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Modern Set Design

Need for Variety of Types

PROSPECTIVE purchasers are constantly asking how much they should pay for a wireless set, a question which is by no means easy to answer unless the answer has first been found to a number of other points having a direct bearing on the same problem.

We suppose that the reply might be that the average mains set of to-day costs about twelve guineas, but there are better and worse sets at higher prices, just as there are at prices below this figure. For years manufacturers have been torn between two lines of approach to the problem of marketing sets ; should they cater for the cheapest possible market so as to bring their sets within the means of even the poorest homes in the country, or should new wireless receivers continue to be regarded as something of a luxury, leaving the cheaper market to be supplied with the second-hand sets which make way for the new ones in the homes of those more fortunately placed ?

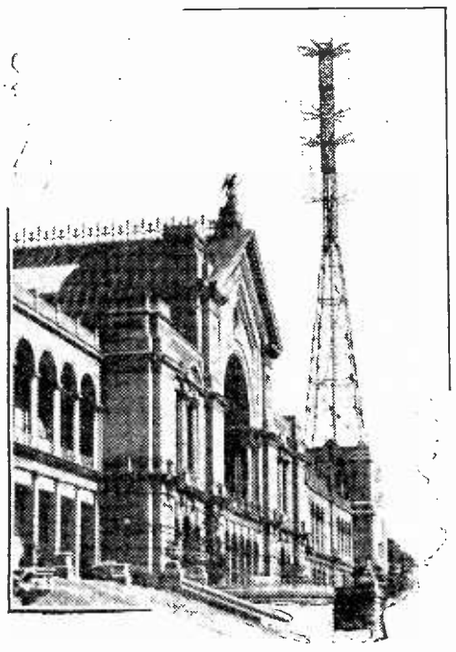
Price "Rings"

Hard things are often said on the subject of associations between manufacturers to control prices, and there have been unfortunate examples in some industries of abuse of positions created by such organised "rings." But a trade association which endeavours to prevent a reckless reduction of prices on a competitive basis more often than not is doing the public user a valuable service, especially where the articles manufactured are of such a nature as wireless sets, requiring that every precaution should be taken to avoid slipshod or over-hasty production. When, too, manufacturers are in cut-throat competition, each trying to produce the cheapest article, the margin of profit to the manufacturer is small and there is nothing left to spend on research and development work to improve the quality and efficiency of the product, and no prospect of anything beyond minimum wages for those employed in manufacture.

"Bottle-neck" Receivers

No one would wish that the public should have to pay more than is strictly necessary for a wireless set, and for this reason the substantial reductions in set prices which have taken place progressively during past years is everywhere welcomed, but it is necessary to look ahead and endeavour to guard against a position which might quite easily arise where the lowest price at which sets are sold would come to be regarded by the public as the highest price they should pay. Better sets with better quality of reproduction, better performance, and of greater durability and dependence, would cease to be the aim of designers and manufacturers, and might even disappear from the market.

There is room to-day for the cheap set as well as the expensive one, and a wide variety of types helps to keep the receiving side elastic. It is highly undesirable that at any time we should reach a position where the majority of the listening public regarded the cheapest set as the standard, and as good enough for the reception of broadcasting. If that time should ever come it will have shown private enterprise in broadcast receiver manufacture as incapable of acting as an auxiliary to the transmissions which, however good, would be brought to the level of performance of the receivers, which are, after all, the bottle-neck of reception quality.



Ultra-Short-Wave

Some Experiments on the Television Signals

THE range of ultra-short-wave signals, and especially the dependable range—in other words, the service area—is still a matter for controversy. This article, written after making a series of observations on television signals from the Alexandra Palace, will help to clear up many misconceptions on the subject.

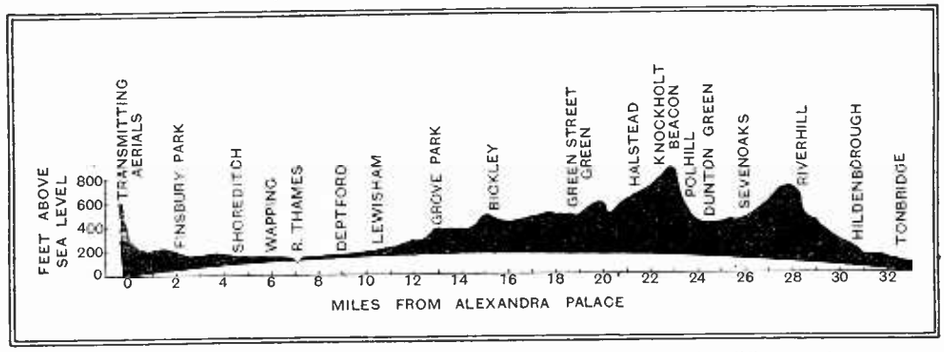
A WEEK or two ago I gave some results of observations made on the preliminary "tuning-up" of the Alexandra Palace television transmissions. The Radio Exhibition schedule made it possible to carry out much more extended tests which may shed some light on the question of the range at which the station may be expected to give a reliable service.

For this purpose it was necessary to have a receiver that was easily portable, did not take long to lash up, and that enabled the strength of the signal to be judged. The loudness of reception is generally a very uncertain guide, as the modulation is constantly changing (the sound programme was used for the tests, being less irritating to listen to for prolonged periods than the vision). The super-regenerative type of receiver might at first thought be considered to be particularly unsuitable because of its almost perfect AVC characteristics, whereby all except very weak signals are brought to a uniform level. But actually it is ideal for the purpose, because the background noise, which is initially very loud, decreases as the *carrier wave* strength increases and gives a useful indication of field strength over a wide range of intensity.

The dipole described in the previous article was a rather cumbersome piece of apparatus for moving about, and did not permit of observations being made while in motion. The tests to be described were made with a simple super-regenerative receiver having wire ends reaching to floor and non-metallic roof of the car. These were later replaced by a telescopic dipole made from tubular camera tripod legs.

The ground covered lay in the direction that presumably is least favourable for reception, having the whole of London lying between it and the Alexandra Palace transmitter. Even the National transmission from Brookmans Park, admittedly some miles farther away, but very much higher in power and wavelength, is known to be absorbed very seriously by this path and diminished to a barely satisfactory field strength within a mere twenty miles. Absorption in built-up areas is agreed to be still more pronounced as the wavelength is shortened. But whether this is serious when the whole of the transmitting aerial is raised well above the level of the city is open to question.

Starting at the south-eastern boundary of London, at Lewisham, the main road was followed as far as Tonbridge. To explain why this route was considered likely to be particularly interesting, a section of the ground between the Alexandra Palace and Tonbridge, 33 miles long, is shown. The vertical scale is, of course, exaggerated; actually about 25 times. But it will be seen to include two hills, or, rather, ridges, of even greater height than the transmitting tower itself. There is also appreciable curvature of the earth, which is shown. The section is along a straight line, but the road happens to follow it fairly closely all the way, and the high ground stretches for considerable distances at right angles to the section.



A section of the ground covered during the tests described. Note the difference between horizontal and vertical scales.

The field strength was very good at the start, the background noise being negligible; but just before actually joining the main road the car had to pass through a deep cutting at right angles to the direction of the transmitter and bordered by large trees. As was expected, reception fell off very badly here, but was still fairly good, except that at more or less uniform intervals there were curious bursts of background noise, corresponding to almost complete extinction of the signal. At first it was supposed that these might occur at the same intervals as the lamp standards, but this was soon found to be wrong. The phenomenon was to be noticed quite often later on.

Local Absorption

Passing through busy streets the reception fluctuated a good deal, and local absorptions were noted, but the severest effects of these were generally confined within limits of a foot or two. Some interference from the ignition systems of passing cars could occasionally be heard, and of course the continuous noise of the car in which the receiver was installed (not fitted with suppressors), but this was not bad enough to render speech hard to follow or to mask the background noise generated by the receiver itself.

An open level stretch of road conformed to expectations in giving excellent reception, but even here a periodical extinction or fluctuation was sometimes observed. Mental calculation based on the speed of the car showed that whenever this effect was observed it was usually at intervals of the order of half a wavelength. This is rather surprising, as the "interference"

Service Area

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

(in the optical sense) between sets of waves converging from directions not widely separate, such as the direct ray and that reflected from the ground, would lead to minima at intervals of a good many wavelengths.

This effect was examined later with improved apparatus, and the intervals between minima estimated to be slightly less than half a wavelength. The idea that standing waves on overhead wires might have some connection with it was disproved when similar results were obtained along roads devoid of overhead wires or metal fencing. Though there seems no doubt that standing-wave "patterns" due to reflections from various objects were responsible, it was not possible to identify these objects in any given situation. The same phenomenon can be demonstrated in acoustics by moving the ear into different positions when listening to a high-pitched note.

A somewhat similar effect takes place when the receiver is stationary and turned so as to obtain a minimum of reception. A vehicle moving past upsets the balance-out of the signal and gives rise to a succession of maxima and minima. It was found possible to detect even a bicycle at 40 feet and an aeroplane at several thousand feet. The moving object reflects a certain amount of the signal (an aeroplane is in a strong field and contains many wires and other parts, some of which may quite possibly resonate) and, when the direct signal is balanced out by the angle at which the receiving aerial is placed, the receiver is at its maximum sensitivity for picking up such stray reflections. As the object moves, the phase of the reflected signal changes periodically, causing fluctuations in reception.

Easily Explained Fluctuations

The screening effect of woods or thick borders of trees close to the road was noticeable; and also that due to buildings or high walls, but perhaps less so than was expected. The contour of the road likewise had its effects; in fact, most, but not all, of the fluctuations in signal strength could be related to the visible surroundings according to known principles.

The descent of the first steep slope carrying the road well below the direct line of the transmitter was awaited with interest. The upper part of the ascent gave excellent signal strength, but rather unexpectedly it fell off very noticeably before the descent of Polhill actually commenced. The fact that trees became fairly numerous at this point seemed hardly to be enough to account for it, but it is possible that the effect was supplemented by a less favourable angle between the radiation and the receiver, and by the cancellation of the direct ray by a reflected ray. Since making this observation it has been found to be in agreement with those of other experimenters.

As the hill was descended the signal declined steadily, and about half-way down, surrounded by trees, was so weak as to enable only occasional words of speech to be distinguished even with the engine stopped. But it must be remembered that the aerial and receiving conditions generally were far from ideal, and even in this exceptionally unfavourable location, 24 miles from the transmitter, a more ambitious receiving system with a raised aerial might achieve fair results. Incidentally, the vision signal on 6.7 metres seemed rather stronger, in so far as such different types of transmission could be compared at all.

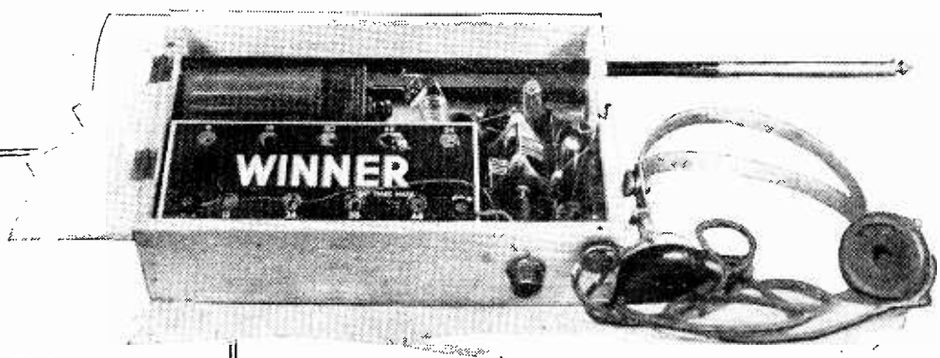
Further descent of the hill, but at an easier gradient, restored a large part of the lost signal strength; and at Dunton Green, 500 feet below the horizon of the transmitting aerial, reception was as good as in the more urban localities at half the range.

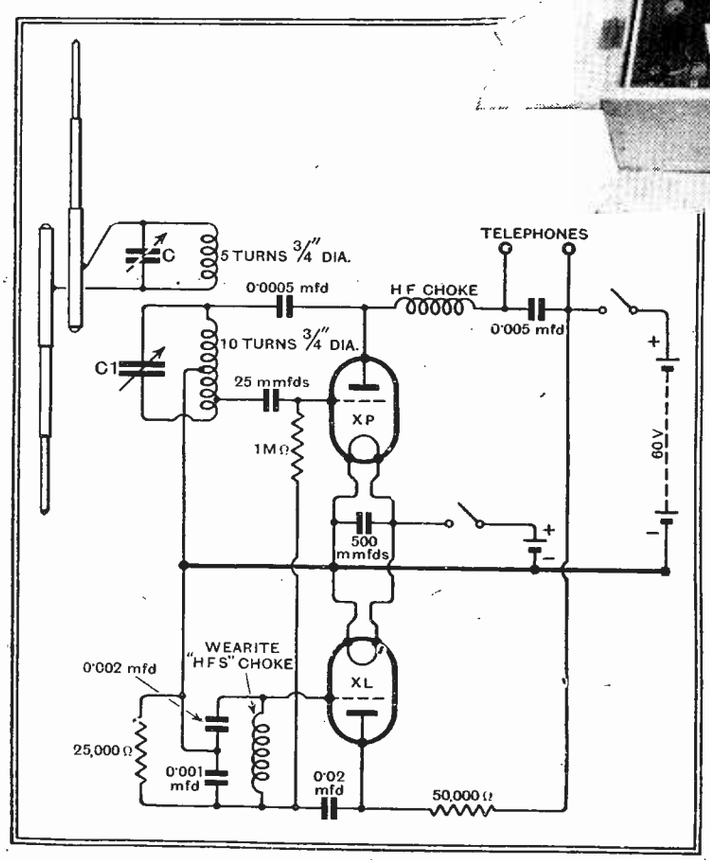
The next big hill, beyond Sevenoaks, again showed a rapid declension of signal very little beyond the crest. Although five miles farther on, and steeper in gradient, the loss of strength was less than at Polhill, and again there was a marked recovery on the lower slopes.

On the very low ground of the Medway Valley, around Tonbridge, reception was undoubtedly a lot weaker than on the rising country before Polhill, but hardly more so than would have been expected in view of the increased distance, let alone the intervention of two ranges of the North Downs.

Some other roads were surveyed without adding materially to the findings already described, except to dispel a faint suspicion that the overhead wires along the main road might have been helping reception.

A justifiable conclusion seems to be that 33 miles need not by any means be regarded as the maximum reliable range, even when the receiver is below the transmitter horizon. In the experiments described there was good reception in places where the radiation would have to turn





Circuit diagram of the super-regenerative portable receiver shown in the accompanying photograph. The aerial circuit condensers C and C1 are of about 100 m-mfds. Quenching is carried out by a separate valve.

Ultra-Short-Wave Service Area—

through an angle of as much as 4 degrees to clear the high ground.

Incidentally, the configuration of the ground in the opposite direction is curiously similar; Aylesbury taking the place of Tonbridge, and the Chilterns corresponding to the North Downs. Elsewhere, except perhaps towards the south-west, the topographical conditions for long range are more favourable. With the development of improved methods of reception, such as directional aerial arrays, considerable ranges are likely to be established. Such aerials are valuable not only for the increased signal reception, but also for reduction in interference when they are properly designed and located. One may also expect a diminution of interference at the source as suppressors become normal practice. It seems likely that the most troublesome factor at the fringe of ultra-short waverange will be fading due to variation in the standing wave patterns set up by objects that divert the radiation, for these are not necessarily stationary.

Since the results already described were obtained, an investigation was made along the Great North Road for a distance of 36 miles from the Alexandra Palace, using the improved telescopic dipole. A photograph and circuit diagram of this receiver are shown. Although the conditions of use while in motion did not permit of more than half of the full 6-foot extension being brought into action, quite strong reception was obtained up to the maximum distance, some miles north of Biggleswade, where the signal was actually received with the aerial completely telescoped and lying horizontally in the bottom of the car—the worst possible conditions. There was appreciable screening just beyond the hill (440 feet) near Stevenage, but otherwise little of interest. In general, the strength of reception over the greater part of the distance was such as to render even the car ignition inaudible.

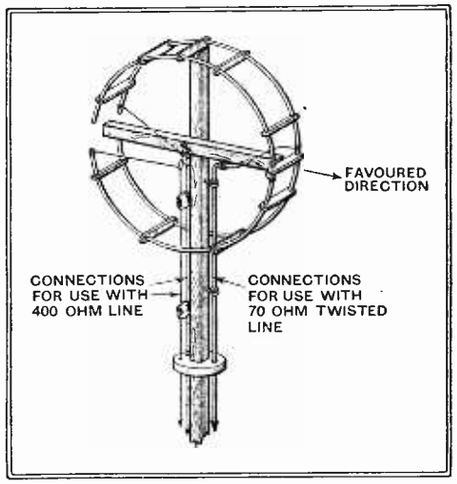
The relationship between strength of reception and orientation of dipole was subject to local variations, but most usually there was a maximum with the aerial vertical, and there was always a very large increase when the apparatus was raised even as little as a foot from the normal position with one end resting on the floor of the car.

Going to still greater distances, the sound programme was heard quite strongly and clearly, though with a fair background of super-regenerative noise, indoors about 100 feet above sea-level at Eastbourne. This is sixty-two miles from the transmitter, and no fewer than 3,000 feet below the horizon. Not only is there considerable earth curvature intervening, but a direct line passes right over Tatsfield, selected by the B.B.C. for a receiving station by virtue of its altitude. Similar results were obtained farther along the South coast at Rye, while out-of-doors, on the top of Beachy Head, the signal was really strong—good enough to suppress all background noise even when unmodulated.

Aerial Efficiency

Designing the Antenna for the Wavelengths to be Used

ONLY a few years ago a really good aerial was almost indispensable for the satisfactory reception of any broadcast station other than the local. Today, owing to the great improvement in receiver design even the poorest of aerials suffice almost anywhere. Actually, there is very little the listener can do to improve the efficiency of an aerial for ordinary broadcast use unless it be in cases where local electrical interference is troublesome. Then it is not the actual efficiency that is considered, but ways and means of improving the signal-to-noise ratio even though this may entail some reduction in the efficiency of the aerial as a collector of signals.



Reinartz Rotary Beam; a compact ultra-short wave directional aerial.

An aerial operates at maximum efficiency only when its length bears a certain relationship to the wavelength on which it is used, but the amount of wire permitted for broadcast use falls far short of the minimum necessary to achieve this object.

On the other hand, very efficient aerials of the resonant type can be employed on the short and ultra-short waves, as one for the 7 Mc/s amateur band, for instance, requires a wire only about 66 feet long. An aerial of this type is also quite efficient at all the harmonics of the wavelength for which it is designed.

The subject of aerial design is of such importance in amateur experimental work that the engineering staff of the American journal *Radio* has produced an 80-page book dealing exclusively with aerials. The *Radio Antenna Handbook*, as it is called, is published by Radio, Ltd., 7460, Beverly Boulevard, Los Angeles, California, U.S.A., and costs 50 cents in the U.S.A. and Canada, 2s. 6d. in the United Kingdom, and 3s. in Australasia.

It deals with the design of all the various types of aerials suitable for amateur use on the short and ultra-short waves, including directional arrays, and also with the design and construction of all-wave aerials of the kind sometimes referred to as the anti-interference type.

An example of a novel type for the ultra-short waves, and which is described in the handbook as the Reinartz Rotary Beam, is illustrated here. It is claimed to give a worth-while gain in signal strength both for transmission and reception in the favoured direction, for the aerial is uni-directional in a plane parallel to the loops and in a direction opposite to the open ends. As it takes up comparatively little space and is far more easy to handle than a dipole for the same wavelength, it should prove very useful for television reception, especially in situations where the maximum efficiency is required.

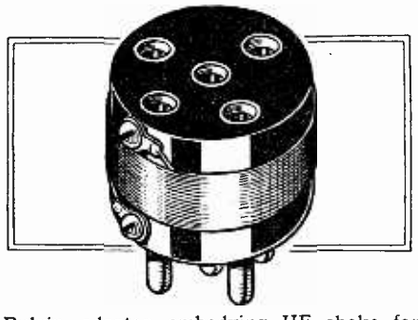
One for 58.5 Mc/s in the amateur band measures only 32ins. in diameter, while for 41.5 Mc/s, the sound accompaniment of television, the size of the loops would be about 45ins.

The book is profusely illustrated and will be found a valuable addition to the amateur's bookshelf. H. B. D.

Suppressing Television Interference

BROADCAST listeners in proximity to Alexandra Palace who may have experienced some interference from the television transmitters will be interested to learn that A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex, have produced a special HF choke for suppressing the interference.

In order to be effective it should be joined direct to the grid of the detector valve, and this is arranged by winding the HF choke on a split-grid adaptor, so that, by removing the valve, inserting the adaptor, and then plugging the valve into the adaptor, the choke is included in the circuit without having to disturb a single wire.



Bulgin adaptor embodying HF choke for suppressing interference from television transmitters.

This choke is available at present wound on either a four- or a five-pin adaptor, and is intended chiefly for use in mains or battery sets of the straight type.

We understand that some small HF chokes suitable for inserting in the grid lead of valves with top-plug connectors and for use in superheterodynes will shortly be available.

"Parallel Wires as RF Transformers"

A CORRECTION

IN the above article an error occurred on p. 347, col. 2. Beginning at the 5th line, the sentence should read "mainly upon R_0 and the frequency it is desired to transmit. Naturally, as R_0 becomes *greater . . .*"

Inherent Receiver Noise

1—THE ULTIMATE LIMITS OF SENSITIVITY

By A. L. M. SOWERBY, M.Sc.

THE promise of anti-interference legislation suggests that, with a quieter background, an increase in the average sensitivity of receivers might be worth while. The assumption is reasonable, but inherent noises generated in the receiver put an ultimate limit to the amount of magnification that can be usefully employed; the nature of these noises and their evaluation is explained in this article.

CONTINUAL efforts are being made in all countries to reduce the interference with wireless reception set up by electrical machinery. What with silencing devices on the machinery itself, and "noise-proof" aerials equipped with high-frequency transformers and screened down-leads, there is, perhaps, some hope that, in time, the interference from this type of source will vanish completely. When it does, what then? Shall we be able, by sufficiently enhancing the selectivity of our sets, to pick up even the faintest and most distant stations on a background of perfect silence? Will it be possible to economise by reducing the power of transmitters and making a corresponding increase in the sensitivity of receiving apparatus?

Up to a point this would be possible, perhaps, but there is a definite natural limit to the useful sensitivity of a set. Such fundamental and inescapable things as the ultimate structure of matter and electricity begin to take a hand in the game if a set is made sufficiently sensitive.

In our schooldays most of us were introduced to a topic bearing the imposing title of "The Kinetic Theory of Gases." The term "theory" is perhaps misleading to many people, in that the word is so often used to imply an airy and possibly baseless speculation. In the present connection there is no ghost of such a flavour about it; the theory in question is the only possible interpretation of a huge host of observed facts, for which it accounts not merely in a rough general way but down to the last decimal point of painstaking measurement work.

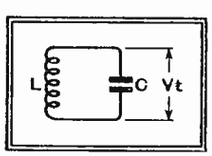


Fig. 1.—Tuned circuit resonating to 500 kc/s. Owing to thermal agitation of the atoms in the wire of the coil the circuit will spontaneously generate high-frequency voltages of a few microvolts across C.

The conclusions summed up in this theory are to the effect that a gas consists of a number of entirely independent particles (atoms or molecules) in extremely rapid movement, and that the apparently steady pressure exerted by a gas on the walls of the vessel in which it is confined is in reality the sum-total of the ceaseless rain of tiny blows given by the countless host of flying particles. By observing the manner in which the pressure of a gas changes with temperature, and interpreting the changes in the light of this theory, it becomes quite evident that the heat-energy put into a gas in warming it eventually goes to increase the kinetic energy of the movement of the particles; that is, it increases their velocity of flight.

It is equally true, though less easily demonstrated, that the atoms or molecules of a solid are also in continual movement. Since a solid retains its shape indefinitely it is clear that the average position of each atom must be fixed; we conclude, therefore, that the movement of the atoms takes place round this fixed position. Once again the movement of the atoms is the ultimate form in which heat energy is stored, so that the movement could only be completely stilled by abstracting all heat from the material—that is, by reducing its temperature to the "absolute zero," which is 273 Centigrade degrees below the freezing point of water. At all temperatures above this there is movement, the movement being faster the higher the temperature.

All this does not seem at first sight to have much connection with wireless. But we know that in a conductor there are free electrons, for it is their movement from atom to atom under the drive of a potential difference that constitutes the electric current. We therefore have to imagine some of these perpetually moving atoms as carrying, even if only momentarily, an extra electron, while others, the suppliers of the extra electrons, are temporarily short of their normal complement. This means that some atoms are negatively, some positively, charged, and the atoms in movement consequently have to be regarded as electric charges in movement.

Over any reasonably prolonged period—a second, for example—the random to-and-fro movements of so huge a host of charges will almost exactly balance, leaving an excess of movements in one direction or the other which is so small as to be negligible in comparison with the enormous total of the number of movements. But it is not difficult to see that on many occasions within that second there will have been instants when the net number of electrons moving one way appreciably exceeded those moving in the contrary direction. If, during the whole of one particular millionth of a second, the number of electrons going upwards in the wire of the coil in Fig. 1 exceeded the number going downwards, the circuit as a whole, if tuned to 500,000 cycles per second, would receive an impulse that would send it momentarily into oscillation. Ignoring resistance, it is clear that this oscillation would persist until chance brought about an exactly equal excess of electrons so accurately timed to match the period of oscillation that the current round the tuned circuit was opposed and wiped out by it. In a practical case, where the circuit would contain resistance, the oscillation would die away slowly unless either killed prematurely in the way suggested or reinforced by a second momentary current.

This mode of looking at the effects of the random movements of electrical charges in a conductor makes clear that they can set up, and so may be said to contain, oscillations at a frequency of 500 kc/s. But there is no special magic in that particular figure; just the same considerations would hold if we had thought of our tuned circuit as resonating to any other frequency.

We can only conclude, then, that the atomic movement due to stored heat-energy in a conductor is equivalent to simultaneous currents of all possible frequencies.

Thermal Agitation

In the circuit of Fig. 1, then, the thermal movements in the wire of which the coil is wound will produce currents of all frequencies. But the impedance of the circuit is high only towards currents of frequencies round about that to which it is tuned, and low to currents of other frequencies; the voltage developed across the circuit will therefore be limited to a band centred on 500 kc/s. If the tuned circuit is part of a receiver this means that the received carrier will be accompanied by thermal voltages at and round the same frequency. Those close to, but not exactly at, the resonant frequency will be heterodyned at the detector by the carrier in just the same way as are the normal sidebands sent out by the transmitter; since all neighbouring frequencies are present, none more than

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another, they will appear in the loud speaker as noise and not as a musical note.

When two voltages at different frequencies are simultaneously applied to a detector the frequency of the output is equal to the difference of the frequencies of the applied voltages, while the magnitude of the output is proportional to the product of their amplitudes. Thermal noise-voltages alone, in the absence of any other received signal, will give a certain output by mutual heterodyning, but on tuning in a carrier of amplitude several times greater than the noise-voltages these will be rectified as sidebands of the carrier and the noise-level will rise. It is this effect that is at least partly responsible for the considerable increase of noise always observed when a carrier is tuned in.

In transmitting a musical programme it is found that the modulation depth required to give the correct aural impression of loudness drops with a rise in frequency of the note being sent out. Noise-voltages, however, are the same (so far as the tuned circuits permit) at all audible frequencies. This accounts for the fact that when aurally estimated noise appears to consist mostly of higher frequencies—taking the words to imply pitch only, and not loudness—we should describe noise as having the characteristics of a "hiss" rather than a "roar."

It is possible to calculate, on purely theoretical grounds, the thermal noise-voltage developed across any circuit. Since the atomic agitation that gives rise to these spontaneous voltages is due to the heat-energy that the atoms contain, the noise will be greater the higher the temperature, and can be made to cease only by cooling the circuit to the absolute zero. A second factor, besides temperature, is the frequency range over which the thermal voltages are to be measured; as we have seen, there are voltages at all frequencies, and the wider the frequency range our receiver includes the greater will be the noise. The third factor is the resistance across which the noise is developed; we must remember that thermal agitation merely produces currents, and that it is only when they

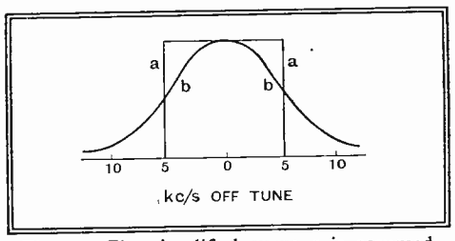


Fig. 2.—The simplified curve *a* is assumed for purposes of approximate evaluation of noise instead of the truer resonance curve *b*.

flow through a resistance that they produce voltages.

At a temperature of T degrees absolute the total noise-voltage within the frequency band $f1$ to $f2$ that is developed across a resistance R is given by the formula:

$V^2 = 5.5 \times 10^{-23} T(f1 - f2)R$ (V in volts).

For the particular temperature 290° absolute (=63° F.), which represents very fairly well that at which wireless sets are generally used, the formula becomes:

$$V = 1.25 \times 10^{-10} \sqrt{R \times F} \text{ volts,}$$

where F stands for the width, in cycles, of the frequency band $f1$ to $f2$.

In the case of a receiver not of superheterodyne type, and built for the ordinary broadcast band, the interference due to thermal noise-voltages can be estimated quite readily, provided we do not try to do it too accurately. We will suppose that the overall resonance curve of the receiver has the perfectly square-topped form shown at *a* in Fig. 2, making the rather absurd assumption that the tuned circuits pass all frequencies within 5 kc/s on either side of the carrier at undiminished strength, and then cut off suddenly. In a real case, of course, frequencies less than 5 kc/s from the carrier are to some extent attenuated, while frequencies still further out are not entirely eliminated, as indicated by the curve at *b* in Fig. 2. Allowing for all this would be so complicated that the rough-and-ready simplification of replacing curve *b* by curve *a* for purposes of calculation is a very acceptable one.

Noise Level : a Typical Case

If the grid circuit of the first valve of the receiver contains a tuned circuit of dynamic resistance about 80,000 ohms and, as suggested, the set passes signals over a total range of 10 kc/s, the noise-voltage at room temperature works out thus:

$$V = 1.25 \times 10^{-10} \sqrt{R \times F} = 1.25 \times 10^{-10} \sqrt{88{,}000 \times 10{,}000}$$

$$= 1.25 \times 10^{-10} \sqrt{8 \times 10^8} = 1.25 \times 2.8 \times 10^{-6} \text{ volts}$$

$= 3\frac{1}{2}$ microvolts.

As we have seen, this noise-voltage has to be compared not with the carrier but with the sidebands of a received signal. At 10 per cent. modification a signal of carrier amplitude 35 microvolts at the grid of the first valve would give a rectified output in the speaker at the same volume level as the thermal noise. Allowing for a step-up of 10 times in the tuned circuit between aerial and first grid brings us back to $3\frac{1}{2}$ microvolts as the faintest signal that will not be more or less drowned out by thermal noise, while we might hazard, as a pure guess, that a carrier strength of not much less than 50 microvolts at the aerial terminal will be required to provide a programme in which even the quietest parts will rise sufficiently above the noise level to be enjoyable rather than merely intelligible. But this last, evidently, is a matter of opinion rather than of calculation.

If the thermal noise includes voltages up to 10 kc/s away from the carrier, it is clear that after detection they will be represented as speech-frequency currents up to 10,000 cycles per second. Whether the whole of these will eventually reach the listener's ear depends partly on the characteristics of the low-frequency amplifier and partly on the characteristics of the loud speaker and the room in which it is used. This rather complicates the problem. To obtain accurate information as to the interference actually reaching the speaker we have to consider first the mixture of noise, carrier, and sideband voltages at the detector and

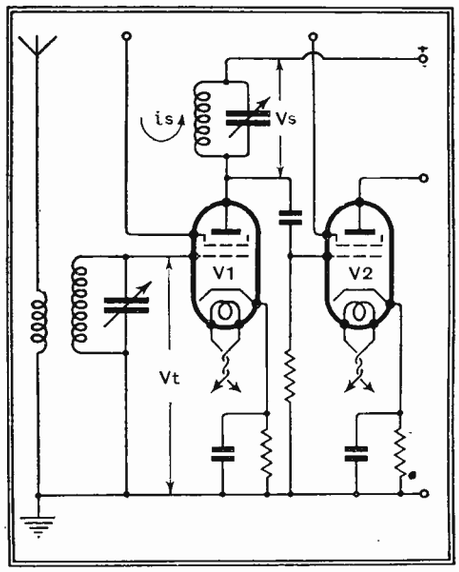


Fig. 3.—Skeleton circuit showing sources of noise. *Vt* = thermal voltage, *is* = shot-noise current, *Vs* = shot-noise voltage. Note that *Vt* appears, amplified, across the tuned anode circuit where *Vs* originates.

find out, by calculation or measurement, what radio-frequency voltages will result after detection. Of these audio-frequency voltages some will reach the speaker at full amplified strength, some will be much less amplified, and some will be lost entirely. The point of this two-stage working out will be seen when it is realised that two thermal voltages, at 10 and 14 kc/s from the received carrier, can jointly contribute at least a little noise at 4 kc/s after passing the detector; it is therefore not quite safe to disregard these voltages on the grounds that the AF amplifier cuts off at 5,000 cycles.

Inherent Valve Noise

In a wireless receiver there is a second source of irregularity, in nature closely akin to the thermal agitation of which we have been speaking. The current through a valve consists of free electrons arriving individually at the anode, and though the current appears steady when observed over any prolonged period, this is only so because we are unable to perceive directly the separate electrons which make it up. An apparently steady 3 milliamps. of plate current is subject to trifling random variations round this mean value; it is therefore correct to regard it as a direct current on which is superposed a second "noise current" in character exactly like the thermal noise. On account of the fact that this new noise owes its origin to the bombardment of the anode of the valve by the electrons, which pepper it like small shot, the name "shot noise" is used to describe it.

As before, the currents are distributed over all possible frequencies; the magnitude of the shot current therefore depends

Inherent Receiver Noise—

again on the frequency range we have to take into consideration. Further, since the disturbance consists in variations in the number of electrons arriving from instant to instant at the anode, a larger current leads to larger variations. If the average anode current is I amperes, the total of all noise currents lying between the two frequency limits $f1$ and $f2$ is given by:

$i^2 = 3.18 \times 10^{-19}(f1 - f2)I$ (i in amperes)

or, putting F for the frequency range as before,

$$i = 5.54 \times 10^{-10}\sqrt{F \times I} \text{ amperes.}$$

How does this compare in magnitude with the thermal noise? If we make the same assumption of a set passing undiminished all frequencies up to 5 kc/s on either side of the received carrier and then cutting off sharply, and take 3 mA as a likely current for the first valve, we get as shot noise current:

$$i = 5.64 \times 10^{-10}\sqrt{10 \times 3 \times 10} = 5.64 \times 10^{-10}\sqrt{30}$$

$= 3.1 \times 10^{-9}$ amperes, or 3.1×10^{-3} microamps.

This noise current flows through the anode coupling impedance of Fig. 3, and develops it across a voltage depending on the magnitude of that impedance. If we take this as a tuned circuit of dynamic resistance 80,000 ohms (the figure assumed for the grid circuit in which thermal noise was developed) the noise voltage passed to the grid of the second valve will be $3.1 \times 80 = 248$ microvolts.

In practice the voltage found is considerably less than the calculated value, for the calculation is based on the assumption that all the electrons emitted by the cathode reach the anode. It is known that the large space charge round the cathode, consisting of electrons held back by the customary negative voltage on the grid, exerts a very considerable "cushioning" effect, and reduces the current fluctuations producing the noise even below the value proper to the reduced anode current. In such a case as that for which we have worked out the voltage the figure found in a set would not be much over a third of that calculated from the formula. For comparison with the thermal noise we might take the shot noise at 100 μV. at the grid of the second valve; at this figure we shall at least not be underestimating it.

Even this reduced value appears enormous compared with the thermal noise-voltage of $3\frac{1}{2}$ μV. But it must be remembered that this appears a stage earlier in the set than the shot noise, and so is subject to amplification before it reaches the grid of the second valve. If the first valve has a mutual conductance of 2mA/v., and is followed, as assumed, by a tuned circuit of dynamic resistance 80,000 ohms, the stage gain will be approximately $80 \times 2 = 160$ times. The thermal noise at the grid will therefore be amplified up to give $3\frac{1}{2} \times 160 = 560$ μV. at the grid of the second valve. It is this figure that must be compared with the shot noise 100 μV. developed in the anode circuit of the first valve.

These relative figures show that in a set designed for the ordinary broadcast wavelengths, and beginning with a stage of radio-frequency amplification, the limit to usable sensitivity is set by the thermal noise arising in the first grid circuit. By comparison, the shot noise is negligibly small, adding only some $1\frac{1}{2}$ per cent.* to the total noise-voltages in the particular case we have considered

(A concluding instalment will deal with some other aspects of receiver noises.)

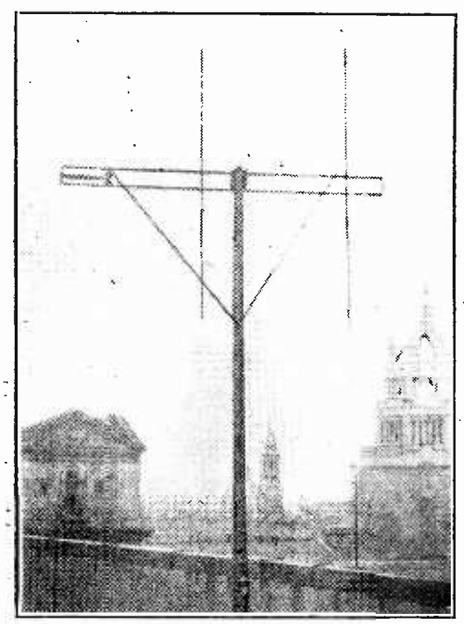
* Noise-voltages, being random in character, have to be added according to rule: $V^2 = V_1^2 + V_2^2$, where V is the total voltage.

DISTANT RECEPTION NOTES

SO far, the general increase in the field strength of the more distant medium-wave stations that has been noticeable during the evenings of early autumn has shown no signs of producing the crop of heterodynes that seemed possible with the coming of the season of shorter days and longer nights. The good work of the I.B.U. is very much in evidence.

On the night before this note was written I went carefully over the medium-wave band between nine and ten o'clock with a modern superhet., keeping a record of the stations that were received well enough and sufficiently free from interference of any kind to have real entertainment value. Had I been asked to guess the number beforehand I should have put it at 30-35. To my surprise it turned out to be 51! And no fewer than twenty of these were on wavelengths below 300 metres.

At first sight, then, the indications appear to suggest that a wonderful season, for European stations at any rate, is before us.



PUBLIC TELEVISION DEMONSTRATIONS.—Special aerial erected at the Science Museum, South Kensington, for reception of the Alexandra Palace transmissions. Demonstrations are being given daily from 11 a.m. to noon and from 3 p.m. to 4 p.m; on Friday and Saturday of last week, they were attended by over 2,000 persons.

Probably it is, but we are not yet so far out of the wood as to justify shouting. Quite a number of stations are due to bring new and far more powerful transmitting plants into action during the next few months. These are almost bound to cause a certain amount of trouble at first, and it may be a little while before the I.B.U. is able to straighten matters out. On the whole, though, I am bold enough to forecast the best autumn and winter for European listening that we have had yet. With a reasonably good set in a reasonably good locality the choice after dark should run to at least forty stations.

About transatlantic listening I am not so sanguine. The main enemy here is the atmospheric. Disturbances have been very bad of late, and, as we approach the sunspot maximum, they are bound to become worse.

With the possible exception of the Russian RED I have always thought that the Japanese JOAK was one of the most appropriately named radio stations. JOAK has become twins, so to speak, during the last few years. No. 1 works on 508 metres, and No. 2 on 345. And something further has happened just lately. Both No. 1 and No. 2 have blossomed out as 150-kilowatt stations. There is every chance that one or other of them may be logged in this country. JOAK, when a singleton of small power, was actually heard here on one memorable evening by many listeners a good many years ago.

These are not the only Japanese stations to be raised to the high-power level. The whole broadcasting system of that progressive country is being overhauled, and several others will be using brand-new plants rated at from 50 to 100 kilowatts before long.

But for the industrial troubles from which France has been suffering, the new Radio-Normandie would have been at work some weeks ago. At it is, delays have been inevitable, and as I write the old plant at Fécamp is still in action. At any time now, though, you may find the new Louvetot transmitter making its *début*.

Speaking of French stations, a correspondent in India tells me that he has lately had excellent reception at Simla of the 0.7-kilowatt *Ile de France*. He could hardly believe his ears until he verified the call sign beyond all possibility of doubt.

Trustworthy Electrical Connectors

A PARTICULARLY well-prepared catalogue has just been issued by Belling and Lee under the title of "Radio and Electrical Accessories." As might be expected, it deals largely with terminals, plugs, sockets and other non-spectacular but none the less vital parts used in the construction of modern wireless apparatus.

The book, which contains clear dimensional drawings as well as perspective illustrations of all the accessories listed, is a valuable source of information on parts for special requirements. Among the more recent and less well-known devices described are screened plugs and sockets, Air Force wander plugs (with a locking device), low-loss bushings, and a valve hood combined with a screened connector. Lastly, there is a summary of suppressor devices which are more fully dealt with in other Belling and Lee publications.

Most of the trade literature reviewed in our pages is issued free, but the present publication is so different from the usual run of small-part catalogues that few will object to the charge of sixpence which is made for it. Copies are obtainable from Belling and Lee, Ltd., Cambridge Arterial Road, Enfield, Middx.

Mixing Circuits

COMBINING THE OUTPUTS OF PICK-UPS AND MICROPHONES

ONE difficulty which always arises in PA equipment is the mixing of the outputs of various pick-ups and microphones. The circuits generally employed are discussed in this article, and it is shown that the only entirely satisfactory method involves the use of an input valve for each channel.

By W. T. COCKING

IN public-address equipment above all there often arises the problem of combining the outputs of several pick-ups and microphones so that they are mixed to any desired degree. It is commonly required, for instance, to reduce the volume on gramophone temporarily so that announcements can be made while retaining a gentle background of music. At first sight there appears to be little difficulty in arranging a circuit which will permit this to be done, but it is actually by no means an easy problem.

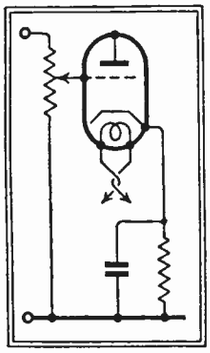


Fig. 1.—The usual volume control circuit for one input channel.

The usual input circuit for a single channel is shown in Fig. 1, and is quite satisfactory under most conditions. Suppose we have two channels, however, we cannot combine them as in Fig. 2, for if we use the arrangement of (*a*) setting one volume control to zero short-circuits the other, while the alternative of (*b*), although it avoids this difficulty, is unsatisfactory because the input impedance changes greatly. This change in impedance has a very bad effect upon the frequency response characteristic. There are, however, two modifications which do permit a much better performance to be obtained. The first of these, Fig. 3 (*a*), is a development of the circuit of Fig. 2 (*a*), and it will be seen that the resistances R2 are introduced in order to prevent the short-circuiting effect of one volume control on the other. It will only do this effectively if R2 is much larger in value than R1; if it is not, an alteration in the setting of one control will have an effect on the volume obtained through the other channel, and it will also have some effect upon the frequency response.

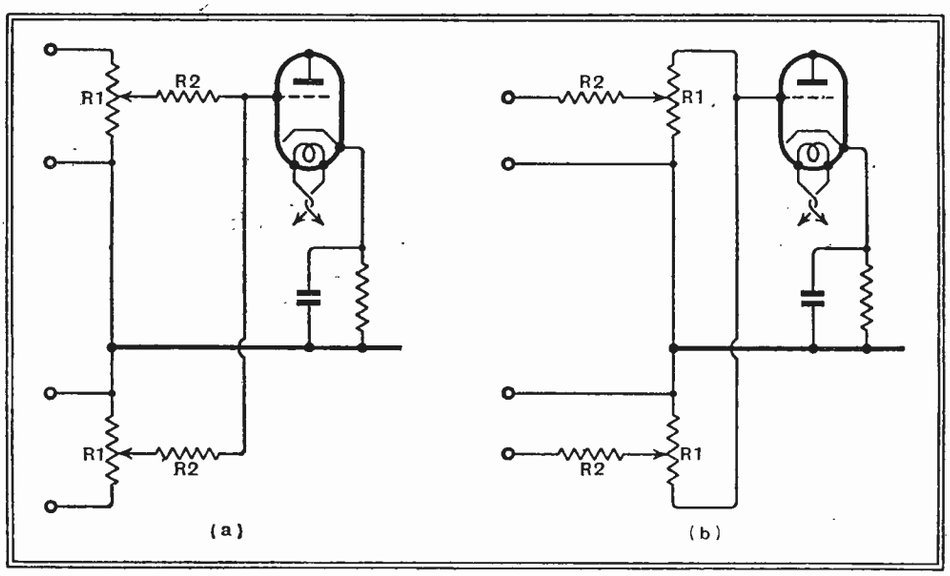


Fig. 2. — (Left) As explained in the text the circuit (*a*) will not work, while (*b*) seriously affects the quality.

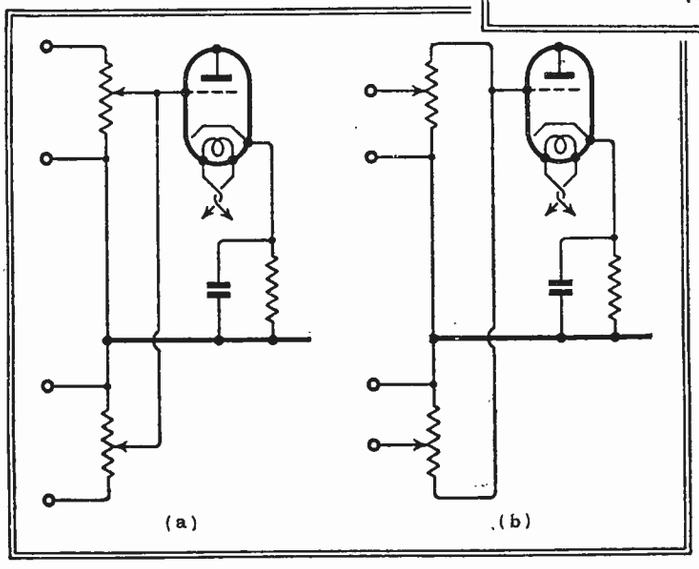


Fig. 3. — (Above) The circuits of Fig. 2 are greatly improved by the addition of the resistances R2. The circuit (*a*) is widely used.

Now, in practice, there are difficulties in making R2 much higher than R1, for the volume control can rarely be of lower resistance than 0.25 megohm, and may have to be higher in order to suit the pick-up. If R2 is of high value, however, the upper audible frequencies will be attenuated because of the input capacity of the valve, which may be as much as 0.0001 mfd. under operating conditions. Even if R2 is no higher than 0.25 megohm, there will be appreciable attenuation.

It is possible similarly to modify the circuit of Fig. 2 (*b*) by introducing resistances R2, as in Fig. 3 (*b*). For satisfactory results R2 must be appreciably larger than R1, and even then the effect on quality is not entirely removed. Furthermore, there is a considerable loss in voltage, and hence increase in the signal to noise ratio.

It can thus be seen that none of these circuits even approaches the ideal, but there is no doubt that the one of Fig. 3 (*a*) is the best, and quite good results can be secured, particularly when the volume controls R1 can be of only moderate value. One method sometimes adopted is to connect the controls in series as in Fig. 4, but this is rarely of much practical use, because the stray capacities are usually quite large, and the operation of one control has a big effect on the quality through the other channel. Serious difficulty is also likely to be found from hum pick-up.

It is not difficult to see that the defects of these methods of mixing are all really due to the input and output impedances of the volume controls not being constant. In Figs. 2 (*a*) and 3 (*a*) the input impedance of each control is the same at all settings, but the output impedance varies

Mixing Circuits—

over a wide range. In Figs. 2 (*b*) and 3 (*b*) the position is reversed, the input impedance being variable and the output impedance constant. To obtain an entirely satisfactory arrangement, therefore, it is necessary to abandon the conventional potentiometer type of volume control and to employ a control having both input and output impedance constant at all settings.

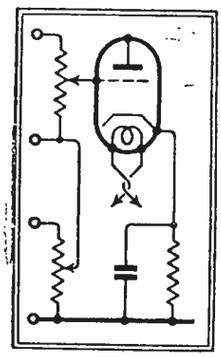


Fig. 4.—A simple mixing circuit which is rarely satisfactory, since the quality is affected and hum pick-up is often serious.

One control of this type is known as the T-attenuator, and it is shown in Fig. 5. It will be seen that three variable resistances, R1, R2, and R3, are used instead of a potentiometer. R1 and R2 are usually equal in value at all settings of the control, and it can be shown that the input resistance is equal to $R1\sqrt{1+2\,R3/R1}$ when it is terminated in a resistance of this value, and that the output resistance is the same when the input is closed through this value of resistance. With two T-attenuators correctly terminated at their input ends the outputs can be paralleled, for each attenuator has the correct output resistance for terminating the other. As the control knob is rotated for increased volume, the values of R1 and R2 decrease while that of R3 increases. With correct design a wide range of control can be secured while maintaining constant impedance relationships.

Attenuators of this nature are widely used in communication engineering, but less commonly in wireless and public address work. One reason for this is that they are quite expensive. The components generally used embody tapped wire-wound resistances, and the control is actually a switch changing the volume in steps of 1 or 2 db. With such a construction it is almost impossible to obtain high-impedance units, and the usual T-attenuator is built for an impedance of 600 ohms, and is consequently unsuitable for use with a pick-up or microphone without matching transformers. It would, of course, be quite possible to build an attenuator by using a three-gang high-value variable resistance of the ordinary compound type, but the units would have to be specially tapered.

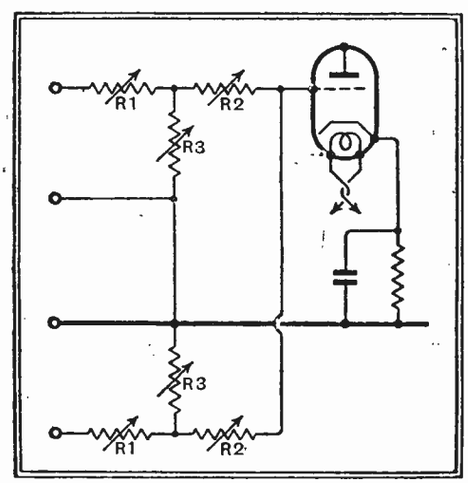


Fig. 5.—The ideal mixing circuit is too expensive for general use, since it involves ganged variable resistances which must be correctly graded. In general, it is only suitable for low-impedance circuits.

In view of this practical drawback of the T-attenuator, it is not very widely used in public-address equipment. This does not mean, however, that we are forced back to one of the circuits already described and which we have already seen to suffer from one defect or another. There is an alternative, and it is one which is becoming more and more widely used in high-class apparatus, particularly in America. This alternative is to retain the simple potentiometer type of volume control, which, as we all know, is very satisfactory on a single input channel, but to provide a separate stage for each channel. Thus in Fig. 6 two channels are shown, and the first stage of amplification is consequently duplicated. It can be seen that the two input circuits are entirely separated, and the volume controls are therefore completely independent, the operation of either having no effect on the volume or quality through the other.

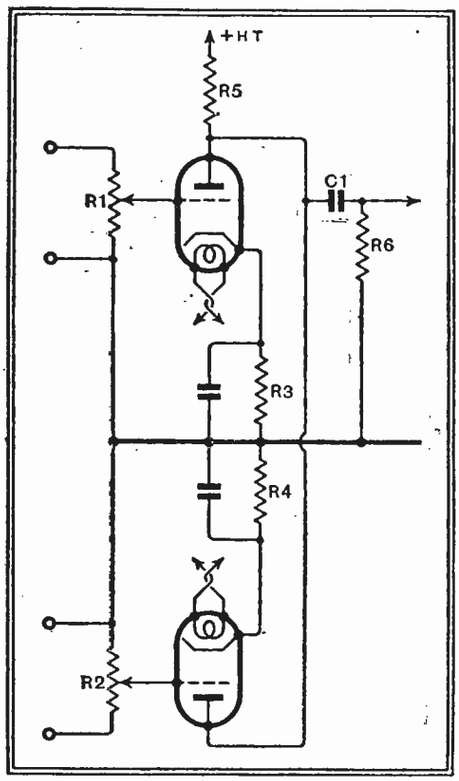


Fig. 6.—A simple and effective mixing circuit employing a separate valve for each channel.

The only point upon which difficulty might arise in design lies in the choice of operating conditions for the valves. If only a single input stage were used the load on the first valve would be R5 in parallel with R6. In general, however, R6 is much larger than R5, so that there is little error in ignoring it and saying that the load is due to the resistance of R5. Using two input valves, however, the load on one valve is R5 in parallel with the AC resistance of the other, and, as both valves will presumably be of the same type, this means that the load on each valve must be less than its own AC resistance. There is consequently a greater risk of harmonic distortion occurring than with the usual arrangement, with which the load on a valve is several times the AC resistance of the valve. It is, therefore, practicable to use this system only when very small signal voltages are involved.

Optimum Operating Conditions

The amplification given by a stage of this type is calculable from the usual formula $A=\mu R/(R+Ra)$, where R is the load resistance, Ra is the AC resistance of the valve, and μ is its amplification factor. With any number of valves of the same type used with common anode connections, as in Fig. 6, $A=\mu R5/(Ra+nR5)$, where n is the number of valves. With the two valves shown in this illustration, $A=\mu R5/(Ra+2\,R5)$.

Now, in general, it will be difficult, on account of the drop of voltage in R5, to make R5 greater than twice Ra. Let us, therefore, decide to adopt this relationship, and let $R5=2Ra$; then $A=2\mu/(1+2n)$. With two channels, as shown in Fig. 6, the amplification is then 0.4μ as compared with 0.66μ for the conventional input system embodying one valve only. This is by no means a great loss, and is

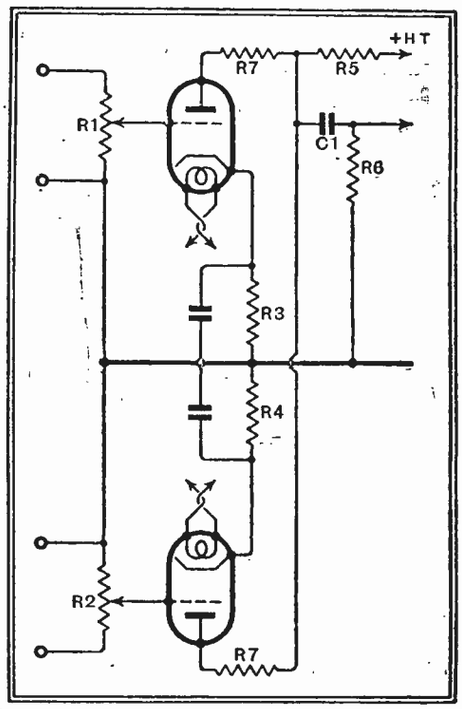


Fig. 7.—The circuit of Fig. 6 is improved by the insertion of the resistances R7, since each valve can then have its correct load impedance.

Mixing Circuits—

in practice not very important. Actually, there is only one objection to this method of mixing, which is that, as the load on the valves is rather small (load = $Ra/(n-0.5) = Ra/1.5$ for two channels), there is an increased risk of amplitude distortion.

This risk may not be serious when only small amplitudes are involved, but there is no doubt that it is present. Fortunately, it is by no means difficult to overcome it, and the arrangement of Fig. 6 can be used if a resistance is inserted in series with each anode lead. This is shown, again for two channels, in Fig. 7, where the resistances are shown at R7. In order to reduce the design to a reasonably simple matter it is necessary to fix some of the relationships arbitrarily; it will accordingly be assumed that R5 equals $2Ra$, and that the load on each valve is to be maintained at twice its AC resistance, a good value for the avoidance of amplitude distortion. The values of the resistances R7 then depend only on the number of channels, and may readily be calculated from the formula $R7 = Ra[1-2n+\sqrt{4n^2+12n-15}]/2$. This gives for one channel $R7 = 0$, which means that it disappears and the circuit becomes the conventional one; when there are two channels, as in Fig. 7, $R7 = Ra$, three channels $R7 = 1.275\,Ra$, and four channels $R7 = 1.42\,Ra$.

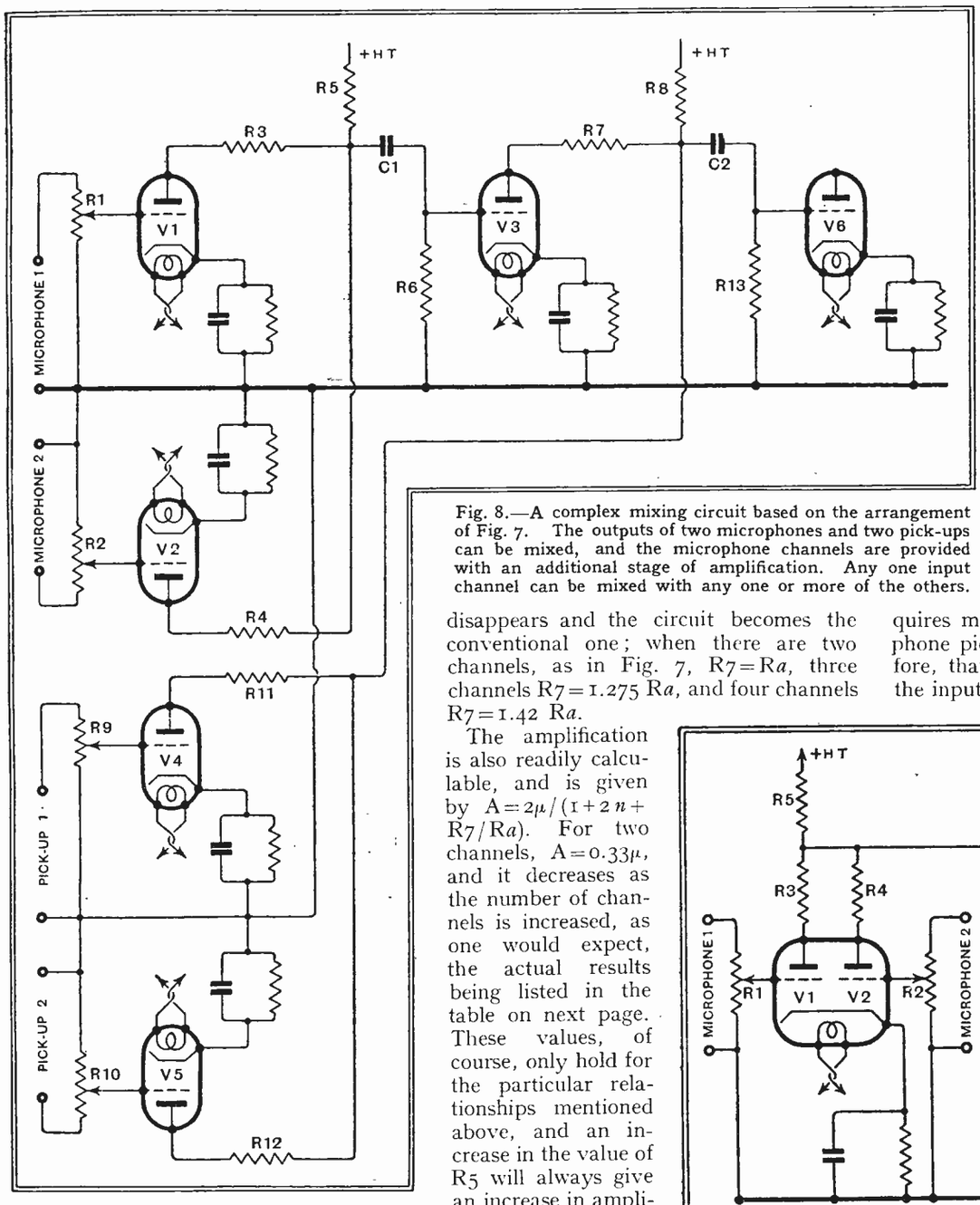


Fig. 8.—A complex mixing circuit based on the arrangement of Fig. 7. The outputs of two microphones and two pick-ups can be mixed, and the microphone channels are provided with an additional stage of amplification. Any one input channel can be mixed with any one or more of the others.

The amplification is also readily calculable, and is given by $A = 2\mu/(1+2n+R7/Ra)$. For two channels, $A = 0.33\mu$, and it decreases as the number of channels is increased, as one would expect, the actual results being listed in the table on next page. These values, of course, only hold for the particular relationships mentioned above, and an increase in the value of R5 will always give an increase in amplification. The gain is, however, very small, and is certainly not worth the increased supply voltage necessary to maintain the anode voltage of the valves.

Now let us compare the results with the simpler circuit of Fig. 6. With two channels the amplification is 0.33μ as compared with 0.4μ, so that the loss is only 1.6 db. With three channels the figures are 0.242μ and 0.286μ, again a loss of only 1.44 db, while with four channels they become 0.192μ and 0.222μ, which means a loss of 1.24 db. The greater the number of channels used the smaller is the difference between the gain given by the two arrangements, but the lower the load on the valves in Fig. 6, and hence the greater the risk of distortion with this arrangement. It follows that the modified circuit of Fig. 7 is most beneficial when many channels are used, but even with only two channels the small decrease in amplification is a worth-while price to pay for the more linear dynamic valve characteristics which are obtained.

Even now we have found a satisfactory method of mixing, our problems are not at an end, for in practice it often happens that the different channels require different degrees of amplification. A microphone, for instance, requires more amplification than a gramophone pick-up. It often happens, therefore, that it is not desired to connect all the input channels to the beginning of the

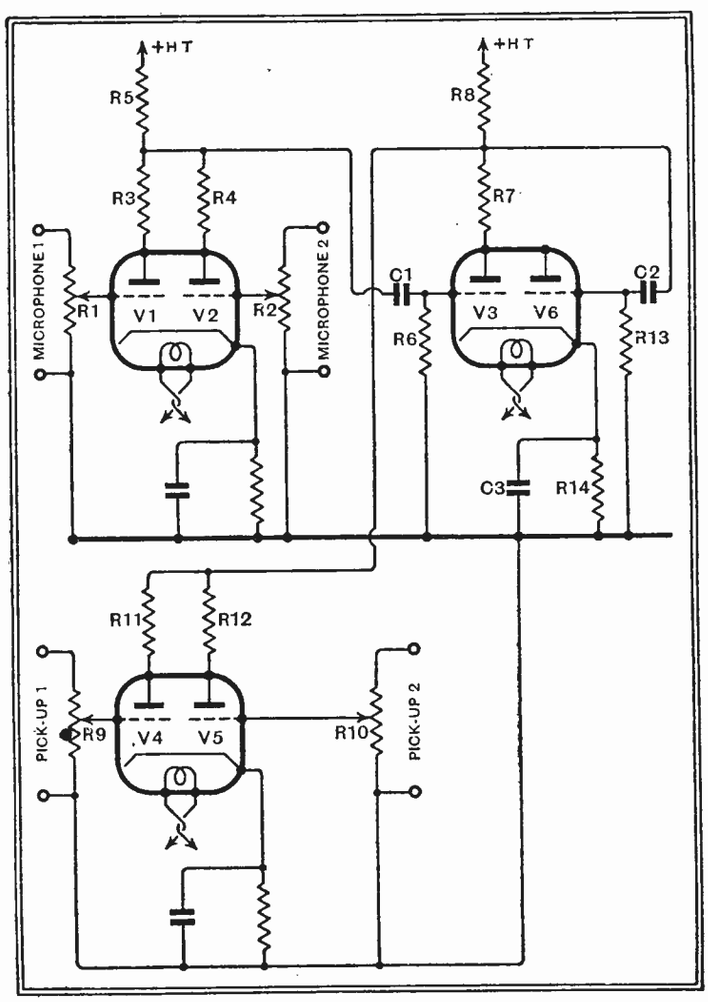


Fig. 9.—A simplified circuit equivalent to that of Fig. 8, but using double-triode valves.

Mixing Circuits—

main amplifier, but to connect some of them only at this point and the others at later stages.

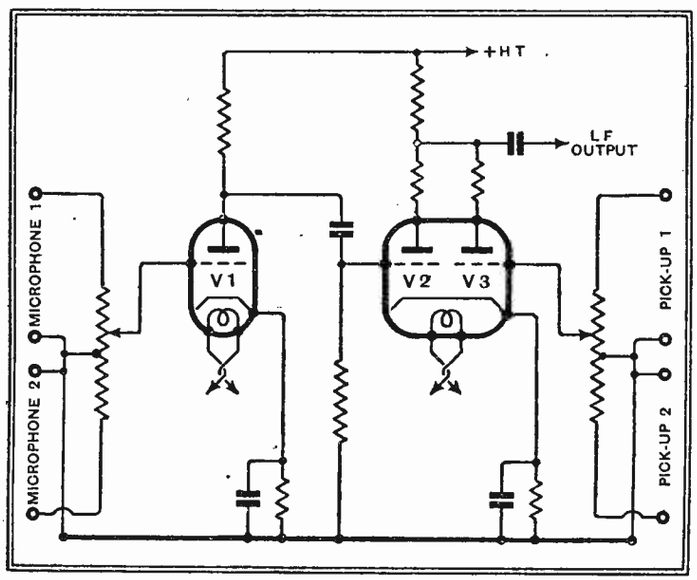


Fig. 10.—A less ambitious arrangement which permits either of the two microphone channels to be mixed with either of the two pick-up channels.

Let us suppose that we are building rather a large mixing unit and amplifier with two microphone and two pick-up channels, and that the microphones require one stage more of amplification than the pick-ups. The first step is to design a two-channel mixer for the microphones using the arrangement of Fig. 7. This is represented in Fig. 8 by that portion of the circuit preceding V3. Valves V1 and V2 must be of the same type, and the volume controls R1 and R2 are chosen to suit the microphones or their transformers. Following the rules already laid down, it will be seen that $R5 = 2Ra$, and $R3 = R4 = Ra$, where Ra is the AC resistance of V1 and V2; C1 and R6 are, of course, chosen according to the usual rules for resistance coupling. The valves V1 and V2 will each give a gain of $0.33\mu_1$ (where μ_1 is their amplification factor).

TABLE
Values of R7 and Amplification

No. of Channels.	R7 =	A =
1	0	0.66μ
2	Ra	0.33μ
3	$1.275\ Ra$	0.242μ
4	$1.42\ Ra$	0.192μ

Now, in the next stage there are the two pick-up channels to be mixed and combined with the output of the microphone mixing stage. A three-stage mixer is consequently needed, and is formed by V3, V4, and V5, which must all three be of the same type, but need not be the same as V1 and V2. The inputs to V4 and V5 are controlled by the individual volume controls R9 and R10, which are chosen to suit the pick-ups. The coupling components in the anode circuits are chosen according to the rules laid down, so that, as there are three channels, $R8 = 2Ra$, and $R7 = R11 = R12 = 1.275\ Ra$, where Ra is the AC resistance of V3, V4, and V5. Each of these valves gives a gain on its own channel of $0.242\mu_2$, where μ_2 is the amplification factor of V3, V4, or V5. Again, C2 and R13 are chosen according to the usual laws of resistance amplifiers, and R13 will often be another volume control potentiometer controlling all channels simultaneously and serving as a master gain control.

It is easy to see that the amplification preceding V6 is $0.242\mu_2$ for the pick-ups, and $0.33\ \mu_1 \times 0242\ \mu_2 = 0.08\ \mu_1\ \mu_2$ for the microphones. One might quite well use similar valves throughout, and the amplification factor might be 40. On gramophone the gain would then be 9.68 times, and on microphone 128 times. As such valves usually have $Ra = 15{,}000$ ohms, typical values for the components would be, $R3 = R4 = 15{,}000$ ohms. $R5 = 30{,}000$ ohms, $R7 = R11 = R12 = 19{,}100$ ohms, $R8 = 30{,}000$ ohms.

Simplifying the Circuit

The method is actually much simpler and less costly than it at first appears, for the arrangement of Fig. 8 can be simplified to quite a large degree without impairing its usefulness. It is not essential to employ individual bias resistances and by-pass condensers for the valves in any mixing stage, and if all the valves are alike a single resistance having a value $1/n$ times that required for one valve with a by-pass condenser of n times that needed for one valve can be used. The second simplification is mechanical, and consists of the use of double-triodes instead of separate valves. In this country the only double-triodes are Class "B" battery valves, and the type requiring negative grid bias can be used if the use of accumulators for the LT supply is not considered objectionable; such valves should be given about one-half the normal grid bias. Indirectly heated double-triodes are available in America, however, and types such as the 79, 53, and 6A6 can be used.

With three such double valves it is possible to use the circuit of Fig. 8 by arranging it as in Fig. 9. Somewhat lower amplification is to be expected from the valves available, but in other respects the results should be entirely satisfactory. It is, however, particularly important that C3 be large enough to by-pass the bias resistance R14 properly, since these components are common to two successive stages of amplification.

In perhaps the majority of cases a less ambitious arrangement will suffice, for one does not often wish to be able to mix as many as four channels. If the requirements are made less stringent, the apparatus can be correspondingly simpler. It is not often necessary, for instance, to mix the outputs from different microphones or from different pick-ups, but only to mix the microphone and pick-up outputs. It would then be possible to use an ordinary fader to control two microphones with another fader to control two pick-ups, and a single two-channel mixing stage will suffice. This arrangement is shown in Fig. 10, and only two valves are needed if one of them is a double-triode. In Fig. 10 the first triode provides amplification for microphone only, while the double-triode gives amplification on both gramophone and microphone, and is the mixer stage.

With the arrangement of controls shown the output of either microphone can be

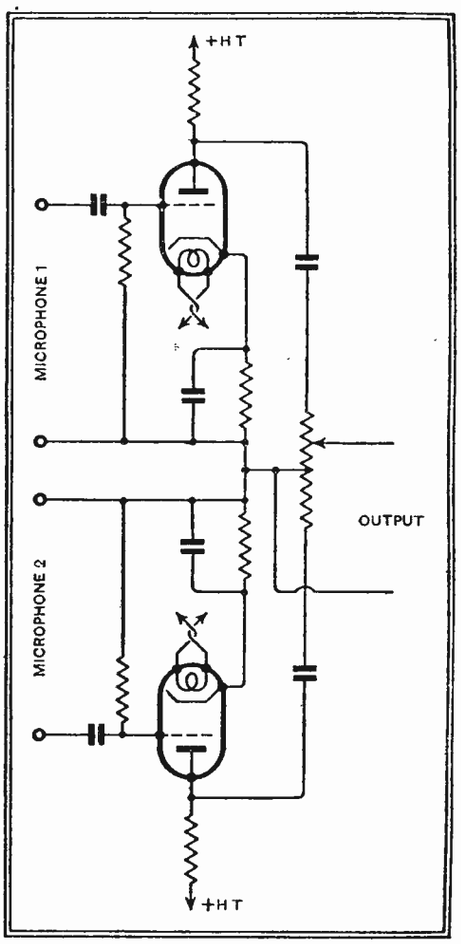


Fig. 11.—With some microphones, it is necessary to provide each with its own pre-amplifier. The circuit can then take this form, a fade-over from one to the other being obtained after initial amplification.

mixed with the output of either pick-up, and by means of the faders either microphone can be faded into the other and

Mixing Circuits—

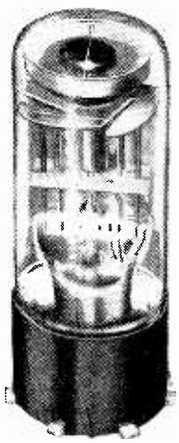
either pick-up into the other. This will probably meet most requirements, but if it is necessary to mix any one of the four channels with any other, or several simultaneously, then the more complex arrangement of Figs. 8 and 9 must be used.

So far, no word has been said about the use of piezo-electric or condenser microphones. For good results these types must be terminated in a very high resistance, and quite high amplification is required. It is consequently not usually permissible to connect a volume control across them. Each microphone must be provided with its own input valve, therefore, and the outputs of these valves mixed. A suitable fading system for two piezo-electric microphones is shown in Fig. 11, and the output can be coupled to the input of V1 or V2 of Fig. 10 according to the degree of amplification necessary. It will be noticed that the fader, which acts as a volume control, is connected after the first valves. This is not objectionable with piezo-electric microphones, since their output is small, and there is little or no risk of the valves being overloaded. It is, indeed, advantageous for the signal to noise ratio is improved. The amplification required with modern high-quality microphones is so high that valve hiss has become an important factor, and it is necessary to take every precaution to obtain the optimum ratio of signal to noise. In some cases special valves are needed.

Cathode-Ray Tuning Indicator

Miniature CR Tube with Triode Amplifier

VARIOUS types of tuning indicator have been produced from time to time, but the meter and the neon indicators have so far held the field. A new indicator has now arrived to challenge their supremacy: this is the Mullard TV4, and it operates upon the cathode-ray principle. It comprises a miniature cathode-ray tube with a triode amplifier built into a single glass envelope; in external appearance it is rather like a valve of unusually small dimensions, and the lower part carries the triode elements. The upper part contains the cathode-ray tube, however, and the indications are seen through the top of the bulb, which must consequently be mounted in a visible position.



The circuit connections recommended by the makers are shown in Fig. 1, and it will be seen that the input to the triode amplifier is derived from the load resistance R1 of the diode detector through a resistance-capacity network comprising R2, R3, R4 and C1. The purpose of R2 and R3 is chiefly to keep the loading on the detector at a minimum while permitting R4 C1 to give good filtering, so that the indicator is not influenced by the modulation on a signal. Maximum indication is secured with only 4 volts input to the triode. The triode-anode is joined to the target of the cathode-ray tube through a 2-megohm resistance R5, and the latter electrode is connected directly to the HT supply which must be not more than 250 volts.

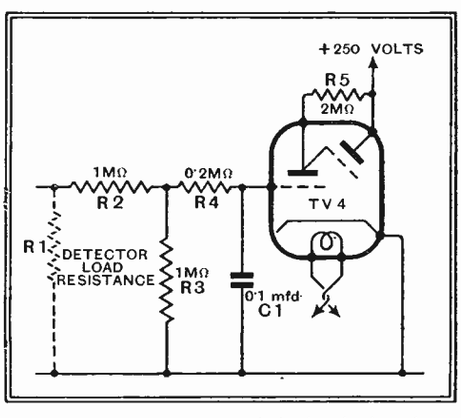


Fig. 1. The recommended circuit for the new tuning indicator. R1 is the load resistance of the diode detector.

The valve is indirectly heated and consumes 0.3 ampere at 4 volts, and the heater takes 20 seconds to warm up. Under normal operating conditions with no signal, the triode anode current is 120 μA. and the target current 0.29 mA. With a signal giving an input of -4 volts to the triode, and hence full indication, the currents fall to 30 μA. and 0.27 mA. respectively.

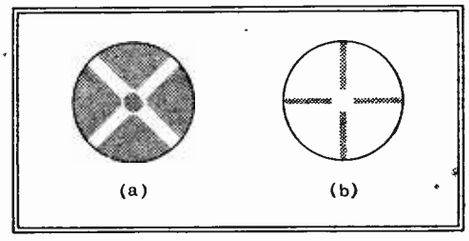


Fig. 2. When no signal is tuned in the indicator shows a green cross on a dark ground (a) but when a signal appears the illumination spreads and the effect is that of a dark cross on a green ground (b).

Certain limits are set by the makers, and it is recommended that the resistance in the grid circuit of the triode should not exceed 2.5 megohms, and that the voltage between heater and cathode should not be greater than 50 volts. Furthermore, the target voltage must never be more than 250 volts, and the tube should be operated under such conditions that full indication is always obtained on a signal.

When the receiver is tuned to no-signal a narrow cross of green light appears at the end of the tube, as shown at (a) in Fig 2. This broadens on tuning in a signal and at first assumes rather the shape of a Maltese cross; eventually, when full indication is secured, almost the whole of the tube is light save for a narrow cross of dark as shown at (b). Actually, there are four segments of light, and the width of the segments increases with signal strength until the limit of indication is reached and practically the whole area is illumined.

The tube must be correctly mounted if even illumination is to be secured, but this is readily arranged by rotating the base correctly. The indicator is fitted with a side-contact base, the connections for which are given in Fig. 3.

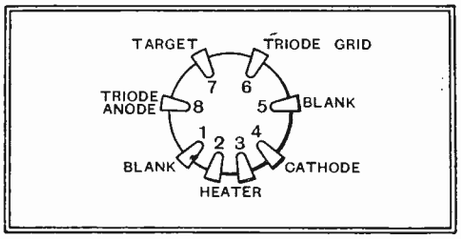


Fig. 3. The base connections of the TV4 indicator.

On test the indicator functioned in a very satisfactory manner and gave a clear-cut image. It proved to be rapid in action and to be unaffected by the modulation of a signal. The appearance is good, and is certainly assists in making the tuning of a receiver easier for the unskilled. The component is priced at 17s. 6d.

NEW BULGIN PUBLICATIONS

A USEFUL 64-page book, the "Bulgin Service Manual," has just been issued by the well-known component manufacturers. The book, which costs 1s., has been written to appeal to the amateur as well as to the professional service man, and so practical descriptions, illustrated by a large number of clearly drawn explanatory sketches, are given of all the details that go to make up the modern receiver.

In the make-up of the book the plan is to give these explanatory notes and sketches on left-hand pages, the facing pages being devoted to a more detailed and theoretical examination of the matter under discussion. A few of the subjects dealt with are: Ganging in Modern Sets, Automatic Volume Control, Aerial Efficiency, and Faults in Receivers. The book can be thoroughly recommended to anyone who wishes to improve his knowledge of radio practice.

Another new Bulgin publication is a second edition of "Radio Progress," which contains constructional details of ten modern receivers and pieces of apparatus, including an all-wave superhet., a "switch-over" local-station set, and a modulated oscillator for AC or DC. This book also costs 1s.; copies are obtainable from A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex.

EXTRA SERVICE

A PAMPHLET recently received from Alfred Imhof, Ltd., of 112-116, New Oxford Street, London, W.C.1, describes a free service scheme that has obvious attractions to buyers of receivers. The scheme is quite apart from, and additional to, the manufacturer's guarantee; it is on a definite and clear-cut basis, and contains no nebulous promises that are bound to be unsatisfactory to both buyer and seller.

Briefly, the buyer of a receiver is given three Service Vouchers, valid for either three or six months, each of which entitles him to a free service visit up to 15s. maximum. The conditions under which the vouchers may be used seem eminently fair and equitable; replacement of parts or valves is not included in the free service, but these may, of course, be covered by the maker's guarantee.

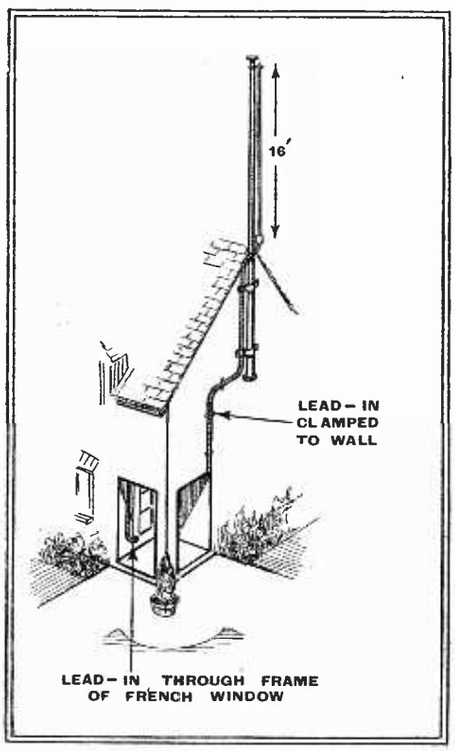
Television at Home

A RECORD OF FIRST IMPRESSIONS

By An "Observer" at Welwyn

DURING next month high-definition television will be launched on the public as a regular experimental B.B.C. service. The possibilities latent in this innovation are at present one big question mark; it may, therefore, be of value to note down how the preliminary programmes from the Alexandra Palace are being received under ordinary home conditions, on a standard production-model receiver.

During and since the hastily devised Radiolympia programmes I have been "looking-in" at my home, 15 miles north of the London television station. It happened that when the Baird service engineer came to instal my receiver the Alexandra Palace was temporarily not radiating, so that I was left to carry out for myself the initial tuning of an instrument which was completely strange to me.



Television aerial as finally installed by the Author.

It proved simpler than I expected. The first time I switched on to the test transmissions I got a picture almost immediately, and had very little difficulty in centring or focusing it. Once this was done, the picture remained stable—in marked contrast to the tuning acrobatics of my last experience of television reception, a few years back, with one of the old 30-line rotating-disc sets.

Expert installation is essential, and the question whether installation costs should be inclusive in the price of the receiver, or charged as an extra, is one upon which the various manufacturers of television sets will no doubt come to an agreement.

The service engineer's first responsibility, of course, is the erection of an efficient aerial. In my case a light temporary aerial was slung outside an upstair window, to keep me going while a permanent fixture was being prepared by a local carpenter. The temporary aerial was a simple dipole with a lead-in of ordinary flex—and signal strength proved to be more than ample. Despite my unfamiliarity with the controls, there was not the slightest difficulty in finding the London station. Tuning, in fact, is fairly flat. Signal strength was such that the sound volume control had to be considerably turned down, and the steadiness of the picture, already noted, is no doubt due to the good strength of the image-signal, with its attendant synchronising impulses.

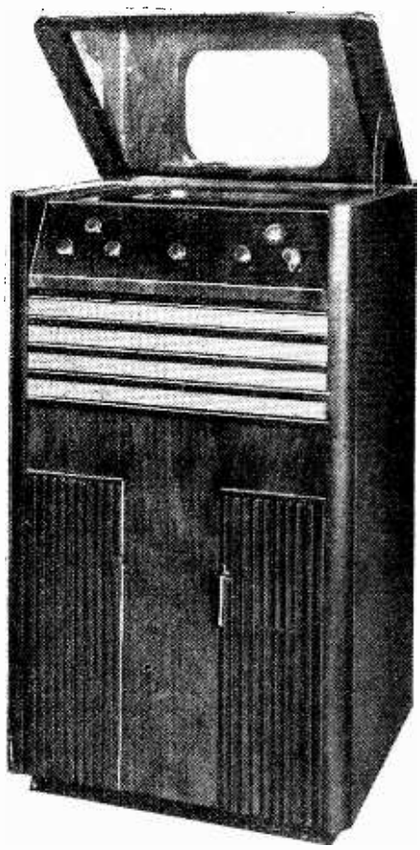
Signal Strength

When the service engineer returned a few days later (the carpenter having completed his construction of the mast) he also was impressed by the signal strength, which augurs well for the range of the station in this northerly direction. At Welwyn we are 350 feet above sea level, and on the "air-line" between us and the Alexandra Palace the ground rises to over 400 feet. The Palace itself is only 300 feet above sea level, but the aerials rise an additional 300 feet.

The permanent receiving aerial which is now erected is of a special anti-interference design of the Baird Comany's. It is a vertical dipole about 16 feet from end to end. To place this aerial in as high and unscreened a position as possible, a 25ft. mast was attached to the end of the house, with 16ft. projecting above the roof-top. Thus the entire aerial is unscreened by the roof.

The lead-in is a low-impedance concentric cable, with the lead covering earthed. This cable was fixed to the wall, down to a room on the ground floor, scrupulous care being taken at bends to avoid any kinking.

By ear and eye one did not observe any great difference in signal strength on the new aerial as compared with the temporary one, but where it did make improvement was in the reduction of interference from motor cars. This is not now serious, unless a motorist stops immediately outside the house and leaves his engine running. The effect is of white flashes horizontally across the screen, with a crackle in the loud-speaker. The aerial is only 20 yards from the road.



A home Televisor, Model T5, made by Bush Radio.

Visitors to my house, as well as my family, enthused about the entertainment value of the transmissions. Personally, I found it rather dull to return to ordinary listening afterwards. After seeing the *whole* of the 1½ hours entertainment directed to Radiolympia, there were no complaints of eyestrain from the home audiences.

Programme Features

The features which drew the greatest appreciation were the outdoor shots at the Alexandra Palace grounds (which never failed to excite the astonishment and wonder of those who had come with no idea of what modern television can do), the variety entertainment in the studio, with its striking use of successive shots from various angles, and, among the films, the news reels and the excerpt from "Show Boat."

On the other hand, in studio programmes, head-and-shoulder views and interviews soon bored the watchers. Frequent change of scene and viewpoint seems to be probably even more important in television than in the cinema. This is where the variety show scored, and although the "Show Boat" excerpt was simply of Paul Robeson singing "Ol' Man River," the film producer has presented this song with such variety of viewpoint, combined with rugged simplicity of masses, and of light and shade, that it

Television at Home—

makes perfect television entertainment. Films with intricate small detail (particularly noticeable in captions) and films which were static, were the least effective.

The lighting of studio scenes seemed to vary considerably, but of course in this, and in the matter of make-up, the television producers will have to feel their way for some time. When the camera moved rapidly towards or away from an artist there was a frequent tendency to go out of focus, evidently because the cameraman has at present no sufficiently positive rapid-focusing device.

The most remarkable effect of television in my house was its enthusiastic adoption by children. They have never shown any great interest in sound broadcasting—even the Children's Hour. But television they watched with rapt attention, and with screams of laughter for the comic horse in the variety show; and not merely once. They insisted on seeing the programme through again and again as it was repeated daily for Radiolympia. They never tired of it, which seems to indicate that it was not the "novelty appeal" of television which was having effect, but real entertainment value.

The receiver used, a Baird "Televisor" model T5, is a 20-valve instrument (including two mains rectifiers). The power consumption from the mains is 240 watts. The image, measuring 12 inches by 9 inches, is reflected from a vertical cathode-ray tube by a mirror inside the lid, held open at 45 degrees. The end of the tube is covered by a window of safety glass, and the tube is guaranteed for 1,000 hours.

The six main controls are mounted on the front of the cabinet:

The Wavelength tuning control tunes-in both vision and sound simultaneously; the peak tuning point is easiest found by ear. The volume of sound may then be adjusted by the *Sound Volume control,* which operates on sound only. *Vision control* is virtually a "Volume Control" for vision—it controls the output from the vision chassis, and once set I find it need rarely be adjusted. If turned up too far it has a "reaction" effect, causing closely-meshed patterns on the screen. *Picture brightness* controls the luminosity, which is such that pleasant reception may be obtained in daytime without fully darkening the room—usually we draw the curtains to avoid reflection of the windows in the mirror. I find it convenient to work this brightness control in conjunction with the *Contrast control,* the effect of which is to vary the black-and-white contrast in the picture. *Focus,* finally, must be carefully adjusted, or a "fuzzy" picture results.

Behind a door in front of the cabinet is concealed the switch for changing over between Baird and Marconi-E.M.I. reception, and also the time-base controls. It was a little more difficult to get the knack of these. As the service engineer would normally set these controls, leaving the owner only to make an occasional vernier adjustment, I do not look upon this as a serious complication, though, of course, it *is* a complication to have to work to a double standard of transmission, and a future elimination of controls is partially bound up with the ultimate standardisation of television transmission.

PYE SERVICE EQUIPMENT

Special Instruments for Tests and Alignment

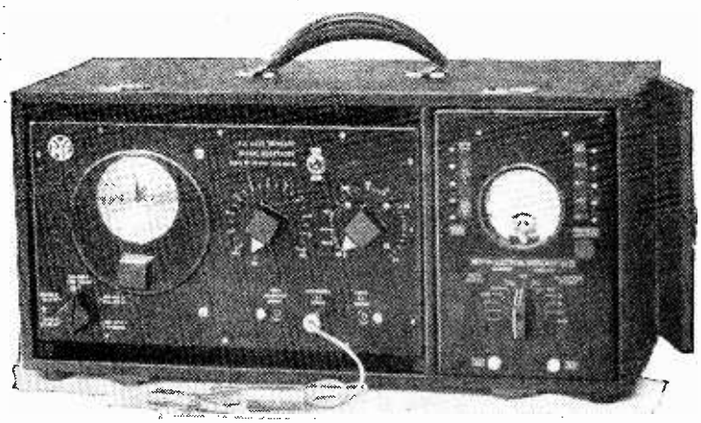
FOR the benefit of agents and their service-engineers Pye Radio recently decided to introduce a series of reasonably priced and efficient testing instruments.

Perhaps the most generally useful and technically interesting of the series is the "All-Wave Trimeasy Signal Generator." This oscillator, of which the purpose is self-evident from its title, covers a wave-range of from 12 to 3,000 metres (25 Mc/s to 100 kc/s) in five steps, with switch selection. The radio-frequency output, controlled by an attenuator calibrated in db., ranges from below one microvolt to about 0.1 volt, and is modulated to a depth of 30 per cent. at 400 cycles. There is also a higher output giving an RF signal up to 0.5 volt.

Used as an audio-frequency generator, the instrument gives an output, controllable by an additional attenuator, of 2.3 volts maximum, which is delivered through a separate socket.

The instrument, which is supplied with two dummy aerials and is hand-calibrated, is battery operated; it is stated to be extremely economical in current consumption. A similar generator without short wave-bands is also available at a lower price.

If required, the signal generator described above can be combined with a Weston Selective Analyser, the two instruments being mounted in a convenient carrying case and aptly described as the Pye Complete Tester.



Pye All-purpose Tester, combining a signal generator with a multi-range meter.

Another useful instrument for the service engineer is the Pye Valve Tester, which provides for tests of emission and mutual conductance of all types of valves, as well as of inter-electrode insulation; readings are given directly on a 6-inch scale.

Other Pye service equipment includes an output meter calibrated in milliwatts and decibels, a set of trimming tools, and a "kit" of materials—polishes, compounds, etc.—for the renovation and repair of cabinets.

The Wireless World Diary

APART from the diary proper, no fewer than 80 pages of data useful to the wireless enthusiast are contained in the 1937 *Wireless World* Diary, which has just made its appearance.

One of the most helpful features is the inclusion of a table giving the wavelength, frequency and power of all European stations, and a similar table dealing with the short-wave stations of the world. A list of special telephony transmissions—such as those emanating from police cars—together with wavelength details, is also given.

Among the many pages of useful data are to be found formulæ for calculating output transformer ratios, resistance amplifier design, and decibel loss or gain. A table of standardised colour codes forms another valuable feature. Those troubled with interference will find a page of very helpful information. Not the least valuable section of the diary is that containing abacs for the rapid estimation of such information as the wavelength to which a circuit containing a given inductance and capacity will resonate, and for the quick designing of short-wave coils. Constructors and servicemen will find that very helpful diagrams are given, together with explanatory notes, in order to illustrate the correct connections to the sockets of the many types of modern valve base, including American ones, which are available nowadays. Included also will be found the Morse code, the International "Q" code, and a wealth of other information for the keen listener. The diary, which costs eighteenpence, may be obtained through any newsagent, or for 1s. 7d., post free, direct from the publishers, Messrs. Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

The Radio Industry

A 20-PAGE booklet dealing at length with the principles, construction and installation of the "Eliminoise" screened aerial system has just been published by Belling & Lee, Ltd., Cambridge Arterial Road, Enfield, Middx.

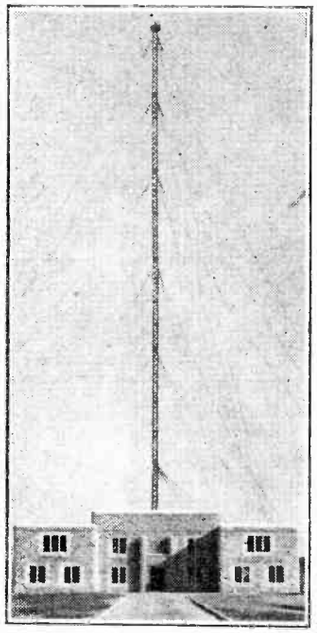
Copies of the new catalogue of Eddystone short-wave components can now be obtained from Stratton & Co., Ltd., Bromsgrove Street, Birmingham. There is also a new edition of the Eddystone Short-Wave Manual (price 1s.), which contains constructional details of several receivers, transmitters and modulated oscillators, as well as other useful information for the short-wave enthusiast.

Degallier's Ltd. has moved to 18, Connaught Street, Marble Arch, London, W.2. Telephone number is unchanged—Paddington 2745.

B. J. Round & Sons, 8, 9, and 10, Northampton Street, Birmingham, 18, have just issued a revised edition (price 1s., post free) of their booklet describing the "Epalex" system of electro-plating. A leaflet (free) deals with the protection of aluminium by the "Pylumin" process.

BROADCAST BREVITIES

News from Portland Place



BURGHEAD will be brought into operation on Monday next, October 12th, using the same wavelength as Scottish Regional (391.1 metres.)

Mast Climbing at Droitwich

"DAWN over England" is the title chosen for Kenneth Adam's description of what he sees from the top of the Droitwich mast at 6 a.m. on October 22nd. The actual date of the broadcast is October 23rd, an electrical recording of the talk being broadcast between 8.45 and 9 in the National evening programme. The Recording Department will thus have nearly forty-hours for "sub-editing" purposes.

Something Like a View!

Droitwich happens to be very near the geographical centre of England, and as Mr. Adam will take his stance—a somewhat cold stance, one imagines—about 700 feet above ground level, a very fine prospect should be unfolded.

If the morning is clear the Malvern Hills should be plainly discernible and there should also be a good view of Bredon Hill, the valleys of the Avon and Severn, Worcester Cathedral and the Abberley Hills, with the Shropshire Clees beyond. To the north it should be possible to see the Lickey Hills and perhaps the tower of Birmingham University.

Mr. Adam will also describe his sensations during his climb in the lift.

New "Proms" Scheme for 1937

THE principal source of annoyance to the musically minded has been the tantalising thought that the concerts have been going on night after night, as usual, but have been broadcast only in snippets. If the concerts themselves had been curtailed the complaints might have been fewer.

Meanwhile Dr. Boult and his assistants, overjoyed by this public vindication of the musical side of the B.B.C.'s activities, are quietly planning a better scheme for 1937.

Where Scotland Leads

SCOTSMEN are supposed to be somewhat canny with the postage stamps, which makes it all the more surprising that, if we except Londoners, listeners north of the Tweed are writing more letters to the B.B.C. than their brethren in the South. Next to them come the Welsh.

Of the other provincial regions, the North is the most vocal. Midland and the West of England regions practically tie for the next place. As might be expected, Northern Ireland, with its comparatively small listener population, is a long way behind.

Too Many Organ Recitals?

ARE we to have a glut of organ broadcasts this winter? As already stated in these columns, the new theatre organ in St. George's Hall is to be heard at least twice a week, yet there is apparently no question of reducing the number of recitals on the Concert Hall organ.

The third series of B.B.C. organ recitals opens on Friday, October 23rd, when Dr. Harold Darke, famous for his Bach recitals at St. Michael's, Cornhill, will give a forty-five minute programme of works by Mozart, Bach and Stanford.

Staff Changes at Broadcasting House

THE B.B.C. announces that the resignation of Major Gladstone Murray from the post of Assistant Controller (Programmes) to the B.B.C., following his appointment as General Manager of the Canadian Broadcasting Commission, has involved several staff changes at Broadcasting House. Mr. R. H. Eckersley, who, like Major Gladstone Murray, has been Assistant Controller (Programmes), will take over from Mr. C. A. Siepmann the Directorship of Regional Relations. Mr. Siepmann will succeed Mr. R. E. L. Wellington as Director of Programme Planning, and Mr. Wellington will become Assistant Controller (Programmes).

Quality Transmission from Daventry

GREAT joy in the Empire Department over this tribute in the *Sydney Bulletin*: "One notable circumstance about the B.B.C. transmissions is that while the signal strength may not equal that of other nations, the quality of the transmission excels."

Such praise of a short-wave station from the other side of the globe is rare and refreshing.

Italian Methods in Studio Opera

SPECIAL studio technique is to be employed in broadcasts of Italian opera this autumn and winter.

Gordon McConnel, who has been responsible for the production of such operatic successes as "The Life of Verdi" and "Puccini, the Man and His Music," has paid two visits to Italy to discover the "secrets" of the Italian broadcasting studios, in which opera production has admittedly reached a very high standard.

Improvements on Theatre Broadcasts?

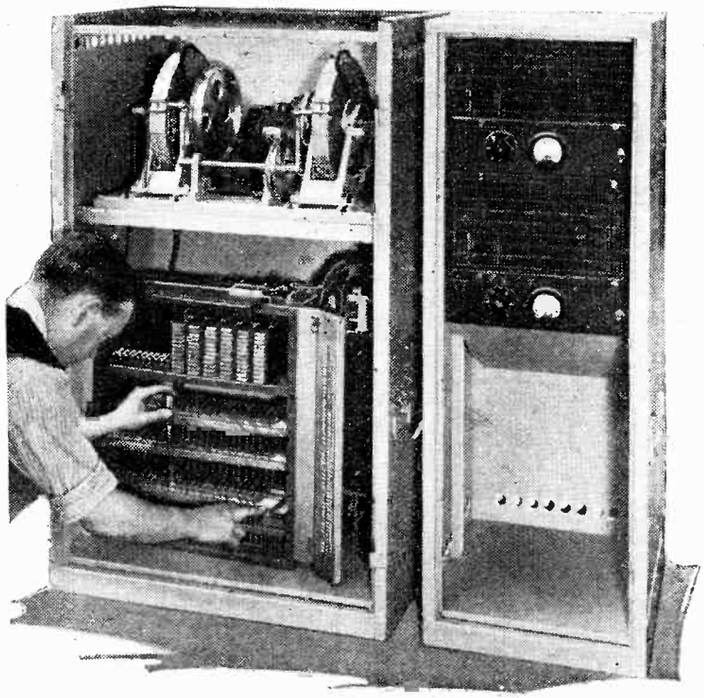
The Italians, in fact, often succeed in making a studio presentation more acceptable than an O.B. from an opera house, the reason being that a typical opera audience in Rome or Naples is almost too vociferous in its applause. Moreover, the Italian engineers seem happier in dealing with studio acoustics than with those of the opera house or theatre.

The B.B.C.'s next operatic programme in the studio will be Act I of Massenet's "Manon," to be given in November.

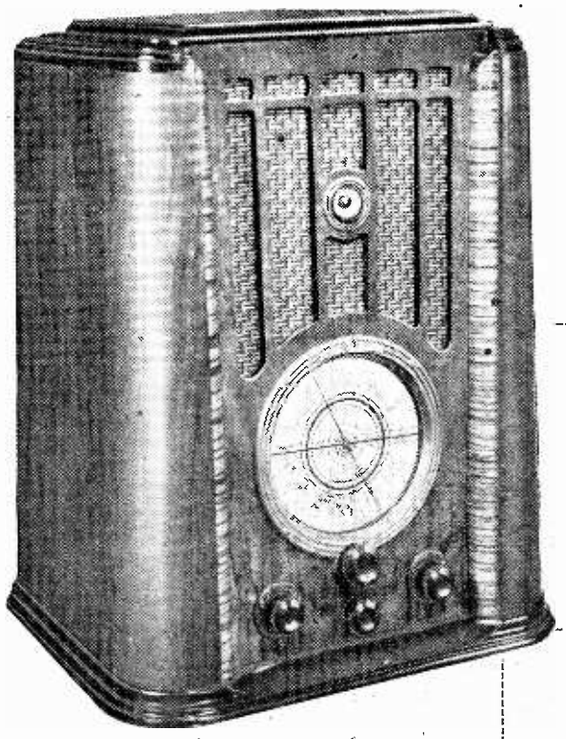
Surprise for the Music Department

THE conclusion of the "Proms" season for 1936 finds the B.B.C. in a reflective mood. Last year there were noisy complaints that the Promenade Concerts were monopolising too much programme time, so the Corporation, bent on pleasing everybody, decided that it would be better to cut down the Queen's Hall relays by half.

The result has been a real eye-opener. If every proof was required that broadcasting has raised the musical tastes of the nation it would be found in the B.B.C. postbag during the past two months. From all quarters letters have poured in condemning the new policy and urging the Corporation to revise its plans for next year.



ADJUSTING THE ELECTRONE for the St. George's Hall organ prior to its installation. The inaugurating broadcast on this masterpiece of organ building will be given Nationally at 8 on Tuesday, October 20th, when four well-known broadcasting organists will demonstrate its capabilities.



Pilot MODEL U650

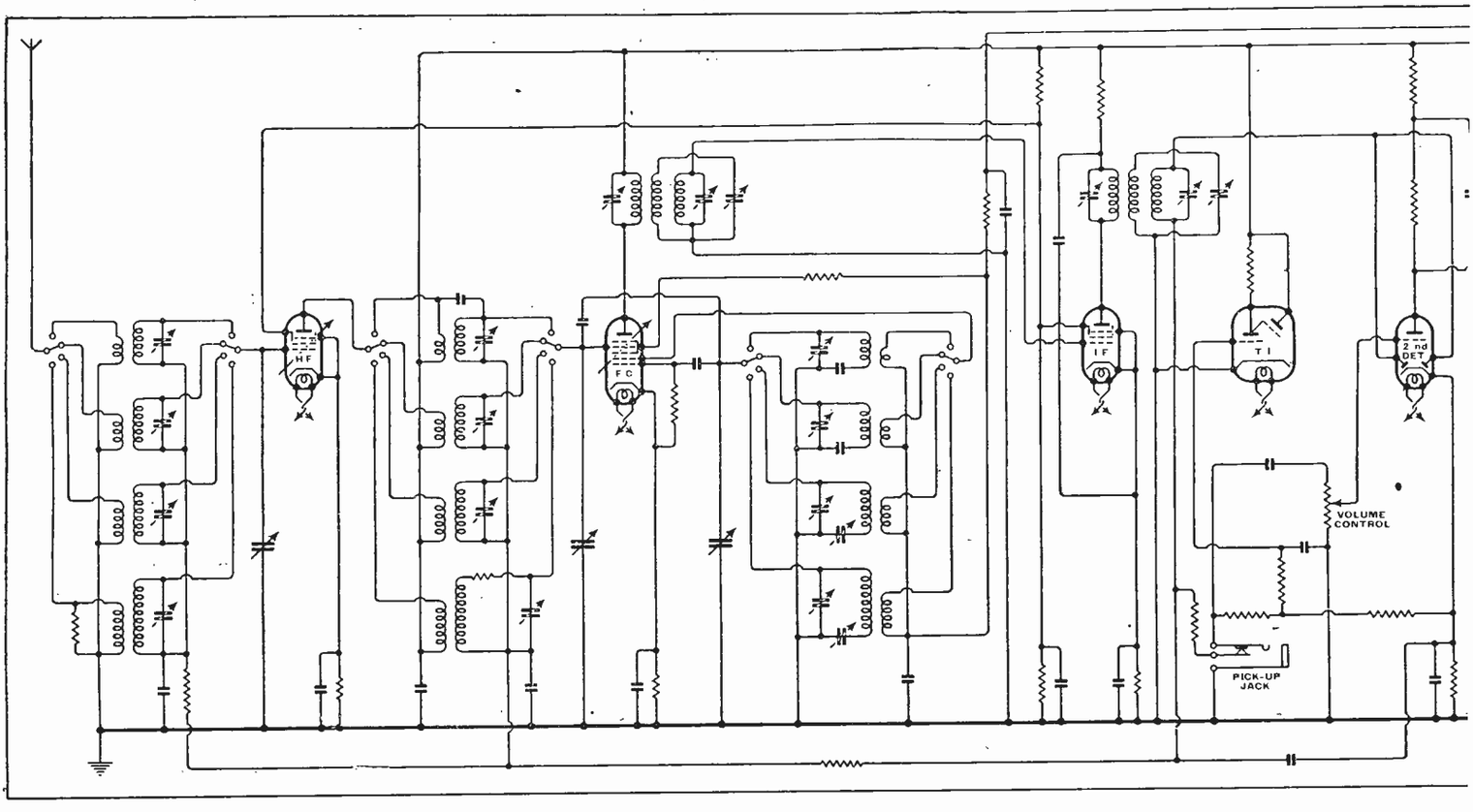
Efficient Performance from an Essentially Simple Circuit

FEATURES. — ***Type.*** — *Table model all-wave superheterodyne for AC mains.* ***Waveranges.***—*(1) 16-52 metres. (2) 48-150 metres. (3) 175-550 metres. (4) 750-2,100 metres.* ***Circuit.***—*Var. mu pentode HF amplifier — heptode frequency-changer — pentode IF amplifier — double-diode-triode second detector — pentode output valve. Full-wave valve rectifier.* ***Controls.***— *(1) Tuning. (2) Volume. (3) Waverange. (4) Tone control and mains on-off switch.* ***Price.***—*16 guineas.* ***Makers.***— *Pilot Radio Ltd., 87, Park Royal Road, London, N.W.10.*

ALTHOUGH the name of this set may be new to many broadcast listeners, short-wave experimenters will already be familiar with the range of Pilot components which had already established a reputation outside their country of origin long before there were any signs of the present popular interest in all-wave receivers. The accumulated experience gained as a result of serving experimenters in the early stages of the short-wave art has now been incorporated in a series of complete receivers, and a factory has been set up for their manufacture in this country.

Before one has traversed more than a few degrees of the dial on the 16-52-metre band it becomes apparent that the performance on short waves is something quite out of the ordinary. The crisp response and excellent signal-to-noise ratio are only two of the qualities which mark this set out as a thoroughbred. Reception of W2XAD at 4 o'clock in the afternoon was perfectly steady, and the volume was such that the control had to be turned down to permit telephone conversations in the same room. One virtue of the high signal-to-noise ratio is that the receiver seemed much less susceptible to the prevailing local interference, and as a result the tone control could be turned much more than usual towards the high position with a consequent improvement in quality. There was no trace of second-channel interference and double tuning points.

It is interesting to find in view of the outstandingly good short-wave performance that the circuit is remarkably simple and free from "frills." Where other makers have added extra valves and circuits in an effort to improve performance the designers of the U650 appear to have worked inwards and made sure of obtaining the maximum efficiency from each component in an essentially simple circuit. The first valve is a variable-mu pentode RF amplifier which functions on all wave bands. Simple transformer coupling is employed in the aerial circuit and between the RF amplifier and the frequency-changer, the only deviation from medium-frequency broadcast practice being in the



addition of some top-end capacity coupling on the shortest waveband. The heptode frequency-changer is followed by a single IF stage, which is interesting for the fact that triple tuned circuits are used in each of the two associated transformers. The IF valve, incidentally, is not controlled from the AVC line, which supplies bias only to the RF and frequency-changer valves. A double-diode-triode, in which both diode anodes are strapped together, occupies the second detector stage, and there is a cathode-ray tuning indicator controlled from a tapping on the diode load resistance.

The resistance coupling between the triode portion of the second detector and the pentode output valve is of the simplest possible type. The output valve is designed to give an undistorted output of three watts, and tone control is effected by the usual condenser and variable resistance in parallel with the primary of the output transformer. The external loud-speaker sockets are also connected at this point, so that a suitable output transformer will be required in the external loud speaker unit.

The quality of reproduction is bright, and fully in keeping with the lively performance of the receiver. The speaker has a rather generous reserve of response in the upper middle register, and except in a few cases the bass response is balanced with the tone control approximately in the mid-position.

As regards the performance on the other wavebands the 48-150-metre band was not productive of any specially interesting transmissions at the time of the test, but the medium-wave band maintained the high standard of performance found on the lower wave ranges.

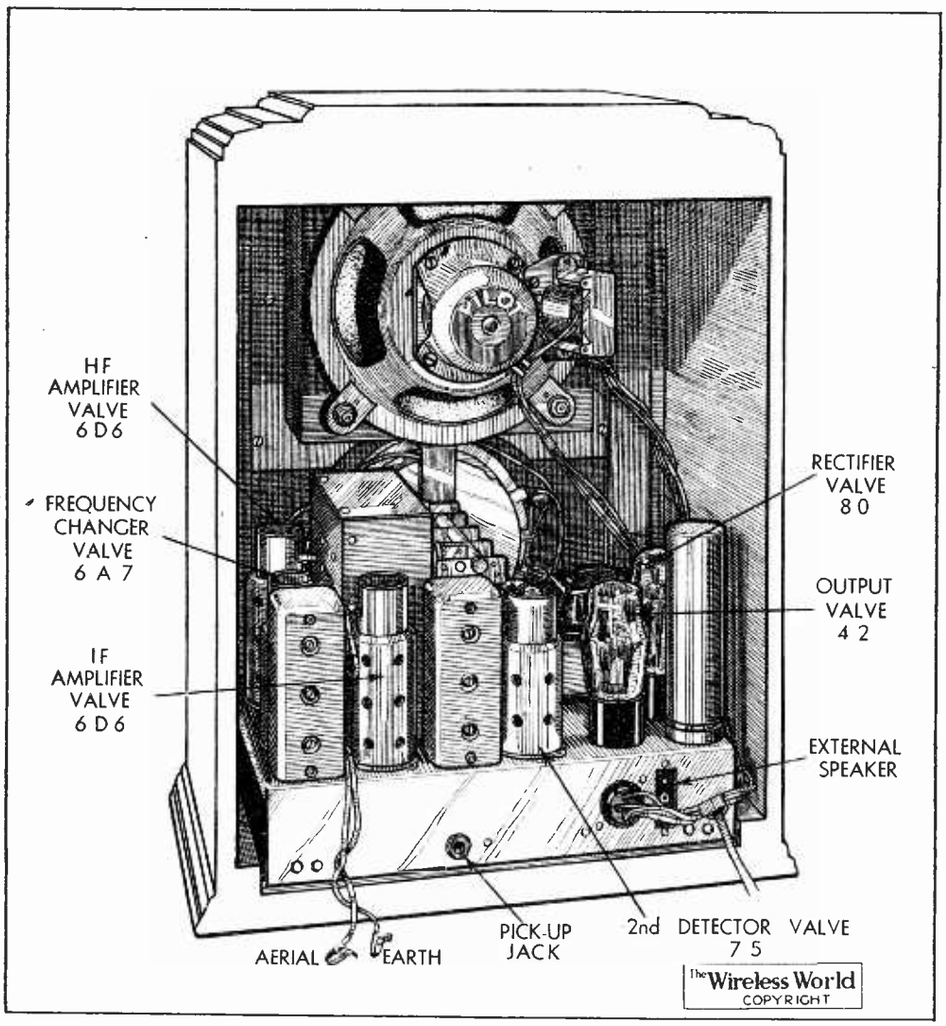
Selectivity on the medium-wave band is such that the Brookmans Park transmitters can be approached within 1½ channels on either side of their normal settings when using the set in Central London. Some difficulty was experienced, however, in finding the Deutschlandsender between Radio-Paris and Droitwich. This is no doubt accounted for by the damping which the circuit shows to have been deliberately introduced on the long-wave band, but if this has resulted in some slight loss of selectivity there is no appreciable diminution of range on long waves by comparison with any of the other wavebands.

The receiver incorporates the conventional type of clock-face dial, but in this case it is of really useful diameter and permits a larger proportion of the number of stations within the range of the set to be marked on the dial. The calibration, incidentally, is remarkably accurate on all four wavebands, so that the wavelength settings may serve as a useful guide in the identification of unknown stations. The pointer is driven by a single knob through a choice of two reduction gears with ratios of 12½ : 1 and 95 : 1; the latter gear for fine tuning being brought into operation by pulling out the knob.

The cathode-ray tuning indicator is mounted in the centre of the loud speaker grille and the valve-holder is carried on a metal "spider" which is clamped underneath the rim of the loud speaker chassis. To replace the tuning indicator, therefore, it will be necessary to remove the loud speaker, but this is really quite a simple matter.

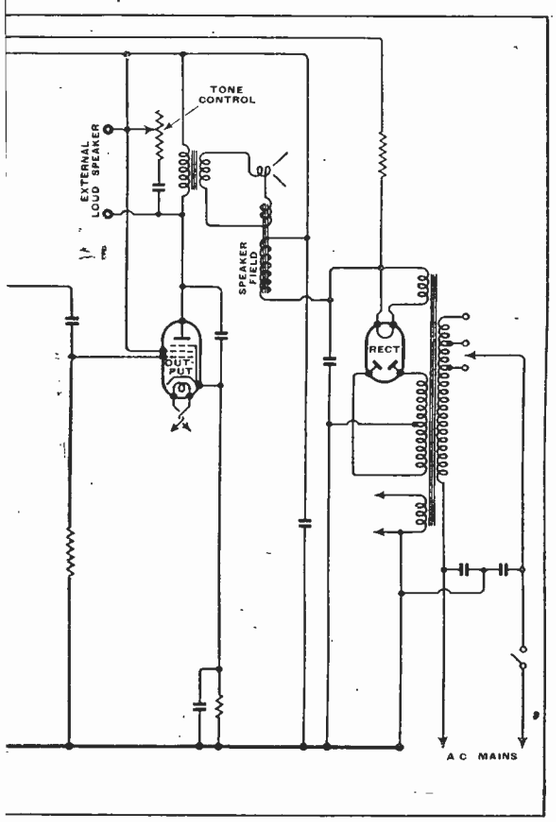
At the back of the chassis a jack has been provided for gramophone pick-up connections, and it is interesting to note that flexible leads with spring clips take the place of the usual aerial and earth terminals or sockets.

Although we have stressed the short-wave performance of this model it should not be inferred that the normal broadcast bands suffer by comparison, and from every point of view we regard the U650 as a well-balanced design.



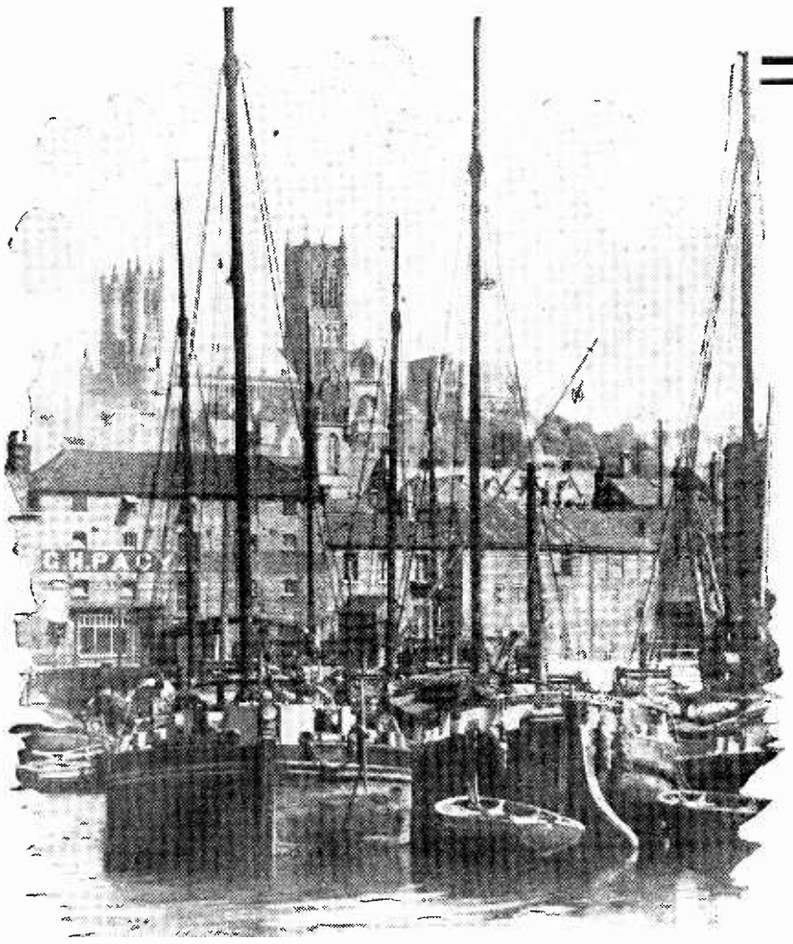
The loud speaker is spaced from the front of the cabinet by a wood block to give space for mounting the cathode-ray tuning indicator in the centre of the loud speaker grille.

Simplicity is the key-note of the circuit, the only important deviation from standard practice being the use of triple tuned circuits in the IF couplings.



Listeners'

Outstanding Broadcasts at



LINCOLN CATHEDRAL seen from Brayford through the rigging of coasting craft. The cathedral choir will be heard in a programme of Byrd's music tonight (Friday) at 9.0 (Reg.).

THIS week brings to the listener a very varied bill of good music: by "good" I mean classical.

The choir of Lincoln Cathedral with the strings of the B.B.C. Northern Orchestra conducted by Gordon Slater, organist and Master of the Choristers, will be giving a recital of the music of William Byrd (1543-1623), which will be broadcast Regionally tonight from 9 to 10. The first part will be rendered in the vestibule of the Chapter House; this will be followed by an organ solo, and then the second part will be heard from the Minster Choir.

The B.B.C. Symphony Orchestra, comprising 119 players, pays a visit to Hanley, Stoke-on-Trent, this week, and the concert, which will be given in Victoria Hall under the direction of Dr. Adrian Boult, is to be broadcast Nationally on Wednesday from 8 to 9 and 9.20 to 10.5.

On the following evening (Thursday) the London Philharmonic Orchestra, conducted by Sir Thomas Beecham, will be heard during the Royal Philharmonic Society's concert at the Queen's Hall from 8.15 to 9.35 and 9.50 to 10.30.

The works of Richard Dering are chosen for this week's music series. Motets and canzonets will be sung by the B.B.C. Singers conducted by Sir Richard Terry. The first concert is on Sunday at 4 (Nat.), and the succeeding concerts on Monday at 6.55 (Nat.), Tuesday at 9.40 (Nat.), and Thursday at 7.45 (Reg.), also a talk on the music of Dering will be given by Sir Richard Terry at 6.40, preceding Monday's concert.

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BEST SELLERS

A NEW and interesting idea has been hit upon by Geraldo, who will bring the first instalment of this broadcast, which is to be a fortnightly feature, to National listeners on Monday at 7.20. Under the heading "The Music Shop," with his orchestra he will play the song hits that have been best sellers during the past fortnight. In this way personal choice will be ruled out. It will be interesting for those keen on dance tunes to see the rise and fall in popularity of "hits" from fortnight to fortnight.

"LOTS OF LOVE"

ALTHOUGH broadcast as recently as last March this story by Holt Marvell (words) and Jack Strachey (music) which is of a modern Don Juan who falls in love with a girl whilst staying on the Côte d'Azur, will be heard again on Monday at 6 (Reg.) and Tuesday at 8 (Nat.). Only a few of the original cast will be available. Of these Nora Howard will again play Minnie. Newcomers to the cast include Joan Carr, Valerie Taylor and Richard Ainley. The music will be in the hands of the Television Orchestra, and the soloists are Anne Ziegler (soprano), John Ticehurst (harpsichord), Marie Goossens (harp), John McKenna (tenor), and Jim Hands (accordion).

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"IN TOWN TO-NIGHT"

A. W. (BILL) HANSON brings this popular favourite back into the programmes again on Saturday at 7.30. It will be on similar lines to last season's except that it will not include the serial thriller which will be given as a separate item at 8. "The Palaver is Finished" is the title of the story chosen, which is on the adventures of Commissioner Sanders and Lt. "Bones," and is adapted from the Edgar Wallace story. Each instalment will be complete in itself.

SADLER'S WELLS

WE hear so little opera in this country that when a relay is provided it is welcomed by opera lovers. From Sadler's Wells on Saturday listeners to the Regional programme will be treated to the second act of Wagner's "Lohengrin" at 9, preceded by a five-minute introductory talk. The scene of this act is laid in the Palace courtyard at night. The title-rôle will be filled by Tudor Davies and that of Elsa by Joan Cross.

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SPORT

COMMENTARIES on three different sporting events will be given during the current week. On Saturday at 3.15 (Reg.) Captain H. B. T. Wakelam will give a running commentary on part of the Rugby football match between Blackheath and Newport from the Rectory Field, Blackheath. Immediately after this, at approximately 3.40, a much less boisterous contest, a snooker match, will be the subject of a commentary by Willie Smith from Thurston's Hall. H. Lindrum and Newman will be the contestants in the *Daily Mail* Gold Cup Sealed Handicap Tournament.

The International Association Football Match between Scotland and Germany at Ibrox Park, Glasgow, will be the scene of a running commentary which will be broadcast Regionally at 3.45 on Wednesday.

ERIC FOGG conducting the B.B.C. Empire Orchestra in the Concert Hall at Broadcasting House. Isobel Baillie (soprano) will be heard with the orchestra in an hour's programme on Thursday.

Guide for the Week

ne and Abroad

TRAILERS

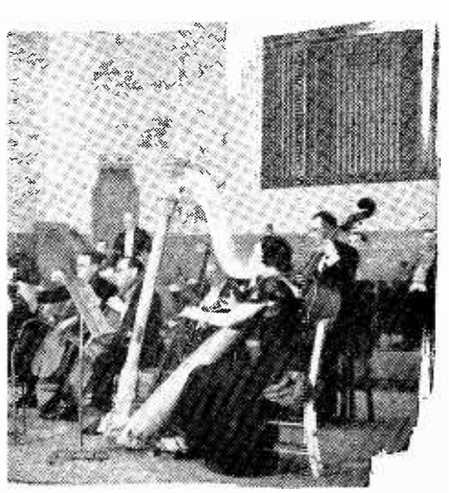
THE B.B.C. are following the procedure of cinemas in giving trailers of forthcoming events. The first to be given will be on Thursday at 9.20 (Nat.) and is of the Greek drama, "Hippolytus" of Euripedes, which will be produced in the National programme on Sunday, October 18th. This idea should prove quite useful in enabling listeners to "taste and see" and then to make a note of forthcoming worthwhile programmes.

CABARET

A LATE-NIGHT cabaret half-hour, "Stepping Out," will be presented by Brian Michie (compère) and Ernest Longstaffe (producer) to National listeners at 10.5 on Wednesday. They will introduce into the programme a new and ultra-modern "swing" band, Phil Green and his Ballyhooligans, leading exponents of "swing" dance music. Also billed for this show are Marjorie Holmes and Ray Meux, a comparatively new find among comedians.

ALL WOMEN

THE play by Aimée and Philip Stuart, "Nine till Six," which was produced in London in 1930, has been adapted for radio by Aimée Stuart and will be produced by Barbara Burnham twice during the present week, on Monday and Tuesday at 9.35 (Nat.) and 6 (Reg.) respectively. The cast is entirely feminine and comes as a contrast to the all-male show "Eight Bells." It is set in a dressmaker's establishment—Business Hours: Nine till Six—the proprietress of which will be played by Gladys Young.



MOLLY, MARY AND MARIE, the Three Sisters, who broadcast with Henry Hall and the B.B.C. Dance Orchestra, and will again be heard in Henry Hall's Hour on Saturday. They are named here in the order from top to bottom.

SAILORS ALL

THE third edition of Mungo Dewar's "Eight Bells" will be given to Regional listeners at 8.15 on Wednesday. The characters will be the same as before plus one or two new ones, and the programme promises to be as breezy as ever. The stokers, Boyle and Shovell, will be well to the fore.

OPERA FROM ABROAD

ONE of the later works of Respighi, who died in April this year, will be given from Milan at 7.45 on Saturday: it is his "La fiamma."

Two almost simultaneous public performances of Rossini's "Barber of Seville" are announced in the German programmes; one comes from the National Theatre, Munich, and will be heard from Munich at 7, while the other, timed for ten minutes later, takes place at the Municipal Theatre, Freiburg, and will be relayed by Frankfurt. Thursday brings an important relay from Warsaw at 7.10 with the Grand Theatre performance of Moniuszko's "The Haunted Castle" for the opening of Warsaw's Opera Season.

OPERETTA

A NEW operetta "Der Verliebte Wauwau" by Goetze, one of the ultra-modern German composers of light music, will be given by Munich at 7.10 on Saturday.

In an interesting programme from Radio-Paris on Tuesday at 9.15 which consists of works of Vorcet is included a three-act operetta for radio entitled "Miss Cacahuette."

HIGHLIGHTS OF THE WEEK

FRIDAY, OCTOBER 9th.
Nat., 7.30, "Cavalcade." 9.40, "Mincing Lane," London's Tea and Spice Market. 11.15, Jack Payne and his Band.
Reg., 8.15, Eddie Carroll and his Music. 9, Relay from Lincoln Cathedral.
Abroad.
Radio-Paris, 8.45, "Madame Favart," Opéra-comique (Offenbach).

SATURDAY, OCTOBER 10th.
Nat., 7.30, "In Town To-night." 8.15, B.B.C. Orchestra (D). 9.20, Music Hall.
Reg., 4.15, Rex London's "London's Latest." ¶"Legends of the Peak"; Tale and Tradition from the Derbyshire Hills. 9, Sadler's Wells Relay. 10.25, Henry Hall's Hour.
Abroad.
Vienna, 7.5, Bruckner Festival.

SUNDAY, OCTOBER 11th.
Nat., 5.20, The Brosa String Quartet and John McKenna. 7.55, Service from St. Martin-in-the-Fields. 9.50, B.B.C. Orchestra (D).
Reg., 5.45, Edward German Programme; B.B.C. Orchestra (E), B.B.C. Singers and Raymond Newell. 6.45, Mr. Pickwick Still Going Strong. ¶Victorian Melodies, No. VIII.
Abroad.
Königsburg, 8, Bach Festival, the St. John Passion.

MONDAY, OCTOBER 12th.
Nat., 7.20, "The Music Shop." ¶Recital: Muriel Brunskill and Anthony Collins (viola). 9.30, "Nine Till Six."
Reg., 6, "Lots of Love." 9, B.B.C. Orchestra (E) and Isolde Menges. 10.25, The Grosvenor House Dance Band.

Monday, October 12th (*continued*)
Abroad.
Frankfurt, 7.10, Niemann Concert for his Sixtieth Birthday; the composer at the piano.

TUESDAY, OCTOBER 13th.
Nat., 6.25, The Orpheus Trio. ¶H. Robinson Cleaver at the Organ of the Regal Cinema, Bexley Heath. 8, "Lots of Love."
Reg., 6, "Nine Till Six." ¶"The Everlasting Waltz"; B.B.C. Dance Orchestra. 8, Sonata Recital, Adolf Busch and Rudolf Serkin.
Abroad.
Luxembourg, 8.50, Operetta-Revue from the Théâtre des Variétés, Paris.

WEDNESDAY, OCTOBER 14th.
Nat., 6.40, Falkman and his Apache Band. ¶Van Phillips and his Two Orchestras. 8 and 9.20, B.B.C. Symphony Orchestra at Hanley. 10.5, "Stepping Out": Cabaret.
Reg., 8.15, "Eight Bells." ¶"Bigger Business": Claude Hulbert and Bobbie Comber. 10.25, Bram Martin and his Dance Orchestra.
Abroad.
Strasbourg, 8.30, Concert from the Palais des Fêtes.

THURSDAY, OCTOBER 15th.
Nat., 6.40, Empire Orchestra and Isobel Baillie. 9.40, Variety. 10.20, Lew Stone and his Band.
Reg., 6.40, From the London Theatre. 8.15 and 9.50, London Philharmonic Orchestra at the Queen's Hall.
Abroad.
Warsaw, 7.10, "The Haunted Castle" (Moniuszko) from the Grand Theatre.

PAUL BEARD, leader of the B.B.C. Symphony Orchestra. The first public appearance of the orchestra with its new leader since its European Tour last April will be at Hanley on Wednesday.

TUNE IN THIS

LUXEMBOURG'S 9 o'clock transmission on Wednesday has the intriguing title "Music Hall—A Neapolitan Soirée in 1900." This should be well worth tuning in.

THE AUDITOR.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Biasing the Output Valve

I WAS interested to read Mr. H. Wightman Harris' letter in which he states that as a result of the temporary leakage of the electrolytic bias condenser, he abandoned auto-bias in favour of a separate bias system.

This is easily remedied if a resistor is connected between the positive end of the bias resistance and HT+, thus partly charging the bias condenser before the output valve takes any anode current.

The bias resistance naturally has to be reduced in accordance with the extra current passed through it, and I have found that with a DO/25, a bias resistance of 1,200 ohms, and a condenser charging resistance of 80,000 ohms is suitable for an HT supply of 400 volts. This develops approximately 6 volts, which I found to be ample for the initial polarisation of the bias condenser.

London, N.12. N. L. BOLLAND.

Local SW Interference

WITH reference to Mr. Browning's letter, which appeared in *The Wireless World* dated August 28th, the experience of receiving a nearby short-wave transmitter on a receiver tuned to the normal broadcast bands is by no means an uncommon one, and has occurred in several instances within the writer's experience. In most cases it is found that the presence of an HF stage greatly accentuates the interference from the short-wave station.

The effect is due to several causes either acting together or separately. The most obvious of these is cross-modulation due to the fact that the high-frequency valve is being operated on the wrong part of its characteristic, so that rectification takes place. This effect is increased on account of the valve being effectively overloaded by the interfering short-wave signal; this tending to produce grid current. The short-wave signal is enabled to reach the grid of the HF valve, since in the majority of cases the medium-wave tuned input circuit exhibits subsidiary or parasitic resonances which are frequently set up or increased by tappings, transformer windings, etc., which generally form an integral part of the tuning coil. Several of these resonances may occur and at frequencies corresponding to both short and ultra-short wavelengths. Alternatively, the medium-wave coils may act as chokes on the short wavelengths, so that aperiodic circuits are formed, and so enable the powerful short-wave signals to reach the grid of the HF valve. Here, assuming the conditions of operation referred to as holding good, the modulation of the short-wave signal is transferred to the medium-wave carrier, obliterating the modulation of the latter on account of the relative strengths of the signals, and so being passed to the loud speaker.

This effect, however, is almost certainly not the cause of the effect to which Mr. Browning refers, since cross-modulation depends on the existence of a carrier on the broadcast band and Mr. Browning states that the interference persists over the whole of the tuning dial. Cross-modulation is, however, mentioned as of general interest, as being some times responsible for a short-wave signal being superimposed on a medium- or long-wave station.

The interference in the present case is most probably produced by the tuned medium-wave input and output circuits of the HF amplifier, acting aperiodically, i.e., as chokes to the powerful ultra-short wave signal, so that the effect is independent of the setting of the tuning condenser. On the other hand, subsidiary resonances in the tuning coils or aerial at the ultra-short wave frequency would effectively produce a stage of ultra-short wave amplification in addition to that produced on the medium waves by the normal action of the tuned circuits, this giving a ready passage for the interfering signal. If, due to this cause, the effect would occur at all settings of the dials, as Mr. Browning describes, it would incidentally be greatly increased by stray parasitic back couplings from the output to the input circuits of the HF amplifier, either externally or through the residual inter-electrode capacity of the valve, these stray back couplings thereby forming a tuned reaction circuit at the parasitic or ultra-short wave frequencies. As designers know, one of the greatest drawbacks to high gain amplifiers employing specially tapped coils is parasitic oscilation, which often consists of frequencies corresponding to the ultra-short waves.

The reason for the interfering signal being nearly inaudible on the det-LF receiver to which Mr. Browning refers is most probably due to the absence of stray reaction effects brought about by the inherent simplicity of the circuit; the different type of coil, and the use of a long aerial. It is probable that the construction of the coil is such that subsidiary resonances on the ultra-short wave band do not occur. Further, the reaction circuit may be so arranged on the det-LF receiver as to suppress or reject ultra-short wave resonances, while reinforcing the desired medium-wave frequency.

Another possible explanation is that the 35ft. indoor aerial of which Mr. Browning speaks in the case of the HF set, resonates with the aerial coupling circuit (which may consist of a series condenser and/or tappings or transformer) at a frequency within the ultra-short wave band. In the case of the det-LF set, however, the use of a longer aerial than in the case of the HF set, together with a probably tighter degree of coupling between the aerial and the tuned circuit, would tend to produce an aerial circuit resonance of much longer wavelength, which would, in effect, greatly reduce the response to the ultra-short wave signal.

Grantham, Lincs. E. P. RUDKIN.

Home Recording

THE article on "Experiments in Home Recording," by Robert W. Bradford, in the September 25th issue of *The Wireless World*, is a useful addition to the scanty literature available on a subject which is now receiving widespread attention.

I have given much time to research on this work, especially in an effort to produce a suitable recording blank, during which an investigation was carried out as to the possibilities of employing blanks made of pure aluminium, aluminium-alloy, tin, zinc, bakelite, gelatine, aldehyde resins, celluloid, celluloid esters, cellulose acetate, cellulose nitrate, all the "plastics," silica, tar, hydrates, and various waxes. These materials were tried unbacked, or flexible; rigid, i.e., backed with a base or carrier of cardboard, metal or glass, and also as applied surface coatings.

Other experiments included the use of mouldings, pressings, case-hardening surfaces, hardening surfaces by baking, and softening surfaces (before cutting), then subsequently hardening and polishing by chemical solutions. In addition, all commercial blanks obtainable in England, and several types from America and the Continent, were tested.

After this exhaustive consideration of all recording materials, I would like to corroborate Mr. Bradford's statement that the "Simplat" glass disc is the best for direct, or instantaneous recording. There are two or three other blanks purchasable that are very good, and cheaper in cost than the "Simplat," but I find the latter successful from all technical viewpoints.

The "Simplat" surface cuts cleanly, it will permanently "hold" a wide frequency response, it will carry transients well, it has a long playing life, and the surface-noise can be less than that on the average professional solid stock record.

To conclude, may I correct Mr. Bradford's impression, as mentioned in his article, that the surface covering on the "Simplat" disc is of cellulose? The coating is gelatine, mixed with a water soluble oil, plus a colouring dye; the hardening fluid is formaldehyde, and the polishing fluid a compound of waxes.

Ilford, Essex. D. ALDOUS.

"Inter-line" Synchronising

IN von Ardenne's book "Television Reception," just issued, he attributes the present television synchronising system by which a signal is interposed between every line traversed to Dr. Schriever in June, 1933. In fairness, it should not be forgotten that "inter-line synchronising" received its first mention in your issue of July 3rd, 1929, where the statement appears "To interpose a synchronising signal between each successive traverse of the object at the transmitter is a logical suggestion." Prior to this, television had no system of synchronising and without synchronising there could be no television. The proposal contained in the article was quickly acted upon, for shortly afterwards it was adopted by the Baird Company in their arrangement whereby the inter-line synchronising signal was applied to a phonic wheel, and the effect of this was that their system at once became a working proposition. To use such a signal in conjunction with a cathode ray tube embodies even less novelty, as cathode-ray time bases have invariably adopted circuits wherein provision is made for injecting a synchronising beat. To *The Wireless World* and its contributor, F. H. Haynes, therefore, goes the credit of inter-line synchronising, by which the present vogue of television was made possible.

London, N.15. B. RUDDER.

UNBIASED

By FREE GRID

SOS

I WONDER if any of you who are gardening experts could spare the time to give me a little advice concerning this hobby in return for the many valuable wireless hints and tips that I have conveyed to you in these columns? Although it is horticultural advice that I need, my problem is really of a radio nature.

Briefly, my trouble is that I am haunted by mistletoe, which is slowly and surely strangling my wireless mast to death. I don't know why it possesses such an affinity for my mast, although I am told it is because the latter consists of the trunk of an old apple tree which was flourishing at the bottom of the garden when I took the house. This tree was of considerable age and had an exceptionally tall trunk, and so it was a simple matter for me to saw off all the boughs and thus possess myself of a mast which was really and truly rooted in the ground and therefore not likely to collapse by reason of the base rotting.

This answered my purpose very well, although I well remember that at the time there was a great outcry among sentimentalists in the neighbourhood, who quoted nauseous rubbish about "the shade of the old apple tree" and similar poetic nonsense. All went well until Mrs. Free Grid was foolish enough to dump the remnants of the Christmas decorations at the base of the pole, and apparently the mistletoe among them, revived by the near presence of the ex-apple tree, took heart and started to commence life afresh.

At first I remember I foolishly thought that the mistletoe-entwined pole looked rather pleasant and I let it go on until it began seriously to affect the efficiency of my reception, when I did some vigorous pruning. Unfortunately, however, I had let things go too far and the mistletoe had got a firm hold on life, and even though I prune it regularly every week-end it has been slowly gaining on me for some months past and things have now come to a pretty pass, as you can see by the accompanying photograph.

A few weeks ago I determined on drastic measures and obtained a generous supply of arsenic, although not without much signing of poisons books and a suspicious look on the part of the chemist, who seemed reluctant to supply my needs. Unfortunately, however, the arsenic has proved a complete failure, since not only is the mistletoe still hale and hearty, but I regret to say that Mrs. Free Grid's most cherished chrysanthemums have passed into a coma and are almost beyond the aid of artificial respiration. Furthermore, the trouble seems to be spreading rapidly, as some Michaelmas daisies in an adjoining bed are looking distinctly pale, while the cat has gone off its feed.

You will understand the desperate nature of my plight when I tell you that Mrs. Free Grid, who is spending a week or two at the seaside and knows nothing of the illness afflicting her wretched plants, may be back at any moment. I hope, however, by the despatch of money, to keep her on holiday until such time as the horticultural experts among you can assist me with advice as to the best methods to adopt in order to counteract the effects of arsenic. Needless to say, I should also welcome advice on how to keep the mistletoe in check, for, as mentioned above, it is choking the life out of my wireless pole, and soon I shall be entirely bereft of any wireless entertainment. In order to lend wings to your pens, I may mention that I am not feeling any too well myself.

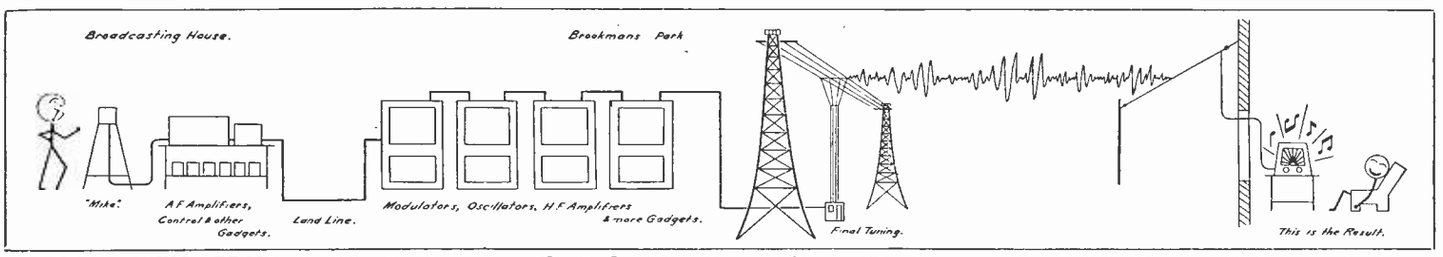
As you can see here, things have now come to a pretty pass.

More Teletroubles

I SEE that there is a great deal of speculation concerning the precise form which should be taken by the television interval signal when the regular programmes start. There was quite enough ado about the interval signal for ordinary broadcasting, and even now many people are far from being satisfied with the sound of Bow Bells. I gather, however, that this will pale into insignificance in comparison with the rumpus that is likely to arise over the visual signal.

It is quite obvious, of course, that something will have to be caused to appear on our television screens during the intervals between the various programme items. If our screens are simply left blank many people will be apt to jump to the conclusion that their television set has broken down and forthwith proceed to disembowel it. So far, I understand, the B.B.C. have hit upon no original ideas, but are proposing to show something which is placid and likely to inspire confidence, such, for instance, as the image of the director-general. The obvious objection to that is, of course, that as in the case of the cinema, the very essence of a television show is life and movement rather than placidity.

It would be quite easy, of course, to send a moving picture of Bow Bells ringing, this being derived from a record—or, in other words, a film—just as the sound one is. I cannot help thinking, however, that this would be exceedingly tame and that something more exciting is called for, but for the life of me I cannot offer any suggestions at the moment. There must surely be some of you, however, who can think of something to help the B.B.C. out of its trouble. Remember that the "signal" can be as complicated as you like, since it will, of course, be recorded on a cinema film. You should, when sending your suggestions to the B.B.C., not omit mention of my name as, if you do this, you will, I assure you, receive special attention.



BROADCASTING FROM A TO Z.—A reader, Mr. C. Scarlett, who contributes this picture, suggests that if we publish it no further articles on Broadcast Transmission will be necessary.

Current Topics

EVENTS OF THE WEEK IN BRIEF REVIEW

Royal Radio Amateur

PRINCE Mohammed Abdul Monnen of Egypt has just passed the French test for amateur transmitters and has received his licence for the operation of a short-wave station.

New Short-wave Station

THE Czechoslovakian broadcasting authorities have been very busy erecting a new short-wave transmitter at Podiebrad, the famous bathing resort. At present the station is not open for public service, but is experimenting with wavelengths of 10.06, 25.51 and 49.05 metres.

South African B.B.C.

AS in the case of the B.B.C., the privately owned company which has been hitherto responsible for South African broadcasting is to pass into the hands of a public-utility corporation. The corporation has acquired all the assets of the private company for £150,000, this sum being fixed by arbitration. Although the corporation has been founded by Act of Parliament, it is stated to be completely free of Government control.

Mayor Appointed Announcer

SO far as is known, no man has yet combined the posts of wireless announcer and mayor of a town. This honour will now fall to the Mayor of Ercé, a town of 2,600 inhabitants in France, who has recently been appointed as an announcer on the staff of the P.T.T. Thus the voice of the mayor of this small town will be heard throughout France, a distinction of which the mayors of many of the largest cities cannot boast.

I.E.E. Wireless Meetings

THE following are the dates of the meetings of the I.E.E. Wireless Section for the 1936-37 session: November 4th, December 2nd, January 6th, February 3rd, March 3rd, April 7th, May 5th. It should be noted that the meetings are always on a Wednesday.

Taxi Radio Slump in France

LAST year there was a tremendous boom in wireless sets for French taxis, but this seems to have been purely a passing phase, as 3,000 of the licences have not been renewed this year. This state of affairs is thought to be the reason why in certain parts of France the net increase in the total number of wireless licences has been exceptionally small during the past few weeks.

Austrian Licences

THE numbers of listeners in Austria has now risen to 357,465. The powers that be are far from satisfied with these figures, however, and are making a great effort to increase the number to half a million by Christmas.

India Anxious for Wireless Progress

A PROPOSAL has been made to form an Indian Radio Relay League, its constitution being based on the American Radio Relay League. It is complained that India has not kept abreast of other countries in the matter of wireless progress, and that this has been due to the absence of any proper organisation for furthering amateur wireless interest.

Craftsmanship Competition

THE Physical Society announces that the eighth annual craftsmanship and draughtsmanship competition will be held, as usual, in conjunction with its annual exhibition of scientific instruments and apparatus in January next. Competitors must be in the regular employ of a firm or institution which will be exhibiting or has exhibited at least once during the previous three years.

Football Commentaries and Gate Money

FOR some time there has been a dispute in Italy concerning the broadcasting of running commentaries on football matches. The football authorities complain, as has been the case elsewhere, that if a commentary is broadcast the gate-money is seriously reduced, as many people who originally intended to be present at the particular match broadcast prefer to listen-in at home. An agreement has now been reached whereby one football match is allowed to be broadcast every Sunday afternoon. No announcement is to be made in advance as to which particular match is to be dealt with, and it is hoped that by this means no detrimental effect will be had on the attendance figures.

French Radio Film

A SPECIAL film dealing with "The Mystery and Glory of Radio" has been prepared in Paris with a view to popularising wireless. It has been done by a well-known film company in conjunction with a famous French radio factory and a popular broadcasting station. Names are not disclosed. Leading broadcasting artistes appear in it, and apart from this there is a section dealing with the assembly of a wireless receiver in the factory and the technical processes in a broadcasting station.

Morse Mangling

AMATEUR transmitters are justly renowned for their technical knowledge, while their operating skill is of no mean order. In respect to the latter ability, however, there are a few morse manglers who are apparently in the habit of sending with their foot, as it is difficult for a skilled listener to distinguish some of their dots from their dashes. A well-known short-wave listener is said to have conceived the idea of taking a tape recording of the sending of certain offenders and forwarding it to them. It seems highly probable, however, that this will prove merely a waste of time and money, since such offenders have usually proved quite impervious to repeated complaints in the past.

Another Death-ray ?

REMARKABLE happenings are reported from Archangel, where cars are said to be breaking down with monotonous regularity in the vicinity of a wayside garage. All efforts to restart the engine are unavailing, and cars have to be towed into the garage, where engine power seems to be miraculously restored without any actual adjustments being carried out. The matter has been investigated by the authorities, who lay the blame on "a peculiar effect of terrestrial magnetism which apparently affects the ignition." Other explanations suggest themselves when it is remembered that as far back as 1920 or thereabouts a "death-ray" inventor successfully demonstrated that it was possible to stop a petrol engine at distances of a few feet by means of ultra-short-wave transmissions of a special nature.

Sydney "Sun" Photo.

AUSTRALIA'S BIGGEST "S.B."—When the Rt. Hon. J. A. Lyons, Prime Minister of Australia, recently spoke on the trade situation with Japan his voice was broadcast over the vast area of the Commonwealth through 95 government and commercial stations, linked by over 18,000 miles of telephone line.

Back to 1922

A WELL-KNOWN London firm of loud speaker manufacturers recently received an enquiry which read as follows: "Can you supply and fit a loud speaker to my portable wireless set which, since the alteration in wavelength, is no longer satisfactory?" We thought that this sort of thing had died out long ago.

Wireless Fans Flames

A GROUP of scientists who have been experimenting with the effect of Hertzian waves on flames originating through gaseous mixtures, are reported to have made some remarkable discoveries. It is stated that under the influence of a five-hundred-metre wavelength an oxygen-acetylene flame is greatly increased in intensity, a given quantity of gas being consumed in half the normal time. At 20 metres the effect disappears entirely, but reappears at 8.8 metres. The research workers attribute this effect to "the agitation of the molecules of the gas by ionisation due to the passage of the waves." They do not, however, offer any reason for the phenomenon only occurring at certain critical wavelengths.

THE special issue of *The Autocar*, on sale to-day (October 9th), is the first of three special numbers dealing with the Motor Show. A complete show report will appear on October 16th and a review of progress on October 23rd.

Welding with Thyratron Control

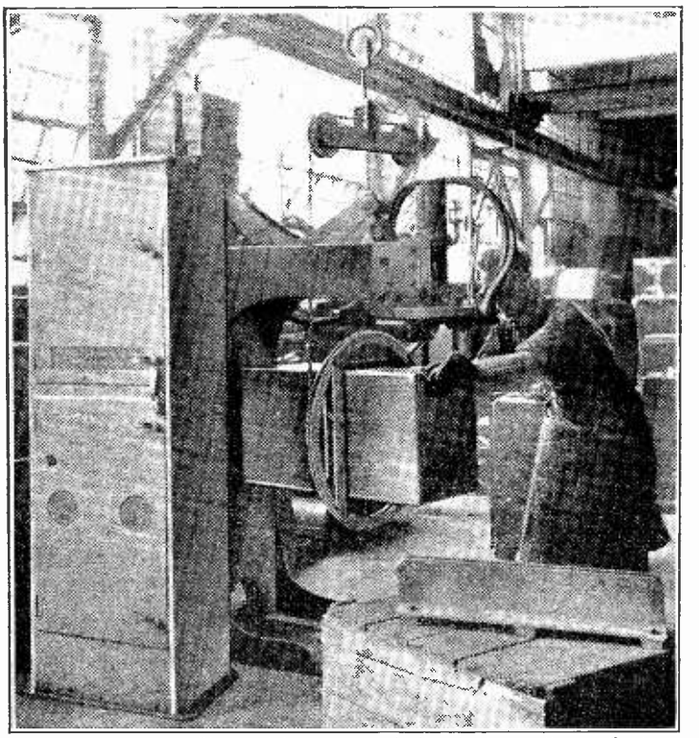
ELIMINATING ERRORS DUE TO THE HUMAN ELEMENT

By HARLEY CARTER

THE radio engineer, accustomed to think in terms of frequencies ranging up to many millions of cycles per second, and realising that thermionic tubes can respond to such frequencies with great accuracy, is apt to overlook the fact that his brother, the mechanical engineer, while normally dealing with time-cycles of much longer duration, sometimes has to face problems involving periodic operations which, although far below radio frequency, are too rapid to be controlled purely mechanically. To an ever-increasing extent thermionic tubes are being used to assist the heavy engineer in such cases.

One such application is in resistance welding, in which the metals to be joined are pressed together and a low-voltage AC source applied across the work, the comparatively high resistance at the point of contact generating sufficient heat to raise the metal to welding temperature. There are three main types of resistance weld—the spot weld, in which the work is positioned between two heavy copper electrodes which close on to the joint on the depression of a pedal by the operator; the continuous seam weld, in which the work is passed between two disc electrodes; and the intermittent seam weld, which employs a similar machine, but the welding current is interrupted regularly to give a series of overlapping spot welds. The latter is preferable to continuous seam welding because it reduces the risk of overheating and burning the work.

In both spot and intermittent seam welding, accurate control of the time during which the welding current is "on" is essential to ensure good quality work,



A continuous welding machine in which the current is controlled by Thyratrons.

Photograph by courtesy of the British Thomson-Houston Company.

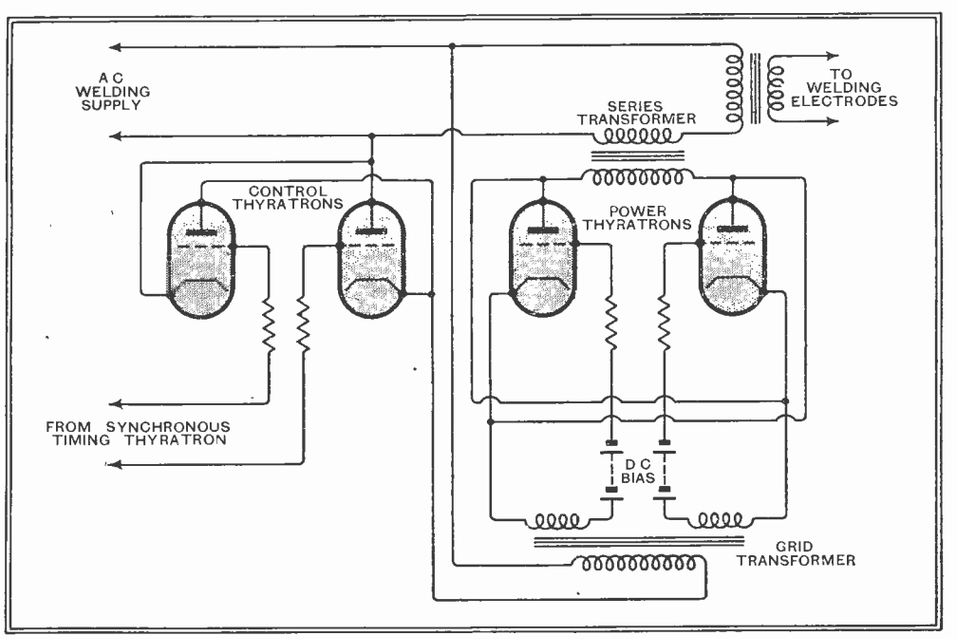
and it must be adjusted to suit the section of the material being welded. This period can be accurately controlled by Thyratron tubes.

The simplest application is for spot welding in which the welding contacts are applied by pressure upon a pedal. In uncontrolled welding, the duration of the welding current is determined by the length of time for which the operator keeps his foot on the pedal. The human element can be avoided by a circuit in which the operating pedal not only closes the welding current contactor, but also opens a second contactor which permits the grid of a thyratron, previously held at a definite negative bias, to build up to the critical voltage at which the thyratron will pass current, the time taken to reach this voltage being accurately adjustable by varying the grid leak resistance. In the anode circuit is inserted the trip coil of the welding contactor, and when the Thyratron becomes conducting, the welding contactor opens.

For more accurate timing, such as that required in high-speed intermittent seam welding, contactors are dispensed with, the welding control being synchronised with the periodicity of the AC supply.

The basis of the control is a "synchronising unit," which is a single Thyratron adjusted to become conducting at regular intervals at a certain point on the voltage wave of the AC supply, the range of adjustment including an almost endless variety of combination, such as one cycle "on" and one cycle "off"; three cycles on and six cycles off; and so forth.

The synchronous timer regulates the main circuit, which is shown diagrammatically in the figure. The synchronising unit controls the grid circuits of two small Thyratrons, whose anode circuit is completed through the primary of a transformer having two secondaries, one connected in the grid circuit of each of two main power Thyratrons and working in series with a pre-adjusted negative DC biasing supply. At those times when the small control Thyratrons are conducting, the voltages developed in the grid transformer secondaries render the grids of the power Thyratrons positive at a definite point in the voltage wave, and the power Thyratrons become conductive so long as this positive voltage appears every cycle. During the period when these tubes are conducting they act as a short circuit across the secondary of a series transformer, the primary of which is included in the welding supply, and therefore practically the whole of the line voltage becomes available across the primary of the welding transformer, permitted a weld to be made. When, however, the power Thyratrons are rendered non-conducting, the secondary of the series transformer is, in effect, open-circuited, and the primary, acting as a choke, reduces the voltage across the welding transformed primary to a negligible value, while grid control of the power tubes also controls the welding current.



Basic circuit for Thyratron control of welding current "duty-cycle."

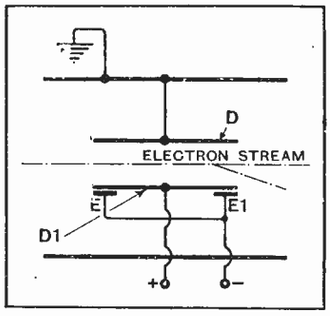
Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

CATHODE-RAY TUBES

THE electron stream through a cathode-ray tube may be undesirably influenced by the marginal fields set up near the ends of the usual deflecting-electrodes. To offset this tendency, one or more auxiliary electrodes are arranged so as to neutralise the fields in question.

For instance, if the upper electrode D is anchored to earth, disturbing "transverse" fields are likely to occur near the two outer



Arrangement of special electrodes in cathode-ray tube described in Patent No. 449245

margins of the condenser formed by the two electrodes D, D1. According to the invention, such fields are counterbalanced by arranging two suitably charged plates E, E1 in the positions shown in the drawing.

Radio-Akt D. S. Loewe. Convention date (Germany) October 23rd, 1933. No. 449245.

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MOUNTING "ACORN" VALVES

IN the so-called "Acorn" type of valve used for ultra-short-wave working, the top and bottom of the glass bulb are both sealed off in a "pip," and the leads to the electrodes are brought out radially, as shown, for instance, at T, T1, in Fig. 1, from a central flange F. In order to reduce the external inductance and capacity to a minimum, the valve is mounted in a holder consisting of a baseplate B fitted with a number of U-shaped spring contacts S, shown enlarged in Fig. 2. The baseplate is fitted with an upper protecting plate P of insulating material formed with a series of slots Q. The radial leads T are first inserted through the slots Q, and the valve pushed down into contact with the baseplate. It is then given a slight turn or twist so as to force the leads under the flanges of the spring contacts S.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of B. Selzberg). Convention date (U.S.A.) September 12th, 1934. No. 447461.

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FINE TUNING

ANY initial mistuning of the circuits of a wireless receiver is automatically adjusted by virtue of the fact that a change in the bias on the outer grid of a hexode valve automatically alters the reflected capacity across the input circuit of that valve. The capacity in question is arranged in shunt with the tuning-condenser of the local oscillator valve, which is, in consequence, readjusted to bring the receiver accurately into step with the incoming signal wave.

As shown in the drawing, the output circuit of the intermediate-frequency valve V consists of a series-tuned circuit L, C. The voltage across the inductance L is applied to one, and the voltage across the capacity C to the second of the two diodes of a rectifier D. Should the set be correctly tuned, there will be no resultant voltage across the two load resistances R, R1, since these are arranged in opposition. Any initial mistuning, however, upsets the balance and so applies an additional bias to the grid G of the hexode control valve V1. This, in turn, will alter the effective capacity of the input circuit of that valve, which, being in shunt with the tuning condenser C1 of the local oscillator circuit, automatically brings about the desired adjustment.

R. E. Spencer. Application date December 14th, 1934. No. 449391.

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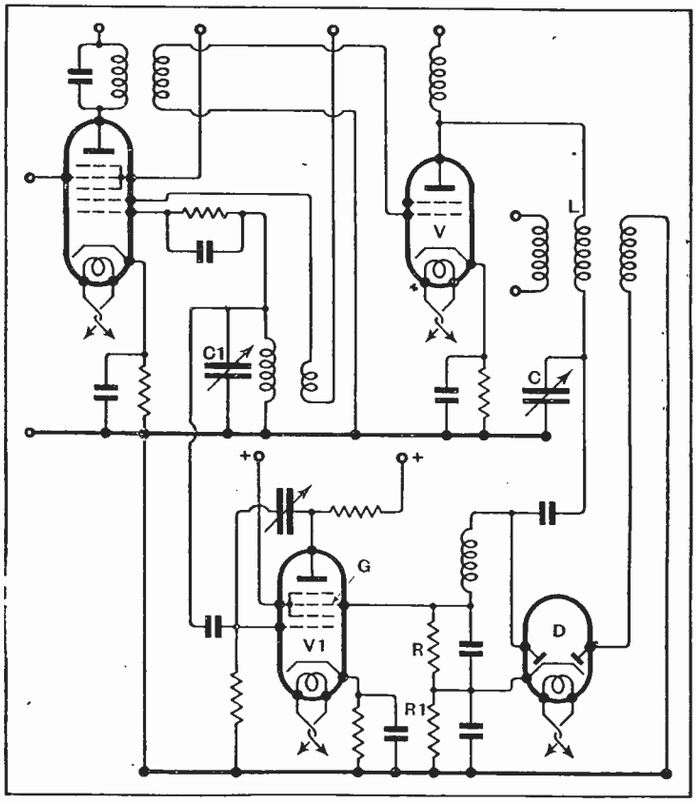
TELEVISION

FOR televising a local event at some point distant from the main transmitter, it is desirable that the portable "pick-up" apparatus should be kept as light and compact as possible. The usual time-base circuits for synchronising are accordingly dispensed with. In their place, synchronising signals are radiated from the main transmitter and are picked up by a suitable receiver included with the portable gear. The signals are then amplified and applied to control the working of the portable television camera or "pick-up" apparatus. The final signals, including the synchronising impulses, are either fed by line or radiated back to the main transmitter.

Telefunken Ges. fur Drahtlose Telegraphie m.b.H. Convention date (Germany) March 26th, 1935. No. 450303.

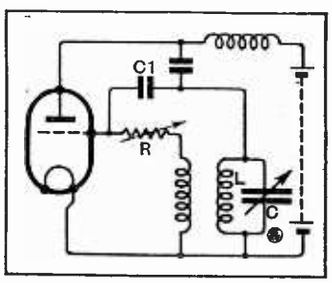
VALVE OSCILLATORS

THE circuit shown is designed to offset the effect of valve-curvature and other factors, such as a fluctuating supply-voltage on the frequency-stability of a back-coupled valve. This is ensured by providing, in addition to the tuned back-coupling circuit L, C,



Circuit for automatic tuning correction

an "anti-reaction" condenser C1, which feeds back energy from the anode to the grid in the sense opposing self-oscillation. The impedance of the condenser C1 decreases with increasing frequency, so that it is particularly effective in offsetting any tendency to produce harmonics. In addition a variable resistance R is used to control the amplitude of the generated oscillations until only the fundamental frequency persists; it also limits the effect of



Method of obtaining good frequency stability in a valve oscillator.

the capacity C1 upon the frequency-determining circuit L, C.

L. H. Paddle. Application date January 2nd, 1935. No. 449871.

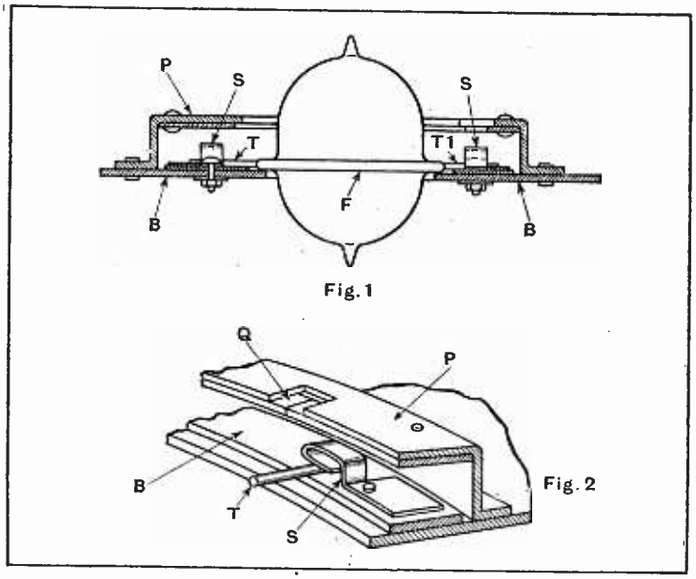
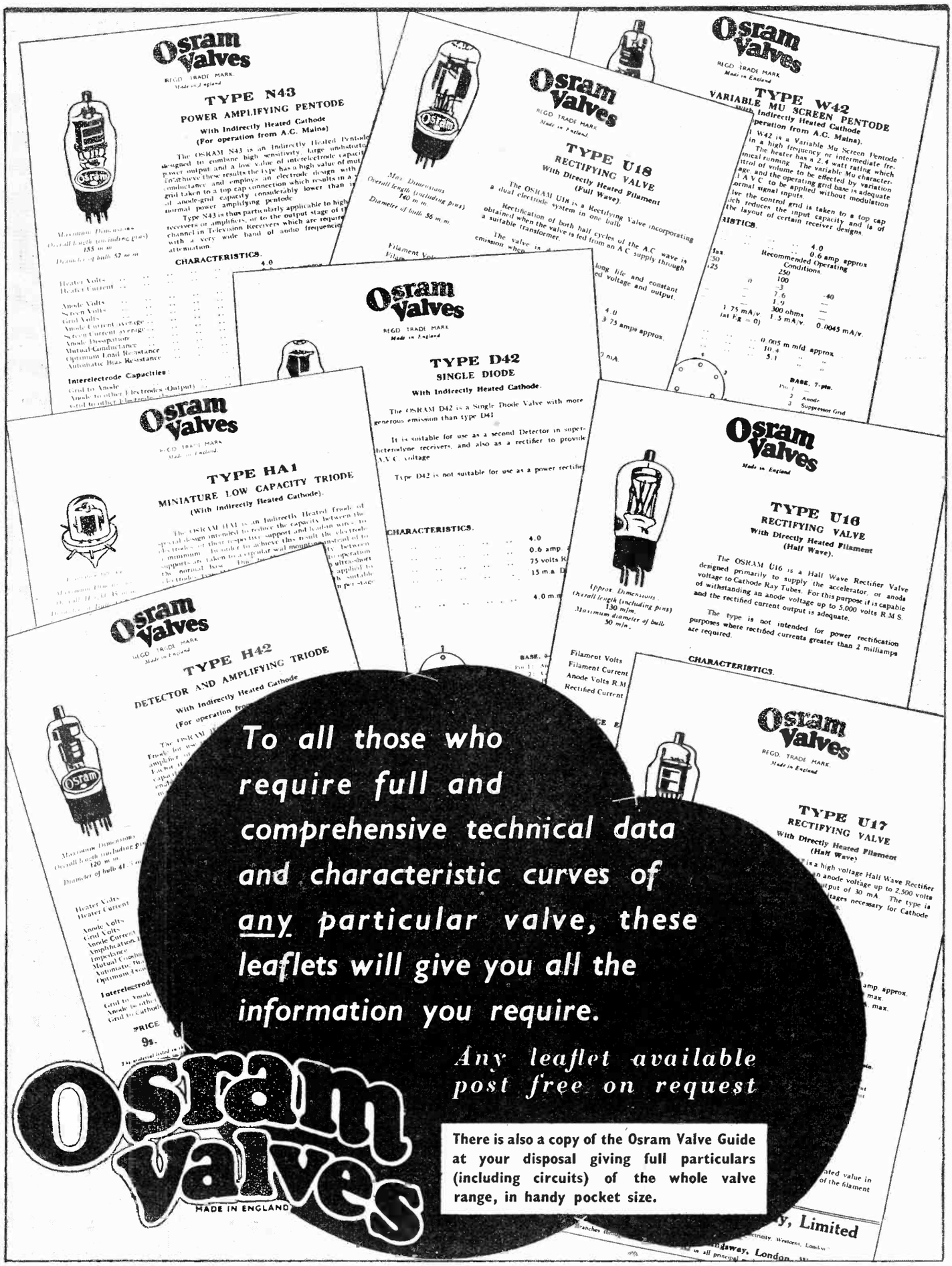


Fig. 1.—Low-capacity holder for "Acorn" valves. Fig. 2.—Enlarged view of one of the spring contacts.



Advt. of The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.

Mention of "The Wireless World," when writing to advertisers, will ensure prompt attention.

MISCELLANEOUS ADVERTISEMENTS

NOTICES

THE CHARGE FOR ADVERTISEMENTS in these columns is

12 words or less, 3/- and 3d. for every additional word.

Each paragraph is charged separately and name and address must be counted.

SERIES DISCOUNTS are allowed to Trade Advertisers as follows on orders for consecutive insertions, provided a contract is placed in advance, and in the absence of fresh instructions the entire "copy" is repeated from the previous issue: 13 consecutive insertions 5%; 26 consecutive, 10%; 52 consecutive, 15%.

ADVERTISEMENTS for these columns are accepted up to **FIRST POST on MONDAY MORNING** (previous to date of issue) at the Head Offices of "The Wireless World," Dorset House, Stamford Street, London, S.E.1, or on **SATURDAY MORNING** at the Branch Offices, 19, Hertford Street, Coventry; Guildhall Buildings, Navigation Street, Birmingham, 2; 260, Deansgate, Manchester, 3; 26B, Renfield Street, Glasgow, C.2.

Advertisements that arrive too late for a particular issue will automatically be inserted in the following issue unless accompanied by instructions to the contrary. All advertisements in this section must be strictly prepaid.

The proprietors retain the right to refuse or withdraw advertisements at their discretion.

Postal Orders and Cheques sent in payment for advertisements should be made payable to ILIFFE & SONS Ltd., and crossed & Co. Notes being untraceable if lost in transit should not be sent as remittances.

All letters relating to advertisements should quote the number which is printed at the end of each advertisement and the date of the issue in which it appeared.

The proprietors are not responsible for clerical or printers' errors, although every care is taken to avoid mistakes.

NEW RECEIVERS AND AMPLIFIERS

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DEGALLIER'S, Ltd.—Again, owing to increased business, we have to extend our premises now at 18, Connaught St., Marble Arch, W.2.—The firm for reliable short wave radio (1937), have on show in London the largest selection of fully guaranteed brand new all-wave receivers; callers invited to handle all at their leisure without obligation to purchase; all S.W. receivers guaranteed to get stations on the low bands, including the Americas, etc. Hours of business 10 a.m.-7 p.m., Saturdays 9 p.m. All goods cash with order or c.o.d.; send 2d. stamp for beautifully illustrated catalogues and full reports by technical department of this journal on Challenger receivers.

WE Guarantee to Receive the American Transmissions at full programme strength after 4.30 p.m. daily; those interested welcomed without obligation

6/6 Each, Valves, "never before such a bargain," every one a first, no throw-outs or seconds, metal, metal-glass, glass counterparts, and glass: 1a6, 1b5/25s, 1c6, 1v, 2a3. 2a5, 2a6, 2a7, 2b7, 5y3, 5z4, 6a6, 6a8, 6b5, 6b7, 6c5, 6c6, 6d6, 6e5, 6e6, 6f5, 6f6, 6f7, 6h6, 6j7, 6k7, 6L6, 6L7, 6Q7, 6z5/12Z5, 10, 12a, 12a5, 12a7, 12z3, 15, 18, 19, 22, 24a, 25y3, 25z5, 26, 27, 30, 31, 32, 32, 34, 35/51, 36, 37, 38, 39/44, 41, 42, 43, 45, 46, 47, 48, 49, 50, 53, 55, 56, 57, 53, 59, 71A, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 89; 6r7, 25a6, 25z6, 6n7, 6X5, 5W4. Line cords for American Midgets, 4/9.

£3/10.—5-valve Midget T.R.F., medium and long wave, 7X, 10X6, A.C./D.C., 200-250 volts, carriage 1/4; also several others at £2/15, £4, £4/10, and £4/2/6.

£7.—"Challenger" Table Model 6-valve superhet, 3 bands, 16-52, 190-550, 900-2,000 metres, A.V.C. tone control, P.U., terminals (17×13×9), A.C./D.C., 100-250 volts; carriage 4/-.

£8.—"Challenger" Table Grand Model 6-valve superhet, "Mono-vision" tuning control, A.C. 200-250 volts, 3 bands, 18-55, 190-550, 800-2,000 metres, 3½ watts output, tone control, delayed A.V.C.; carriage 4/6; (16½×16×8).

£9.—Challenger Car Radio 6-valve superhet, no interference, A.V.C., remote control, definitely no suppressors needed on plugs, carriage 4/3; also the R.C.A. Car Aerial, "the last thing," 15/- post paid.

13 Guineas.—The New Challenger 8 (type 800) table model de luxe, 22×18×12, high fidelity 8-valve superhet, A.C., 200-250 volts, 4 distinct bands, 11-39, 39-108, 190-550, 900-2,000 meters; this receiver has the following improvements and additions over the last series of the famous Challenger 8: wave bands calibrated in meters and station names, simplified centralised tuning, super Vernier, slow-fast tuning, self-contained control panel, perfect tone quality at low volume, new type 10 inch M.C. speaker, from a whisper to 8 watts pure undistorted tone, no overloading at full volume, oscillator fundamental without use of harmonics, persistent oscillator of highest output, isolating filters eliminate oscillation and motor-boating, fully delayed A.V.C. bias, abso-

(This advertisement continued in third column.)

We don't pull the Wool over your Eyes

The other day I was in the shop of one of our Yorkshire dealers, and on the wall I saw a poster issued by one of the well-known mass-production set makers. It showed a Yorkshire lad and his wife standing before Big Ben and below was writ this statement: "Nay lass—it's nowt like as real as our. . . ."

Not being a specialist in writing advertisements, I may be unable to appreciate the humour of this, but it did bring home to me the fact that there are millions of listeners who kid themselves that what they hear on their radio sets is what they fondly imagine to be a reproduction of what happens in the studio.

It isn't; not even on a Hartley-Turner receiver is it. But—and here is the point—if you have any sort of desire to start a spot of debunking your poor old ears, then I do think that you should not take your radio set too seriously. If, on the other hand, you insist on taking your radio seriously, then I think you should also use your discriminative faculties.

Before I ever thought of Hartley-Turner, I was fond of music, and not only was I fond of it, but I understood it. In the course of wandering up and down the countryside, I meet a lot of people who profess to understand music and to recognise the reproduction of it. The amount of arrant nonsense that is talked about the subject is a source of amusement to me, because I have got to the stage when I can laugh at people instead of getting 'cross with them.

I can listen to Hartley-Turner reproduction with pleasure; not because I am Hartley but because I am still fond of music and understand it. I wish that those who often talk nonsense about musical reproduction would take the trouble to remind themselves what music really sounds like, and then they would realise what I am getting at.

I did not say that you cannot listen to any other "make" of reproduction. I only infer that I do not find Hartley-Turner reproduction nearly so offensive as all the others that I have heard.

H. A. Hartley

Full particulars gladly sent on request.

HARTLEY-TURNER RADIO LTD.,
THORNBURY ROAD,
ISLEWORTH, MIDDLESEX.
Telephone: HOUnslow 4488.

NUMBERED ADDRESSES

For the convenience of private advertisers, letters may be addressed to numbers at "The Wireless World" Office. When this is desired, the sum of 6d. to defray the cost of registration and to cover postage on replies must be added to the advertisement charge, which must include the words Box 000, c/o "The Wireless World." All replies should be addressed to the Box number shown in the advertisement, c/o "The Wireless World," Dorset House, Stamford Street, London, S.E.1. *Readers who reply to Box No. advertisements are warned against sending remittance through the post except in registered envelopes: in all such cases the use of the Deposit System is recommended, and the envelope should be clearly marked "Deposit Department."*

DEPOSIT SYSTEM

Readers who hesitate to send money to advertisers in these columns may deal in perfect safety by availing themselves of our Deposit System. If the money be deposited with "The Wireless World," both parties are advised of its receipt.

The time allowed for decision is three days, counting from receipt of goods, after which period, if buyer decides not to retain goods, they must be returned to sender. If a sale is effected, buyer instructs us to remit amount to seller, but if not, seller instructs us to return amount to depositor. Carriage is paid by the buyer, but in the event of no sale, and subject to there being no different arrangement between buyer and seller, each pays carriage one way. The seller takes the risk of loss or damage in transit, for which we take no responsibility. For all transactions up to £10, a deposit fee of 1/- is charged: on transactions over £10 and under £50, the fee is 2/6; over £50, 5/-. All deposit matters are dealt with at Dorset House, Stamford Street, London, S.E.1, and cheques and money orders should be made payable to Iliffe & Sons Limited.

SPECIAL NOTE.—Readers who reply to advertisements and receive no answer to their enquiries are requested to regard the silence as an indication that the goods advertised have already been disposed of. Advertisers often receive so many enquiries that it is quite impossible to reply to each one by post. When sending remittances direct to an advertiser, stamp for return should also be included for use in the event of the application proving unsuccessful.

NEW RECEIVERS AND AMPLIFIERS

(This advertisement continued from first column.)

lute minimum of noise, and sensitivity control for noise suppression. A.V.C. re-enforced capacitators prevent drift, pre-aged intermediate frequency transformers, I.F. barrier, discs anchor coil leads, plug in loud speaker, also provision for external speaker, moisture sealed out by tropical zone impregnation, self healing electrolytic condensers, one complete chassis of dreadnought construction, moderate voltages assure full valve life, economical to operate (consumption 45 watts), long life eliminates repairs, correct valve selection, no compromise, no hum, full weight transformer, true push-pull, stabilised high tension supply, stabilised biasses, ceramic coil insulation, fully loaded plate coils give maximum gain, pre-balanced coil assembly, matched sets of individual coils, no taps, sealed insulation, thin laminations of special silicon steel, 7 K.C. selectivity, fractional microvolt sensitivity, shielded switching permits high-gain, positive silver-plated contacts eliminate switch noises, audio frequency range 30-8,000 cycles, diode detection, prizmatone high fidelity R.F. preselector stages on all bands, carriage 6/- for experimenters, less cabinet deduct 15/-; if public address Rola, 12in. G.12 supplied in place of standard speaker add £2. (Note.—This speaker cannot be incorporated in table model cabinet.)

£17.—Challenger 8 Console 800C, height 3 feet 6 inches, width 24 inches, depth 12½ inches, chassis as incorporated in 800 model but incorporating the G.12 high fidelity 12in. speaker; carriage and crate 10/-.

29 Guineas.—"Challenger 800 R.G." radiogram with automatic record changer, measurements, height 2 feet 8 inches, width 3 feet, depth 21 inches; this also incorporates the G.12; carriage and crate 15/-.

NOTE.—The Challenger 800 is available for A.C./D.C. 200-250 volts, employing 11 valves, at an additional cost of 20/- on each model.

£16.—Challenger 12 A.C./D.C. 200-250 volts, the first time that D.C. users have been able to get 10 watts undistorted from their speaker, which is a large 12in. K. type Rola, triple parallel rectification, push-pull parallel four pentode output; carriage and crate 7/6; chassis, valves and speaker alone, £15.

£26/5.—Midwest R.T. 18 chassis, valves and P.A. speaker, 6 bands A.C. 100-250 volts, calibrated in metres and K.C. illuminated pointer indicator, silent tuning control, automatic visual band selector, metal valves, 36 tuned circuits, 10 tuned circuits in cascade, range 4½-2,400 metres, output 20 watts undistorted; carriage 10/-; also available in the Midwest D.C. cabinet at £36/15; carriage and crate 20/-.

£40.—Challenger 24-valve superhet twin chassis, valves and 2 speakers, handling 50 watts output, sensitivity ¼ microvolt absolute, tuned H.F. stages on all bands, 3 I.F. stages, the last one being used for selectivity only, frequency response at the speakers, within 2db, over whole range, wave band coverage 8-2,050 metres in 5 bands, magic eye tuning, variable selectivity; carriage 18/-; various cabinets available; this is the actual receiver that we supply to the Navy, Army and Air Force canteens.

DEGALLIER'S, Ltd., 18, Connaught St., Marble Arch, London, W.2. Paddington 2745. [2781

"Radio Data Charts," A Series of Abacs Post free 4/10

No. 7

Notes on the Suppression of Electrical Interference with Broadcast Reception

We are getting just a little impatient with people who tell us to send them an anti-interference unit provided we can guarantee that it will cure their trouble. This sort of thing is by no means confined to the non-technical section of the public.

We cannot guarantee that any one suppressor will cure every form of interference. For some reason best known to themselves, the public will buy an "anti-ference" aerial (if we may coin a word) more readily than any other form of device, but no such aerial can give immunity from mains-conducted interference which usually accompanies re-radiated and direct interference.

It is advisable and frequently essential to use some form of mains filter with every anti-interference aerial. Very few set-makers fit adequate filters as an internal component, because this would add a pound to the price of the receiver, and is not always required; therefore, one of the Belling-Lee set lead range is necessary.

There are rare cases where with an ideal "anti-ference" aerial system, and perfect mains filtration, it is still possible for strong directly radiated interference to be picked up by the receiver itself, which is generally incompletely screened. Here again we get the blame which in this case should rightly go to the set maker. However, we are glad to be able to state that with a good *"Eliminoise" aerial system and with set lead suppression, conditions will generally be found satisfactory.

A very great number of people who have installed set lead suppressors during the last two years and who have changed over to a modern all-wave receiver, find that they experience disappointing results due to interference below 50 metres. Last year's range, types 1211 and 1256, do not give suppression on this band, and must be replaced with type 300, which is efficient down to 10 metres and is designed to carry 1 amp.—price 21/-.

*Trade Mark.

PREMIER SUPPLY STORES

THE LARGEST RADIO MAIL ORDER HOUSE IN THE WORLD

Offer the following Set Manufacturers' Brand New Surplus Goods at a Fraction of the Original Cost; all goods guaranteed perfect; carriage paid over 5/-; under 5/- postage 6d. extra. Orders under 5/- cannot be sent C.O.D.

***ALL POST ORDERS TO* JUBILEE WORKS, 167, LOWER CLAPTON ROAD, LONDON, E.5**

CALLERS, AS USUAL, TO 20-22, HIGH ST., CLAPHAM, S.W.4 (Macaulay 2381) 'Phone: Amherst 4723

And 165 & 165a, FLEET ST., E.C.4 (Next door to Anderton's Hotel). **Central 2833.**

SHORT WAVES

SHORT-WAVE COILS, 4- and 6-pin types, 13-26, 22-47, 41-94, 78-170 metres, **1/9** each, with circuit. Special set of 3 S.W. Coils, 14-150 metres, **4/-** set, with circuit. Premier 3-band S.W. Coil, 11-25, 19-43, 38-86 metres. Simplifies S.W. receiver construction, suitable any type circuit, **2/-.**

COIL FORMERS, in finest plastic material, 1¼in. low-loss ribbed, 4- or 6-pin, **1/-** each.

SUPER CERAMIC CONDENSERS, S.L.F. .00016, .0001, **2/9** each; double-spaced, .00005, .000025, .000015, **3/-** each. All brass with integral slow motion, .00015 tuning, **3/9**; .00015 reaction, **2/9.** British Radiophone 2-gang .00016 with trimmers, **5/6.**

MAINS VALVES, famous Europa 4 v. A.C. types, **4/6** each: HL., L., S.G., Var.-Mu-S.G., H.F.-Pens., Var.-Mu-H.F. Pens. 1, 3 and 4-watt A.C. directly-heated output Pentodes. Full-wave rectifiers, 250 v. 60 m.a. **A.C./D.C.** types. 20-volt. .18 amp. S.G., Var.-Mu-S.G., H., HL., Power.
Following Types all **5/6** each. Full-wave rectifiers, 350 v. 120 m.a. and 500 v. 120 m.a. 2½ watt indirectly-heated Pentodes.
Frequency Changers, Octodes and Heptodes.

BATTERY VALVES. 2 volts, H.F., L.F., **2/3.** Power, Super-Power, **2/9.** S.G., Var.-Mu-S.G., 4- or 5-pin Pentodes, H.F. Pens, V.-Mu-H.F. Pens., **5/-.** Class B, **3/6.**

AMERICAN VALVES. Genuine American **HYTRON** first-grade Valves, 3 months' guarantee. All the following types: 1A6, 1C6, 2A3, 2A5, 2A6, 2A7, 2B7, 6A4, 6A7, 6B7, 6C6, 6D6, 6F7, 00A, 01A, 11, 12, 15, 18, 19, 20, 22, 24A, 26, 27, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39/44, 40, 41, 42, 43, 45, 46, 47, 48, 51, 53, 55, 56, 57, 58, 59, 71A, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 89, V99, X99, 112A, 1VO, 5Z3, 12Z3, 25Y5, 25Z5, 6A6, 6B5, 185R, **5/6** each. 210 and 250, **8/6** each. New Metal-glass Valves, all types, **6/6** each. Genuine American **DUOTRON** Valves, all types, **3/6** each.

VALVE HOLDERS for all above types, **6d.** each. Octal Bases, **9d.** each.

MAINS TRANSFORMERS

PREMIER wire-end type with screened primaries, and tapped 200-250 v. Centre-tapped (filaments guaranteed one year). **H.T. 8 & 9** or **H.T. 10** with 4 v. 4 a. C.T. and 4 v. 1 a. C.T., **8/6. 250-250 v. 60 m.a.,** 4 v. 1 a., 4 v. 2 a. and 4 v. 4 a., all C.T., **8/6. 350-350 v. 120 m.a.,** 4 v. 1 a., 4 v. 2 a. and 4 v. 4 a., all C.T., **10/6.** Any of these transformers with engraved panel and N.P. terminals, **1/6** extra. **500-500 v. 150 m.a.,** 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 3-4 a., all C.T., **19/6.**

AUTO TRANSFORMERS, step up or down, 60 watts, **7/6**; 100 watts, **10/-.**

SMOOTHING CHOKES, 25 m.a., **2/9**; 40 m.a., **4/-**; 60 m.a., **5/6**; 150 m.a., **10/6.** 2,500 ohms, 60 m.a. Speaker Replacement Chokes, **5/6.**

MILLIAMMETERS, moving-iron, flush 2½in., all ranges from 0-10, **5/9.** Visual tuning, 6 or 12 m.a. Moving-coil meters, 2⅜in.-0-1 m.a., **18/6**; 3½in. 0-1 m.a., **22/6.** Multipliers, **1/-** each.

ELECTROLYTICS. U.S.A. 4, 8 or 12 mfd. 530 v. peak, **1/9** each. **Dubilier,** 4 or 8 mfd 500 v., **3/-**; 50 mfd. 50 v., **1/9**; 12 mfd. 20 v. **6d.**; 25 mfd. 25 v., **1/-.** T.C.C. 4 or 8 mfd. 650 v., **4/-**; 15 mfd. 50 or 100 v., **1/-**; 50 mfd. 12 v., **1/-.**
Paper Condensers. W.E., 250 v. working 4 mf., **2/-**; 2 mf. **1/-**, 1 mf. **6d.**; 350 v. working 4 mf., **2/6**; 2 mf., **1/6**; Dubilier 500 v. working 4 mf. **4/-**; 800 v. 4 mf. **6/-.**
Wego 450 v. working 1 mf. **1/-**, 2 mf. **1/9**, 4 mf. **3/-**; 700 v. working 2 mf. **2/-**, 4 mf. **3/6.**

TRANSFORMERS, latest type Telsen R.G.4 (list 12/6), **2/9.** Lissen Hypernik Q.P.P. (list 12/6), **3/6.**

ELIMINATOR KITS for A.C. mains. 120 v. 20 m.a., or 150 v. 25 m.a., **10/-,** tapped S.G. det. and output. Complete Kit with long-life valve rectifier (replacement cost only 2/-).
High-grade **POWER PACKS** by prominent makers. Input 100-250 v. A.C. Output 220 v. at 40 m.a., 4 v. 3 a. C.T. Complete with valve rectifier, **16/6.**

PREMIER L.T. CHARGER KITS for A.C. mains, including Westinghouse Rectifiers and Tapped Mains Transformers. 8 volts at ½ amp., **14/6**; 8 volts 1 a., **17/6**; 15 volts 1 a., **19/-**; 15+15 volts 1 a., **37/6**; 15+15+15 volts 1 a., **50/-**; 8 volts 2 a., **29/6.**

TELSEN iron-cored screened coils, W.349, **4/-** each.
Electric **SOLDERING IRONS,** 200-250 v., A.C./D.C., **2/3.**

SHORT WAVE KITS

SHORT-WAVE KIT for 1-valve receiver or adaptor, complete with chassis, 4 coils, 14-150 metres, condensers, circuit and all parts, **12/6 VALVE GIVEN [FREE! DE LUXE MODEL, 17/6.** SUPERHET CONVERTER KIT, **13/6. 2-VALVE S.W. KIT, 19/6. VALVES GIVEN FREE! 3-VALVE S.W. KIT,** S.G. Det. and Pen., **42/-. VALVES GIVEN FREE!**

ALL-WAVE "ALL-WORLD RANGE" 3-valve Kit, 12-2,000 metres in 4 wavebands without coil changing, complete kit of parts with 3 valves, S.G., H.F., S.G. det. and pentode (2 volts); **50/-.** Q.P.P Model, **6/6** extra.

BAND-PASS TUNING PACK, comprising set of Telsen 3-gang iron-cored coils with integral switching, mounted on steel chassis with 3-gang condenser, illuminated disc-drive and 4 valve holders, **25/- the lot.** All Mains or Battery circuit. **FREE!**

LISSEN ALL-WAVE COILS, 12-2,000 metres, complete with switching and wiring diagram, **12/6.**

PREMIER AMPLIFIER KITS

3-WATT A.C. AMPLIFIER, 2-stage for mike or pick-up complete kit of parts with 3 valves; **40/-.**

SPECIAL OFFER! 12/6 P.M. Speaker, 35/- Transverse Current Mike, complete with transformer and 7/6 Stand. If purchased with above kit, **25/- the lot.**

7-WATT A.C./D.C. AMPLIFIER. 3-stage, high-gain, push-pull output. Complete kit of parts with 5 specially matched valves, **£4 4s.**

SPECIAL OFFER! 21/- pair Matched Speakers, 35/- Transverse Current Mike, complete with transformer and 7/6 stand. If purchased with above kit, **35/- the lot.**

10-WATT 3-stage A.C. Amplifier Kit with 5 valves, **£5 5s.**

SPECIAL OFFER! 21/- pair Matched Speakers, 35/- Transverse Current Mike, complete with transformer and 7/6 stand. If purchased with above kit, **35/- the lot.**

20-WATT 3-stage A.C. Amplifier Kit with 5 valves, **£8 8s. SPECIAL OFFER!** £6 pair P.M. Exponential Horn Speakers, 35/- Transverse Current Mike with transformer and 7/6 stand If purchased with above kit, **£5 10s. the lot.**

MOVING COIL SPEAKERS

MAGNAVOX. Mains energised. '154,' 7in. cone, 2,500 ohms 4 watts, **12/6**; '152,' 9in. cone, 2,500 ohms, **17/6**; '152 Magna,' 9in. cone, 2,500 ohms, 6 watts, **37/6. Magnavox** P.M.s—'154,' 7in. cone, **16/6**; '252,' 9in. cone, **22/6.** Reliable P.M.s, **10/6**; Cossor P.M.s, **13/6.**

ROLA latest type P.M.s, **18/6. KB** 7in. mains energised, 1,500 or 2,500 ohms, **7/9. GOODMANS'** 8in. mains energised, 1,000 ohms field, **10/6** each.

DIALS.—Clarion Illuminated S.W. slow-motion Dial with 2in. knob, **2/-. Premier** All-Wave 2-speed Dial, full vision straight-line, dual ratios 10-1 and 150-1, **6/6,** with escutcheon.

Potentiometers by well-known makers. All values up to 1 meg., **2/-**; with switch, **2/6.**

PREMIER (Reisz Pattern) Transverse-current MIKE, High Output, Straight Line Response, 30/-. Transformer, 5/-. Table Stand, 7/6.

GRAMOPHONE MOTORS Collaro Gramophone Unit consisting of A.C. motor, 100-250 v. high quality pick-up and volume control, **45/-**; Collaro motor only, **30/-**; Collaro Universal Gramophone Motor, 100-250 v., A.C./D.C., with high quality pick-up and volume control **67/6**; Collaro Universal Motor only, **49/6**; Edison Bell double-spring motors, including turntable and all fittings, **15/-**; Cosmocord Gramo unit, comprising A.C. motor pick-up and volume control (list 55/-), **35/9.**

TUBULAR CONDENSERS, non-inductive, all values up to .5 mfd., **6d.** each.

Wire-end **RESISTORS,** any value, 1 watt, **6d.**; 4 watts, **1/-**; 8 watts, **1/6**; 15 watts, **2/-**; 25 watts, **2/6** each.

Reliable **MORSE KEYS** with Morse Code engraved on bakelite base, **2/-** each.

Bakelite case **BUZZERS, 1/6**; "Loud-tone," **2/6** each.

Super Quality lightweight **HEADPHONES, 3/9** pair.

RECEIVERS. G.E.C., A.C./D.C. mains, 3-valve sets, complete with 3 Osram valves, in exquisite bakelite cabinet with Osram M.C. speaker, ready to plug in to any mains, brand new, in sealed cartons, fully guaranteed (list £7 15s.), **69/6.** Carriage paid.

H.F. CHOKES. S.W. 10-200 metres, **2/-**; S.W. screened, **1/6**; standard screened 180-2,000 metres, **1/6.**

HAVE YOU HAD OUR LATEST GIANT ILLUSTRATED CATALOGUE AND VALVE LIST? IF NOT, SEND 4d. IN STAMPS FOR THIS AMAZING LIST OF BARGAINS!

RECEIVERS AND AMPLIFIERS

CLEARANCE, SURPLUS, ETC.

CLEARANCE List (Trade Only).—Write Leonard Heys, 36, Henry St., Blackpool. [0527

SEND for Bargain List of Brand New Decontrolled Receivers; amazing prices.—P. A. C., Ltd., 54, Lamb's Conduit St., W.C.1. [2243

£3/15 for Full Size Table Grand Model 5-valve Superhet.; carriage paid; cash with order or c.o.d., or send for list of other equal bargains.—Kay, 1, Old Church Lane, N.W.9. Colindale 8266. [0535

BARGAINS.—5- and 6-valve 1936 superhets by well-known makers, reconditioned and guaranteed 3 months; cash with order, 7 days' approval; £7/7, or c.o.d.—Wyndham Trust, Station St., Birmingham. [2613

BATTERIES & CHARGING PLANT

2-AMP. 2-6v. Battery Charger, 21/-; 1-amp., 15/-; ½-amp. 10/6; 12v. car charger, 45/-.—Full particulars, Sussex Charger Co., 40, Western Rd., Hove. [2888

PUBLIC ADDRESS EQUIPMENT

SPECIAL Offer!!!

8½ Guineas Assembled; 8 guineas kit; Vortexion 20 watt 3-stage P.A. amplifier, in steel case, 8in.×10in.×9in. high, with carrying handle, input with controls for microphone and pick-up and tone control, output for 7½ and 15 ohm speakers, weight 25lb.; only 8½ guineas, with valves.

VORTEXION, 182, The Broadway, Wimbledon, S.W.19. See also New Mains Equipment. [2787

PUBLIC Address Work Undertaken.

P.A. Vans for Hire, stationary equipment for fetes, conferences, etc., portable equipments for small dances, etc.

ROSS and ROBINSON, Ltd., 8, Western Circus, W.3. [0521

HIGH-GRADE, Flexible and Inexpensive P.A. Equipment is fully described in the Partridge P.A. Manual, including:—

12W. Amplifier, with mixing circuits, etc., costing £8 to construct; 30W. ditto, £10, complete with valves; also gives all necessary information on line technique, where to obtain suitable mikes, speakers, etc.; free trade only from:—

N. PARTRIDGE, B.Sc., A.M.I.E.E., King's Buildings, Dean Stanley St., London, S.W.1. [2800

12-WATT A.C. Amplifier, motor, pick-up, in cabinet, separate speaker; £12/10.—Welfare Secretary, J. and P. Stott, Ltd., Heybrook, Rochdale. [2848

TANNOY Transportable G.A.60 Amplifier, A.C., output 20 watts, complete with 2 Tannoy P.S. speakers, new Tannoy microphone, E.D.C.C. 250-watt convertor, steel silence cabinettte, spare D.A.60 G.U.1 valves, perfect condition; accept £49, or near offer, a bargain.—W. Littler, 2, Barras Lane, Coventry. 'Phone: 5933. [2873

USED SETS FOR SALE AND WANTED

HARTLEY-TURNER

HARTLEY-TURNER 1936 Quality Receiver Chassis, in perfect condition, output 12 watts; sacrifice, £23.—Further particulars write P.O., Gasstown, Dumfries, Scotland. [2863

HYVOLTSTAR

1936 Hyvoltstar Universal All-wave Superhet Ten De Luxe Horizontal Table Model, as new; cost 43 guineas, best offer.—Box 9488, c/o *The Wireless World*. [2856

R.G.D.

R.G.D. 1202 Automatic Radiogram, new November, 1935, in new condition, only used 3 months; cost £112/7, will accept 45 guineas.—Apply T. and E. Hammond, Penn Rd., Beaconsfield, Bucks. Telephone: Beaconsfield 393. [2847

MISCELLANEOUS

WE Specialise in Modern Used Radio, and hold large stocks of mains sets by noted makers, and all reconditioned and in perfect order, which we offer at cash balgain prices; stamp for lists.—Radio Mart, Henderson Rd., Eastney, Portsmouth. [2746

TWO "Wireless World" Sets, 6-watt A.C. Quality amplifier, dual Rolas, Collaro motor, Marconi pick-up, fitted in splendid 150-record cabinet, £12; Monodial A.V.C. A.C. Super, 6-watt power, Rola speaker, modern cabinet, £12; call and hear.—Hunt, 18, Aberdeen Rd., London, N.5. [2855

NEW MAINS EQUIPMENT

ALL POWER TRANSFORMERS, Ltd.—Transformers and chokes embodying all the best in design; no better value at any price; Radiolympia models; tapped and screened primaries, filaments, centre tapped.

250-0-250v. 60 m.a., 4v. 1-2a., 4v 2-4a., 12/6, post 7d.; extra filament, 4v. 1a., 12/6.

350-0-350v, 60 ma., 4v. 2-3a., 4v. 2-4a., 15/-, post 8d.; extra filament, 4v. 1a., 16/-.

350-0-350v. 120m.a., 4v 2-3a., 4v. 4-6a., 4v. 1-2a., 19/-, post 1/-; extra filament, 20/-.

WRITE for List; special quotations by return.

ALL POWER TRANSFORMERS, Ltd., 8a, Gladstone Rd., Wimbledon, S.W.19. Tel.: Liberty 3303. [2771

NEW MAINS EQUIPMENT

VORTEXION Lead Again.

ALL Fitted Screened Primaries and Tapped 200-250v., with centre tapped filaments, guaranteed one year.

250 0-250 60 m.a., 4v. 1-2a., 4v. 2-4a.; 10/- open, 12/6 shrouded.

350 0-350v. 60 m.a., 4v. 1-2a., 4v. 2-4a.; 12/6 open, 15/- shrouded.

350 0-350v. 120 m.a., 4v. 2.5a., 4v. 2-4a., 4v. 2-5a.; 14/6 open 16/6 shrouded.

425 0-425v., 120-160 m.a., 4v. 5-10a., 4v. 2.5, 4v. 1-2, 4v. 1-2, supershrouded model, 2½% regulation; 26/-.

500 0-500v. 120 m.a., L.T.'s, as above; 19/- open, 23/- shrouded 400 or 450, same price.

500 0-500v. 150 m.a., 3v., 4v. 2a., 4v. 2-5a., 4v. 4a., 26/- open, 30/- shrouded; 400 or 450, same price.

CHOKES, 30h. 60 m.a., 5/6; 7-13h., 10/6; 30h., 150 m.a., 12/6; regulation, 7/6.

OUTPUT Transformers, 4-10 watt, W.W. Q.A., 17/6; 20 watt super shrouded, 30/-.

AUTO Transformers, 100-120 to 200-240v. 60 watt, 9/-; 120 watt, 12/6; 200 watt, 16 6; 500 watt, 30/-.

QUOTATIONS for Specials by Return.

VORTEXION (S. A Brown). 182, The Broadway, S.W. 19. Tel.: Lib 2814. [2885

PARAMOUNT Mains Transformers.

PARAMOUNT in Quality, lowest in price; example, 250v. 60 m.a., 4v. 1a., 4v. 4a., open type 9/-, shrouded, 11/-, post 9d.; 350v. 75 m.a., 4v. 2.5a., 4v. 4a, open type 12/-, shrouded 14/- post 9d.

WRITE for List. "Paramount Mains Transformers."—R. H. Salter, 66, Hartfield Rd., Wimbledon, S.W.19. 'Phone: Liberty 3226. [2303

TANTALUM for A.C. Chargers, H.T. and L.T.—Blackwell's Metallurgical Works, Ltd., Garston, Liverpool. [2729

CABINETS

MANUFACTURER'S Clearance.

"ULTRA" Tiger Radiogram Cabinets, 35×21×16, 35/-; undrilled (reconditioned).

HALCYON Radiogram Cabinets, rich, dark, figured walnut, 33×23×19½, 45/-; many others, 30/- upwards; photos for selection sent on request.

"ULTRA" Table Cabinets, 20×16½×9½ (undrilled), 10/6; many others from 4/6.

SPEAKER Cabinets; 4/6 upwards.

SEND Particulars of Your Requirements (giving size of set, etc.), or call and make your choice from our stocks of over 100 different types; from 3/6 to £4/10.

H. L. SMITH and Co., Ltd., 287-9, Edgware Rd., London, W.2. Tel.: Padd. 5891. [0485

HIGGS' Cabinets for Constructors' Radiograms and Receivers, finished in high quality figured walnut, at £3 and 15/- respectively; particulars on application.—Westbourne Radio Co., 4, Westbourne Place, Hove. 3. [2779

DYNAMOS, MOTORS, ETC.

1h.p. A.C. Induction Motors, 1,425 revs., self starting, all 4 voltages; 49/9.—Easco, 18, Brixton Rd., S.W.9. [0455

CRYPTO Converter, 200/250 D.C. to 110 A.C., 350 watts, with auto-transformer for Stepping up from 200-1,000 volts A.C., complete with starter, smoothing and cabinet; £6/15.

HENRY'S, 72, Wellington Av., London, N.15. Stamford Hill 2907. [2897

G.E.C. Rotary Converters, 200-250 D.C. to 200-250 A.C., 200 watts, complete with smoothing equipment, in steel silence cabinet, condition as new; £6 10.—Johnson Engineering, 86, Great Portland St., W.1. Museum 7852. [2886

ELECTRO Dynamic Rotary Converters, complete with smoothing and silence cabinet, input 200-240 D.C., output 220 volts A.C., 50 cycles, 90 watts, in new condition; £6, carriage forward; many other converters in stock; send for details.

WARD, 46, Farringdon St., London, E.C.4. Tel.: Holborn 9703. [0518

NEW GRAMOPHONES, PICK-UPS AND RECORDERS

PERMAREC Home Units.—Discs—Permarec, acetate and glass base coated; cutters—steel and sapphires; frequency records; amplifiers; microphones—carbon, moving coil, piezo; matching transformers.—Holiday-Hemmerdinger, Dolefield, Bridge St., Manchester [2814

NEW LOUD-SPEAKERS

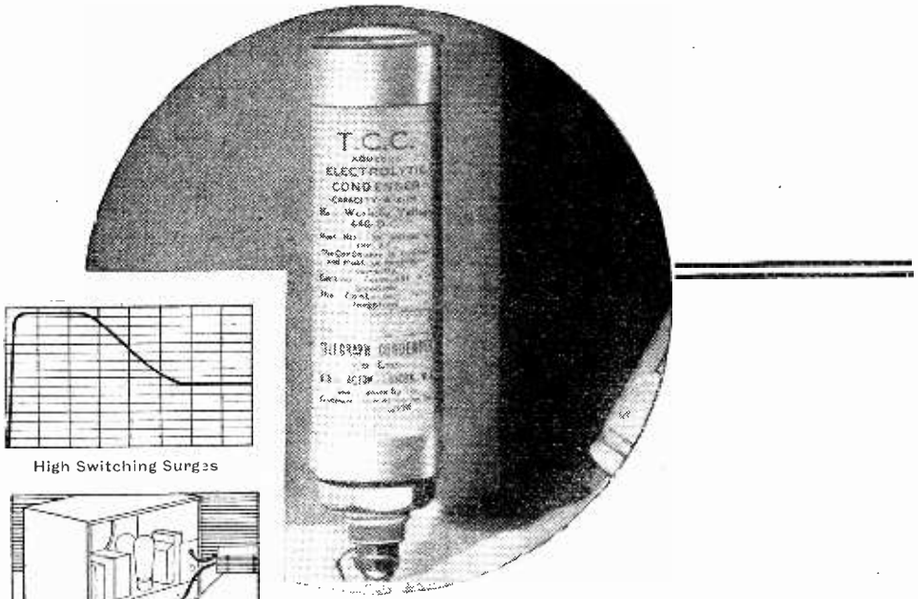
HULBERT for Quality Surplus Speakers.

THE Following Genuine Bargains are Made by One of the Best-known Manufacturers of high-grade moving coil speakers. All are brand new and offered at considerably under half list prices. The Auditorium models are fitted with latest dual curved cones, giving remarkably wide and even frequency response, resulting in quality reproduction of both speech and music.

37/6 Only, usual price £5; Auditorium permanent magnet speaker, with Alni magnet and die cast frame, large 12in. dual cone, comprising latest curved cone with auxiliary bakelite cone; complete with large 25 ratio transformer.

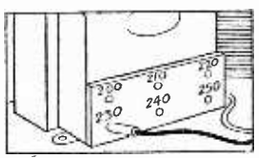
59/6 Only, usual price £6; Auditorium electro-magnet speaker, 1,000, 1,250, 2,000, or 2,500 ohms field; exceptionally large magnet of high permeability steel, giving enormous flux density; 2in. moving coil; large dual cone, comprising latest curved cone with auxiliary bakelite cone, giving wide frequency response; complete with universal transformer; the ideal speaker for use with "Wireless World" and other quality amplifiers.

(This advertisement continued on next page.)

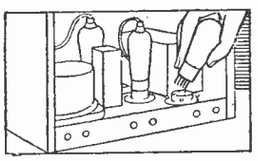


High Switching Surges

Disconnected Speaker.



Use of wrong Transformer Tapping.


Leaving the Pentode out.

Designed to CUT SERVICE COSTS

SURGE-PROOF CONDENSERS

Don't let High Surge Voltages rob you of well-earned profits. Stop once and for all the damage due to this cause. Fit T.C.C. Wet Electrolytic Voltage Regulators and feel secure against wasted service-men's time, against heavy replacement charges—and against lost prestige.

"No load" surges just cannot pass; realise what this means in terms of £ S. D.—Write for full details to-day.

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Special types available to meet the stringent conditions in A.C./D.C. Receivers. Manufacturers are invited to ask for particulars.

Type	Capacity	Continuous Working Volts
802	16 mfds.	440 volts Peak
602	8 mfds.	440 volts Peak
805	8 mfds.	500 volts Peak
809	32 mfds.	320 volts Peak

T.C.C. VOLTAGE REGULATING WET ELECTROLYTICS

The Telegraph Condenser Co., Ltd., Wales Farm Road North Acton, W.3

"Radio Receiver Measurements." Price 4/6 By post 4/9

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EPOCH Domino 10½ F.200-250 field, with speech transformer, £3/10; also one with A.C. equipment, £4, carriage extra.—112, Pentonville Rd., London. [2875

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ALL Post Orders Should be Addressed to Jubilee Works, 167, Lower Clapton Rd., London, E.5. Callers as usual to:—

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165 and 165a, Fleet St., E.C.4 (next door to Anderton's Hotel). Early closing Saturday 1.30 p.m. Central 2833. [0488

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TUBULAR Condensers, by well-known manufacturer, 0.002, 0.01, 0.02, 0.05, 3d.; 0.1, 0.25, 5d.

ERIE Resistors, 1-watt, all values; 4d.

SHORTWAVE Plug-in Coils, fit standard valve-holder, 13-26, 22-47, 41-94 metres, 4- or 6-pin, 1/9 each; super quality, 2/6 each; set of three, 7/-.

SHORTWAVE Condensers, 0.0001, 0.0015, 0.0002, 0.00025, 1/11; with 10-1 slow motion and 3in. dial and knob, 2/11.

SHORTWAVE All-brass Slow Motion Condensers, 0.0001, 0.00015, 4/3; 0.0002, 0.00025, 4/9.

SHORTWAVE Low-loss Chokes, 10-100 metres; 7d. each.

SHORTWAVE Straight Vision Drive, 4/9; dual ratio 8-1 and 100-1, 5/6.

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AMERICAN Valves, first grade Hytron, 3 months' guarantee, all types, 5/-; fine cords, 2/6 each.

SHORTWAVE Bargain List Now Available; send stamp.

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MAINS RADIO DEVELOPMENT COMPANY, 4-6, Muswell Hill Rd., London, N.6. Tudor 4046.

MAINS RADIO Offer Everything for Constructors; stamp for list, trade list; carriage paid.

ELECTROLYTICS, all brand new, dry, B.I.C 1-hole 8 mfd. 550v., 2/6; Plessey 8×8 mfd. 525v., 3/-, 1-hole fixing; Plessey wax cased 8 mfd. 550v., 2/-; 50 mfd. 50v., 1/8; 40×24 mfd. 200v., 3/-; 16 mfd. 525v., 2/6; 80×40 mfd. 200v., 3/6; 50 mfd. 12v., 25 mfd. 25v., 9d.; 200 mfd. 15v, 2/3.

SHORT Wave Steatite Condensers, super rigid 0.000015, 0.000025, 0.00016 mfd., 3/-; S.W. H.F. chokes, low loss, 4d.; Steatite valve holders, chassis, 5- and 7-pin, 8d.

RESISTORS, unused, 1 watt, colour coded, wire ends, best make, any size; 3½d., 2/9 per dozen.

TUBULAR Condensers best makes, 400 volt working, 0.0001 to 0.05 mfd., 3d.; 0.1 mfd., 6d.; 0.5 mfd., 8d.; tags, 0.0001 to 0.0005 mfd., 1d.; 0.001, 0.002, 0.005 mfd., 1½d.

CONDENSERS, all unused, 350v. working, metal cased, B.I.C. 4 mfd., 1/8; 4×4 mfd., 2/6; Standard Telephones, 2 mfd., 6d., 1 mfd., 4½d.; Dubilier 0.1×0.1 mfd., 1,000v. buffers, 9d.

CLIX Chassis Valve Holders, 4-pin, 1½d.; 5-pin, 2d.; Plessey 7-pin, 4d.; American chassis type, 4-, 5-, 6-, and 7-pin, 6d.; Lotus, 2/6; H.F. chokes, 6d.

ROTOROHM Switched Potentiometers, 10,000, 500,000 ohms, 1/8; Sator 25,000 ohms, 10d.; Centralab 500,000 ohms, 1/-.

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NEWPORT SURPLUS STORES Offer Wholesale Bargains in Components, meters, etc.; every article guaranteed, and satisfaction assured. It will be worth your while to pay us a visit.—24a, Newport Court, Charing Cross Rd., W.C.2. Ger. 2791. [2883

PRIVATE Sale.—Goods accepted to liquidate debt. Sets, Ultra Panther 5-v. A.C. superhet., £5/10; G.E.C. suitcase portable S.G. 4-v., £2/17/6; Pye Q. 4-v. portable, £3/5; Lissen All-wave 3-v. Skyscraper, M.C. speaker, £2/7/6; Lissen Skyscraper 3-v., M.C. speaker, £1/17/6. Chassis only, Cossor 3-v. S.G. battery, 15/-. Alpine ultra-violet sunray lamp, cost £60; nearest offer £20.—109, Goldsmith Av., Southsea. [2862

GALPINS

ELECTRICAL STORES

75, LEE HIGH ROAD, LEWISHAM, LONDON, S.E.13

TELE.: LEE GREEN 5240

Cash with Order or C.O.D.

UNIVERSAL MOTORS, A.C. or D.C., approx. ⅛ h.p., 200/250 v., for television, sewing machines, grinding, drilling, etc., **19/6.** Post 1/-.

UNIVERSAL MOTORS, A.C. or D.C., approx. ¼ h.p., 200/250 v., for baby cines, television, or any small power work. **12/6.** Post 6d.

"FOSTER" AUTO-TRANSFORMERS, as new, 200 v. to 100 v. or vice versa, 750 watt, **25/-**; 1,650 watt, **35/-**; 2,500 watt, **42 6.** Carriage forward.

LARGE TRANSFORMERS, windings not known, 1 kw., **15/-**; 2 kw., **25/-**; 3 kw., **32/6.** C/F.

ROTARY CONVERTORS, 200 v. D.C. input, 100 v. A.C. 100 watt output, **60/-**; 200 v. D.C. input, 100 v. 200 watt A.C. output, **95 -**; 250 v. input, 200 v. 600 watt A.C. output with starters, **£8 10 0.** C/F. Guaranteed.

VARIABLE RESISTANCES, 300 ohms ½ amp., 20 studs small size, **12/6.**

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DYNAMOS for Lighting or Charging, all shunt wound, fully guaranteed. 100 volt 10 amp., **60/-**; 50/75 v. 12 a., **65/-**; 40 v. 15 a., **70/-**; 150 v. 1 a., **17/6**; 100 v. 3 a., compound, **30/-**; 200 v. 3 a., compound, **50/-**; 20 v. 5 a., compound, **30/-**; Aero dynamos, 12 v. 8 a., **10/-**, all C/F.

CHARGING RESISTANCES or Shunt Regulators. Stud-switcharm type, **12/6** each, to suit your requirements.

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ISENTHAL VARIABLE RESISTANCE, to carry 10 to 15 amps., fitted 0 to 15 a/meter and Pilot Lamp, as new, **17/-.** C/F.

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WESTERN ELECTRIC MICROPHONES, solid back type, very sensitive, **2/6** each. Microphone Transformers, **2/6** each.

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DUPLEX TELEGRAPH MORSE KEYS, send-and-receive type, **12/6.**

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SHORT WAVE COILS, 14 to 150 metres, with circuit diagram. Set of 3 coils, **5/-,** post free.

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X-RAY TUBES, by well-known makers, **15/-** each. C/F. With Platinum Targets, **17/6, 25/-.**

AUTOMATIC TELEPHONE DIALS, 0 to 9, **2/-** each.

MAINS CHOKES, 20 and 30 henry, 40, 60, 80 m/A, **1/3, 1/9, 2/6** each.

10 K.V.A. X-RAY TRANSFORMER, 154 volts, 50 cycles input, 110,000 volts output, **£12 10s.** Carriage forward. Large transformer, 350 volts input, 170 volts 15,000 watts output, **£5 10s.** C/F.

VERTICAL ROTARY CONVERTER, 440 volts D.C. input, 300 volts 6 K.V.A. A.C. output, **£12 10s.** C/F.

FLUORESCENT SCREENS, 17×14in., complete with mounting frame and plate holder, **£3 5s.** C/F.

EX-ARMY DIRECTORS. Theodolite type. Complete with lenses and all vernier adjusting gear. All parts sound, but not guaranteed complete. **17/6** each. C/F.

EX-R.A.F. SEARCHLIGHT, 12in. dia. beam arc type, as new, power 2 kW., **£5.** C/F.

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THE Mail Order House with the World-wide Reputation; quality goods and satisfaction assured.

ANNOUNCING Greater Bargains than Ever in Guaranteed Radio.

PRICE £8/19/6.—Plessey 6-valve all-wave A.C. receiver, wave range 15-2,000 metres, 9½in., auditorium speaker, provision for external speaker and pick-up, handsome walnut cabinet of modern design, brand new, made for export; to sell at 20 guineas.

50/-.—Lissen band-pass 3 kit, sealed, with valves.

EXCLUSIVE British Rights Held by Us for Construc-trad Short-wave Kits, all kits supplied valves free, 5 interchangeable coils, covering a range from 15-600 metres; complete set, not a converter.

29/6.—1-valve battery kit.

37/6.—2-valve battery kit.

37/6.—1-valve A.C./D.C. kit.

49/6.—2-valve A.C./D.C. kit.

£5/19/6.—Ever-Ready 5-valve battery, S.H., incorporating A.V.C. large square-type dial, provision for pick-up and extension speaker; listed 12 guineas; stocks are limited, order at once to avoid disappointment.

39/6.—Lissen 4-valve A.C. receiver, complete with valves, P.M. moving coil speaker, handsome horizontal cabinet, S.G. det. pen. rectifier.

70/-.—Lissen 4-valve A.C. Band Pass receiver, a quality job listed at £9/15, sent out aerial tested, complete with valves.

55/-.—Lissen battery Band Pass receiver, complete with valves.

35/-.—Lissen 3-valve plus Barreta D.C. receiver, fitted handsome horizontal walnut cabinet, complete with valves.

35/-.—Alba H.F. Pen., detector, pen., 3-valve chassis, brand new, fitted Mullard valves.

75/-.—A.C./D.C. American Midget, 5-valve type, a real quality job, Jensen moving coil speaker, etc., brand new, boxed.

BRYCE Mains Transformers and Chokes, standard for the season, finest made, British and guaranteed.

8/6.—250-0-250, 80 m.a., 2-0-2 volts 2.5 amp., 2-0-2 volts 4 amp.

10/6.—350-0-350, 120 m.a., 2-0-2 volts 2.5 amp., 2-0-2 volts 4 amp.

12/6.—350-0-350, 150 m.a., 2-0-2 volts 2.5 amp., 2-0-2 volts 4 amp., 2-0-2 volts 2 amp.

17/6.—500-0-500, 150 m.a., 2-0-2 volts 2.5 amp., 2-0-2 volts 6 amp., 2-0-2 volts 2 amp., 2-0-2 volts 2 amp.

8/6.—H.T.8 transformer, 250 volts, 60 m.a., 2-0-2 volts 4 amp.

17/6.—Ditto, with H.T.8 metal rectifier.

ALL Transformers are Fully Shrouded.

MAINS Chokes.

4/6.—40 m.a., 30 hys.

6/-.—60 m.a., 40 hys.

10/6.—150 m.a. 40 hys.

21/-.—250 m.a, 15 hys.

6/-.—60 m.a., 80 hys., 2,500 ohms, for speaker replacement, etc.

12/6.—Special clearance choke, 250 m.a., 12 hys., 100 ohms heavy duty type interleaved windings, etc.; cannot be repeated.

TRIAD American Valves, highest quality. All types 5/6 each as follows: 01A, 24A, 27, 30, 31, 32, 33, 35, 37, 38, 39, 41, 43, 45, 46, 47, 53, 55, 56, 57, 58, 59, 71A, 75, 78, 80, 6A6, 1C6, 6F7, 2A3, 5Z3, 12A7, 6A7, 6C6, 6D6, 12Z3, 25Z5.

ALL these Valves Carry a 90-day Guarantee and Free Replacement, provided that the filament or heater is intact and the glass is not broken when returned to us.

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1/11—6 plus 6, 450 volt working, electrolytic condensers, metal case, wire ends, by well-known manufacture.

2/6.—14 plus 8, ditto.

1/-.—25v. 25 mfd. electrolytic condensers, tubular type, by well-known manufacture.

10/6.—P.M. moving coil speaker, 6in. cone, by well-known manufacture.

13/6.—P.M. moving coil speaker, 7½in. cone, by well-known manufacture.

3/6.—Multi-purpose valve, suitable for H.F. pentode, list 21/-.

2/-.—Lissen 126 kc/s I.F. transformer, fully screened.

2/-.—G.E.C. 110 kc/s, I.F. transformer, fully screened, with trimmers, midget type.

6D.—Tubular condensers, wire end type, all sizes up to 0.1.

1/6.—Lissen centre tapped chokes, brand new, boxed.

1/-.—Lissen inter-valve chokes, brand new, boxed.

5/11—Midget 2-gang 0.0005 condenser, fully screened, top trimmers, by well-known manufacture.

HOURS of Business, 9 a.m. to 7 p.m., Saturdays 9 a.m. to 1 p.m.

ALL Orders Value 5/- and Over, post free.

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ENQUIRIES, 1½d. stamp if reply expected.

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AN APOLOGY: The demand for our new Super Quality Triple Speaker has been so great since our last advertisement that we have been unable to cope with the demand and we apologise for delay in deliveries. We are now, however, able to give delivery in seven days from receipt of order. Music lovers should write now for latest leaflet—"Loud Speaker Tailoring"—fully describing this remarkable speaker.

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We will allow you a good price for your old speaker in part exchange for a **BAKER** Super Quality Triple Speaker. Write now for quotation.

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Owners of **BAKER'S** Super Power Speakers can considerably improve reproduction by fitting **BAKER'S** latest triple cone assembly comprising main curved cone and dual bakelite and duralumin cones combined.

PRICE **25/-** including coil.

Get in touch now with the Pioneer Manufacturers of Moving Coil Speakers—(1925 to 1936).

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RECORD

The quality valve in the COMPLETE range

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is worth knowing

It is a fine mould made paper in white and five colours, bearing the British Stationery Council quality mark.

1'9 to 3'6 per box.

See this symbol—your guarantee of value—on every box or pad.

Pepys Stationery

"Radio Data Charts," A Series of Abacs Post free 4/10

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SOUTHERN RADIO'S Wireless Bargains.—All goods guaranteed and sent post paid.

SPEAKERS.—Celestion Soundex, permanent magnet, 10/-; Telsen permanent magnet, latest 1936 model, with 10-ratio transformer for any set, 12/6; Telsen loud speaker units, 2/6; all brand new and boxed.

RECEIVERS.—G.E.C. A.C./D.C. mains 3-valve sets, complete with 3 Osram valves, in exquisite Bakelite cabinet with Osram M.C. speaker, ready to plug in to any mains, brand new, in sealed cartons, fully guaranteed; £3/5 each (list £7/15).

G.E.C. 3-valve Battery Sets, complete with 3 Osram valves, P.M. moving coil speaker in beautiful Bakelite cabinet, each set brand new in original sealed cartons, G.E.C. type No. BC.3536, listed at £5/10; our price 50/- per set, an unbeatable bargain.

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MICROPHONES.—Ace (P.O.) microphones, complete with transformer, ready for use with any set; 4/6.

RESISTANCES.—"Tru-ohm" 1-watt wire coils, colour coded and marked, 36 assorted capacities on card; 6/- per card.

POTENTIAL Dividers.—Lissen wire-wound, 3-section, 60-watt, 4,500 ohms, 3,000 ohms, 2,000 ohms; 3-section, 5 watts, 20,000, 20,000, 20,000 ohms; 2-section, 60-watt, 2,500, 500 ohms; 2-section, 50,000, 30,000 ohms all 1/3 each; in sealed cartons.

AMERICAN Valves.—A full range of valves for all American receivers; 6/- each.

SOUTHERN RADIO.—Branches at 271-275, High Rd., Willesden Green, N.W.10; 46, Lisle St., W.C.2. All mail orders to 323, Euston Rd.

SOUTHERN RADIO, 323, Euston Rd., London, N.W.1 (Near Warren St. Tube). 'Phone: Euston 3775. [2840

BIRMINGHAM RADIOMART, the short wave specialists, offer the following perfect goods at clearance prices:

RADIOMART.—Huge purchase Cossor 1936 Super-ferrodyne receivers, half price; £2/19/6. Stamp for full list.

RADIOMART.—Alba 1936 battery receiver, beautiful walnut cabinet, searchlight tuning, Magnavox speaker; £2/2/6

RADIOMART.—Featherweight headphones, 2/6; Varley bifocal iron-cored coils, 2/6; matched pair 4/6.

RADIOMART.—Special offer, worth 30/-, Class B kit, comprising driver transformer, valve and holder 5/-.

RADIOMART.—Telsen screened dual range coils, 2/6; pair 4/6; milliammeters, 25ma. upwards, 5/9; super, 6/9.

RADIOMART.—American mains transformers, 230 v., fully shrouded, 350-350, 6.3 v., 5 v.. 6/11; Majestic, 250-250, 2.5 v. 5 v, 4/11.

RADIOMART.—Heavy duty mains transformer, worth 35/-, 350-350, 150 ma., 4 v., 2.5 ACT., 4 v., 6 ACT., 12/6.

RADIOMART.—465 kc. IF transformers, 2/11; B.T.H. speaker transformers, 2/11; Telsen Ace, 1/11; RG4 Radiogrands, 2'9

RADIOMART.—Utility straight line wavelength dials, 3/11, Telsen HF chokes, 1/11.

RADIOMART.—Utility 2-gang uniknob and dial, 3/11; 1,500-volt tubular condensers, 6d.; Ilelsby electrolytics, 8 mf. 500, 2/11; 4×4 mf., 1/11; 25 mf. 25 volt, 1/-; 2 mf. 300 v., 1/-.

RADIOMART.—Smoothing chokes, 20 hy. 120 ma., 3/11; 100 ma., 2/11, 40 ma., 1/11.

RADIOMART.—Pushback wire, 6 yds. 6d.; heavy 9d.; 2 gross solder tags, 6d.; resin-cored solder, 9lb. 6d.

RADIOMART.—Centralab pots, all sizes, 1/6; switched 2/-; tubular glass fuses, 2d.

RADIOMART.—Lissen 3-gang superhet kit coils, two IFs, ganged condenser, ditto bandpass, ditto 2-gang all-wave, 10/ kit.

RADIOMART.—Traders monster bargain parcels, value £4/10, for 10/-; also 5/- parcels.

RADIOMART.—Famous Continental A.C. valves, 4/6; American Duotron, etc., all types, 3/6; battery from 2/3.

RADIOMART.—Utility 8/6, microdisc dials, 3/11; Radiophone, 0.00016 short wave condensers, 3/6; series gap, twin 3/9.

RADIOMART.—Ceramic all brass microvariables, 15 mmfd., 1/4; 40 mmfd., 1/7; 100 mmfd., 1/10; short wave, H.F.C., 9d.

RADIOMART.—Order 5/- post free; get our bargain catalogues; General 1½d., Short wave 1½d.—44, Holloway Head, Birmingham. Tel.: Mid. 3254 [0507

RADIOPAKS. (75/- superhet), boxed, 19 6; Polar Midget 2-gangs, 4/9.—MacLachlan, "Balvaig," Strathyre. [2890

HEAVY Duty Marconi Mains Energised Speakers, 6-volt field, ohm speech coil, perfect, with transformer; 25/-.

ELECTRIC Gramo Motors, for 100-250 volt A.C., by Marconi, brand new, less turntable; 16 6.

B.T.H. Universal Gramo Motors, for 60-250 volts A.C. or D.C., complete with sliding resistance, less turntable, list over £5; 25/-.

EPOCH Super Cinema Speaker, 14in. cone, 6-volt field, nearly new; 59/6.

UNIVERSAL Recording Outfit, complete with tracking gear and cutter, real good instrument; £7 15.

10-WATT Amplifier, in steel cabinet, made G.E.C., 200-250 A.C., in perfect order; £7/15.

ALL Lines Advertised Last week Still Available.

HYAMS RADIO, 23, Lisle St., Leicester Sq., W.C.2. Ger. 2969. [2894

"Wireless Servicing Manual." Post free 5/4

COMPONENTS—SECOND-HAND, CLEARANCE, SURPLUS, ETC.

OLIVERS, of Boscombe, offer: Erie resistances, 1-watt colour coded, all values; 3½d. each, 3/- dozen, 2/6 dozen in lots of 3 dozen.

ALUMINIUM Chassis, 18 gauge, 16in.×10in., undrilled 5/-; panels, special cabinets, etc., supplied to specification; quotations upon request.

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