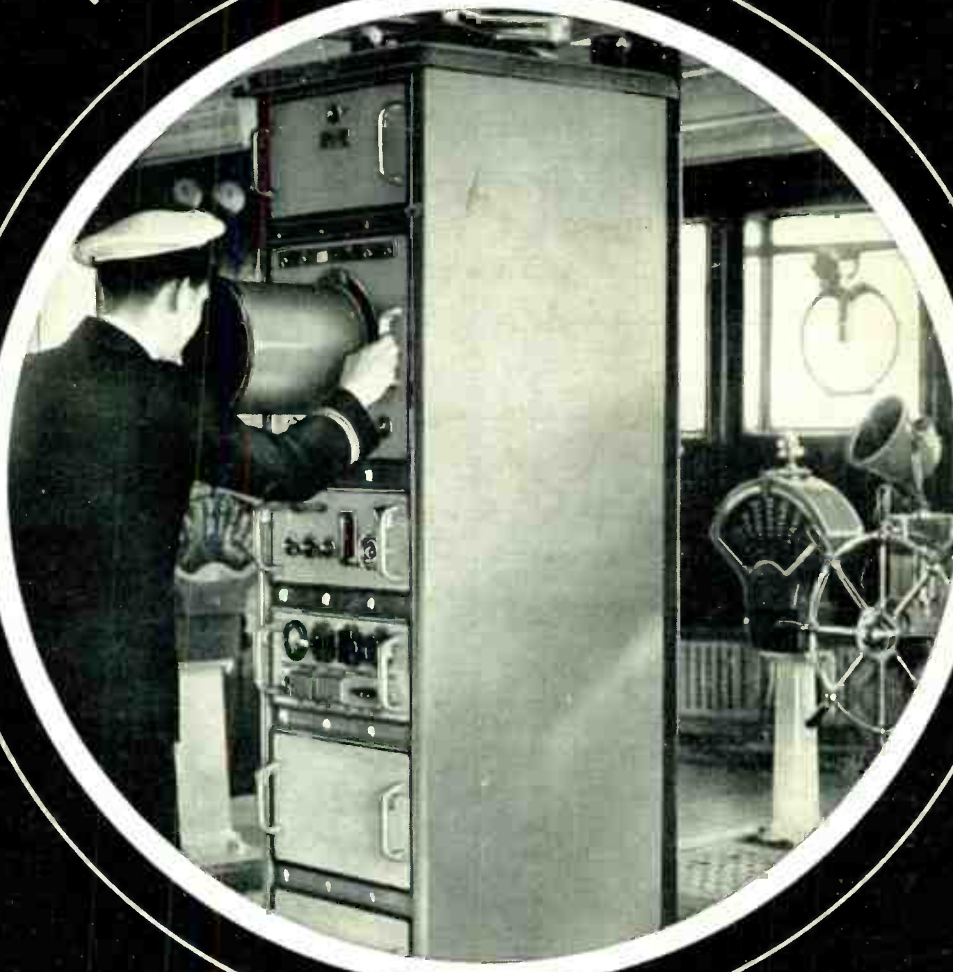
Wireless World

RADIO AND ELECTRONICS



SEPT. 1947

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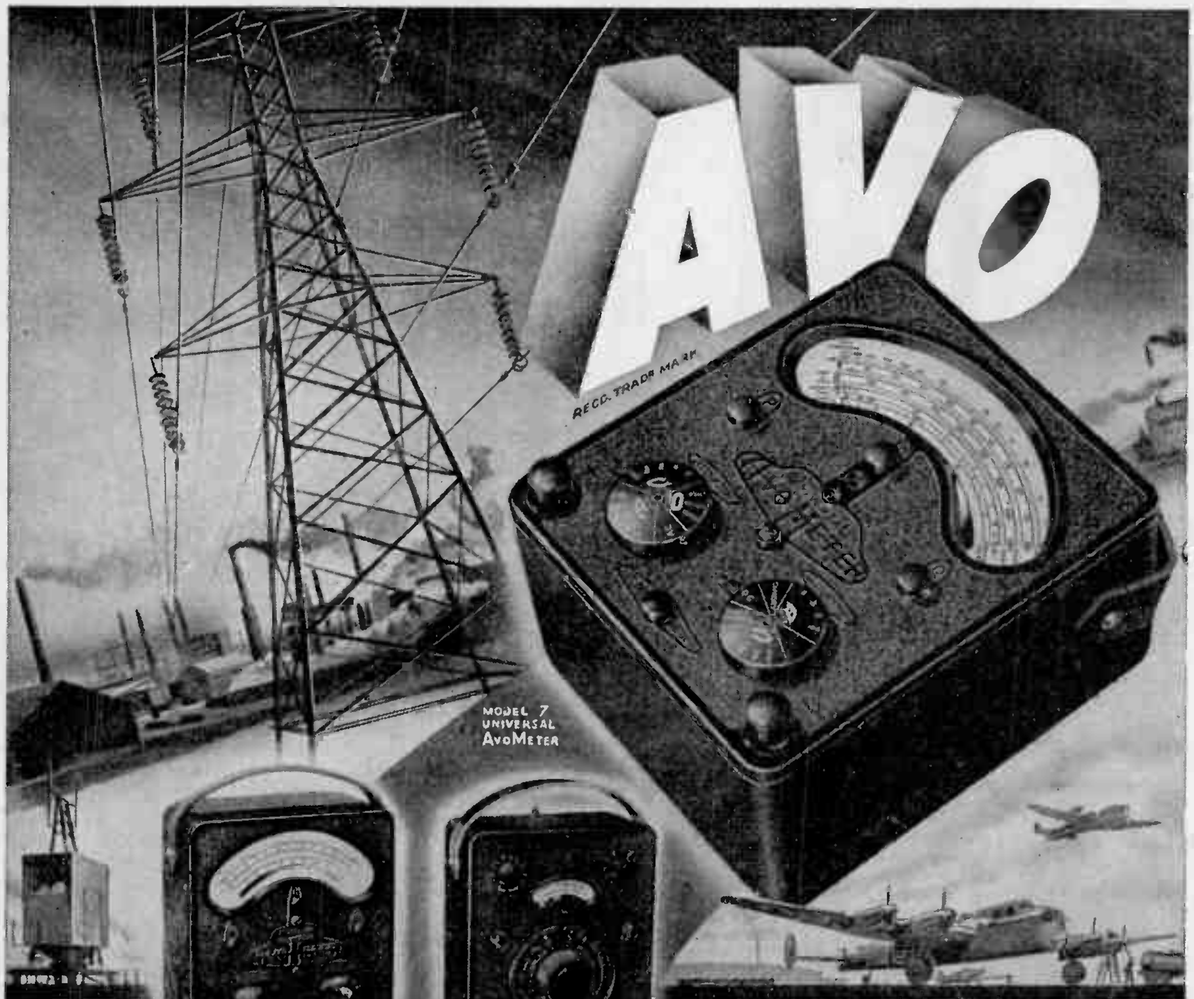
Vol. LIII. No. 9

IN THIS ISSUE: BROADCAST RECEIVING AERIALS



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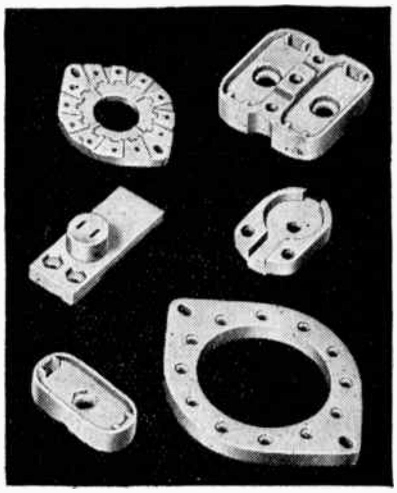

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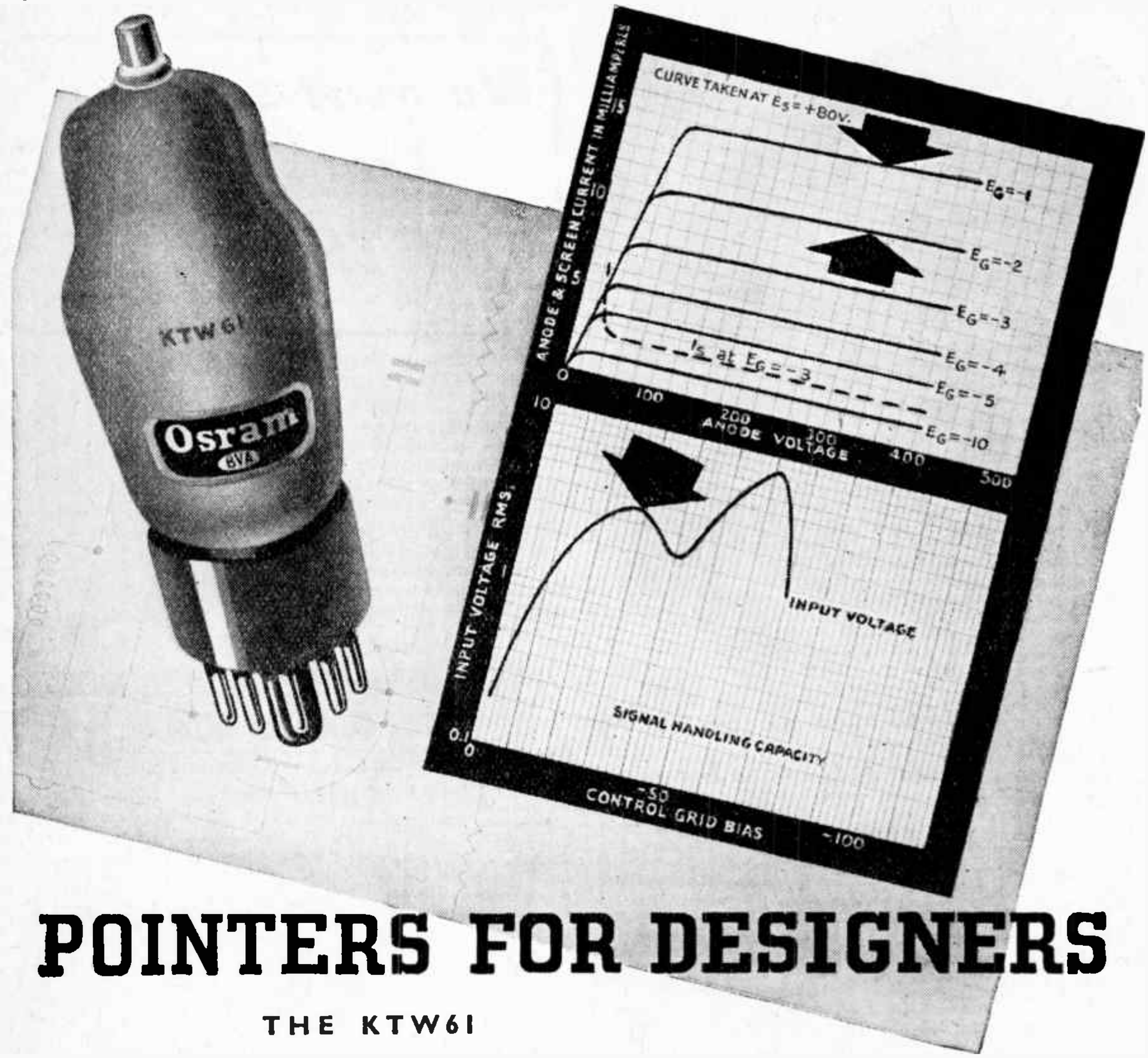

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THE KTW61

A screened tetrode with suppressor plates and with variable-mu characteristics, the OSRAM KTW61 is specially suitable for use as an R.F. or I.F. amplifier in superhet receivers. Its outstanding features include :—

- High order of mutual conductance (2.9 mA/Volt) combined with low leakage capacitance (0.0025 $\mu\mu$F), which facilitates high stage gain.
- Negligible distortion with the maximum signal likely to be encountered in practice. Conditions of use — as an I.F. amplifier with screen dropping resistance, and in conjunction with OSRAM frequency changer X61M.
- Marked improvement in signal to noise ratio, particularly on the short waves, when used as an R.F. amplifier with fixed screen voltage.

A detailed technical data sheet is available on request.

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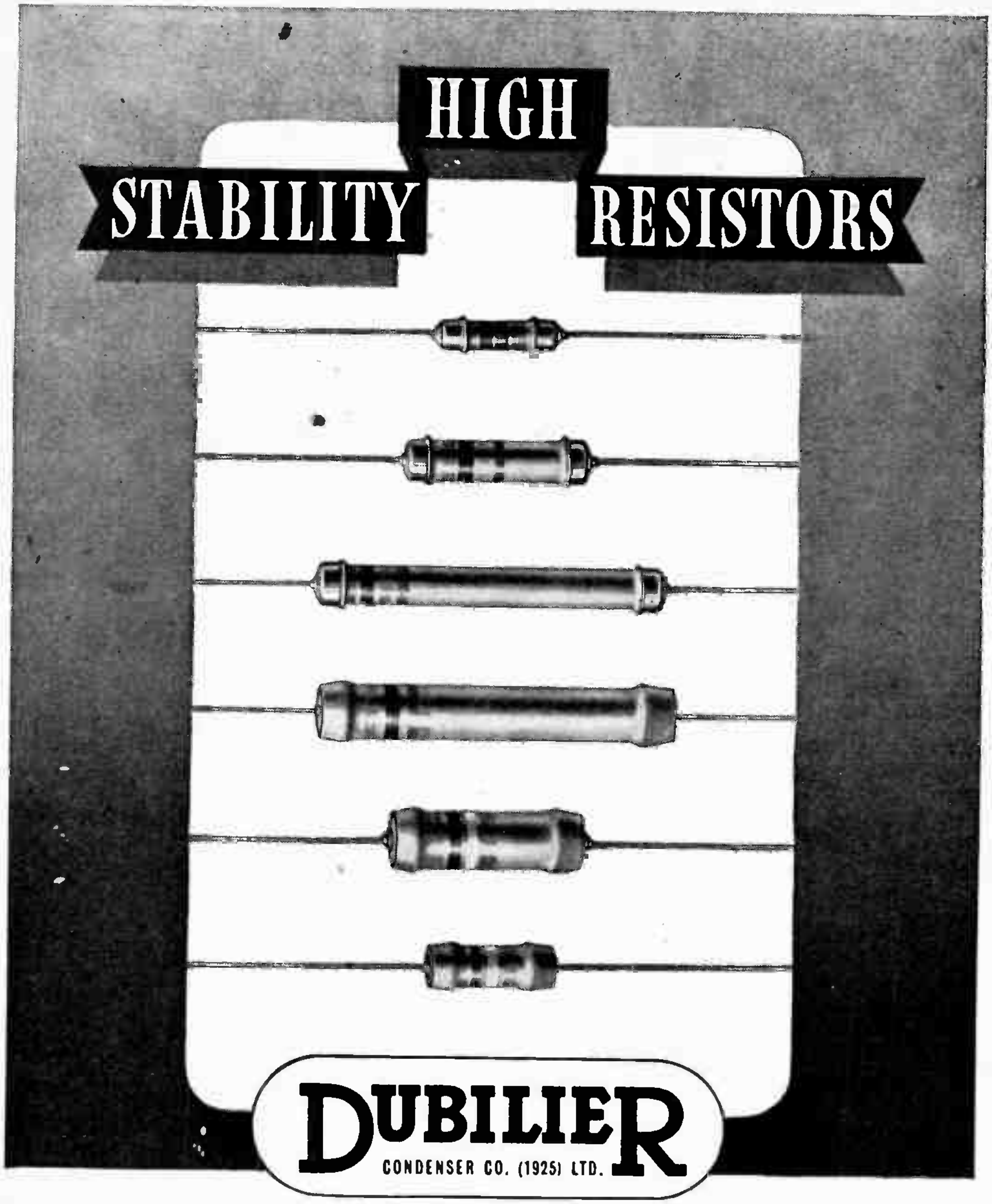

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It is for such installations that the Vitavox Bitone Reproducer has been designed. High frequency reproduction in this instrument is handled by a small multicellular horn and moving coil pressure unit, this assembly providing adequate coverage and at the same time because of its high efficiency, a rising high note characteristic which is an advantage in auditorium reproduction. A 12" moving coil cone type loudspeaker operating in a vented enclosure reproduces low frequencies and a cross-over filter network is fitted to divide the frequency spectrum correctly between the two units. The whole assembly is mounted in a polished Walnut finished cabinet as standard, Oak and Mahogany veneered models being available to special order, and can be relied upon for applications where quality of performance rather than first cost is the main consideration.

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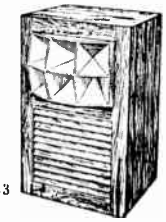
Power Handling Capacity: Model 610—10 watts; Model 620—20 watts. *Size:* 32" x 21" x 20". *Terminating Impedance:* 7·5 ohms. *Filter Attenuation:* 12 d.b. per octave. *H. F. Distribution (appx):* 60° x 40°.

MODEL 610 — £42 0 0
MODEL 620 — £50 0 0



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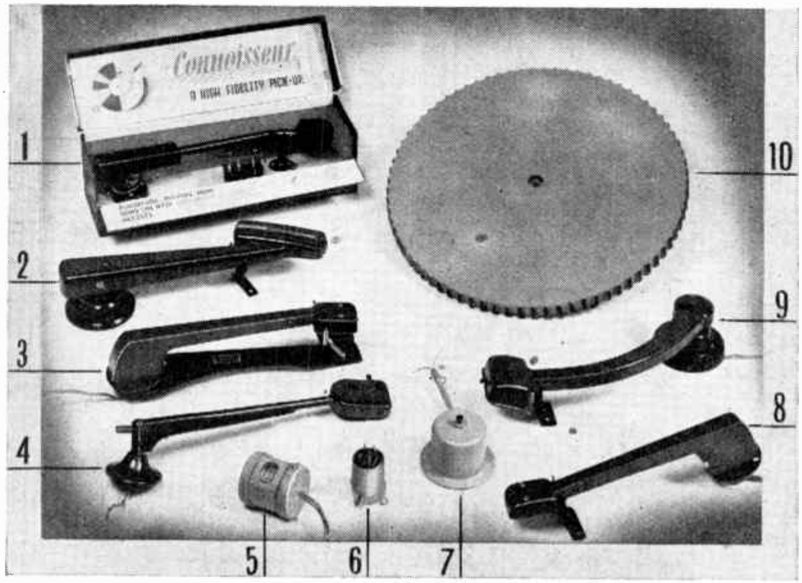

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2. Rothermel "Senior" Crystal Pickup. A recognized standard of comparison for Crystal Pickups. Frequency range 50–7,500 c/s. Average output 1.5 volts. For standard needles £2 16 3

3. Lexington "Senior" Moving Coil Pickup. Advanced modern design, incorporating ingenious semi-automatic insertion and rejection of sapphire needles. Given a good Amplifier and Loudspeaker, reproduction is superb £6 14 6

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5. Lexington Input Transformer. In mu-metal box for efficient screening. Made especially for Lexington "Senior" and "Junior" Pickups, and also recommended for use with home-made or experimental Moving Coil Pickups £1 14 2

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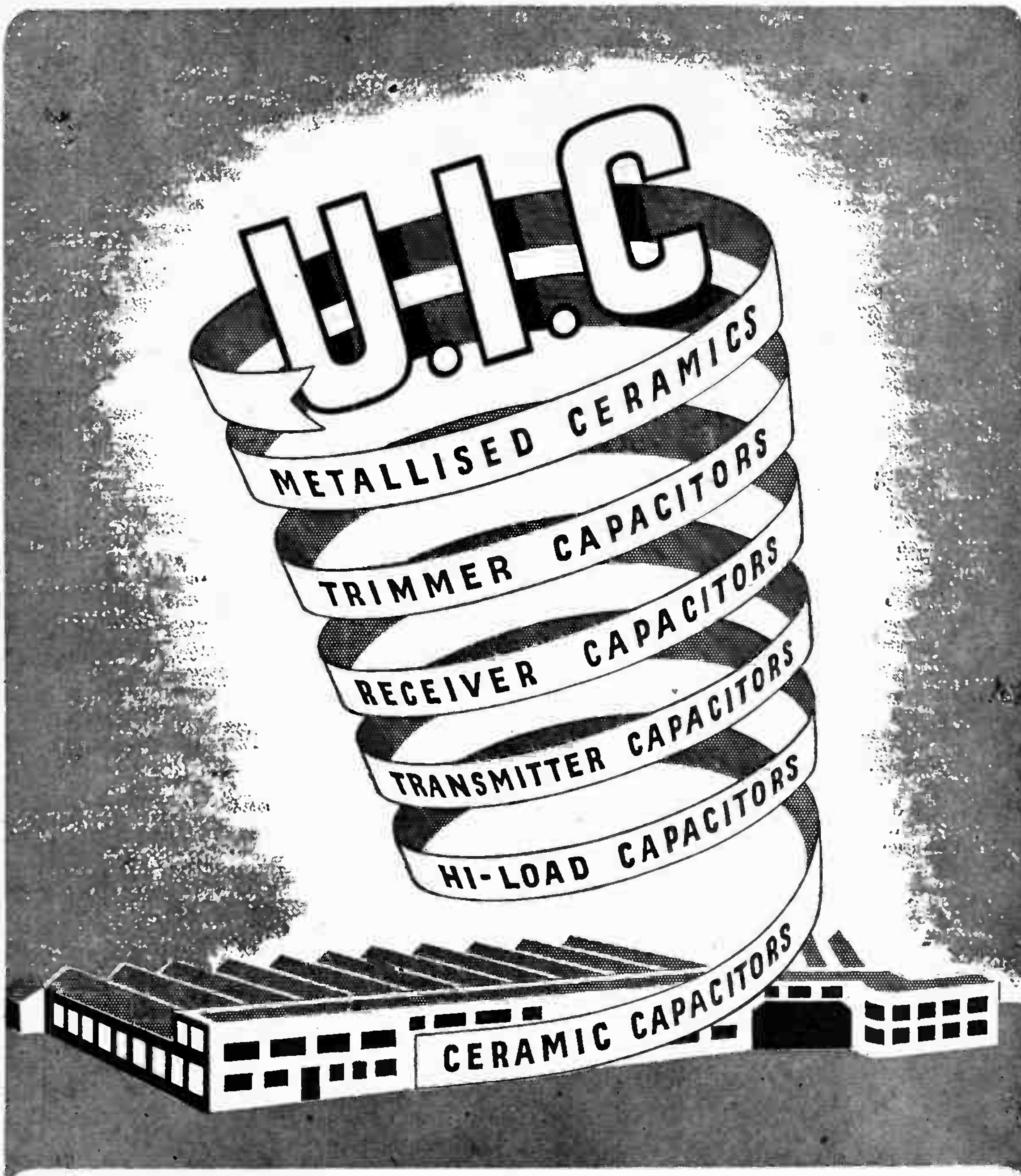

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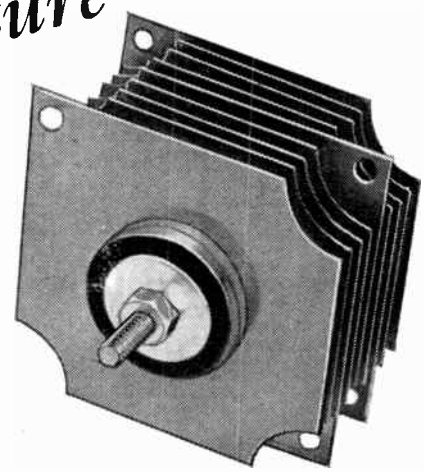

Typical unit for H.T. supply to radio receivers.

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Twenty years past performance has shewn that there is no rectifier quite as reliable as Westinghouse. Its robust all-metal construction and high efficiency have given it a long and useful life and it is these qualities that indicate the future working and durability of this modern rectifier.

A complete range is available for use in AC and AC/DC receivers and battery eliminators, with outputs from 120 volts 20mA, up to 600 volts 120mA. Units of the new range are smaller than earlier models, the overall size of a rectifier to give 600 volts 120mA, for example, is but $4\frac{1}{16}''$ long, with $2\frac{1}{4}''$ square fins.

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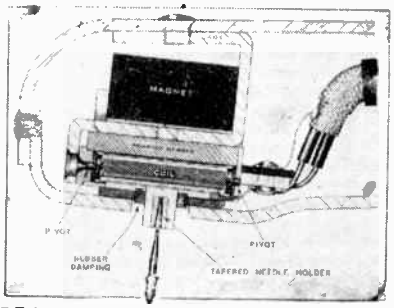
It's easy to make Pick-ups — if you know how.

The know-how in the manufacture of

Lexington MOVING COIL PICK-UPS



is the result of long experience and precision watch-making standards which give a finely constructed instrument the details of which are shown in the sectional diagram.

DE LUXE MODEL ● Robust design. ● Accidental dropping on record will not damage Pick-up ● Extremely low moment of inertia (80 milli-grams total weight of movement) ● Pure sine wave with no harmonic distortion ● Automatic needle or sapphire changing opens new fidelity field to the amateur ● Can be used with normal record changer without fear of damage. Price (without sapphire) £5.10.0, plus 24/6 P.T.

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Sapphire Needle with specially tapered shank, 15/3 (incl. P.T.)

PRE-AMPLIFIERS having an inverse of the recording characteristic incorporated are available for use with pick-ups. These are necessary with some amplifiers. Price complete with valve and input Transformer, £6.1.0.

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15-WATT HIGH FIDELITY

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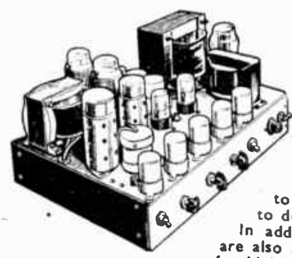


Designed in our laboratories for use with our own Pick-ups, also as an Audio-channel for high quality local station radio feeder units.

The amplifier is available completely constructed or the necessary circuit diagrams and technical details can be supplied to technical amateurs who prefer to do their own construction.

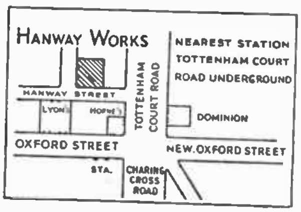
In addition technical details and circuit are also available showing the construction of a high quality **RADIO FEEDER UNIT** incorporating local stations and television sound bands for use with the above amplifier, making a perfect combination for the connoisseur.

Prices and details of the above will be sent upon request.

This service is introduced at the request of the many satisfied users of our Pick-ups.

Illustrated Technical Brochure *upon request.*

Export and Trade Enquiries invited.



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50 c/s to 250 kc/s.

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±5% of the actual reading.

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2 megohms.

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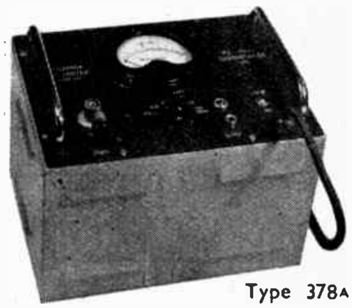
Stable and remains set on all ranges.



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This instrument is now available from stock. Write for full particulars and specification. PRICE £75

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Moving Coil Hand Mike with Switch 6/6

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(ALL the above have genuine Alni magnets.)

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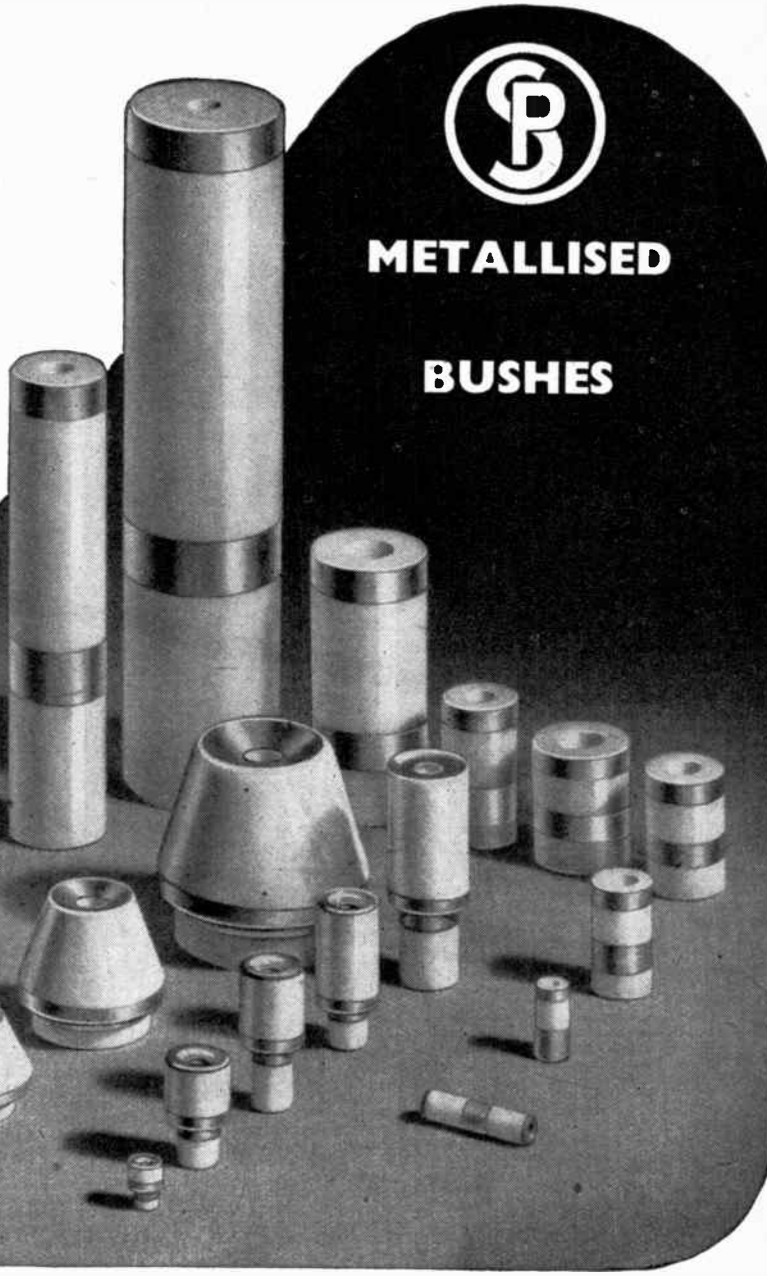
There's a size for every job in the S.P. range of metallised bushes



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Editor:
H. F. SMITH

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

VALVES AND THEIR APPLICATIONS

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

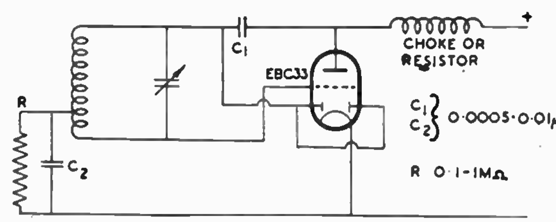
No. 9: Mullard DOUBLE-DIODE-TRIODE EBC33

THE use of a double-diode-triode as a combined detector, a.g.c. rectifier, and a.f. amplifier has been common practice for so long that comment on this application may be superfluous. There are of course many examples of highly specialized circuitry using diodes and triodes which can conveniently be combined. Radar personnel will no doubt be able to think of some. Between these two extremes is a field of common though not mass-production application—oscillators, in many of which there are advantages to be gained by employing a diode for automatic amplitude control (a.a.c.).

One generally wants to be sure that an oscillator will oscillate, even though everything chance to be lower-limit; so the tendency is to aim for plenty of margin. What happens then is that oscillation is obliged to build up to a more or less excessive amplitude in order to introduce sufficient losses or reduction of valve gain to arrive at a balance of power. This condition is not conducive to good waveform and frequency stability. A grid condenser and leak, by developing a negative grid bias nearly equal to the peak value of oscillatory voltage at the grid, provides automatic restraint both of amplitude and of anode current (which otherwise is liable to become uneconomical or even injurious to the valve), but does not altogether overcome the other disadvantages, and unless one is careful is liable to squegg.

The principle of a.a.c. is to separate the biasing and grid-driving functions, using a diode to provide the control bias and thus making it possible for the amplitude of oscillation to be (if desired) much less.

The diagram shows a very simple adaptation of the Hartley circuit to a.a.c. Besides simplicity and effectiveness, this circuit is very uncritical as regards component values. Those specified are suitable for frequencies of the order of 10^6–10^7 c/s; but the circuit can be used for a.f. If C_1 and C_2 are unnecessarily large they render the a.a.c. sluggish and transient fluctuations consequently prolonged. The normal position for the coil tapping is that which divides the coil in the ratio 1:A, where A is the amplification of the valve under desired operating conditions. Unless oscillation is only barely possible, the exact point is not at all critical.



This circuit does not keep the amplitude closely constant under all conditions—it is roughly proportional to H.T. voltage, for example, and varies somewhat with Q or load—but it does keep it well within the grid base and maintains I_a always at a minimum for the load applied.

Mullard

This is the ninth of a series written by M. G. Scroggie, B.Sc., M.I.E.E., the well-known Consulting Radio Engineer. Reprints for schools and technical colleges may be obtained free of charge from the address below. Technical Data Sheets on the EBC33 and other valves are also available.

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Wireless World

Radio and Electronics

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MONTHLY COMMENTARY

Reading "*Wireless World*"

LIKE every other periodical, *Wireless World* observes certain journalistic conventions—not from any slavish adherence to tradition, but because it is thought that to do so makes reading easier. That object would be attained if every reader could be assumed to know the rules; recent experiences make us doubt if such an assumption is justified, and so a brief exposition of these conventions, as observed by this journal, should be helpful.

The obligation on every responsible publication to draw a clear distinction between news and views is already widely known. We are constantly on our guard, when reporting happenings in the world of wireless, to avoid the slightest coloration of the facts in order to bring them into harmony with the interests of this journal or the personal views of the individual concerned. Equally, we take care that the distinction between fact and comment is made clear at the most superficial reading. Where any useful purpose is served by doing so, we give the source of the information. The spreading of rumours has no place in a responsible technical journal, but occasionally it is thought desirable to print a report that cannot be verified. Here it is our practice to warn the reader by prefixing the paragraph with some such phrase as "According to a report from . . ."

The difference between a signed and an unsigned article is not always fully appreciated. The unsigned contribution may always be assumed to be one for which we assume the fullest responsibility, both for statements of fact and expressions of opinion. Such material is almost always written by a member of the staff; on the rare occasions where it is not, by someone in whom we repose equal confidence. Articles signed by the name or initials of the author or by a *nom de plume* are in an entirely different category. Here *Wireless World* takes the usual precautions to verify facts, but any views expressed are those of the author; we do not necessarily agree with them. This is not a case of shelving responsibility; the onus of deciding whether the author's views are worth expressing rests, of course, on us, as does the legal responsibility for libellous statements or infringements of the Official Secrets Act, etc.

As we limit our endorsement of signed articles, still more do we decline to endorse the views expressed by writers of "Letters to the Editor." Sometimes, indeed, we print communications with which we disagree most profoundly, in the hope that they will provoke discussion. Radio has recently celebrated its jubilee as an applied science, but it is still a growing art, and there is often need to clarify ideas and even to dispel widely held misconceptions. The present correspondence on "Loudspeaker Damping" will probably turn out to be a case in point. Anonymous letters are never published, though *noms de plume* are accepted if authenticated by the writer's name; especially if we are convinced that the writer has reasonable grounds for concealing his identity.

In touching upon this question of anonymity we are raising one of the skeletons of the journalistic cupboard. All our inclinations are towards the contribution signed with the writer's name, whether in the form of a letter or article, but particularly the latter. The catch-phrase "Freedom of the Press" involves at least three freedoms, of which we are modest enough to think that our own freedom to print is the least. The reader's freedom to read the latest information on his chosen subject is far more important, but this he cannot enjoy unless the writer is equally free to write. There is a regrettable and increasing tendency in some less-enlightened quarters to place obstacles in the way of the technical writer, and so it is not surprising that he sometimes wishes to shelter under a pseudonym. This discouragement of authorship is especially to be deplored in relation to technical journalism, which depends on the technician rather than the professional writer for outside contributions.

Is a Big Aerial

Clarifying Ideas on an Awkward Problem

FROM time to time it is urged that much of the performance of a broadcast receiver is thrown away if it is not connected to a good aerial.[1] Nevertheless, the general public show no signs of profiting by this advice. Quite the contrary, so far as one can see there is no break in the increasing tendency to rely on stray pick-up from the mains, the line cord, or at most a piece of wire around the room.

Who is right—the experts or the public?

The public would probably argue that they are not very much interested in performance; not enough, at any rate, to go to the bother and expense of erecting an electromagnetically good outdoor aerial, which is liable to be carried away by gales or struck by lightning, spoils the appearance of the place, anchors the receiver to one position in one room, and may even be prohibited by the landlord. Moreover, did not the dealer say an aerial was unnecessary and actually impaired the selectivity? So long as the main programmes can be heard satisfactorily without all this trouble, why worry?

So long as one can, and so long as one is content with no more, why indeed?

No doubt the great majority of listeners can be dismissed at this point. But there surely remain a substantial number who, because of strong local interference, cannot satisfy even these modest desires, and others who would like to hear a wider choice of programmes but who find them so crackly that it is a relief to turn back to the locals. Many of these people probably fail to realize how much better off they would be if they installed a proper aerial.

It is only natural for the dealer, when his customer quotes his rival's claims, to assert that his sets, too, need no aerial. Would not the customer suspect him of ulterior motives if he urged the extreme desirability of having an elaborate aerial installation put in hand, of course at extra cost? And the manufacturer is caught up in the same web of circumstance, for if he designed his receivers primarily for use with an outdoor aerial, they would compare badly with other makes on the far more likely "bit of wire." So it is hardly surprising if a general impression exists that a set for which an outdoor aerial is recommended must be a pretty poor sort of affair.

Wireless World readers, whose motives no doubt are beyond suspicion, can help the uninstructed and suffering public to achieve quieter and/or more varied reception by overcoming this prejudice, explaining in simple terms the function of the aerial and suggesting how it might be arranged to meet the listener's objections while being reasonably efficient. There is, of course, always the risk of being called upon actually to do the job, but, well . . . .

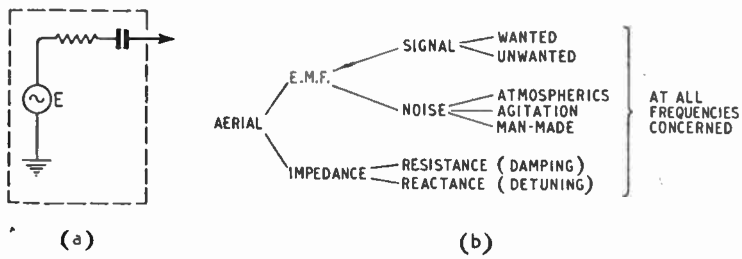


Fig. 1. The equivalent circuit of an aerial (*a*), and its properties and products analyzed (*b*)

Maximum Performance

Before embarking on a propaganda campaign, it would perhaps be as well to clarify our own ideas, and to consider the aerial question on a basis of maximum performance. Such consideration may profitably be given by owners or designers of more or less ordinary broadcast receivers who want to get the best out of them, and still more by enthusiasts whose interests lie with sets of the communications type.

Leaving out of account sets with no provision for external connection, the aerial is the one item in the complete outfit which is outside the control or knowledge of the commercial designer. He is therefore faced with a number of indeterminate variables. Not only is the range of probable signal input voltage greatly extended by this uncertainty, but—a still more tricky problem—he has to guarantee the preselector tuning without knowing what sort of impedance may be connected (or left unconnected) to Aerial and Earth.

The aerial can be regarded as a generator of assorted R.F. E.M.F.s, good and bad, with its internal impedance, as shown in Fig. 1*a*. At any one frequency the impedance can be specified simply as a resistance and either a capacitance or inductance, but these elements vary widely over the usual wavebands.

Fig. 1*b* is an analysis of the subject that may help to guide our thoughts. First, considering the aerial in its intentional role as a source of desired signals, such signals cover a wide range of voltage, which may be represented as in Fig. 2 (a—g). The top limit is the E.M.F. generated in the aerial by the strongest field produced at the place of reception by a station that is liable to be wanted; the "local station," say. The bottom limit is the weakest wanted E.M.F. that is capable of overriding noise E.M.F.s to the satisfaction of the listener furnished with a perfect receiver. In a quiet situation (i.e., one rela-

[1] For example, by the Editor on page 235 of the July issue, and by a correspondent, T. H. Kinman, on page 192 of the May issue.

Worth While?

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

tively free from atmospherics and noise picked up by the aerial) the latter limit is low, giving a large range of available signal strengths, as at *a*. In a noisy situation, on the other hand, it is high, as at *b*.

Putting up a larger aerial in the *b* situation raises the diagram bodily, as at *c*, if it is assumed that signal and noise continue to be picked up in the same ratio. As is well known, however, if the source of noise is close to the receiver the likelihood is that the large aerial will pick up little more of it than the smaller one, so the diagram will look more like *d*. This compares more nearly with *a* for range of signals available, and in addition is at a higher general level. At the opposite extreme, *e* represents a very small aerial in a noisy situation, and *f* the same aerial in a quiet situation. Lastly *g*, a large aerial with low noise. (A "large" aerial herein means one that develops a relatively strong E.M.F. from a given field, whether mainly because of size, shape, or position.)

On the right-hand side are shown to the same scale the corresponding limits of the receiver; at the top the strongest signal that can be applied to the aerial terminal without overloading the set, and at the bottom the weakest signal that can override the internally generated "set noise." The extent of the receiver acceptance range depends on what the listener is prepared to tolerate as regards overloading and noise. But taking that for granted it can be increased by good design, as illustrated at *j* compared with *h*. The general level of the range is determined by the aerial coupling; with a looser coupling (*k*) the receiver obviously requires (or can stand) a stronger input from the aerial.

These diagrams must not be taken too literally, of course, because they are subject to such complications as aerial impedance, the effect of the aerial connection on set noise, and—most of all—the nature of the overloading (whether it is due to the wanted signal or to some other). These details will be considered in turn, but in the meantime it should be noted that whereas there is no limit to shifting the acceptance range upwards by loosening the coupling (except for pick-up by the receiver other than *via* the aerial socket) there is a very definite point beyond which the lower limit cannot be shifted down by tightening it.

So, comparing the two sides of Fig. 2, it appears that to get the maximum choice of signals the aerial ought to be at least large enough for its bottom limit to be above the dotted line. It might then appear that there is a risk of its top limit coming above the receiver top limit. In practice this is unlikely to happen, because as we shall see later it is generally necessary or desirable for other reasons that the coupling should be quite loose. That being so, the real risk is that by using too small an aerial a large part of the range of signals brought in by it may be below the lower limit of the receiver and thereby lost, while at the same time a large part of the receiver's range may be above the aerial's top limit and so never used. Tightening the coupling to adapt a receiver to a weak-signal aerial had bad secondary effects, such as detuning; but loosening it for a strong-signal aerial has good secondary effects, and moreover is the more easily done without getting inside the receiver.

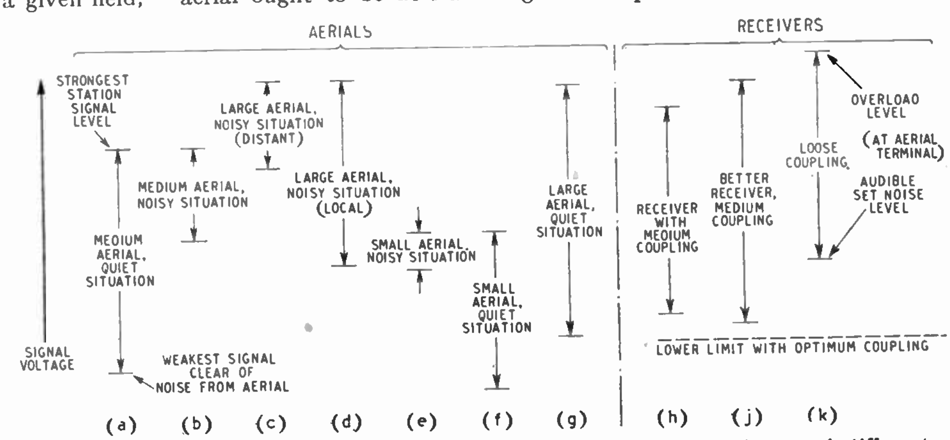


Fig. 2. Diagrams representing the upper and lower useful signal limits of different aerials and receivers. Ideally the depth of the aerial line (for a given "strongest station") should be as great as possible, and the receiver line should embrace at least the same range.

Flexible Input Circuits

Regarding the aerial as a source of signals, then, it seems fair to say "the bigger the better." At the same time it ought to be noted that the benefit of a really good aerial in a quiet locality with a strong local station cannot be fully realized unless the whole of its extensive range of signal level comes within the receiver limits. In other words, the receiver should be well designed and expensive enough for its limits to be far apart, or should be provided with variable or alternative coupling.

Unfortunately many receivers, and not least the latest, are neither. Of the twenty-eight 1946-7 models for which information was available, and capable of being connected to an aerial, not one has a preselector stage, and

Is a Big Aerial Worth While?—
all but three have fixed aerial coupling, without even a choice of socket to suit a large or small aerial (unless the provision of an internal frame or plate aerial in five others can be reckoned as an alternative "coupling"). As we have seen, the designer of a fixed-coupling set is almost bound to assume the aerial will be small. Connecting a very large aerial, which if appropriately coupled would give much better reception, may therefore be liable to produce some of the following results:—

(1) Cross-modulation, due to a strong unwanted signal being of such an amplitude as to sweep one or more valves over a sufficiently non-linear range for its own modulation to be impressed on the wanted carrier wave, no selectivity beyond this point being of any avail to remove it. The general abandonment, in these austere days, of more than one tuning circuit before the frequency-changer, accentuates this trouble. (Only one of the twenty-five fixed-coupling sets mentioned has band-pass tuning.)

(2) Whistles, due mainly to excessive strength of unwanted signals.

(3) Distortion, due to overloading of pre-volume-control stages by a wanted local signal.

(4) Interference to other listeners by oscillator radiation. For example, a listener to Droitwich on 200 kc/s, using an I.F. of 465-470 kc/s, has his oscillator working at a frequency that could seriously worry his neighbour tuned to North Regional on 668 kc/s.

(5) Other disadvantages to be considered under the heading of aerial impedance.

Better Sets Wanted

The moral of all this is not that aerials capable of long-range reception should forthwith be universally abandoned, but that wherever possible the receiver should include a preselector stage or at least a two-circuit tuner, and of course well-designed valve operation; and that sets which unhappily must conform to the present economy regime should as an absolute minimum have two alternative aerial sockets, and not attempt the impossible, as so many do.

So far we have considered a larger aerial primarily as delivering a stronger signal. But it is not necessarily used in this way, which, as we have seen, may be undesirable unless the receiver has adequate preselection or other provision against overloading. The alternative advantages of a large aerial are related to the other items in the left-hand column of Fig. 1*b*.

Undesired signals, for example. It has often been stated that a

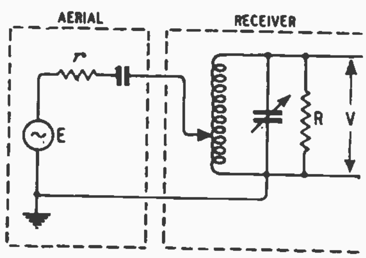


Fig. 3. R is the value of the dynamic resistance of the tuned circuit (with aerial disconnected) together with the valve input resistance and any other losses, for purposes of calculating maximum signal voltage V.

larger aerial reduces selectivity. Assuming connection is made to the same coupling that suits a smaller one, that is undoubtedly true. It does it in two main ways: by overloading, and by damping and detuning the first tuned circuit. Overloading has just been discussed, and damping and detuning will come up for consideration later. Anticipating, however, it may be said that the answer is just the same—it is not the size of the aerial that is at fault; suitably coupled, a large aerial is in general better for selectivity than a small one.

Next there is noise. While atmospherics (worst at the lower frequencies) and celestial noise (worst at the very high frequencies) certainly increase as the aerial is enlarged, the signal/noise ratio is hardly likely to be worse, and may well be better, because even if the aerial is omnidirectional a low one is generally more screened from the signal source than from natural noise. And, of course, if it is practicable to make the aerial directional there is considerable scope for discriminating against noises of these kinds.

But it is with regard to man-made noise that the possibilities of the aerial are greatest. It must be a familiar story to nearly all readers; that an indoor aerial is closely coupled to all the electrical noise generated in the house and brought into it by wires, etc., while it is more or less screened from radio signals so that even the strongest may not always override the noise. An outdoor aerial, even without any special anti-interference features, normally brings in far more signal than additional noise, so the ratio goes up strongly in favour of the listener. But obviously this simple truth has yet to penetrate many of the homes of the people.

In the more difficult situations—those in which severe interference comes largely from outside the house—merely putting up an outdoor aerial may not be enough; a specially sited aerial with a screened lead-in may be needed.

So much for the aerial as a signal source. Turning now to its impedance; it is impossible to connect an aerial to a receiver in such a way as to use the aerial as a signal collector without transferring some of its impedance to the receiver. The effect of the resistive component is to reduce the Q and hence the selectivity of the circuit to which it is coupled, and the effect of the reactive component (inductive or capacitive) is detuning, which, if not corrected, further reduces selectivity, and signal strength as well. So the problem is to couple the aerial in such a way as to introduce as much as possible of at least the weakest wanted signals, reduce selectivity as little as possible, detune as little as possible, and do all of these things over all the wavebands of the receiver, preferably without any effort on the part of the listener.

The object of the present inquiry is not to solve this admittedly sticky problem but to decide how the size of aerial affects the matter in terms of results.

Referring to Fig. 3, the aerial is shown as a generator of (among other things) a desired voltage which we denote by E, a resistance r, and a reactance, usually capacitive. This system is coupled in any of a large variety of different ways to the input tuned circuit of the receiver, across which it is desired to set up a signal voltage; call it V. With the aerial disconnected, the resonant tuning circuit can be represented as a resistance—the dynamic resistance—denoted in Fig. 3 by R. The input resistance of the valve, which at the very high frequencies may be low enough to dominate the situation, can also be incorporated in the value of R.

Assuming first of all that the set noise is negligible compared with V, and that the object is to make V/E as great as possible, the well known law of generator and load supplies the answer; namely, that the aerial coupling must be arranged so as to make the receiver, looked at from the aerial, have a reactance equal and opposite to the aerial's (so neutralizing it) and an equal resistance. This done, the voltage across r is obviously E/2 and the power dissipated in it is $E^2/4r$. The power delivered to the receiver is clearly V^2/R, and as the matched load condition just applied makes these quantities equal we have

$$E^2/4r = V^2/R$$

and hence

$$V = \frac{E}{2}\sqrt{\frac{R}{r}}$$

as the condition for maximum possible V, assuming no loss introduced by the coupling. Given this perfect coupling, the aerial yielding the strongest signal is the one with the highest $E/\sqrt{r}$. Putting up a large well-designed aerial greatly increases E and may even reduce r in comparison with that of an inefficient indoor aerial. Certainly it would have to be very bad for r to *increase* as rapidly as E^2!

The ideally coupled aerial appears to the receiver as the equivalent of a resistance equal to R in parallel with its own R, so the effect on the Q of the receiver circuit is to reduce it by one half. And since at any given frequency Q is a measure of the selectivity, that also is reduced by a half. While it is true that nearly all receivers nowadays are superhets, in which the first tuned circuit has very little influence on adjacent-channel interference, yet its selectivity is important for protecting the receiver against cross-modulation, second-channel interference, I.F. interference, and certain whistles. Whereas a poor aerial, with small E and large r, has to be fairly closely coupled in order to deliver a reasonable V, a large aerial can give equal or greater V with far less than optimum coupling, and the natural selectivity of the pre-selector need therefore hardly be affected.

Selectivity and Signal Strength

So in a true sense the large aerial promotes selectivity as well as signal strength. But again the important thing is coupling. Fig. 4 shows how coupling can be reduced considerably below optimum before signal strength falls off badly, while selectivity is substantially improved. A large aerial allows one to reduce the coupling much more than a small one.

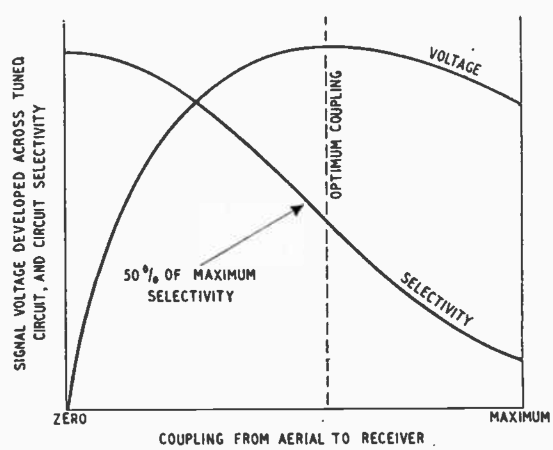


Fig. 4. Typical effect on signal voltage across the pre-selector tuning circuit, and on its selectivity, of varying the aerial coupling.

These curves also indicate the deplorable effects of connecting a large aerial via a coupling that is optimum for a small one—both selectivity and signal strength are less than they could be.

When set noise is the limiting factor, as it is when receiving weak signals of very high frequency on an adequately sensitive receiver, signal/noise ratio rather than signal strength is the criterion. This subject has been dealt with recently by L. A. Moxon[2] so there is no need to do more than recall that the coupling giving maximum signal-noise is *closer* than the matched-load optimum which delivers the strongest signal, especially if the set noise is mainly thermal agitation in the input circuit. This happens because the loss of signal caused by overcoupling is not as rapid as the reduction in thermal noise resulting from the shunting effect. If the valve shot noise predominates, however, there is negligible advantage in over-coupling.

Lastly, aerial reactance. Although it is possible at any one frequency to neutralize it by, say, an equal and opposite reactance in series, this not only introduces more resistance but is hardly practicable over wide tuning bands. So in practice the aerial reactance either detunes the first circuit, or has had to be corrected. Detuning is of course even worse than damping, in that it may actually strengthen interference as well as weaken the wanted signal. Correction would be easy if the aerial plus its coupling were equivalent to a constant capacitance or inductance throughout any tuning band, because it could be done once for all in the design, and the ganging would not be upset. It is difficult enough to achieve such a coupling even if the properties of the aerial are known in advance, and impossible if they are not. Moreover, the type of coupling that comes nearest to this ideal is quite unlikely to be the best for signal transfer and selectivity also over the whole tuning range. So the designer has to arrive at some compromise that gives as fair a balance as pos-

[2] *Wireless World*, May, 1947, pp. 171-176.

C

Is a Big Aerial Worth While?

sible of all three interests at all working frequencies and with all possible aerials. Of course it is an outrageous demand. Nearly every designer tries something different, but is any satisfied?

It is a different matter altogether with a fixed-frequency installation, or even for the enthusiast who does not mind adding variable coupling and variable aerial tuning controls to his DX receiver. But in a saleable broadcast set it is necessary to fix the coupling much below optimum in order to avoid excessive detuning. Some types of coupling can be closer for a given detuning than others; Fig. 5, for example, compares auto-transformer and series capacitor methods, showing the great superiority of the former. The whole business would be very much easier if one could assume that all aerials were of one kind, either large or small. But of the two, large would be far the better, because for a given signal delivery it can be coupled so much more loosely. Or, alternatively, for a given detuning it delivers so much stronger a signal.

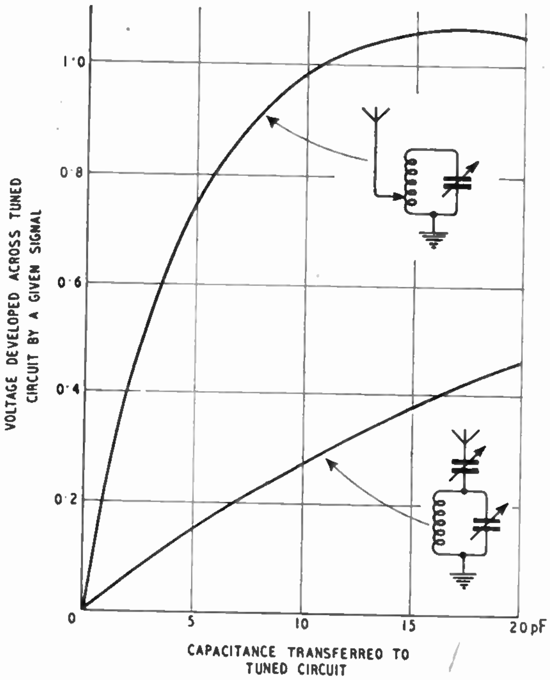


Fig. 5. Typical measured results showing how inductive coupling gives much stronger reception for a given small transfer of aerial capacitance to the tuned circuit than series capacitance coupling.

But if a large aerial is connected by a coupling designed for a small one, the results are excessive detuning, damping, and overloading; while the reverse gives very poor signal strength in relation to set noise (see Fig. 2 again). So here once more the importance of suiting the coupling to the aerial stands out.

Summarizing, then: even with a coupling designed for it, an indoor aerial or mains aerial deprives one of weak-field programmes, either because the signal voltage delivered by it is insufficient to give a useful output if the gain of the receiver is limited, or to override set noise if gain is unlimited. Such an aerial may even fail to supply noise-free reception of *any* programme, owing to its vulnerability to local interference. A good outdoor aerial, on the other hand, is better in every respect — signal strength, signal/noise ratio, selectivity, and absence of detuning. Either sort of aerial unsuitably coupled gives very poor results, but it is easier to remedy the faults externally with the large aerial. It is up to the set-maker, however, to render his 4+1 products suitable both for the Home-and-Light brigade and for those who want better results. A great all-round improvement in broadcast reception would result at trifling cost if he would at least fit two alternative aerial sockets. The small-aerial or "no"- aerial people could then get a rather stronger signal, while there would be no need to deter the more ambitious listeners from putting up a large aerial. Where economy is not so binding, a more flexible coupling still, and better preselection, are the clues to an improved range of signal acceptance.

MANUFACTURERS' LITERATURE

VITRIFIED enamel and fired metal markings on glass are described in a new publication (2572) "Permanent Scales and Markings on Glass," issued by Johnson, Matthey and Co., 73-83, Hatton Garden, London, E.C.1.

List No. 132, Issue No. 1, "Capacitors—Paper, Mica, Ceramic," from The Telegraph Condenser Co., North Acton, London, W.3.

Receivers for export (Models E.A.C.91, E.U.91, E.A.C.95 and E.U.95) are described in a coloured brochure issued by Bush Radio, Power Road, Chiswick, London, W.4.

The following illustrated leaflets have been received from Rediffusion, Broomhill Road, London, S.W.18: "Industrial Radio Heating, an "Introduction," "Radio Heat Plastic Welder, Model J.P.1," "Communication Equipment, Radio and Audio Frequency Installation for Ground, Sea and Air Services."

New edition (including text in French and Spanish) of "For Those Who Seek the Finest Cored Solder in the World," an illustrated brochure giving technical details of Ersin Multicore solder, from Multicore Solders, Mellier House, Albemarle Street, London, W.1.

Illustrated leaflet describing V.S.E. receivers and sound amplifying equipment from V.S.E. Construction Co., 5-7, Denman Street, London, W.1.

Leaflet describing permanent-magnet loudspeakers made by Richard Allan Radio, Caledonia Road, Batley, Yorks.

Catalogue of electrical products (issue No. 4) from M.O.S., 24, New Road, London, E.1.

"Push-pull Phase Splitter": Correction

In expression (3) of the appendix (our August issue) the square should have been omitted from μ_1 in the numerator. This article by Capt. E. Jeffery, A.M.I.E.E., was written by permission of the Commandant, Electrical Wing, R.E.M.E. Training Centre.

Bass Compensation

A System Using Negative Feedback

By J. ELLIS, B.Sc.

IN a disc recording the output from the pickup is proportional to the transverse velocity of the needle in the groove. Hence, with constant output the recording amplitude is inversely proportional to the frequency, and the required amplitude for very low notes becomes impracticably large. This is normally overcome by having a recording response which is constant above a given frequency (usually about 250 c/s), and proportional to frequency below this.

In order to restore the response, the gain of the reproducing amplifier must be constant above 250 c/s and inversely proportional to frequency below this.

The usual circuits amplify above the normal level required and produce a response of approximately the right shape by a series of R-C filters. These can be made very close to the theoretical response with a carefully designed circuit, but have the disadvantage that they tend to be critical in the choice of component values and it is difficult to vary the frequency at which correction starts.

The following system is based on the fact that in an amplifier of high gain with negative feedback the response is inversely proportional to the amount of feedback (β); so that if this is made proportional to frequency, the output may be expressed as $\frac{\omega_0}{\omega}$ where ω is the angular frequency and ω_0 is the angular frequency at which the gain is unity.

If this response is added to the original signal the response is $\frac{\omega_0}{\omega} + 1$, which is correct at low and high frequencies, but when $\omega = \omega_0$ the gain is 2 instead of 1. If however the two components are 90° out of phase the magnitude is $\sqrt{1 + \left(\frac{\omega_0}{\omega}\right)^2}$ which is $\sqrt{2}$ when $\omega = \omega_0$. This is only 3db up on what is required, giving an overall response of $\pm 1\frac{1}{2}$ db.

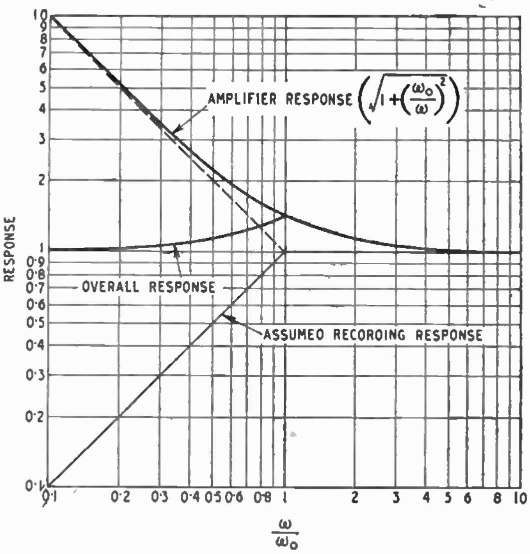


Fig. 1. Calculated response when feedback is 90 degrees out of phase.

Fig. 1 shows the response from a device of this form. It is expressed in terms of $\frac{\omega}{\omega_0}$.

A simple circuit having this response is shown in Fig. (2).

If the input is v_i and the output is v_o and the gain of the amplifier is high the voltage at the grid of the valve can be taken as zero, so

$$v_i \frac{R_2 + \frac{1}{j\omega C}}{R_1 + R_2 + \frac{1}{j\omega C}} + v_o \frac{R_1}{R_1 + R_2 + \frac{1}{j\omega C}} = 0$$

$$\therefore \text{Response} = \frac{v_o}{v_i} = -\frac{R_2 + \frac{1}{j\omega C}}{R_1} = -\frac{R_2}{R_1}\left(1 + \frac{1}{j\omega CR_2}\right)$$

Thus the normal gain is $\frac{R_2}{R_1}$, and $\omega_0 = \frac{1}{CR_2}$.

By making $R_2 > R_1$ this circuit can provide gain as well as bass compensation, but of course this reduces the available increase for low frequencies since the upper limit of gain is the normal gain of the valve without feedback.

With an R.F. pentode and a fairly high H.T. voltage, a gain of 200 can be obtained. In pushing up the gain, however, R should be kept small in comparison with R_2 to avoid a shunting effect by R_2 since R and R_2 are effectively in parallel as the grid is nearly at earth potential.

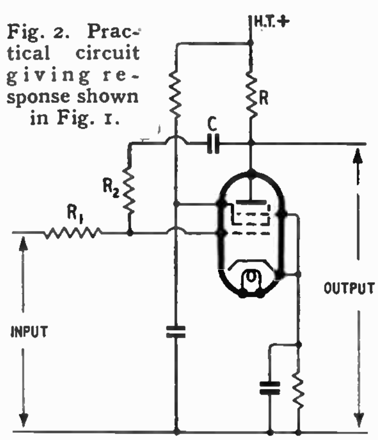


Fig. 2. Practical circuit giving response shown in Fig. 1.

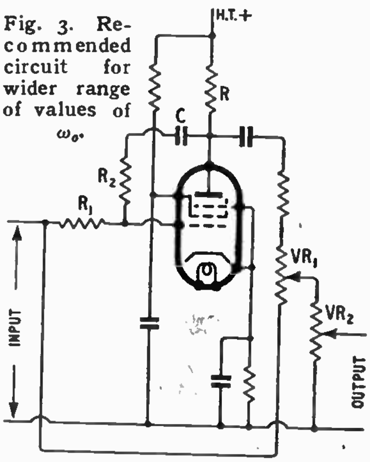
The best theoretical way of varying ω_0 is by making C variable, but it is often more convenient in practice to vary R_2. This alters the gain unless a double-ganged potential divider is used and R_1 made proportional to R_2. This complicates matters by altering the impedance of the feedback circuit and seriously

Bass Compensation—
limits the upper value of R_1 and R_2, due to the difficulty of obtaining high-value " pots."

If then a fixed value of ω_0 or only a small adjustment is required this circuit provides an accurate bass compensation with a simple circuit and 20 per cent tolerance components. Of course, more accurate values are required to give a precise value of ω_0, but as ω_0 can be varied easily this is of little importance. Moreover, this circuit is practically distortionless because of the large proportion of negative feed-back, for although the feedback may not be very great at low frequencies in some cases the feedback at the harmonic frequencies will be much more effective and it is the harmonics in the output which cause the trouble.

If a wide variation of ω_0 is required, the rather more complex circuit of Fig. 3 is better. This, roughly, produces a response of $j\frac{\omega_0}{\omega}$ and this is added to the original. ω_0 can be varied by altering the proportion added to the original signal. Call this proportion α, then the response is :

Fig. 3. Recommended circuit for wider range of values of ω_0.



$$1 - \alpha\frac{R_2}{R_1}\left(1 - \frac{1}{\omega CR_2}\right)$$

$$= 1 - \alpha\left(1 - \frac{1}{\omega CR_2}\right), \text{ if } R_1 = R_2$$

$$= (1 - \alpha)\left(1 + \frac{\alpha}{j\omega CR_2(1 - \alpha)}\right)$$

$$= (1 - \alpha)\left(1 + j\frac{\omega_0}{\omega}\right),$$

$$\text{where } \omega_0 = \frac{\alpha}{CR_2(1 - \alpha)}.$$

α is varied by VR_1. By varying α between 0 and 1, ω_0 can be varied between 0 and ∞.

I have not given exact circuit values for these two circuits as they will vary with the type of valve used, the H.T. supply available, the gain required and the amount of variation of ω_0 required.

Using the circuit of Fig. 2 and requiring unity gain and a frequency of 250 c/s for the start of the correction, with an H.T. supply of 250 volts, and using an EF36 $R_1 = R_2 = 1M\Omega$, $R = 220\,k\Omega$, $C = 600\,\mu\mu F$ and a screen-dropping resistance of $2.2M\Omega$ should give good results. A pot included as part of R_2 will provide fine adjustment for ω_0.

In the circuit of Fig. 3 $R_1 = R_2 = 1M\Omega$, $R = 220k\Omega$, $C = 200\mu\mu F$ will give $\omega_0/2\pi = 250$c/s when $\alpha = 0.25$. VR_1 and VR_2 should be high, preferably with $VR_2 > VR_1$ and $R_3 = VR_1$. Of course, if no volume control is needed at this point VR_2 is simply the grid leak of the next valve, or is left out altogether if there is a D.C. path to earth through the input.

In adding one of these circuits before an existing A.F. amplifier it must be remembered that it acts as an additional stage and " motor-boating " may be experienced due to low-frequency feedback through the power supply unless the usual precautions for multistage amplifiers are observed.

Measuring Gear at Stockholm

Lost British Opportunities

(From a Correspondent)

AMERICAN, British, Czech, Danish, French, Finnish, Swiss, Swedish, Italian, Dutch, Norwegian and Austrian firms were all represented at the international exhibition of measuring instruments and laboratory equipment held in Stockholm from May 31 to June 3. It was surprising to find how little new there was in the radio and electronic field and how closely the Continental equipment resembled the British and American familiar designs. Six years of isolation have produced no major differences in technique.

The exhibition, like that of the Physical Society, covered a very wide range of equipment. On the fringe of the radio engineers' field were three exhibits of electron microscopes, one Swedish, one Dutch and one American, all giving very satisfactory demonstrations.

Generally speaking, it was all rather discouraging to a British visitor. Sweden is a "hard-currency" country and is anxious to buy equipment. Great Britain is supposed to be anxious to sell goods abroad, and the light-current electrical industry has an almost ideal export article, using relatively little material for a high price. The enormous capital investment in war-time "know-how" is an asset, but a wasting one, and every instrument sold now is some return on this capital. British manufacturers and their agents did not appear to be making the most of their opportunities in Stockholm.

There were some notable exceptions. Cambridge Instruments and Sullivan both showed equipment which was unmistakable and well maintained the British reputation in their field. Here indeed there was no question of our supremacy. Only Johnson Matthey and Avo were notable among the other exhibitors. Johnson Matthey showed a wide range of their materials, including ceramics, and silvered mica condensers, while Avo, represented by Svenska Radio A.B., had their full range of test equipment on view, and a very willing demonstrator. Only one stand showed any microwave equipment, and this was merely a jumble of magnetrons, T.R. gaps and bits of wave guides. A great opportunity was wasted here, for commonplaces of British technique are novelties in Sweden, and the future for navigational aids for shipping is a very great one.

The British Council stand deserves special mention in this note. Throughout the morning of my visit it was deserted, and a collection of out-of-date textbooks lay where they had fallen when dusted the day before. The main feature was a screen carrying photographs of early English navigational aids. There are some British devices later than Harrison's chronometer—indeed, there are so many that no one seems to know which to use. And there are some new books, too. Copies of *Wireless Engineer*, the *Journal of Scientific Instruments* and the *Proceedings* of the Radiolocation Convention of the I.E.E. would have been fitting supporters.

R-C Oscillator Control

Design of Network for Single-Component Frequency Adjustment

By
B. J. SOLLEY

THE operation of an R-C oscillator is based upon the possibility of arranging a number of resistive and capacitive elements to form a network having, at one critical frequency, a phase shift of zero, or 180 degrees, from input to output.

The typical R-C oscillator, as represented by the two-stage regenerative amplifier of Fig. 1, embodies the well-known frequency-selective network derived from the Wien Bridge[1] the characteristic of which is that at the critical frequency $f=1/2\pi RC$ there is zero phase shift, and a minimum attenuation of 1/3. The amplifier is accordingly designed to provide zero phase shift throughout the desirable frequency range and the gain is adjusted to slightly in excess of that required to sustain oscillations, i.e., 3 plus.

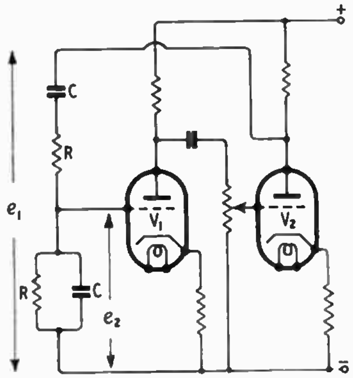


Fig. 1 Basic Wien bridge R-C oscillator.

Among the principal advantages are good frequency stability and the possibility of obtaining a convenient frequency law by suitable choice of values. The outstanding disadvantage, however, with wide-range operation is the necessity for ganged tuning controls. In order to overcome this, the writer recently developed a form of composite network in which the tuning may be accomplished by means of a single potentiometer control.

The basis of this development may be understood by reference to Fig. 2, which shows two networks fed from the same source. The normal output terminals are bridged by a high resistance potentiometer P, and the output of the composite network is taken from the slider of the potentiometer. Suppose that network 1 has a critical frequency of 100 c/s, and that of network 2 is 1,000 c/s. When the slider is at its left extremity, point *a*, the transmission characteristic will be that of the left network. Similarly, when the slider is at point *b* the characteristic is that of the right-hand network. At any intermediate point the composite characteristic will be intermediate between the two extremes.

When such a network is embodied in an oscillator it will be found that with a perfectly linear potentiometer the frequency law is exactly logarithmic, which is very desirable in many applications. At the centre of the potentiometer track, for example, the frequency will be the geometric mean of the two extremes. In the example above this would be $\sqrt{100{,}000}=316.2$ c/s. Conversely, by using a truly logarithmic potentiometer, the frequency law will be linear. The potentiometer must have a value in excess of about seven times the highest component resistor to ensure that the two component networks do not interact. Thus where the highest resistor in the network is 100kΩ a potentiometer of 1MΩ will be satisfactory.

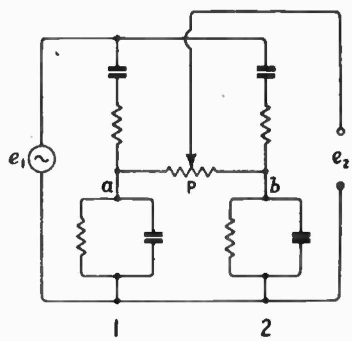


Fig. 2 Combination of two dissimilar frequency discriminating networks.

It is tempting to suppose that by using two component networks with a large ratio of critical frequencies a very wide range could be accommodated. The matter may be elucidated as follows:—

The phase shift of the network is given by:

$$\tan\phi=\frac{1-a^2}{3a} \text{ where } a=f/f_0.$$

f being any frequency and f_0 being the critical frequency.

The attenuation is given by: $\frac{\cos\phi}{3}$.

It can be shown that the locus of the vector ratio e_2/e_1 is a circle, as the frequency is varied from zero to infinity. The circle diagram of Fig. 3 has been constructed from the above expressions for phase and attenuation,

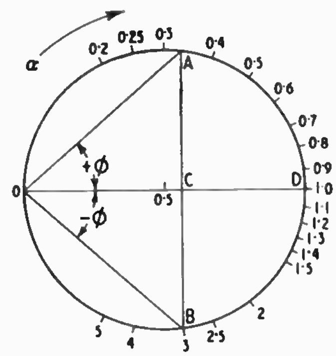


Fig. 3 Circle diagram for output vector of R-C network.

[1] "New Type of Selective Circuit and Some Applications," by H. H. Scott, *Proc. I.R.E.*, February, 1938, p. 226.

R-C Oscillator Control—

and from it the value of e_2/e_1 may be obtained for any value of a. At $a=1$ the value is 1/3 and the phase shift is zero, corresponding to the vector OD. For greater convenience this line OD has been divided into tenths. Let us take the case where the ratio of critical frequencies of the composite network is 9:1, e.g., left network 100 c/s and right network 900 c/s. If the input is connected to an audio generator operating at 300 c/s (i.e., the geometric mean), then the individual vectors of the networks will be represented by the lines OA and OB in the diagram with the slider at the centre of the potentiometer track. By joining the two vectors with the line AB the output at the slider will be given by the line OC. In this case, the output

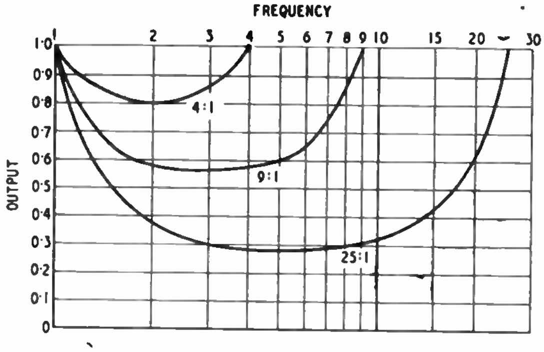


Fig. 4 **In-phase output of composite network for three ratios of critical frequencies.**

OC (in-phase) is 0.56 of maximum. As would be expected, this point gives the value of the lowest output for the whole interval between the two extreme positions. Thus, if the input is varied, at constant amplitude, from 100 to 900 c/s and the slider is made to follow to give no phase shift at all frequencies throughout this range, then the curve of output against frequency will be as shown in Fig. 4, labelled 9:1. Some other curves are also given to show how the output varies with frequency, at zero phase shift, for different ratios of critical frequencies in the component networks.

It will now be clear that for use in an oscillator the composite network must be associated with an amplifier having some form of automatic gain or regeneration control in order to compensate for the "dip" in characteristic over a wide range. For a smaller range the network ratios may be selected on the basis of some given permissible change in amplitude. For example, if the output is not to vary by more than 1 db, then the maximum frequency ratio will be seen from the curves to be 4:1. The greatest advantage will obviously be gained at the higher frequencies, where a given ratio embraces a larger absolute range.

A further interesting development of this system is to use the network inverted; that is, to derive the output from across the series elements of the networks, as in Fig. 5. The circle diagram for this condition shows that the amplitude changes are much smaller than before. A set of curves for this system is given in Fig. 6.

A more complicated arrangement, but one which has many points in its favour, is to use a composite network in the variable oscillator of a B.F.O., the

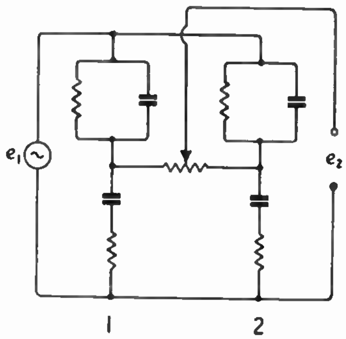


Fig. 5 **Output taken across series-connected elements.**

fixed oscillator employing a simple network. Reference to Fig. 4 shows that for a frequency change of 20 per cent the output of the composite network changes

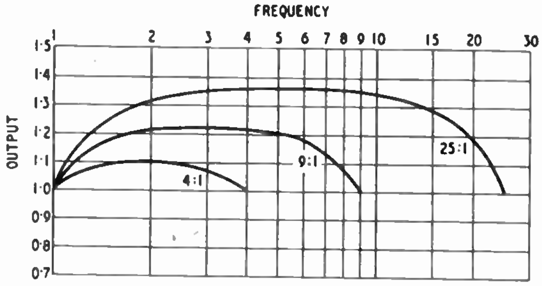


Fig. 6 **In-phase output of inverted composite network.**

less than 0.5 per cent. Accordingly, in the case where the variable oscillator operates from 100 c/s to 120 c/s, the output would be practically constant. In such an arrangement it becomes a relatively simple matter to ensure the same stability for both oscillators. Consequently a very uniform output of low distortion is obtainable. Using a linear potentiometer, the frequency law over a 20 c/s range would be substantially linear because of the small range of frequency in the composite network.

With any of these arrangements employing the composite network the use of a tapped bridging resistor is quite practicable, and the work of computing the values between the taps is simple, since for a given frequency range the values required are related only to the total value of the bridging resistance.

Television Papers

REPRINTS in full of a large number of papers by R.C.A. authors are contained in "Television." Vol. III covers 1938-1941 and has 486 pages, while Vol. IV covers 1941-1946 in 510 pages. Summaries of papers not given in full are included, and in Vol. III there are also summaries of the papers in Vols. I and II which cover 1936-1938 and are out of print.

They are priced at \$2.50 each (\$1.50 paper bound) and are published by R.C.A. Review, Radio Corporation of America, R.C.A. Laboratories Division, Princeton, New Jersey, U.S.A.

TEST REPORT

Bush Television Model T91

Straight Circuit for Vision: Superhet for Sound

IT can be seen from the circuit diagram that the receiver consists essentially of a straight vision channel with four R.F. stages, diode detector, and one V.F. stage. The sound channel is a superheterodyne fed from the second vision R.F. stage and comprises a triode-hexode frequency changer, one I.F. stage, duo-diode-triode detector, A.V.C. source and A.F. amplifier and pentode output valve. Noise suppressors are fitted in both channels.

A 9-in C.R. tube is used with electromagnetic deflection, the saw-tooth currents being generated by two two-valve time-bases.

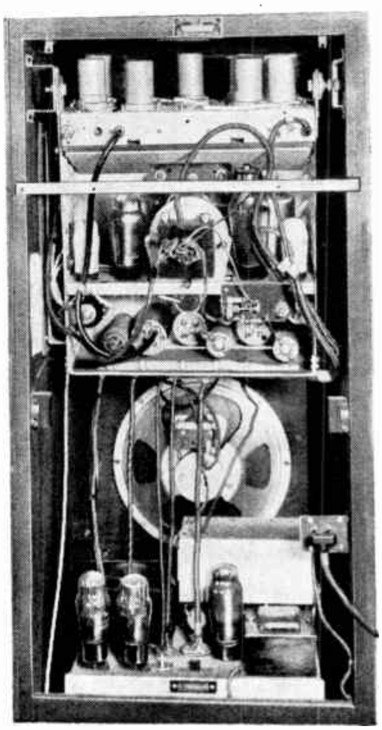
The E.H.T. supply is taken from the mains with a transformer and valve rectifier and there are two rectifiers in the H.T. supply for the rest of the equipment.

In the vision channel the inter-valve couplings are a mixture of single- and double-tuned circuit types, the latter having the form of "top end" capacitance-coupled band-pass filters. No unavoidable capacitance is added to the circuits and the circuits are trimmed by movable brass slugs fitted to the coils.

The detector and V.F. stage are conventional so far as the vision signal is concerned and the output at the anode of the V.F. valve is fed directly to the grid of the C.R. tube. A resistance is included in the cathode of the V.F. valve and the V.F. signal is developed here also but in opposite phase to that at the anode. A diode limiter is connected to the cathode and it produces positive-going sync pulses in its output which are fed through a differentiator and an integrator respectively to the line and frame time-bases.

Picture Size: 7½in × 6in.
Valves: 16+3 rectifiers.
Front Panel Controls: Sound volume, tone.
Side Panel Controls: Contrast, brightness, frame hold, line hold, tune.
Subsidiary Controls: Height, width, focus, linearity, vision, noise limiter, frame and line holds, local-distance switch.
Price: 56 gns.+£13 4s 3d purchase tax.

The saw-tooth generators for both scans are thyratrons and they feed output pentodes which supply the saw-tooth deflecting currents to the coils through transformers. Negative feed-back by means of variable resistors in the cathode lead of the line-scan amplifier is used to control the output and the resistor forms the picture-width control. On the frame amplifier the input is controlled by a potentiometer which forms the height control. Other variable resistors in the saw-tooth generators control the charging currents of the time-base capacitors and form the line- and frame-hold controls.



The power unit, which includes the sound output valve, is housed at the bottom of the cabinet.

A limiter with an adjustable threshold is connected to the grid of the C.R. tube and it limits the input at the peak white level. It thus removes much of the nuisance value of ignition interference because it prevents the large white blotches which would otherwise occur through the de-focusing of the spot on large peaks of interference. The limiter is a diode which is normally biased to be non-conductive but which conducts virtually to short-circuit the tube input when the grid becomes more positive than the peak white level.

The sound channel is unusual in being a superheterodyne with an intermediate frequency of 725 kc/s and the frequency-changer is fed from the output of the second vision-channel stage

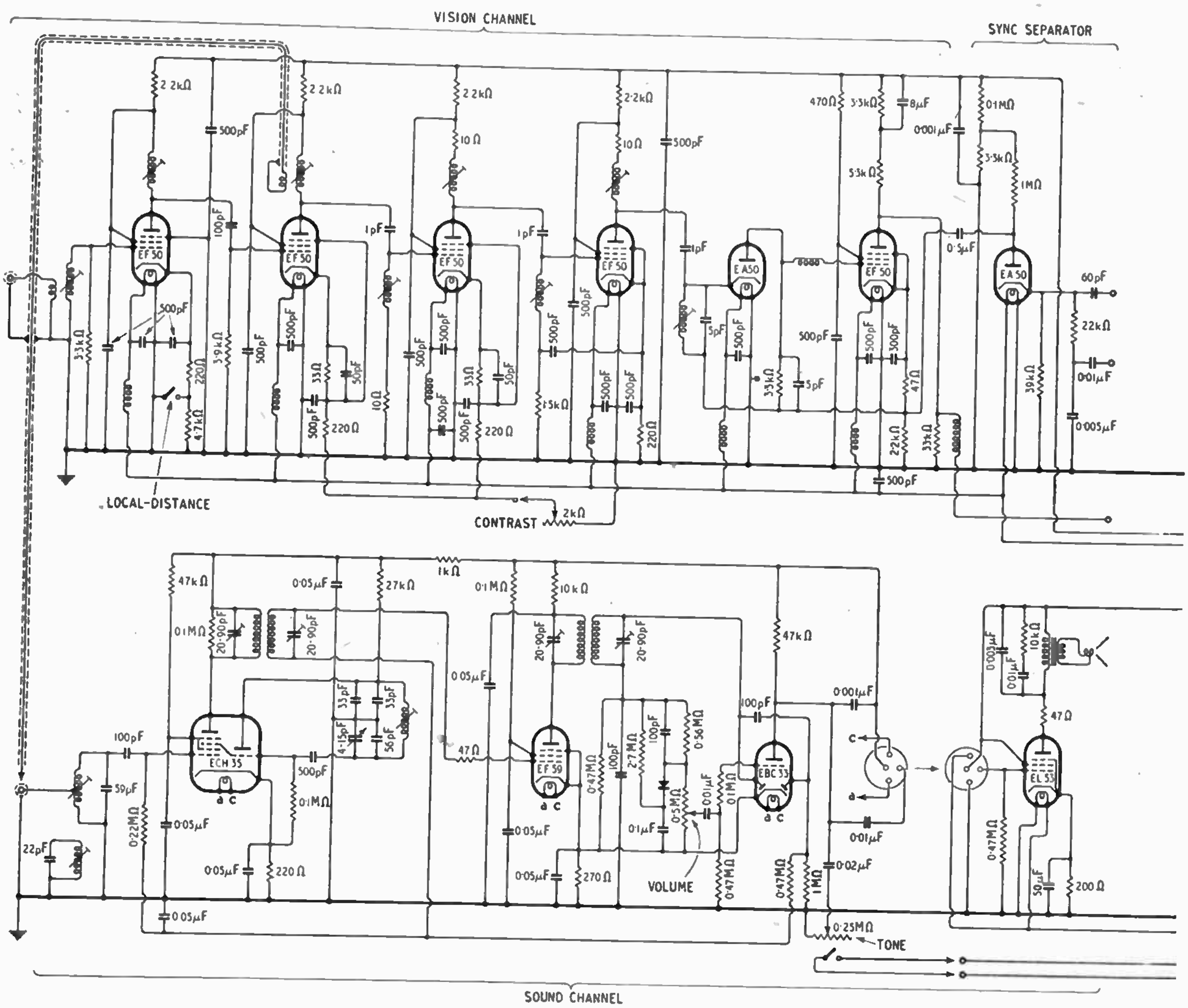
Bush Television Model T91—
of the R.F. amplifier. A trap circuit tuned to the oscillator frequency is coupled to the input circuit of the mixer.

The I.F. amplifier has one valve with two coupled pairs of tuned circuits arranged for a wide pass band to minimize the effects of oscillator drift. The oscillator tuning is largely pre-set, but a panel-mounted trimmer is provided to give a small range of control.

A duo-diode-triode acts as detector and first A.F. stage and also provides A.G.C. in the sound channel only. The sound volume control is the customary potentiometer on the detector output. On the vision side gain control, labelled "contrast," is provided by a variable resistor in the cathode circuit of the 2nd and 3rd R.F. stages, and the range of control is increased by the local-distance switch which enables an additional resistor to be included in the circuit of the first stage for areas of high field strength.

The noise suppressor on the sound channel is of a conventional type and is automatically biased by the rectified D.C. output of the detector. It is arranged so that the metal rectifier is normally non-conductive, but it becomes conductive virtually to short-circuit the volume control when a noise pulse of greater amplitude than that corresponding to the peak of 100 per cent modulation is received.

The two sound-channel controls are volume and tone, and the on-off switch is combined with the latter. They are mounted on the front between the speaker and the tube. The vision-channel controls are mounted at the side of the cabinet in a recess and are of two kinds. Those for normal user adjustment are fitted with knobs and others—subsidiary controls which need only occasional use—have no knobs but have saw-cuts in their shafts to take a screw-



driver. The normal controls are:—

Contrast = Vision channel R.F. gain.

Brightness = C. R. tube bias.

Line Hold = Line scan saw-tooth frequency.

Frame Hold = Frame scan saw-tooth frequency.

Tune = Sound-channel oscillator frequency.

The screwdriver controls on the side-panel are:—

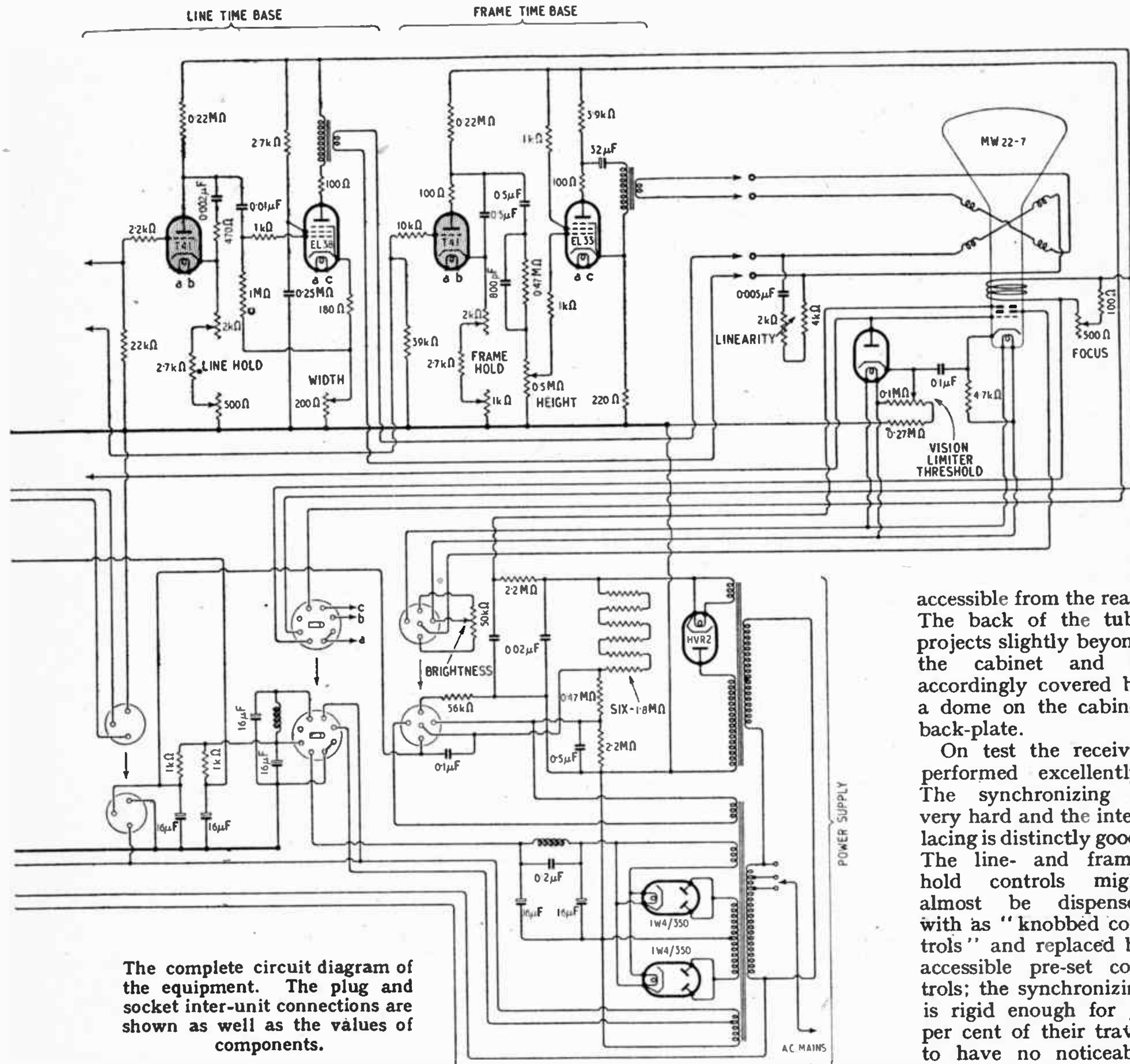
Height = Gain control in line-scan amplifier.

Width = Gain control in frame-scan amplifier.

Focus = Resistor shunting the focus coil.

In addition, there are a number of screwdriver-adjustment controls accessible by removing the rear cover of the set and intended mainly for use by servicemen. They include the vision-channel noise limiter threshold control and the linearity control. This last is a variable resistor which, in series with a capacitor, is shunted across the line-deflector coil to provide the correct damping.

The focus coil can be tilted for centring the picture by three adjusting screws which are easily accessible from the rear. The back of the tube projects slightly beyond the cabinet and is accordingly covered by a dome on the cabinet back-plate.



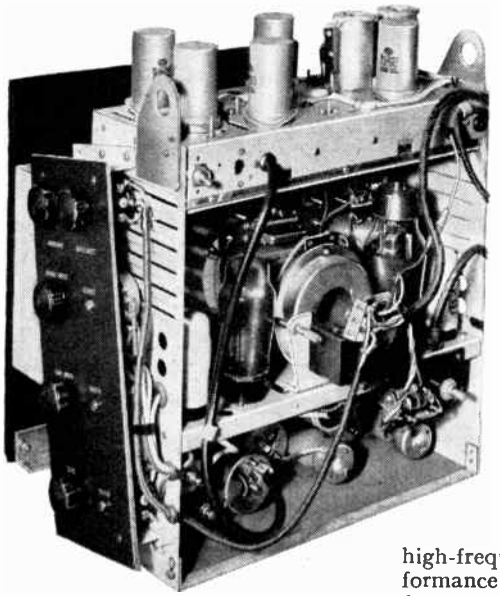
The complete circuit diagram of the equipment. The plug and socket inter-unit connections are shown as well as the values of components.

On test the receiver performed excellently. The synchronizing is very hard and the interlacing is distinctly good. The line- and frame-hold controls might almost be dispensed with as "knobbed controls" and replaced by accessible pre-set controls; the synchronizing is rigid enough for 50 per cent of their travel to have no noticeable effect. At no time during the tests was it necessary to adjust these controls.

The contrast and brightness controls in themselves function normally and are by no means critical. Their operation is, how-

Bush Television Model T91—

ever, rather tied up with the noise limiter adjustment and is complicated by the fact that this is an internal pre-set control. On setting up, the correct procedure



would normally be to back off the noise limiter and adjust Contrast and Brightness for the best picture. Then the limiter would be adjusted so that it just has no effect on peak white.

However, it is often found that some subsequent adjustment to the brightness control is needed to suit different programmes and the limiter does then seem to restrict the range available. When correctly adjusted the limiter is very effective in preventing defocusing of the spot under conditions of ignition interference and it thus greatly reduces the visible effect of such interference. The slight increase in the complexity of adjustment is a small price to pay for this.

The focus is good and does not drift noticeably with changes of temperature, nor does the tuning of the sound channel which shows that the sound bandwidth is adequate in relation to the oscillator stability. The picture quality is excellent and the brightness adequate for daylight viewing.

On the sound side, the quality is good with an adequate

The vision channel is at the top with the sound channel at the bottom and the time-bases between them.

high-frequency response. The performance of the ignition-interference suppressor is very satisfying and reduces the major part of interference experienced to negligible proportions.

The set is housed in a cabinet standing 3ft ½in high and measuring 16¾in wide by 15½in deep. The cowling over the C.R. tube projects 2¼in at the rear. The set is in two units with plug interconnections, the sound output valve being housed on the power unit.

The equipment is intended for use with a coaxial feeder and an attenuator is available for areas of exceptionally high field strength.

Interference from R.F. Heaters

Investigations of External Fields

A REPORT recently issued by The British Electrical and Allied Industries Research Association reveals some interesting facts on the nature and extent of the interference that may be caused by industrial R.F. heating equipment, especially when the apparatus is inadequately shielded.

The report does not cover mains-borne interference but only that produced by radiation from the R.F. generator and the auxiliary equipment.

Investigations were undertaken on three different installations, (a) a 45-kW induction heating plant generating R.F. power at about 600 kc/s; (b) a dielectric heating set delivering 25 kW at frequencies of the order of 15 Mc/s; (c) a 2.5-kW dielectric heater for 5 to 20 Mc/s operation.

For investigating the external fields a modified Army set type R206 was used. This is a sensitive 11-valve superhet covering 550 kc/s to 30 Mc/s with provision for operation from a 12-V battery.

Equipment (a) was housed in a ½-in square mesh galvanized iron screened cubicle with a standard mains filter installed. The R.F. current in the work coil was 150 A.

Interference was recorded over an irregular area due no doubt to the presence of buildings. A field strength of 40 db above 1 μV per metre was recorded over an area of approximately 0.0945 square mile and of 30 db over 0.27 square mile. The longest radius of the higher signal level was about 80 yards.

The set (b) was unscreened and its radiated field extended over a very considerable area, 70 db above the datum level being recorded over 0.013 square mile, 50 db over 0.11 square mile and 30 db over 2.4 square miles. Removing the load circuit gave only a small reduction in the intensity of the radiated interference.

Installation (c) was fully screened in a sheet-steel cabinet with filtered mains supply. Very little interference was recorded and a field strength of 20 db only affected a small area of 0.1 square mile.

The same equipment, but with extended unscreened work electrodes, produced a slight increase in local interference raising the area for a 20-db field to 0.15 square mile.

Conclusions drawn from these tests reveal that with unscreened equipment interference can be very severe, the 25-kW set (b), for example, producing 100 μV per metre of interference over approximately 0.5 square mile at 15 Mc/s.

Radiation takes place from the R.F. generator and the work electrodes and any unscreened part of the apparatus carrying R.F. currents.

Harmonic frequencies are also radiated, the lower order ones can have amplitudes up to 50 per cent of the fundamental. Both amplitude and frequency modulation are present, the former mainly due to inadequate H.T. smoothing, the latter to effects of applied loads.

Quite simple screening produces a very marked reduction of the field intensity and the higher field strengths can be confined largely to the factory area.

This report, which is obtainable from the E.R.A. at 15, Savoy Street, London, W.C.2, is priced at 3/6.

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with a 1D6

12Z3

← PUNCH HOLES HERE →

There are two suitable alternatives to the 12Z3—the 1D6 and the 25Z4G; both need a change of socket. The 12Z3 has a 12.6 volt heater whereas those of its replacement types have 25 volt, necessitating a small decrease in line cord resistance. All three types are half-wave rectifiers.

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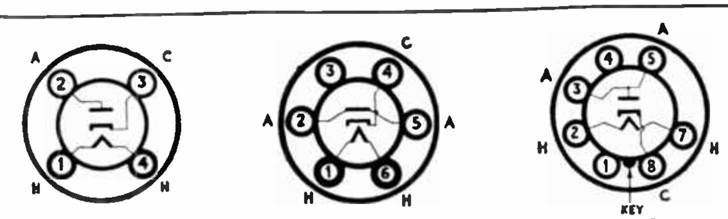

12Z3 1D6 25Z4G

TYPE	CHANGE SOCKET FROM	CHANGE SOCKET TO	CHANGE CONNECTIONS FROM OLD SOCKET	CHANGE CONNECTIONS TO NEW SOCKET	OTHER WORK NECESSARY	PERFORMANCE CHANGE
1D6	UX 4-Pin	UX 6-Pin	Pin 1 „ 2 „ 3 „ 4	Pin 1 „ 2 or 5 „ 4 „ 6	Decrease line cord by 40 ohms.	NEGLIGIBLE
25Z4G	UX 4-Pin	INT/OCTAL	Pin 1 „ 2 „ 3 „ 4	Pin 2 „ 3 or 5 „ 8 „ 7	Decrease line cord by 40 ohms.	NEGLIGIBLE

BRIMAR
RADIO VALVES

★ *BRIMARIZING—a service which first-class dealers can offer those customers whose radio sets have been designed round valves which are in short supply.*

INSTRUCTIONS: Punch holes where indicated and cut away this portion. Cut out and file them in the order in which they appear. This column will then give you a quick reference index.

6

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.

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Broadcast Reception for Schools

Description of an "Approved" Installation

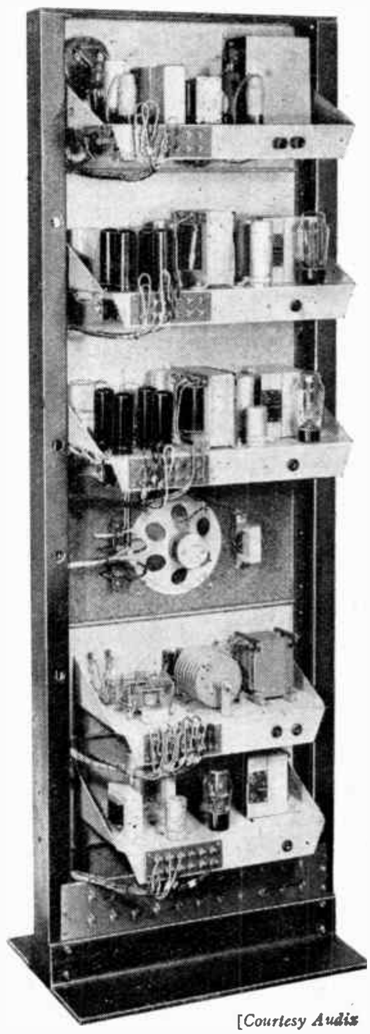
EXTENDED listening tests in school classrooms have shown that a far more exacting specification for the radio receiver and its associated equipment than is generally found in the ordinary domestic set is desirable for educational purposes. An effective audible range of from about 60 c/s to 12,000 c/s is required from the sound-amplifying equipment if speech and music are to appear sufficiently natural to prevent aural fatigue and the consequent wandering of the pupils' attention. Over this range of frequencies the response must be linear and with a total harmonic distortion not exceeding about 2 per cent.

Given these desirable qualities, the actual intensity of sound required adequately to serve a large classroom becomes surprisingly low, and this is an important factor since it prevents the distraction of attention in adjoining classrooms.

The requirements at different schools vary so widely that it is very doubtful if any one type of receiving equipment, or any standardized layout of the units, could be made to satisfy them all. The issue is also complicated by the fact that facilities for gramophone reproduction are also required in many cases. In these circumstances a number of different arrangements must be considered. Details of three typical ones are as follows:—

System No. 1.—In this system the radio receiver is located in a central radio room and the output taken at a low audio level to a portable amplifier in the classroom. The receiver can be switched on and off by remote control and each classroom is thus wired with a suitable control line and a balanced pair cable of about 300 ohms for the low-level audio output from the radio set. This low-level signal is then amplified in the classroom and the volume adjusted on the amplifier for the prevailing conditions.

If recorded matter is to be employed a portable gramophone unit is plugged into the amplifier.



[*Courtesy Audix*

Rear view of the central receiving equipment. At the top is the radio receiver, below are the two amplifiers, then follow a local monitoring loudspeaker and finally contactor and power units.

System No. 2.—With this system all the apparatus is located in a central radio room. It comprises a radio receiver, radio amplifier, gramophone amplifier and contactor unit which switches the radio or gramophone output as required to the appropriate classroom on operation of the remote switching there.

In the classroom is a loudspeaker and a remote control unit, the latter being fitted with a socket for plugging in a gramophone unit.

In this system the amplified radio signal is fed to the classroom, while if gramophone reproduction is required the output from the gramophone unit is fed from the classroom to the central amplifier, then back again at high level to the classroom loudspeaker.

Unless duplicate gramophone amplifiers are installed only one classroom can have recorded matter, but all fitted classrooms can, of course, have the radio programme, which condition also applies to the No. 1 arrangement.

System No. 3.—This is a modification of No. 2 and employs centralized equipment, but has, in addition, a central control point where any classroom can be switched to the radio programme or to a gramophone recording. A feature of this installation is the provision at the central control for a microphone, the output of which, suitably amplified, can be relayed to any particular classroom, or to all at the same time. The only control in the classroom is of the loudspeaker output.

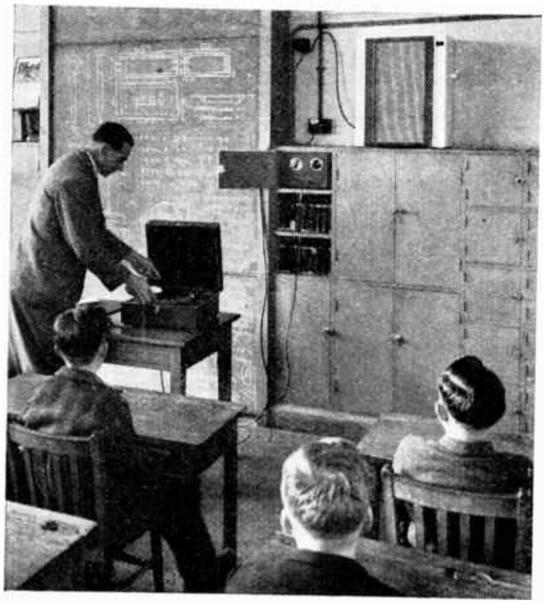
Experimental Prototype.—Comprehensive radio and sound amplifying equipment has recently been installed at Rowland Hill School, Tottenham, London, by Audix, of Sheldrake House, London, S.E.5. It was designed in collaboration with the Central Council for School Broadcasting, and, apart from serving the needs of this particular school, was intended to form a basis on which designs to meet the varying requirements of other educational authorities may be built.

In conception it follows very closely the design of the second installation plan described, as all the main equipment is centralized and only a loudspeaker and control unit fitted in each of the 10 classrooms wired into the system.

One addition has been made, and that is the provision of a separate amplifier in the school assembly hall giving a somewhat larger power output than would be obtainable from the classroom equipment. It provides for radio, gramophone or microphone reproduction, taking the radio programme from the school central receiver and the recorded matter from a self-contained gramophone unit. A schematic layout of this installation is reproduced here.

Radio Unit.—Rack construction is adopted for the central equipment, which consists of a five-valve superheterodyne receiver, radio and gramophone amplifiers, power supply units and relay panel. The radio receiver covers the medium and the long waves only, using a normal tuning system, and has provision also for four pre-tuned programmes, three in the medium and one in the long wavebands. These are selected by a rotary switch. An unusual feature is the incorporation of a valve voltmeter as a tuning meter, it being considered that far more accurate tuning is effected by this means than by any other.

The receiver includes one R.F. stage, a triode-hexode frequency changer, one I.F. amplifier at 465 kc/s giving bandwidths of ±6.5, ±9.8 or ±16 kc/s. Following the I.F. stage is a double-diode triode providing detection, A.G.C. and a stage of A.F. amplification. The output is taken from the cathode circuit of this valve, which has an output impedance of 300 ohms. A tunable filter, covering a range of 7 to 14 kc/s, is connected in the grid circuit of the last valve for suppressing any adjacent-channel whistles that may occur as a result of the wide I.F. bandwidths.

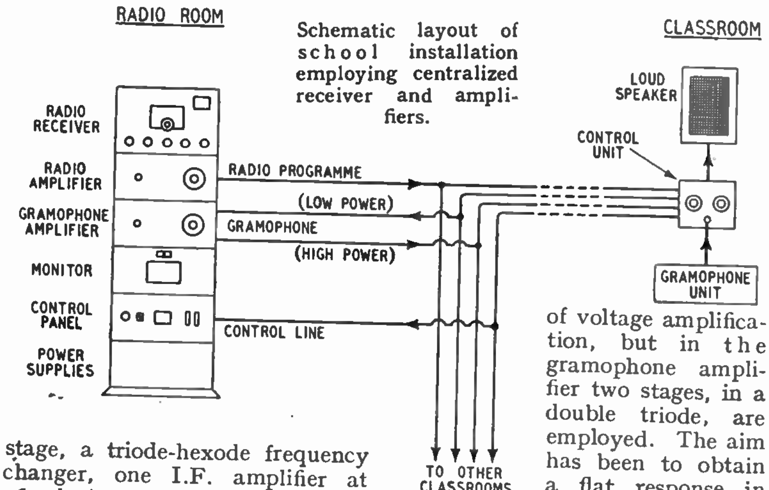


[Courtesy Audix

Typical classroom installation comprising loudspeaker, wall-mounted control unit and portable gramophone.

Radio and Gramophone Amplifiers.—Mounted in the rack are two power amplifiers capable of 20 watts audio output each, one for radio and the other for gramophone. They are similar in that both employ four 6L6 valves in a parallel push-pull output circuit with negative feedback. The driver stage is a double-triode functioning as a phase splitter.

In the radio amplifier the phase splitter is preceded by one stage of voltage amplification, but in the gramophone amplifier two stages, in a double triode, are employed. The aim has been to obtain a flat response in these amplifiers and over the range 25 to 15,000 c/s the variation does not exceed ±1 db.



Schematic layout of school installation employing centralized receiver and amplifiers.

Switching on and off of the radio receiver and the gramophone amplifier is normally effected in the classrooms through the remote control unit. This connects to what is described as a contactor panel on the equipment rack which provides the 24-volt D.C. supply needed for operation of the various relays. A low voltage only is thus passed over the control wire circuits and the insulation problem is thereby considerably simplified.

As previously explained, each classroom in the Rowland Hill School installation has a control panel and a loudspeaker as permanent fittings. This unit serves three functions: remote switching of the central apparatus, audio power attenuation in the classroom and provision for feeding into the equipment the output from a gramophone unit. The volume attenuator, a constant impedance network as looked at from the line, provides 4 steps of 2 db each, 5 steps of 3 db and 3 steps of 5 db.

Loudspeaker Housings.—Some interest attaches to the loudspeakers as these are not merely chassis units assembled in cabinets. In order to preserve the good characteristics of the electrical part of the installation a special design of housing is used. This behaves as an acoustic chamber and extends the usable range of the loudspeaker below

Broadcast Reception for Schools—that which would be attainable with a baffle of comparable size. A linear response of from 60 to 8,000 c/s is claimed for this acoustical system and a demonstration fully confirmed that an extremely wide range is covered without any noticeable trace of distortion. The loudspeaker unit used is a 12in moving-coil type capable of handling 10 watts.

Normally the classroom attenuators are set at position eight, giving a power level 8 db below the maximum of 2 watts available. This gives a maximum power of 300-milliwatts only. Although heavy-duty loudspeakers are employed they can be justified on the grounds that they contribute to the good results obtained, since no part is stressed, while their high efficiency makes the use of such low power practicable.

Short-wave Conditions

Expectations for September

By T. W. BENNINGTON

(Engineering Division B.B.C.)

DURING July the average maximum usable frequencies for these latitudes were about the same as those for June, both for day and night. Daytime working frequencies were, therefore, relatively low—except for north/south paths—and those for night-time relatively high. A very considerable amount of Sporadic E occurred during the month, and medium-distance communication on very high frequencies by way of this region was frequently possible.

There was relatively little ionosphere storminess during July, though one severe disturbance occurred during the period 17th-20th. Short-lived storms of minor intensity took place on 2nd, 23rd and 29th. Of the several "Dellinger" fade-outs which occurred, that at 1430 on the 23rd appears to have been the most severe.

Forecast.—There should be a very considerable increase in the daytime M.U.F.s during September, for, though it is problematical as to whether or not the sunspot maximum will have been passed by then, solar activity will in any case be very high, and the Northern Hemisphere seasonal effect will also tend to produce high ionisation. Night-time M.U.F.s should be a little lower than during August.

Working frequencies for long-distance transmission paths should therefore be exceptionally high by day, and the higher frequencies—like 28 Mc/s—should be usable for long periods in most directions from this country. Frequencies as high as 17 Mc/s should remain usable till after midnight on many circuits, and those below 11 Mc/s should not be really necessary at any time during the night.

Though the E and F1 layers may control transmission over medium distances for an hour or two around noon, this effect will be of much shorter duration and much less marked than during the past few months.

Sporadic E is likely to decrease sharply in the frequency of its occurrence, and little communication over medium distances is likely to take place by way of this region.

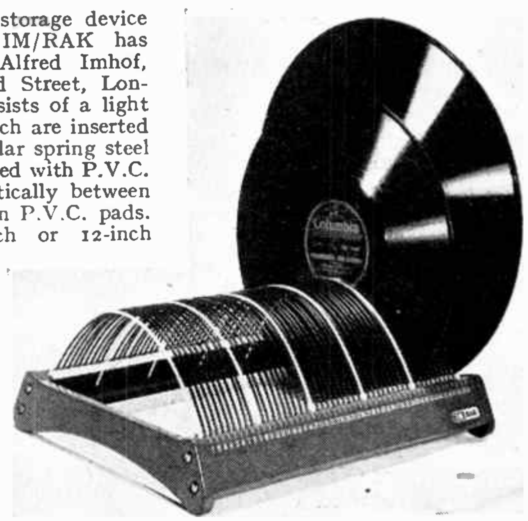
Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during September for four long-distance circuits running in different directions from this country. Times are G.M.T. In addition a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month for communication by way of the regular layers:—

Montreal :	0000	15 Mc/s	(20 Mc/s)
	0100	11 ,,	(17 ,,)
	0900	15 ,,	(20 ,,)
	1000	17 ,,	(24 ,,)
	1200	21 ,,	(31 ,,)
	2100	17 ,,	(25 ,,)
	2300	15 ,,	(21 ,,)
Buenos Aires :	0000	17 ,,	(23 ,,
	0100	15 ,,	(22 ,,)
	0300	11 ,,	(19 ,,)
	0800	15 ,,	(20 ,,)
	0900	21 ,,	(28 ,,)
	1000	26 ,,	(37 ,,)
	2000	21 ,,	(29 ,,)
	2200	17 ,,	(24 ,,)
Cape Town :	0000	17 ,,	(23 ,,)
	0100	15 ,,	(22 ,,)
	0300	11 ,,	(21 ,,)
	0500	15 ,,	(22 ,,)
	0600	17 ,, or 21 Mc/s	(26 ,,)
	0800	26 ,,	(39 ,,)
	1900	21 ,,	(30 ,,)
	2100	17 ,,	(25 ,,)
Chungking :	0000	11 ,,	(17 ,,)
	0400	15 ,, or 17 Mc/s	(21 ,,)
	0600	21 ,,	(29 ,,)
	1000	26 ,,	(35 ,,)
	1400	21 ,,	(27 ,,)
	1600	17 ,,	(23 ,,)
	1800	15 ,,	(20 ,,)
	2100	11 ,,	(18 ,,)

There is usually some increase of ionosphere storminess during September, and some periods of poor short-wave communication must be anticipated. At the time of writing it would appear that disturbances are more likely to take place during the periods 1st-3rd, 9th-12th, 16th-19th, 22nd-23rd and 28th-30th than on the other days of the month.

Record Storage Unit

A SIMPLE record storage device known as the IM/RAK has been produced by Alfred Imhof, 112-116, New Oxford Street, London, W.C.1. It consists of a light metal frame into which are inserted a series of semi-circular spring steel wires, which are coated with P.V.C. The records slip vertically between the wires and rest on P.V.C. pads. Up to fifty 10-inch or 12-inch records can be accommodated, and the spaces are numbered for quick reference. The price of the unit is 29s 6d and an optional dust-proof plastic cover is available at 7s 9d. Purchase tax is additional to these prices.



Television Receiver Constru

7.—The Receiver Unit

A CHOICE between the straight set and the superheterodyne for television reception is by no means easy at the present time. Each has its own peculiar merits and its shortcomings, but they are very evenly balanced and under the present conditions of a single vision transmitter at 45 Mc/s there is really very little to choose between them.

In the straight set all pre-detector valves pull their full weight as amplifiers, whereas in the superheterodyne the frequency-changer may use two valves and provide a gain of no more than one-third of that of an amplifier. There are no problems of oscillator drift or radiation to be solved in the straight set and it is free from I.F. harmonic feedback troubles, second-channel interference and I.F. pickup.

It is easier to achieve stability with the superheterodyne than with the straight set but there is no serious difficulty with the latter at 45 Mc/s. The real drawback of the straight set lies in achieving the required bandwidth combined with sufficient selectivity to avoid interference from the sound channel on 41.5 Mc/s. Ideally a response from 48 Mc/s to 42 Mc/s is required with high attenuation at 41.5 Mc/s; the change of frequency from the pass region to the sound channel is only 1 part in 84.

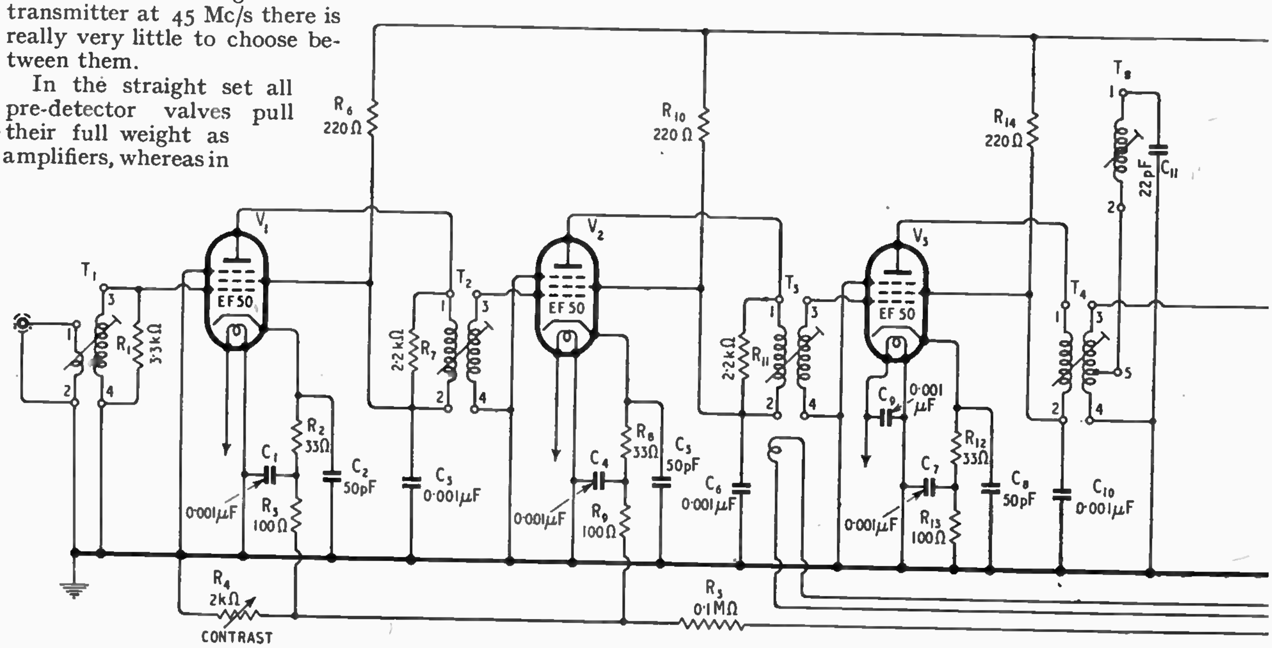
In a superheterodyne the passband might well be 16 Mc/s to 10 Mc/s with the sound channel at 9.5 Mc/s and the change of frequency is then 1 part in 20. The separation of the two channels by rejector circuits is then easier.

At the present time it is just possible to obtain adequate sound channel rejection with the straight set. If television transmissions were on a higher frequency than 45 Mc/s it would probably become impracticable to secure it. Thus, if the vision transmitter were at 65 Mc/s with a sound channel at 61.5 Mc/s the sound channel rejection would have to be obtained for a frequency change of only 1 part in 122. This alone would almost certainly necessitate the adoption of the superheterodyne. In addition, the lower input resistance of valves at such a frequency might well render its use advisable.

These points do not arise at present because the only vision transmitter operates at 45 Mc/s. When the Birmingham station is opened, however, the position may well be different. No announcement of its operating frequencies has yet been made, but if they are much higher than the present ones a superheterodyne receiver may well become almost a necessity.

There is a further point. If more than a single television transmission is receivable in any area then some form of station selection mechanism becomes necessary. This alone almost forces one to the superheterodyne because station selection can be achieved with changes to at most three circuits, whereas in the straight set the tuning system would have to operate on at least nine circuits!

All this lies in the future, for the present Alexandra Palace transmissions are guaranteed for some years to come. For their reception the straight set is adequate and is simpler than the superheterodyne except, perhaps,



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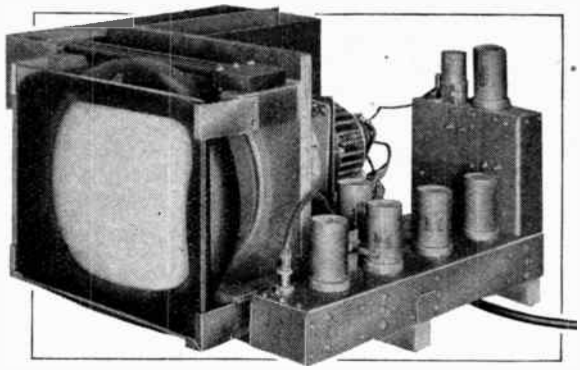


when the highest sensitivity is needed. The set described in this article is accordingly of this type. In *Wireless World* for November 1946, when giving some preliminary details of the apparatus, it was said that it was intended to describe two different receivers—one of very high and the other of medium sensitivity. The present set is the latter and represents probably the simplest satisfactory form of receiver. The aim in design has been to obtain the widest bandwidth consistent with adequate sound-channel rejection with a simple form of construction.

The set is intended mainly for use in areas of moderate to high field strengths in which ignition interference is not usually a serious problem. Accordingly no suppression circuits are included.

The second receiver, to be described later, will be of higher sensitivity and will be designed primarily for use towards the limits of the service area. As ignition interference can be very serious in such areas, it will include limiters to minimize its effect. It will be a superheterodyne—partly because of the higher sensitivity required and partly to permit its ready modification for signal frequencies other than 45 Mc/s.

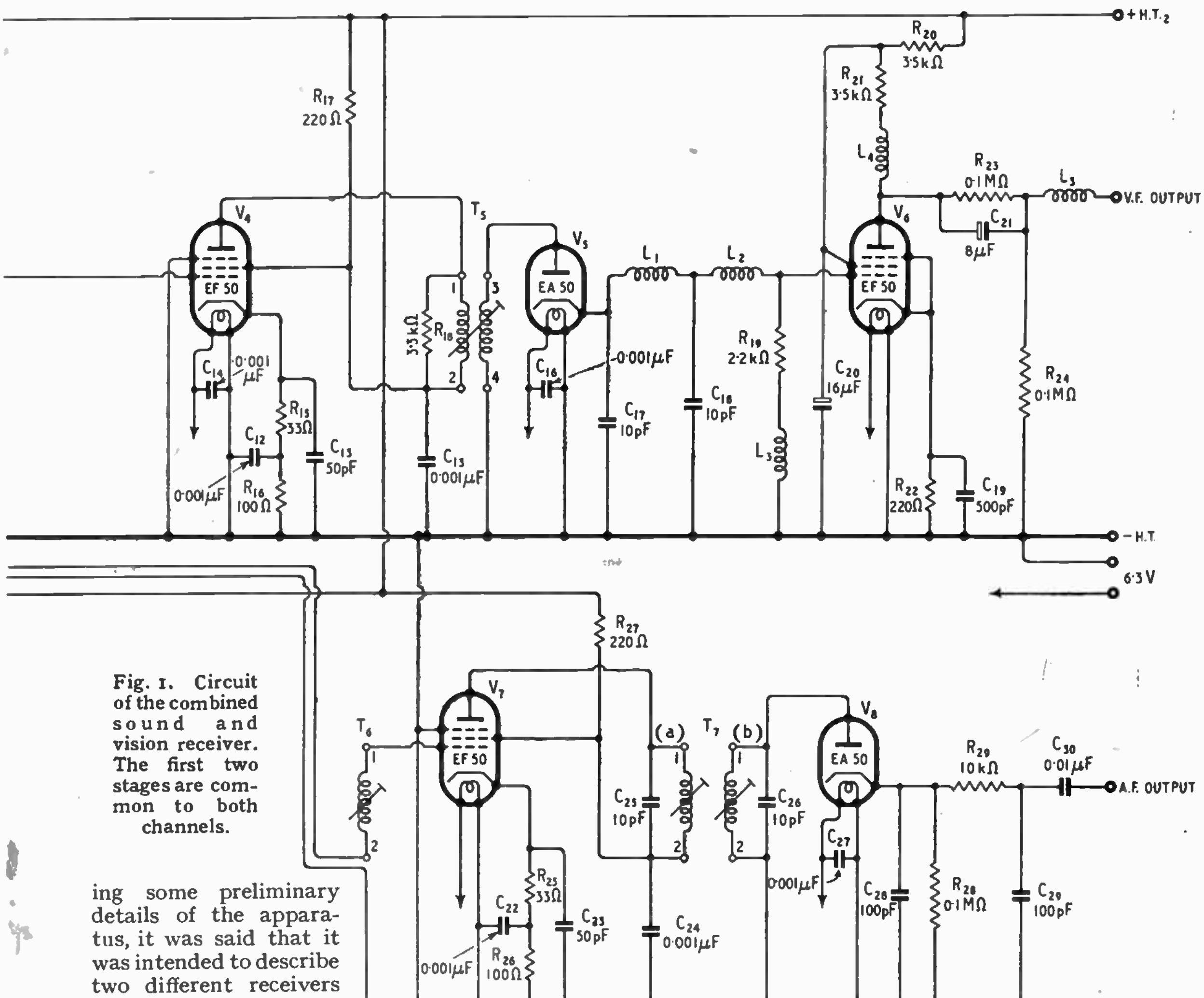


Fig. 1. Circuit of the combined sound and vision receiver. The first two stages are common to both channels.

Television Receiver Construction—
requirements. As a conservative estimate of its capabilities it will be entirely satisfactory in most suburban areas up to 10 miles from Alexandra Palace, except possibly in a few blind spots, or where the aerial is close to a main road carrying heavy traffic. The sensitivity is probably adequate for ranges of 15–20 miles or even more when the aerial is on high ground. Ignition interference may become troublesome at such ranges, however, and it is hoped to describe in a further issue suitable limiters which can be added in such cases.

The circuit diagram is given in Fig. 1 and it will be seen that on the vision side there are four R.F. stages, a diode detector and one V.F. stage. The first two R.F. stages are common to vision and sound; the sound signal is picked out of the coupling between the second and third stages and fed to a further R.F. stage for sound only, which in turn feeds a diode detector.

The sound channel stops at the detector, for it is felt that most people have an existing A.F. amplifier or a broadcast receiver with pickup terminals which can be employed. The output obtainable is of the same order as that of the average magnetic pickup.

At a frequency of 45 Mc/s the chassis material is important, as also are the connections to it and their disposition. On account of its high conductivity, copper is necessary for the chassis. Copper-plated steel would probably be satisfactory, but is usually harder to obtain than copper sheet. It is necessary to solder earth points on valveholders directly to the chassis with very short leads; this is not difficult if tackled in the right way and will be dealt with later.

Referring to the circuit diagram, it will be seen that EF50-type valves are used throughout for all amplifiers and that the bias circuits of the R.F. valves appear somewhat unusual. In the case of V_4, for instance, there is a network R_{15}, C_{13}, R_{16} and C_{12} in the cathode lead. Bias is provided by R_{15} and R_{16} totalling 133 Ω; R_{16} is by-passed to R.F. by C_{12} of 0.001 μF. Consequently, at radio-frequency there is effectively the impedance of R_{15} (33 Ω) and C_{13} (50 pF) in parallel in the cathode lead of the valve. In conjunction with the grid-cathode capacitance of the valve, this has the effect of increasing the effective input resistance of the valve to something like 19 kΩ, and at the same time stabilizes the input capacitance so that it changes negligibly with a change of grd bias.

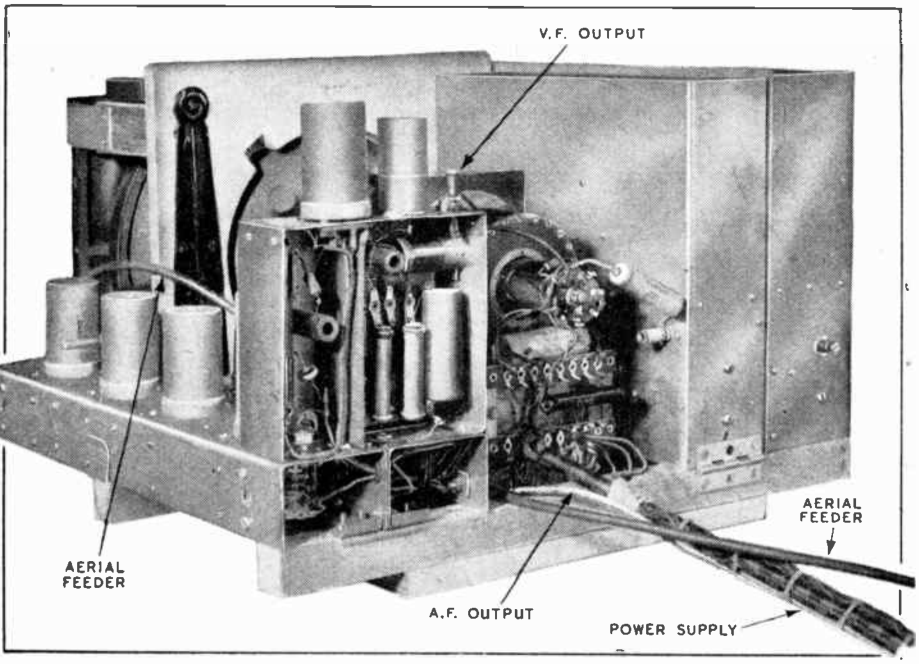
This last point is important in the case of V_1 and V_2, for with these the bias is variable by means of R_4 to obtain gain control (contrast).

The screens and anodes are fed at the same voltage and have common decoupling components; viz:, R_{17} and C_{15} in the case of V_4. The intervalve couplings are effectively single-tuned circuits with their resonance frequencies staggered about the mid-band frequency of 45 Mc/s in order to obtain the required bandwidth. They are double wound so that the anode and grid return leads can be taken directy to the appropriate valves. If a single winding were used with a coupling capacitor this would not be possible, and it has been found that the increase in R.F. currents in the chassis materially reduces stability.

Details of the coils and the actual resonance frequencies are given later. The input is built to match a 75-Ω coaxial cable, and this is *necessary*. The use of a twin-feeder will cause instability at full gain because it is not screened; a screened twin-wire feeder might be satisfactory, but it has not been tried.

The first circuit T_1 is damped by the transferred impedance of the feeder, the resistor R_1 of 3.3 kΩ and the input resistance of V_1. It is tuned mainly by the input capacitance of V_1.

The second circuit T_2 is damped by the resistor R_7 of 2.2 kΩ and



A rear view of the complete receiver with the C.R. tube and both time-base units. All units are mounted on hinges so that access to their interiors is easily obtained.

the input resistance of V_2. The capacitances effective here are mainly the output capacitance of V_1 and the input capacitance of V_2, but of course the wiring capacitance and the self-capacitance of the coils have quite an appreciable effect. Because of the higher capacitance the inductance of T_2 is lower than that of T_1.

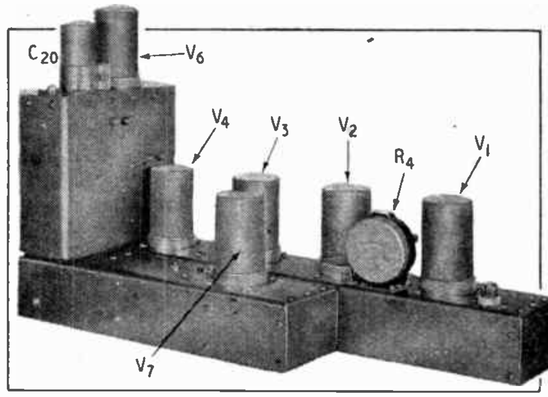
The following circuits in the vision channel are substantially the same, but in T_3 a single-turn coil is coupled to the main windings and is connected in series with T_6 to form the first sound-channel circuit. This plays a dual role. In the first place it feeds the sound signal into the sound amplifier, and in the second it acts as a rejector of the sound signal in the vision amplifier.

A further rejector is provided in T_4 and is the circuit T_8 with C_{11} and is connected to a tapping on the secondary of T_4 at one turn from the earthy end. No deliberate damping is used on T_4. A diode detector is used and direct-coupled to the V.F. stage through a double filter L_1, L_2 of resonant chokes. The diode load is R_{19} of 2.2 kΩ with a correction choke L_3 in series. The V.F. valve is biased by R_{22}, which is shunted by C_{19} to give a rising response at very high frequencies to compensate in some measure for the tailing response of the R.F. circuits.

Direct coupling to the cathode of the C.R. tube is adopted with a double-compensation circuit involving the two inductances L_4 and L_5.

On the sound side there is one R.F. stage V_7 feeding a diode detector V_8 through a pair of coupled circuits which together form T_7. They are loosely coupled and as, with the narrow bandwidth needed, there is no difficulty in obtaining sufficient impedance for the required amplification, 10-pF capacitors are added to the circuits to reduce the L/C ratio and improve the selectivity.

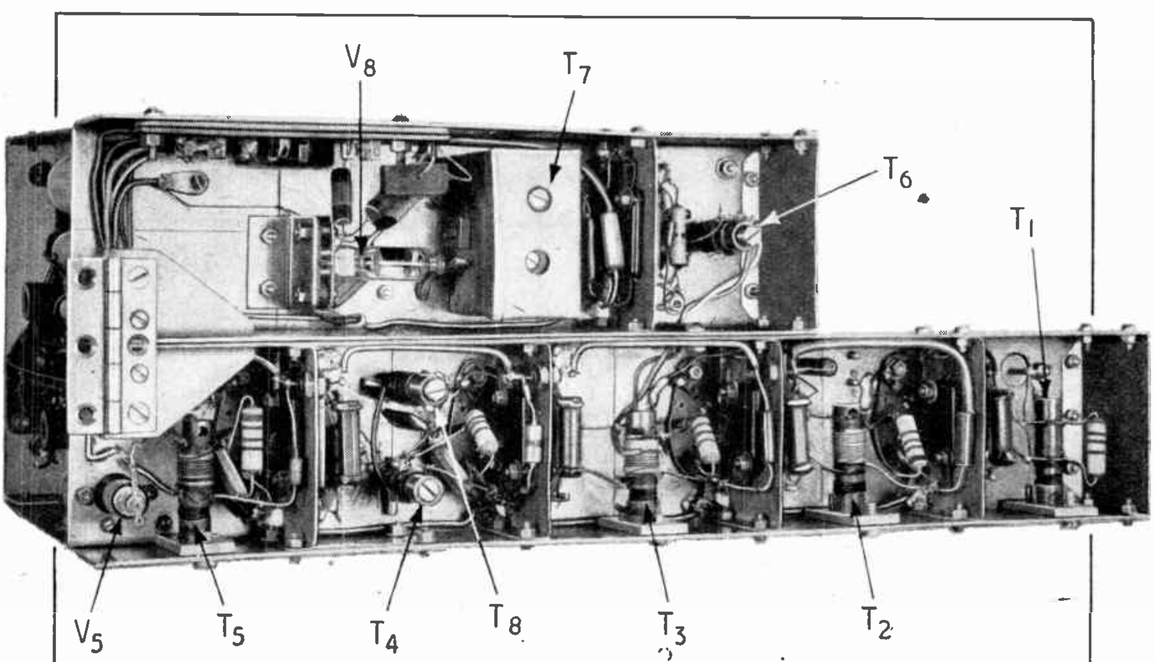
It will be noticed that V_3, V_4, V_5 and V_8 have 0.001-μF capacitors connected across their heaters. These are not necessarily for stability since the amplifier is quite stable without them. They are used to prevent interaction between the sound and vision channels. Without them it is found that the sound signal is carried by the heater wiring into the vision channel and vice versa.



A general view of the receiver unit is shown above and the under view, below, clearly shows the arrangement of the main parts.

Data on the coils and detailed photographs of the chassis showing the R.F. wiring—a very important item—will be given next month. In the meantime it may be said that the chassis are of No. 20 gauge copper sheet with cross-screens of No. 26 gauge copper.

The vision channel chassis measures 14in. by 2½in wide by 1¾in high, while the sound channel



chassis is 9in long, but otherwise the same. The rear section, erected on the main chassis, can be of brass or copper, and is 5in wide by 1¾in deep and stands 4¾in above the main chassis.

LIST OF PARTS

Resistances		
R_1, R_{18}	3.3 kΩ, ½ W	Erie
R_2, R_8, R_{12}, R_{15}, R_{25} ...	33 Ω, ½ W	Erie
R_3, R_9, R_{13}, R_{16}, R_{26} ...	100 Ω, ½ W	Erie
R_4	2 kΩ, 3 W, variable, wire-wound.	Reliance Type 1 W
R_5, R_{23}, R_{24}, R_{28} ...	100 kΩ, ½ W	Erie
R_6, R_{10}, R_{14}, R_{17}, R_{22}, R_{27}	220 Ω, ½ W	Erie
R_7, R_{11}, R_{19}	2.2 kΩ, ½ W	Erie
R_{20}, R_{21}	3.5 kΩ, 2 W	Erie
R_{29}	10 kΩ, ½ W	Erie
Capacitors		
C_1, C_3, C_4, C_6, C_7, C_{10}, C_{12}, C_{15}, C_{22}, C_{24}	0.001 μF, 350 V, mica ...	T.C.C. Type M
C_2, C_5, C_8, C_{13}, C_{23} ...	50 pF, silvered mica ...	T.C.C. Type CM23
C_9, C_{14}, C_{16}, C_{27}	0.001 μF	Hunts Type L1/2 (M.O.)
C_{11}	22 pF, silvered mica ...	T.C.C. Type CM23
C_{17}, C_{18}	10 pF ceramic or silvered mica	T.C.C. Type CC30y or CM23
C_{19}	500 pF, 350 V, mica ...	T.C.C. Type M
C_{20}	16 μF, 500 V, electrolytic	Dubilier Drilitic CT1650
C_{21}	8 μF, 500 V, electrolytic	Dubilier Drilitic BR850
C_{25}, C_{26}	10 pF, silvered mica ...	T.C.C. Type CM23
C_{28}, C_{29}	100 pF, silvered mica ...	T.C.C. Type CM23
C_{30}	0.01 μF, 350 V, tubular paper	T.C.C. Type 345
Valves		
V_1, V_2, V_3, V_4, V_6, V_7 ...	—	Mullard EF50
V_5, V_8	—	Mullard EA50
Miscellaneous		
Coaxial cable plug ...	—	Belling-Lee Type L.604/P
Coaxial cable, socket ...	—	Belling-Lee Type L.604/S

New Domestic Receivers

THE Model A746ARG radio-gramophone recently introduced by Philco Radio, Perivale, Greenford, is a six-valve (plus rectifier) superhet, covering long, medium and short waves, the latter from 10 to 66 metres in two ranges. There is an R.F. amplifier before the frequency changer and the output valve is a 6V6G. The record changer has a capacity of eight mixed 10- or 12-inch records and employs a moving-iron armature type of pick-up. The price of the A746ARG, which is housed in a figured walnut cabinet of dimensions 36½in x 32½in x 18in, is £78 15s, plus £17 1s 3d purchase tax.

Ultra Electric, Western Avenue, London, W.3, have produced an interesting A.C./D.C. superhet with a power output of 6 watts. This is obtained from two Mazda 10P14 tetrodes in push-pull. A choice of three combinations of wavebands is available; all three include the 200-550 metre band and the choice of the remaining pair lies between the following: 16-50m, 1,000-2,000m; 16-50m, 50-120m; or 11-22.5m, 23-51m. The price of the U51 is £25 plus £5 7s 6d purchase tax.

A seven-valve version of the post-war R.G.D. radio-gramophone has been developed and will be known as the Model 746G. It dispenses with an R.F. stage before the frequency changer and has a single pentode with feed-back in the output stage. The pickup is designed to take standard steel needles. In general appearance and in the layout of the chassis it resembles the larger Model 1046G reviewed in our October, 1946, issue. The price is £115 10s, plus £24 14s 1d purchase tax.

A console model of the Murphy "baffle" set, Model 122C, keeps the general idea of large frontal area and shallowness back-to-front. Based on the A122, which is the successor to the A104 (reviewed in our Dec., 1946 issue), it has a similar four-valve plus rectifier superhet circuit covering short, medium and long waves, but does not include the optical tuning system for short waves used in the A104. Separate scales for the three wavebands are placed end-to-end in an aperture in the top of the cabinet. The A122C employs a 10-in loudspeaker and costs £33 12s 3d including purchase tax.

A radio gramophone (Model ARG37) incorporating an automatic record changer has been introduced by E. K. Cole, Southend-on-Sea. The receiver incorporates variable selectivity, and bandspread tuning on seven short-wave bands. In addition to normal tuning on medium and long waves, there is provision for push-button selection of five pre-tuned stations, three on medium and two on long waves. The push-pull output stage delivers 8 watts to a 12-inch Goodmans loudspeaker with a frequency range of 30-10,000 c/s. A four-position tone control varies the balance from "bass boost with maximum top" to "normal bass and top cut." The pickup is a Garrard high-fidelity type with permanent sapphire stylus. Housed in a walnut veneer cabinet with anodised aluminium loudspeaker grille, the ARG37 costs £126 plus £27 1s 10d purchase tax.

The new Ekco universal receiver Model V49 is an A.C./D.C. version of the Model A23 with manual tuning on three wavebands and push button tuning for five stations. The short waves include the television sound channel. A four-valve plus rectifier superhet circuit is employed and the price is £23 2s plus £4 19s 4d purchase tax.

Ultra Model 51 which employs the Mazda low-consumption universal valves.

BELLING-LEE QUIZ (No. 15)

Answers to questions we are often asked by letter and telephone

Question 44. *My broadcast programmes are being ruined by sizzles and crackles, plops and bangs. I have been told you can do something about it, what do you advise?*

Answer 44. This is typical of a number of enquiries we are getting daily and they are increasing. The noises typified by the descriptions given are caused by electrical machinery, instruments or appliances such as lifts, refrigerators, vacuum cleaners, hair driers, food mixers, bacon cutters, electro-medical appliances, etc., also electric signs and even household switches. Most things depending upon electric motors and most switches must be suspected. The interference they create is fed back on to the electric wiring and may either be conducted into your receiver, or may be re-radiated from the electric wiring on to your aerial.

The logical place to suppress the interference is at its source but there is, so far, no legislation to enforce this so we can only depend upon the goodwill of tradesmen who are generally reluctant to offend customers, and to ordinary neighbourliness.

If in real difficulty we suggest you go to the nearest post office and ask for the appropriate form which, when completed, will in due course bring a specially trained post office engineer who will investigate your problem and who will try to trace the source to the " butcher or baker or candlestick-maker," or to your downstairs. neighbour who uses a vibro-massage equipment. It may be your own refrigerator, in which case it is probably being troublesome to your near—and not so near—neighbours.

The post office engineer will probably recommend to the offender that a condenser suppressor *3 L.1118 be fitted at the troublesome appliance. If the source cannot be found then you may try the same suppressor fitted to your incoming mains.

The official view of the matter is that every listener should be able to enjoy reasonably interference-free reception from a choice of two B.B.C. programmes, using an aerial as good as the listener can be expected to erect, and that does not mean no aerial at all, or a wire round the room or under the carpet. Such an aerial picks up the programme *and* the interference from the electric wiring in the house: not a very happy state of affairs.

In very bad situations, or where a really critical listener is anxious either to listen to programmes from home or distant stations, it may be necessary to install a *1 " Skyrod " anti-interference aerial with *2 " Eliminoise " transformers. In not so bad cases a *4 " Winrod " window mounting aerial will suffice. It may be necessary to fit a set lead filter *5 L.300 close to the set as well as the special aerial, to keep interference from entering the receiver via the mains.

*1 **" Skyrod "** Reg. Trade Mark.

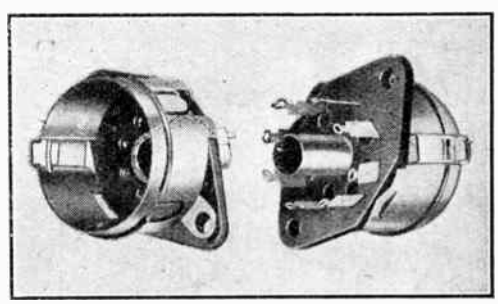
*2 **" Eliminoise "** anti-interference transformers Reg. Trade Mark. U.K. patents 477218, 479118.

*3 **L.1118** Condenser suppressor. List price (as illustrated) **27/6.**

*4 **" Winrod "** Reg. Trade Mark. List price **19/6.**

*5 **L.300/3** Set lead suppressor. List price **58/6.**

B8A type VALVEHOLDER L620



THE floating contract pen nib type sockets are constructed from a carefully controlled grade of silver-plated phosphor bronze and are designed to grip the valve pins with negligible transverse pressure. A neat spring circlip over the shroud ensures a snap lock-in. Insertion and withdrawal forces adjusted to secure adequately low contact resistance with minimum danger of damage to the valve.

The contact shape and size provide a low shunt capacitance, and will also handle a peak to peak voltage swing of 1,500 volts between every pair of adjacent contacts, or, between any contact and the spigot and shell connected together.

This test can be survived after a sample has been conditioned for 8 hrs at 60° C followed by 6 hrs at 60° C and 99% relative humidity, followed by a 1 hr drying period at 20° C and 60% R/H.

The holder complies with tentative specification agreed by the R.C.M.F. standardisation panel working in close collaboration with the radio and electronic engineering industry.

List No. **L620.** Price **9d.** each.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX

WORLD OF WIRELESS

Scope of Radiolympia ✦ Record Exports ✦ London's Tele-cinemas ✦ French Television Standards

RADIOLYMPIA

THE number of exhibitors at the fifteenth National Radio Exhibition, which opens at Olympia on October 1st, has increased to 186.

The coverage of this, the first post-war Radiolympia, has been extended in scope to include, in addition to broadcasting and television equipment, navigational aids and the application of electronics to industrial processes.

Among the "non-commercial" users of radio who will be exhibiting is the Metropolitan Police Force which will be staging a demonstration of the V.H.F. system employed for communication between patrol cars and Scotland Yard.

A private view of the exhibition will be held on September 30th. The show will be open daily, except Sunday, between 11 a.m. and 10 p.m. from October 1st to 11th. Admission will be 2s 6d.

The next issue of *Wireless World* will be enlarged to include a comprehensive illustrated report of the show.

SYMBOLIC This poster and another giving fuller details is being used to advertise the exhibition.

IMPORTS AND EXPORTS

FIGURES recently published by the Board of Trade show that the value of the exports of domestic receivers (including chassis substantially assembled) for the first half of the year was over ten times that of the corresponding period in 1938. In terms of quantity the 1947 figure is just under five times that of 1938.

In addition to the figures for domestic sets tabulated below, £625,128 worth of telecommunication equipment (excluding valves) was exported.

There has also been a considerable increase in the number of valves and cathode-ray tubes exported. During the period under review over 2,035,000 valves and C.R.T.s were exported compared with 1,103,000 during the same period in 1938. The respective values were £696,368 and £247,633.

When comparing the figures in the table cognizance must be taken of the effect of the fuel shortage on production early in the year.

On the import side the value of domestic receivers brought into the country during the period January to June was less than 40% of the 1938 figure. In 1938 it was £60,886; 1946, £55,260; and 1947, £23,448. Whilst the value of imported valves had increased from £65,356 (1938) to £123,332 (1947) the number had decreased from 609,147 (1938) to 490,907 (1947). It should be pointed out that the 1947 figures include cathode-ray tubes.

DOMESTIC RECEIVER EXPORTS (JAN.-JUNE)

To	Quantity			Value (£)		
	1938	1946	1947	1938	1946	1947
Channel Islands	1,644	6,100	2,541	9,580	53,750	30,719
Palestine	78	16,143	15,573	1,818	139,229	171,350
South Africa	2,223	8,418	20,789	16,188	71,374	230,305
India	2,453	24,836	52,292	16,854	207,098	546,096
Malaya	879	1,158	10,280	7,954	10,796	115,362
Other British Countries...	18,334	15,727	23,220	92,902	152,390	278,121
Belgium	154	7,635	8,444	1,038	65,521	72,073
Egypt	232	6,549	9,417	2,122	58,251	107,398
Persia	22	2,816	18,125	184	28,732	197,959
Brazil	445	509	7,756	1,789	4,830	94,138
Other Foreign Countries	15,856	16,180	38,096	70,103	148,353	401,990
Total	42,320	106,071	206,533	220,532	940,324	2,245,511

CINEMA TELEVISION

NO technical details are at present available of the equipment to be used by the J. Arthur Rank Organization or large-screen television which, it has been announced, will be introduced in several London cinemas later this year.

Six cinemas will at first be equipped to receive transmissions from the Organization's research station at Sydenham, South London, which will be beamed to the West End for reception and redistribution.

FRENCH TELEVISION

A DECREE has recently been published by the French Government embodying the recommendations of the Joint Television Committee regarding the future of television in France.

The present standard of transmission from the Paris station (425 lines, 25 frames interlaced) will be continued for a period of ten years. A higher definition system (probably 1,029 lines) will also be put into service in the Capital within the next two or three years and extensions to the provinces will be on this standard.

Transmissions from Paris are at present radiated five days a week on 46 Mc/s (vision) and 42 Mc/s (sound).

MAGNETIC TAPE RECORDING

A MEETING was held recently at Broadcasting House to explore the possibility of standardization of magnetic tape and equipment for high-fidelity sound recording. Useful progress was made in fixing tape and spool sizes but it was thought that it was premature to attempt to

World of Wireless—

standardize magnetic characteristics.

When more data has been accumulated, it is proposed to hand over the results to the British Standards Institution as a basis for a standard specification. The meeting was attended by representatives of the B.B.C., B.I. Callender's Cables, Boosey & Hawkes, B.T.-H., E.M.I., G.E.C., Plessey, R.G.D., and Standard Telephones & Cables.

CAR RADIO TAX

As foreshadowed in last month's issue, the Treasury has made an order, entitled "The Purchase Tax (Charges) (No. 2) Order, 1947," making receivers "designed for use on road vehicles" and valves for use in them chargeable with Purchase Tax at the basic rate of 33⅓% of the wholesale value.

The order came into force on August 11th.

RADIO RESEARCH

Some months ago the Research Committee of the Institution of Electrical Engineers set up a panel to review the facilities for, and co-ordination of, radio research in Great Britain. The report of this panel has now been issued by the Institution.

Among the recommendations are the setting up of an agency, perhaps under the ægis of the Department of Scientific & Industrial Research, to disseminate details of research work; to continue the work undertaken during the war by the Radio Components Research and Development Committee of the Ministry of Supply by a Committee sponsored, say, by the Radio Industry Council and the Telecommunication Engineering and Manufacturing Association; and the provision of additional post-graduate scholarships in radio.

The report "British Research in the Radio Field" is obtainable from the I.E.E., price 1s.

I.E.E. PREMIUMS

A large proportion of the awards by the Council of the Institution of Electrical Engineers of Premiums for papers read before the Institution or accepted for publication during the 1946-47 session deal with radio and allied subjects.

Among the awards were:—

Institution Premium (£50), Dr. H. G. Booker, "Slot Aerials and their Relation to Complementary Wire Aerials" and "The Elements of Wave Propagation using the Impedance Concept."

Kelvin Premium (£25), Drs. H. A. H. Boot and J. T. Randall, "The Cavity Magnetron."

John Hopkinson Premium (£25), Dr. H. A. Thomas, "Industrial Applications of Electronic Techniques."

Duddell Premium (£20), Dr. D. C. Espley, E. C. Cherry and M. Levy, "The Pulse-Testing of Wide-Band Networks."

Ambrose Fleming Premium (£10), W. Ross, "Fundamental Problems in Radio Direction-Finding at High Frequencies (3-30 Mc/s)", "Site and Path Errors in Short-Wave Direction-Finding" and "The Development and Study of a Practical Spaced-Loop Radio Direction-Finder for High Frequencies."

£10 Premiums, C. Crampton, "Naval Radio Direction-Finding"; Dr. D. Gabor, "New Possibilities in Speech Transmission" and "Theory of Communication"; J. Bell, M. R. Gavin, Dr. E. G. James, and G. W. Warren, "Triodes for Very Short Waves."

£5 Premiums, C. J. Banwell, "The Use of a Common Aerial for Radar Transmission and Reception on 200 Mc/s," Dr. J. H. Fremlin, A. W. Gent, D. P. R. Petrie, P. J. Wallis and Dr. S. G. Tomlin, "Principles of Velocity Modulation." D. Cooke, Z. Jelonek, A. J. Oxford, and E. Fitch, "Pulse Communication."

PERSONALITIES

H. W. Allen is the sole survivor of the original staff of Marconi's Wireless Telegraph Co., formed on July 20th, 1897. He successively held the posts of secretary, general manager and deputy managing director. Other early members of the staff who are still living are: **C. E. Rickard** (1898), **Andrew Gray, C. S. Franklin, H. M. Dowsett, P. J. Woodward** and **W. Densham** (1899).

L. H. Bedford, O.B.E., M.A., B.Sc. (Eng.), Director of Research of Cossor's, is joining the English Electric Group of companies in October. It is understood that his work will be mainly with the Marconi Company at Chelmsford. He and Dr. J. M. Dodds (Metrovick) were the first industrial engineers to be taken into the confidence of the Government on radar. The "Bedford" attachment for early gun-laying radar was evolved by him. He is a vice-president of the Brit. I.R.E.

L. H. BEDFORD, O.B.E.

Leslie Gamage, joint managing director of G.E.C., has been re-elected chairman of the British Export Trade Research Organization (B.E.T.R.O.).

R. J. F. Howard, who was, until recently, in charge of the development laboratory of the industrial electronics section of English Electric, has joined British Electronic Products, Ltd., of Moxley Road, Bilston, Staffs, as chief engineer.

J. A. Roddy, who formerly handled television sales for Cossor, has been transferred to Cossor Radar, Ltd., as contacts officer. He was a radio officer in the Merchant Navy from 1916 to 1928.

Dr. R. L. Smith-Rose, superintendent of the Radio Division, N.P.L., has been nominated vice-president of the American Institute of Radio Engineers for 1948.

C. E. Strong, O.B.E., B.A., B.A.I., the chairman of the I.E.E. Radio Section for the coming session, has been chief radio engineer of Standard Telephones and Cables since 1938, with which company and its associates he has served for 24 years. His work with the company has been largely concerned with the development of high-power transmitters. He is a member of the Technical Directive Board of the R.I.C. and recently visited India as a member of the R.I.C. delegation, which, at the invitation of the Government of India, was asked to advise on the technical problems of broadcasting in India.

Dr. Emrys Williams, B.Eng., Ph.D., who has been lecturer in electrical engineering at King's College, Newcastle-on-Tyne, for the past ten years, has been appointed Professor of Electrical Engineering, University of North Wales, Bangor. He was formerly in the G.E.C. Research Laboratories, Wembley. Dr. Williams was chairman of the I.E.E. North-Eastern Radio and Measurements Group for last session.

IN BRIEF

Television Tests using the method of transmitting sound and vision on one carrier, as in the Pye "Videosonic System," have recently been made by the B.B.C. Reception on a receiver in which the scanning spot is not blacked out during the fly-back is, of course, marred by the sound signal which is inaudible.

International Stations.—Broadcasting authorities of twelve nations met in Paris at the beginning of August to discuss the creation of an international radio network. The proposal to establish an international network of stations to be operated by the United Nations Educational, Scientific and Cultural Organization (Unesco), was considered to be impracticable. The countries represented were Australia, Belgium, Brazil, Canada, China, Czechoslovakia, France, Mexico, Sweden, Switzerland, the U.K. and the U.S.A.

Electron-Microscopy.—The applications, rather than the construction, of the electron-microscope will be dealt with at the seventh conference on electron-microscopy which has been organized by the Electron-Microscopy Group of the Institute of Physics at the University of Leeds, on September 16th and 17th.

Canadian F.M.—Permission to erect frequency-modulation transmitters has been granted to nine commercial broadcasting stations in Canada and a further five applications are pending. None of the stations is at present operating.

Mexico has placed a temporary ban on the import of certain goods "considered as luxury or non-essential," among them are radio receivers.

Moroccan Experiment.—The chief engineer of the international broadcasting station in Tangier is interested in establishing ½-metre two-way working between Tangier and Gibraltar. Interested amateurs in Gibraltar should communicate with J. M. Cordova, Radio International, 34, Calle Goya, Tangier, Morocco.

B.I.F.—It is announced by the Board of Trade that the 1948 British Industries Fair will be held in London and Birmingham from May 3rd to 14th.

Colonial Radio-telephony.—Six British colonial territories were provided by Cable and Wireless and its associated companies with extended radio-telephone facilities during July: Kenya was linked with Australia, India, Barbados and Bermuda; Barbados and Bermuda with India, South Africa and Australia; Ceylon with South Africa and Australia; and Trinidad with Tobago.

International Amateur Radio.—Licensed amateurs from among the delegates of the seventy-five nations represented at the Atlantic City conference met informally at the invitation of local amateurs to discuss the importance of international amateur radio.

Chinese Amateurs are planning to hold an International Amateur Radio Exhibition in Chungking on May 5th next year.

Appointments Bureau.—The Professional Engineers' Appointments Bureau has been incorporated as a company under limited guarantee. Members of the Institutions of Electrical, Civil and Mechanical Engineers are invited to register and employers of professional engineers are invited to submit concise details of positions vacant on their staff to the Registrar, 13, Victoria Street, London, S.W.1.

A Scottish Branch of the Radar Association has now been formed. The secretary of the association, which aims at preserving "the comradeship founded in the (R.A.F.) radar commands regardless of trade or rank," is Alex Moore, 25, Wellington Street, Glasgow, C.1.

Speeding the Plough.—Transmitter-receivers are being produced in the U.S.S.R. for fitting to tractors in the main grain areas of Siberia and the North Caucasus to provide communication between the tractor stations and the agricultural centres. Next year 1,000 sets will be fitted and in 1949 the target is 3,000.

International Show.—An international radio exhibition is being planned jointly by the Czechoslovakian broadcasting authorities (Ceskoslovensky Rozhlas) and the International Broadcasting Organization. It will be held in Prague between May and September next year.

Marine Radar.—Twenty-five Swedish ships are to be fitted with 3.2-centimetre radar installations by the Radiomarine Corporation of America, a division of R.C.A.

Institute of Physics.—The annual report of the Institute records that its membership increased during the past year by 299 to 2,830.

C. E. STRONG, O.B.E., the new chairman of the I.E.E. Radio Section.

I.E.E. Council.—The new president of the I.E.E., who will take office on September 30th, is P. Good, C.B.E., director of the British Standards Institution. Among the new members of the Council are two from the Radio Section: T. E. Goldup, a director of Mullards, and H. L. Kirke, C.B.E., head of the B.B.C. Research Department.

I.E.E. Radio Section.—The vacancies occurring on the Committee of the Radio Section of the I.E.E. on September 30th have now been filled. The new chairman is C. E. Strong, O.B.E., B.A.I (Standard Telecommunication Laboratories), and the vice-chairman, F. Smith, O.B.E. (M.O. Valve Co.). The ordinary members are: C. F. Booth (G.P.O. Research Station); H. W. Forshaw, O.B.E. (M.o.S. Directorate of Telecommunications Research and Development [Defence]); E. L. E. Pawley, M.Sc. (Eng.), (B.B.C.); and J. A. Ratcliffe, O.B.E., M.A. (Cavendish Laboratory, Cambridge).

B.S.R.A.—The first lecture of the 1947-48 season will be given by Dr. L. E. C. Hughes on the subject of "Sound and Its Relation to Recording" at the Royal Society of Arts, John Adam Street, London, W.C.2, on September 26th at 7.0.

Not Our Kind of Radio!—A prize of £20 is to be awarded by the British Society of Dowsers to the author of an article which, in the opinion of the Council, does most to promote the science or practice of dowsing or radiesthesia. The prizewinning article will be published in the Society's journal, *Radio-perception.*

Navigation Prize.—The council of the Royal Society of Arts is again offering a prize of £50 under the Thomas Gray Memorial Trust for an invention originated between January 1st, 1942, and December 31st, 1947, which, in the opinion of the judges, is considered to be an advancement in the science or practice of navigation. Entries, giving full particulars, should be sent to the Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, between October 1st and December 31st.

Licences.—The June total of 10,861,650 broadcast receiving licences in Great Britain and Northern Ireland included 20,300 for television receivers. The month's increases were 79,650 and 1,450 respectively.

An Appeal.—A copy of the American journal *Electronics* for June, 1944, is required to complete a volume in a reference library. Will any reader who is willing to supply the missing number please send it to the Editor?

INDUSTRIAL NEWS

Pye.—In his report at the annual general meeting of Pye, the chairman, C. O. Stanley, stated that during the past year the company had made only one-third of the intended number of television sets. Cathode-ray tubes have been the controlling factor. In view of the limited output the price of Pye television sets has been increased to £42.

Bush.—The foundation stone of a new Bush Radio factory at Ernsettle, Plymouth, was recently laid by the Lord Mayor.

Philips Electrical.—From September 1st Philips Lamps, Ltd., will be known as Philips Electrical, Ltd., to be more in keeping with the wide range of Philips products.

Cossor radar scanner is being fitted on the roof of Olympia for the Engineering and Marine Exhibition which opens on August 28th. The scanner will feed a Cossor P.P.I. fitted in a replica of a ship's chart room.

New Zealand Importers.—Speddings, Ltd., of Commerce Building, Beach Road, Auckland, C.1, New Zealand, is celebrating its jubilee this year. The firm was among the first to import broadcast receivers into the Dominion, and hopes, when the present regulations are relaxed, to resume this activity. Speddings wish to hear from manufacturers who are considering extension of their export activities to New Zealand.

Half-thou. Foil.—Ratcliff Metals, of 21, New Summer Street, Birmingham, 19, are producing copper foil of the exceptional thinness of 0.0005in. The firm would be interested to hear from any wireless manufacturing firm having an application for this material.

Airmec Laboratories, Ltd., is the new name adopted by P.R.T. Laboratories. The address, Cressex, High Wycombe, Bucks, and telephone number, High Wycombe 2060-4, remain unchanged.

Marine P.A.—Ardente "Sonomarine" sound-reproducing equipment has been installed in the Southern Railway Company's S.S. "Dinard" and "Falaise." Separate circuits are used for general announcements and for musical programmes, and announcements are always made at full volume irrespective of the setting of the volume controls which are provided at most loudspeaker stations.

Ardente.—The temporary sales office of Ardente Acoustic Laboratories, Ltd., at 309, Oxford Street, London, W.1, has been closed and the sales department accommodated at the works at

World of Wireless—

"Limnerslease," Compton, near Guildford, Surrey. Tel.: Guildford 3278-9.

R.G.D.—The telephone number of the temporary London service depot of R.G.D. has been changed to Macaulay 5592.

Philco.—The address of the Sales Department of the Philco Radio and Television Corporation is now 204-206, Great Portland Street, London, W.1. Tel.: Euston 5566.

Frank Murphy of London, Ltd., has gone into liquidation as a result of a meeting of creditors on July 11th, when it was stated that there was a deficiency of £55,285. The company, incorporated in May, 1944, as a private company, was converted to a public company in June last year, and had premises in Liverpool, Hitchin and Nottingham. The liquidator is L. S. Findlay, 4, Charterhouse Square, London, E.C.1.

CLUBS

Bromley.—Meetings of the North-West Kent Amateur Radio Society will in future be held on the first Friday of each month at 8.0 at Aylesbury Road School, Bromley. The annual general meeting will be held in October. Sec.: L. Gregory, G2AVI, 18, Upper Park Road, Bromley, Kent.

Carlisle.—Meetings of the Carlisle Amateur Radio Society are held on the first and third Fridays of each month at 7.0 at the Richmond Hall, Y.M.C.A., Fisher Street, Carlisle. Sec.: J. Ostle, 2, Outgang, Aspatria, Carlisle, Cumbd.

Catterick.—New headquarters for the Catterick Amateur Radio Club have been established at Marne Lines, Catterick Camp, where the club transmitter has been installed (temporary call G3AKF/A). Meetings, Tuesdays 7.15. Sec.: Cpl. A. Hall, c/o 2 Sqn., 1st T.R., Royal Signals, Catterick Camp, Yorks.

Edgware.—A 1.8 Mc/s D.F. contest has been arranged by the Edgware and District Radio Society for Sunday, September 14th, which is open to non-members on payment of the entrance fee of 1s. Assembly point will be Stanmore (Bakerloo) station at 1.0. Intending contestants should notify H. W. Pope, G3HT, 4, Gainsborough Gardens, Edgware, not later than September 5th. Sec.: R. H. Newland, G3VW, 3, Albany Court, Montrose Avenue, Edgware, Middx.

Grimsby.—Transmitting members of the Grimsby Amateur Radio Society have been given QSL cards by the Grimsby Fish Merchants' and Fish Curers' Association. Visits by short-wave listeners to members' transmitters will be arranged by the Secretary, R. F. Borrill, G3TZ, 115, Garden Street, Grimsby, Lincs.

Harrogate.—Naval airborne radar gear will be described to members of the Harrogate and District Short-Wave Radio Society on September 3rd. Meetings are held on alternate Wednesdays at 7.30 at the Y.M.C.A., Victoria Avenue, Harrogate. Sec.: K. B. Moore, 2a, Wayside Crescent, Harrogate, Yorks.

Who Invented the Aerial—

Marconi or Popov?

IN the Editorial of our May issue, writing on the subject of the Marconi Jubilee, we said that Marconi's first great technical contribution to the radio art was the addition of an elevated aerial to Hertz' oscillator. Some doubts have been expressed as to the correctness of this statement, and without taking sides on the issue, it seems appropriate to quote from an article by Marquis Luigi Solari in the April-May number of our Italian contemporary *L'Antenna*. Solari was a close friend and business associate of Marconi for many years. The following passages are translated directly from his article:—

The aerial was used by Marconi for the first time at the radio transmitting and receiving station of Pontecchio (Bologna) in 1896 and formed the principal and most ingenious part of the first Marconi patent dated 2nd June, 1897. There was much discussion about this because Prof. Popov, physics professor at the Imperial Naval College, Cronstadt had used in 1895 (one year before Marconi) an aerial, that is to say a wire supported by a tall wooden pole and with its lower end connected underneath to an apparatus for recording the electrical discharges of the atmosphere. This apparatus resembled as regards certain parts (I repeat: certain parts) the first Marconi receiving apparatus, but was merely used for recording the electrical discharges of the atmosphere. The Marconi receiver was very different, being far more complete and perfected, and was connected to a Morse instrument for receiving telegraph signals. However, the principal and decisive argument in favour of Marconi resides in the fact that Popov never used the aerial for transmitting electric waves and did not erect any installation for transmitting and receiving electric waves prior to Marconi. This was stated in my presence by Popov himself at Cronstadt in August, 1902, in the following circumstances:

At that time Marconi and I were on board the cruiser *Carlo Alberto* which had proceeded to Cronstadt on the occasion of the visit paid by the King of Italy to the Czar of Russia. The whole of the Russian Press then published enthusiastic articles on the wireless communication established by Marconi for the first time between Russia and Britain (the *Carlo Alberto*, in Russian waters, and Poldhu, Britain).

In view of this great event, Prof. Popov came on board the *Carlo Alberto* to pay tribute to Marconi.

Marconi and I were close to the gangway of the *Carlo Alberto* to receive Prof. Popov, who, as he stepped on board, expressed himself in these exact words: "I should like to greet the father of wireless telegraphy." Marconi shook him very warmly by the hand, took him down to the admiral's cabin and asked him about his experiments. Popov (who was then about fifty years of age) mentioned that he had conducted some experiments in 1895 for recording electrical discharges in the atmosphere, but stated most definitely that he had never effected any transmission of electric waves before Marconi, or any wireless telegraphy communication, and that his research had been confined to electrical discharges in the atmosphere.

Discussion on the aerial used in wireless may thus be considered closed, but before leaving this subject, I should like to repeat exactly the statements made on this matter by Prof. Righi, the well-known continuator of Hertz' experiments and Prof. Slaby, who founded the first German wireless company "Telefunken," after visiting the first Marconi station in Great Britain.

Marquis Solari ends his article by quoting verbatim statements by Righi and Slaby in support of Marconi's priority in the use of an elevated aerial, and stresses the importance of this addition to the equipment of earlier workers.

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Magnetic Units

By "CATHODE RAY"

Guide Through the Mazes of the C.G.S. and M.K.S. Systems

A READER has suggested that it would be a good thing if I were to clarify magnetism. He says that most students get muddled with all the different units—lines, gauss, gilberts, webers, oersteds, and so forth—and their relationships to one another. I sympathize very warmly, because I have found them most remarkably muddling. The fact that the meanings of some of these units have been officially altered from time to time has not tended to make matters any easier.

Before discussing the units, it would be just as well to be quite clear about what they are units of. So let us recapitulate.

Most of the books base everything on "unit magnetic poles," although the more honest of them admit that no such things exist. Nor do lines of force, of course; but, like the lines that cartoonists draw to represent indignation radiating from Saturday's goalkeeper, they are a convenient means of visualizing something that does exist. Unit poles, on the other hand, are a purely hypothetical idea, corresponding to nothing that has ever been observed in nature. They are not even necessary to an understanding of the subject.

So we start off with that peculiar state of affairs found in the neighbourhood of electric currents—a magnetic field. Important effects produced by magnetic fields are the mechanical forces exerted on moving electric charges (i.e., electric currents), and the E.M.F.s generated by moving or varying magnetic fields. The name given to the magnetic quantity that determines the force or E.M.F. in a given region is *flux* (ϕ). The mechanical force is proportional to ϕ, and the E.M.F. proportional to rate of change of flux, $\frac{d\phi}{dt}$.

The influence that causes magnetic flux is named magnetomotive force (F), and is the thing that coils are designed to produce.

At this stage it is customary to bring in the electrical analogy, saying that flux corresponds to current, and M.M.F. to E.M.F., and therefore the ratio $\frac{F}{\phi}$ corresponds to the ratio $\frac{E}{I}$, which everybody knows is resistance. $\frac{F}{\phi}$ is named, quite understandably reluctance; and is denoted, not so understandably, by S.

This analogy is a very useful one, but quite likely to lead to confusion unless two things are noted about it. The first is that the closest analogy is not between magnetic fields and electric current, but between magnetic field and electric field. It is a fundamental principle of teaching, however, that the obscure should not be explained in terms of the still more obscure. Magnetic fields are often tackled at a stage when the student is familiar with volts and amps, but is not at all clear about electric field and displacement. So he is generally introduced at once to the electric circuit analogy, which may rather spoil him for the more perfect field analogy later. It is necessary to beware against tying oneself too tightly and permanently to the former, because magnetic flux and electric current are really quite different sort of things, and one should try to outgrow the need for having to bring in current in order to think about flux.

The other thing (as I explained in connection with permanent magnets) is that the most commonly used magnetic relationship is not between flux, M.M.F., and reluctance, but between flux density (B) (=flux per unit area), magnetizing force (H) (=M.M.F. per unit length), and permeability (μ). This corresponds to an electric current relationship that is comparatively seldom used, and therefore perhaps less helpful as an analogy, namely, that between current density, E.M.F. per unit length, and conductivity. If one takes the trouble to follow up this point, it is likely to be well worth it for the clearer understanding gained.

The reason for showing magnetic data as B/H or permeability curves, instead of F/ϕ or reluctance curves, you remember, is that reluctance is a function of the size of the magnetic path as

TABLE 1

Magnetic Quantity	Symbol	Corresponding in electric circuit to—
(1) Flux	ϕ	Current
(2) Magnetomotive force	F	Electromotive force
The ratio of (2) to (1) is		
(3) Reluctance	S	Resistance
Sometimes it is more convenient to use the ratio of (1) to (2) :—		
(3a) Permeance		Conductance
Getting down to unit dimensions, there follow :—		
(4) Flux density ... ... (ϕ per unit cross-section area)	B	Current density
(5) Magnetizing force ... ... (F per unit length of path)	H	Voltage gradient
So in a magnetic circuit F = Hl		
And the ratio of (5) to (4) is :—		
(6) Reluctivity		Resistivity
But usually the ratio of (4) to (5) is used :—		
(6a) Permeability	μ	Conductivity

Magnetic Units—

well as of the material occupying it. The information can be generalized for any material by dividing flux by unit area of the path's cross-section, and M.M.F. by its length, giving reluctance per unit cube, or reluctivity, which is $\frac{1}{\mu}$.

One other thing to recall is the magnetic equivalent of Kirchhof's Second Law (about the sum of the potential drops in a circuit being equal and opposite to the sum of the E.M.F.'s). Both E.M.F. and potential difference are measured in volts, although one is cause and the other effect; like the mechanical back-pressure when you push against a wall. The idea of magnetic potential difference is worth grasping, because the total M.M.F. needed to produce a required flux in a magnetic circuit is equal to the sum of the magnetic potentials across all the parts of the circuit in series.

The chief magnetic quantities, then, with the corresponding quantities in the electric circuit are shown on the preceding page (Table 1).

Nos. (1) and (2) are cross-related with their corresponding electric circuit quantities; current produces M.M.F., and varying flux produces E.M.F. (In the true, or field, analogy, the quantity corresponding to magnetic flux is electric flux, emanating from a charge; M.M.F. is caused by varying electric flux).

The basic relationships of all these things are, of course, pre-set by Nature; but it is up to human wit to express them as simply as possible. Ohm's Law is a good model. But we find that with the units used in most books the E.M.F. generated by flux changing at unit rate is, not 1 volt, but 0.01 microvolt. And 1 ampere-turn gives rise, not to unit M.M.F., but to $\frac{10}{4\pi}$ units. The more theoretical aspects are worse still. Whereas unit electric charge is said to give rise to 1 line of electric flux, the corresponding unit magnetic pole is said to give rise to 4π lines of magnetic flux.

Any common-sense student approaching this subject with a fresh and open mind would say: "I know about volts, amps, ohms, watts, etc., and I like them, because I don't have to bother about constants—in Ohm's Law, for example. Is there any reason why the magnetic units shouldn't follow on in the same scheme, so that constants only appear where there is a good and obvious reason?"

The answer is that the system of units officially and internationally approved as long ago as 1935 does fit the practical unit scheme. But the majority of people still cling to various pure and adulterated forms of several pre-1935 systems. Admittedly it is difficult to get a deeply established system changed, even for a better one; and in this particular situation there is a rather awkward complication. There are two different versions of the new system, and opinion on them was so divided that the international conference (as is the manner with international conferences) just couldn't decide either way, and hopefully left it to sort itself out.

C.G.S. System of Units

It is a long story, but briefly the sequence of events is this. The fundamental physical quantities are length, mass and time; and when units have been fixed for these, systems of units for other quantities can be based on them. For scientific purposes, the basis is generally the centimetre, gram, and second (c.g.s. system). One can start off deriving electrical units by defining unit charge as that which, placed 1 cm from equal charge of opposite sign, attracts it with a 1 c.g.s. unit of force (dyne); and from that build up a consistent system of electrical units. More than that; as magnetic quantities are inter-related, magnetic units can be derived as part of the same system.

But if one starts off on the other foot, by considering the force (also in dynes) between the imaginary unit magnetic poles (also 1 cm apart), another c.g.s. system of electric and magnetic units can be built up. Unfortunately the two systems disagree by the considerable factor of approximately 30,000,000,000, which turns out to be the speed of light through space, in c.g.s. units. This is not just a coincidence, of course, because light consists of electromagnetic waves, and its velocity is a result of interrelated electric and magnetic forces. Calculation of these forces brings in two characteristics of space (or whatever else the waves are travelling in); on the magnetic side is permeability (μ), and on the electric side permittivity (κ). It works out that the velocity of electromagnetic waves in space, denoted by c, is equal to $\frac{1}{\sqrt{\mu_0 \kappa_0}}$, μ_0 and κ_0 being the μ and κ for empty space. Now we know c by experiment, so we know $\mu_0 \times \kappa_0$, but neither μ_0 nor κ_0 separately. If μ_0 is assumed to be 1, it follows that all the electric and magnetic units are precisely those arrived at by considering the forces between magnetic poles, i.e., the electromagnetic c.g.s. system. κ_0 is then found to be $1/c^2$, or approximately

1/900,000,000,000,000,000,000,

which is not a particularly convenient number. On the other hand, if for simplicity κ_0 is taken as 1, resulting in the electrostatic c.g.s. system of units, μ_0 must be 1/900 . . . . —well, $1/9 \times 10^{20}$).

So whatever is done, κ_0 and μ_0 cannot both be 1 at the same time, because that would mean altering the universe to make the velocity of light 1 cm per sec, which would be awkward.

In the meantime, neither of the c.g.s. systems had suited the electrical engineers of the time, because the units were nearly all much larger or smaller than the magnitudes they were used to. So they had created the so-called "practical" units, derived from the e.m.c.g.s. units by multiplying them by what were considered suitable powers of 10. This was how we got our volt, amp, ohm, henry, farad, etc. (By the way, directly a factor is applied to one of the c.g.s. units to make it a more handy size, the factors for the others follow automatically. So the farad couldn't be helped! It might have been worse; the other practical units are fairly reasonable). The magnetic units remained just as they were in the e.m.c.g.s. system, and involve factors like 10^8 when calculating the E.M.F. generated by varying magnetic flux. When working with basic electrostatic relationships, one has either to use the entirely different e.s.c.g.s. system of units, or else stick to e.m.c.g.s. or practical units and have huge powers of 10 and 3 everywhere. And just to make it more difficult somebody had introduced 4π differently in electric and magnetic theory, thereby spoiling the analogy between them.

Is it surprising that the student is muddled? Especially when he is now faced with two varieties of still another system!

M.K.S. System of Units

By basing all units on the metre and kilogram instead of the centimetre and gramme, the three foregoing systems merge into one, which, fortunately, includes all the familiar volt-amp-ohm practical series. The unit of magnetic flux turns out to be 10^8 times as large as the e.m.c.g.s unit, leading to the happy result that when it changes at the rate of 1 unit per second the E.M.F. generated in an interlinked path is 1 volt.

The fact that the dimensions are in metres is perhaps not quite in tune with the present trend towards miniaturization, and may be one reason why radio engineers haven't leapt to embrace the m.k.s. system, as it it called. Those who are concerned with aerials, feeders, and propagation should be quite happy with it, however.

The silly factor of 10 in the M.M.F. formula drops out, of course, but what about the 4π, also silly? It is because of it that some authorities (following Heaviside) go further and, as they say, *rationalize* the m.k.s. system. They simply alter the sizes of the unrationalized m.k.s. units of M.M.F., field strength, and reluctance to fit, and at the same time imagine unit magnetic pole to be the thing from which 1 line (not 4π lines) of magnetic flux originates, making it correspond with the 1 electric flux line from unit charge. All this leads to delightfully simple results; for example, the M.M.F. along any magnetic path surrounding a straight wire carrying a current of 1 amp is 1 rationalized m.k.s. unit. The same holds good inside a toroidal coil or a long solenoid or an iron-cored coil. At the same time the electric 4π's are cleared up too. In the theory of electromagnetic waves it is even more helpful, and most of us need all the help we can get in that subject.

Where is the catch?

We have seen that it is absolutely impossible for both μ_0 and κ_0 to be 1 in any single system of units. So one or both are bound to be more or less awkward constants. To fit the unrationalized m.k.s. system, μ_0 has to be $1/10^7$, and κ_0, $1/(9 \times 10^9)$. To rationalize, these values are altered by the factor 4π ($\mu_0 = 4\pi/10^7$; $\kappa_0 = 1/(36\pi \times 10^9)$). Seeing that they cannot, in any case, both be ideally simple, one might as well hide *all* the awkward features away in them, for the sake of perfect tidiness everywhere else.

But, you may say, is it really tidy everywhere else? B in air used to be conveniently equal to H, and now we are asked to make it $4\pi H \times 10^{-7}$! Well, there is bound to be a ragged end somewhere, and if you can think of a better place to hide it, say on. It is easier, surely, to tie an inevitable odd number to one particular thing (and a rather mysterious indeterminate thing at that) than have it spread illogically all over the place in a way that just has to be memorized.

A New Start

As I said, there is a lot more in the story, which provides unlimited scope for argument; and I can quite understand anybody resenting the m.k.s. system as tending to make confusion worse confounded. (That was why I didn't dare to divide the issue by introducing it into "Permanent Magnets" last month, especially as magnet data are invariably in gauss and oersteds). If the c.g.s. systems could be blotted out from every textbook and every lecturer's mind and notes, and if the rationalized units were given names, I think there could be no doubt at all that the latter would be accepted universally. Anybody who has still to learn electromagnetics would find his brain run much cooler if he could work from the start in rationalized m.k.s. units. That, I think, is the justification for asking everybody to learn them now, in addition to any systems already held, for the sake of future generations of students. It is likely to pay some dividends even to us, by showing

Magnetic Units—

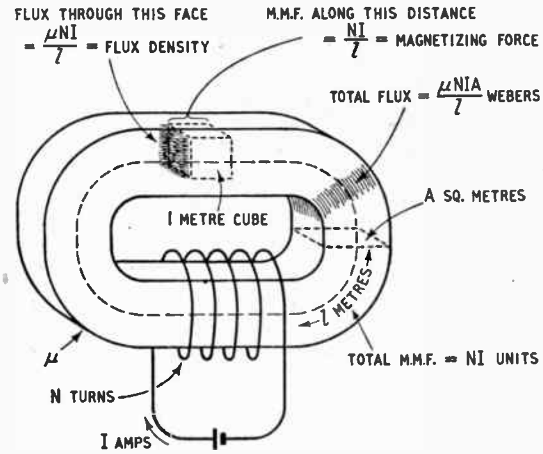
up basic theory in all its unobscured simplicity.

Here, for example, are a few of the relationships of rationalized m.k.s. units:—

Suppose a coil of N turns carrying a current of I amps has an iron core. A square metres in section and l metres long, which can be assumed to carry all the flux (see Fig. and Table 2). Then the M.M.F. is NI units, the magnetizing force is NI/l units, the flux density is $\mu NI/l$ webers per sq metre and the flux is $\mu NIA/l$ webers. So if the current varies at the rate of 1 amp per second, the flux varies at the rate of $\mu NIA/l$ webers per second, and the back-e.m.f. generated in each turn is $\mu NIA/l$ volts. The total back-e.m.f. is, therefore, $\mu N^2IA/l$ volts, and the self-inductance of the coil (by definition of the henry) is $\mu N^2IA/l$ henries. What could be easier?

Considering turns as simply a scheme for multiplying current, M.M.F. is seen to be measured in amps, just as E.M.F. is measured in volts. And just as conductance in an electric circuit is equal to conductivity multiplied by a size factor $\left(\frac{\text{area}}{\text{length}}\right)$, inductance (of one turn) is equal to permeability multiplied by $\frac{A}{l}$. (And, incidentally, capacitance is equal to κ multiplied by $\frac{A}{l}$, where A is the area of each plate and l the distance between). If A and l are 1 metre, the inductance of the arrangement is equal to μ (and the corresponding capacitance is equal to κ). So it is reasonable to refer to the value of μ_0 in the rationalized m.k.s. system as 1.257 microhenries per metre (and κ_0 as 8.854 picofarads per metre). Of course, plates or coils of these unit dimensions would have large "edge effects," so are to be regarded theoretically only; but if the constants μ_0 and κ_0 are remembered in the above form they can be used in practical problems. For example, the capacitance of a condenser with one dielectric 0.01 sq metre in area and 0.0004 metre thick, and with relative permittivity (or dielectric constant) 5, is $\frac{8.854 \times 0.01 \times 5}{0.0004} = 1107\text{pF}$. And the inductance per turn of a toroidal air-cored coil 0.8 metre along the axis and 0.001 sq metre section is $\frac{1.257 \times 0.001}{0.8} = 0.00157$ μH. If the number of turns were 400, the inductance of the coil would be $0.00157 \times 400^2 = 251\mu$H.

One could go on to show how the speed of waves along transmission lines, and their characteristic impedance, follow naturally from all this; and how it simplifies cathode-ray tube and waveguide theory. But perhaps enough has been said to convince you that you should start your baby now on m.k.s. Refuse worthless substitutes; insist on genuine *rationalized* brand m.k.s.!



Showing the simple relationships between magnetic units in the rationalized m.k.s. system. The usual mixed "practical" and c.g.s. system necessitates various constant factors composed of 10 and 4π.

TABLE 2

Quantity	Symbol	Rationalized m.k.s. unit	Relationship to e.m.c.g.s. unit
Mass	m	kilogramme	$= 10^3$ grammes
Length	l	metre	$= 10^2$ cms
Mechanical force ...	F	newton	$= 10^5$ dynes
Magnetic flux	I	weber	$= 10^8$ maxwells (or lines)
Magnetic flux density ...	B	weber per sq metre	$= 10^4$ gauss (or lines per sq cm)
Magnetomotive force ...	F	ampere-turn	$= 4\pi/10$ gilberts
Magnetizing force, or magnetic field strength	H	amp-turn er metre	$= 4\pi/10^3$ oersteds
Absolute permeability	μ		$= 4\pi/10^7 \times \mu_{(c.g.s.)}$
Relative permeability ...	μ_r $(=\mu/\mu_0)$		Same in both systems (= 1 for vacuum)

BOOKS RECEIVED

Calculating Machines, by D. R. Hartree, F.R.S., Plummer Professor of Mathematical Physics, Cambridge University.

Reprint of an inaugural lecture on recent and prospective developments in the design of calculating machines, and their impact on mathematical physics. Contains photographs and a description of the E.N.I.A.C. machine, but deals with its functions rather than its anatomy. Pp. 40; two plates. Published by the Cambridge University Press. Price 2s.

Drafting for Electronics.—By L. F. B. Carini, Ph.D. After dealing at some length with the fundamentals of instrument drawing the author devotes five chapters to Schematic Delineation, Schematic Circuit Projection, Schematic Patent Drawing, Industrial Electronics and Technical Outline Drawings. Other chapters deal with the preparation of graphs and of drawings for reproduction. The twenty-page appendix includes relevant data, conversion tables and a bibliography of visual aids. All material is based on standards of the American Standards Association and the American Institute of Radio Engineers. 211+ix pages with 186 figures. McGraw Hill Publishing Co., Ltd., Aldwych House, London, W.C.2. Price 12s 6d.

LETTERS TO THE EDITOR

"Damping Factor" ♦ Thunderstorms and Television Signals ♦ Close-Spaced Television Aerials ♦ What is a Filter?

Loudspeaker Damping

I WAS extremely interested to read the letter by F. Langford-Smith in your August issue on speaker damping.

I have thought for some time that, within limits, the output impedance of an amplifier is not so important as is often stated. If one considers a triode amplifier having a typical output impedance of, say, 3 ohms feeding a 15-ohm speaker having a D.C. resistance of, say, 10 ohms, the resistance of the circuit can only be reduced to 10 ohms compared with 13 ohms, even if the output impedance of the amplifier is zero. Unless negative feedback is applied from the secondary of the output transformer, the output impedance of the amplifier includes the resistance and leakage reactance of the transformer, which are by no means negligible in a normal transformer (say, 1 to 2 ohms).

Some time ago, with the help of a colleague, I performed some experiments on a cathode follower. A triode amplifier was constructed so that the output valve could be changed by means of a switch from normal operation to operation as a cathode follower. By measuring the output impedance on the secondary of the output transformer the value obtained as a cathode follower was about half that obtained with the amplifier operating in the normal manner. Aural tests were made with a number of observers. Most observers stated that they could not tell any difference, and those that said they thought they could were actually unable to tell, with any certainty, which arrangement was actually in use. Tests were also taken with an oscillograph by observing the damped oscillation obtained across the speech coil when the speaker was fed with sharp pulses. No conclusive difference could be observed.

Although these tests were never really completed, we came to the conclusion that if there was any difference in the performance it was so small as to be not worth while.

I think that many of the statements made about amplifiers having much better transient response due to lower output impedance are misleading. The conditions of tests are, I think, often doubtful. It is a fact that one imagines a new amplifier (particularly if you have just built it) to be better than the old one if you are unable to compare them side by side. The only real test is to have the two amplifiers arranged so that they can be switched quickly from one to the other. The actual amplifier used should not be known to the listener.

G. N. PATCHETT.

Eccleshill, Bradford.

F. LANGFORD SMITH has assumed a series resistance twenty times the resistance of an ideal loudspeaker on the basis of 5 per cent efficiency. Whilst this may be so when referred to middle frequencies, the efficiency is many times greater than 5 per cent at the resonant frequency, and it is at the resonant frequency that the damping factor becomes important.

If we assume an efficiency of 40 per cent at resonance, then with an ideal amplifier of zero output resistance the effective damping factor would be 0.66. We can therefore say that the amplifier damping factor must be large compared with this figure. For practical applications it would seem that increasing the amplifier damping factor above 4 or 5 will result in little or no audible improvement whatsoever, and this is certainly borne out by tests which the writer and his colleagues have been able to carry out.

P. J. WALKER.

The Acoustical Mfg. Co., Ltd., Huntingdon.

F. LANGFORD SMITH'S suggestion that the electromagnetic damping of a loudspeaker is limited by the equivalent series impedance (or resistance) of the loudspeaker itself is quite sound, and if the efficiency of the loudspeaker is 5 per cent, then the equivalent series resistance will be large enough to make the effects of a low output impedance negligible.

The point which is overlooked, however, is that at resonance points the efficiency rises to a value considerably higher than the mean efficiency. The result is that the equivalent resistance is reduced and the damping improved at these points where damping is needed.

C. J. MITCHELL.

Cuffley, Herts.

(*Letters continue on page 344.*)

Letters to the Editor—

WHEN thinking of damping we are more concerned with the loudspeaker as a current generator than with its efficiency as an electro-acoustic device. The damping depends on the current generated by the speech coil moving in a magnetic field, and this current is obviously dependent on the total effective impedance in the loudspeaker circuit.

If we take as example a 10-Ω speech coil in circuits having damping factors of 1 and 20, the corresponding total circuit impedances will be 20 Ω and 10.5 Ω respectively. The damping current is clearly greater in the second case, and this improvement stands, regardless of loudspeaker efficiency.

Nevertheless, Mr. Langford Smith is quite correct when he states that progressively increasing the damping factor will have little effect beyond a certain point. In the example quoted, if we double the damping factor from 20 to 40, the total impedance drops only from 10.5 Ω to 10.25 Ω, a decrease of less than 2½ per cent.

Also it is almost certain that the loudspeaker which is efficient in electro-acoustic transfer will be correspondingly efficient as a current generator, so that the damping will improve with efficiency.

Bristol. E. J. JAMES, B.Sc.

"Television Aerials"

WE should like to make a few comments on the article "Television Aerials," by N. M. Best and R. O. Beebe, in your August issue.

It appears from the figures and polar diagrams which they give that they are advocating the design of television aerials so that the maximum available back-to-front ratio occurs at 41.5 Mc/s, so as to give maximum interference rejection on the sound channel. Our view is that as it is common practice to fit noise limiters to television receivers, which are capable of much better noise reduction on impulsive type noise such as ignition interference, the directional discrimination is better arranged to be a maximum at 45.0 Mc/s, so that it can be used to reduce ghost images, which can be removed in no other way, apart from the physical removal of the reflecting objects.

We were particularly interested in their attempts to measure bandwidth, as they have adopted a method differing fundamentally from the one usually employed. We consider their method rather less accurate as they have included the bandwidth of the transmitting aerial in their measurements, since the radiated field will not be constant at all frequencies in the band although the aerial current may be maintained constant. The use of coaxial cable for the receiver and transmitter aerial feeders also introduces a source of error as signals will be picked up on the receiver feeder and radiated from the transmitter feeder due to the balanced termination. This must introduce a considerable error, as the magnitude and phase of this component cannot be estimated. Had a balance-to-unbalance transformer been incorporated in the aerial system, or balanced twin feeder line used, this effect could have been eliminated.

In view of these sources of inaccuracy we do not see how the authors can have measured a bandwidth flat within 1 db, as the experimental errors must have considerably exceeded this.

F. R. W. STRAFFORD.
J. N. PATEMAN.
Research Dept.,
Belling and Lee, Ltd.,
Enfield.

Filters

THOMAS RODDAM'S remarks in your August issue are surely irrelevant. There is no mention of "ideal wave filters" in H. E. Styles' article.

In effect, Roddam asks us to give up the use of a general descriptive term in order that there shall be no confusion when he uses it as shorthand to mean one particular fictitious conception.

If he belongs to the esoteric coterie of wave filter designers I can understand his difficulty in envisaging an "untuned filter" but practical men will continue to use untuned resistance-capacity circuits to filter out unwanted R.F. from the audio output of a detector stage, and to understand each other when they discuss scratch filters, tunable whistle filters, and untuned resistance - capacity filters for smoothing H.T. supply circuits.

HENRY MORGAN.
London, S.E.1.

Television and Thunderstorms

I AM using an experimental television receiver at this address, about 90 miles from the transmitter. The signal is normally just good enough to enable the picture to be held, and is subject to considerable fading.

It has been observed during the last month or two that for two to three hours prior to the arrival of a thunderstorm in this area the signal has increased to a point where "local station" results are obtained with a complete absence of fading.

This has happened on five or six occasions, and each time the storm has approached from roughly the direction of the transmitter. I should like to know why. Perhaps the effect has been observed by others whose knowledge of propagation at television frequencies is greater than mine. E. G. HILL.
Halesworth, Suffolk.

Purchase Tax on Listening

WHY must a battery set user pay purchase tax on his listening while the mains set user can waste power all day long tax free?

The purchase tax on high-tension batteries should be removed.

ROBERT C. BELL.
Ambleside.

BOOK REVIEWS

Radar Engineering. By Donald G. Fink. Pp. 644, with 471 diagrams. McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C.2. Price 35s.

THIS textbook is not an attempt to supply information on all the ingenious radar devices that were used during the War. Such a mass of detail would in any case be far too voluminous for one book, and would be of very limited practical value. It is a presentation of the underlying principles and commonly-used techniques, illustrated by some typical examples. The reader is assumed to have a basis of conventional radio, but not necessarily of television, pulse techniques, or microwaves.

So the author has devoted a large part of his space to the theory of transmission lines, waveguides, cavities, magnetrons klystrons, beam aerials, and so forth. He has arranged his material well. After a brief review of radar, which identifies the different methods of scanning and indication, and clearly brings out the significance of the leading variables, such as wavelength and pulse frequency, the theoretical principles are discussed. They are classified broadly into pulse and R.F. principles. The second half of the book deals with applications to the various essential constituents of any radar system—modulator, transmitter, radiator, receiver, indicator, etc. An exceptionally full index completes the book.

Although the term "radar" is used in its strictest sense, so that respondors, Gee, and other aids to navigation are not specifically mentioned, and although the sets described in detail are limited to one U.S. Army wartime ground radar system in each of the 200, 600, 3,000, and 10,000 Mc/s bands, the fact that the author has devoted his effort mainly to expounding fundamentals enables his teaching to be applied not only to systems miscalled "radar" but to such fields as television and microwave communications.

It is a pity that a work which is in most respects so good is seriously inaccurate in the most elementary parts of the theory, where the effects of current and voltage pulses on inductance, capacitance and resistance, separately and combined, are described and illustrated. The cases considered are for the most part rather artificial ones and would not be the best introduction to pulse circuit theory even if correct. Several of them flagrantly contradict Kirchhof's Second Law, as well as the other elementary principles quoted by the author. One of them shows an exponentially varying voltage across a dead-shorted resistance! The author draws attention to the analogy between current and inductance on the one hand and voltage and capacitance on the other, yet if he had applied this analogy himself to the whole series, summarized in Fig. 51, his errors would have been manifest. An extraordinarily involved and wildly erroneous explanation is given of the supposed behaviour of the response of L and R in parallel when a voltage pulse is applied. Coming (much too late, p. 322) to the more practically important differentiating circuit, the leading edge of the voltage peak across R is ascribed to the *charge* of C, and the exponential trail-off to the *discharge*. It would have been far better if the author had assumed a knowledge of circuit theory and omitted it, for what has been given is likely either to confuse the reader at the start, or else arouse his doubts about the reliability of the whole book. The more advanced sections that follow are much more satisfactory, however.

Circuit techniques are the weakest in the second half also. The production of sawtooth sweep waveforms is tackled in two places, very inadequately in both, and there is no reference to Puckle's book or other source of more up-to-date information. Linearizing technique stops short at the simple pentode, and there is no mention of the Miller time-base principle, or of the floating paraphase or Schmitt circuits, nor is an anti-astigmatism circuit shown.

These are, perhaps, debatable questions of choice, however, and if the comparatively brief elementary circuit sections are carefully ignored this is a readable, well-arranged, and, for the most part, accurate textbook. M. G. S.

The Metre-Kilogram-Second System of Electrical Units. By R. K. Sas and F. B. Pidduck. Methuen & Co., Ltd., 36, Essex St., London, W.C.2. Price 4s.

REFERENCE is made in this monograph to the fact that many books on physics written recently in the United States have used the m.k.s. system of units, which was adopted by the International Electrotechnical Commission in 1938. The authors consider that a wider use of the system in this country will be of the greatest service to students of physics and

Book Reviews—

engineering. If one were starting *de novo* there is little doubt that a single system embracing the practical units and the various electrostatic and magnetic units would be preferable to three separate systems, but when one has been brought up on the electrostatic, the electromagnetic, and the practical system of units, and feels perfectly at home changing from one to the other, the introduction of a fourth system is bound to be confusing. We must confess that if, on opening a text book, we find that the formulæ are based on the m.k.s system, we feel tempted to close it again quickly. The same is true of the so-called rational system in which the 4π is missing from its accustomed place and turns up in unexpected corners.

The monograph under review is divided into nineteen sections each of two or three pages. The first few deal with the disadvantages of the three systems in use up to the present, with the question of rationalization and with the perennial problem of the relation between H and B. Section 5 is appropriately entitled "Tribulations of the Student": he might have been saved some of these tribulations if the authors had taken a little more care in correcting errors, such as $4\pi\sigma S$ for the electric intensity just outside a conductor which is, of course, independent of the area S, $\Delta \times u$ instead of $\nabla \times u$ for the curl of u and flex where flux was intended. They omit the "per second" and instead of 50 c/s we have such things as 50 c=314 p and frequency of electric oscillations $\omega = 1/(LC)^{\frac{1}{2}}p$, in which p stands for pulses.

On p. 23 the authors do something which one would have thought impossible; they take as their unit of H the ampere-turn per metre and give it the name *oersted*. Now the oersted is already internationally used as the unit of magnetic force or intensity in the c.g.s. system, and it is quite inexcusable to apply it to another unit. To say that the earth's horizontal component is about 15 Oe when it has for some years been given as 0.18 Oe is to show an utter disregard of recognized nomenclature.

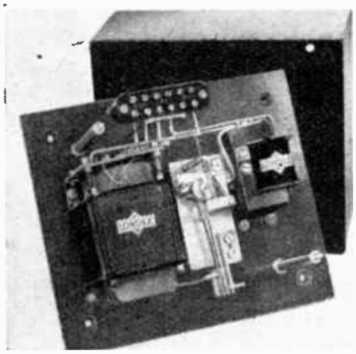
The concluding section consists of a table of formulæ in the m.k.s. system and the reader is told that he "should learn the formulæ and not convert from systems of units which are better forgotten." This may be possible if one has no previous knowledge of the subject, but it will certainly be very difficult for anyone whose whole previous education has been based on the earlier systems.

We must confess that we are disappointed with this monograph and feel that more care should have been taken in its preparation.

G. W. O. H.

Remote Control Components

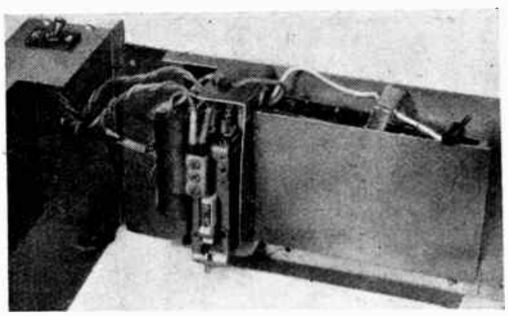
THE Londex two-step relay performs the functions of the secondary relay described in a recent article.[1] The unit, Type LF/FS/AC measures $7\frac{3}{4}$in × $6\frac{1}{2}$in × $3\frac{3}{4}$in and consists of an A.C. relay, fed at 25 volts from a transformer the primary of which is tapped for voltages from 110 to 250 V. The armature of the relay drives a ratchet mechanism which opens and closes a pair of heavy-duty contacts at successive operations. The movement of the contacts occurs on releasing the relay; i.e., at the end of the current pulse. The transformer and relay coil are continuously rated, so the current pulses may be of unlimited duration. After being energized on test for 15 minutes, the transformer was quite cold, and the relay coil only warm to the touch. The components are mounted on a heavy insulating base plate and provided with a sheet metal case. A neat terminal block is provided, appropriately marked for connection in a radio receiver remote control circuit. If separate wires are provided for the control leads, no extra equipment is needed apart from push-buttons. The unit is priced at £4 17s 6d and the makers are Londex, Ltd., Anerley Works, 207, Anerley Road, London, S.E.10.



Londex Two-step Relay Unit.

A second piece of equipment is a complete remote control unit. Known as the "Switchmatic, No. 700," it is the product of the Carlton Manufacturing Co., 4, Carlton Terrace, Portslade, Sussex. The circuit comprises a 9-volt battery and 1,000-ohm P.O. Type 3,000 relay which are wired in series and connected across the extension loudspeaker leads. A capacitor prevents current flow through the wireless set output transformer secondary. The extension loudspeaker provides a D.C. path across the extension leads, and the relay is thus energized. In this way control of the receiver is effected without any additional wires. The relay carries a single-pole "make" contact which is wired in series with the mains lead to the receiver. When the set is "on" (i.e., when the relay is energized) a continuous drain of 9 mA is imposed on the battery. Switching the set on and off is accomplished by a switch at the extension loudspeaker in series with the speech coil. A switch on the "Switchmatic" unit itself is arranged to short-circuit the relay contacts when the remote control facility is not required.

It would be useful if this switch carried extra contacts which also disconnected the battery, as otherwise it is possible, if the switch on an extension loudspeaker is left on, to impose a continuous drain on the battery without being aware of it.



The Switchmatic No. 700 Remote Control Unit.

The components and battery are together mounted in a metal case, $9\frac{1}{2}$in × 5in × $2\frac{1}{4}$in and the price is 64s 6d.

[1] "Receiver Remote Control," *Wireless World*, June, 1947, Vol. LIII, p. 212.

Unbiased

By FREE GRID

D.C. Defence League

IT is an axiom in this or any other country that if you have a grievance, whether it be against the Government or anybody else, you have only to bawl loudly enough and you will get it redressed no matter how imaginary it is. On the other hand, if you don't bawl nothing will be done about your grievance no matter how just your cause. This holds true from earliest infancy, for I personally soon discovered that a hearty yell was far more productive of the good things of life and got them much sooner than any amount of good behaviour.

A noisy and vociferous minority who wants the Government to provide red flannel underclothing for the grass-skirted maidens of the South Sea Islands can, by constantly bombarding M.P.s and Cabinet Ministers with postcards and telegrams, get far more action from them than the patient and silent majority who would rather have some red flannel underclothing for themseves but haven't organized themselves into a body to demand it.

I have been at some pains to make the foregoing clear as there is in this country a long-suffering and patient radio minority for whom the fat and prosperous wireless community at large—including listeners, manufacturers and the hierarchy of *Wireless World*—care not a rap. I refer, of course, to the despised fraternity of D.C. users which is nothing but the Cinderella of the wireless community and will remain so unless the members organize themselves and set up such a yell that something will be done to redress their grievances.

Nowadays, of course, when the grid is groaning under its load, the big cry is that it is no time to think of adding to it. I am, however, willing to wager six bowler hats to a packet of cigarettes that in five years' time, when we may reasonably expect the shortage of generators and electrical transmission gear to be but a dim memory, D.C. users will find themselves in exactly the same position as now unless they get together and do something about it.

The least that can be expected is the provision of A.C./D.C. sets in adequate variety and quantity until such time as D.C. itself disappears for ever. As it is, one sees dealers' shops crammed to bursting point with post-war models of A.C. and battery sets with here and there a stray A.C./D.C. set holding up its head amidst the obvious sneers of the "A.C. only" aristocracy all around it. I don't know whether it will be the same at Olympia next month and I only hope that it is not too late now for the organizers to get all the D.C. exhibits into one corner of the show instead of leaving us to pick them out here and there in an obscure corner of each stand.

Silent P.A. at Last

IT is gratifying to learn from somebody in a very high position in the railway world that my recent protest against the use of P.A. in our large railway stations to add to the existing nightmare of noise has had the desired effect. In the case of one company, at any rate, serious consideration is being given to an alternative suggestion which I submitted privately to the directors.

In my letter to them I pointed out that since a cathode-ray tube was roughly the same shape as the horn-type P.A. loudspeaker they employ, it would not detract from the beauty and symmetry of the general layout of their stations if they substituted one for the other and installed a closed circuit television system for their announcements. By doing this, several objects would be achieved apart from the elimination of the nerve-wracking noise and irritating reiteration emanating from the P.A. loudspeakers, for in between the announcements the company could sandwich highly profitable advertisements about "Marvellous Margate" and "Soul-Satisfying Southend."

It is, of course, futile to raise the objection that to have train announcements prominently displayed in this manner won't meet the case in the same way as an audible announcement. After all, the most important thing in a railway station is Time, with a capital T, and this is "announced" in a manner perfectly satisfactory to all by means of a silent clock hung up where all can see it. Nobody expects the clock to strike or to contain a hidden loudspeaker constantly bellowing out the passing moment, and everybody would heartily resent it if it

Unbiased—

did. It will be the same with the television train announcer; people will learn to look up to it as they do the clock and marvel that they could ever have put up with the present horror for so long.

Free Grid, Volta, Henry, Faradia, Mrs. Free Grid.

In Memoriam

IT is with deep regret that I have to record the sudden and untimely death of Alan Gelli who for seventeen years has been my collaborator in the production of "Unbiased." It was his creative genius which gave birth to the caricature of the classic features of Free Grid as *Wireless World* readers know them, and later of Mrs. Free Grid and the family as exemplified in the illustration reproduced on this page.

It will be no easy task to fill his place.

RANDOM RADIATIONS

By "DIALLIST"

Radiolympia

IF it comes up to the hopes and intentions of its organizers, this year's Radiolympia should be the most interesting that we have yet had. To put it in a nutshell, it's to be a radio and not just a broadcasting exhibition. In the past the keen wireless man has had all too few opportunities of making early first-hand contact with new and important radio developments. He could read about them in *W.W.* and *Wireless Engineer*, but unless he had the *entrée* to the Physical Society's exhibition and to that of the R.C.M.F. and other semi-private shows, he could neither see them in concrete form nor put to experts qualified to give the answers the questions which arise naturally from such an inspection. When there was something really new and really important at Olympia he found far too often in years gone by that the stand on which it was displayed was populated entirely by high-pressure (or at any rate medium-pressure) salesmen who probably thought that Ohm was a character in *Twelfth Night* and had, anyhow, had it dinned into them that the state of their firm's current accounts was directly proportional to their pressure upon sales resistance!

Plenty to Show

This year we are promised exhibits, not only by firms concerned chiefly in making various kinds of electronic equipment, but also by Government departments with a vital interest in communications systems of many different classes. Several firms will also be showing transmitters and communication receivers. The Home Office has fathered during the last year or two outstanding developments in V.H.F. radio designed for police purposes; the B.B.C. has given a lead by producing quantitative data for A.M. and F.M. on 45 and 90 Mc/s; the television transmitters for Birmingham and (probably) Manchester now under construction by the Marconi Company are designed for a bandwidth of 7-8 Mc/s and will ensure on the screens of first-class receivers images unparalleled in the rest of the world for clarity; the Ministry of Civil Aviation can show navigational, blind flying and blind landing appliances unexcelled by those of any other country; at sea the Decca system was recently found by an international conference held in New York to be the best in existence. I won't prolong the list of our radio and radar achievements, though it could be vastly extended. You'll see that we have sufficient material for a whole host of thrilling exhibits. One only hopes that our traditional—and very real—reluctance to blow our own trumpet won't result in inhibition rather than in exhibition.

Let Them Know

It is certainly about time that we did a little trumpet-blowing, for at the present moment the rest of the world hardly realizes how much our physicists and engineers have achieved in radio, radar and other branches of applied electronics. The main reason is the paper shortage, which has made it impossible for full accounts of all developments to be published—and by published I mean not only printed, but made available to everyone. Take radar: the proceedings of the I.E.E. Radar Convention held last year would have filled every page of *W.W.* for over two years! The remarkable record of achievement which they embody has been put into print in ten special numbers of Part III of the *I.E.E. Journal*; but the number of copies of the journal is limited and the cost of the radar issues to non-members is £3. The I.E.E. has played its part nobly, producing a magnificent documentation of our country's part in the conception and development of radar; but the paper shortage means that that documentation, though printed, is not really published. Much the same thing will, I fear, be true of this year's Communications Convention. And so, unfortunately it goes on. The ordinary man living in other countries reads little or nothing of discoveries, inventions and developments in electricity made in Britain, and so, not unnaturally, concludes that we're not doing much.

Not Too Good

One of the most valuable things about exhibitions is that they bring foreigners here and let them see for themselves what we are doing. For that reason it is essential that everything possible should be done to enable them to come here without any bother; but that doesn't always happen. One eminent foreign radio components manufacturer whom I know ardently desired to visit the R.C.M.F. Exhibition and made all arrangements to do so; but the passport visa procedure proved to be so complicated and so slow that he did not receive the necessary

OUR COVER

RADAR EQUIPMENT installed on the bridge of R.M.S. *Queen Mary*, which recently made her first transatlantic run after refitting, forms the subject for this month's cover illustration. The console unit of the Metrovick "Seascan" radar is fed by a scanner mounted above the superstructure in a transparent weatherproof dome. In addition to the Metrovick equipment the vessel is, like her sister ship, *Queen Elizabeth*, fitted with Admiralty Type 268 radar.

authorization until the exhibition had closed its doors. That sort of thing is not good.

□ □ □

Those Problems

AS some readers seem to want the answers to the simple problems in last month's notes, here they are. First the two steel bars, one of which is magnetized and the other not. You can find out which is which by arranging them in T formation. When the magnet is used as the "crossbar" there is no attraction between them. Next the direction of movement of the C.R.T. spot when that of the line-scan deflector-coil's field is upwards. The key here is that the beam of electrons is equivalent to a current-carrying conductor, free to move in a magnetic field. You can thus solve the problem by Fleming's Left Hand Rule, if the fertility of your imagination is such that you can picture the beam of electrons as travelling from the screen to the cathode. As I can't quite manage that one, I prefer the Diallist Right Hand Rule, which gives the answer without involving a similar strain on the imagination. Then the forefinger (field) points upwards, the middle finger (current) towards you and the thumb (direction of movement) to the right. You'll see, of course, at once what the direction of the field of the frame-scan deflector coils must be in order to produce a downward movement of the spot.

□ □ □

A Different Problem

THE question "What is a broadcasting station?" raised editorially in last month's issue involves some queer problems in addition to those mentioned. For instance, suppose I tune in one of the B.B.C.'s beamed transmissions intended for, say, Ruritania or Yugotoblazia, am I thereby breaking the law? Such a station obviously doesn't broadcast; it narrowcasts. Nor are its transmissions intended for me. Yet it is run by the British Broadcasting Corporation and its transmissions form part of the foreign broadcasting service. And, though it is a narrowcast as regards the greater part of the world, it is a broadcast in the countries to which the beam is directed. Then, is it legal to listen to the American transmissions (again not strictly broadcasts) beamed on Europe? And can a medium-wave station which uses an aerial system designed to reduce the field strength of its transmissions in certain directions properly be styled a broadcasting station? It is all very perplexing!

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

RADIO BEACON

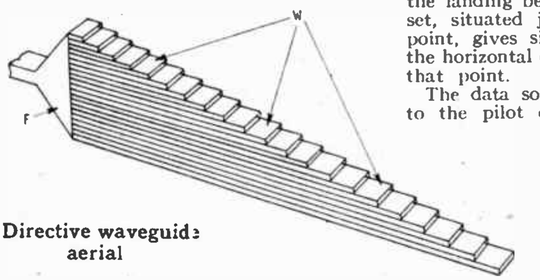
TWO dipoles, backed by a common reflector, are alternately energized to radiate a pair of beams which overlap symmetrically about a median line. The whole aerial system is slowly rotated, the carrier wave being modulated from a gramophone record, which announces each compass bearing as the median line passes through it.

The two aerials are switched, by electronic control, at a frequency of 1,500 c/s, and this forms a masking signal which only drops to zero along the median line. Accordingly, as the latter passes through any given listening point the bearing of that point is clearly heard.

W. A. S. Butement and L. H. Bedford. Application date January 28th, 1944. No. 581576.

BEAM AERIALS

A SHORT-WAVE aerial of high directivity consists of an array of parallel open-ended waveguides W, arranged in echelon. The relative lengths and the cross-sectional dimensions of each of the elements are arranged to ensure that outgoing waves are radiated in phase only in the end-on direction. Similarly, incoming



Directive waveguide aerial

signals can build up in phase only when they arrive from that direction. The assembly is connected to a common R.F. source through a flared coupling F, and provides a convenient scanning unit for use in radar.

Western Electric Co., Inc. Convention date (U.S.A.) June 11th, 1942. No. 579773.

SLOT AERIALS

ENERGY flowing through a waveguide is radiated from a slot formed in a metallic disc placed at or near one end of the guide, and at right angles to it. The disc is made of copper or silver, and the length and shape of the slot are such that the aperture is resonant to the transmitted wave. In effect, the field potential is concentrated across the open edges, whilst currents flow in the disc, so that the slot stimulates the behaviour of an ordinary dipole.

The slot may be formed as a straight narrow rectangle, or the two ends may be enlarged and rounded off to resemble a dumb-bell, the major axis being perpendicular to the direction of propagation and to the electric component of the wave, or a circular aperture may be used. For beam working, the aperture is arranged at the focal point of a parabolic reflector. Formulæ are given relating the dimensions of the slot to those of a rectangular guide transmitting a given wavelength.

The British Thomson-Houston Co., Ltd. (Communication from the General Electric Co. of America.) Application date November 2nd, 1943. No. 582328.

BLIND LANDING SYSTEMS

A NUMBER of short-wave transmitter and receiver units are strung out below the ground, where the transmitters radiate a field of uniform strength along the landing line. The transmitters are triggered from a distant control post so as to emit very short exploring pulses, a fraction of each pulse being returned to the control post directly over the feed-line. Echo signals from the approaching plane are also relayed over the same line from the local receivers, so that the time interval gives the control officer an indication of the point-to-point altitude of the craft as it glides down the landing beam. An auxiliary radar set, situated just beyond the landing point, gives similar information as to the horizontal distance of the craft from that point.

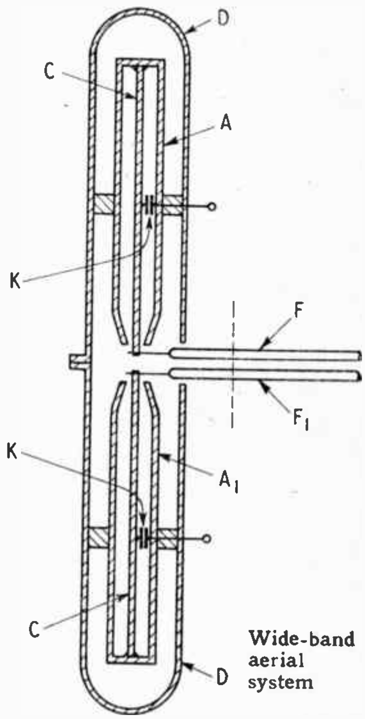
The data so obtained is transmitted to the pilot of the plane (after the time intervals have been multiplied in a double-beam C.R. tube) in the form of coded signals superposed on an approach beam of the switched cardioid type.

Marconi's Wireless Telegraph Co., and S. W. H. W. Falloon. Application date, October 5th, 1939. No. 583787.

AERIAL COUPLINGS

THE terminal reactance of a short-wave aerial is converted by the use of a short-circuited half-wave stub coupling into a pure resistance, which gives a substantially flat amplitude-frequency characteristic over a wide waveband, extending say from 100 to 150 Mc/s.

As shown, a pair of half-wave hollow dipoles A, A1 are each fitted with a coaxial conductor C to form a compensating stub. Current supplied through coaxial feeders F, F1 flow up the centre wire C and down the inner surface of the hollow dipoles to their outer surface, from which radiation takes place. Condensers K serve to tune the stub to half-wave resonance, so that its impedance is zero at the mean operating frequency, and the aerial load is purely resistive. The inner end of each dipole is tapered, and the two feeders F, F1 are fitted with quarter-



Wide-band aerial system

wave matching transformers (not shown). The dipoles are protected by a weatherproof insulating casing D.

Standard Telephones & Cables, Ltd. and E. O. Willoughby. Application date November 5th, 1943. No. 579778.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price of 1/- each.

VELOCITY MODULATION

IN a discharge tube of the kind in which the electron stream is directed by a magnetic field through the aperture of a tubular resonator for velocity modulation, the control flux from the usual external magnet is strengthened by mounting two auxiliary pole-pieces separately inside the evacuated tube. This shortens the normal width of the field gap. One of the internal poles is located behind the cathode and may be fixed to it; the other is placed at the far end of the resonator and serves as the collecting anode.

For a magnet of given size and weight, the arrangement is stated to provide better control and focusing of the electron stream, with a corresponding gain in operating efficiency.

Standard Telephones and Cables, Ltd.; J. H. Fremlin and R. N. Hall. Application date August 2nd, 1940. No. 579155.

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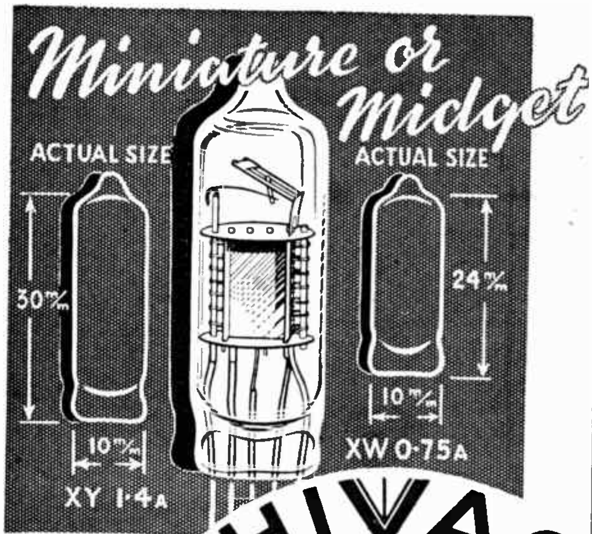

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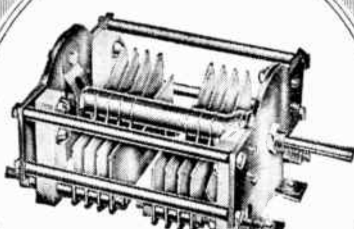

TYPE TRMSS — TRANSMITTING

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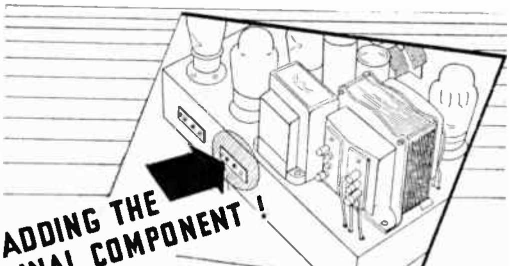

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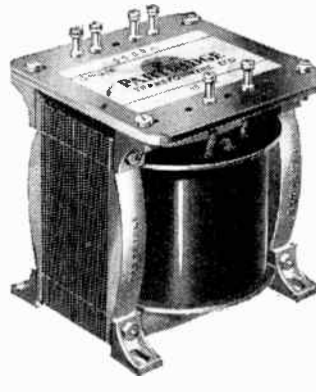

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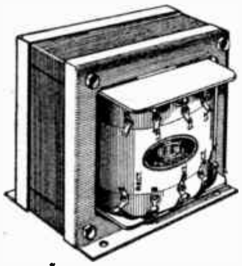

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LEXINGTON Senior pickup, transformer, can, needle, as new, £7/10.—1350, Stratford Rd., Birmingham, 28 [8058

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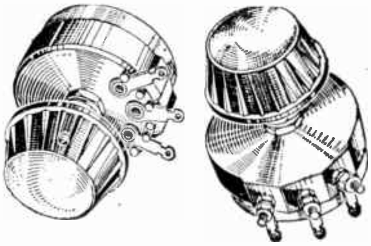

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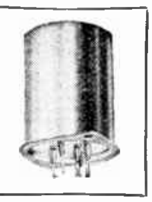

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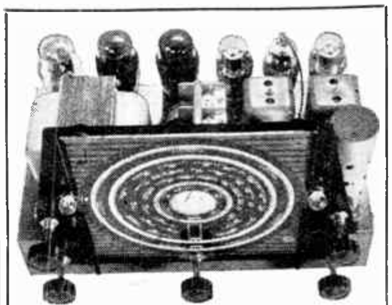

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10 VALVE ALL-WAVE SUPERHET RADIOGRAM CHASSIS for D.C.-A.C. mains

Last month we announced model RF 103, a very efficient 10 v. Receiver for use on A.C. Mains. Now we introduce Model UNI-103, a 10 valve Receiver for use on D.C. or A.C. mains, particularly, of course, for Listeners on D.C. mains. Whilst we appreciate this is a very small market we feel this new model will be appreciated by customers who are normally limited to the small universal types in their selection of a receiver.

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★ 10 VALVE CIRCUIT.
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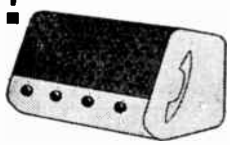

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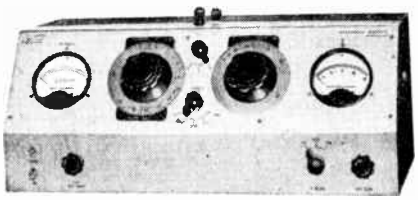

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