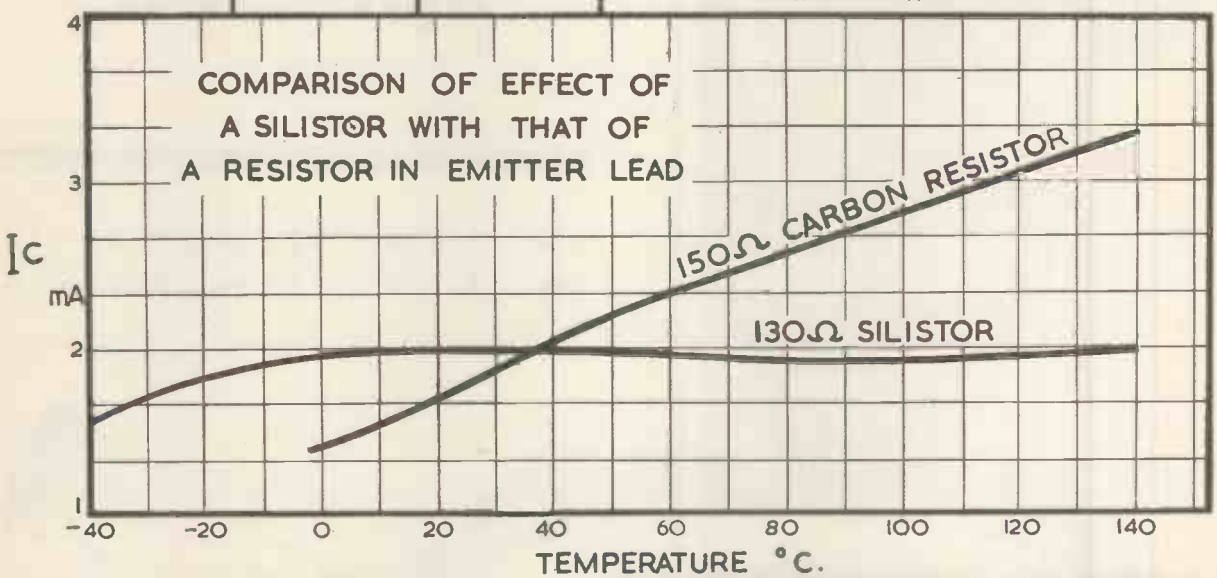




*Data sheets and further information gladly sent on request.*

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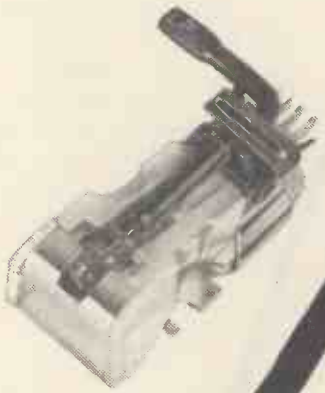

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|---|---|---|---|---|---|---|---|---|---|---|
| $V_{a1}$ ..... (kV) | 0.5 | 1.0 | 1.5 | 2.0 | 1.5 | 1.4 | 2.0 | 4.0 | 1.5 | 1.5 |
| $V_{a3}$ ..... (kV) | 0.5 | 1.0 | 1.5 | 2.0 | 1.5 | 1.8 | 2.0 | 4.0 | 4.0 | 1.5 |
| $V_{a4}$ ..... (kV) | — | — | — | 4.0 | 3.0 | 4.0 | 4.0 | 8.0 | 8.0 | 15 |
| $V_{a5}$ ..... (kV) | — | — | — | — | — | 10 | — | — | — | 15 |
| Y scan ..... (mm) | 28 | 55 | 70 | 80 | 75 | 60 | 95 | 95 | 95 | 60 |
| Y sensitivity .. (V/cm) | 45 | 11.5 | 16 | 23 | 27 | 12.5 | 17.5 | 36 | 36 | 2.7 |
| X scan ..... (mm) | 28 | 55 | 90 | 90 | 90 | 95 | 115 | 115 | 115 | 100 |
| X sensitivity .. (V/cm) | 53 | 20 | 23 | 36 | 27 | 26.5 | 29 | 60 | 60 | 11.2 |
| Screen diameter (mm) | 30 | 71 | 94 | 108 | 108 | 137 | 137 | 137 | 137 | 137 |
| **SCREEN TYPES:** | | | | | | | | | | |
| Medium persistence .. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
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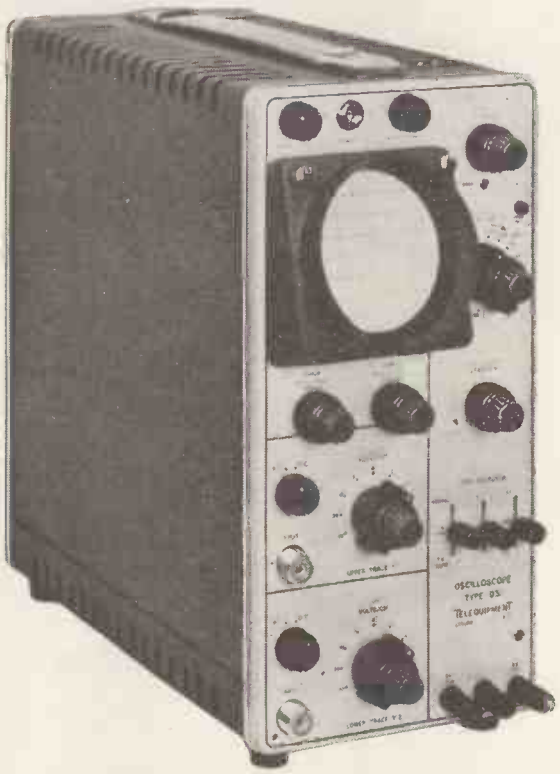
**I.E.A. EXHIBITION**

**D 3 1** double beam Serviscope . . . a logical development of the original, highly successful S.31 single beam Serviscope. Though weighing only 26 lbs. in its rugged steel case, the D.31 has capabilities greater than many more elaborate instruments, plus many improved features which make for wider application, more accurate measurements and simpler operation.



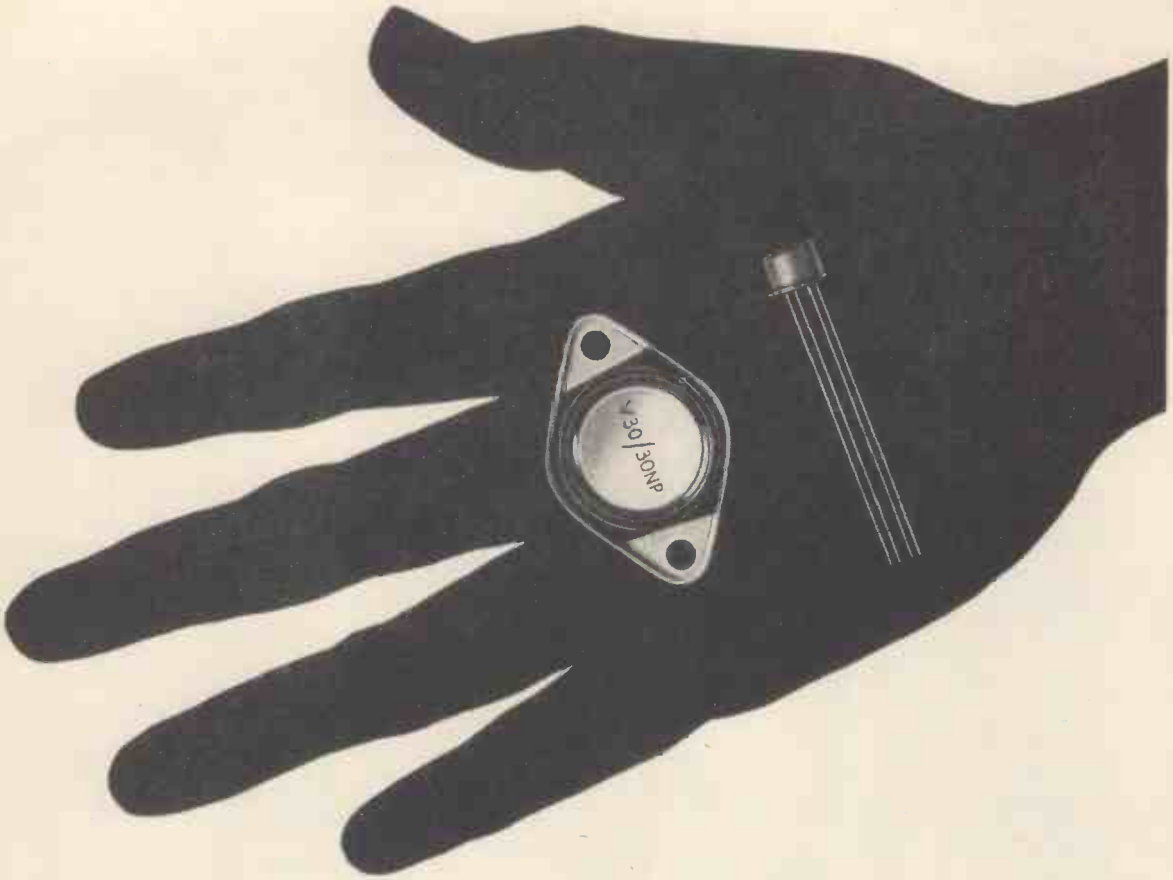
D.C. amplifiers and slow speed time base (down to 5 sec/cm if necessary) are eminently suitable for servo work and similar applications. Fast rise time (.06 μsec) and high writing speed (10 cm/μsec at maximum expansion) are essential for any work dealing with fast pulses or TV waveforms. The unique triggering arrangements enable complex waveforms to be examined in detail with complete accuracy of synchronisation. At this moment D.31 is in use in the diverse fields of computer development and servicing, radar equipment, telemetering applications, closed circuit and broadcast TV, automatic telephone equipment—in fact in any field where a double beam oscilloscope is essential.

*The D.31 costs £95*

**See the D.31 double beam 'Serviscope' on stand S853 at the IEA Exhibition.**

**TELEQUIPMENT**

TELEQUIPMENT LTD., 313 Chase Road, Southgate, London, N.14. *Telephone: FOX LANE 1166*




# Which of these could solve your problem?

Newmarket Transistors Limited have added the following transistors to their range:

## The new Noodle Transistor

(V15/15NP V15/30NP V30/15NP V30/30NP)

1. Amplifies at 10 amps.
2. American diamond construction interchangeability.
3. No fixing screw problems.
4. Cold welded case for increased reliability.
5. Higher frequency operation.

## VHF Drift Transistor (V15/20R)

1. Oscillates up to 100 Mc/s.
2. Amplifies up to 20 Mc/s.
3. Jedec 30 case.
4. Higher operating voltage.

## Fast Switching Transistors

(V10/1S V10/2S)

1. Phenomenal peak current performance—will switch 1 amp. peak.
2. Fifty Milli-microseconds risetime.
3. 20V collector rating.
4. British standard cylindrical construction.
5. Cold welded case for increased reliability.

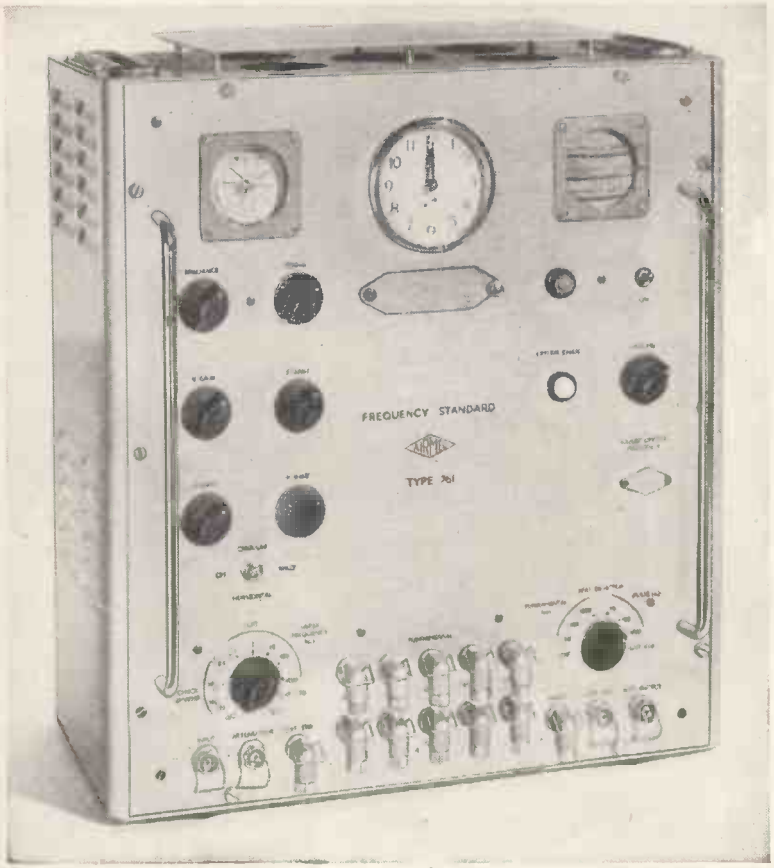

*Ask for copy of our booklet "Semiconductor Device Data" if you do not already have one.*

**NEWMARKET TRANSISTORS**

**Newmarket Transistors Limited**

Exning Road, Newmarket, Suffolk.

*Tel: Newmarket 3381/4 Cables: Semicon Newmarket.*




AIRMEC

# FREQUENCY STANDARD

**TYPE 761**

## FUNCTION

Provides an excellent crystal controlled frequency and time standard of small size and moderate cost. The short term frequency stability of better than 1 part in $10^6$ obtainable upon installation improves with time and correct treatment up to a working stability approaching 1 part in $10^7$.

## OPERATION

*Sinusoidal and pulse signals are produced at five standard frequencies, the pulse waveform being rich in harmonics. The instrument includes both an Oscilloscope and Heterodyning Circuit as independent facilities and is therefore extremely flexible in operation.*

## FEATURES

- **100 kc/s crystal housed in an oven controlled at 70°C.**
- **Standard signals provided at 100 c/s, 1 kc/s, 10 kc/s, 100 kc/s, and 1 Mc/s.**
- **Identification of an unknown signal by Lissajous figure or beam modulated circular trace.**
- **Beat output available from a plug on the front panel.**
- **Suitable for rack mounting.**

**IMMEDIATE DELIVERY**

in instrumentation . . .

Airmec

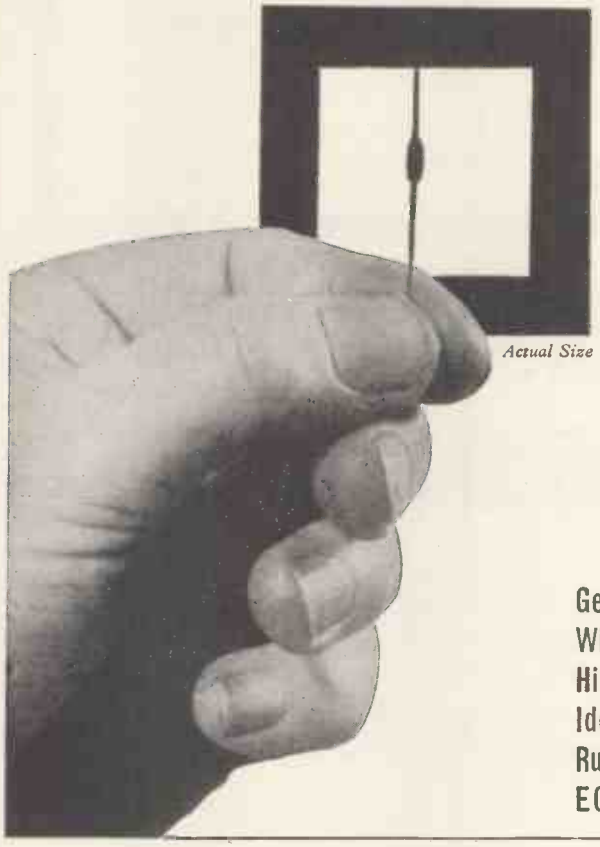
makes most things . . . better

AIRMEC LIMITED

HIGH WYCOMBE · BUCKS

*Telephone: High Wycombe 2501/7*

# one of the world's smallest



*Actual Size*

# SILICON DIODES MULLARD OA202

**Generously rated**
**Wide temperature range**
**High back resistance**
**Ideal for automatic wiring**
**Rugged construction**
**ECONOMICALLY PRICED**

Despite its extremely small size, the Mullard Silicon Junction Diode OA202 will handle peak currents of up to 250 mA at 25°C. Apart from other favourable electrical and mechanical characteristics, the OA202 is distinguished by its cost which is kept at the lowest possible level by very large scale production.

This all-glass diode is hermetically sealed and really is a rugged device. It is made in exactly the same way as the Government Type Approved CV7040, whose rigorous specification includes temperature cycling, climatic cycling, fatigue and shock tests, 1000 hour life tests and high temperature storage.

*Brief electrical data is given below. For further information please contact Mullard House.*

ABRIDGED DATA (AT 25°C UNLESS OTHERWISE STATED)

| | |
|---|---|
| Max. peak inverse voltage | 150 V |
| Max. peak forward current | 250 mA |
| Max. d.c. forward current | 160 mA |
| *Average forward current (sinusoidal input with resistive load) | 80 mA |
| Typical forward voltage drop at 30 mA | 0.9 V |
| Inverse current at −150 volts: | |
| Maximum at 25°C | 0.1 μA |
| Maximum at 125°C | 10 μA |
| Ambient temperature range | −55 to +125°C |

**Max. averaging time 50 millisecs.*

(An alternative type, OA200, is available for lower voltage applications.)

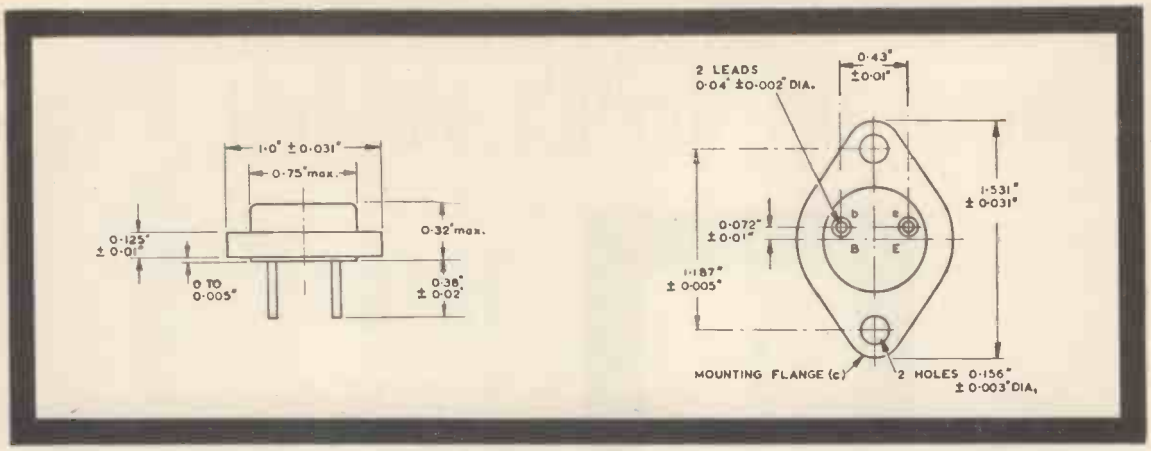
**See Mullard Semiconductor Devices on Stand M559 at the INSTRUMENTS, ELECTRONICS AND AUTOMATION EXHIBITION**

**MULLARD LIMITED · SEMICONDUCTOR DIVISION**
**MULLARD HOUSE · TORRINGTON PLACE · LONDON · WC1**
**TELEPHONE: LANGHAM 6633**

**Mullard**
industrial semiconductors

SILICON

MIS 142




# POWER TRANSISTORS TYPES XC155 and XC156

These germanium p-n-p alloy transistors are intended for power switching, voltage regulator, convertor and other heavy duty industrial applications. Full particulars of these and other Ediswan Mazda semiconductor devices will be sent gladly on request If you wish to keep up to date with the latest developments in this field, please ask us to add your name to our semiconductor mailing list.

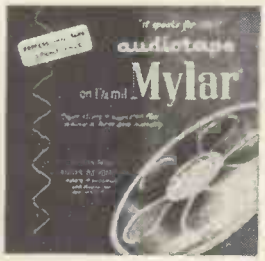
| **Maximum Ratings (Absolute Values)** | | **XC155** | **XC156** |
|---|---|---|---|
| Peak collector to base voltage (volts) | | −80 | −100 |
| Peak collector to emitter voltage, base open circuit (volts) | | −50 | − 65 |
| Peak collector to emitter voltage, base and emitter joined or with an external base/emitter circuit resistance less than 40 ohms (volts) | | −65 | − 80 |
| Peak emitter to base voltage (volts) | | −60 | − 60 |
| Peak collector current (amps) | | −10 | − 10 |
| D.C. Collector current (amps) | | − 5 | − 5 |
| Collector dissipation (mounting flange temperature 85°C) (watts) | | 10 | 10 |
| **Switching Characteristics (Common Emitter)** (*Typical production spreads*) | | | |
| D.C. Current gain ($V_{ce}$ = −1.5V, $I_c$ = −4A) | minimum | 20 | 20 |
| | average | 26 | 26 |
| | maximum | 50 | 50 |
| D.C. Collector to emitter saturation voltage ($I_c$ = −4A, d.c. $I_b$ = −400 mA) (volts) | average | −0·4 | −0·4 |
| | maximum | −0·8 | −0·8 |

**EDISWAN** SEMICONDUCTORS
MAZDA

**Associated Electrical Industries Ltd**
Radio and Electronic Components Division
PD 15, 155 Charing Cross Road, London, W.C.2
Tel: GERrard 8660 Telegrams: Sieswan Westcent London
CRC 15/59

# Sensational Success of audiotape

TRADE MARK






Tape Recording experts and enthusiasts all over the country are changing to AUDIOTAPE for its flawless perfection of sound reproduction over the entire audio range and its **consistent, uniform quality** from reel to reel

Available on all standard reel sizes, there are eight different types to meet every recording requirement . . . AUDIOTAPE, manufactured in the U.S.A. by Audio Devices Inc., **gives you the truest sound your recording equipment can produce—try AUDIOTAPE** . . . it speaks for itself.

*sensational C–SLOT REEL!*

All 5in. and 7in. reels of AUDIOTAPE are supplied on the exclusive C-slot Reel—the fastest-threading tape reel ever developed The tape end, dropped into a slot in the hub anchors itself automatically at the first turn of the reel.

ELPICO *A NAME FOR BETTER PERFORMANCE*

*Concessionaires to the United Kingdom.*

**LEE PRODUCTS (G.B.) LIMITED, "Elpico House," Longford Street, London, N.W.1**

Telephone: EUSton 5754 (all lines). Telegrams: Leprod, London.

# 2·3 kW channelised transmitter

The versatility and reliability of this new, tropicalised Mullard transmitter make it eminently suitable for h.f. en-route, ground-to-air services and point-to-point communication networks. The GFT.560/2 is of unit construction and consists of three basic cabinets — r.f. unit, modulator unit and power supply units — which can be used in combination for multi-frequency working and a number of types of emission. There are ancillary units available that permit remote control of the transmitter over telephone circuits.

Frequency Range 1.5 to 30 Mc/s.
Frequency Stability to Atlantic City 1947 standards.
Power Output 3kW. c.w., 2kW m.c.w. or r/t.
Types of Emission c.w., m.c.w., telephony, frequency shift (with external keying unit), A1, A2, A3, F1.
Output Impedance 600 ohms balanced.
Power Supply 400V, 50-60 c/s 3-phase.

A PRODUCT OF
**MULLARD EQUIPMENT LIMITED**
A COMPANY OF THE MULLARD GROUP

MULLARD LIMITED
Mullard House, Torrington Place,
London · W.C.1

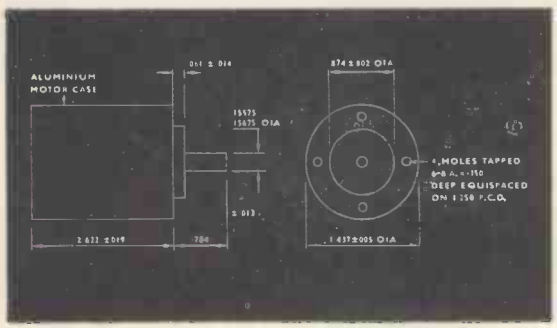
ME592a

# A NEW EMI HIGH TORQUE BATTERY MOTOR

*Illustration actual size*

## Provisional Technical Specification

| | |
|---|---|
| Voltage Range: | 8v to 12v D.C. |
| Current: | No load 120mA max. 8-12v<br>At 45 gcms 310mA max. 8-12v |
| Rotation: | Anticlockwise viewed from spindle end. |
| Speed and Output: | Max. continuous rating. |
| | 2440-2500 r.p.m. at 45 grm. cms. torque at 12v DC +0v |
| | 2390 r.p.m. minimum at 45 grm. cms. torque at 8v DC —0v |
| | Speed regulation over governed range at constant voltage 0.75 r.p.m. per grm. cm. torque. |
| | Speed regulation over governed range at constant torque 12·5 r.p.m. per volt D.C. Max. |
| | No load ungoverned 12v<br>No load governed 8v |
| | Minimum torque at governed speed 15 grm. cm. at 12 v DC. |




### *For Professional and Scientific Applications*

Designed primarily for Professional Tape Recorders this new EMI Battery Motor (part no. 98170D) is also suitable for Television camera remote control, and for medical and other scientific uses. A high-grade precision-built Motor for long life and exceptional speed regulation over a wide range of load and voltage. A Multi-pole Armature gives low electrical interference, long brush life and high efficiency and a Ball Race bearing is incorporated for handling heavy duty side loads.

*EMI also manufacture a wide range of inexpensive battery motors suitable for Domestic Tape Recorders, Gramophones, Fans and a host of other applications where a governed torque of up to 10 gm. cm. at 1600 r.p.m. or 2600 r.p.m. is required.*

**THE GRAMOPHONE COMPANY LIMITED**
*(Components Division)*
**Hayes · Middlesex · England**
**SOUTHALL 2468 · EXT. 635**
gdcl4 *(One of the EMI Group of Companies)*

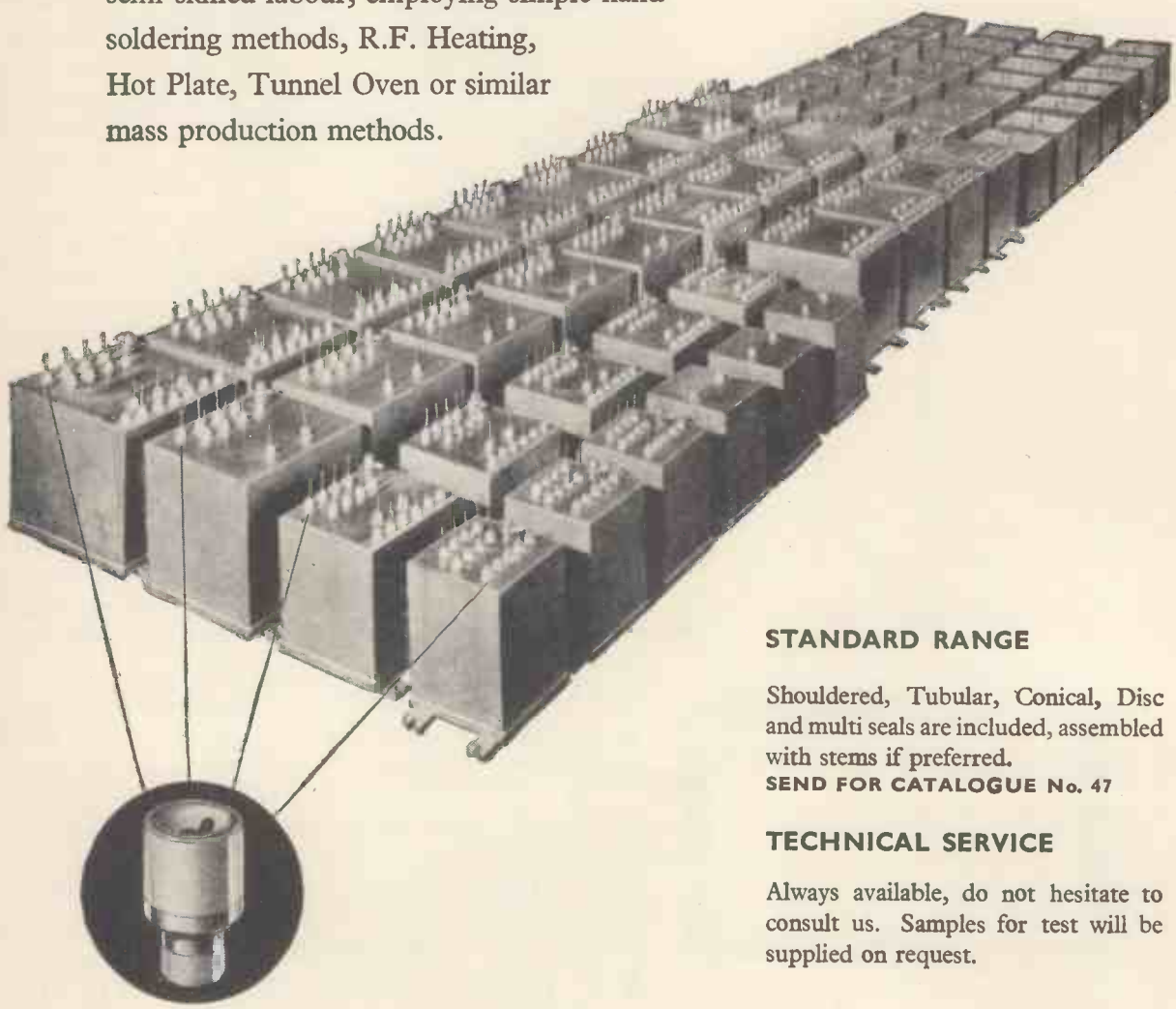
# Hermetic Sealing

**STEATITE & PORCELAIN**
**NICKEL METALLISING**
Quality Approved (Joint Service R.C.S.C.)
**WILL MEET THE MOST EXACTING REQUIREMENTS**

**METALLISED BUSHES**

# Perfect Terminations

—made readily without special precautions by semi-skilled labour, employing simple hand soldering methods, R.F. Heating, Hot Plate, Tunnel Oven or similar mass production methods.



**STANDARD RANGE**

Shouldered, Tubular, Conical, Disc and multi seals are included, assembled with stems if preferred.
**SEND FOR CATALOGUE No. 47**

**TECHNICAL SERVICE**

Always available, do not hesitate to consult us. Samples for test will be supplied on request.

## STEATITE & PORCELAIN PRODUCTS LTD.

**STOURPORT ON SEVERN, WORCS.** **Telephone: Stourport 2271** **Telegrams: Steatain, Stourport**

SP100


**regular type**

*Used alone as a load-carrying nut on light duty assemblies, or used on top of ordinary nuts on high stress assemblies*


**acorn type**

*Smooth dome shape covers up unsightly rough bolt ends for attractiveness and protection against scratching*


**adjusting type**

*Used as a lock nut when seated, or as an adjusting nut or stop nut anywhere on threads*

**wing type**

*Combines locking principle of Dotlocs with ease of finger tightening and removal*


**tension nuts**

*Holds adjusting screws to desired setting. For ease of assembly and simple adjustments*

**washer type**

*Incorporates grounding base and seal against water and dust*

# Improve production with DOTLOC REDUCE parts operations and COSTS!

DOTLOCS are single-thread precision-made locking nuts made of spring-tempered steel. A single DOTLOC replaces two, three or even four fastening parts.

The economy of handling one DOTLOC instead of many fasteners, simplifies not only assembly, but the whole ordering, stocking and accounting procedure.

**DESIGN & LOCKING PRINCIPLE**

**The thread engaging portion** is formed in true relation to the pitch of the screw thread. The inner contour is designed to provide maximum strength from a single-thread nut.

**Perfect hexagon shape,** straight sides, ample height for easy, speedy handling and wrenching.

**Save weight.** DOTLOCS save more than 65% of the weight of plain nuts, 80% of nut and lockwasher, 85% of nut, lockwasher and plain washer.

**Save space.** DOTLOCS require less space than many other fastenings. This is especially true where lockwashers and flat washers are eliminated.

**Interchangeable.** DOTLOCS are interchangeable with other commonly used locking devices and generally require no change in design.

**Withstand high temperatures.** Spring steel DOTLOCS are not affected by temperatures up to 400°F.

**Quick assembly.** Either the DOTLOC or the screw can be driven in the assembly procedure, whichever is more convenient.

**Locking action.** Safer for assembling fragile or brittle parts and materials. Resilient DOTLOC thread form permits firm but spring-cushioned pressure on assembled parts.

**CARR FASTENER COMPANY LIMITED**
**Stapleford, Nottingham.** Phone: Sandiacre 3085
LONDON:
195/197 Gt. Portland Street, London, W.1.
Langham 3253-5

*quick secure fastening at LOW COST with* **DOTLOC**

# A new Grommet development

## THE DOUBLE SEALING EMPIRE RUBBER GROMMET

**infinitely accommodating in use: considerably reduces range of sizes because the same grommet can be used with several plate thicknesses or cable sizes**

PAT. APP. No. 5255/59

This newly developed self-conforming grommet, because it is immediately self-locking against the elements, is the solution to many of an engineer's sealing problems.
Any one size will not only accommodate itself to a variety of mounting plate thicknesses, but (designed for cable or control rod) will take these in a variety of sizes and be weather-, water- and dust-proof at a variety of angles to the cable or rod.

Because of its capacity to conform to many varying requirements, it enables a workshop stock range of grommets to be reduced to perhaps one tenth of that at present maintained.

THE NEW BLIND GROMMET

FREE

Note how when sprung into position the grommet provides a perfect double seal by its own permanent pressures. The angled groove also creates a tight pressure hold on the metal plate.

THE NEW DESIGNED GROMMET

FREE


FITTED

In the cable grommet variety the same double pressure seal is created, allied to tight seal on various diameters of cable. This new grommet gives sound sealing at *all* vital points.

A useful feature of this cable grommet is that by reason of the designed taper of the cable entry and the flexibility of the web, a considerable angle of cable entry and a variety of cable size are possible. This avoids necessity for special grommets with angled bores.

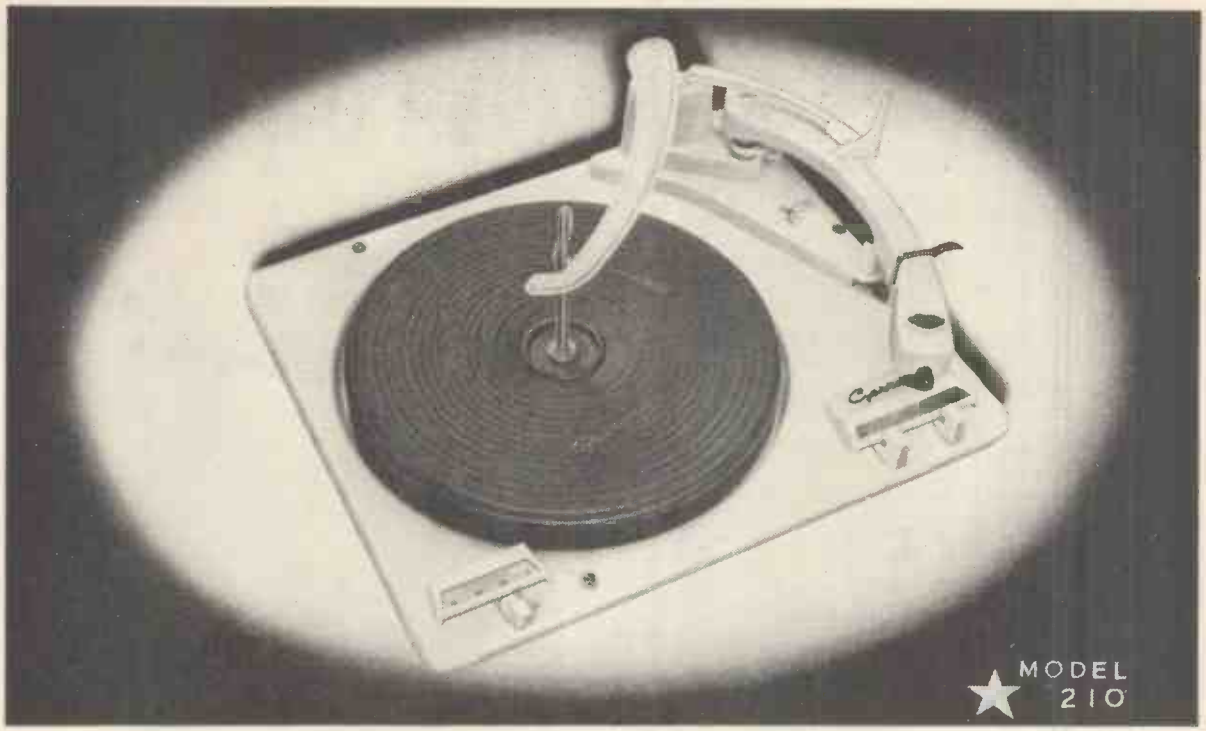
In the conventional grommet, only one thickness of plate and only one size of cable can be accommodated. No effective seal is afforded by the parallel groove.

Now being produced in a range of sizes
THESE GROMMETS WILL SOLVE YOUR SEALING PROBLEMS

ENQUIRE
*for catalogue section and detailed particulars.*

EMPIRE RUBBER COMPANY • DUNSTABLE • BEDFORDSHIRE • ENGLAND

R.B.101




# fit Garrard for Good....

**MODEL 4 HF**

A high quality single Record Player elegantly styled and carefully designed to provide maximum reliability with fidelity of reproduction. Fitted with TPA 12 Pick-Up Arm which allows records up to 16in. to be played.

**MODEL TA Mk. II**

A single Record Player particularly suitable for the home constructor. It is mounted on a rectangular unit plate. Voltage range 100/130 and 200/250 A.C. only. A model for battery operation is also available.

**And now the latest unit to bear the Garrard name—Model 210 Record Player and Automatic Record Changer. Elegantly styled to match in with modern equipment design. Produced with the same engineering skill that characterises everything in the Garrard range.**

★ **MODEL 210**

Plays any number of records up to eight, either 7in., 10in. or 12in. at 16 2/3, 33 1/3, 45 and 78 r.p.m. 10in. and 12in. of the same speed can be mixed in any order. May also be played manually.

**MODEL TPA 12**

Transcription Pick-Up Arm designed for monaural and stereophonic record reproduction. It is an instrument of the highest quality with its modern styling finished in Ivory, Chrome and Red. Fitted with M.P.M.4 Plug-in moulding which accepts most cartridges, it is the companion to the Model 301 Transcription Motor.

# ....and always

GARRARD ENGINEERING & MANUFACTURING CO. LTD.

Factory and Registered Office: NEWCASTLE STREET, SWINDON, WILTSHIRE

Telephone: SWINDON 5381 (5 lines) TELEX 44-271

GARRARD SWINDON TRADE MARK REG.

# COMPACT SPEAKER SYSTEMS
# with clean bass

In each of the models mentioned in this advertisement L.F. output is produced by a special 12in. unit type WLS/12 fitted with a heavy cone and a new type of suspension which permits large linear excursions and gives a low fundamental resonance of 25/30 c/s.

## W2

**A two-speaker model complete with treble volume control. Cabinet size 23½" x 14" x 12". Weight 42 lb. complete. Impedance 15 ohms. Max. input 15 watts. Price £29.10.0 complete, tax free.**

## W3

**A three-speaker system complete with mid-range and treble volume controls. Cabinet size 28" x 14" x 12". Weight 48 lb. complete. Impedance 15 ohms. Max. input 15 watts. Price £39.10.0 complete, tax free.**

## W4

**A four-speaker system complete with mid-range and treble volume controls. Cabinet size 35" x 24" x 12". Weight 65 lb. complete. Impedance 15 ohms. Max. input 15 watts. Price £49.10.0 complete, tax free.**

Each model is available in a choice of Walnut, Oak or Mahogany Veneers. Also available in Whitewood slightly cheaper. Tropical models with resin bonded plywood approximately £2 extra.

**Wharfedale**
**WIRELESS WORKS LTD**
**IDLE BRADFORD YORKS**

**Catalogue giving full technical details, response curves and oscillograms of the above models, available on request.**

Telephone: Idle 1235/6 Telegrams: 'Wharfdel' Idle, Bradford

# WHAT HAS THE **7182** **S BAND MAGNETRON** IN COMMON WITH THIS CAT?

A good question! According to legend, a cat has nine lives—something that has yet to be proved. The 7182, on the other hand, has a *proved* life 8 to 10 times greater than any similar S-Band Magnetron.

The 7182 retains its remarkable stability and reliability during a life of 10,000 hours, and is one of a series of Magnetrons now in production providing peak powers of 5MW. These Magnetrons operate at voltages and current densities usually associated with Magnetrons rated at a fraction of the power output.

A parallel development in L-Band ensures that attainments in this field equal the phenomenal successes already achieved with S-Band Magnetrons.

**'ENGLISH ELECTRIC'**
AGENTS THROUGHOUT THE WORLD

**ENGLISH ELECTRIC VALVE CO. LTD.** *CHELMSFORD, ENGLAND*
*Telephone : Chelmsford 3491*

*AP134*

LEEVERS RICH

# *Precision* is an outstanding feature of the Leevers-Rich magnetic recorder.

*MODEL ED-142K TWO-CHANNEL (STEREO) RECORDING CONSOLE*
*This recorder is also available in single-channel and in portable or rack-mounted versions. Other models include multi-channel recorders for ¼in. and 1 in. tapes.*

## Precision in Tape Motion

The Leevers-Rich capstan design includes a special mechanical filter of exceptional performance, giving a residual flutter and wow content of well under 0.15% r.m.s. at 7½in. per second and at all higher tape speeds. This is particularly important when the F.M. carrier system of recording is used, since any fluctuation of tape speed will appear as " noise " or variation of D.C. level.

## Precision in Tape Alignment

Special tape guides limit the lateral weave of tape to a figure which is difficult to detect by measurement. This reduces changes of amplitude due to skew or weave to a very low figure and enables the full performance of the best tapes now available to be realised in practice.

## Precision in Head Adjustment

Micrometer adjustments of the heads within their machined cavities in a solid dural head block unit ensure accuracy of setting and interchangeability of tapes and machines. Accuracy of alignment between the gaps of multi-track cluster heads ensures freedom from phase discrepancies even at the very shortest wavelengths.

## Precision in Mechanical Construction

Major units such as the head-block and capstan units may be removed individually for service, and replaced on their seatings without disturbing alignment.

Advanced design, fine workmanship and precision throughout make the Leevers-Rich " Analyst " recorders the first choice for high quality audio recording, and for all forms of data recording where high performance must be maintained for long periods of service.

# LEEVERS-RICH EQUIPMENT LTD.

78B Hampstead Road, London, N.W.1
Euston 1481

D

## ...a new company in the PYE GROUP

Pye has been responsible for carrying the idea of television across the globe and, today, Pye equipment is used by the television services of 28 countries. To deal with the ever-increasing world-wide demand for the Pye product, a new company has been formed— Pye T.V.T. Ltd. It will continue the work of the existing Television Transmission Division and expand its activities in the fields of industrial television, atomics and other forms of special-purpose closed circuit TV.

# PYE TVT Ltd

PYE TELEVISION TRANSMISSION LIMITED

PYE LIMITED OF CAMBRIDGE · ENGLAND

# SO YOU THINK

# COSSOR SPECIALISE ONLY

# IN OSCILLOSCOPES

## then study this fully screened signal generator 150 kc/s to 390 Mc/s for £21

This work-a-day Cossor Signal Generator gives a wider frequency range and higher accuracy than any other general purpose instrument of comparable price. The accuracy is ±1% up to 33 Mc/s and ±2% for higher frequencies. The signal is available modulated by the internal audio frequency oscillator or alternatively external modulation may be applied.

As befits a general purpose instrument, the Cossor Signal Generator is built of high grade materials so that it is durable and reliable under all conditions of service, and is easy to operate.

**See this and other Cossor instruments at Stand E212, I.E.A. Exhibition.**

*1045 Signal Generator Priced £21 . 0 . 0 U.K. only*

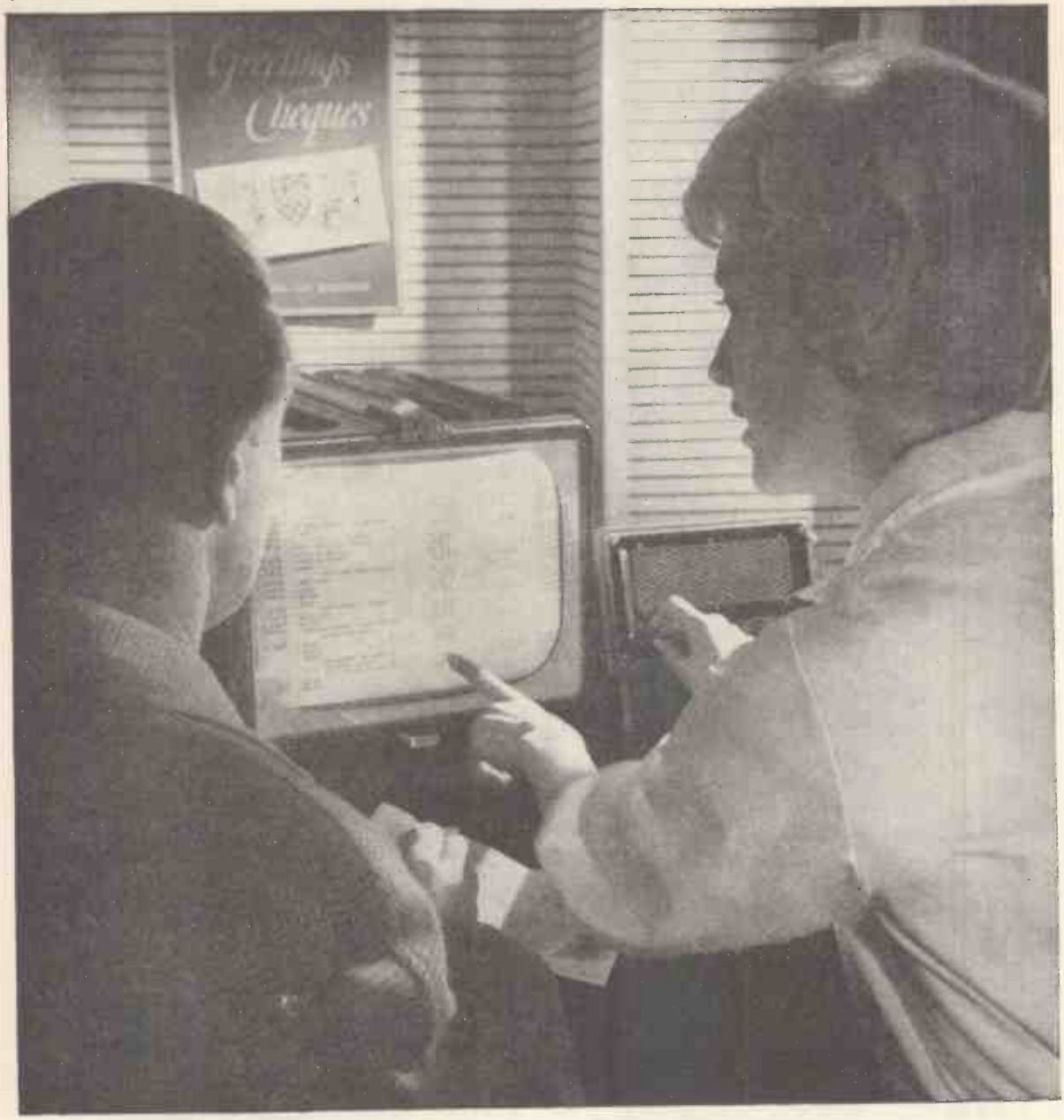
COSSOR INSTRUMENTS

## Cossor Instruments Ltd

COSSOR HOUSE. HIGHBURY GROVE, LONDON. N.5

Telephone: CANonbury 1234 (33 lines)

JSP 1045A




# Westminster Bank uses Pye Television

The Pye Industrial TV Division, a member of the Pye Instrument Group, has supplied all the television equipment to the Westminster Bank for the first inter-branch TV network. The new system which makes centralised book-keeping possible has been brought about by the closest co-operation with the GPO who have supplied Post Office lines to carry the signals. The illustration shows a customer checking his banking account.

*The Pye Instrument Group consists of: Pye Atomics Division, Pye Industrial Television Division, Faraday Electronic Instruments Ltd., Labgear Ltd., W. G. Pye & Co. Ltd., Pye Telecommunications Ltd., Unicam Instruments Ltd., W. Bryan Savage Ltd., W. Watson & Sons Ltd.*


# The Ferranti 3 DIGIT VOLTMETER Type D101

The need for instruments capable of measuring voltages with a high degree of accuracy and with a fast reading time has long been apparent. The Ferranti 3 digit voltmeter has been developed to meet this requirement. The advantages of this precision instrument will undoubtedly prove attractive to those engaged in the fields of automatic testing and monitoring, analogue to digital conversion, calibration of moving pointer instruments and many similar applications.

## Special Features

- **Automatic Ranging and Polarity**
- **High Accuracy and Resolution**
- **Fast Reading Time**
- **Complete Reliability**

## SPECIFICATION

| | |
|---|---|
| **Display** | Three digit plus automatic polarity indication and automatic decimal placement. |
| **Automatic Ranges** | D.C. Volts in 3 ranges<br>0.01 — 9.99 V<br>10.0 — 99.9 V<br>100V — 999 V |
| **Accuracy** | 0.1% of full scale reading on any range. |
| **Average Reading Time** | 0.7 seconds. |
| **Input Impedance at Balance** | 10 Megohms. |
| **Input** | 110 — 250V A.C.50—60 c/s 50W. |
| **Weight** | 50 lbs. approximately. |
| **Style** | Bench cabinet 17″ x 13″ x 10½″ high with optional brackets for standard rack mounting. |

*In view of continuing development, the right is reserved to alter the specification or design of this instrument.*

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**Brief Specification**

| | |
|---|---|
| Frequency Range | 6875—7425 Mc/s. |
| R.F. Power Output | 1 watt. Under favourable siting conditions a transmission distance of 50 miles or more can be obtained. |
| Vision Signal-to-Noise Ratio | 59dB (weighted) assuming standard 70dB path loss. |

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# Wireless World

ELECTRONICS, RADIO, TELEVISION

JUNE 1960





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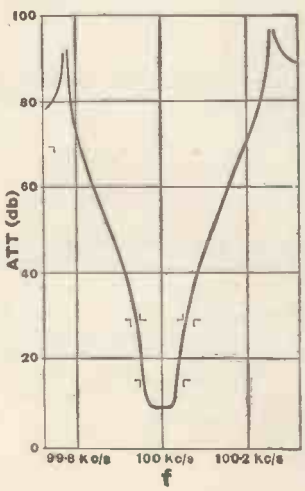


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# Aspects of design

This is the twenty third of a series of special features dealing with advanced problems in television and radio circuit design to be published by The Ediswan Mazda Applications Laboratory. We will be pleased to deal with any questions arising from this or other articles, the twenty fourth of which will appear in the July 1960 issue.

## 23 CLASS B TRANSISTOR OUTPUT STAGES (Part 2)

Last month the conditions for the Class B stage under quiescent conditions only were considered, but it is also necessary to ensure that the maximum collector dissipation is not exceeded under drive conditions, and that thermal runaway does not occur when the drive is removed.

The maximum collector dissipation per transistor in a matched Class B stage is given very closely by

$$P_c = \frac{E^2}{\pi^2 (R_L + R_e)} + I_q^2 (R_L + R_e)$$

where $R_L$ and $R_e$ are the lower tolerance limit of the speaker load and emitter resistor, and $I_q$ is the quiescent current corresponding to the peak junction temperature.

A value is assumed for $I_q$, and $\Delta Tj$ calculated from $\Delta Tj = P_c\theta + \Delta T_{amb}$ where $\theta$ is the thermal resistance of the transistor. Putting this value for $\Delta Tj$ in the expression

$$\left( 2\Delta Tj + \frac{R_b + R_e + r_{bb'}}{\beta} I_{ceo} + 20 \right) \text{ mV},$$

and reducing the value of $V_{be}$ in the $V_{be}$ $I_c$ curve at 20°C by this amount, the V, $I_c$ characteristic at the working junction temperature ($\Delta Tj$ above standard) is obtained. If the initial estimate for $I_q$ is right, this curve will intersect the load line $V = V_{bb} - \frac{R_b + (\beta + 1) R_e}{\beta} I_c$ at $I_c = I_q$. If the curve intersects the load at a lower point, then the value of $I_q$ has been over-estimated, and similarly if the curve intersects the load line at a higher point the value of $I_q$ has been underestimated. A few successive approximations will give the correct value of $I_q$ and the corresponding peak junction temperature. It is unnecessary to draw the whole curve, for (see Fig. 4) if the estimated value of $I_q$ is high, the point ($V$,$I_q$) will lie to the right of the load line, and similarly if it is low the point ($V$, $I_q$) will be to the left of the load line.

The requirements to be met are that (a) at the highest ambient temperature, the junction temperature does not exceed the rating for the transistor given in the data sheets, and, (b), $I_q$ is less than the value of $I_c$ given by the second intersection of the load line and the V, $I_c$ characteristic (point B in Fig. 4).

If condition (a) is not met, then the value of $R_L$ should be increased to a value at which it is satisfied. If (a) is met, but not (b), then $R_L$ can be increased, which will decrease the peak dissipation, and/or $R_e$ can be increased, which will principally affect the slope of the load line and the point of intersection B. In general, it will be found that the greater audio output will be obtained when $R_e$ is made as small as possible, and $R_L$ is increased to a safe value. This also has the advantage of giving a better power gain.

The maximum available power output (collector voltage swinging to zero volts) is given by $\frac{E^2 R_L}{2(R_L + R_e)^2}$

**EXAMPLE :** A class B output stage using an XC131 unit.

The average value of $V_{be}$ for $I_c$ = 2 mA at 20°C ambient is 170 mV, and the average direct current $\beta$ at 2 mA is 64. The value of $R_b$ is made 100 Ω, and $R_e$ is estimated to be 4.7 Ω. Then

$$V_{be}\,(\text{at } 2\text{ mA}) + \frac{2}{\beta}\left\{ R_b + (\beta + 1) R_e \right\} = 170 + 12.5 = 182.5 \text{ mV}.$$

With 6 volts across the base potentiometer and $R_2$ = 51 Ω, a value of 1600 Ω for $R_1$ makes the average value of $V_{bb}$ = 185 mV. Using 5% resistors the maximum value for $V_{bb}$ is 204 mV. The value for $\frac{R_b + R_e + r_{bb'}}{\beta}$ in deriving the expression for V versus $I_c$ is taken as $\frac{100 + 4 + 50}{70} = 2.2\,\Omega$, and the limit value of $I_{ceo}$ is 10 mA at a junction temperature of 65°C (doubling in value for every 7°C increase in temperature). The average (V, $I_c$) curve at a junction temperature of 20°C, and the limit curve at 55°C ambient are shown in Fig. 5.

If it is considered that the maximum permissible quiescent current at 55°C, ambient should not exceed 18 mA, the load line is drawn through the 18 mA point on the V versus $I_c$ curve and the point V = 204 mV on the axis. This line has a slope of 5.6 Ω. Putting $R_b$ = 100 Ω, the minimum value of $R_e$ is $5.6 - \frac{100}{70} = 4.2\,\Omega$, and if the tolerance for $R_e$ is ± 0.5 Ω, the nominal value becomes 4.7 Ω. Using a nominal speaker impedance of 25 Ω with a low limit of 22 Ω, the low limit for $R_e$ of 4.2 Ω, and estimating the quiescent current at the working junction temperature under drive as 22 mA, the peak collector dissipation is

$$\frac{6^2}{\pi^2 \times 26.2} + (.022)^2 \times 26.2 = 0.152 \text{ watts}.$$

With a thermal resistance of 0.1°C/mW, the temperature rise is 15.2°C. This corresponds to a maximum junction temperature of 70.2°C. The V, $I_c$ curve for this junction temperature intersects the load line well below the second intersection point, and so the circuit is thermally stable, and the quiescent current is 22 mA (which is the estimated value). The maximum nominal power output is $\frac{6^2 \times 25}{2(25 + 4.7)^2} = 0.51$ watts.

FIG.4.

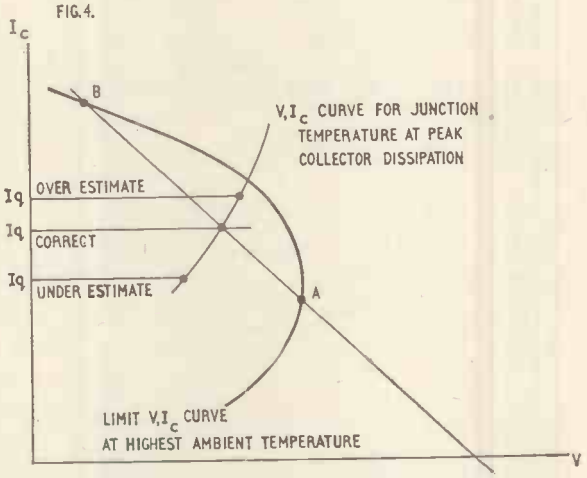
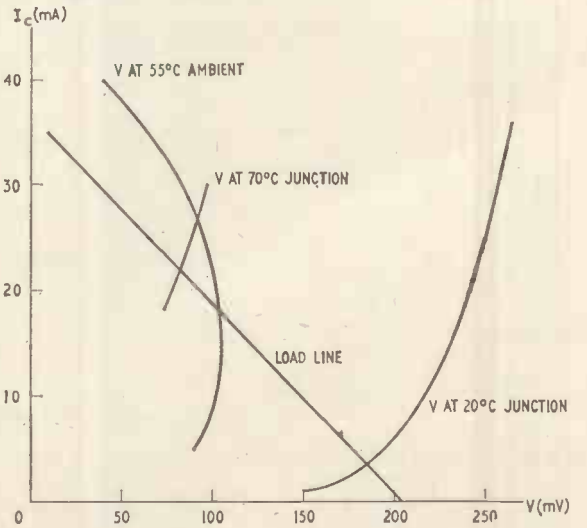



FIG.5.



# EDISWAN MAZDA XC131 OUTPUT TRANSISTOR

The XC131 unit consists of a matched pair of germanium pnp junction transistors, supplied in a special holder designed to give a low thermal resistance when mounted on a heat sink. These transistors are intended for use in a Class B Push Pull Output stage.

## TENTATIVE RATINGS AND DATA

**Maximum Temperature Ratings (Absolute Values)**

| | |
|---|---|
| Junction Temperature (°C) | 75 |
| Storage Temperature (°C) | 75 |

**Maximum Ratings (Absolute Values for $T_{amb}$ = 45°C)**

| | |
|---|---|
| Peak or Mean Collector to Base Voltage (Common Base Circuit) (Volts) | −35 |
| Peak or Mean Collector to Emitter Voltage (Common Emitter Circuit) (Volts) | −16 |
| Peak Collector to Emitter Voltage with Base driven to cut-off (Common Emitter Circuit) or with $R_{be}$ < 500Ω (Volts) | −35 |
| Peak or Mean Emitter to Base Voltage (Volts) | −12 |
| Collector Dissipation (mW) (Per Transistor) | 300 |

Note: The user must also ensure that operating conditions and circuit stability are such that thermal runaway cannot occur under the most adverse conditions likely to be encountered.

**General Characteristics ($T_{amb}$ = 25°C)**

Thermal Resistance per Transistor with Heat Sink (for unit clamped to a 20 S.W.G. aluminium plate of 12 sq. ins. minimum area) (°C/mW) 0.1

| | Min. | Av. | Max. |
|---|---|---|---|
| Collector to Base Leakage Current ($V_{cb}$ = −15 V, Emitter Open Circuit) (μA) | — | — | −10 |
| Collector to Emitter Leakage Current ($V_{ce}$ = −12 V, Base Open Circuit) (μA) | — | — | −250 |
| Static Current Amplification (d.c.) ($V_{ce}$ = −1 V, $I_c$ = −200 mA) | 40 | 74 | — |
| Base to Emitter Forward Voltage ($V_{ce}$ = −6 V, $I_c$ = −2 mA) (mV) | −138 | −158 | −178 |

## TYPICAL OPERATION

**Class B Single Ended Push Pull—Common Emitter**

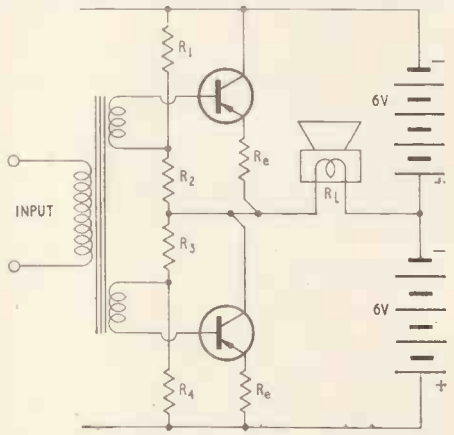
| | † | †† |
|---|---|---|
| Battery Supply Voltage (Centre Tapped), Total (Volts) | −12 | −12 |
| Speaker Load Resistance (ohms) | 25 | 15 |
| Emitter Stabilising Resistance, per Transistor (ohms) | 4.7 | 3.9 |
| Equivalent d.c. Resistance of Base Circuit, per Transistor i.e. Transformer and Bias Potentiometer (ohms) | 100 | 100 |
| No Signal Collector Current per Transistor, Average Transistors (mA) | 2.8 | 2.9 |
| Open Circuit Bias Voltage Required Across Lower Limb of each Potentiometer (mV) | 184 | 184 |
| Maximum Power Output for Less than 10% Total Harmonic Distortion, Average Transistors (mW) | 500 | 750 |
| Peak Collector Current at Maximum Power Output (mA) | 200 | 317 |
| Peak Base Current at Maximum Power Output, Average Transistors (mA) | 2.7 | 5.0 |
| Peak Base Current at Maximum Power Output, Low Limit Transistors (mA) | 5 | 9.3 |

†Data given for 25°C ambient, but the circuit conditions will give satisfactory operation up to an ambient temperature of 55°C.

††Data given for 25°C ambient, but the circuit conditions will give satisfactory operation up to an ambient temperature of 45°C.

## TYPICAL CIRCUIT

**Class B Single-ended Push Pull—Common Emitter**




| | † | †† |
|---|---|---|
| $R_L$ (speaker) (ohms) | 25 | 15 |
| $R_1$, $R_3$ (ohms) | 1600 | 1600 |
| $R_2$, $R_4$ (ohms) | 51 | 51 |
| $R_e$ (ohms) | 4.7±0.5 | 3.9±0.5 |

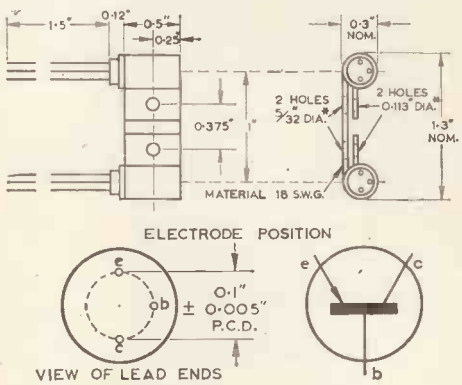
Resistor tolerances ±5% except where stated otherwise.

Notes.

†This circuit will give satisfactory operation up to an ambient temperature of 55°C.

††This circuit will give satisfactory operation up to an ambient temperature of 45°C.

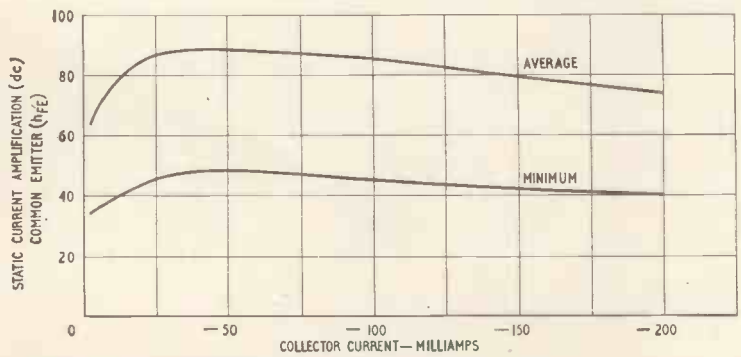
## DIMENSIONS AND BASING




Note.

The lead wires should not be bent close to the glass seal. Solder should not be applied closer to the seal than 0.375in. and during the soldering operation a heat sink (e.g. pliers) should be applied between seal and joint.

Recommended screw sizes, Barber-Coleman Type 1. 6BA for screwing to chassis or 4BA for screwing to clip.




**Tentative characteristic curves of Ediswan Mazda Transistor Type XC131.**

Variation of static current amplification (dc) with collector current. (Common Emitter Configuration.)

Curves taken with short duration pulse (collector dissipation less than 3mW). Collector Voltage −1V. Ambient Temperature 25°C.

Note: The minimum curve is typical of production spread.

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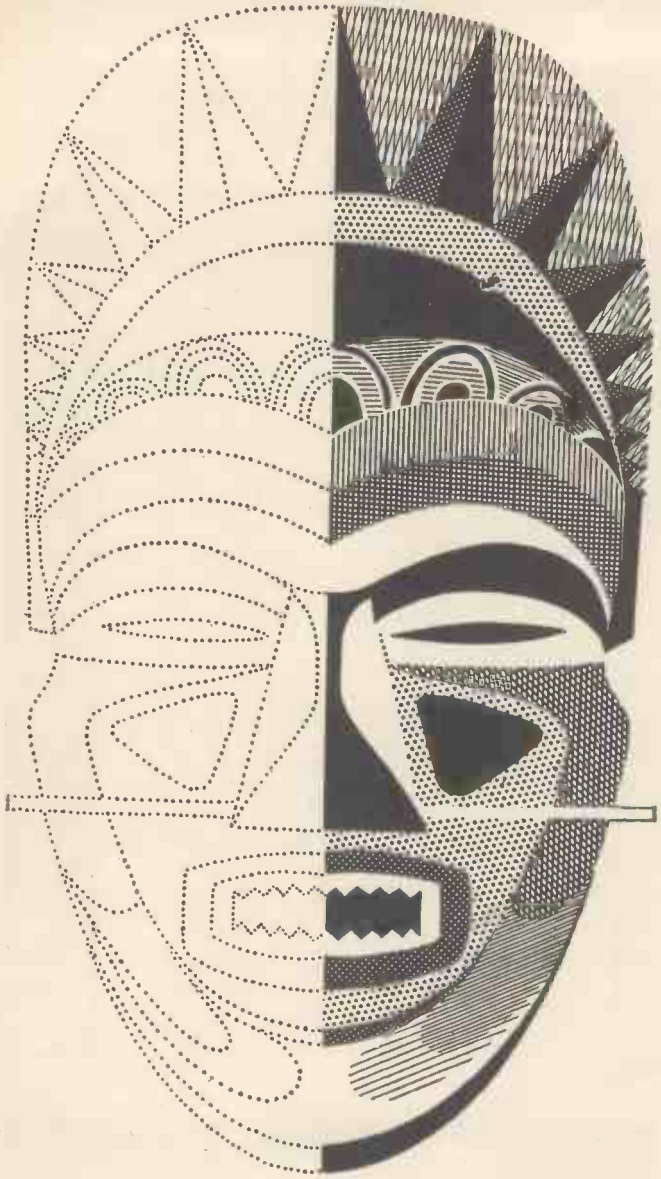

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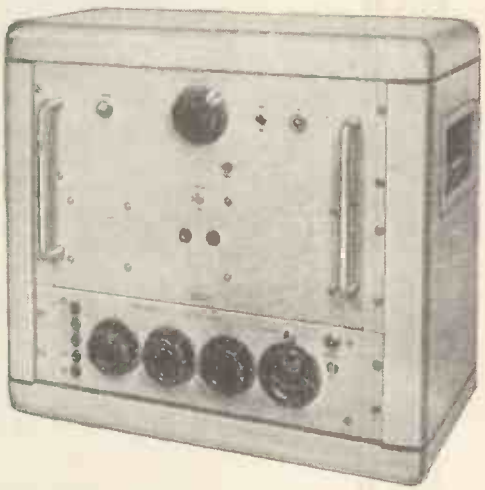

Will deliver 120 watts continuous signal and over 200 watts peak Audio. It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 0.2% and the noise level —95 dB. A floating series parallel output is provided for 100-120 V. or 200-250 V. and this cool running amplifier occupies 12¼ inches of standard rack space by 11 inches deep. Weight 60lb.

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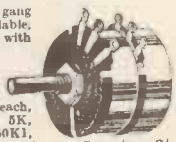
## Morganite Potentiometers



Single and 2-gang types available, standard size with good length spindle, all new and boxed. Single types, 1/- each, values available: 5K, 10K, 25K, 50K), 100K, 250K, 1 meg., 2 meg., Gang type 3/- each—values available: 5K + 5K, 100K + 100K, ½ meg. + ½ meg., 2 meg. + 2 meg.

## Yaxley Switches

| | |
|---|---|
| 1 Pole 3 Way | 1/6 |
| 1 Pole 5 Way | 2/- |
| 1 Pole 11 Way | 2/6 |
| 2 Pole 2 Way Ceramic | 2/6 |
| 2 Pole 4 Way | 2/- |
| 2 Pole 6 Way | 2/6 |
| 2 Pole 8 Way | 3/6 |
| 2 Pole 11 Way | 3/6 |
| 2 Pole 12 Way | 4/6 |
| 3 Pole 3 Way | 1/6 |
| 3 Pole 6 Way | 3/6 |
| 4 Pole 4 Way | 3/- |
| 6 Position Shorting | 2/- |
| 6 Pole 3 Way | 2/6 |
| 6 Pole 3 Way Ceramic | 3/6 |
| 8 Pole 2 Way | 2/- |
| 9 Pole 3 Way | 2/6 |
| 12 Pole 2 Way | 2/- |

## T.V. Workshop Aids

E.H.T. SEALER. Apply with soldering iron. Stops corona discharge, etc. 2/6 per stick.

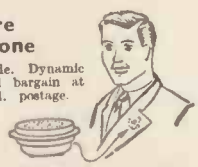
POLYTHENE TAPE. 2in. × 10 thou. for E.H.T. insulation up to 25 kV, 5/- per 20ft. roll.

SPONGE STRIP. ¼in. × ¼in. For sealing or cushioning, 9d. per foot.

ANTI-STATIC SCREEN CLEANER. For TV tubes and screens. Perspex or glass. Delays accumulation of dust, 3/- per tube.

CELLULOSE CEMENT. Specially prepared for radio gluing of metal, glass, ceramic, wood, fabrics, 4/6 per tin.

## Miniature Microphone



American made. Dynamic type. Real bargain at 2/6. plus 6d. postage.

## PHILIPS TRANSCRIPTION UNIT

Philips AG2009 Record Player, 4 speed. Ideal for the enthusiast. Pick-up arm wired for stereo, fine adjustment on all four speeds. Continuously variable pick-up weight (2-12 gms.). Supplied with Philips Hi-Fi crystal head, type AG3019 for micro-groove and 78 r.p.m. Frequency response 30-15,000 c/s. Pick-up lifting and lowering device. Individually balanced heavy turntable. Muting switch. Can be used with any amplifier or radio set. Complete with monaural pick-up. £10/10/-, or 2 gns. deposit and 19 fortnightly payments of 10/-. Available also with stereo head, diamond or sapphire stylus. Prices on request.

## Unique Opportunity to build Fine Transistor Set


Constructor's parcel to build Pocket 6 Transistor Set as currently being sold at £17/17/-. Parcel comprises motifed, two-tone cabinet as illustrated, tuning dial, two gang tuning condenser, combined bakelite chassis/printed circuit and easy-to-follow circuit. Costing value 57/6—offered while supplies last at only 29/6, plus 2/6 post. Suitable for your own circuit or to build original circuit. All parts available at highly competitive prices. Do not miss this tremendous bargain.

## Component Storage Drawers

Stout board construction these drawers are ideal for small parts. Supplied complete with simple erection instructions — 1/6 each or 12 drawers each 6×2½×6½in., 13/6, post 2/-.

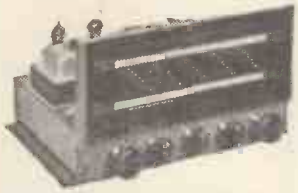
## RE-GUNNED TUBES

We offer television tubes which have had new gun assemblies, new getters, new screens and have virtually been rebuilt as new. 12in. £4/19/6; 14in. £5/9/6; 17in. £5/19/6. Non-callers please add 10/- carriage and insurance.

## Voltage regulated 50 cycle A.C. source heavy MOTOR GENERATOR

Input 20-26 volt 11 amp. D.C. regulated. Output 230 volts 50 cycles, 80-100 watts. Complete in grey metal case fitted with output volt meter, input and output fuses and switch. Output is kept regulated over the entire D.C. input. Robustly built for the Navy. Ideal for working TV set, etc. Limited quantity. £47/10/- each.

## Fine chassis by Armstrong



The AF208 handbuilt to the traditional Armstrong standard is ideal for building into a new set-up or for bringing that old favourite up to date. FM 87—108 Mc/s. AM 187—570 mtrs. 5 watts output, 15 dB neg. feedback, separate base and treble, 2 compensated inputs for pick-up, frequency response 30-22 thousand C.P.S. Plus or minus 2 dB. Tape, record and playback facilities. Price 22 gns. or H.P. terms on request.

## Heavy Duty Thyratron

Heater 5 volt 20 amp. Peak anode 16,000 volts. Peak plate current 120 amps. Unused, perfect condition. £5.

## High Voltage Rectifiers

| | | |
|---|---|---|
| CV19 | 63 kV, Peak 800 mA | £4 17 6 |
| CV1504 | 60 kV, Peak 1200 mA | £5 17 6 |
| CV74 | 40 kV, Peak 600 mA | £2 17 6 |
| CV1508 | 8 kV, Peak 1000 mA | £1 17 6 |
| CV1111 | 14 kV, Peak 350 mA | 7 6 |

## SPECIAL THIS MONTH

Battery Charger Rectifier—selenium 12-15 v., 5 amp., 12/6.

Blank Metal Chassis—all 2½in. deep from 18 gauge aluminium. Sizes: 6in. × 2in., 4/6; 7½in. × 5in., 6/-; 13½in. × 9in., 10in. × 7½in., 7/-; 11½in. × 7½in., 8/-.

Metal Chassis—punched for Mullard 510 Amplifier, complete with inner screening sections and stove enamelled. 12/6 set.

Geiger Counter Tubes—20th century type, Type No. G24, with circuit of geiger counter, 29/6.

Luminous Switch, double pole designed for electric blankets, neon indicators glow when appliance is switched on, 10/-.

Waterproof Heater Wire—suitable electric carpets, electric blanket, hand muffs, foot pads, etc., 8d. per yard.

Twin Twisted Lighting Flex—equivalent 14/36, rubber insulated, cotton covered, 12/6 per 100 yard coil.

Moving Coil Meters

| | | |
|---|---|---|
| 0-500 microamp | 2in flush | 17/6 |
| 250-0-250 microamp | 2½in. surface | 27/6 |
| 750 microamp | 2½in. surface | 17/6 |
| 5-0-5 milliamp | 2½in. flush | 17/6 |
| 0-30 milliamp | 2½in. flush | 17/6 |
| 0-100 milliamp | 2½in. flush | 15/- |
| 0-300 milliamp | 2½in. flush | 15/- |
| 0-500 milliamp | 2½in. flush | 15/- |

Unbreakable Mains Lead type of lead fitted to electric razors makes fine lead for test meters and any other devices where subject to continuous bending. Twin figure eight construction, soft cream p.v.c. covered. Normally costs 2/- per yard. Three 6ft. leads for 2/-.

Filament Transformer, 6.3 v., 1½ amps. 6/6.

.3 Amp Dropper—tappings marked 200/220/250, 3/6.

Output Transformer—standard pentode—4/6, multi ratio, 6/6.

Bi-metal Strip with heavy duty contact—ideal for thermostat, fire, lamp, etc., 2/6.

Neon Lamp—midget wire ended, ideal mains tester, etc., 2/-, ex Govt., 1/6.

Philips Trimmers—0-30pF, 1/- each, 9/- doz.

Set of 8 Allen Keys, 3/6.

Heavy Duty Test Prods—red and black with plug-in lead attachments, 8/6.

Install those extra points. 3.029 twin flat T.R.S. cable. Big purchase enables us to sell this at 45/- per 100 yds., carriage 3/6.

Low Resistance Head Phones. Ideal crystal sets, etc., 7/6, plus 2/6.

Goodmans Multi Ratio Output Transformer. 6 watt, 8 ratios, from 12-1 to 72-1. Centre tapped for push/pull, 7/6, plus 1/-. Ditto, unbranded, 6/6, post 1/-.

Cold Cathode Valve CV413. Voltage regulator or trigger switch—unused but ex-equipment, 2/- each.

Tag Panels. Ideal for constructors, experimental circuits, etc., 3 of each of 12 different types, 5/-, post 1/6.

Slydlok Panel Mounting Fuses with carrier. 5 amp. 2/- each, 15 amp. 2/6 each.

Belling Lee 2BA fully insulated terminals for mounting through metal panels, 2/- each.

Terminal Heads, insulated 4BA, 2/- doz.

.1 mFd. 350 v. Small tubular metal cased condensers made by Dubilier, 2/6 doz.

50 Assorted Resistors. Well mixed and useful values ¼ and ½ watt, 5/- for 50. Ditto, but 1 watt, 6/6 for 50.

Mains Transformer. Standard 230 v. input 250-0-250 at 80 mA., 6.3 v. at 5 A., 12/6, post 1/6.

Toggle Switch. Standard metal body, type with round dolly, fixing ring and on/off indicating plate, 1/3 or 12/- doz.

Metal Rectifier. 250 v. 60-80 milliamps., ideal for mains set or instrument or to replace that expensive valve, 5/6.

Screened Cable. Rubber covered flexible with metal braiding, ideal for microphone or gramophone extensions, 4d. per yd., 30/- per 100 yds.

Install 2-Way Switches. Our outfit comprises: 30 yd. multicore cable, two 2-way switches, two wood blocks. Full instructions, 9/6 each, post and insurance 2/6.

Long, Medium and Short Wave Coil Pack. An exceptionally well made coil pack which covers the standard long, medium and short wavebands for 465 k/c I.F. complete with diagram of connections, 19/6. plus 1/6 postage and insurance—limited quantity only.

# ELECTRONIC PRECISION EQUIPMENT, LTD.

**post orders are dealt with from Eastbourne, so for prompt attention please post your orders to 66 Grove Road, Eastbourne, marked Department 2. Callers may use any one of the Companies below:**

**Electronics (Croydon) Ltd., 266 London Road, Croydon.**
Phone: CRO 6558.
Half day, Wednesday.

**Electronics (Finsbury Park) Ltd., 29 Stroud Green Road, Finsbury Park, N.4.**
Phone: ARChway 1049.
Half day, Thursday.

**Electronics (Manor Park) Ltd., 520 High Street, North, Manor Park, E.12.**
Phone: ILFord 1011.
Half day, Thursday.

**Electronics (Ruislip) Ltd., 42-46 Windmill Hill, Ruislip, Middx**
Phone: RUISLIP 5780.
Half day, Wednesday.

# EDISWAN MAZDA 10FD12

Double Diode Variable-mu Pentode for a.c./d.c. Broadcast Receivers. The 10FD12 pentode is intended for use as RF or LF amplifier and the diodes for AM detection.

| | | |
|---|---|---|
| Heater Current (amps) | $I_h$ | 0.1 |
| Heater Voltage (volts) | $V_h$ | 19 |

## MAXIMUM DESIGN CENTRE RATINGS

| | | |
|---|---|---|
| Anode Dissipation (watts) | $p_{a(max)}$ | 2.25 |
| Screen Dissipation (watts) | $p_{g2(max)}$ | 0.45 |
| Anode Voltage (volts) | $V_{a(max)}$ | 250 |
| Screen Voltage (Anode Current < 4mA) (volts) | $V_{g2(max)}(I_a<4mA)$ | 250 |
| Screen Voltage (Anode Current > 8mA) (volts) | $V_{g2(max)}(I_a>8mA)$ | 125 |
| Diode Peak Inverse Voltage (Each Section) (volts) | $PIV_{max}$ | 200 |
| Peak Diode Anode Current (Each Section) (mA) | $i_{ad(pk)max}$ | 5 |
| Mean Diode Anode Current (Each Section) (mA) | $I_{ad(max)}$ | 0.8 |
| Cathode Current (mA) | $I_{k(max)}$ | 16.5 |
| Resistance Control Grid to Cathode (MΩ) | $R_{g1-k(max)}$ | 3 |
| Resistance Control Grid to Cathode (Grid Current Biasing) (MΩ) | | 22 |
| Heater to Cathode Voltage (volts) | $V_{h-k(max)}$ | 100* |

*From cathode to higher potential heater pin.

## INTER-ELECTRODE CAPACITANCES (pF)†

| | | |
|---|---|---|
| **PENTODE** | | |
| Input Capacitance | $c_{in}$ | 5.0 |
| Output Capacitance | $c_{out}$ | 5.2 |
| Anode to Grid 1 | $c_{a-g1}$ | <0.0025 |
| **DIODES** | | |
| Anode Diode 1 to Cathode | $c_{a'd-k}$ | 2.5 |
| Anode Diode 2 to Cathode | $c_{a''d-k}$ | 2.5 |
| Anode Diode 1 to Anode Diode 2 | $c_{a'd-a''d}$ | <0.25 |

## CROSS CAPACITANCES

| | | |
|---|---|---|
| Anode Diode 1 to Grid 1 | $c_{a'd-g1}$ | <0.001 |
| Anode Diode 2 to Grid 1 | $c_{a''d-g1}$ | <0.0008 |
| Anode Diode 1 to Pentode Anode | $c_{a'd-ap}$ | <0.025 |
| Anode Diode 2 to Pentode Anode | $c_{a''d-ap}$ | <0.15 |

†Inter-electrode capacitances in fully shielded socket, without can.

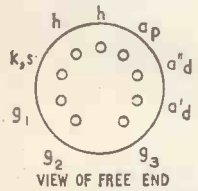
## TYPICAL OPERATION

| | | | | | |
|---|---|---|---|---|---|
| Supply Voltage (volts) | $V_b$ | 170 | 170 | 200 | 200 |
| Anode Voltage (volts) | $V_a$ | 170 | 170 | 200 | 200 |
| Suppressor Voltage (volts) | $V_{g3}$ | 0 | 0 | 0 | 0 |
| Grid No. 1 Voltage (volts) | $V_{g1}$ | −0.5‡ | −1.5 | −0.5‡ | −1.5 |
| Screen Resistor (kΩ) | $R_{g2}$ | 27 | 21 | 47 | 30 |
| Cathode Resistor (Ω) | $R_k$ | — | 105 | — | 105 |
| Anode Current (mA) | $I_a$ | 11 | 11 | 9.5 | 11 |
| Screen Current (mA) | $I_{g2}$ | 3.4 | 3.4 | 2.8 | 3.3 |
| Mutual Conductance (mA/V) | $g_m$ | 5 | 4.5 | 5 | 4.5 |
| Mutual Conductance for $V_{g1}=-20V$ (μA/V) | | 65 | 65 | 115 | 120 |
| Valve Anode Resistance $(\partial v_a/\partial i_a)$ (MΩ) | $r_a$ | 0.45 | 0.45 | 0.6 | 0.6 |
| Equivalent Grid Noise Resistance (kΩ) | $R_{eq}$ | 2.5 | 3.5 | 2.5 | 3.5 |

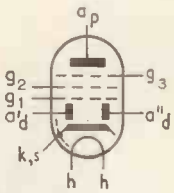
‡This voltage is produced by the grid current flowing through the grid resistor and the steady current of the diode. If this condition is not acceptable the negative grid bias should be increased to −1.5V.

**MOUNTING POSITION:** Unrestricted.

**BASE** B9A (Noval)



VIEW OF FREE END

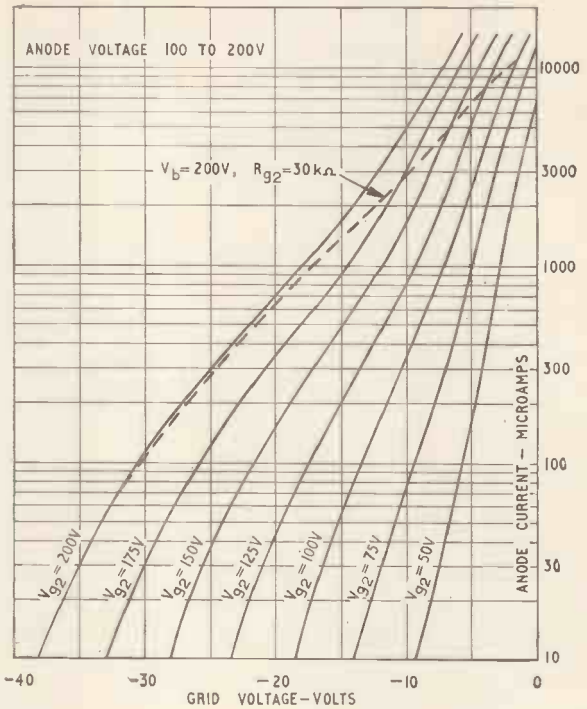


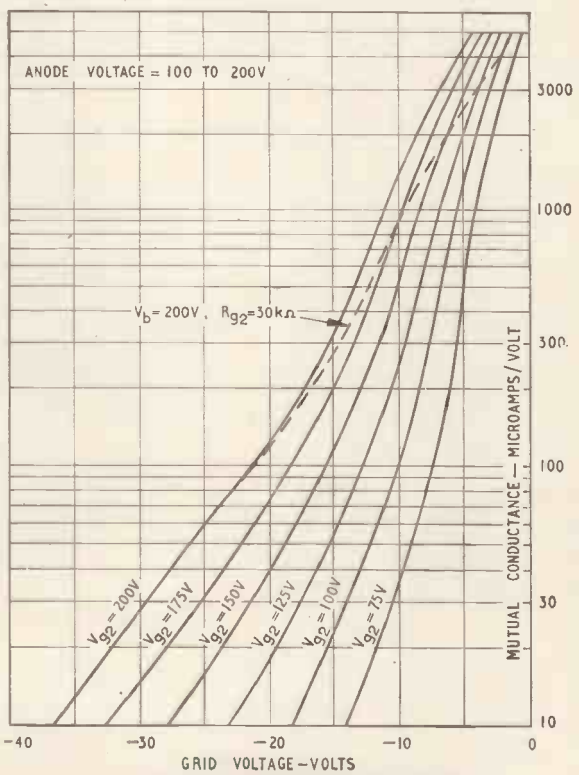

## MAXIMUM DIMENSIONS (mm)

| | |
|---|---|
| Overall Length | 67.5 |
| Seated Height | 60.5 |
| Diameter | 22.2 |

**Associated Electrical Industries Ltd**
Radio and Electronic Components Division
Technical Service Department
155 Charing Cross Road, London, W.C.2
Tel: GERrard 8660. Grams: Sieswan, Westcent, London

**Characteristic curves of Ediswan Mazda Valve Type 10FD12**




**EDISWAN**
MAZDA

CRC15/78

# we can get you out of a stabiliser problem

If you're worried about varying voltages... or if you're in a rage over rectifiers or in a diode of despair—don't worry. We'll get you out of all that! (Why, we've made some of our customers actually beam at tetrodes!) It's because we've experienced over 40 years bottling up valves—Tx, Rx, rf, audio, hard, soft, gov't., special—that problems like this no longer hold any terrors for us. Also, we've everything on the research and production side you could possibly wish for. So the next time you're enveloped in a valve problem, particularly one involving Corona Stabilisers, let us know.

| Type | Standard Voltages | Current Range | Size |
|---|---|---|---|
| SC3 | 350, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000 | 5 to 100μA | 1½" + wire ends |
| SC1 | 350, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000 | 10 to 500μA | B7G |
| SC2 | 2500, 3000, 3500, 4000 | 25μA to 1mA | B9A |
| SC4 | 5000, 6000, 7000 | 25μA to 1mA | B9A |

G.E.C.

valves are obtainable from

**THE M-O VALVE CO. LTD.**

BROOK GREEN · HAMMERSMITH · LONDON W.6.

A subsidiary of the General Electric Co. Ltd.

## C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit and for C.R. Tubes with falling emission. Full instructions supplied.

Type A. Low Leakage windings. Optional Boost 25% and 50%. Tapped mains primaries.

| | |
|---|---|
| 2 volt | 12/6 each |
| 4 volt | 12/6 each |
| 6.3 volt | 12/6 each |
| 10.8 volt | 12/6 each |
| 13.3 volt | 12/6 each |

**OUR LATEST SUPERIOR PRODUCT.** Type A2. High Quality. Low capacity, 10/15pf. Optional boost 25%, 50%, 75%. **16/6** each

Type B. Mains input. Low capacity. Multi Output 2, 4, 6.3, 7.3, 10 and 13 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes **21/-**.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg., ½ w., 4d.; ¼ w., 4d.; 1 w., 6d., 1½ w., 8d.; 2 w. **1/-**. HIGH STABILITY, ¼ w., 1%, **2/-**. Preferred values 100Ω to 10 meg.. Ditto 5% **9d.**, 100Ω to 5 meg.

5 watt, 10 watt, 15 watt } WIRE-WOUND RESISTORS 25 ohms—10,000 ohms. { 1/3, 1/6, 2/-

15,000 ohms—50,000 ohms, 5 w.. **1/9**; 10 w..... **2/3**

**WIRE-WOUND POTS**, 3 w Pre-set Min. T.V. type Knurled Slotted knob, All values 25 ohms to 25K., 3/- ea., 30 K., 50 K., **4/-**. Ditto, ¼ w. Carbon Track 30 K. to 2 Meg., 3/-.

**WIRE-WOUND POTS**, 4 w. Standard size Pots, long Spindle High Grade. All values 100 ohms to 50 K., 6/6; 100 K. **7/6**. W/W EXT. SPEAKER CONTROL 10Ω. 3/-.

**O/P TRANSFORMERS.** Heavy duty 50 mA., **4/6**. Multi-ratio push-pull, **7/6**. Miniature 3V4, etc., **4/6**. Hygrade Push-pull 10 watts, **15/6**. MULLARD "510" 6k or 8k **30/-**. **L.F. CHOKES 15/10H** 60/65 mA.. 5/-. 10H 85 mA., **10/6**. 10H 150 mA., **14/-**.

**MAINS TRANSFORMERS 200/250 v. A.C.**

STANDARD 250-0-250, 80 mA., 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a., tapped 5 v. or 4 v. 2 a. Ditto 350-0-350 ..... 22/6

MINIATURE 220 v. 20 mA., 6.3 v, 1 a..... 10/6

MIDGET, 220 v. 45 mA., 6.3 v. 2 a..... **15/6**

SMALL, 220-0-220 50 mA. 6.3 v. 2A. ..... 17/6

STANDARD, 250-0-250, 65 mA., 6.3 v. 3.5 a..... 17/6

HEATER TRANS., 6.3 v. 1½ a., **7/6**; 3 amp..... **10/6**

GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 A..... 22/6

ALADDIN FORMERS and cores, ¼in., 8d.; ½in., 10d. 0.3in. FORMERS 5937 or 8 and Cans TV1 or 2, ½in. sq. × 2½in. or 1in. sq. × 1½in., 2/- with cores.

SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.

SOLON, Midget Soldering Iron, 230 v. 25 w., **24/-**.

REMPLOY INSTRUMENT IRON. 230 v. 25 w., 17/6.

MAINS DROPPERS. 3 × 1½in. Adj. Sliders, .3 amp. 1,000 ohms **4/3**. .2 amps. 4/3. .1 amp. 2,000 ohms, **5/-**.

LINE CORD. .3 amp., 60 ohms per foot, .2 amp., 100 ohms per foot, 2 way, 6d. per foot, 3 way, 7d. per foot.

### CRYSTAL MIKE INSERT by Acos 6/6

Precision engineered. Size only ¾ × ⅜in.
ACOS CRYSTAL STICK MIKE 39-1. Bargain 37/6.

MIKE TRANSF. 50 : 1, **3/9** ea.; 100 : 1 Potted **10/6**.

LOUDSPEAKERS P.M. 3 OHM. 5in. Rola, 17/6. 6in. × 4in. Rola, **18/-**. 7in. × 4in. R.A., **21/-**. 10in. × 6in. Rola, 27/6. 8in. Plessey, 19/6. 6½in. Rola, **18/6**. 8in. Rola, **21/-**. 10in. R.A., **30/-**.

HI-FI TWEETERS, 4in. **25/-**. 12in. Plessey, 30/-. 12in. Baker 15 wt. 3 ohm and 15 ohm models, **105/-**. 12in. Baker foam suspension 15 w. 15 ohm. **£8**. 12in. 15 ohm Plessey 10 wt., **45/-**.

### I.F. TRANSFORMERS 7/6 pair

465 kc/s. slug tuning miniature can 2½ × 1 × 1in. High Q and good bandwidth. By Pye Radio. Data sheet supplied.

Wearite M800 I.F. Miniature 465 kc/s., 12/6 pair.
Weymouth I.F. Standard size 465 kc/s., 12/6 pair.

CRYSTAL DIODE G.E.C., 2/-. GEX34, 4/-. 40 Circuits, 3/-. H.R. HEADPHONES. 4,000 ohms, brand new, 15/- pair. SWITCH CLEANER Fluid, squirt spout, 4/3 tin. TWIN GANG CONDENSERS. 365 pf. Miniature, 1½in. × 1½in. × 1½in., 10/-. .0005 Standard with trimmers, 9/-; less trimmers, 8/-. Midget 7/6; Single 50 pf., 2/6; 100 pf., 150 pf., 7/-. Solid dielectric 100, 300, 500 pf., 3/6. VALVE HOLDERS. Pax. int. Oct., 4d. EF50, EA50 6d. B12A, CET, 1/3. Eng. and Amer. 4, 5, 6, 7 pin 1/-. MOULDED Mazda or int. Oct. 6d., B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6; B12A, 1/3. B9A with can, 1/9. CERAMIC, EF50, B7G, B9A, Oct., 1/-; B7G, B9A Cans, 1/-. SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-, 25in. × 35in., 10/-. Tygan 54in. wide, 10/- ft. 27in. wide, 5/- ft. Samples, S.A.E.

WAVECHANGE SWITCHES

2 p. 2-way, 3 p. 2-way; short spindle..... 2/6
5 p. 4-way, 2 wafer, long spindle ..... 6/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle..... 3/6
3 p. 4 -way. 1 p. 12-way, long spindle..... 3/6

Wave change "MAKITS" 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer 16/-; 4 wafer 19/6; 5 wafer 23/-; 6 wafer 26/6.

TOGGLE SWITCHES. S.P., 2/-; D.P., 3/6; D.P.D.T., 4/-.

MORSE KEYS, good quality, 2/6.

SUB-MINIATURE ELECTROLYTICS (15 v.), 1, 2, 4, 5, 8, 25, 50 mfd., 100 mfd., 3/- each.

### EDISWAN TRANSISTORS JUNCTION TYPE P.N.P.

AUDIO XB102, for amplifiers and output stages up to 250 milliwatts in push-pull. PRICE **10/-**

R.F. XA104 frequency changer up to 4 Mc/s. **18/-**

XA103 IF amp. etc. up to 2 Mc/s. **15/-**

Mullard OC44, 28/-, OC45 23/-. Power V15/10p 20/-.

## RCS "REGENT" 4 VALVE

"96" RANGE VALVES

KIT PRICE

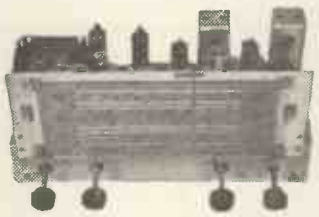
**£6. 6. 0.**

Carr. 4/-.

## PRINTED CIRCUIT BATTERY PORTABLE KIT

Medium and long wave. Powerful output from 6in. high Flux Speaker. T.C.C. Printed circuit and condensers. All components of finest quality clearly identified for assembly with full instructions. Osmor Ferrite Aerial and Coils, Rexine covered attache case type cabinet. Size 12in. x 8in. x 4in. Batteries used B126 (L5512 and AD35 (L5040), **10/-** extra. Details and instructions 1/9 (free with kit). Mains Unit ready made for above **39/6**. Same size as batteries, sold separately.

## 1960 RADIOGRAM CHASSIS



THREE WAVEBANDS
S.W. 16 m.—50 m.
M.W. 200 m.—500 m.
L.W. 800 m.—2,000 m.
12-month Guarantee. A.C. 200/250 v., 4-way switch. Short-Medium-Long-Gram. Feedback. 4.2 watts. Chassis 13½in. × 5½in. × 2½in. Glass Dial Size 10 × 4½in. horizontal or vertical. Two Pilot Lamps. Four Knobs. Walnut or Ivory. Aligned and calibrated. Chassis isolated from mains.

FIVE VALVES
LATEST MULLARD
ECH81, EF89, EBC81, EL84, EZ80.

**BRAND NEW £9. 10. 0.** Carr. 4/6.

TERMS: Deposit £5/5/- and 5 monthly payments of £1. MATCHED SPEAKERS 8in. 17/6; 10in. 25/-; 12in. 30/-.

## RECORD PLAYER BARGAINS

| | | | |
|---|---|---|---|
| 4 Speed Autochangers, B.S.R., U.A.8 | £6 | 19 | 6 |
| Collaro Conquest | £7 | 19 | 6 |
| Garrard RC121 Mk. II | £9 | 19 | 6 |
| 4 Speed Single Players, EMI | £6 | 19 | 6 |
| Garrard TA Mk. II | £8 | 8 | 0 |
| Garrard 4 HF | £17 | 19 | 6 |

### THE HI-GAIN BAND 3 PRE-AMP

Cascode circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack. Plans only 6d. Also Band I version same prices. (PCC84 Valve if preferred)

### TELETRON POCKET RADIO KIT

**Transidyne Superhet Six** 6" × 4" × 1¾"

T.C.C. Printed Circuit, internal Ferrite aerial, Rola loudspeaker push-pull output. All parts, cabinet, 6 Ediswan transistors, GEX34 diode. Details 9d. **£9. 9. 0.**

### VOLUME CONTROLS

Midget size: Long spindle. Guaranteed 1 year. All values. 5 K. ohms up to 2 Meg. No switch 3/- D.P. Sw 4/9 Linear or Log Tracks.

### 80 ohm Cable Coaxial

Semi-air spaced. ¼in. dia Ideal Band III **6d.** yd. Losses cut 50% Post 1d. per yard extra. **FRINGE QUALITY** AIRSPACED .... 1/- yd.

COAXIAL PLUGS ....1/- LEAD SOCKETS .... 2/-
PANEL SOCKETS ....1/- OUTLET BOXES .... 4/6
BALANCED TWIN FEEDER per yd. 6d., 80 Ω or 300 Ω
TWIN SCREENED BALANCED FEEDER 1/6 yd., 80 ohm.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled with 4 sides, riveted corners and lattice fixing holes, with 2½in. sides, 7 × 4in., 4/6; 9 × 7in., 5/9; 11 × 7in., 6/9; 13 × 9in., 8/6; 14 × 11in., 10/6; 16 × 14in., 12/6 and 18 × 16 × 3in., 16/6.

BLACK CRACKLE PAINT. Air drying. 3/- tin.
P.V.C. CONN. WIRE, coloured, single or stranded, 2d. yd.
NEON MAINS TESTER SCREWDRIVERS, 5/-.
CORED SOLDER RADIOGRADE, 4d. yd., ½lb., 2/6.
PAXOLIN 1/16in. 8in. × 10in., 1/6. ION TRAPS 5/-.

### PLASTIC RECORDING TAPE

| | |
|---|---|
| Long Play 7in. reel, 1,700ft. | 32/6 |
| 5½in. reel, 1,200ft. | 22/6 |
| 5in. reel, 850ft. | 19/6 |
| 3in. reel, 225ft. | 7/6 |
| Standard 7in. Reel, 1,200ft. | 21/- |
| 5in. reel, 300ft. | 15/- |

"Instant" Bulk Tape Eraser and Head Defluxer, 200/250 v. A.C., 27/6. Leaflet, S.A.E.

RECTIFIERS, RM1, 5/-; RM2, 6/-; RM3, 8/-; RM4, 16/-; RM5, 20/-; FC31, 27/6; 14A86, 17/6; 14A100, 25/-.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 mA., 7/6; 60 mA., 8/6; 85 mA., 9/6; 200 mA., 21/-; 300 mA., 27/6; Full Wave 250 v. 120 mA., 15/-.
COILS. Wearite "P" type, 3/- each. Osmor Midget "Q" type adj. dust core from 4/- each. All ranges.
TELETRON. L. and M. T.R.F. with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 8/9; M. & L., 12/6.
T.R.F. COILS. A/HF, 7/- pair. H.F. CHOKES, 2/6.

JASON F.M. TUNER COIL SET, 28/-. H.F. coil aerial coil, Oscillator coil, two I.F. transformers 10.7 Mc/s., Detector transformer and heater chokes. Circuit and component book using four 6AM6, 2/6. Complete kit FMT1 with Jason Calibrated dial and 4 valves, 26/5/-. With new Jason Cabinet, FMT2, 30/- extra.

CONDENSERS. New Stock. .001 mfd. 7kV. T.C.C., 5/6. 20 kV., 9/6. .1 mfd. 7kV., 9/6. 100pf. to 500pf. Micas, 6d. Tubular 500 v. 0.001 to 0.05 mfd. 9d.; 0.1, 1/-; 0.25, 1/6; 0.5, 1/9; 0.1/350 v., 9d.; 0.1/1,000 v., 1/9; 0.1 mfd., 2,000 v., 3/6; 0.001 mfd., 2,000 v., 1/9.
CERAMIC CONDS. 500 v. 0.3 pf. to 0.01 mfd., 9d.
SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf., 1/3.
CLOSE TOLERANCE (1 ± pf.) 1.5 pf. to 47 pf., 1/6. DITTO 1% 50 pf. to 815 pf., 1/9; 1,000 pf. to 2,000 pf., 2/-.
TRIMMERS. Ceramic, 30, 50, 70 pf., 9d., 100 pf., 150 pf., 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9. Philips. 1/- ea.

### NEW ELECTROLYTICS. TUBULAR

| | | | |
|---|---|---|---|
| 1/350 v. | 2/- | 50/350 v. | 5/6 |
| 2/450 v. | 2/3 | 100/25 v. | 3/- |
| 4/450 v. | 2/3 | 250/25 v. | 3/- |
| 8/450 v. | 2/3 | 500/12 v. | 3/- |
| 8/500 v. | 2/9 | 8+8/450 v. | 4/6 |
| 16/450 v. | 3/6 | 8+8/500 v. | 5/- |
| 16/500 v. | 4/- | 8+16/450 v. | 5/- |
| 32/450 v. | 5/6 | 8+16/500 v. | 5/6 |
| 25/25 v. | 1/9 | 16+16/450 v. | 5/6 |
| 50/25 v. | 2/- | 16+16/500 v. | 6/- |
| 50/50 v. | 2/- | 32+32/350 v. | 4/6 |

### FAMOUS MAKES CAN TYPES

| | | | |
|---|---|---|---|
| 8/500 v. | 3/- | 8+8/500 v. | 6/6 |
| 16/500 v. | 4/- | 8+16/500 v. | 7/- |
| 32/450 v. | 5/6 | 32+32/450 v. | 6/6 |
| 50+50/350 v. | 7/- | 64+120/350 v. | 11/6 |
| 100+200/275v. | 12/6 | | |

FULL WAVE BRIDGE/SELENIUM RECTIFIERS. 2.6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6; 6 a., 22/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v. 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6. Charger circuit free. AMPMETERS, 4 a., and 5 a., 13/6.

### VALVES

90-day guarantee

| NEW and boxed | | | | | |
|---|---|---|---|---|---|
| 1R5 | 7/6 | 6L6G | 10/6 | EA50 | 1/6 |
| 1S5 | 7/6 | 6N7M | 6/6 | EABC80 | 8/6 |
| 1T4 | 6/- | 6Q7G | 7/6 | EB91 | 6/- |
| 2X2 | 3/6 | 6SA7M | 6/- | EBC33 | 8/6 |
| 3S4 | 7/6 | 6SJ7M | 6/6 | EBC41 | 8/6 |
| 3V4 | 7/6 | 6SN7 | 6/6 | EBF80 | 10/- |
| 5U4 | 7/6 | 6V6G | 6/6 | ECC84 | 9/6 |
| 5Y3 | 7/6 | 6X4 | 7/6 | ECF80 | 9/6 |
| 5Z4 | 9/6 | 6X5 | 6/6 | ECH42 | 10/6 |
| 6AM6 | 5/- | 12A6 | 7/6 | ECL80 | 10/6 |
| 6BE6 | 7/6 | 12AT7 | 8/- | ECL82 | 10/6 |
| 6BH6 | 9/6 | 12AU7 | 8/- | EF39 | 5/6 |
| 6BW6 | 9/6 | 12AX7 | 8/- | EF41 | 9/6 |
| 6D6 | 6/- | 12BA6 | 8/6 | EF50 | 5/6 |
| 6FG6 | 7/6 | 12BE6 | 8/6 | EF80 | 8/- |
| 6H6GT | 3/6 | 12K7 | 6/6 | EF86 | 14/6 |
| 6J5 | 5/6 | 12Q7 | 6/6 | EF92 | 5/6 |
| 6J6 | 5/6 | 35L6 | 9/6 | EL32 | 5/- |
| 6J7G | 6/6 | 35Z4 | 7/6 | EL41 | 9/6 |
| 6K6GT | 6/6 | 80 | 9/6 | EL84 | 8/6 |
| 6K7G | 5/- | 807 | 5/6 | EZ40 | 7/6 |
| 6K8G | 7/6 | 954 | 1/6 | EZ80 | 7/6 |

| | | | |
|---|---|---|---|
| EY51 | 9/6 | | |
| EY86 | 10/- | | |
| EABC80 | 12/6 | | |
| HVR2A | 6/6 | | |
| MU14 | 9/- | | |
| P61 | 3/6 | | |
| PCC84 | 9/6 | | |
| PCF80 | 9/6 | | |
| PCL82 | 11/6 | | |
| PEN25 | 6/6 | | |
| PL82 | 10/6 | | |
| PY80 | 7/6 | | |
| PY81 | 9/6 | | |
| PY82 | 7/6 | | |
| 8P61 | 3/6 | | |
| UBC41 | 9/6 | | |
| UCH42 | 9/6 | | |
| UF41 | 9/6 | | |
| UL41 | 9/6 | | |
| UY41 | 8/- | | |
| U22 | 8/- | | |
| U52 | 7/6 | | |

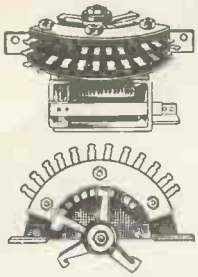
# RADIO COMPONENT SPECIALISTS

48 HOUR MAIL ORDER

337 WHITEHORSE RD. WEST CROYDON

THO. 1665. Buses 133 or 68

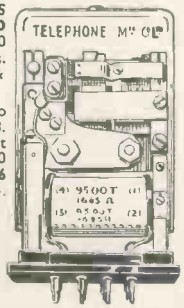
POSTAL SERVICE 1/-, OVER £2 FREE. C.O.D 1/6 (EXPORT C.W.O. POST EXTRA) Wed. 1 p.m.

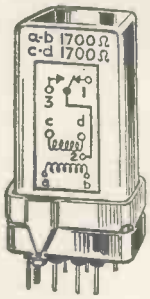


**MINIATURE UNISELECTOR SWITCH.** Two banks of ten plus home contacts one bank continuous of normal. 30 ohm coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6. As illustrated.

**NEW CARPENTER'S TYPE POLARISED RELAYS.** 2 x 9,500 turns at 1,685 ohms. Price 22/6 each. P. & P. 1/-.

Carpenter's, similar to above, but type 5A48. Coils 1 x 3200 turns at 100 ohms and 1 x 2000 turns at 145 ohms, 22/6 each. P. & P. 1/-. Bases for same 2/6.




**SIEMENS H.S. RELAY.** Very latest type, sealed. H96E. 1,700 ohms. plus 1,700 ohms, single C.O. contacts, Brand new with fixing clip. In maker's cartons. Price 16/6 each, plus 1/- P. & P.

Siemens sealed similar relay to above, but 2.2 ohms plus 2.2 ohms. Minus clips, 12/6 each. Plus 1/- P. & P.

**MINIATURE MOVING COIL DIFFERENTIAL RELAY.** Two coils 350 ohms each. Operating current minimum 140 microamp., nominal 400 microamp, maximum 8 milliamp. One pole two way, or, centre stable. Two way contact current 100 mA. at 50 V. A.C. or D.C. Size 1¼ x ⅝ x ¾in. Price 22/6 each.

**A VERY SUPERIOR BRAND NEW RELAY IDEAL FOR MODEL WORK.** 7,000 ohms coil. Will pull in at 750 microamp. and out at 450 microamp. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2½ oz. Price 18/6. P. & P. 1/-.

**U.S.A. 27-volt 4-pole CHANGE-OVER RELAYS.** Brand new and boxed, 5/6 each. P. & P. 6d.

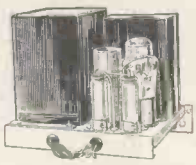
**ROTARY RELAY.** 12 volt. Heavy duty change-over contacts and one low current for external circuit, plus one break set. Price 7/6. P. & P. 1/6.

**NEW WIRE WOUND RHEOSTAT ON CERAMIC.** 58 ohm. 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

**W. W. RHEOSTAT.** New. 3.5K or 5K 25 watts. Price 7/6. P. & P. 1/6.

**EX P.O. MAGNETIC COUNTER.** 3 ohms type for 4½/6 volt D.C. operation. Price 6/6 each. P. & P. 1/-.

**AS ABOVE** 500 ohm for 24/36 volt D.C. operation. Price 6/6 each. P. & P. 1/-.

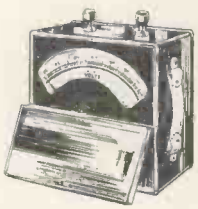


**MAINS POWER SUPPLY UNITS** Potted and sealed transformer and choke by famous maker. Mounted on metal chassis 6½ x 7½in., complete with 5Z4 rectifier valve and full smoothing. Input tapped 220-230-240 volts.
Output: 300 V. D.C. at 100 mA.
6.3 V. A.C. at 4.5 amp.
6.3 V A.C. at 2 amp.
Rectifier supply 5 V. A.C. at 3 amp. Very conservatively rated. Price 42/6 plus P. & P. 6/6.

**DESK TELEPHONE HANDSETS** Brand new (perfect) complete with two-way calling system (buzzer), internal battery. All ready for simple two-wire connection. Price £3/5/- each, or £6/5/- the pair. P. & P. 3/6 each unit.

**BRAND NEW FREQUENCY METERS manufactured by Crompton Parkinson. Calibrated 45 cycles to 55 cycles per second. 6" dial. Panel mounting type. In original manufacturers' boxes. PRICE £10.15.0 each. Postage 3/6.**

**AUTO TRANSFORMERS.** Step up, step down, 110–200–220–240 v. Fully shrouded. New. 300 watt type £2/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each. P. & P. 6/6.



**LABORATORY PRECISION VOLTMETER.** Brand new in polished teak case. Moving Iron instrument reading D.C. or A.C. 0-160 volt on 8in. mirror scale. Accuracy 2% £4/19/6 each. P. & P. 3/6.

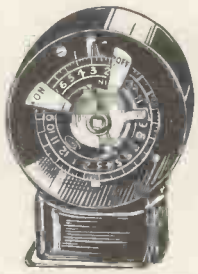
**BRAND NEW SOUND POWER OPERATED EX ADMIRALTY HEAD AND BREAST SETS.** Two such sets connected up will provide perfect intercomm., no batteries required. Will operate up to ½ mile. Original manufacturer's boxes. Price 17/6 each, plus P. & P. 2/-; or 32/6 per pair. P. & P. 3/-.

**MUIRHEAD PRECISION,** 4 bank, 1 pole 24 position Stud Switch. Heavy duty contacts. Brand new, Original boxes. Price 17/6 each. P. & P. 1/-.

**CERAMIC PRECISION SWITCH.** 2 pole, 6 way, 4 banks. New in manufacturer's boxes. Price 10/6. each. P. & P. 1/6.

**MINIATURE INSTRUMENT RECTIFIERS,** Bridge Type 1 milliamp. Guaranteed perfect, 7/6 each.

**8-day clockwork Time Switch.** Contacts 2½ amp., 230 volt, 24 hour phase, ¼ hour divisions, allow setting for one make and one break to be made every 24 hours. complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 1/6.



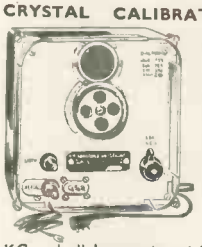
**METERS GUARANTEED PERFECT**

| | |
|---|---|
| **Charging Types** | |
| 2½ amp.D.C. M.I. 2in. fl. rnd. | 7/6 |
| 5 amp. D.C. M.I. 2½in. fl. rnd. | 11/6 |
| 7½ amp. D.C. M.I. 3½in. proj. rnd. | 12/6 |
| 9 amp. D.C. Hot Wire W.R. 2½in. fl. rnd | 6/6 |
| **Voltmeters** | |
| 12 v. D.C. M.C. 2½in. proj. rnd. | 8/6 |
| 20 v. D.C. M. C. 2in. fl. sq. | 9/6 |
| 25 v. D.C. M.C. 2in. fl. rnd. | 7/6 |
| 30 v. M.I. 3in. proj. rnd. | 10/6 |
| 40 v. M.C. 2in. fl. sq. | 9/6 |
| 300 v. A.C. M.I. 2½in. fl. rnd. | 22/- |
| 400 v. A.C. M.I. 4½in. fl. rnd. | 35/- |
| **Milliammeters** | |
| 1 mA. M.C. 2½in. fl. rnd. | 25/- |
| 2 mA. M.C. 2½in. fl. rnd. | 14/6 |
| 500 mA. M.C. 2½in. fl. rnd. | 9/6 |
| **Microamp.** | |
| 50 microamp., scaled 0–100, M.C. 2½in. fl. rnd. | 42/6 |
| 200 microA., M.C. 2½in. fl. rnd. (calibrated 0–50) | 24/6 |
| 50 microA. 2½in. squares, idefitting 3 scales | 35/- |
| 500 microA. M.C. 2in. rnd. | 16/6 |

*Postage on all meters 1/- each.*

Miniature latest type moving coil 0-5 milliamp meter, 1½in. diameter, flush fitting complete with fixing clip. Price 17/6. P. & P. 1/-.

**CRYSTAL CALIBRATOR No. 10.** A crystal controlled 4-valve high-grade instrument in the same category as the famous B.C.221. DIrectly calibrated, does not require cross reference or charts — functions as follows: (1) A crystal controlled ocsillator which provides fixed frequency signals of 500 KC and all harmonics of 500 KC to beyond 10 Meg. and up to 30 Meg.



(2) A variable oscillator from 250 KC to 5 KC, this enables all intermediate frequencies between 250 Kc/s. and 30 Meg. to be produced and modulated.
Supplied complete with 3 spare valves, all leads and maker's instruction book in carrying haversack. The complete outfit is brand new—repeat NEW. Price: £4/19/6. Carr. 3/-.

**TWELVE PLATE F.W. BRIDGE CONNECTED RECTIFIER** mounted on 200/250 volt A.C. input transformer. Output 36/40 volt D.C. at 1.2 amps. New, perfect. Price 16/6. P. & P. 3/6.

**SOLENOID OPERATED MAGNETIC RELAY.** Type 5CW/3945, 4 pole changeover, 10A contacts 24v. operation. Brand new 13/6 P. & P. 1/6.

**WE ARE EXPERTS AT OVERSEAS PACKING & SHIPPING!**

# SERVICE TRADING Co.

*PERSONAL CALLERS ONLY:* **8 Little Newport Street, London, W.C.2.** *Tel: GER 0576*
*ALL MAIL ORDERS:* *(Early Closing Thursday.)*
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*Telephone: KINgston 4585*

## R.S.C. HI-FI TAPE RECORDER KIT

OR DEPOSIT 3 GNS. and 12 monthly payments of 45/9. Cash price if settled in 3 months.

*Build a high quality recorder in the £70 class for only* **25½ GNS.** Carr. 17/6.

**Can be assembled in ½ to 1 hour.**

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR, THE LINEAR LT45X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7×4in. LOUDSPEAKER, Reel of Best Quality TAPE. Spare Tape Spool, a Portable Cabinet, size approx. 16×13×9in., finished in two-tone rexine, and connection diagram for wiring amplifier to transcriptor.

FEATURES INCLUDE

★ 3 SPEEDS. ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZATION FOR EACH SPEED. ★ OUTPUT 4 WATTS. ★ MAGIC EYE RECORDING LEVEL INDICATOR. ★ 3 MOTORS. Fast rewind. ★ TAPE MEASURING AND CALIBRATING DEVICE. ★ TAKES FULL 7in. DIAMETER REELS OF TAPE. ★ NEGLIGIBLE HUM. ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.

Full descriptive leaflet supplied on receipt of S.A.E.

## HI-FI 10 WATT AMPLIFIERS

BRAND NEW BUT IN SLIGHTLY SOILED CONDITION **£5-19-9** Carr. 7/6

A REMARKABLE OPPORTUNITY

Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs, for mike and gram. Separate bass and treble controls. High sensitivity. Output for 15 ohm loudspeaker. Guaranteed, tested, and in perfect working order.

**VALVES!** Full range at really competitive prices All guaranteed!

### 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/charger is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided The W. Ch. Sw. incorporates Gram-position. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV. input depending on Ae location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

**WAYNE KERR SIGNAL GENERATORS** Type CT53. 3-9 to 300 megacycles. Suitable for aligning V.H.F. Radio or TV. receivers. Output 1 microvolt to 10 millivolts. Worth approx. £100. Few only at 19 Gns. with charts.

## METERS

0-50 micro-ammeters, 2½in. scale, scaled 0-100. **39/6.**

0-500 micro-amp., 3½in. scale, scaled in decibels. **59/6.**

Ferranti Multimeters, D.C. and A.C., complete in carrying case, **59/6.**

### ACOS HI-FI CRYSTAL 'MIKES'

Mic 40 hand or Desk type **27/9** (Listed 45/-)

39-1 Stick type **39/6** (Listed 5 Gns.)

Limited number.

## R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½×4½×2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagram **39/9** or ready for use **46/9.**

Type BM2. Size 8×5½×2½in. 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 H.T. 2 v. ACCUMULATORS** when connected to A.C. mains supply 200-250 v. 50 c/s. **SUITABLE FOR ALL BATTERY RECEIVERS** normally using 2 v. accumulator.

Complete kit with diagrams and instructions. **49/9** or ready for use **59/6.**

**BUILD A PORTABLE BATTERY OPERATED RECORD PLAYER FOR ONLY £6/19/6.** Portable Cabinet, Garrard 45 r.p.m. motor and pick-up unit, all parts for transistor amplifier, and circuit diagrams. Parts sold separately.

## THE SKY FOUR T.R.F. RECEIVER

A design of a 3 valve 200-250 v. A.C. mains L. and M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, SP61, 6F6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point wiring diagram. 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.

**EXTENSION SPEAKERS.** Handsome walnut veneered cabinets. All standard 2-3 ohms. 6½in. 29/9; 8in. 35/9.

**PARMEKO RE-ENTRANT LOUDSPEAKERS.** Horn type for factory or outdoor use. Highly efficient, will handle up to 10 watts. Matching 15 ohms or 200 ohms. Brand New. Boxed. **59/6.** Carr. 5/6.

## R.S.C. A12 STEREO AMPLIFIER KIT

A complete kit of parts to construct a good quality 3 + 3 watt (total 6 watt) stereo amplifier providing really life-like reproduction. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains Astonishing value.

**4 GNS.** Carr. and packing 7/6.

### W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS

HF1012, 10 watts, 15 ohms (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. **£4/10/9.** Please state whether 3 ohm or 15 ohm required.

### SELENIUM RECTIFIERS

We can quote special prices for quantities of 12 to 10,000 of most types. Special types made to order.

| L.T. Types | |
|---|---|
| 2/6 v. ½ a. h.w. .. | 1/9 |
| 6/12 v. 1 a. h.w. .. | 2/9 |
| Following F.W. (Bridge) | |
| 6/12 v. 1 a. ..... | 3/11 |
| 6/12 v. 2 a. ..... | 6/11 |
| 6/12 v. 3 a. ..... | 9/9 |
| 6/12 v. 4 a. ..... | 12/3 |
| 6/12 v. 5 a. ..... | 14/6 |
| 6/12 v. 6 a. ..... | 15/6 |
| 6/12 v. 10 a. .... | 25/9 |
| 6/12 v. 15 a. .... | 35/9 |

| H.T. Types H.W. | |
|---|---|
| 120 v. 40 mA. .... | 3/9 |
| 250 v. 50 mA. .. | 3/11 |
| 250 v. 60 mA. .... | 4/11 |
| 250 v. 80 mA. .... | 6/11 |
| 250 v. 250 mA. .. | 12/9 |
| Contact Cooled | |
| 250 v. 80 mA. .... | 6/11 |
| 250 v. 75 mA. .... | 8/11 |
| F.W. (Bridge) | |

**JACK PLUGS.** Standard type complete with 4ft. screened lead. **1/11** each.

**JUNCTION TRANSISTORS.** R.F. Type. **11/6.** Audio type. 5/9. Power type Goltop V15/10P 2 watts. **17/9.** OC71, 10/-. OC72 17/-. XB102 10/-. XB104 10/-. XA101, OC44, XA102 17/6, and many other types.

**RECORDING HEADS.** Baird Record Playback and Erase. (Housed in one container.) 9/6 pr.

## All Battery Chargers and Kits for 200-230-250 v. 50 c/s. A.C. Mains

### HEAVY DUTY CHARGER KIT

**6/12 v.** variable charge rate up to **6 amps.** Consisting of Mains Trans., F.W. (Bridge) Selenium Rectifier, 0-7 amp. meter, multi-position switch with knob, fuses, fuse-holders, panels, plugs, and circuit. Only **59/6** Post 4/6.

**TANNOY RE-ENTRANT LOUDSPEAKERS.**
8 watt
7.5 ohms ..... **19/6**
Or a pair for .... **35/-**

### ASSEMBLED CHARGERS

| | |
|---|---|
| 6 v. 1 a. ..... | 19/9 |
| 6 v. 2 a. ..... | 29/9 |
| 6/12 v. 1 a. ..... | 29/9 |
| 6/12 v. 2 a. ..... | 38/9 |
| 6/12 v. 4 a. ..... | 56/9 |

Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. & pkg 3/6.

### CHARGER TRANSFORMERS

| | |
|---|---|
| 200-230-250 v. 50 c/s. | |
| 0-9-15 v. 1½ a. ... | 12/9 |
| 0-9-15 v. 2½ a. ..... | 15/9 |
| 0-9-15 v. 3 a. ..... | 16/9 |
| 0-9-15 v. 5 a. ..... | 19/9 |
| 0-9-15 v. 6 a. ..... | 23/9 |

### BATTERY CHARGER KITS

Consisting of Mains Transformer F.W. Bridge, Metal Rectifier well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9. extra.

| | |
|---|---|
| **6 v. or 12 v. 1 amp.** ..... | 24/9 |
| As above, with ammeter ... | 32/9 |
| **6 v. 2 amps.** ..... | 25/9 |
| **6 v. or 12 v. 2 amps.** ..... | 31/6 |
| **6 v. or 12 v. 2 amps.** ..... (inclusive of ammeter) | 42/9 |
| **6 v. or 12 v. 4 amps.** ..... | 53/9 |
| **6 v. or 12 v. 4 amps.** with variable charge rate selector and ammeter ..... | 59/9 |

### CHARGER AMMETERS

0-1.5 amp., 0-3 amp., 0-4 amp., 0-7 amp., 0-25 amp., 0-60 amp. **8/9**

### ASSEMBLED CHARGER

**6 v. or 12 v. 2 amps.** Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only Carr. 3/9. **49/9**

As above, but for 3 amp. charging. Only **59/6.** Carr. 3/9

### ASSEMBLED 6 v. or 12 v. 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. 5/-. Or Deposit **13/3** and 5 monthly payments of **13/3.** **69/9**

As above, but for 6 amp. charging **4 GNS.** Carr. 5/-. Or Deposit **16/-** and 5 monthly payments of **16/-.** The 6 amp. model only is slightly store soiled and is being offered at well below usual price.

**VIBRATORS.** Oak and Wearite, synchronous 7-pin, 2 v. **7/9,** 6 v. 8/3, 12 v. 4-pin non-synchronous **7/9.**

**2 v. 16 A.H. EX. GOVT. ACCUMULATORS.** New Boxed. Only 5/6 each, 3 for **15/-,** plus 3/6 carr.

### EX. GOVT. MAINS TRANSFORMERS

All 200-250 v. 50 c/s. input.
Pr. 0-110-200-230-250 v., 275-0-275 v., 100 mA., 6.3 v. 7 a., 5 v. 3 a. ..... 22/9
250 v. 60 mA., 6.3 v. 2 a. ..... 10/11
300-0-300 v. 60 mA, 6.3 v. 2 a. ..... 11/9
265-0-265 v. 150 mA., 6.3 v. 11 a., 5 v. 3 a., 5 v. 3 a. 29/11
350-0-350 v. 100 mA., 6.3 v. 2 a., 5 v. 2 a. ..... 18/9
0-24-26-28 v. 15 amps. A.C. conservative Govt. rating (marked with D.C. rating after rectification) **89/9.** Carr. 15/-.
0-10-20-25 v. 24 a. (Govt. rating) **79/6.** Carr. 15/-.
AUTO 500 watts 0-215-220-225-230-235-240 v. .. 29/9
Carr. 7/6. 50 watts, 0-110/120-230/250 v. ..... 8/11

**D.C. SUPPLY KITS.** Suitable for electric trains. Consists of mains trans. 200-250 v. 50 c.p.s.; 12 v. 1 amp. selenium rect. (F.W. Bridge): 2 fuseholders, 2 fuses, change direction switch, variable speed regulator, partially drilled steel case and circuit. Very limited number, **33/9.**

**EX. GOVT. SMOOTHING CHOKES**
200 mA., 3-5 H., 50 ohms. Parmeko **8/9;** 100 mA., 5 H., 100 ohms 3/11; 150 mA., 10 H., 50 ohms 9/9; 80 mA., 20 H., 900 ohms 5/9; 120 mA., 12 H., 100 ohms **8/9;** 50 mA., 50 H., 1,000 ohms 6/9; 100 mA., 10 H., 100 ohms 6/9; 60 mA., 5-10 H., 250 ohm. 2/11.

**EX. GOVT. CASES.** Well ventilated, black crackle finished, undrilled cover. Size 14×10×8½in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.

**POWER PACK KITS.** Only **18/11.** Fully smoothed H.T. output of 250 v. 60 m.a., and L.T. supply of 6.3 v. 1.5 amp. Consisting of Double Wound Mains Transformer 230/250 v. 50 c.p.s. A.C. primary. Selenium Rectifier, Smoothing Choke, Double Electrolytic Condenser, Aluminium Chassis and Circuit.

**P.M. SPEAKERS.** 2-3 ohm 2½in. Perdio 21/9. 5in. Goodmans 17/9. 7×4in. R.A. Elliptical 19/9. 6½in. Rola 19/9 8in. Rola 19/9. 8in. Goodmans 25/9. 8×6in. Elac with high flux magnet 25/9. 10in. R.A. 28/9. 10×6in. Elliptical Goodmans 29/9, 12in. R.A. 29/11. 12in. R.A. 8 or 15 ohms. 10 watts, 12,000 lines, **59/6.**

**TWEETERS,** 4in. Plessey, 3 ohms, **18/9.** R.A. 15 ohm 25/9.

# R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86 EF86, ECC38, 807, 807, GZ34. Tone Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt 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. Or Factory built with 12 months' guarantee £13/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 12 monthly payments of 24/9.

ONLY **11 Gns.** Carr. 10/-

Cover as illustrated 18/9 extra.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE. Frequency response ± 3 D.B. 30-2,0000 c/cs. Tone Controls ± 12 D.B. at 50 c/cs. + 12 D.B. to − 6 D.B. at 12,000 c/cs., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12×9×9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS, IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.

**FULL RANGE OF LINEAR HIGH FIDELITY AMPLIFIERS ALWAYS IN STOCK.**

**LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER.** Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. Bass and Treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves. Size only 6×5×5½in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5/19/6** Or Deposit 22/- and 5 monthly payments of 22/-. Send S.A.E. for leaflet.

**GL3A MINIATURE 3 WATT GRAM AMPLIFIER**

For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11½×2½×2½in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only 59/6.

**R.S.C. A7 3-4 WATT QUALITY AMPLIFIER.** Spec. exactly as A5 below with exception of output voltage. Complete kit of parts, diagrams and instructions £3/15/-, carr. 3/6.

**R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER**

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is so slight being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/- or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

## R.S.C. TRANSFORMERS. Fully Guaranteed. Interleaved and Impregnated.

**MAINS TRANSFORMER. Primaries 200-230-250 v. 50 c/s.**

**FULLY SHROUDED UPRIGHT MOUNTING**

| | |
|---|---|
| 250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a. | 17/6 |
| 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. | 25/9 |
| 300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. | 25/9 |
| 350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. | 25/9 |
| 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. | 33/9 |
| 425-0-425 v. 200 mA., 6.3 v. 4 a., c.t. 5 v. 3 a. | 49/9 |

**TOP SHROUDED DROP-THROUGH TYPE**

| | |
|---|---|
| 260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. | 16/9 |
| 350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a. | 18/9 |
| 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. | 23/9 |
| 300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. | 23/9 |
| 300-0-300 v. 120 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a., suitable for Mullard 510 Amplifier | 29/9 |
| 350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. | 23/9 |
| 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. | 29/9 |

**ELIMINATOR TRANSFORMERS.** Primaries 200-250 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 |

**FILAMENT TRANSFORMERS.** Primaries 200-230 v. 50 c/s.

| | | | |
|---|---|---|---|
| 6.3 v. 1.5 a. | 5/9 | 12 v. 1 a. | 7/3 |
| 6.3 v. 2 a. | 7/6 | 6.3 v. 3 a. | 8/11 |
| 0-4-6.3 v. 2 a. | 7/9 | 6.3 v. 6 a. | 17/6 |

**OUTPUT TRANSFORMERS**

| | |
|---|---|
| Midget Battery Pentode 66:1 for 3S4, etc. | 3/9 |
| Small Pentode 5,000Ω to 3Ω | 3/9 |
| Standard Pentode 5,000Ω to 3Ω | 5/9 |
| Standard Pentode 8,000Ω to 3Ω | 5/9 |
| Push-pull 8 watts 6V6 to 3 ohms | 8/9 |
| Push-pull 8 watts EL84s to 15 ohms | 8/9 |
| Push pull 10-12 watts 6V6 to 3Ω or 15Ω | 16/9 |
| Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω | 17/9 |
| Push-pull EL84 to 3 or 15 ohms | 17/9 |
| Push-pull Ultra Linear for Mullard 510 | 27/9 |
| Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., for 3 or 15 ohms | 23/9 |
| Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω | 47/9 |

**SMOOTHING CHOKES**

| | | | |
|---|---|---|---|
| 250 mA., 5 H., 100Ω | 11/9 | 80 mA., 10 H., 350Ω | 5/6 |
| 150mA., 7-10H., 250Ω | 11/9 | 60 mA., 10 H., 400Ω | 4/11 |
| 10 mA., 1 H., 200Ω | 8/9 | 1 amp. 0.5Ω L.T. type | 6/6 |

**PARMEKO MAINS TRANSFORMERS** Fully shrouded.

| | |
|---|---|
| 450-0-450 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a. | 29/9 |
| 500-0-500 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a. | 31/9 |

***STOP PRESS: All deposits must now be 20% of the cash price.***

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**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 stated. Trade supplied. Post orders to **Mail Order Dept. 29-31 Moorfield Road, Leeds, 12.**

# HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

**PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES**

Two input sockets with associated controls allow mixing of "mike" and gram. as in A.10. High sensitivity. Includes 5 valves: ECC83, ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ± 3 D.B. 30-30,000 c/cs. Six negative feedback loops. Hum level 60 D.B. down, ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx.: 12.9-7in. For A.C. mains 200-250 v. 50 c/cs. Output for 3 and 15 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 45/- extra). ONLY **8 Gns.** Carr. 10/-. If required louvred metal cover with 2 carrying handles can be supplied for 18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 18/9, and 12 monthly payments of 18/9. Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones, etc., with cash and credit terms.

## R.S.C. PORTABLE GUITAR AMPLIFIERS

**JUNIOR 5 WATT.** High Quality Output. Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 mv. High Flux 8in. 1/speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /instrument Pick-up. Handsome strongly made cabinet (size approx. 14×14×7in.). Finished in satin walnut and fitted carrying handle.

**£8/19/6** Carr. 7/6. Or Deposit £1 and nine monthly payments £1.

Send S.A.E. for leaflet.

**SENIOR 10 WATTS.** High Fidelity Push Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated, a 12in. P.M. for Bass notes, and 1 7×4in. elliptical for Treble. Cabinet is well made and finished satin walnut. Size approx. 18×18×8in. 15 Gns. Plus 10/- carr. H.P. TERMS. DEPOSIT 28/9 and 12 monthly payments 28/9. Both models for 200-250 v. A.C. mains.

**STAAR GALAXY 4-SPEED MIXER AUTO-CHANGERS.** Brand New, cartoned. Turnover sapphire styli. Many exclusive features. Unique design motor virtually free from rumble. For 200/250 v. A.C. mains. Limited number tested and guaranteed, £5/19/6. Carr. 4/6.

**COLLARO CONQUEST 4-SPEED AUTO-CHANGERS.** With studio pick-up with turnover head. BRAND NEW. Cartoned. Latest model For 200-250 v. A.C. mains. £7/19/6. Carr. 4/6.

**B.S.R. MONARCH AUTO-CHANGER.** Type UA8, 4 speed t/o Pick-up with sapphire stylus £7/19/6. Carr. 4/6.

**COLLARO JUNIOR.** 4-speed Single Players with Hi-Fi T/O crystal pick-up head. £3/19/6.

**LOUDSPEAKER IN POLISHED WALNUT FINISHED CABINET.** Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only £4/19/6. Carr. 5/-. TERMS: DEPOSIT 11/- and 9 monthly payments of 11/-.

12in. 20 WATT 15,000 line t/speakers 15 ohms, in Cabinet finished as above. Size 18×18×8in £7/19/6 or Deposit 13/10 and 12 monthly payments 13/10.

**ACOS HGP59 Hi-Fi Crystal Cartridges.** (Turnover type with sapphire stylus.) Standard replacement for Garrard and Collaro. Only 19/9. B.S.R. Pul-Fi 19/9. Garrard GC2 19/9.

**ACOS HIGH FIDELITY PICKUPS.** GP54 with HGP59/52 cartridge. Turnover sapphire styli, cream finish. Limited number at approx. half price. Only 29/11.

**PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS**

(15 ohms), consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only £5/17/6 Or Deposit 10/6 and 12 monthly payments of 10/6

# STERN'S MULLARD DESIGNS

## COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification

### MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-Linear PARMEKO or the PARTRIDGE Output Transformer

Price: COMPLETE KIT (Parmeko O/put Trans.)..... **£10.0.0**

Alternatively we supply ASSEMBLED AND TESTED **£11.10.0**

ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

### MULLARD'S PRE-AMPLIFIER TONE CONTROL UNIT

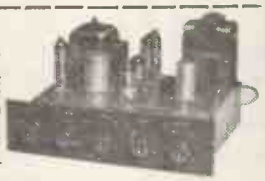
Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIER, but also perfectly suitable for other makes. Supplied strictly to MULLARD SPECIFICATION and incorporating:

- Equalisation for the latest R.I.A.A. characteristics.
- Input for Crystal Pick-ups and variable reluctance magnetic types.
- Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
- Sensitive Microphone Channel
- Wide range BASS and TREBLE Controls.

Price: COMPLETE KIT OF PARTS **£6.6.0**

Alternatively we supply. ASSEMBLED AND TESTED **£8.0.0**

### COMPLETE MULLARD 5-10 AMPLIFIER



The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction.
Specified components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE ULTRA Linear Output Transformers.

Price: COMPLETE KIT. Parmeko Transformer..... **£11.10.0**

Alternatively we supply ASSEMBLED AND TESTED.. **£13.10.0**

Hire Purchase (Assembled Amp. only). Deposit £2/14/-, 12 months at 19/10.

ABOVE incorporating PARTRIDGE OUTPUT TRANSFORMER £1/6 -extra.

### COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OF PARTS ..... **£7.10.0**
(Plus 6/6 carriage and insurance).
Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance).... **£8.19.6**

H.P. TERMS: Deposit £2 and 8 monthly payments of £1.

Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

### COMPLETE STEREO AMPLIFIER

A thoroughly recommended design that very effectively meets the many requests for a low priced but good quality DUAL CHANNEL STEREOPHONIC AMPLIFIER.

Price: COMPLETE KIT OF PARTS **£8.10.0**

Alternatively ASSEMBLED AND TESTED.. **£10.10.0**

Two Mullard ECL82 Triode Pentode Valves are incorporated in the design, they form a "CLASS A" single ended output stage in each channel. The input sensitivity is 300 m/volts, therefore when used with most STEREO Crystal Pick-ups, or Radio Tuning Units, an output of 2 watts per channel is achieved, or similarly when switched to MONAURAL Pick-up position a combined output of 4 watts is produced.

### SPECIAL CASH ONLY OFFER!!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY **£8.7.6** (plus 7/6 carr. and ins.). The Amplifier consists of a 2-stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey Colour Rexine—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-stage (plus Rectifier) AMPLIFIER £4 2 6
(b) The PORTABLE CARRYING CASE £3 17 6
(c) 6½in. P.M. SPEAKER ..... 18 9

(Carriage and Insurance 4/- extra).

### "Hi-Fi" LOUDSPEAKERS

WE HAVE IN STOCK A COMPLETE RANGE BY
GOODMANS WHARFEDALE
W.B. STENTORIAN
ILLUSTRATED AND PRICED LEAFLETS ON REQUEST

### ! ! HOME CONSTRUCTORS ! !

**A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS**

Designed by the W.B. "STENTORIAN" COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" Speakers give really first-class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Pre-amplifiers, Tuning Units, Record Players, etc. All models are very easily assembled in fact only a screwdriver is required.
Fully illustrated leaflets are available including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please enclose S.A.E.

Please enclose S.A.E. if ILLUSTRATED and DESCRIPTIVE LEAFLETS are required . . . alternatively the COMPLETE ASSEMBLY MANUALS containing component Price List and practical Drawings, etc., are available at 1/6 each.

## SPECIAL PRICE REDUCTIONS

(c) The COMPLETE KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-Stage Pre-Amplifier Control Unit..... **£15.15.0**

(d) The "5-10" and the 2-Stage Pre-Amplifier both Assembled and Tested ..... **£18.18.0**
H.P. TERMS: Deposit £3/16/- and 12 months of £1/7/8.

(e) The COMPLETE KIT OF PARTS to build the Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit..... **£21.10.0**

(f) The Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested..... **£25.0.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16/8.

(g) The COMPLETE KIT OF PARTS to build one "5-10" Main Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier Control Unit ..... **£21.10.0**

(h) One "5-10" Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier both Assembled and Tested ..... **£25.0.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16/8.

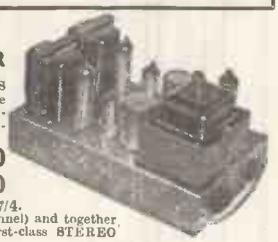
(i) COMPLETE KIT OF PARTS to build Two "5-10" Main Amplifiers (incorporating Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit ..... **£31.0.0**

(j) Two "5-10" Amplifiers (Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested ..... **£36.0.0**
H.P. TERMS: Deposit £7/4/- and 12 months of £2/12/-.

Carriage and insurance 7/6 extra.

Prices quoted are subject to £1/6/- extra for Partridge Trans.

### STEREO 3-3 MAIN AMPLIFIER



Comprises two "3-3" MAIN AMPLIFIERS on one chassis and is designed to operate with our DUAL CHANNEL PRE-AMPLIFIER for both STEREOPHONIC or MONAURAL operation.

Price: COMPLETE KIT OF PARTS ..... **£10.0.0**
Alternatively ASSEMBLED AND TESTED ..... **£11.15.0**
H.P. Terms: Deposit £2/7/-, 12 months at 17/4.
Its output power is 6 watts (3 watts per channel) and together with our PRE-AMPLIFIER provides a first-class STEREO installation.

### STEREO DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREOPHONIC or MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 m/v.

Price: COMPLETE KIT OF PARTS **£12.10.0** Alternatively ASSEMBLED and TESTED..... **£15.0.0**
H.P. Terms: £3 Deposit and 12 months of £1/2/-.
Perfectly suitable for MONAURAL only operation, with one "3-3" or one "5-10" MAIN Amplifier to which the second Main Amplifier can at any time be added thus very easily providing for both STEREO or MONAURAL reproduction.
Recommended combination for STEREO operation.

(a) The DUAL CHANNEL PRE-AMPLIFIER together with the Dual "3-3" MAIN AMPLIFIER.
(b) The DUAL CHANNEL PRE-AMPLIFIER together with two "5-10" MAIN AMPLIFIERS. Assembly Manual is available for 3/- or send S.A.E. for Descriptive Leaflet. When ordering please advise MAKE and MODEL OF AMPLIFIER in use.

### ! ! RECORD PLAYERS ! !

**The LATEST MODELS are in Stock. Many at REDUCED PRICES!!!**

**Send S.A.E. for ILLUSTRATED LEAFLET**

B.S.R. MONARCH UA8 4-spd. Mixer Autochanger with Crystal Pick-up. **£6.19.6**

The COLLARO "CONQUEST" 4-spd. Autochanger, Studio "O" Pick-up. **£7.10.0**

The latest COLLARO "CONTINENTAL" 4-speed MIXER Autochanger. Studio "C" Pick-up.... **£8.10.0**

The NEW COLLARO model RP594, 4-speed Single Record Player, Studio Cartridge ..... **£9.18.9**
The COLLARO 4-speed Single Record Player, incorporating the Studio "O" Pick-up ..... **£6. 9.6**
THE NEW B.S.R. model UA12 is in stock. A 4-"SPEED" MIXER AUTOCHANGER ..... **£8. 7.6**
UA12 is also available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records ..... **£10.10.0**
GARRARD RC210 4-speed Autochanger fitted with latest Crystal Pick-up ..... **£10.10.0**
The latest GARRARD TRANSCRIPTION MOTOR "301" with Stroboscopically marked turntable ..... **£23.18.4**
The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.S. Crystal Cartridge **£18. 7.6**
GARRARD Model TA/Mk. II Single Record Player fitted with high output Crystal Pick-up, detachable head ..... **£8.10.0**

HIRE PURCHASE TERMS available on all units £3/19/6 and over
Carriage and Insurance on each above 5/- extra.

**STERN RADIO LTD.** DEPT. W. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

# Stern's "fidelity" TAPE EQUIPMENT

## A SELECTION OF HIGH FIDELITY PORTABLE TAPE PRE-AMPLIFIERS

*Adds "Hi-Fi" Tape Recording to your existing Audio Installation.*

IN ALL MODELS WE INCORPORATE THE

**TYPE "C" PRE-AMPLIFIER**

*and offer it complete in portable case with . . .*

(a) The new "COLLARO" STUDIO 3 speed Deck. Deposit: £7/6/-. 12 months £2/13/6..... **£36.10.0**

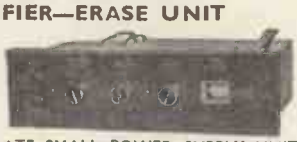
(b) The COLLARO Mk. IV "Transcriptor" 3 Speed Deck. Deposit: £8/6/-. 12 months £3/0/11..... **£41.10.0**

(c) The new TRUVOX Mk. VI Tape Deck. Deposit: £8/14/-. 12 months £3/3/10..... **£43.10.0**

(d) The BRENELL Mk. V 3 Speed Deck. Deposit: £10/6/-. 12 months £3/15/7..... **£51.10.0**

(e) The WEARITE MODEL 4A Tape Deck. Deposit: £12/4/-. 12 months £4/9/5..... **£61.0.0**

### STERN'S MULLARD TYPE "C" TAPE PRE-AMPLIFIER—ERASE UNIT



INCORPORATING THE NEW FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and 3 SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR.

PRICES . . . INCLUDING SEPARATE SMALL POWER SUPPLY UNIT

COMPLETE KIT OF PARTS **£14.0.0** ASSEMBLED AND TESTED **£17.0.0**

Deposit £3/8/- and 12 months of £1/4/11. Assembled unit only.

ALSO AVAILABLE EXCLUDING POWER SUPPLY UNIT FOR **£11.15.0** and **£14.10.0** respectively. (Carr. and Ins. 5/- extra)

Send S.A.E. for leaflet or 2/6 for Complete Assembly Manual.

**WHEN ORDERING PLEASE STATE MAKE OF TAPE DECK TO BE USED**

We present this "Hi-Fi" Pre-amplifier strictly to Mullard's specification etc., incorporating ONLY NEW HIGH GRADE COMPONENTS and the SPECIFIED NEW MULLARD VALVES. It comprises a COMPLETELY SELF-CONTAINED UNIT, all components and valves being contained in a well ventilated Box—Chassis neatly finished in Hammered gold with a very attractively engraved PERSPEX FRONT PANEL.

### FOR PERMANENT HIGH FIDELITY INSTALLATIONS

**WE ALSO OFFER (excluding Case)** the following

(a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and Power Unit Assembled and Tested..... **£32.10.0**
H.P. Terms: Deposit £6/10/- and 12 months at £2/7/8

(b) As above but TYPE "C" PRE-AMPLIFIER supplied as complete Kit of Parts..... **£29.0.0**

(c) The COLLARO Mk. IV TAPE DECK and the MULLARD Type "C" Pre-amplifier and Power Unit assembled, tested ..... **£35.0.0**
H.P. Deposit £7 and 12 months £2/11/4.

(d) As in (a) above but the Type "C" supplied as COMPLETE KIT OF PARTS..... **£32.0.0**

(e) The TRUVOX Mk. VI TAPE DECK and the assembled Type "C" Pre-amplifier and Power Unit..... **£40.0.0**
H.P. Deposit £8 and 12 months £2/18/8.

(f) As above but the Type "C" supplied as complete KIT OF PARTS..... **£36.10.0**

(g) The BRENNEL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and POWER UNIT..... **£46.0.0**

(h) As above, but the Type "C" supplied as complete KIT OF PARTS..... **£43.0.0**

(i) The WEARITE 4A DECK with Type "C" assembled and tested ..... **£56.0.0**
H.P. Deposit £11/4/- and 12 months £4/2/1.

(Carriage and Insurance on above quotes 10/- extra)

## STERN RADIO LTD.

DEPT. W 109 FLEET ST., LONDON, E.C.4

Telephone: FLEET STREET 5812/3/4

# THE FINEST RANGE OF TAPE EQUIPMENT FOR THE HOME CONSTRUCTOR

## YOU CAN BUILD A COMPLETE HIGH QUALITY TAPE RECORDER for £36.0.0

H.P. TERMS . . . Deposit £7/4/-, 12 months £2/12/10

FOR THIS WE SUPPLY:—
COMPLETE KIT OF PARTS TO BUILD THE HF/TR3 TAPE AMPLIFIER.
THE NEW COLLARO "STUDIO" TAPE DECK.
PORTABLE CARRYING CASE (as illustrated).
ROLA/CELESTION 10in. x 6in. P.M. LOUDSPEAKER.
ACOS CRYSTAL MICROPHONE 1,200ft. SPOOL E.M.I. TAPE.

Alternatively for those who prefer another type of TAPE DECK we will supply precisely as above—but IN PLACE of the COLLARO "STUDIO" DECK—WE INCLUDE:—

(a) The Mk. IV COLLARO "TRANSCRIPTOR" DECK . . . H.P. TERMS . . . Deposit £8, 12 monthly payments of £2/18/2 (£1 extra if we are required to wire up the Transcriptor Switch Banks). **£39.15.0**

(b) The new TRUVOX Mk. VI DECK..... **£45.0.0**
H.P. TERMS: Deposit £9, 12 months of £3/6/- (Carr. and Ins. on all above is 12/6 extra).

For constructors with their own Cabinet—WE OFFER:—

(a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK..... **£28.0.0**

(b) As above but HF/TR3 ASSEMBLED and TESTED ..... **£31.10.0**
H.P. TERMS: Deposit £6/6/-, 12 months of £2/6/2.

(c) COMPLETE KIT to build the HF/TR3 together with the Mk. IV COLLARO "TRANSCRIPTOR" DECK (£1 extra if we are required to wire up Deck Banks) **£30.15.0**

(d) As above but HF/TR3 ASSEMBLED and TESTED..... **£34.10.0**
H.P. Terms: Deposit £7, 12 months at £2/10/5.
(£1 extra if we are to wire up Deck Switch Banks)

(e) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. VI TAPE DECK..... **£36.0.0**

(f) As above but HF/TR3 ASSEMBLED and TESTED..... **£39.10.0**
H.P. Terms: Deposit £7/18/-, 12 months of £2/17/11.

(g) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENELL Mk. V TAPE DECK..... **£41.10.0**

(h) As above but HF/TR3 ASSEMBLED and TESTED..... **£45.0.0**
H.P. Terms: Deposit £9, 12 months of £3/6/-.

(i) THE ASSEMBLED and TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4I DECK, incorporates Wearite Head Lift Transformer, etc..... **£55.0.0**
H.P. TERMS: Deposit £11, 12 months of £4/0/8.

(Carriage and Insurance on each above is 10/- extra.)

Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it together with ROLA/CELESTION 10/ 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE —and 1,200ft. SPOOL E.M.I. TAPE—ALL FOR..... **£9.0.0**
(Carriage and Insurance 5/- extra.)

**WE HAVE THE NEW 2-SPEED TWIN TRACK**

**TRUVOX Mk. VI Tape Deck in stock £26.5.0** Deposit £5/5/-. 12 months £1/18/6

It incorporates PRECISION REV. COUNTER and PAUSE CONTROL and fully maintains the general high standard of all Truvox equipment. The very popular COLLARO Tape Decks and the BRENELL Mk. V Decks are also available.

## THE MODEL HF/TR3 TAPE AMPLIFIER

Incorporating
*3-SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR*

PRICE for COMPLETE KIT OF PARTS **£12/15/-**

FULLY ASSEMBLED AND TESTED **£16/10/-**

HIRE PURCHASE: Deposit £3/6/6 and 12 months at £1/4/2. A very high quality amplifier based on the very successful Type "A" design completed in the MULLARD LABORATORIES. ONLY NEW HIGH-GRADE COMPONENTS are incorporated including MULLARD VALVES and a GILSON OUTPUT TRANSFORMER . . . other features are: Magic Eye Recording Head Indicator—Effective Tone Control—Monitoring and Extension Speaker Sockets—has own Power Supply and can be used as independent Amplifier for direct reproduction of Gram. Records or from Radio Tuner. Overall size 11 x 6 x 6in.—Truvox—Collaro—or Brenell—please specify, which. Send S.A.E. for leaflet or 2/6 for Assembly Manual.

**PLEASE ENCLOSE S.A.E. WITH ALL CORRESPONDENCE**

# FOR VALVES, TUBES AND COMPONENTS: BY RETURN POST SERVICE

ALPHA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ACHLDDD 10/- | EL36 ... 19/11 | PY83 ..... 8/6 | 1A3 ..... 3/6 | 6N7GT 7/6 | 30FL1 ... 10/6 | 302 ..... 10/6 |
| AC/P .....7/6 | EL38 ... 26/6 | PZ30 ... 19/11 | 1A7GT 12/6 | 6P1 ..... 19/3 | 30L1 ... 19/11 | 304 ..... 10/6 |
| AC5PENDD 26/6 | EL41 ... 10/6 | PEN4DD 26/6 | 1C2 ..... 11/6 | 6P26 ... 19/11 | 30L15 ... 23/3 | 305 ..... 10/6 |
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| AZ31 ... 10/- | EL84 ... 9/- | PEN383 23/3 | 1H5GT ... 8/6 | 6SA7GT 8/- | 30PL1 ... 12/6 | 955 ..... 4/- |
| AZ41 ... 13/11 | EL91 ... 5/6 | PEN220A 4/- | 1L4 ..... 6/6 | 6SG7 ... 7/6 | 30PL13 21/11 | 956 ..... 3/6 |
| B36 ..... 10/- | EL821 ...26/6 | PEN45DD 26/6 | 1LD5 ... 3/6 | 6SH7 ... 4/6 | 35L6GT 10/- | 5763 ..... 9/- |
| CBL1 ... 26/6 | EM34 ... 9/6 | PENA4 12/6 | 1N5 ... 10/6 | 6SJ7 ... 8/6 | 25Y5 ... 9/9 | 9002 ..... 5/6 |
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| CCH35... 23/3 | EM81 ... 10/6 | QP21 ... 5/- | 1S4 ... 10/6 | 6SL7GT 8/- | 35Z4GT 8/- | 9006 ..... 5/6 |
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| CL33 ... 19/3 | EY86 ... 10/- | SP41 ..... 3/- | 1T4 ..... 6/- | 6SQ7 ... 9/3 | 35Z3 ... 16/7 | OA70 .....4/- |
| CY31 ... 16/7 | EZ35 ... 16/7 | SP61 ..... 3/- | 2C26 ... 11/6 | 6U4GT 12/- | 35Z5GT 9/- | OA79 ... 4/- |
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| EABC80 9/- | H30 ..... 5/- | U45..... 15/- | 5V4 ... 11/6 | 7C5 ..... 8/- | 301 ..... 10/6 | |
| EAF42 ... 10/6 | H63 ... 10/- | U50..... 8/- | 5Y3G ... 8/- | 7C6 ..... 8/- | | |
| EB34 ... 2/- | HL23DD 8/6 | U76 ..... 8/- | 5Y3GT... 8/- | 7D6 ... 13/6 | | |
| EB41 ... 8/6 | HL22 ... 6/6 | U339 ... 12/- | 5Z4G ... 9/- | 7H7 ..... 9/- | | |
| EB91 ..... 6/6 | HN309 24/7 | U403 ... 16/7 | 5Z4M ... 10/- | 7Q7 ..... 9/- | | |
| EBC33 ... 6/9 | K40N ... 9/- | U404 ... 11/4 | 6A7 ..... 10/- | 7S7 ..... 9/6 | | |
| EBC41... 9/6 | KF35 ... 8/6 | U801 ... 29/10 | 6A8G .....9/- | 7Y4 ..... 8/6 | | |
| EBC81... 11/4 | KK32 ... 21/11 | UABC80 10/- | 6AC7 ... 4/- | 8D2 ..... 2/9 | | |
| EBC90... 12/7 | KLL32... 24/7 | UAF42 ... 9/6 | 6AG5 ... 5/6 | 9D2 ..... 3/6 | | |
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| ECC81 ... 8/- | KT63 ... 7/6 | UCC84 10/11 | 6AU6 ... 10/6 | 10F18 ... 15/3 | | |
| ECC82 ...7/6 | KT66 ... 17/6 | UCC85 10/6 | 6B8G ... 4/- | 10L1 ... 15/11 | | |
| ECC83 ...9/- | KT88 ... 22/6 | UCF80 16/7 | 6BA6 ... 7/6 | 10LD11 12/- | | |
| ECC84 10/- | KTW61 6/6 | UCH21 23/3 | 6BE6 ... 8/- | 10M2 ... 23/3 | | |
| ECC85... 9/6 | KTW63 7/6 | UCH42 10/6 | 6BG6G 23/3 | 10P13 ... 15/- | | |
| ECF80... 12/- | KTZ41... 3/6 | UCH81 10/6 | 6BH6 ... 9/- | 10P14 ... 19/3 | | |
| ECF82... 13/- | MH41 ... 7/9 | UCL82 16/7 | 6BJ6 ..... 9/- | 12A6 ..... 6/6 | | |
| ECH3 ...26/6 | ML4 ..... 8/6 | UCL83 13/6 | 6BR7 ... 12/6 | 12AH8 12/- | | |
| ECH21 23/3 | MSP4/5... 7/6 | UF41... 9/- | 6BW6 ... 9/- | 12AT6... 10/6 | | |
| ECH35 23/3 | MSP4/7... 7/6 | UF42... 17/3 | 6BW7 ... 8/6 | 12AT7 ... 7/6 | | |
| ECH42... 9/6 | MX40... 12/6 | UF80 ... 13/11 | 6C4 ..... 4/6 | 12AU6 ... 8/- | | |
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| ECH83 13/11 | N37 ... 19/11 | UF86 ... 17/11 | 6C6 ..... 5/- | 12AX7 ... 8/- | | |
| ECL80 10/- | N78 ... 19/11 | UF89 ..... 9/- | 6C9 ... 17/3 | 12BA6 ... 9/- | | |
| ECL82... 12/6 | N339 ... 17/6 | UL41 ... 10/- | 6C31 ... 7/6 | 12BE6 ... 9/- | | |
| ECL83 ...19/3 | OZ4 ..... 5/6 | UL44 ... 26/6 | 6CD6G 29/10 | 12C8 ..... 9/- | | |
| EF9 ..... 23/3 | P61 ..... 3/6 | UL46 ... 26/6 | 6D6 ..... 5/- | 12H6 ... 3/6 | | |
| EF22 ... 8/6 | PABC80 13/11 | UL84 ..... 9/- | 6CH6 ... 10/6 | 12J5GT... 3/- | | |
| EF36 ..... 5/- | PCC84... 9/- | UU6 ... 19/11 | 6F6G ... 7/6 | 12JG7 ... 10/6 | | |
| EF37A ...15/- | PCC85 14/7 | UU8 ... 26/6 | 6F6M ... 7/6 | 12K7GT 7/6 | | |
| EF39 ..... 5/9 | PCC88... 23/11 | UY1N ... 12/6 | 6FI ... 14/- | 12K8GT 13/6 | | |
| EF40 ... 14/6 | PCC89 19/11 | UY41 ... 7/6 | 6FI3 ... 14/- | 12K8M 13/- | | |
| EF41 ..... 9/9 | PCF80 ... 9/6 | UY85 ... 7/- | 6FI4 ... 26/6 | 12Q7GT 7/6 | | |
| EF42 ... 11/- | PCF82 ...12/6 | VP13C ... 3/6 | 6FI5 ... 14/- | 12SG7... 7/6 | | |
| EF50 ... 4/- | PCF84 ...16/7 | VP23 ..... 6/6 | 6FI8 ... 15/3 | 12SH7 ... 6/- | | |
| EF50SYL 7/- | PCL82 ...12/- | VP41 ..... 8/6 | 6F23 ... 18/7 | 12SJ7 ... 6/- | | |
| EF54 ..... 6/- | PCL83... 14/6 | VR22 (PM2A) 3/- | 6F33 ..... 7/6 | 12SK7 ... 6/- | | |
| EF55 ... 10/- | PCL84... 16/7 | VR105/30 8/- | 6H6 ..... 2/6 | 12SL7 ... 8/- | | |
| EF80 ... 8/- | PL36 ... 14/6 | VR116 ... 4/- | 6H6GT ... 2/6 | 12SN7GT 10/- | | |
| EF85 ..... 7/6 | PL38 ... 17/6 | VR150/30 7/6 | 6J5G ... 3/6 | 12SQ7 ... 8/6 | | |
| EF86 ... 13/- | PL81 ... 12/6 | VU120A 3/6 | 6J5GT ... 5/- | 14S7 ..... 17/- | | |
| EF89 ..... 8/9 | PL82 ... 8/6 | VU39 (MU12/14) ... 8/9 | 6J5M ... 6/6 | 15D2 ... 7/9 | | |
| EF91 ... 5/9 | PL83 ... 11/6 | VU111 ...2/6 | 6J6 ..... 6/- | 19AQ5 ... 9/9 | | |
| EF91(BVA) 9/- | PL84 ... 12/7 | W101 ... 8/- | 6J7G ... 6/6 | 19BG6G 23/3 | | |
| EF97 ... 13/3 | PL820 ... 18/7 | W61M ... 8/- | 6K7G ... 4/- | 20D1 ... 15/3 | | |
| EF98 ... 13/3 | PX25 ... 12/6 | W76 ..... 7/6 | 6K7M ... 6/9 | 20F2 ... 26/6 | | |
| EL32 ..... 4/6 | PY31 ... 16/7 | W77 ..... 8/6 | 6K8G ... 7/6 | 20L1 ... 26/6 | | |
| EL33 .....14/- | PY32 ... 17/11 | W729... 10/6 | 6K6GT ... 7/- | 20P1 ... 26/6 | | |
| EL34 ... 19/11 | PY80 ... 7/6 | Y63 ..... 7/6 | 6K7GT ... 5/9 | 20P3 ... 23/3 | | |
| | PY81 ... 8/6 | Z21 4 pin) 8/6 | 6K8GT 10/- | 20P4 ... 26/6 | | |
| | PY82 ..... 7/- | Z309 ..... 7/6 | 6K25 ... 19/11 | 20P5 ... 23/3 | | |
| | | Z359 ... 7/6 | 6L6G ... 8/- | 25A6G 10/6 | | |
| | | | 6L6M ... 9/6 | 25L6GT 10/- | | |
| | | | 6L7G ... 7/6 | 25Z4 ... 9/6 | | |
| | | | 6L1 ..... 23/3 | 25Z5 ..... 8/- | | |
| | | | 6L18 ... 11/6 | 25Z6 ... 10/- | | |
| | | | 6L19 ... 23/3 | 27SU ... 19/11 | | |
| | | | 6LD20 15/11 | 30C1 ... 10/6 | | |
| | | | 6M1 ... 17/3 | 30F5 ... 10/6 | | |

## ACOS MICROPHONES

**Acos Mic 39/1.** Crystal Stick Microphones for use as a hand, desk or floor stand unit for high quality recording, broadcasting and public address work. List Price £5/5/-. **OUR PRICE 39/6.** With table stand 47/6. With floor stand adaptor 52/6. Postage 1/6.

**Acos Mic 40,** as supplied with most modern tape recorders, with folding rest and 8ft. lead, response 40-6,000 c.p.s. Listed at 35/-. **OUR PRICE 25/-.**

## CONVERT YOUR RADIO GRAM WITH ONE OF THESE MODERN AUTO MATIC RECORD CHANGER UNITS.

**Monarch UA8,** 4-speed automatic record changers with Ful-Fi turnover crystal cartridge, £6/19/6. Carriage 3/6.

**Collaro Conquest,** 4-speed fully mixing changer complete with Studio "O" crystal cartridge, £7/19/6. Carriage 3/6.

**Garrard RC120/D,** Mk. II, 4-speed unit manual control to enable records to be played singly, £8/19/6. Carriage 3/6.

## TAPE DECKS

**Latest Collaro Studio Tape Transcriptor.** 3 motors, 3-speed, 1⅞, 3¾, 7½ i.p.s., takes 7in. spools. Push-button controls. Price £15/15/. Tape extra. Carr. & Ins. 12/6.

**Latest B.S.R. "Monardeck,"** single-speed, 3¾ i.p.s., takes 5¾in. spools. Simple controls. Price £9/19/6. Tape extra. Carr. & Ins. 12/6.

**Best Quality Recording Tape**

| | |
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| 1,200ft. on 7in. spool | 21/- |
| 850ft. on 5¾in. spool | 18/6 |
| 600ft. on 5in. spool | 13/9 |
| 200ft. on 3½in. spool | 5/3 |

**Transistors**

| | |
|---|---|
| Red spot | 5/- |
| White spot | 7/6 |

Germanium Diodes from 1/- ea.

**Collaro Junior**

Single 4-speed record player unit in cream, complete with pick-up fitted turnover cartridge. Special Price 75/- each. Post 3/6.

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**12 MONTHS' GUARANTEE.**

| | | | |
|---|---|---|---|
| MW31/71 | £5 | 10 | 0 |
| CRM123 | £5 | 10 | 0 |
| CRM 141 | £5 | 10 | 0 |
| CRM 171 | £6 | 0 | 0 |
| CRM 152B | £6 | 0 | 0 |
| MW 36/24 | £5 | 10 | 0 |
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ALLOWANCE ON OLD TUBE IF RETURNED.

**CLAROSTAT POTENTIOMETERS FOR STEREOPHONIC AMPLIFIERS, etc.** 50K x 50K Log, 100K x 100K Log, 500K x 500K A/Log, 1 Meg x 1 Meg Log, 250K x 250K Log, 1 Meg x 1 Meg Linear, 500K x 500K Linear. All 6/6 each.

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| 3 pole, 4 way | 3/- each |
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| 1 pole, 4 way | 2/- each |
| 1 pole, 12 way | 3/- each |
| 2 pole, 6 way | 3/- each |
| 4 pole, 4 way | 4/6 each |
| 3 pole, 3 way | 3/- each |
| 3 pole, 3 way, 3 bank | 2/3 each |

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★ **All Brand New.**
★ **Note the Special Prices.**
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| 2½in. Square Units by Celestion | 18/6 |
| 3in. Square Units by Celestion | 18/6 |
| 4in. Square Units by Elac | 19/6 |
| 5in. Round Units by Goodman, Celestion and Plessey | 16/6 |
| 6½in. Round Units by Celestion | 17/6 |
| 8in. Round Units by Goodman, Elac | 18/6 |
| 10in. Philips Type with tweeter | 27/6 |
| 10in. Round Units by Elac | 22/6 |
| 12in. Round Units by Plessey | 32/6 |
| 7in. x 4in. Units by Plessey and Goodman | 19/6 |
| 8in. x 5in. Units by Celestion and Richard Allen | 25/6 |
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**SPECIAL MAINS DROPPER RESISTORS**

| | |
|---|---|
| SMD1 Philips 209U | 6/3 |
| SMD6 Ultra Twin 50 | 5/3 |
| SMD7 Ultra Twin 50 | 5/3 |
| SMD15 Philips 141U and Stella ST105U | 5/3 |
| SMD27 Pye Piper | 6/9 |
| SMD30 KB Rhapsody, MP151/1 | 6/9 |

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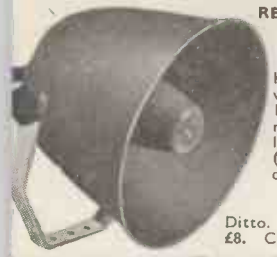

**RE-ENTRANT LOUD HAILERS** (Ex-Govt.) Heavy duty 20 watts all-metal 15 ohms. Diameter. 15in., length 15in. (approx.) good condition. **£6/10/-.** Carr. 10/-. Ditto. Brand new, **£8.** Carr. 10/-.

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12in. P.M. 15 ohms 15 watts, 30-14,000 c.p.s. Our price **£4/10/-.**
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**12 v. 25 A.H.** (as on left) 45/-. Carr. 7/6.

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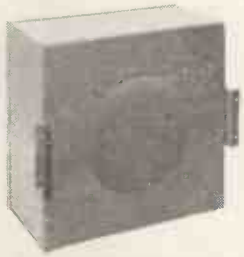

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**Complete with O.P. trans, in all steel blue-grey double grilled cabinet.**
**6in. 30/- Carr. 3/6**
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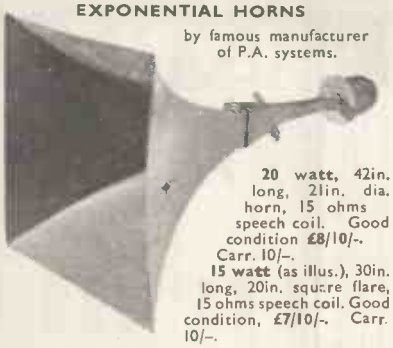
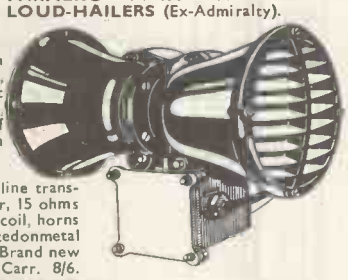
**10in. 45/- Carr. 5/-**

**EXPONENTIAL HORNS** by famous manufacturer of P.A. systems.



**20 watt,** 42in. long, 21in. dia. horn, 15 ohms speech coil. Good condition **£8/10/-.** Carr. 10/-.
**15 watt** (as illus.), 30in. long, 20in. square flare, 15 ohms speech coil. Good condition, **£7/10/-.** Carr. 10/-.

**PARMEKO TWIN BAKELITE LOUD-HAILERS** (Ex-Admiralty).



Length 15in., height 9in. dia. of horn 8½in. With line transformer, 15 ohms voice coil, horns mountedonmetal base. Brand new **£3.** Carr. 8/6.

**TRUVOX/TANNOY LOUD-HAILERS** With 180 ohm line transformer and condenser. Impedance 7½ ohms, handling capacity 8 watts. Complete in slope-front wooden case. Brand new **25/-.** Carr. 4/6.

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**RECORDING TAPES.** Super quality P.V.C. 1,800ft. L.P. 7in. spools, **30/-**; 1,200ft. Std. 7in. **19/-**; Empty 7in. spools **3/9** each. Send S.A.E. for Tape Bargain List.

**RECORDING WIRE,** ½lb. spools, 3½in. dia. New and unused, **12/6.** P. & P. 1/-.

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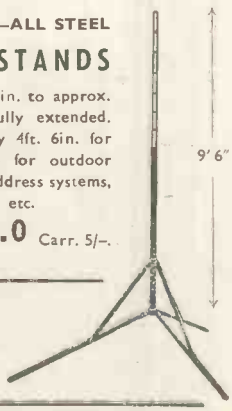
Adustable every 6in. to approx. 9ft. 6in. when fully extended. (Folds up to only 4ft. 6in. for storage). Suitable for outdoor speakers, public address systems, floodlighting; etc., etc.
OUR PRICE **£3.10.0** Carr. 5/-.




These stands are ideal for our RE-ENTRANT LOUD HAILER as described above.

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Readers will no doubt be pleased to know that our working model of this amazing organ for home construction, may now be heard and seen, at our Hi-Fi Showroom in Tottenham Court Road, W.1. For the benefit of constructors all components, keyboards, chokes, etc., are available ready made. Full constructional details are available in book form at 15/- plus 1/6 p. and p. We shall be happy to forward a complete price list on receipt of a stamp. Please address all organ enquiries for the attention of Mr. L. Roche.

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First delivery Famous American Ferrodynamics Acetate Base High Quality Recording Tape. An enthusiast's "must." Brand new (NOT SUB-STANDARD), 5in. 600ft. 16/-, 5in. 900ft. 18/6, 5¾in. 1,200ft. 23/6, 7in. 1,200ft. 25/-, 7in. 1,800ft. 35/-. Professional quality "MYLAR" Du Pont 5in. 1,200ft. 37/6. 7in. 1,800ft. 44/-, 7in. 2,400ft. 60/-, each on plastic spool. P. free.

**DECCA PORTABLE AMPLIFIER.** As supplied in famous DECCA-MATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve. Size 3 x 3½ x 8¾in. Only 59/6 plus 2/6 P.&P.
**SPECIAL CELESTION** 8 x 6in. elliptical high flux loudspeaker 30/- plus 1/- P. & P. to fit.
**VERY ATTRACTIVE PORTABLE CABINET** in two-tone rexine covering for accommodating the above items and ancillary equipment. 75/- plus 5/- P. & P.
**Note.** If the above three items are purchased together they will be supplied at the special inclusive price of £7/2/6 plus 6/6 P. & P.

**EXTRA SPECIAL OFFER!!**

A small three-valve **PORTABLE RECORD-PLAYER AMPLIFIER** mounted on baffle 12 x 7in., with High Flux 6½in. Loudspeaker. Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts Will match all types of high impedance pick-up. Ready to use, £5/12/6. P. & P. 3/6
**NEW STYLE CABINET** finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification. also most types of Ancillary Equipment. Overall size 18 x 13½ x 8½in. Fitted with carrying handle, £3/9/6 plus 5/- P. & P.
**NOTE. If both items purchased together they will be supplied at a special inclusive price £8/7/6 plus 6/6 P. & P.**

**LATEST COLLARO STUDIO TAPE TRANSCRIPTOR.** 3 motors, 3 speeds: 1⅞, 3¾, 7½ i.p.s., takes 7in. spools. Push-button controls, £15/15/- plus 5/- P. & P. Usual H.P. facilities.
**TAPE RECORDER AMPLIFIER** for use with Collaro Studio Transcriptor. Size 11¼ x 5 x 3in Uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. i.s. jack, superimposing switch. £12/12/-. Complete with matching knobs (Gold/Black). Circuit, etc. Post 3/6.
**LATEST B.S.R. "MONARDECK."** Single speed Tape Deck. Takes 5¾in. spools—3¾ i.p.s. At £9/19/6 only plus 5/- P. & P.

NEW COMPETITIVELY PRICED

## TAPE RECORDER KIT

NOW READY!!

**3 watts output, printed circuit construction, valve line-up EF86, EL84, ECC83, EZ80 and EM84 recording indicator. Latest 9in. x 4in. High Flux Speaker. Complete with Tape and empty Spool, and Acos 39-1 stick mike with stand. Attractive two-tone Cabinet. Supplied with latest COLLARO Studio 3-speed deck. Total price 25 guineas. N.B. The amplifier kit is supplied with basic components already mounted on the printed circuit board. Full assembly instructions are included. Please add 7/6 for packing and carriage. All parts available separately. Full details on appliation.**

### RECORD PLAYERS

**Full range at usual competitive prices. Interesting H.P. facilities.**

**COLLARO JUNIOR**

4-speed turntable and pick-up complete with crystal cartridge and sapphire styli.
**SPECIAL OFFER** at only 75/- plus 2/6 P. & P. Or **TURNTABLE** and **MOTOR** only at 52/6 plus 2/6 P. & P. **PICK-UP** only at 27/6 plus 1/6 P. & P.

**B.S.R. TU9.** 4-speed single-record unit with separate lightweight pick-up fitted with T.C.8H. crystal insert and sapphire styli. An ideal unit for a small portable gramophone. Brand new and fully guaranteed. SPECIAL PRICE: 75/- plus 2/6 P. & P. or motor and turntable only at 52/6 plus 2/6 P. & P. or Pick-up only at 27/6 plus 1/6 P. & P.

**E.M.I. 4-SPEED STEREO SINGLE RECORD UNIT.** Complete with Stereo Head and Sapphire Styli Brand New and Fully Guaranteed. **ONLY £6/19/6** plus 3/6 P. & P.

**GARRARD RC120/4H.** 4-speed autochanger with GC2 insert. Brand new, fully guaranteed. £8/19/6. P. & P. 3/6.

**GARRARD RC.121D MK. II STEREO/MONAURAL 4-SPEED AUTOCHANGER. Complete with latest G73/1 plug in crystal head for Stereo or Monaural recordings. Fully guaranteed. Few only. £11/0/6 plus 5/- P. & P.**

**B.S.R. UA8 MONARCH.** 4-speed Mixer Autochanger complete with turnover crystal insert and Sapphire Styli. Few only, now at £6/19/6 plus 3/6 P. & P. Brand new and fully guaranteed.

**THE LATEST COLLARO "CONQUEST."** 4-speed autochanger in cream with Studio "O" insert. Brand new, fully guaranteed. £7/19/6 plus P. & P. 3/6.

**COLLARO "CONQUEST" STEREO/MONAURAL.** Latest type—full guarantee. Brand new. £8/19/6 plus 3/6 P. & P.

**No. 38 AFV WALKIE-TALKIE.** A wonderful offer. This famous trans-receiver unit, with relay operated SEND/RECEIVE switch, covering 7.4–9 Mc/s band, range approx. 5 miles. Good condition. ONLY 22/6 plus 2/6 P. & P. per unit (less accessories). Quantity export inquiries welcomed.

**PNEUMATIC LID STAY** with pressure adjuster. Heavy duty 10/- complete. P. & P. 1/6.

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**RED SPOT** (Audio/Experimental Application) ..... 5/- ea.
**WHITE SPOT,** R.F. up to 2.5 Mc/s ..... 5/- ea.
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**FRUSTRATED EXPORT—Not repeatable! L., M. and S.W. SUPERHET RECEIVER.** Manufactured by McCarthy for export. At present for operation on 6 volts, but conversion details supplied free.

Valve line-up: 6K8G, 6K7G, 6Q7G, 6F6G, 6X5G and 6 volt 4-pin non-synchronous vibrator. 8in. P.M. Speaker, 4 watts output, P.U. socket, Ext. L.S. socket, etc. Tone control. Fitted in polished wood cabinet, size 21¾in. x 10¼in. x 10¾in. These cabinets are slightly soiled owing to storage, but each is guaranteed unused, in serviceable condition, tested prior to despatch. Price £5/19/6 only plus P. & P 7/6, plus 27/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

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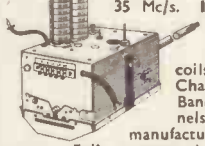
Goodmans 8in. x 2¾in., 3 ohms, 24/- plus 1/6 P. & P. 10in. Elac High Flux 3 ohm, 39/6 plus 2/6 P. & P. 8in. Celestion High Flux 3 ohm, 32/6 plus 2/- P. & P. 4in. Plessey Tweeter, 15/- plus 1/6 P. & P. R. & A. Type 9120, Mk. II, 12in., 10–12 watts, 3 ohm, 12,000 gauss, 55/- plus 3/6 P. & P., R. & A. Type 8120, Mk. II, 12in., 10–12 watts, 3 ohm, 10,000 gauss, 39/6 plus 3/6 P. & P. 12in. Bakers Selhurst, 15 ohms, 15 watts, 30–14,000 c.p.s., £4/10/- plus 3/6 P. & P. All the above brand new and fully guaranteed.
**Special! Latest E.M.I. full frequency speaker.** Size 13¾in. x 8¾in., 3 ohm speech coil. Double cone. Unrepeatable at 39/6 Plus 3/6 P. & P.
**12 CHANNEL TV TURRET TUNER** (By famous manufacturer). Brand new, **NOT** surplus or ex-equipment, 35 Mc/s. **I.F. PCC 84** and **PCF 80** valves. Complete with coils: Band I Channels 1 to 5. Band III Channels 8 to 11. In manufacturers original carton. Fully guaranteed at only 39/6 plus 2/6 P. & P.



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# VALVES

**Brand new, individually checked and guaranteed**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AC/DD | 2/6 | EA50 | 1/6 | FW4/500 | 6/6 | PM4DX | 3/- | 1A5GT | 5/- | 6F8G | 6/6 | 12AH7 | 7/- | 813 | 67/6 |
| AC/P | 4/6 | EAC91 | 4/6 | H30 | 5/- | PT25H | 7/6 | 1C5GT | 7/6 | 6F12 | 4/6 | 12AT7 | 6/6 | 815 | 80/- |
| AC/PI | 2/6 | EB34 | 1/6 | H63 | 3/6 | PY82 | 8/- | 1D8GT | 6/- | 6G6G | 3/- | 12AU7 | 6/9 | 816 | 30/- |
| AC5PENDD | 4/- | EB91 | 4/3 | KBC32 | 5/- | QP21 | 6/- | 1E7GT | 7/6 | 6H6M | 2/- | 12AX7 | 7/- | 829A | 30/- |
| AC6/PEN | 5/- | EB91 | 3/7 | KF35 | 5/- | QP25 | 5/3 | 1L4 | 3/9 | 6H6GT | 1/9 | 12C8 | 7/6 | 843 | 7/6 |
| AC/SP3 | 4/6 | EI524 | 6/6 | KT2 | 4/- | QQVO 6-40 | 45/- | 1LD5 | 3/6 | 6J5 | 3/6 | 12EI | 22/6 | 861 | 15/- |
| AL60 | 6/- | EBC33 | 6/- | KT31 | 8/- | QS75/20 | 6/9 | 1R5 | 6/9 | 6J7 | 7/6 | 12H6 | 2/- | 866A | 10/- |
| AR8 | 5/- | EC52 | 3/- | KT33C | 7/- | QS95/10 | 6/9 | 1S5 | 6/- | 6J5G | 3/3 | 12JSGT | 3/6 | 872A | 35/- |
| ARDD5 | 2/- | ECC32 | 4/- | KT44 | 7/- | QS108/45 | 6/9 | 1T4 | 4/- | 6J6 | 4/3 | 12SC7 | 4/6 | 930 | 8/- |
| ARP3 | 3/- | ECC81 | 6/6 | KT63 | 6/- | SQ150/15 | 6/9 | 2A3 | 8/- | 6K6GT | 6/6 | 12SG7 | 6/6 | 954 | 2/- |
| ARP4 | 3/6 | ECC82 | 6/9 | KT241 | 9/- | R10 | 12/6 | 2A6 | 7/- | 6K7G | 2/3 | 12SH7 | 4/9 | 956 | 2/- |
| ARP12 | 2/9 | ECC83 | 7/- | KTW62 | 7/6 | REL21 | 25/- | 2C34 | 2/6 | 6K7GT | 5/3 | 12SJ7 | 6/- | 1619 | 5/- |
| ARP21 | 5/6 | ECC84 | 7/9 | KTW63 | 6/6 | RK34 | 2/6 | 2D4A | 4/- | 6K8G | 6/6 | 12SK7 | 5/- | 1625 | 6/- |
| ARP24 | 3/6 | ECC91 | 4/- | L30 | 4/- | SP2 | 4/- | 2X2 | 4/- | 6L5G | 6/- | 12SL7 | 7/- | 1626 | 4/6 |
| ARP34 | 4/6 | ECL80 | 9/6 | MH4 | 3/6 | SP4B | 7/6 | 3A4 | 6/- | 6L6 | 9/- | 12SR7 | 6/- | 1629 | 4/6 |
| ATP4 | 2/9 | EF22 | 7/3 | ML4 | 4/- | SP13C | 4/6 | 3B24 | 3/- | 6L6G | 6/6 | 15D2 | 6/- | 7193 | 1/9 |
| ATP7 | 5/6 | EF32 | 5/- | ML6 | 6/- | SP41 | 2/6 | 3E29 | | 6L34 | 4/6 | 15R | 7/6 | 7475 | 5/- |
| AU1 | 5/- | EF36 | 3/6 | MPT42 | 5/3 | SP61 | 2/- | (829B) | 60/- | 6N7G | 6/6 | 30 | 5/- | 8010AR | 22/6 |
| AU4 | 5/- | EF39 | 4/6 | MS/PEN | 6/- | SP210 | 4/- | 3Q5GT | 9/- | 6N7GT | 7/- | 35T | 30/- | 8013A | 10/- |
| AW3 | 4/- | EF50 | 2/6 | N34 | 8/- | STV280/40 | 12/- | 3V4 | 7/3 | 6Q7G | 6/3 | 35Z4 | 5/- | 8020 | 6/- |
| BL63 | 6/- | EF52 | 5/- | NR15A | 3/- | SU2150A | 4/9 | 4A1 | 4/6 | 6R7G | 7/6 | 35Z4GT | 7/- | 9001 | 5/- |
| BT45 | 40/- | EF54 | 3/6 | NT37 | | T41 | 19/- | 4D1 | 2/6 | 6R7GT | 8/- | 39/44 | 6/- | 9003 | 5/6 |
| BT9B | 40/- | EF55 | 6/- | (4033A) | 10/- | TP25 | 15/- | 5U4G | 5/- | 6SA7 | 6/- | 53A | 3/- | 9004 | 4/- |
| D41 | 3/3 | EF70 | 4/- | OD3 | 5/- | TT11 | 3/- | 5V4 | 7/- | 6SC7G | 5/6 | 58 | 6/- | 9006 | 4/- |
| D42 | 4/- | EF80 | 6/9 | OZ4 | 5/- | U17 | 5/- | 5Y3GT | 6/9 | 6SC7GT | 6/- | 59 | 6/- | Cathode Ray Tubes: | |
| D77 | 4/3 | EF85 | 6/10 | OZ4A | 5/- | U18 | 6/6 | 5Z3 | 8/6 | 6SG7 | 5/- | 71A | 4/6 | | |
| DA30 | 12/6 | EF86 | 9/- | P61 | 2/6 | U27 | 8/- | 5Z4G | 8/- | 6SH7 | 5/- | 77 | 6/- | 3BP1 | 25/- |
| DAF86 | 8/- | EF89 | 8/9 | PCC84 | 8/- | U52 | 5/- | 6A6 | 5/- | 6SJ7 | 6/9 | 78 | 7/- | 5BP1 | 35/- |
| DET5 | 15/- | EF91 | 4/10 | PCC85 | 8/- | UL84 | 8/6 | 6AB7 | 5/- | 6SF5 | 8/- | 80 | 6/3 | 5CP1 | 42/6 |
| DET19 | 2/6 | EF92 | 5/- | PCF80 | 8/- | UL85 | 7/- | 6AC7 | 4/3 | 6SJ7G | 6/6 | 82 | 8/- | 5FP7 | 45/- |
| DET20 | 2/6 | EL32 | 3/9 | PEN25 | 4/6 | V2D33B | 8/- | 6AG5 | 4/6 | 6SK7 | 5/6 | 83V | 12/- | VCRX258 (with scanning coil) | 45/- |
| DF70 | 9/- | EL35 | 9/- | PEN46 | 5/6 | V248A | 4/- | 6AG7 | 8/- | 6SL7GT | 6/9 | 84 | 12/6 | | |
| DF72 | 7/6 | EL84 | 8/3 | PEN65 | 6/6 | VP23 | 3/6 | 6AJ7 | 4/3 | 6SN7GT | 4/6 | 85A1 | 12/- | | |
| DF96 | 8/- | EL91 | 7/6 | PEN220A | 3/- | VR78 | 4/- | 6AK5 | 6/9 | 6SQ7 | 6/6 | 89 | 6/- | Photo Tubes: | |
| DH76 | 4/9 | EM4 | 4/- | PENDD/ 1360 | 9/6 | VR99 | 8/- | 6AK7 | 8/- | 6SR7 | 6/6 | 210LF | 3/- | GS16 | 12/6 |
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| DL72 | 7/6 | EY51 | 8/3 | PL82 | 8/- | VR150/30 | 7/3 | 6AM6 | 6/3 | 6V6G | 5/6 | 217C | 17/6 | 2J31 | 45/- |
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| | | | | | | W31 | 7/- | 6C6G | 4/6 | 810 | £3 | 803 | 22/6 | ACT25 | 40/- |
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**BRAND NEW ORIGINAL SPARE PARTS FOR AR88 RECEIVERS.** Please write your requirements.

**MOVING COIL ROUND HAND MICROPHONE No. 13.** 2½in. diam. with press switch. **12/6.** P. & P. 1/-.

**PLATE TRANSFORMER.** Input 190–210–230–250 v. Output 2,250–02,250 C.T. 400 mA, 13 x 9 x 6½in. Weight 75lb. **£6/10/-.** Carr. 10/-.

**I.F. TRANSFORMERS.** 4–5 Mc/s. American made in black crackle finish housing, **6/-.** P. & P. 1/-.

**HRO MAINS** power pack, input 115/250 v. A.C. Output 250 v. 75 mA. and 6.3 v. 3.5 amps. **£3,** inc. carr.

**VARIOMETERS** for W/S No. 19. Fully tested and working **12/6.** P. & P. 2/6.

**COMPLETE V.F.O. UNIT** from TX53. Freq. range in 4 switched bands from 1.2–17.5 mc/s. Two V.T. 501s. as oscillator and buffer, 807 as driver, two S130s as voltage stabilizers. Output sufficient to drive two 813s in parallel. Slow motion drive directly calibrated in mc/s. Provision for crystal control, metering of buffer and driver stage. Power requirements 400 v. and 6.3 v. D.C. Can also be used as low power transmitter. In excellent condition with valves and circuit diagram. **£5.** P. & P. 15/-.

**FILAMENT TRANSFORMERS.** Primary 0–190–210–230–250 v:, 50 c/s. Sec. 1. 2.5 v. CT at 10 amps. 2. 2.5 v. CT at 10 amps. 3. 10.5 v. CT at 11 amps., 4,000 v. insulation. Price **£2/19/-.** P. & P. 5/-. Primary 0–190–210–230–250 v. 50 c/s. Sec. 1.. 10 v. CT at 4.5 amps. 2. 10 v. CT at 4.5 amps., 4,000 v. insulation, **£1/16/-.** P. & P. 5/-. Primary 230 v. 50/60 c/s. 67 v/amps. Sec. 1. 6.3 v. 1–6 amps. 2.6.3 v. CT 3 amps. 3. 6.3 v. CT 3 amps. 4. 6.3 v. CT 3 amps. **£1/12/-.** P. & P. 5/-.

**LOW RESISTANCE HEADPHONES.** brand new, type CLR 5/-; Balanced Armature, 7/6. P. & P. 1/-.

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**AVOMINORS** in leather case with leads. Fully tested and guaranteed, with batteries. 2,000 v. D.C., **£2/19/6.** P. & P. 2/6.

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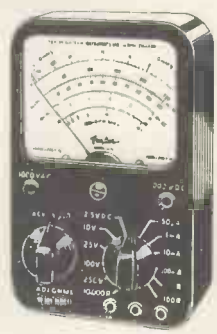

Model 127A Pocket size meter. Sensitivity 20,000 o.p.v. D.C. 1,000 o.p.v. A.C.

20 ranges.

D.C. current 50μA to 1 amp.

D.C. volts 0.3 v.-1,000 v. (25 kV. by probe).

A.C. volts 10 v.-1,000 v.

3 resistance ranges from 0-20 megohms (self contained). Metre 40μA 3½in. arc. Accuracy D.C. 3% A.C. 4% ohms 5%. Dimensions 5¾ x 3¾ x 1¾in. Weight 14 oz. Price **£10** complete with instruction manual, test prods and clips. Leather case **£1/12/-** extra.

**OUTPUT TRANSFORMER,** in screening can giving 9 different ratios 10 : 1 up to 120 : 1 for battery receivers or any high resistance pentodes used as output valves, 6/6. P. & P. 1/6.

**DRIVER TRANSFORMERS.** Primary 500 ohms imp. Sec. to match two 805 in push-pull **£1/7/6.** P. & P. 5/-.

**TRANSFORMERS.** Relay supply. Primary 230 v. Sec. 0–27/29/31 v. at 0.5 amps., 15/-. P. & P. 5/-.

**ROTARY TRANSFORMERS.** 171 watt, 12 v. input. 1,600 v. 110 mA. output, 30/-. P. & P. 7/6.

**COMPLETE SET OF STRONG AERIAL RODS** (American). Screw-in type MP49, 50, 51, 52, 53, total length 15ft. 10in., top diameter 0.615in., bottom diameter 0.185in., together with matched aerial base. MP37 with ceramic insulator. ideal for car or roof insulation. **£2/10/-,** post free.

**AR88D and L.F. Receivers,** completely overhauled and tuned, **£60** and **£57/10/-** respectively. Completely rebuilt with P.V.C. wiring **£85.**

**MODULATION TRANSFORMERS** (U.S.A., Collins), primary imp. 6,000 ohms. C.T., secondary 6,000 ohms, 20 W., 9/6 each, post free.

**R109 RECEIVER.** Covering 2-8 Mc/s. 6 v. D.C. New and tested, **£4/5/-.** Carriage paid.

**VIBRATOR UNIT.** 12 v./160 v. 35 mAmps. Exceedingly well filtered and smoothed, excellent for car radios. New. Including one 6X5G valve and vibrator. **17/6.** P. & P. 5/-.

**CARBON INSET MICROPHONE.** G.P.O. type 2/6. P & P. 1/-.

**INSULATION TEST METER.** Testing voltage adjustable up to 6,000 v. D.C. Mains supply 180/250 v. In wooden case **£25.** Carr. 10/-.

**COSSOR DOUBLE BEAM OSCILLOSCOPES.** 339A. Fully tested and working, **£15.** Carr. 10/-.

**NO. 62 TRANSMITTER-RECEIVER.** 1.6 12 mc/s in two ranges. Ideal for mobile use. Total 11 valves. Rx—A super with separate mixer and local oscillator. Tx uses QVO4-7 as power amplifier VFO or switched selected crystals. C.W., phone (grid modulation) metered for operation and valve testing, Pi output to match rod aerials or long wire "Press to send" operation from mike. Size 8½in. x 17½in. x 13½in. weighs only 29lbs. Completely self contained with internal power unit for 12 v. operation. Power consumption 4.4 amps. on send, 3.4 amps. on receive. As new condition, tested, complete with operation instructions. Price **£27/10/-.** Delivery included.

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**170, GOLDHAWK RD.,**
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**PERSONAL CALLERS WELCOME**

## AVOMETER MODEL D.

**£8.19.6** (*P. & P. 3/6*)

| D.C. Volts | A.C. Volts | D.C. Current | A.C. Current |
|---|---|---|---|
| 150 mV. | 7.5 V. | 15 m/A. | 75 m/A. |
| 300 mV. | 15 V. | 30 m/A. | 150 m/A. |
| 1.5 V. | 75 V. | 150 m/A. | 750 m/A. |
| 3 V. | 150 V. | 300 m/A. | 1.5 Amps. |
| 15 V. | 300 V. | 1.5 Amps. | 7.5 Amps. |
| 30 V. | 600 V. | 3 Amps. | 15 Amps. |
| 150 V. | 750 V. | 15 Amps. | |
| 300 V. | 1.5 KV. | 30 Amps. | Resistance |
| 750 V. | | | 0-1000 ohms. |
| 1.5 KV. | | | 0-10 K ohms. |

Thoroughly overhauled. Complete with batteries and instructions. An extremely robust meter at a very reasonable price.

**CRYSTAL CALIBRATOR No. 10.** A crystal controlled heterodyne wavemeter covering 500 Kc/s. to 10 Mc/s. (Harmonics up to 30 Mc/s.) Requires 15 m/a. and 12 v. 0.3a D.C. but can be easily modified for 120 v. and 1.4 v. working. Size 7×7½×4in. First class condition, complete with valves, crystal, instruction manual and circuit. ONLY **59/6.** Post 3/6.

**CHOKES.** Parmeko 5 H, 200 m/amps., 6/6. AR-88 chokes, 15 H., 90 m/amps., 8/6. Parmeko 8 H., 100 m/amps, **7/6.** Postage any type, 1/6.

**SELENIUM BRIDGE RECTIFIERS.** Funnel cooled. A.C. Input 45 v. RMS. D.C. output 30 v. 10 amps. BRAND NEW. Boxed. **45/-.** Post 3/6.

**MARCONI IMPEDANCE BRIDGE** Type TF373. Measures, L, C & R at 1,000 cycles. Accuracy 1%. 0-100H; 0-100μF; 0-1M Ω each in 5 ranges. Power Factor and "Q." First-class condition, **£35,** carr. paid.

**6-VOLT VIBRATOR PACKS.** HRO type, 180 v. D.C., 65 m/amps. BRAND NEW. **29/6,** post 3/6. Type PU2, 200 v. D.C. 100 m/amps., with OZ4 rectifier. **BRAND NEW, 25/-** Post FREE.

**ADMIRALTY HT TRANSFORMERS** Pri 230 v. 50 c/s. Secs. 620-550-375-0-375-550-620 v. (620 and 550 v. 200 m/amps., 375 v. 250 m/amps.), plus two 5 v. 3 Amp. rectifier windings. Total rating 278 VA. Upright mtg. Wt. 25 lb. Made 1953. **BRAND NEW.** Original boxes. **45/-.** Carr. 5/-.

**INSTRUMENT TRANSFORMERS.** 230 v. A.C. input. Outputs 0-65-130-195 v. 85 m/amps., 6.3 v. 5 amps., 6.3 v. 0.3 amps. Shrouded. Size 3½×3¾×3¾in. high. **15/-,** post FREE.

**AR88D MAINS TRANSFORMERS.** Input 110-240 v. Output 345-0-345 v. 125 m/amps., 6.4 v., 4.5 amps., 5 v. 2 amps. 4¾×4¼×5¼in. high. Wt. 12 lb. Potted. Tag ends. RCA BRAND NEW. Boxed. **29/6,** post 3/6.

**"C" CORE TRANSFORMERS.** Pri. 230 v. 50 c.p.s. 510-0-510 at 275 mA. 375-0-375 at 83 mA. 6.3 v. at 9 A. 6.3 v. at 2A (twice), 6.3 v. at 1A (twice), 6.3 v. at 1.5A. 6.3 v. at 0.5A, 5 v. at 3A. 6¾ins.× 6ins.×7¾ins. high. Weight 25lbs. Removed from equipment but in perfect condition, **52/6.** Carr. 5/6.

**MARCONI CR100**
Completely overhauled. In perfect working order. LOOK LIKE NEW. **£21.**
Later model with Noise Limiter, **£25.**
Carr. Eng. and Wales 30/-. Send S.A.E. for full details.

**RCA AR-88 SPEAKERS**
A high quality 3 ohm unit fitted into heavy gauge black crackled steel cabinet, size 10½×11½×6in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker. CR100, etc. In original cartons. BRAND NEW. **45/-.** Post 3/6.

**MINIATURE 373 IF STRIPS.** For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EF92 and 1 of EB91. A fresh release enables us to offer these once again. BRAND NEW. Complete reprint of conversion instructions and circuit supplied free. **35/-.** OR less valves, **12/6.** Post, either, 2/6.

**LOUD HAILER EQUIPMENT**
IDEAL FOR CROWD CONTROL, FACTORIES, FETES, ETC. CONSISTS OF 4 SPEAKER UNITS AND CONTROL UNIT. COMPLETE WITH MICROPHONE, HEADPHONES AND SPARES. OPERATES FROM 12 VOLTS D.C. (OR 6 VOLTS D.C. WITH SLIGHTLY REDUCED OUTPUT), CONSUMING ONLY 3 AMPS. OUTPUT POWER 8 WATTS. ALL TESTED AND WORKING, BUT SLIGHTLY SOILED. A GENUINE BARGAIN. **£4/19/6.** CARRIAGE 25/6.

**SIGNAL GENERATOR TYPE 54.** Marconi 762A. Frequency 430 to 610 Mc/s. Square or Pulse Int. Mod., provision for Ext. Mod. Attenuation range + 10 to — 100 dB. Directly calibrated dials. As new, **£35,** carr. paid.

**COMMUNICATIONS RECEIVERS R-1155B.** A first class 10 valve Communication receiver, covering 75 Kc/s. to 18 Mc/s. (16.2-4,000 m.) in 5 bands. The large scale and superior dual ratio slow-motion drive make tuning easy, and the R.F. stage and 2 I.F. stages ensure world-wide reception. All the receivers we sell have been thoroughly overhauled, completely re-aligned, and are in first class working order, ONLY **£9/19/6.**

**A.C. MAINS POWER PACK OUTPUT STAGE.** In handsome black-crackled steel cabinet to match the R-1155. Fitted with RCA 8in. speaker. Just PLUG IN and switch on! Only the finest quality components are used, and we guarantee OUR power packs for 6 months. ONLY **£6/10/-.** Deduct 10/- when purchasing receiver and power unit together. Send S.A.E. for further details, or 1/3 for 14 page illustrated booklet giving technical data and circuits etc. (FREE with each receiver.) Add 10/6 carriage for receiver, 5/- for power unit.

**T.C.C. VISCONOL CONDENSERS.** 8 mfd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3×1¾×5in. high. **BRAND NEW.** Boxed. 8/6 each, post paid.

**MINIATURE RELAYS** (ALL BRAND NEW and BOXED)
G.E.C. sealed, wire ends, 670 2M2B H/D M1095..... **8/6**
G.E.C. sealed, wire ends, 670 Ω, 2 H/D makes, M1099... **15/-**
G.E.C. sealed, wire ends, 670 Ω, 4 c/overs, platinum, M1092 **19/6**
G.E.C. sealed, wire ends, 5,000 Ω, 2 c/overs, platinum, M1052 ..... **17/6**
Siemens High Speed, 1K+1KΩ, 1 c/over..... **10/6**

## HRO SENIOR RECEIVER

Complete with ALL NINE general coverage plug-in coil sets for 50 Kc/s. to 30 Mc/s. Instruction booklet, and circuit, but less external power supply unit. Table models, as new condition, **21 GNS.** Rack mounting, **18 GNS.** Packing and carriage 22/- extra. Send S.A.E. for further details.
**HRO POWER PACKS.** 115/230 v. A.C. mains input. Tested, and in good condition. Table or rack, **69/6.** Post 4/-.

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This article consists of a basic 400 microamp meter movement mounted on a bakelite panel 5¾×2⅞. The dial is scaled as a 15 range Testmeter. A circuit and parts list of the original instrument is supplied.
BRAND NEW. Boxed. **35/-,** post paid.

**ELECTROSTATIC METER.** Dia. 6½in. reads 5-18.5 Kv. Manufactured 1953. Contained in wooden case 10×10×9in. high. **£9/19/6.** Post paid.

**SANGAMO-WESTON ANALYSER E772.** A useful multi-range meter. Thoroughly overhauled and in perfect working order. For full details see previous adverts. **£7/10/-.** Carr. 4/6.

**AVO LC and R BRIDGES.** Capacity 5 pFd to 50 mFd. Resistance 5 ohms to 50 megohms. Inductance can be measured against external standard. Balance is indicated on a meter, which can be used as a valve voltmeter from 0.1 to 15 v. Leakage test and Power Factor scale. For use on A.C. mains. Tested and guaranteed. **£8/10/-.** Post 3/6.

**HICKOCK I-177 VALVE TESTERS.** Checks dynamic mutual conductance, shorts, emission, gas, and noise. For UX4 UX5, UX6, UX7, Octal, Loctal, B7G, and Acorn types. Portable, in wooden carrying case 15½×8×5½in. Wt. 13½lb. BRAND NEW. Complete with instruction book and valve testing charts. For 117 v. A.C. 10 gns. Carr. 7/6. Matching auto. transformers for 230 v. A.C. **12/6.**

**MARCONI SIGNAL GENERATORS** 85 Kc/s. to 25 Mc/s. A.C. mains operation. in fair condition and good working order. TF144F. **£40.** TF144G. **£50.**

**MARCONI TF987/1 NOISE GENERATORS.** Range 100 Kc/s. to 200 Mc/s. Determines noise factor of AM and FM receivers. Fully stabilised H.T. supply A.C. mains operation. Brand new and in original boxes. **£15.** Carr. 7/6.

**MARCONI TF.340 OUTPUT METERS.** Perfect working order, **£9/19/6.** Carr. 7/6.

**SCR522 TRANSMITTER/RECEIVERS.** 100-150 Mc/s. Comprises BC624A rec., and BC625 trans., with valves, and in good condition. BC624A, less relay **19/6.** With relay, **25/-.** BC625 **22/6.** These two, on rack **47/6.** Carr. 7/6.

**MOVING COIL PHONES.** Finest quality Canadian with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. **19/6.** Post 1/6.

**RESISTORS**
Morgan "T" (½ watt) and "R" (1 watt). Latest types, all BRAND NEW. 100 assorted, 10/-. Post 1/-.

**HEAVY DUTY SLIDER RESISTORS.** 1.25 Ω 20 A., **12/6,** post 3/6. 1 Ω 12 A., **8/6.**

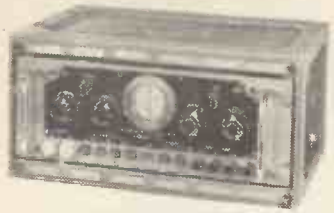
**ZENITH ADJUSTABLE** 25 Ω 4 A., **8/6.** Post 2/6.

**PRECISION RESISTORS.** 1 Megohm. 1% 1 watt wire wound, Ex-U.S.A. BRAND NEW. **10/6** per dozen.

**D.C./A.C. CONVERTERS.** Input 12 v. D.C. Output 230 v. 50 c/s. A.C. at 135 watts. Fitted with 0-300 v. A.C. 2½in. meter and slider resistor for voltage adjustment. In stout wooden carrying case with lid. Perfect working order. **£9/19/6.** Carr. 10/6.
24 v. Input 230 v. A.C. 50 c/s. 100 watts output. In grey metal case. BRAND NEW. **92/6.** Carr. 7/6.

**RADIATION METERS.** Portable dose-rate meter, containing modern type rectangular 50 micro-amp. meter, CVX494 electrometer valve, etc. BRAND NEW. In canvas carrying case, **£3/19/6.** Post 2/6.
*For details of other equipment, see our previous adverts.*

## OSCILLOSCOPE No. 11



Made by A. C. Cossor. Incorporates Hard Valve Time Base with speeds of 1-5-40 milliseconds, but simply converted to produce 3 cycles per second to 30 kc/s. Controls include Fine and Coarse Gain, Brightness, Focus, X and Y shifts. Has Power Pack for nominal 115 v. and 230 v. A.C., with adequate fuse protection. Employs 2½in. tube type ACR10. Grey and black engraved front panel, size 19 × 17in. For standard rack use if required, depth of unit being 12in. In steel transit case as illustrated. Complete with leads and suggested modification data. BRAND NEW. ONLY £12/10/- (carriage 15/-).

## CRYSTAL CALIBRATOR No. 10

A superb Crystal Controlled Wavemeter just released by the Ministry of Supply. Has directly calibrated dial for nominal coverage of 1.5-10.0 Mc/s. but may actually be used from 500 kc/s. up to 30 Mc/s. Complete with 500 kc/s. Crystal, 2 valves type IT4, 1 or IR5 and 1 of CV286 (Neon Stabiliser), and Instruction Book. Size 7in. × 7½in. × 4in., weight 5lb. Used but in first class condition. ONLY £2/19/6. Carr. 3/6.

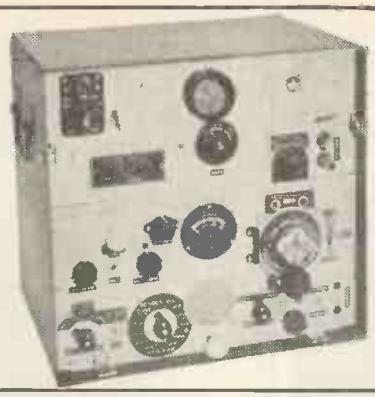
## POWER UNITS TYPE 234

Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 mA., and 6.3 v. 4 amps. Fitted double smoothing. For normal rack mounting (or bench use) having grey front panel size 19in. × 7in. BRAND NEW. Only 59/6.

ALSO POWER UNIT TYPE 3. Specification as above, but has two meters mounted on front panel to read H.T. Current, and Voltage. BRAND NEW. ONLY 79/6 (Carriage on either unit 7/6.)

12 VOLTS AMERICAN DYNAMOTOR. Delivers 220 volts at 100 mills. Size 5½ × 3½in. diameter. Ideal for running Radio and Electric Shaver, etc., from car battery. ONLY 32/6.

MARCONI SIGNAL GENERATOR TF 144G/7. Coverage 85 Kc/s.-2.5 Mc/s. and 8 Mc/s.-70 Mc/s. Complete, and in AS NEW CONDITION. ONLY £95.



## CANADIAN RECEIVER No. 52

A magnificent 10 valve Receiver covering 1.75-16.0 Mc/s. (19-170 metres) in 3 switched bands. Has built in 3 valve Crystal Calibrator employing dual 100/1,000 Kc/s. Crystal to provide marker check points at 10-100-1,000 Kc/s. Other refinements include Valve-check Voltmeter, Internal 3in. Speaker, R.F. and A.F. Gain Controls, Noise Limiter, B.F.O. Switch, Heterodyne Pitch Control, choice of Wide or Narrow Bandwidth, Speaker or Headphones and Manual or Automatic Volume Control on both C.W. or R.T. There are Fast and Slow Tuning Controls, with additional Oscillator Control for Fine adjustment. In steel carrying case as illustrated, size 15in. × 12in. × 15in. First class condition, thoroughly checked and tested, and in perfect working order before despatch. Circuit supplied. Voltages required 12 volts L.T. and 150 volts H.T. ONLY £11/19/6 (carriage etc. 15/-).

A suitable Power Pack, for use on 110-250 volts A.C. or 12 volts D.C., can be supplied (less outer case) for 60/- plus 5/- carriage.

## DOUBLE BEAM OSCILLOSCOPE TUBES

Type CV 1596 equivalent to Cossor O9D as used in oscilloscopes by Cossor (339 series). Hartley and Erskine (13 series). Listed at £12/10/-.

**Our price £2/19/6** (carriage 5/6)

*Brand New in makers' crates.*

## R1155 RECEIVERS

The famous Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges: 18.5-7.5 Mc/s., 7.5-3.0 Mc/s., 1,500-600 kc/s., 500-200 kc/s., 200-75 kc/s., and is easily and simply adapted for normal mains use, full details being supplied. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Fitted with latest type Super Slow Motion tuning assembly. Have had some use, but are in excellent condition. ONLY £9/19/6.

A.C. MAINS POWER PACK OUTPUT STAGE in black metal case to match receiver, enabling it to be operated immediately, by just plugging in, without any modification. Fitted with 8in. P.M. Speaker £6/10/-. DEDUCT 10/-. IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

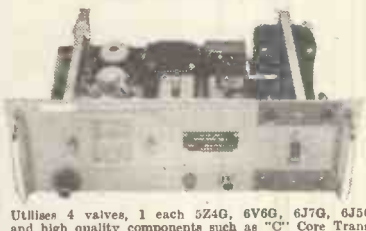
Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc. and is supplied free with each receiver. Add carriage 10/6 for Receiver, 5/- for Power Unit.

RCA RECEIVERS AR88D. Thoroughly re-conditioned and in perfect working order. Cover 500 Kc/s-31Mc/s. ONLY £60 (carriage etc., 25/-).

## RCA 8in. P.M. SPEAKER

In heavy black crackled metal case, designed for use with AR 88 Receiver, or any set with 3 ohms Output. BRAND NEW IN MAKERS' CARTONS. ONLY 45/- (Post 3/6).

## AMPLIFIER N24



Utilises 4 valves, 1 each 5Z4G, 6V6G, 6J7G, 6J5G and high quality components such as "C" Core Transformers and Block Paper Smoothing Condensers. A.C. Mains Pack for nominal 110/230 volts. Provision for 600 ohms or High Impedance Input. Output to 600 ohm Line. For normal use only requires changing Output Transformer. Output approximately 4 watts. Designed for Standard Rack Mounting, having grey front panel size 19in. × 7in. All connections to rear panel, front having "On/Off" Switch. Gain Control, Indicator Light. Fuses and Valves Inspection Panel. BRAND NEW IN MAKER'S PACKING. ONLY £4/9/6 (carriage 10/6).

EHT TRANSFORMERS. 5.5 kV (Rect.) with 2 v. 1 a., 79/6. 7 kV. (Rect.) with 2 v. 1 a., 89/6. 2.5 kV. (Rect.), with 2-0-2 v. 1.1 a., 2-0-2 v. 2 a. (for VCR 97 tube, etc.), 47/6 (postage 2/- per trans.).

## SELECTEST TESTMETER DIII

Manufactured by General Electric Co., and has exactly the same ranges as the Avometer D, but with a rather larger mirror scale. Size 9in. × 7in. × 5in., with carrying strap. Thoroughly overhauled, and in perfect order, with batteries and instructions. A real "snip" while they last. ONLY £7/10/- (postage, etc., 3/6).

## UNIVERSAL AVOMETER 34 RANGE MODEL D

Ex-Air Ministry, but thoroughly reconditioned and checked. Supplied with internal batteries and instructions. Covers ranges as follows:

| D.C. VOLTS | A.C. VOLTS | D.C. Current | A.C. Current |
|---|---|---|---|
| 150 mV. | 7.5 v. | 15 mA. | 75 mA. |
| 300 mV. | 15 v. | 30 mA. | 150 mA. |
| 1.5 v. | 75 v. | 150 mA. | 750 mA. |
| 3 v. | 150 v. | 300 mA. | 1.5 amp. |
| 15 v. | 300 v. | 1.5 amp. | 7.5 amp |
| 30 v. | 600 v. | 3 amp. | 15 amp. |
| 150 v | 750 v. | 15 amp. | |
| 300 v. | 1,500 v. | 30 amp. | Resistance |
| 750 v. | | | 1,000 Ω |
| 1,500 v. | | | 10,000 Ω |

ONLY £8/19/6 (Postage, etc., 3/6).

*Cash with order please, and print name and address clearly.*

PLEASE ADD POSTAGE OR CARRIAGE COSTS ON *ALL* ITEMS

# HARRIS ELECTRONICS (LONDON) LTD.

**Radio Corner, 138 Gray's Inn Road, London, W.C.1. Phone: TERMINUS 7937**

Open until 1 p.m. Saturdays. We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.

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# Special Offer!

## HIGH QUALITY RECORDING TAPE

*By Famous Manufacturers*

| | | |
|---|---|---|
| Stand. Play, 1,200ft., 7in. reel | 22/6 | (P. & P. 1/6) |
| Stand. Play, 600ft., 5in. reel | 16/6 | (P. & P. 1/–) |
| Long play, 1,800ft., 7in. reel | 32/6 | (P. & P. 1/6) |
| Long play, 1,200ft., 5¾in. reel | 25/– | (P. & P. 1/–) |
| Double play, 2,400ft., 7in. reel | 65/– | (P. & P. 1/6) |

*ALL BOXED AND GUARANTEED NEW STOCK*

TRS

# New additions to GOODMANS speaker range

**Latest release of two 10" units**

**AXIOM 110 - £5.** 10 watts 40-1500c/s

**AXIOM 112 - £8 10s.** 12 watts 40-15000c/s

*also the new Triaxiette Super 8in. Unit* **£13/10/-.**

**The well-known 8in. Axiette (£6/12/-) and the 12in. Audiom 60 (£9/12/-) as recommended for two speaker systems, are still available, ex stock.**

### RECOMMENDED RECORD PLAYER BARGAIN

E.M.I.—4-speed Single Player Unit, fitted with latest stereo and monaural Xtal cartridge and dual sapphire styli. Auto stop and start. A fidelity unit and bargain buy at only £6/19/6 (carr. and insurance 3/6).

SINGLE PLAYERS: BSR (TU9), with Ful-Fi P.U., 90/-; GARRARD (4SP), £6/17/6; GARRARD TA Mk. II with plug-in GC8 Xtal head, £7/19/6, carr. and insurance 3/6.

AUTOCHANGERS: BSR (UA8), £6/19/6. BSR UA8 fitted with Stereo/Monaural cartridge, £7/19/6; COLLARO Conquest £7/19/6; GARRARD (RC121 4D, Mk. II). plug-in head, stereo adapted, 10 gns. Stereo head £2 extra.

### RECORD PLAYER CABINETS

Contemporary styled, rexine covered cabinet in two-tone fawn and brown, or mottled red with white polka dot. Size 18½ × 13½ × ht. 8½in., fitted with all accessories, including baffle board and anodised metal fret. Space available for all modern amplifiers and autochangers, etc. Uncut record player mounting board 14 × 13in. supplied.

Cabinet Price £3/3/-. Carr. and Ins. 3/6.

### 2-VALVE 2-WATT AMPLIFIER

Twin stage ECL82 with vol. and neg. feedback. Tone controls AC 200/250 v. with double-wound Mains trans. Complete with knobs, etc., ready wired to fit above cabinet.

**£2/17/6** P. & P. 1/-.

6in. Speaker and matching trans., 22/-. P. & P. 1/6.

## TRANSISTORS

**Bulk Purchase—Brand New**

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|---|---|---|---|
| OA70 | 3/– | All branded BVA Types. First Grade. | |
| OC70 | 8/6 | | |
| OC72 (XC101) | 10/6 | | |
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| OC44 (XA102) | 16/6 | | |

## NOW! The TOURIST Portable

4 valve. Med. & L.W., L'tweight battery Radio. Size only 8in. × 5½in. × 4in. Weight 3½lb. with battery:— P. & P.

Complete receiver componenf kit 57/6 1/6
Set 4 miniature valves (96 series) 35/- 9d.
5in. Speaker & O/put Trans..... 21/- 1/6
Cabinet, Dial and Knobs, etc... 22/6 2/-

Latest superhet circuitry delayed AVC and A.F. Neg. feedback.

***Complete kit—BARGAIN—only £6.10.0, post free***

***Terrific performance—***
***Remarkable size—***
***Staggering Value***

Send for Booklet NOW: 1/6 post free.

### NEW BOXED VALVES ALL GUARANTEED

| | | | |
|---|---|---|---|
| 1R5, 1T4 | 7/6 | EABC809 | 9/6 |
| 185 | 7/6 | EC84 | 10/6 |
| S34,3V4 | 8/- | ECF80 | 11/6 |
| 5Z4 | 9/6 | ECH42 | 10/6 |
| 6K7 | 5/6 | ECL80 | 10/6 |
| 6K8 | 8/6 | EF80 | 9/6 |
| 6Q7 | 8/6 | EF86 | 13/6 |
| 6V6 | 7/6 | EF91 | 8/6 |
| DAF96 | 9/- | EL41 | 10/6 |
| DF96 | 9/- | EL84 | 9/6 |
| DK96 | 9/- | EY51 | 10/- |
| DL96 | 9/- | EY86 | 10/- |
| EZ81 | 7/6 | | |
| MU14 | 9/6 | | |
| PCC84 | 10/6 | | |
| PCF80 | 10/6 | | |
| PCL83 | 12/6 | | |
| PL81 | 12/6 | | |
| PL82 | 9/6 | | |
| PL83 | 11/6 | | |
| PY80 | 7/6 | | |
| PY81 | 9/6 | | |
| PY82 | 7/6 | | |
| U25 | 12/6 | | |

Send for list of more valve bargains.

**SPECIAL PRICE PER SET**

1R5, 1T4, 185, or 3S4 or 3V4, 27/6
DK96, DF96, DAF96, DL96, 35/-
6K8, 6K7, 6Q7, 6V6, 5Z4 or 6X5, 35/-

### COAX 80 OHM CABLE.

Stand ¼in. diam. Low Loss Semi-Air Spaced Aeraxial. Top grade cable—not to be confused with inferior types.

*Special Reduced Prices*

20 yds. 12/6, p. & p. 1/6; 60 yds. 32/6, p. & p. 2/-; 40 yds. 22/6, p. & p. 2/6. All other lengths 8d. per yard.

Coax Plugs 1/-, Sockets 1/-, Couplers 1/3, Cable End Sockets 1/6, Outlet Boxes 4/6.

### JASON FM TUNER UNITS (87-105 Mc/s)

Designer-approved kits of parts for these quality and highly popular tuners available as follows.

STANDARD MODEL (FMT)—as previously extensively advertised. COMPLETE KIT, 5 gns., post free. Set of 4 spec. valves, 30/-, post free.

LATEST MODEL (FMT2)—attractively presented shelf mounting unit to enclosed Metal Cabinet with Built-in Power Supply.

COMPLETE KIT, £7, p. & p. 3/6. Set of 5 spec. valves, 39/6.

NEW JASON COMPREHENSIVE F.M. HANDBOOK, 2/6 post free. 48hr. Alignment Service, 7/6, p. & p. 3/6.

### MULLARD "3-3" AMPLIFIER

Quality built to Mullard's specification, with special sectionalised O/P Trans.

Compiete kit with front panel only £6/19/6. P. & P. 3/6.

## 2 WAVEBAND CAR RADIO KIT

***12 v. operation Med. & Long Waves***

Modern development of the famous Brimar Hybrid vibratorless car radio circuit. Five latest type Brimar low voltage valves and power transistor. R.F. stage and permeability pre-aligned Cyldon Tuner Unit provide extremely good sensitivity and signal noise ratio. Printed circuit for easy construction and 7 × 4in. elliptical speaker for fidelity output. Self-contained in neat metal cabinet 8 × 7 × 2½in., with attractive calibrated dial. Speaker and power transistor stage mounted separately approx. 8 × 5 × 3in.

**Recommended Buy** *Complete Kit* *Bargain Price* **£12.19.6**

Instruction booklet and parts list available. 3/6 post free. P. & P. 3/6.

### C.R.T. Heater Isolation Transformers

***New improved types—mains prim. 200/250 v. tapped***

All isolation Transformers now supplied with alternative *no boost, plus* 25% and *plus* 50% boost taps at no extra charge.

2V. 2A type.... 12/6 (P. & P. 1/6)
6.3V. .6A type.. 12/6 (P. & P. 1/6)
10.5V. .3A type 12/6 (P. & P. 1/6)
13V. .3A type .. 12/6 (P. & P. 1/6)

Small size and tag terminated for easy fitting. Other voltages available.

### RE-GUNNED TV TUBES NEW REDUCED PRICES

**... snd now 12 months guarantee !**

**All tubes rebuilt with new heater, cathode and gun assembly — reconditionedvirtually as new.**

12in. **£6**, 14in. **£7**, 17in. **£8/10/-**, etc.

***10/- part exchange allowance on old tube***

*Carr. and ins. 10/-. Comprehensive stocks—quick delivery.*

**CONDENSERS**—Silver Mica. All pref. values, 2 pf. to 1,000 pf., 6d. each. Ditto ceramics 9d. each. Tubulars 450 v. T.C.C. etc., .001 mfd.-01 and .1/350 v., 9d. each. .02-1/500 v., 1/- each. .25 Hunts 1/6, .5 T.C.C. 1/9. .001 6 kv. 5/6. .001 20 kv. 9/6.

**RESISTORS**—FULL RANGE 10 ohms—10 megohms 20%, ½ w. and ¼ w. 3d., ½ w. 5d. (Midget type modern rating), 1 w. 6d., 2 w. 9d., 10% Hi-Stab. ¼ w., 5d., ½ w., 7d., 5% ¼ w., 9d., 1% HI-STAB, ¼ w., 1/6 (10-100 ohms 2/-).

**PRE-SET W/W POTS.** T/V Type, 25 ohms—50 K ohms 3/-. 50K—2 Meg. (Carbon 3/-).

**SPEAKER FRET**—Expanded Bronze anodised metal 8 × 8in. 2/3; 12 × 8in. 3/-; 12 × 12in. 4/6; 12 × 16in. 6/-; 24 × 12in. 9/-; 36 × 12in. 13/6, etc., etc.

**TYGAN FRET** (Contemporary pat.), 12 × 12in. 2/-; 12 × 18in. 3/-; 12 × 24in. 4/-, etc.

**LOUDSPEAKERS**—P.M. 3 ohms, 2½in., Elac, 17/6. 3½in. Goodmans 18/6; 5in. Rola, 17/6. 6in. Elac, 18/6; 7 × 4in. Goodmans Elliptical, 18/6; 8in. Rola, 20/-; 10in. R. and A., 25/-; 10in. W.B.-HF1012, 99/9. 12in. Plessey 15 ohms with 6/4in. Tweeter and Cross Over Filter, 97/6.

**Electrolytics All Types New Stock**

| TUBULAR | | CAN TYPES | |
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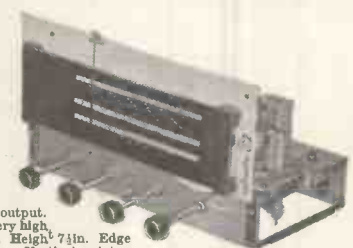
| 25/25 v. 50/12 v. | 1/9 | 8+8/450 v. | 4/6 |
| 50/50 v. 100/25v. | 2/- | 32+32/275 v. | 4/6 |
| 8/450 v. | 2/3 | 50+50/350 v. | 6/6 |
| 16+16/450 v. | 5/6 | 60+250/275 v. | 12/6 |
| 32+32/450 v. | 6/6 | 100+200/275 v. | 12/6 |

Comprehensive range in stock.

**VOLUME CONTROLS**—10K—2 Megohms. ALL LONG SPINDLES, MOCCANITE MIDGET TYPE, 1¼in. diam. Guar. 1 yr. LOG or LIN Ratios less Sw., 3/-. D.P. Sw., 4/6. Twin gang controls ¼ Meg., ½ Meg., 1 Meg. less Sw., each, 8/9.

## 7 VALVE AM/FM RADIOGRAM CHASSIS

*Valve Line-up:* ECC85, ECH81, EF89, EABC80, EL84, EM81, EX80.



Three Waveband and Switched Gram positions. Med. 200-500 m., Long 1,000-2,000 m., VHF/FM 88-95 Mc/s. Philip's Continental Tuning insert with permeability tuning on FM and combined AM/FM IF transformers, 460 Kc/s and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 13½ × 6½in. Height 7½in. Edge Illuminated glass dial 11½ × 3½in. Vertical pointer, Horizontal station names. Gold on brown background. A.C. 200/250 v. operation.

***Aligned and tested ready for use.*** **£13.10.0** *Carr. & Ins. 5/-*

Complete with 4 Knobs—walnut or ivory to choice.
Three ohm P.M. speaker only required. Recommended quality speakers.
8in. Goodmans special cone..... 21/6
10in. Rola (Heavy Duty)..... 30/-
Post & Pkg. 1/6.

As previously announced fresh supplies are now being received, but we regret some slight delay may be experienced in fulfilling orders for this popular item.

**ONLY A FEW ITEMS ARE LISTED FROM OUR COMPREHENSIVE STOCK. WRITE NOW FOR FULL BARGAIN LISTS, 3d.**

*Terms: C.W.O. or C.O.D. post and packing up to ½lb. 7d.; 1lb. 1/1; 3lb. 1/6; 5lb. 2/-; 10lb. 2/9.*

TRS

# RADIO COMPONENT SPECIALISTS

**70 BRIGSTOCK RD., THORNTON HEATH, SURREY**

*Established 1946. Tel.: THO 2188. Hours: 9 a.m.—6 p.m. 1 p.m. Wednesday*

# PORTABLE RADIOPHONES MODEL MK II

***We are proud to offer these Brand New British Army Portable Transmitter Receivers.***

The Mk. II Radiophones are designed for reliable voice intercommunication operating up to 10 miles depending upon obstructions and elevation. The combined Transmitter Receiver covers the whole frequency range between 7.4-9 Mc/s. and is fully tunable on both Transmitter and Receiver. The Receiver is an extremely efficient superhet featuring ultra high amplification, automatic volume control, highly sensitive output, and noise clipping. On test this Receiver astounded us, for on a short aerial we heard 65 Short Wave Stations. One as far away as Russia.

The Transmitter is automatically tuned to the Receiver hence eliminating unnecessary controls, and affording speed and simplicity of operation. Incorporates full side tone facilities. The master oscillator is an electron coupled oscillator and can be regarded as a form of Hartley. Includes R.F. power amplifier, audio modulator, automatic P.A. tuning. The Transmitter range, unlike the receiver, is largely dependent on prevailing obstructions and elevation but these can be compensated for by the addition of extra aerial length.

**ONLY 60/- EACH**

P. & P. 4/-.

**TWO FOR £6 Post Free**

**BATTERIES 20/- Per set**

**DE LUXE 12ft. WHIP AERIAL 12/6. P. & P. 2/6.**

***The improved model MK II (not to be confused with earlier models) is sold exclusively by us!***

The Radiophones are simple and a delight to operate as all controls are mounted on the front panel of the set and clearly marked. The fine tuning dial is fully calibrated and complete with locking position. Change over from send to receive is performed by a flick switch. Operates from standard dry batteries 3 v. L.T. and 120 v. H.T. Consumption: L.T. receive .23 amps., L.T. send .45 amps., H.T. receive 9 m/a. H.T. send 14 m/a. average battery life 30-35 operating hours. The Radiophones incorporate 5 valves: R.F. Amplifier, I.F. Amplifier, Second Detector, Output, and Power Amplifier.

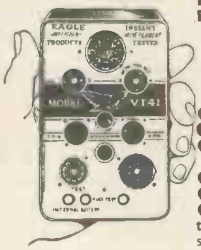
All sets are supplied complete with all accessories comprising of dynamic sound powered headphones, electro magnetic supersensitive microphone, 4ft. aerial, junction box, battery connection details and full circuit diagram.

## WIRELESS SET No. 19 Mk. II

This famous Transmitter-Receiver, incorporates "A" Set —TX/RX covering 2-8 Mc/s. (37.5-150 metres). "B" Set—VHF TX/RX covering 230-240 Mc/s. (1.2-1.3 metres) and intercom. amplifier. Complete with 15 valves, 500 micro-amp. check and tuning meter, circuits, and instruction book. In used condition, 65/-. Carr. 10/-.

## PRECISION ½% RESISTORS

Manufactured by Electrothermal, we offer the following values: 100K, 400K, 500K, all ±½% 1 watt, 1/9 each; 20/- per dozen.



## INSTANT VALVE FILAMENT TESTER MODEL VT 41.

**Pocket-size battery operated GIVES INSTANT CHECK OF:**

- All Radio Valves.*
- All T.V. Valves.*
- All T.V. and Radio Fuses.
- Circuit Continuity.
- All Pilot Lamps.
- Has built-in miniature 7- and 9-pin valve straighteners and battery test.

*International Octal, B.8, B.9, B.7 Battery and Mains types.

Beautifully styled—precision made. Supplied complete. Fully guaranteed. **ONLY 30/-.** P. & P. 2/6.

## POCKET MULTI-METER

Brand new. 2,500 o.p.v. Multi range 6/30/120/300/1,200 v. D.C., ditto D.C. 0-1 k., 0-1 megohm; 400 micro-A., 12 mA., 300 mA.; —00 to +65 db, 1½in. Large clear dial. Leads supplied.

ONLY 70/-. P. & P. 2/6.

## COMMUNICATION RECEIVER R.206

Frequency range 550 kc/s.-30 Mc/s. on 6 frequency ranges. Panel Controls: two speed, backlash free, tuning control. Frequency range selector. Very fine osc. vernier tuning control. Aerial trimmer. L.F. Gain. H.F. Gain. I.F. Bandwidth switch; 0.7, 2.5 or 8 kc/s. A.V.C. switch. B.F.O. control. 900 c/s. filter switch. Transient interference limiter. Aerial, earth, muting, phones and line inputs. Designed for use with an external A.C. or D.C. power supply. Receiver dimensions 25 x 13 x 13½in. Supplied complete with A.C./D.C. power unit with internal speaker. Original cost over £175. Very limited quantity offered at only **£29/10/-**, carr. 50/-.

## STANDING WAVE RATIO METER

"L" Band, Standing Wave Measuring Test Set. Complete set in fitted wood carrying case includes: Bolometer assembly, power cable (operates from 115 volts A.C., 50-1,000 cycles), junction box assembly, probe cable, slotted line assembly, flexible line, flexible line couplet and a number of connections and adaptors, fuses, wrenches, Slotted line approx. 6in. long. Only £14, carr. 25/-.

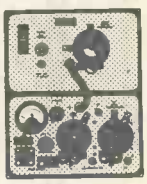
**AR88 RECEIVER.** 540 kc/s. to 32 Mc/s. Complete in working order. **£40**, carr. 30/-.

## T.C.S. TRANSMITTER

Designed for mains or mobile use covering 1.5-12 Mc/s. (160-80-40 metre bands) consisting of a VFO, Buffer, Doubler, PA with an internal push-pull modulator. Provision for VFO or crystal control. Output 40 watts phone, 100 watts C.W. Complete with aerial and plate current meters. Less loading coil. ONLY **£7**, carr. 15/-.

## PORTABLE TRANS/RECEIVER No. 18

A self-contained Trans/Receiver for Telephone and C.W. Range approx. 10 miles. Frequency 6-9 Mc/s. (50-33.3 metres). Valve line-up: 3 ARP-12. 1 AR-8. 1 ATP4. Complete with aerial, H.T. and L.T. meter and all accessories. Weight 20lb. Size 8 x 10 x 17in. Only **60/-**. Carr. 10/-.



## LEAD ACID ACCUMULATORS

(unspillable). 2 volts 16 A.H. Ideal for 6 volts and 12 volts supply. Brand new original cartons. Size 4in. x 7in. x 2in. **5/6** each

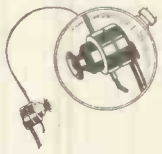
P. & P. 1/6

3 for 15/-. P. & P. 3/6.
6 for 27/6. P. & P. 5/-.

## AMERICAN LIGHTWEIGHT HEAD SET

*They're High and Low Impedance!*

These H.S.30 phones are the smallest used by the U.S. Air Force. 250Ω imp. using soft rubber miniature ear moulds for maximum music and voice reproduction of the finest quality. Supplied free is a small transformer unit with cord and plug which steps impedance up to 4,000Ω. **ONLY 15/-.** P. & P. 2/6.



**Complete HEADPHONE AND MICROPHONE ASSEMBLY.** A must for every Constructor and "Ham", consists of moving coil, padded headphones and "press to talk" microphone. **10/-.** P. & P. 3/6.

**HOOVER ROTARY TRANSFORMERS.** 12v. input, 500 v. output at 65 mA. or 6 v. input, 250 output at 75 mA. ONLY 10/6 each. P. & P. 2/-.

# SIGNAL GENERATOR TYPE CT53

***Manufactured to laboratory standard.***

Complete with internal 110-250 v. A.C. power pack. Incorporates 110 μV R.F. meter with variable carrier control. Five position switched attenuator giving 1μV to 10 MV and 10 db to 20 db. Variable Multiplier 1 to 10 and calibrated 0-20 db. Outputs: C.W. square wave and sine wave. Provisions for external sine wave or pulse. Complete with 7 valves and Calibration charts. Here is your opportunity to own a Laboratory Signal Generator, covering the widest frequency range ever offered at a fraction of the original cost.

***Covering the complete frequency range of 8.9-300 Mc/s. in 6 bands.***

PRICE ONLY **£12.10.0**

Carriage 10/-.

We anticipate an overwhelming demand therefore send your order now to avoid disappointment.

**Relda Radio Ltd**

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***WOT! You don't own a Relda catalogue? It's terrific and fully illus. Only 1/3***

# D.C. OSCILLOSCOPE

## A.C. MAINS 200-250 VOLTS

### SIMPLIFIED SERVICING PROBLEMS WHEN USING THE 'TESTGEAR' SCOPE

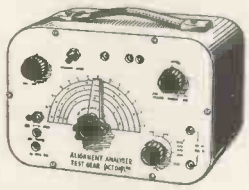
### 3in. D.C. OSCILLOSCOPE

Engineered to precision standards, this high-grade instrument is made available at the lowest possible price, incorporating the essential features usually associated with luxury instruments. This "SCOPE" will appeal particularly to Service Engineers and Amateurs. A high gain, extremely stable differential Y-Amplifier (30 mV/C.M.). Provides ample sensitivity with A.C. or D.C. inputs. Especially suitable for measurement of transistor operating conditions where maintenance of D.C. levels is of paramount importance. Push-pull X amplifier. Flyback suppression; Internal Time-base Scan Waveform available for external use; pulse/output available for checking T.V. Line O/P Transformers, etc.; Provision for external X 1/P and CRT. Brightness Modulation. Size 10in. high, 6½in. wide, 9in. deep. Wgt. 11½lb. **£15/15/-** plus P. & P. 7/6, or 30/- deposit, plus P. & P. 7/6 and 12 monthly payments of 26/6.

**FULL 12 MONTHS' GUARANTEE INCLUDING VALVES AND TUBE**

# ALIGNMENT ANALYSER TYPE MC12

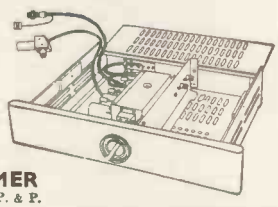
A.C. MAINS, 200/250 volts. Provides:—"WOBBULATOR" (SWEPT FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 Kc/s.—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0—60 pf. and 0—120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned circuit I.F. transformer, etc., to be rapidly determined. Cash price £6/19/6 and 5/- P. & P. H.P. terms 25/- deposit and 5/- P. & P. and 6 monthly payments of 21/6.



# CHANNEL TUNER

Will tune to all Band I and Band III stations. BRAND NEW by famous manufacturer. Complete with P.C.C. 84 and P.C.F. 80 valves (in series). I.F. 16-19 or 33-38. Also can be modified as an aerial converter (instructions supplied.)
Complete with knobs.

**22/6** Plus 3/6 P. & P.



## HEATER TRANSFORMER

To suit the above, 200-250 v., 6/- Plus 1/6 P. & P.

# B.S.R. MONARCH UA8 with FUL-FI HEAD

4-speed plays 10 records 12in., 10in., or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position; colour brown. Dimensions: 12½in. × 10½in. Space required above baseboard 4½in., below baseboard 2½in. Fitted with Ful-Fi turnover crystal head. **£6/19/6.** Plus 5/- P. & P.

**STEREO HEAD £7/19/6** Plus 5/- P. & P.

# LINE E.H.T. TRANSFORMER

With built-in line and width control. 14 KV. Scan coil, 90° deflection, on ferrite yokes. Frame O.P. transformer 500 pf. 18 KV. smoothing condenser. Can be used for 14in., 17in. or 21in. tubes. Complete with circuit diagram. **29/6** Plus 4/- P. & P.

**FOCUS MAGNET** suitable for the above (state tube), 10/-. 2/6 P. & P.

## MAINS TRANSFORMERS

All with tapped primaries 200-250 volts.

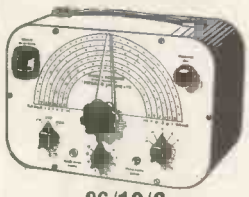
0-160, 180, 200 v., 60 ma., 6.3 v. 2 amps., **10/6** 320-0-320 v. 75 ma., 6.3 v., 2.5 amp., 5 v., 2 amp., **10/6.** 280-0-280, 80 ma., 6.3 v., 2 amp., 6.3 v., 1 amp., **10/6.** 350-0-350, 70 ma., 6.3 v. 1 amp., 6.3 v. 2 amp., **10/6.** 250-0-250, 70 ma., 6.3 v., 2 amp., **10/6.** Postage and packing on the above 3/-.

## WOLSEY 3-ELEMENT FOLDED DIPOLE

I.T.V. Aerial less mounting bracket for external use, complete with 12 yds. of coaxial cable, 15/-; 4 element, 17/6; 5 element, 25/-. P. & P. on above, 3/6.

**INTERCOM or BABY ALARM** in Wooden Cabinet with 8in. speaker and 3 valves. Transistorised input. Provision for talk-back, 49/6. Plus 5/- P. & P.

# SIGNAL GENERATOR

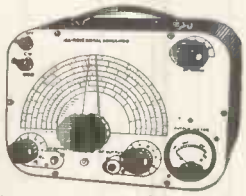


Covering 100 Kc/s.-100 Mc/s. on fundamentals and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. × 6¾in. × 5¼in., grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F., output continuously variable 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.

**£6/19/6**

Or 25/- deposit and 6 monthly payments of 21/6. Post & Packing 5/- extra.

# SIGNAL GENERATOR

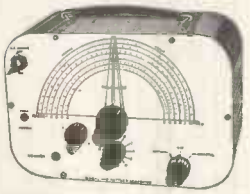


Coverage 120 Kc/s—230 Kc/s., 300 Kc/s.—900 Kc/s., 900 Kc/s.—2.75 Kc/s., 2.75 Mc/s.—8.5 Mc/s., 8 Mc/s.—28 Mc/s., 16 Mc/s.—56 Mc/s., 24 Mc/s. 84 Mc/s. Metal case 10in. × 6¾in. × 4¾in. Size of scale 6¾in. × 3¾in. 2 valves and rectifier A.C. mains 230-250 v. Internal modulation of 400 c p.s. to a depth of 30 per cent., modulated or unmodulated R.F., Output continuously variable, 100 millivolts C.W. and mod. switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%. **£4/19/6**

Or 25/- deposit and 4 monthly payments 21/6. P. & P. 5/- extra.

# SIGNAL & PATTERN GENERATOR

**£6/19/6** P. & P. 5/-.



Or 25/- deposit. P. & P. 5/- and 6 monthly payments of 21/6.
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.

# F.M. TUNER UNIT

By famous German manufacturer. Coverage 88—100 Mc/s. Complete with ECC85. Size 4in. × 2in. × 2in.

**25/-** Plus P. & P. 1/6. Circuit diagram free with unit. **1/-**

**10.7 Mc/s. I.F. and Discriminator Coil 4/- pair**

# 3-TRANSISTOR POCKET RADIO

## Plus GERMANIUM DIODE

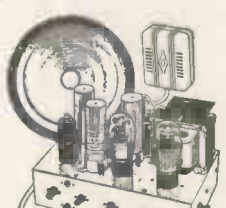
## ON PRINTED CIRCUIT

Size 3¼" × 4" × ⅞"

Incorporating Ferrite Rod Aerial. Tuneable over medium and long waves.

**Kit of parts. 39/6** Plus 1/6 P. & P.

Circuit diagram 1/6 free with kit.



# 8 WATT PUSH-PULL AMPLIFIER

**COMPLETE WITH CRYSTAL MIKE AND 8in. LOUDSPEAKER**

A.C. mains 200/250 v. Size 10½in. × 6½in. × 2½in. Incorporating 6 valves. H.F. pen., 2 triodes, 2 output pens., and rectifier. For use with all makes and types of pick-up and mike. Negative feed-back. Two inputs, mike and gram., and controls for same. Separate controls for Bass and Treble lift. Response flat from 40 cycles to 15 Kc/s. ±2 db; 4 db down to 20 Kc/s. Output 8 watts at 5%, total distortion. Noise level 40 db down, all hum. Output transformer tapped for 3 and 15 ohm speech coils. For use with Std. or L.P. records, musical instruments such as Guitars, etc.

**£4.19.6** Plus P & P. 7/6

Or £1 deposit, plus P. & P. 7/6 and 4 monthly payments of 23/-.

**PORTABLE AMPLIFIER** on printed circuit for A.C. Mains 200/250 v. Size 4in. × 3in., with tone and volume control. Valves: ECL82 and EZ80. 39/6. P. & P. 2/6.

**BUILT POWER SUPPLY UNIT,** A.C. Mains 200-250 v., D.C. output, 250 v. at 75 ma., also 6.3 v. 2 amp. heater winding, 21/-. Plus 3/6 P. & P.

# RADIO AND T.V. COMPONENTS (ACTON) LTD.

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### V.H.F. RECEIVER UNITS BC-624

(part of SCR-522 Transmitter-Receiver)

4 Crystal controlled channels, 100-156 Mc/s. (3.0-1.93 metres). Valves 9003 R.F. stage; 9003 Mixer; Three I.F. stages 128G7; Det/AVC/Audio 12C8; Second Audio 12J5GT; Oscillator 12AH7GT; Harmonic Generator 9002; Harmonic Amplifier 9003; Audio Squelch—other section of 12AH-7GT. High and Low Impedance output. PRICE, complete with valves, with description and circuit diagram, but without squelch relay 25/-, p.p. 5/-. PRICE, chassis only, less valves, 7/6, p.p. 3/6.

**ALSO LIMITED QUANTITY ONLY:**

### TRANSMITTER UNITS BC-625

(part of SCR-522 Radio Set)

Valves: Speech Amplifier 6S87; Push-Pull Modulator (two 12A6); Oscillator 6G6G; 1st Harmonic Ampl. 12A6; 2nd Harmonic Ampl. 832; Power Ampl. 832. Output 8 watts.

PRICE, complete with valves, description and circuit diagram ..... p.p. 5/- 22/6
Price, chassis only, less valves ....p.p. 3/6 7/6
Descriptions and circuits available at 8d. each.

### BRAND NEW AMERICAN BLOCK CAPACITORS

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| 0.5μF 1000 V. G.E., ⅜in. x 1⅛in. x 2⅛in. p.p. 1/6 | 3/- |
| 0.5μF 1500 V. G.E., 1in. x 1⅜in. x 3in. p.p. 1/6 | 4/6 |
| 1μF 400 V. G.E., ⅝in. x 1⅛in. x 2in. .... p.p. 1/6 | 3/6 |
| 1μF 600 V. Cornell Dubilier, 1⅛in. x 2in. x ⅝in. p.p. 1/6 | 4/- |
| 1μF 800 V. G.E., 1in. x 1⅞in. x 2⅛in. .. p.p. 2/- | 5/- |
| 1μF 1500 V. G.E. Stud Terminals, 1⅛in. x 2⅛in. x 3⅛in. ..... p.p. 2/6 | 6/- |
| 1μF 2000 V. Sangamo, Micamold, 1⅛in. x 2⅛in. x 6⅛in. ..... p.p. 2/6 | 8/6 |
| 1μF 18700 V. G.E., Stud Terminals, 5in. x 14in. x 19⅛in. ..... p.p. 10/- | 80/- |
| 2μF 400 V. G.E., 1in. x 1⅛in. x 2⅛in. .. p.p. 1/- | 3/6 |
| 2μF 600 V. TOBE, 2in. x 2in. x 1⅛in. .. p.p. 1/6 | 3/- |
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| 2μF 600 V. G.E., 1in. x 1⅛in. x 3in. .... p.p. 1/6 | 3/- |
| 2μF 1000V. Stud Terminals, 1in. x 1⅛in. x 4⅛in. p.p. 2/6 | 6/- |
| 3μF 250 V., Stud Mounted. ⅜in. x 1in. x 3⅛in. p.p. 1/6 | 2/- |
| 3μF 600 V. Tubular, 1⅛in. dia., 3⅛in. long p.p. 1/6 | 3/- |
| 4μF 220 VAC, Aerovox, 1in. x 1⅛in. x 4⅛in. p.p. 1/6 | 4/6 |
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| 4μF 600 V. Sangamo, Tubular, 1⅛in. dia. x 4⅛in. p.p. 1/6 | 5/- |
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| 8μF 600 V. Dubilier Sprague, 1⅛in. x 3⅛in. x 4⅛in. p.p. 2/- | 6/6 |
| 8μF 1500 V. Aerovox, Stud Terminals, 2⅛in. x 3⅛in. x 5⅛in. ..... p.p. 2/- | 10/- |
| 10μF 350 V. G.E. Pyranol, 1in. x 3⅛in. x 4⅛in. p.p. 2/- | 7/6 |
| 10μF 600 V. G.E. Pyranol, 1⅛in. x 3⅛in. x 4⅛in. p.p. 2/- | 8/- |
| 10μF 600 V. G.E., Sprague, Stud Terminals, 1⅛in. x 3⅛in. x 4in. ..... p.p. 2/- | 7/6 |
| VACUUM CAPACITORS, 50μμF, 32 kV. p.p. 3/6 | 40/- |

### IRON CLAD SINE-COSINE POTENTIOMETERS

Precision Potentiometers 35,400 ohms (continuous rotation) providing resistance proportional to sine or cosine of the angle, their sum or their difference depending on the terminals used. Dimensions 4in. dia. barrel x 4⅛in. overall length. Flange mounting ⅛in. diameter shaft. Price 35/-. Packing and postage 5/-.

### POWER SUPPLY UNITS

**WESTINGHOUSE SELENIUM RECTIFIER POWER UNIT**

115/230 V. A.C. input; fully smoothed and fused output adjustable from 80 to 140 V. D.C. by means of coarse and fine secondary tap switches. Maximum current 400 mA. Dimensions: 17⅛in. x 10⅛in. deep x 3⅛in. high. p.p. 7/6 49/-

**234A POWER UNIT**, Rack Mounted, 180-270 V. H.T. output and 6.3 V. L.T. at 4 amps.

Brand new ..... p.p. 10/- 59/6

### RATCHET MOTORS, 12 v.

1 Amp. (Impulse Motors) 5.75
ohms. ..... 3/6 each
Packing and postage ..... 1/6

### P.O. BUZZERS

Post Office Buzzers model T Mk. I. Minimum operating voltage 3 volts. PRICE (p.p. 1/6) ..... 4/6

### CATHODE RAY TUBES

| Type | $V_{a1}$ | $V_{a2}$ | $V_{g1}$ | Defl. | Price |
|---|---|---|---|---|---|
| 2AP1 | 250 V. | 1000 V. | 60 V. | E-S | ..... 25/- |
| 5FP7 | 340 V. | 1500 V. | 45 V. | E-M | .... 12/6 |
| 5BP7 | 430 V. | 1500 V. | 45 V. | E-S | .... 140/- |
| | | (twin gun tube) | | | |
| 7BP7A | 7000 V. | — | 70 V. | E-M | .... 60/- |

Packing and postage 5/- per tube.

### C.R. TUBE SCREENS

Suitable for 3PB1 and other 3in. tubes, brand new, with rubber lining and mounting foot ..... p.p. 1/- 5/-

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**WESTINGHOUSE POLARIZED RELAY.** Permalloy Reed armature. 1 C.O. 500 mA. contact. One 90Ω Coil and two 1450Ω Coils. Operating current 10 mA. on low and 3.5 mA. on high resistance coils ..... p.p. 3/- 25/-

**SIGMA 5956.** 1 C.O., 5 amps., 1500Ω Twin Coil, Operating Current 7 mA. sealed .... p.p. 1/6 10/6

**ADVANCE C8940-1, 5B.,** 1.5 Amps., 28 V. 250Ω Coil; Operating Current 50 mA. sealed p.p. 2/- 12/6

**ADVANCE F8948-1Y,** 3B 1 Amp., 16,000Ω Twin Coil; Operating Current 1.4 mA. sealed p.p. 2/- 15/-

**ADVANCE B8788-1,** 3 C.O., 1 Amp., 26.5 V. 425Ω Coil: Oper. Current 30 mA. sealed p.p. 2/- 12/6

**GUARDIAN 54874,** 1 C.O.-1M., 2 Amps., 115V. D.C. 11 kΩ Coil; Oper. Current 6 mA. sealed ..... p.p. 2/- 10/-

**ALLIED CONTROL SKHX377,** 4 M. 1 Amp., 9000Ω Coil; Operating Current 7mA sealed ..... p.p. 2/- 12/6

**ALLIED CONTROL PRHX2,** 4 M., 5 Amps., 260Ω Coil, Operating Current 60 mA. sealed ..... p.p. 2/- 10/-

**CLARE B45A,** 4 M., 1 Amp., 7000Ω Coil, Operating Current 5.5 mA. sealed ..... p.p. 2/- 10/-

**HIGH SPEED RELAYS, SIGMA 4C1 or equivalent,** 1B 5000Ω, operating current 4 mA., Second hand ..... p.p. 1/6 5/6

Please write for full list of relays.

### METERS

| | |
|---|---|
| 50μA D.C.M.C. 1⅛in., round panel mounted, miniature, black scale, calibrated 0-5 sealed .. | 35/- |
| 200μA D.C. M.C.:— | |
| 2in. Round Flush Mtd. ..... | 32/6 |
| 2¼in. Rd. Flush Mtd. ..... | 35/- |
| 2¼in. Sq. Flush Mtd. ..... | 35/- |
| 500-0-500μA. D.C. M.C. 3¼in. Rd. Fl. Mtd., calibrated 50-0-50 yards per sec., second-hand .. | 22/- |
| 1 mA. D.C. M.C. 2in. Rd. Fl. Mtd., enclosed in steel square box 2¼in. x 2¼in. with lead ..... | 20/- |
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LOWTHER VHF/FM/AM tuner, current model; £13/10.—Markson, 21 Oriental Rd., Woking, Surrey. [9096

HRO Rx's, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in stock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0053

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DUTIES cover inspection and testing of electronic equipment including radio and radar, accessories and components, and involve the use of meters, signal generators, oscilloscopes, bridges, etc. Applicants should be familiar with electrical and electronic specifications and be able to read circuit diagrams.
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THE successful applicant will be required to assist the Senior Engineer (Maintenance) in supervising maintenance work at transmitting stations, conducting performance tests and analysing maintenance records.
APPLICANTS should be aged between 25 to 35 years, possess a degree in Engineering or its equivalent and a good knowledge of radio and television engineering. Practical experience of television transmitting station design or operation would be an advantage.
STARTING salary according to age and experience in the salary scale £1,170-£1,645. Candidates with exceptional qualifications may be considered for appointment in a scale rising to £1,840. A contributory Pension Scheme is in operation.
APPLICATIONS stating age, experience, and qualifications should be addressed to the Personnel Officer, I.T.A., 62, Brompton Rd., S.W.3, quoting reference number E/14, not later than 13th June. [9086

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STAFF will be based at the Engineering Division of the Company, address below, but their main duties will take place overseas for varying periods installing telecommunications equipment. Whilst overseas a generous daily allowance is paid.
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ENGINEERS and ASSISTANT ENGINEERS with degree or H.N.C. and experience in the field of light electrical engineering, electronics, electro mechanical devices or semi-conductors, to work on the development, installation and flight testing of automatic pilots.
SALARY commensurate with experience; pension scheme.—Apply in writing, giving full particulars, to: Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, Surrey, or 'phone Mr. Barkham, Lodge Hill 3441. [0333

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TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details, to Personnel Officer, Redifon, Ltd., Broomhill Rd., S.W.18. [0252

AN interesting and progressive position arises in a prominent Dublin radio manufacturing company for a young man with a good general education. Essential qualifications are a sound theoretical knowledge of radio and TV, preferably to degree standard, combined with practical workshop ability, and the facility to express ideas in writing. The standard required is high, with salary in accordance.—Box 8705. [9088

PHILIPS RECORDS, Ltd., require a young man, aged 18-23, to assist with the care and maintenance of their studio equipment. Applicants should preferably have an Ordinary National or City and Guilds Certificate in Telecommunications and have a particular interest in recording equipment and techniques.—Please apply to the Personnel Officer, Philips Records, Ltd., Stanhope house, Stanhope Place, London, W.2. [9095

MUZAK require self-reliant experienced public address installation engineers with ability to supervise wiring contractors. Ability to equalise Post Office lines an advantage. Line, Assistant Line and Sound Maintenance Engineers and Electricians are also required. There will be openings in London, Birmingham and Manchester. Applications in own handwriting to Commercial Manager, Planned Music, Ltd., Regent House, 235, Regent St., London, W.1. [9060

TELEVISION engineers who possess sound theoretical knowledge, and some years of practical experience, are invited to apply for permanent, pensionable positions with well-established Rental Company in Middlesex and Surrey; there are vacancies for field and workshop engineers; 3 weeks' annual holiday is given; excellent conditions and equipment; top rates of pay.—Write, giving details of experience, age and wages required, to Box 8619. [0313

AIRCRAFT radio engineers and mechanics required with specific workshop experience of one or more of the following: vhf, hf/mf, adf, ils, vor, X-band radar; 44-hr week: top basic wages.—engineers £16 p.w., mechanics £14 p.w.; also 2 vacancies for trainees, 16-18 years; overtime and bonus system in operation.—Apply in writing, stating experience, to The Managing Director, Air Transport (Charter) (C.I.), Ltd., 7, Willow Rd., Poyle Trading Estate, Colnbrook, Slough, Bucks. [9075

ELECTRONIC Wiremen who are capable of wiring prototype units from circuit diagrams are required for a special products section in the T/V transmission (studio and control equipment) laboratory, previous T/V experience not essential, but applicants must have been employed on circuitry of similar complexity and be able to work with a minimum of supervision, good prospects for candidates of ability.—Applications, quoting "KRR/EWT" should be addressed to the Engineering Personnel Officer, Pye Ltd., Cambridge. [9064

DEVELOPMENT Engineers with practical laboratory experience and qualifications to HNC or C & G standard are required for work on the following: Television Transmission Equipment, Television Receivers, Telecommunications Equipment, Measuring Instruments. Work is varied and interesting and our rapid expansion provides outstanding prospects: Superannuation Fund, Sports-Social Club. Holiday arrangements will be honoured. Apply in confidence, to.—(Staff Appointments), British Relay Wireless, Ltd., 1-7, Croft St., London, S.E.8. [9053

TECHNICAL authors required for the preparation of handbooks giving full technical descriptions, setting-up procedures and servicing instructions for a wide range of equipment in the fields of radar, aids to navigation, air traffic control and industrial electronics, applicants should have a good command of English and familiarity with the requirements of the Services ATP and with specification ATA 100 would be an advantage; pension scheme, housing assistance available in approved cases.—Write giving full details and salary required to: Personnel Officer, Cossor Radar & Electronics, Limited, The Pinnacles, Elizabeth Way, Harlow, Essex. [9071

## SITUATIONS VACANT

SENIOR Electronic Engineer to lead design team for audio-frequency amplifiers up to 10kW frequency, range 5c/s to 10kc/s; qualifications degree or H.N.C. with not less than five years' in development laboratory; experience of broadcast relay systems, P.A. and acoustics desirable; permanent position in expanding concern for man aged 30-45; salary according to qualifications and experience.—Pamphonic Reproducers, 8, Dalston Gdns., Stanmore, Middx. Wor. 0226. [0311

CIRCUIT Designers and Circuit Laboratory Engineers required for design and testing of automatic telephone exchange systems and other similar projects. Candidates should have had previous experience of this work and preferably have at least an O.N.C. or an intermediate grouped C. & G. certificate. Knowledge of Crossbar Switching or totalisators would be an advantage. Good salary paid to selected applicants. Pension scheme after qualifying period.
WRITE giving full details of qualifications and experience, to the Personnel Manager, Ericsson Telephones, Limited, Beeston, Nottingham, quoting Ref. DA/1. [0160

THE INDEPENDENT TELEVISION AUTHORITY invites applications for the appointment of Engineer-in-Charge at each of its Medium Power Transmitting Stations which are now being built at Caradon Hill, near Liskeard in Cornwall, and Stockland Hill, near Honiton in Devon; applicants must have Electronic qualifications, a first-class knowledge of High Frequency and of Television Engineering, and must have gained practical experience of the detailed organisation and operation of a Television Transmitting Station. THE successful applicants may be posted to one of the Authority's existing Medium Power Transmitting Stations, prior to taking up their permanent appointments at Caradon Hill or Stockland Hill early next year.
THE scale for the post is £1,155-£1,865 per annum. A contributory Pension Scheme is in operation.
APPLICATIONS, stating age, experience and qualifications should be addressed to the Personnel Officer, 62, Brompton Rd., London, S.W.3, quoting reference E/13 not later than 13th June. [9087

RADIO Maintenance Engineer required by B.E.A., Birmingham Airport, to be responsible to the Station Engineer for the inspection, maintenance and certification of aircraft radio installations. Applicants should possess Radio Maintenance Engineer's Licence, category A with A rating for radar; have considerable experience of aircraft radio servicing and a good knowledge of modern airborne and radio communication systems, landing and navigation aids; salary £16/5/6-£18/15/6 plus 12/6 per week special bonus.—Write to Senior Personnel Officer (Regions), British European Airways, Bealine House, Ruislip, Middlesex. [9084

OPERATOR, male or female, required for direct reading spectrograph in an analytical metallurgical laboratory in the Birmingham area; duties would also involve maintenance and servicing of the instrument; applicants should have some knowledge of and practical experience with radio or electronic equipment; O.N.C. or P.M.G. certificate standard preferred; experience in spectrography would be an advantage but is not essential, as training for this specific instrument would be provided. Apply, giving particulars of experience, previous employment and salary expected; 5-day week; superannuation scheme.—Box 8623. [9083

MINISTRY OF AVIATION require Electrical Engineers (Assistant Signals Officers) for aviation telecommunications and electronic navigational aids. Min. age 23, 1st or 2nd Class degree in Physics or Engineering, or A.M.I.E.E. or A.F.R.Ae.S. (candidates with Parts I, II and III of A.M.I.E.E. or Parts I and II of A.F.R.Ae.S. or equiv., or of very high professional attainment without these quals. considered); salary £690 (age 23) to £1,125 (age 34), max. £1,300; slightly lower outside London and for women; further details and forms from —Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D.161/0A. [0310

RADIO maintenance engineers to be based at London Airport, for relief duties at U.K. and overseas stations; applicants should have considerable experience of aircraft radio servicing and maintenance; a knowledge of modern airborne civil radio communication and aircraft electrical systems; landing and navigation aids; and possess a current Aircraft Radio Maintenance Engineer's licence to at least "A" category with "A" rating; medical fitness for overseas service is essential in all cases; salary £937/10 to £1,067/10, plus allowances on posting.—Write to Senior Personnel Officer (Regions), British European Airways, Bealine House, Ruislip, Middlesex. [9078

INTERNATIONAL AERADIO, Ltd., has periodic vacancies overseas for Radio Technicians, City and Guilds Intermediate Telecoms. an advantage but not essential if applicant has considerable experience installation/maintenance H.F./V.H.F. low/medium power comms. Equipment; applications ex-service personnel of fully skilled categories welcomed; posts are permanent and pensionable; normally accommodation is provided with tax free emoluments equated to local conditions; additional marriage and child allowances; free air passages and insurance; kit allowance; generous U.K. leave; apply in writing.—Personnel Manager, 40, Park St., W.1. [0262

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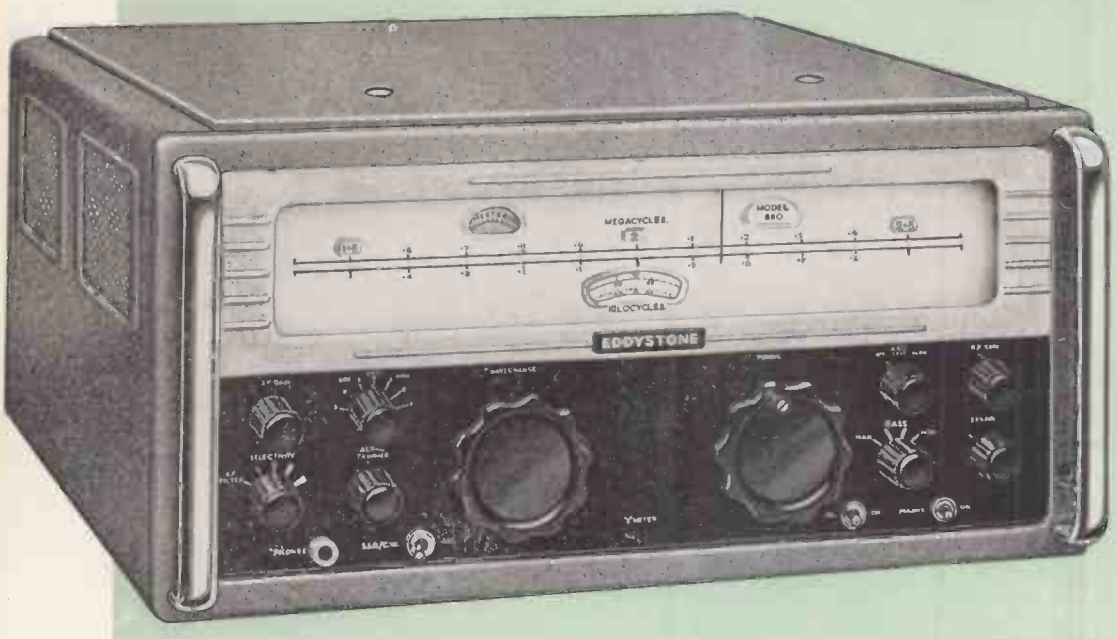


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The quarter-track facilities provided make it possible, when connected to a suitable external amplifier, to reproduce pre-recorded ¼ track or ½ track stereo tapes.

### A PROFESSIONAL SPECIFICATION IS COMMON TO ALL REFLECTOGRAPH MODELS

**DIMENSIONS:** 20″ long x 16″ deep x 10″ overall.
**WEIGHT:** Approx. 50 lb.
**TAPE DECK:** *Motors:* Direct drive synchronous capstan motor. Two Garrard side motors.
*Tape-Speed:* 7½ and 3¾ i.p.s.
*Tape Speed Control:* Switched two speed capstan motor.
*Long Term Speed Stability:* Better than 0.2% for 1200 feet.
*Spool Size:* Up to 8½″.
*Wow and Flutter:* At 7½ i.p.s. better than 0.2% R.M.S.
*Starting & Stopping time:* Less than 1 sec.
*Tape Loading:* Visible placing across heads.
*Magnetic Heads:* Reflectograph Types E.4. Erase, R.4. Record, P.4. Playback.
*Tape Wind:* Controlled by single knob electrical wind with mechanical 'PARK' position. Less than 45 secs. for 1200 ft. tape.
*Position Indicator:* Clock type.
*Controls:* 3 position function lever; mains OFF/ON knob; push button OFF; motors 7½/3¾/OFF knob; wind on/wind back knob.
*Splicer:* Provision for mounting Bib Tape Splicer.

**AMPLIFIERS:** Separate record and playback amplifiers providing continuous monitoring from the tape with provision for instant comparison between input signal and recorded signal.
*Controls:* Record/Playback, with safety button on record. Red and green warning lamps automatically illuminated.

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Tape/Input switch.
**FREQUENCY RESPONSE:** At 7½ i.p.s. to C.C.I.R. specification (or to N.A.R.T.B. to special order). ± 2dB 50 c/s–10,000 c/s (± 3dB 30–50 c/s and 10,000–15,000 c/s).
At 3¾ i.p.s. ± 2dB 40–7,500 c/s.
**SIGNAL/NOISE RATIO:** Better than —43dB (unweighted including hum).
**INPUT SENSITIVITIES:** High Gain: not more than 6 mV for peak record level.
Low Gain: not more than 0.25 V for peak record level.
**OUTPUT VOLTAGES:** From pre-amplifier 150 mV. R.M.S. medium impedance. From amplifier 3 watts across 15 ohms.
**ERASE AND BIAS FREQUENCY:** 63 Kcs.
**TAPE SPEED EQUALIZING:** Automatic for 7½ and 3¾ i.p.s.
**RECORD LEVEL:** Meter indicator, edgewise reading with coloured and calibrated scale.
**INPUT SOCKETS:** High Gain and Low Gain.
**OUTPUT SOCKETS:** Head pre-amplifier. External speaker (15 ohms).
**AMPLIFIER CONSTRUCTION:** Separate record and playback amplifiers across front of instrument.
Access to valves by removing 5 screws from front panel.
**VALVES:** 1/EF86, 1/6BR8, 1/ECC82, 2/ECC83, 1/EL84, 1/EF91, 1/EZ80.
**MONITOR LOUDSPEAKER:** Special Goodmans 10″ x 7″ high quality elliptical high flux, low field.

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*The Model B will not make stereo recordings but in due course facilities will be available for conversion of a Model B for stereo recording if required.*

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