Wireless World

RADIO AND ELECTRONICS

JUNE 1948

38th YEAR OF PUBLICATION

Proprietors: ILIFFE & SONS LTD

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

Editor: H. F. SMITH

Editorial, Advertising and Publishing Offices:
DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1.

Telephone: Waterloo 3333 (60 lines).
Telegrams: "Ethaworld, Sedist, London."

PUBLISHED MONTHLY
Price: 1/6

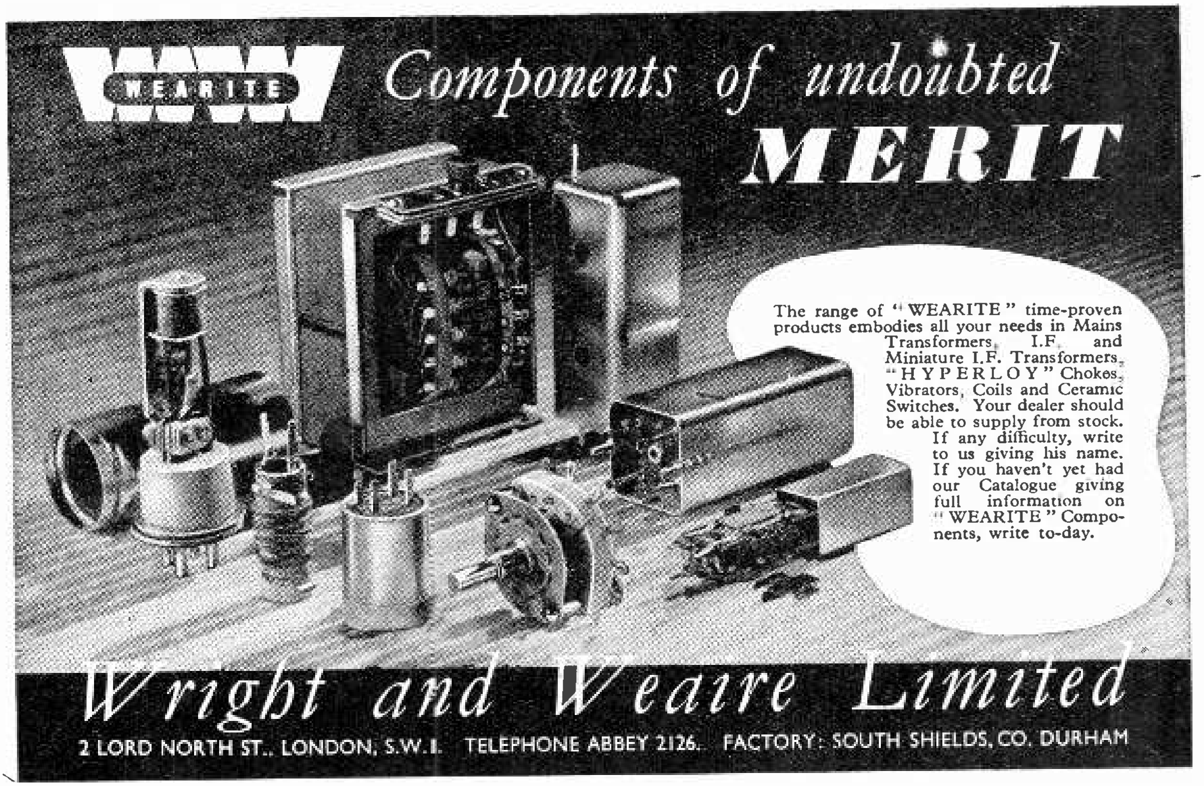
(Publication date 26th of preceding month)

Subscription Rate: 20/- per annum. Home and Abroad

Branch Offices:

Birmingham: King Edward House, New Street, 2.
Coventry: 8-10, Corporation Street.
Glasgow: 26B, Renfield Street, C.2.
Manchester: 260, Deansgate, 3.

In this Issue



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RADIO AND ELECTRONICS

Vol. LIV. No. 6 June 1948

Extra-High-Frequency Broadcasting

IT is generally admitted that there are at present insufficient low- and medium-frequency channels to ensure reasonable broadcast coverage of this country, and few would contend that we are entitled in strict equity to any sensible increase in these bands when new allocations are made. Thus, it is clear that, sooner or later, regular transmissions must be carried out in the extra-high-frequency region—somewhere above 30 Mc/s.

If we accept the argument that E.H.F. broadcasting is a necessary—indeed, an inevitable—ancillary to the existing L.F. and M.F. system, what method is to be employed? The B.B.C. has made it clear that frequency modulation is preferred, and this system is to be used at the new experimental station to be built in Kent; also in the chain of stations that it is proposed ultimately to build for distributing the Third Programme throughout the country.

Problems of F.M. Reception

This decision was not reached hastily. Extensive and painstaking field tests were carried out, and a lengthy report (abstracted in *Wireless World* for October 1946) was published. A good case was made for F.M. transmission, but we think that the problems of reception were dismissed rather too summarily. Unfortunately, an F.M. receiver cannot be cheap; there is no F.M. equivalent to the crystal set, and apparently little hope that a simple but effective converter for adapting existing amplitude-modulation sets for F.M. can be produced. Judging from American experience, such adaptors as have been devised give poor quality, and, worse still, radiate heavy interference. Can this country, in its present economic condition, afford to equip itself for domestic F.M. reception on a large scale?

A much more serious matter is the question of receiver alignment. The performance of which F.M. transmission is undoubtedly capable cannot be realized to the full unless the receiver is correctly aligned; it seems doubtful if a reasonably priced set can be expected to retain its alignment, and consequently its ability to reject noise and to provide high-quality reproduction, without frequent and highly skilled attention. There is also the tuning problem; unless very costly automatic aids are provided, it is doubtful whether the ordinary listener will be able to adjust his set with sufficient accuracy.

Economics of A.M.

We do not suggest that the B.B.C. is wrong in setting up an experimental public F.M. service. One of the great advantages of our method of organizing broadcasting is that such experiments can be carried out effectively at an infinitesimal cost per listener. But we do think that, before embarking on a nation-wide F.M. service, another parallel experiment should be tried—amplitude-modulated E.H.F. This would involve much lower cost for receivers, and comparatively cheap and simple adaptor units could be used with existing sets. The need for specialized alignment techniques would disappear, and a high-quality alternative service would become available to a large number of those who justly complain at present of inadequate distribution of the Third Programme.

Even in America, its spiritual home, F.M. has not had everything entirely its own way. Some engineers there contend that the extra-high frequencies can be much more economically employed for broadcasting by the use of A.M., and we believe that several small-scale experiments have been made to test that theory. It is hoped to describe one of them in our pages shortly. A unified organization like the B.B.C. should be able to carry out more conclusive trials, and we hope that the attempt will be made on a sufficiently large scale to enable useful comparisons to be made with the experimental F.M. service.

Shunt Voltage Stabilizer

By J. McG. SOWERBY, B.A., Grad.I.E.E.

MOST readers will be familiar with the series degenerative (feedback) stabilizer of the kind shown in Fig. 1, but the shunt stabiliser [1, 2], is perhaps not quite so well known. In many applications where the load current variations are not too great the shunt stabilizer is both useful and convenient, since in most of the circuits it employs only one valve. Let us consider, therefore, some of the shunt stabilizer circuits, and note some of their advantages and disadvantages.

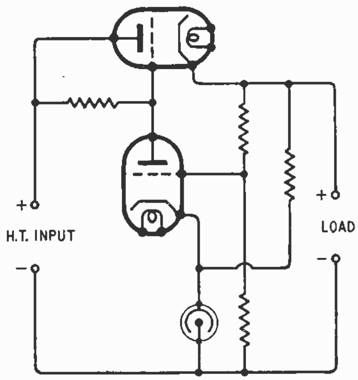


Fig. 1. Series feedback stabilizer.

A voltage stabilizer of any kind can be usefully described in terms of two quantities which we may call the stabilization ratio, S_0, and the internal resistance, R_0. S_0 is defined as the factor by which incoming fluctuations are reduced by the time they reach the load, and R_0 is defined as the A.C. resistance seen when looking back into the stabilizer from the load terminals. From this the regulation of the voltage supply can be found.

Shunt stabilizers are of two main types which we may conveniently call "bridge" and "feedback." The bridge type depends for its correct operation on the balance of two quantities (generally potentials) against one another. At balance there is theoretically no change in voltage at all at the load (i.e. S_0 is infinite). On the other hand bridge stabilizers generally have a relatively high internal resistance.

In contrast, feedback stabilizers are like amplifiers with much negative feedback. In this type S_0 can never be infinite, so that there are always voltage fluctuations—however small—at the load. On the other hand feedback stabilizers generally have a very low internal resistance.

From the foregoing we see that the type of stabilizer required for any given application is largely determined by the load conditions. In Class "A". amplifiers (microphone pre-amplifiers, etc.) where the load is substantially constant, a bridge type would probably be preferred. In supplying pulse generators, time bases, etc., where the load may be varying to some extent, the low internal resistance of the feedback stabilizer would give it an advantage. In any given case a trial calculation will soon show which type of stabilizer is the more suitable.

Bridge Shunt Stabilizers

A simple hum suppressor circuit is shown in Fig. 2, and it will be familiar to many readers as it has been described before in this journal.[3] This is probably the simplest of the shunt stabilizers and is widely used for the suppression of undesired ripple on the H.T. line. Ripple on the H.T. line is applied to the load direct through R_s and in inverse phase indirectly through the valve. If these two ripples are of equal amplitude they cancel, and a bridge balance is obtained.

The condition of balance is found to be

$$R_c = \frac{R_s - 1/g_m}{1 + 1/\mu} \quad .. \quad (1)$$

and if $\mu \gg 1$, we may write

$$R_c = R_s - 1/g_m \text{ (approximately)} \quad .. \quad .. \quad (2)$$

From this we see that R_s can never be less than $1/g_m$ if a balance is to be obtained, and it is a minimum when $R_c = 0$. This simply means that if grid (as opposed to cathode) bias can be used, R_s can be made equal to $1/g_m$ and a balance is then secured which at the same time allows the minimum voltage to be lost across R_s.

When $R_c = 0$, the time constant of the circuit is R_gC_g, but when R_c is inserted and split into the bias resistance R_b and the feedback resistance R_f—as shown in Fig. 2—the input resistance at the grid of the valve is made greater than R_g by the action of the negative feedback. Under these conditions the time constant of the circuit is

$$T = \frac{R_gC_g}{1 - R_f/R_s} \text{ (approximately provided } \mu \gg 1) \quad .. \quad (3)$$

The internal resistance, R_0, turns out to be

$$R_0 = R_s \,.\, \mu/(\mu + 1) \quad .. \quad (4)$$

which is obviously equal to R_s for all practical purposes provided $\mu \gg 1$.

From the foregoing we see that a valve with a reasonable amplification factor (10 or more) is desirable in this circuit. When it is desired to lose the minimum possible voltage across R_s it is obviously desirable to choose a

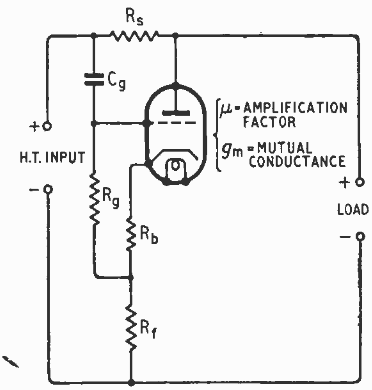


Fig. 2. Simple shunt hum suppressor.

[1] Hunt, F. V., and Hickman, R. W., *Rev. Sci. Inst.* Vol. 10. No. 1. (Jan. 1939).
[2] Neher, H. V., and Pickering W. H. *Rev. Sci. Inst.* Vol. 10. No. 2. (Feb. 1939).
[3] *Wireless World* Nov. 1939.

asis of Design for Low Internal Resistance or High Stabilization Ratio

valve with a large mutual conductance. The writer has found the EF50 and EF55 convenient valves to use if connected as triodes.

Example I.

A practical example will help to fix our ideas of the relative magnitude of circuit components, and the kind of result obtainable.

Suppose we have an H.T. supply of 450 volts and we require 350 volts (stabilized) at 30 mA for early stages in an amplifier. The stabilizer valve anode current is to be 7.5 mA. R_s is immediately

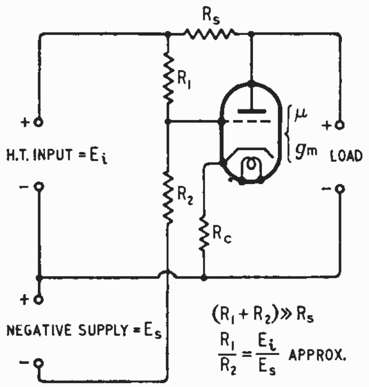


Fig. 3. D.C. bridge stabilizer.

fixed at 2.66 kΩ. If the μ of the valve is 30, R_a is 10 kΩ, and g_m is 3 mA/volt, then by (2), R_c = 2.33 kΩ. For such a valve R_b would be about 1000 Ω, leaving R_f = 1.33 kΩ. We may now make R_g = 2 MΩ and C_g = 0.25 μF. From (3) we find T = 1 sec. Thus the stabilizer would provide perfect stabilization down to 1 c/s or less, and yield an internal resistance, by (4) of 2.66 kΩ. It would handle fluctuations of the supply up to about 20 volts peak. In practice it would be convenient to make all or part of R_f variable and to adjust for zero (or minimum) ripple across the load.

The D.C. bridge stabilizer shown in Fig. 3 requires a negative stabilized supply of 100 volts or so at 1 mA or less—such as may be provided by a suitably energised discharge tube stabilizer (neon lamp), or battery. The operation of the circuit is much the same as in the previous case, except that

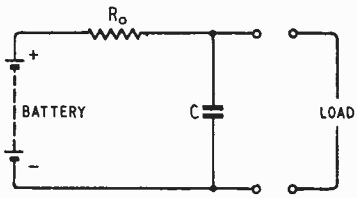


Fig. 4. Equivalent circuit of shunt bridge stabilizer with decoupling capacitance added.

the frequency response now extends down to zero frequency, so that the potential across the load can be maintained constant over long periods of time.

Calculation shows that the condition for balance (when S_0 is infinite) is

$$R_c = \frac{R_s}{1 + E_i/E_s} - \frac{1}{g_m} \quad \text{(approximately)} \; .. \; (5)$$

provided $\mu \gg 1$, and E_s is more than 6 or 8 times the grid base of the valve. Making the same assumptions, the internal resistance of the stabilizer turns out to be

$$R_0 = \frac{\mu}{\mu + 1 + E_i/E_s} R_s \quad \text{(approximately)} \; .. \; .. \; (6)$$

The design procedure for this type of stabilizer is similar to that followed in the previous example and need not be gone into further here. It is worth noting, however, that if a stabilized negative supply is not available, then often a stabilizer discharge tube can be placed in series with the cathode of the stabilizer valve. Under these conditions the calculated value of R_c will include the resistance of the discharge tube which has to carry the full anode current of the valve. There is a "snag" in this method of providing the reference potential since the impedance of a discharge tube may vary with frequency. Thus if a blance is obtained by experiment at 100 c/s, the circuit will not necessarily be balanced at any other frequency. In practice, however, a reasonable approximation to balance can usually be obtained over the band 0 to 100 c/s. Because of this difficulty the connection of Fig. 3 is greatly to be preferred.

There is one point of interest concerning the two foregoing circuits which is worth mentioning: since the condition for balance is independent of the load impedance, the impedance of the stabilizer can be materially reduced by shunting the load terminals with a large condenser. Either circuit will then behave as a supply of the form shown in Fig. 4 at an operating frequency suitable for the stabilizer.

As will now be clear, all that is required of the stabilizer valve in a bridge circuit is a gain of unity between the H.T. line and the load. For this reason no useful purpose is served by the use of more than one valve.

Feedback Shunt Stabilizers

The simplest form of shunt feedback stabilizer is shown in Fig. 5 and it will be seen that it is simply a single-stage amplifier with negative feedback from anode to grid. It is not surprising to find, therefore, that the internal resistance of the stabilizer can be very low. It turns out to be

$$R_0 = \frac{R'R_s}{R' + R_s}$$

where $R' = 1/g_m + R_c$ .. (7)

The assumption has been made that the time constant R_gC_g is long enough to pass the frequencies under consideration with negligible

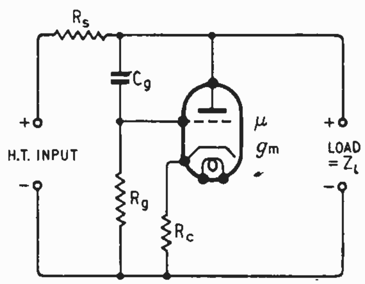


Fig. 5. Single-valve feedback stabilizer; A.C. coupled.

phase shift. The essential point in designing a stabilizer of this type is to choose a valve whose mutual conductance is large, and to reduce R_c as much as possible. It should be pointed out that if

Shunt Voltage Stabilizer—

grid (as opposed to cathode) bias can be used, a much lower internal resistance is obtained. This is so because for high values of g_m its reciprocal will usually

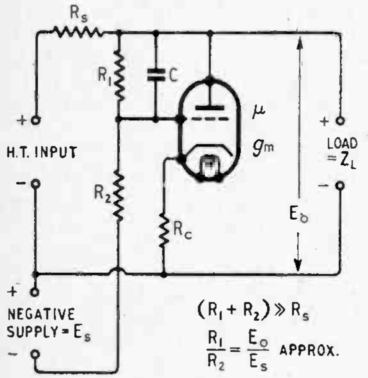


Fig. 6. Single-valve feedback stabilizer ; D.C. coupled.

be much smaller than R_c—the the minimum necessary bias resistance.

The stabilization ratio of this circuit can be shown to be

$$S_0 = 1 + g_m \frac{R_s Z_L}{R_s + Z_L}\left(\frac{1}{1 + g_m R_c}\right) \quad (8)$$

Once again we see that for the best results it is essential to make g_m large and R_c small.

Example 2.

It is required to stabilize 60 mA at 300 volts using an EF55 valve ($\mu = 28, g_m = 11.2$ mA/volt). The H.T. supply potential is 450 volts, and we may allow 20 mA in the stabilizer valve. At once we have $R_s = 1.88$ kΩ. From the valve curves we may take R_c at about 400 Ω. We shall assume the load to be resistive so that $Z_L = 5$ kΩ.

From (8) we find $S_0 = 3.78$ and from (7) $R_0 = 445\Omega$.

Without R_c (grid, not cathode, bias) we find $S_0' = 16.3$ and $R_0' = 87.5\Omega$.

The circuit of Fig. 6 is simply the D.C. version of the previous arrangement. Analyzing this circuit we find that the internal resistance of the stabilizer (down to zero frequency) is given by

$$R_0 = \frac{R' R_s}{R' + R_s}$$

where

$$R' = (1 + E_0/E_s)(1/g_m + R_c) \quad .. \quad (9)$$

provided E_s (the stabilized negative supply) is much greater than the grid base of the valve. The foregoing is true in the absence of the condenser C. When C is present, then at all frequencies at which its reactance is small compared with R_1 the first term in (9) can be taken as unity. By this means a lower R_0 and a better S_0 can be obtained as far as A.C. is concerned. The approximate relation for the stabilization ratio is

$$S_0 = 1 + \frac{1}{1 + E_0/E_s} \cdot \frac{g_m}{1 + g_m R_c} \cdot \frac{R_s Z_L}{R_s + Z_L} \quad .. \quad .. \quad (10)$$

When C is introduced and is effective, E_0/E_s becomes zero in (10).

From (9) and (10) it is obvious that an improved performance can

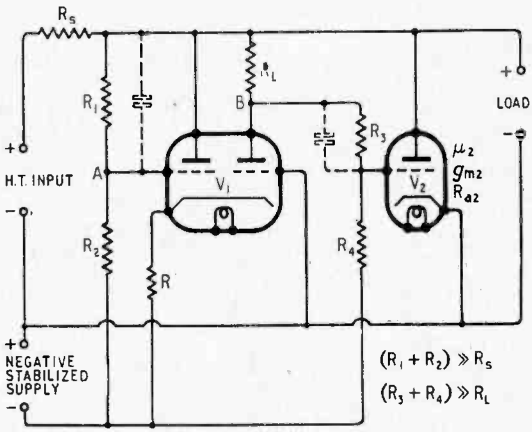


Fig. 7. Two-valve D.C. feedback stabilizer.

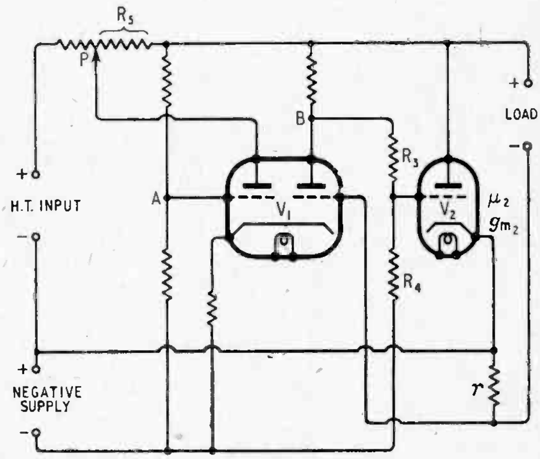


Fig. 8. (Right) Two-valve D.C. feedback stabilizer; showing the modifications described in the text.

be obtained by making $R_c = 0$. Provided a negative stabilized supply is available no difficulty arises, but if suitable operating potentials are obtained by placing a discharge tube in series with the cathode of the valve, then the resistance of the tube must be inserted for R_c in (9) and (10). The difficulties noted in discussing the D.C. bridge stabilizer again arise, but not in quite so serious a way, and the result will be an R_0 and S_0 varying with frequency.

If a performance is required which is better than can be obtained from any of the foregoing circuits, it is generally preferable to revert to the series type stabilizer of Fig. 1. In certain cases, however, when it is desired to add a stabilizer to an existing power pack, it is often worth while to consider the adoption of a two-valve feedback shunt stabilizer as shown in Fig. 7.

The circuit of Fig. 7 uses a double triode valve in addition to the shunt stabilizer valve, and it requires a negative stabilized supply capable of providing a few milliamperes at 100 volts or so. The objection will be raised that the circuit uses three stages, and perhaps it might be more apposite to speak of it as a two-" bottle " circuit.

An approximate analysis of the circuit shows that, provided $R_s > 1/g_m$

$$R_0 = \frac{1}{g_{m2}[1/\mu_2 + b(1 + aM_1)]}$$

(approximately) .. (11)

where :

$$a = \frac{R_2}{R_1 + R_2}$$

$$b = \frac{R_4}{R_3 + R_4}$$

g_{m2} = mutual cond. of V_2

M_1 = gain from A to B in V_1

$= \mu_1 R_L(2R_{a1} + R_L)$ approx.

μ_1 and R_{a1} refer to V_1

An approximate value for the stabilization ratio follows, and is

$$S_0 = 1 + R_s/R_{a2} + R_s g_{m2} b(1 + aM_1) \quad .. \ (12)$$

If R_1 and R_3 are shunted by condensers (shown dotted in Fig. 7), then at frequencies at which their reactances are low compared with R_2 and R_4, the factors a and b in (11) and (12) become unity with consequent improvement of R_0 and S_0.

The performance of this circuit can be very good and values of $S_0 = 500$ and $R_0 = 5$ ohms are commonplace. It can be improved still further, however, by suitable modifications to the circuit of Fig. 7 as shown in Fig. 8. Here two modifications have been made. The first consists of taking the second grid of V_1 to the load side of a small resistance (generally of 3 to 20 ohms). This injects a potential proportional to the load current into the second grid of V_1, and if the resistance (r) is correctly chosen the results is $R_0 = 0$. The value of r is given approximately by

$$r = \frac{1}{g_{m2}}\left(\frac{1}{bM_1 - 1/\mu_2}\right) \quad .. \ (13)$$

If it is desired to make S_0 infinite (as in a bridge stabilizer), R_s—or part of it—can be replaced by potentiometer P, and the first anode of V_1 connected to its slider. There will be a position of the slider where S_0 is infinite. An approximate expression for the resistance of the lower arm of P (R_5) is

$$R_5 = 1/bg_{m2} \quad .. \quad .. \ (14)$$

and this will generally be of the order of a few hundred ohms. If a condenser is used to shunt R_3, then infinite S_0 or zero R_0 can only be obtained at zero frequency or the ripple frequency, but not at both. This is so because the introduction of the condenser makes b unity at all frequencies at which it is effective.

Now that electronic circuits are being called upon to operate under more arduous conditions to more stringent specifications, the use of various stabilizing circuits is becoming more widespread. It is hoped, therefore, that the foregoing notes will be of some use in the alleviation of other circuit problems and difficulties.

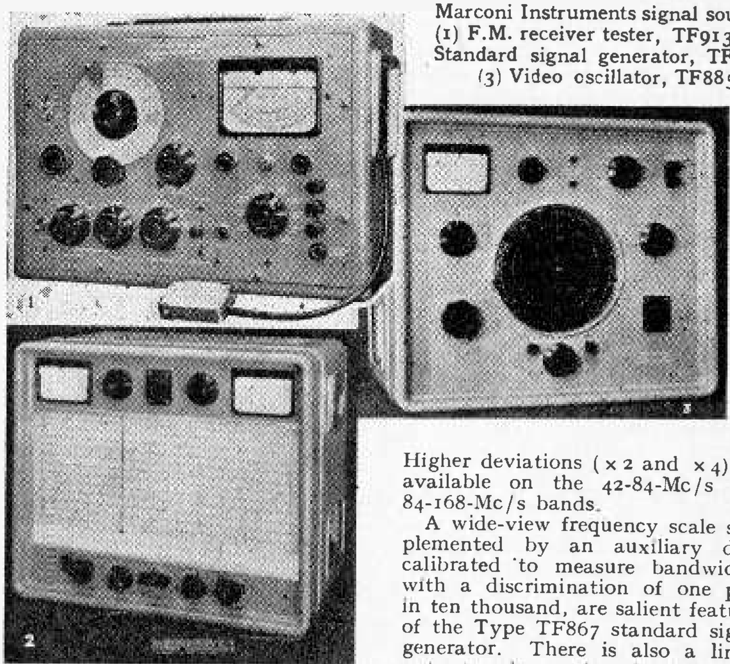
Thanks are due to Messrs. A. Gee and D. Minchin who carried out some experimental work on these stabilizers, also to Messrs. Cinema-Television Ltd. for permission to publish these notes.

New Test Equipment

AN exhibition of test instruments was held recently by Marconi Instruments, in London. The new instruments shown included a video oscillator (TF885), video tester (TF903), F.M. receiver tester (TF913), standard signal generator (TF867), portable receiver tester (TF888), and a dielectric test set (TF704B) based on the N.P.L. design by Hartshorn and Ward.

The video oscillator (TF885) is A.C. mains-operated and delivers up to 1 watt into 1,000 ohms at 20 c/s to 5 Mc/s in two bands. A large circular calibrated dial and built-in output voltage meter are features of the instrument, which also provides square waves over the range 50 c/s to 150 kc/s. The video tester (TF903) gives a sine wave output over the range 20 c/s to 5 Mc/s and, like the Type TF885, works on the heterodyne principle. The maximum output is 0.25 watt.

In the Type TF913 F.M. receiver tester a signal generator for C.W., A.M. or F.M. is combined with an audio-frequency power meter in a case measuring only 15in × 11in × 6in. The carrier range is 21-168 Mc/s in three bands, and a crystal-controlled oscillator provides ten check points each band. Internal amplitude modulation at 1,000 c/s is at a nominal depth of 30 per cent, and the modulation characteristic is flat within 1 db from 50 c/s to 10 kc/s for external modulation up to 80 per cent. Frequency modulation deviation is continuously variable from 0 to 75 kc/s on all bands—accuracy ±5 per cent with a possible additional ±10 per cent for valve ageing or replacement.



Marconi Instruments signal sources (1) F.M. receiver tester, TF913, (2) Standard signal generator, TF867, (3) Video oscillator, TF885.

Higher deviations (×2 and ×4) are available on the 42-84-Mc/s and 84-168-Mc/s bands.

A wide-view frequency scale supplemented by an auxiliary dial, calibrated to measure bandwidths with a discrimination of one part in ten thousand, are salient features of the Type TF867 standard signal generator. There is also a linear output scale running the full width of the instrument and calibrated in voltage and decibels. The frequency range is 15 kc/s to 30 Mc/s in eleven bands, and there is provision for carrier-shift modulation as well as monitored internal amplitude modulation up to 100 per cent at 400 and 1,000 c/s. There is a crystal-controlled oscillator for frequency calibration, and a terminating unit attached to the output cable giving source impedances of 75Ω and 13Ω. The metal case has recessed carrying handles and spaces for accessories, and is ventilated by dustproof ducts designed to suppress radiation.

Selectivity in Television Amplifiers

Problems of Sound-Channel Rejection

By W. T. COCKING, M.I.E.E.

THE technique of designing and constructing wide-band radio-frequency amplifiers is now well understood. Either by the use of stagger-tuned single-circuits as intervalve couplings or by the employment of coupled pairs of tuned circuits it is readily possible to obtain all the amplification needed with a band-width adequate for present-day television requirements, or for any that are likely to arise in the future.

While the performance of present-day wide-band amplifiers, as such, is perfectly satisfactory, an amplifier used in television has to do more than give the required amplification over a specified band of frequencies. It is also necessary that, as far as possible, its amplification should be confined to that band of frequencies in order to avoid interference from signals lying outside it.

It is desirable that the amplifier should give constant amplification within close limits over the band of frequencies radiated by the vision transmitter but that it should give little or no amplification of, or even attenuate, frequencies outside that band.

At the present time it is understood that modulation frequencies up to some 3 Mc/s are radiated by the vision transmitter at Alexandra Palace. The carrier frequency is 45 Mc/s, so that the full radiated band is 42–48 Mc/s and with double-sideband reception this must also be the band covered by the receiver. The bandwidth of 6 Mc/s is usually reckoned between the points on the resonance curve at which the response is — 3 db.

Television sound is radiated on 41.5 Mc/s, only 0.5 Mc/s below the lower edge of the pass-band. For the avoidance of interference from the sound channel the response to it must not be greater than — 30 db and preferably less than — 40 db. Beyond the lower-frequency edge of the pass-band therefore, the response must change by at least 27 db, and preferably more than 37 db, for a frequency change of 0.5 Mc/s. The response curve must thus have a cut-off slope of at least 54 db/Mc/s.

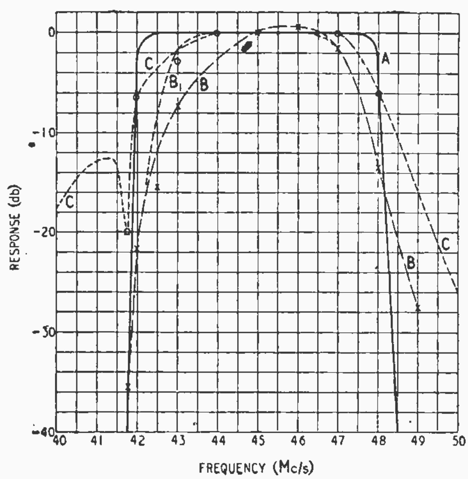


Fig. 1. Curve A shows the ideal response curve and B a measured curve of a typical receiver; the correct form of the latter is probably nearer B_1. Curve C is for an experimental set including a rejector circuit.

There is not the same need for a sharp cut-off on the other side of the pass-band, for there is no particular signal against which discrimination is needed at the present time. However, on general grounds the cut-off should be as sharp as is conveniently possible in order to reduce the general possibilities of interference. Furthermore, in the future there may well be other television transmitters and interference from the one on the adjacent channel must be guarded against.

The ideal response curve thus has the form shown by curve A of Fig. 1. It is flat within 3 db from 42 Mc/s to 48 Mc/s and is — 40 db (or more) at 41.5 Mc/s and 48.5 Mc/s. Beyond these limits the response is not shown; ideally it should not be more than — 40 db but a considerable tolerance is permissible and it will usually be satisfactory if the response does not rise above — 30 db. Also, at present, the cut-off on the high-frequency side need not be nearly so sharp.

Curve B shows the response curve of a typical commercial television receiver. Although satisfactory as regards selectivity the curve departs considerably from the ideal in the pass-band. Some of the defects are undoubtedly due to slight misalignment of the tuned circuits and it is highly probable that the correct form of the curve is like B_1. Considering the latter, therefore, the bandwidth at — 3 db is 47.25 — 42.85 = 4.4 Mc/s and the sound channel rejection is — 36 db. The performance obtained is actually a very satisfactory one, but it does not permit full advantage to be taken of the B.B.C. transmissions.

The response of an experimental receiver is shown by curve C. This has a bandwidth at — 3 db of 47.7 — 42.7 = 5 Mc/s. The response at the sound channel is down by only 20 db and at still lower frequencies it is still poorer, so that the selectivity cannot be considered satisfactory. This receiver represented a determined effort to obtain an approximation to the ideal of curve A by simple means. It was a straight set with stagger-tuned circuits and a sound-channel rejector.

The low sound-channel rejection must be attributed primarily to losses in the rejector circuit, and the restriction of bandwidth on the low-frequency side to the effect of the rejector in the pass-band.

It will be clear from all this that the attainment of adequate selectivity with the correct bandwidth is by no means an easy matter.

In an endeavour to improve matters the first thing that occurs to one is to adopt the superheterodyne and obtain the selectivity at a relatively low intermediate frequency. A not uncommon frequency is 13 Mc/s. The pass-band is then 10–16 Mc/s and the sound signal appears at 9.5 Mc/s. All frequency differences remain unchanged and so the cut-off slope needed is also unaltered.

However, the frequency ratios are much lower and because of this it is commonly believed that it is proportionally easier to obtain the required cut-off slope; but if the effects of rejector circuits are excluded this is not true. The response (in db) of an amplifier with stagger-tuned single-circuit couplings under

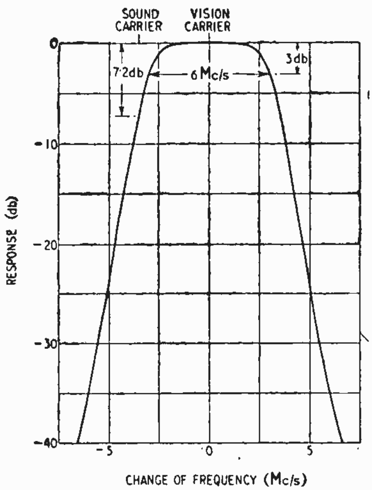


Fig. 2. Response curve of 6-Mc/s, 7-circuit stagger-tuned amplifier for double-sideband reception. Inherent sound-channel rejection 7.2 db.

optimum conditions is given by

$$10 \log_{10}\left[1 + (S^2{}_n - 1)\frac{(2\Delta f)N}{n}\right]$$

where Δf is the frequency difference from resonance f_r, n is the bandwidth, S_n is the ratio of the response at f_r to that at the edges of the band, and N is the number of tuned circuits.

It will be seen that the expression does not involve the resonance frequency, and that this consequently has no influence on the selectivity. In other words, if an amplifier is adjusted so that its bandwidth is the same at all resonance frequencies, then its selectivity is also the same. On this basis, therefore, nothing is gained by using the superheterodyne.

The above expression, however, is an approximate one which is reasonably accurate only when Δf and n are small compared with f_r. When this is not the case the resonance curve becomes asymmetrical and the selectivity is higher on the L.F. side of resonance than on the H.F. side. When f_r and Δf are comparable in magnitude, as occurs at low intermediate frequencies, the asymmetry is very marked.

It is usually undesirable to use a frequency much lower than 13 Mc/s, and at this the asymmetry is not very large, although it is noticeable. It is not unreasonable, although not highly accurate, to use the expression given above at this frequency.

It can be seen, therefore, that in a stagger-tuned amplifier the mean frequency has a negligible effect on the selectivity. The same result is obtained with other forms of intervalve coupling but, of course, methods which involve the use of a greater number of tuned circuits result in improved selectivity for a given bandwidth.

There is, however, an upper limit to the permissible frequency. This occurs when the unavoidable damping on the tuned circuits becomes heavier than that needed to secure the desired bandwidth. Such damping is provided mainly by the input resistance of the valves and increases rapidly with frequency. With a bandwidth of 3 Mc/s, the limiting frequency is likely to be around 50 Mc/s, and it increases with bandwidth. When this limiting frequency is reached the use of the superheterodyne results in improved selectivity.

The curve of Fig. 2 shows the response of an amplifier having seven stagger-tuned circuits. It was calculated by assuming it to be comprised of two amplifiers, one three-circuit and one four-circuit, each having a response of 1.5 db at a bandwidth of 6 Mc/s. This was done because design formulæ were only available for amplifiers of up to four circuits.[1]

The curve shows an attenuation of only 7.2 db at the sound channel. This is quite inadequate, and it is necessary to supplement the amplifier by including tuned-rejector circuits. Before we can conclude that the superheterodyne principle is of little or no benefit on selectivity grounds, therefore, it is necessary to investigate the influence of the operating frequency on the operation of a rejector circuit.

Probably the simplest form of rejector is an acceptor circuit L_1, C_1, R_1, shunted across a single-circuit coupling L, C, R, as shown in Fig. 3. The product L_1C_1 is chosen to resonate at the sound channel and at this frequency the total impedance is very nearly R_1. At the resonance of the main circuit the impedance is nearly R, so that the attenuation of the acceptor is $20 \log (1 + R/R_1)$.

If the acceptor is to have little effect on the main circuit over the pass band its impedance must be high in comparison with it. The main circuit will be of lower impedance than R at the edge of the pass-band, but not much lower if it is one circuit of many. For our present purposes it is sufficiently accurate to take it as R even at this frequency.

For high attenuation at the sound channel we must have $R_1 \ll R$. For the acceptor to have little effect in the pass-band we must have $Z_1 = R_1 + j\omega L_1 - j/\omega C_1 \gg R$ at the edge of the pass-band. If this is obtained $Z_1 \approx \omega L_1 - 1/\omega C_1$ and it is sufficient to have $(1 - \omega^2 L_1 C_1)/\omega C_1 R \gg 1$. If f_∞ is the frequency of the sound channel, where the attenuation is very high, and δf is the frequency difference between this and the nearer edge of the vision channel, the

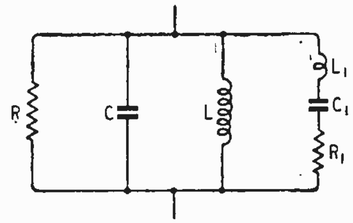


Fig. 3. Typical sound-channel rejector, consisting of an "acceptor" circuit L_1, C_1, R_1 shunted across an intervalve coupling L, C, R.

[1] Design Data (10). *Wireless World*, January 1947, Vol. 53, p. 25.

Selectivity in Television Amplifiers— above relation can be written approximately as

$$\frac{2\,\delta f}{f_\infty}\cdot Q_1\frac{R_1}{R} \gg 1.$$

For a given attenuation R_1/R is a constant, and under present conditions δf is a constant. The frequency dependent factor is thus Q_1/f_∞. If this factor is constant, then once again the operating frequency does not enter into things and the superheterodyne is no better than the straight set. If Q_1 is constant, then Q_1/f_∞ increases as the frequency is lowered, and the superheterodyne has a definite advantage. If Q_1 decreases with frequency, the advantage is still more with the superheterodyne.

Everything thus depends on the way in which the Q varies with frequency. Now the Q of a coil depends not only on the frequency but also upon its physical size, the materials of which it is constructed, the closeness of any screening and upon whether it is air-cored or dust iron-cored.

In the absence of screening and when dielectric losses are negligible it can be shown that the Q of an air-core single-layer coil of optimum design and of constant dimensions increases as the square root of the frequency[2]. Dielectric losses increase with frequency so that in practice the Q is likely to increase less rapidly than this. If the frequency is low enough, too, the use of a dust iron-core results in a higher Q for a given physical size of coil.

It is clear, therefore, that the quantity Q_1/f_∞ will normally increase as f_∞ is reduced and this means that the superheterodyne principle is advantageous in that it permits selectivity to be obtained at a lower frequency than with the straight set. Although there is little to choose between the two when selectivity is obtained by means of cascaded tuned circuits or coupled pairs of circuits, when rejectors are included the lower frequency becomes a definite advantage.

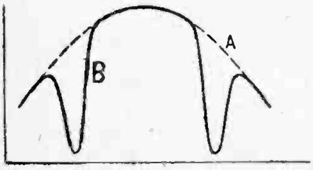


Fig. 4. By the use of rejectors a response curve A can be brought to the form B.

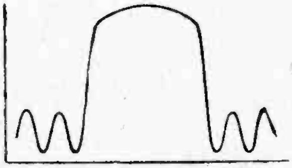


Fig. 5. Further rejectors bring the curve to the form shown here.

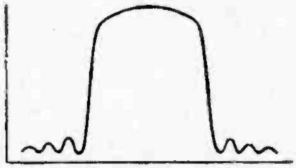


Fig. 6. An increase of the general selectivity brings a curve such as Fig. 5 to this nearly ideal form.

By the addition of rejectors a curve of the form of A of Fig. 4 can be brought to the shape B. The cut-off slopes on the two sides are greatly increased with but little extra material, but the selectivity at some distance from the pass band is hardly affected.

The use of further rejectors, tuned further from the pass-band, leads to a curve of the form of Fig. 5, which is a considerable further improvement. Having achieved such a result the improvement of the general selectivity by the use of additional cascade circuits becomes very beneficial in reducing the peaks between the rejector frequencies. In this way the overall response can be brought to the form of Fig. 6, which is a close approach to the ideal.

Now it has been shown that for a given sound-channel attenuation by means of a rejector with a coil of given Q operating at a given frequency the effect of the rejector on the pass-band is dependent on δf—the spacing of the rejection frequency from the edge of the pass-band. This can also be expressed by saying that for a given effect at the edge of the pass-band the attenuation at f_∞ is dependent on δf.

As the sound and vision carrier frequencies f_s and f_V are fixed $\delta f = f_V - f_s - n/2$ and a reduction of the vision-channel bandwidth n, increases δf and so helps the sound-channel rejection.

It was shown earlier that the selectivity of cascade circuits depends on $2\Delta f/n$ and increases with it. At the sound channel this becomes $2(f_V - f_s)/n$ and increases as n is reduced. A reduction of bandwidth, therefore, increases the selectivity in all ways.

With many tuned circuits the effect on selectivity of reducing n can be very large. It is the normal commercial practice to take advantage of this and to reduce the bandwidth below the ideal 6 Mc/s to something around 4—4.5 Mc/s. Not only is more gain obtained per stage but the number of circuits needed for selectivity is greatly reduced.

Because of the smaller bandwidth greater efficiency can also be secured in the detector and V.F. stages. Also the spot size on the C.R. tube can be somewhat larger. This in its turn may

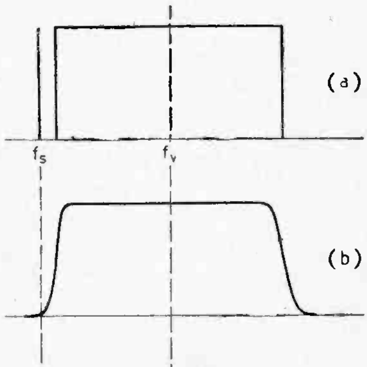


Fig. 7. The spectrum of the vision and sound channels is indicated at (a) with the required receiver response curve for double-sideband working at (b). Two alternative forms of response curve for single-sideband operation are shown at (c) and (d).

[2] "H.F. Resistance and Self-Capacitance of Single-Layer Solenoids." By R. G. Medhurst. *Wireless Engineer*, February and March 1947, Vol. 24, pp. 35 and 80. (See also correspondence, June 1947, p. 185.)

permit the use of a more efficient deflector coil and hence a more economical time base.

The net result of using a smaller bandwidth may thus be a very substantial saving of cost but, of course, the picture definition must necessarily be somewhat poorer.

There is, however, one possibility of improving matters without reducing the picture quality. This lies in the use of single-sideband reception. It is, perhaps, more accurate to give it its American name of vestigial-sideband reception, for it actually works out at double-sideband reception for the lower modulation frequencies and single-sideband for the higher.

In the U.S.A. the method is applied to the transmission and the receiver designer has no choice in the matter. Here there are two ways of adopting vestigial sideband reception, because both sidebands are radiated.

In Fig. 7 the transmitted frequency spectrum is indicated at (a) and the form of the vision-channel resonance curve required for double-sideband reception is shown at (b). This is the kind which we have been considering up to now.

With vestigial-sideband reception the receiver response curve must be of the form shown at (c) or (d) depending on whether we decide to use the lower or the upper sidebands. In each case the vision carrier is placed at the edge of the band at a point where the response is -6 db.

The bandwidth needed is slightly less than one-half of that required for the usual double-sideband operation. It is slightly less because bandwidth has hitherto been defined at the 3-db points on the curve and it is now between the 3-db point on one side and the 6-db on the other.

The response curve of a seven-circuit amplifier of 3-Mc/s bandwidth between the 3-db points is shown in Fig. 8. The bandwidth between -6 db on one side and -3 db on the other is actually 3.25 Mc/s, so that for single-sideband reception it could be reduced slightly.

If the lower sidebands are selected, the case of Fig. 7(c), the vision carrier in Fig. 8 would be placed at $+1.75$ Mc/s and the sound carrier would fall at $1.75 - 3.5 = -1.75$ Mc/s. The sound-channel rejection would then be zero relative to the vision carrier! However, the bandwidth is slightly

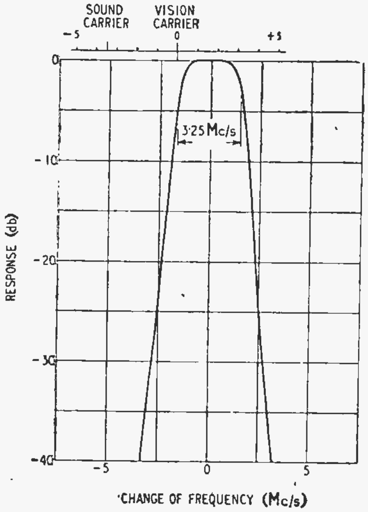


Fig. 8. Resonance curve of 3-Mc/s, 7-circuit stagger-tuned amplifier for single-sideband reception of sidebands remote from sound carrier. Inherent sound-channel rejection 68 db.

greater than is necessary and by reducing it 0.25 Mc/s, the attenuation would rise to some 6—8 db. The gain over double-sideband operation is negligible.

However, if the upper sidebands are selected, as in Fig. 7(d), the case is very different. The vision carrier is now placed at -1.75 Mc/s, and the sound carrier falls at -5.25 Mc/s. The attenuation at the latter relative to the vision carrier is $68 - 6 = 62$ db. This alone is adequate and special rejectors become unnecessary.

In theory single-sideband reception can be applied to the straight set just as well as to the superheterodyne and as little or nothing in the way of rejector circuits is needed it would seem that the straight set would be preferable.

However, the vision carrier must be set quite closely to the right point on the side of the resonance curve if good results are to be secured. In the straight set both the bandwidth and the position of the carrier on the curve are controlled by the same trimmers and one cannot be adjusted without affecting the other. In the superheterodyne the position of the carrier can be controlled independently of the bandwidth by adjusting the oscillator frequency, and this is an important practical advantage.

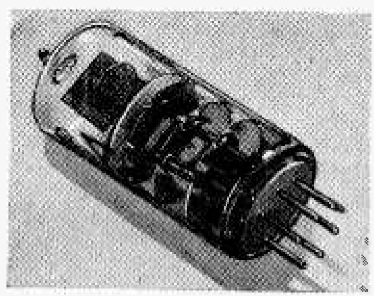
QUARTZ CRYSTALS

THE Marconi Company have been making crystals for use in their own equipment for many years and now these units are being made available to other users.

Included in the range are three different types of crystal units, described as cubic, plate and hermetically sealed respectively. Cubic crystals have exceptionally high stability and are for use in frequency-measuring apparatus. A short-term stability of one part in ten million is possible with these crystals. They are available for frequencies between 200 and 350 kc/s.

The plate type is a general-purpose variety for use where tolerances of from 50 to 100 parts in a million will suffice. They are assembled in rectangular moulded cases with two base pins. The lower frequency crystals are clamped between stainless steel plates, but some of the higher frequency types have gold-sputtered electrodes. The range available is from 500 kc/s to 12 Mc/s.

The hermetically sealed units are assembled in miniature glass valve envelopes with B7G bases and the range includes crystals for oscillation on fundamental frequencies of from 75 kc/s to 15 Mc/s. Overtone plates are also available giving direct crystal control on frequencies between 12 and 35 Mc/s.



Marconi glass-sealed quartz crystal in a miniature valve envelope fitted with a B7G base.

A full description of these crystals with their temperature characteristics, tolerances, and holder dimensions are given in a pamphlet issued by the company. The current prices for single crystals range from £2 17s to £4 18s. The makers are Marconi's Wireless Telegraphy Company, Ltd., Chelmsford, Essex.

Quiet High-gain Amplifier

By
C. C. WHITEHEAD

Tone Control by Negative Feedback

NOISE and hum are the greatest bugbears in the design of relatively cheap and simple high-gain amplifiers, such as those working with high-quality "programme" sources (e.g., moving-coil or ribbon pick-ups or microphones, and pickups of the miniature needle-armature type). Cures generally involve careful screening and placement of the valve-heater connections, and a high degree of smoothing in the H.T. supply, apart from input-circuit screening.

When tone-control devices are incorporated, in the usual manner, the trouble is aggravated, often with the addition of instability, since it is not possible to incorporate these components in that part of the amplifier included in the feedback chain, and it is desirable to include as much of the amplifier as possible within the feedback path.

The use of push-pull stages throughout helps, but it is possible to go one better by making use of the technique used in biological amplifiers, namely, the use of a high value of common-cathode impedance in the push-pull stages[1] and the "Schmitt" type of cathode-coupled phase-splitter.

The large common-cathode resistance gives a high degree of negative feedback in the "parallel" path in which all the major sources of noise and hum operate while it does not appreciably affect the gain in the push-pull signal path.

In the amplifier herein described, the final stage consists of a pair of 4½-W output pentodes in push-pull feeding a 20-ohm speaker via a 22 : 1 transformer.

The intermediate stage is a double-triode (Mullard ECC32) acting as a "long-tailed pair", and the first stage a "Schmitt" phase-splitter with the same type of valve and circuit constants as in the intermediate stage.

The total voltage gain without feedback from the first grid to the push-pull anode load is approximately 87.7 db, giving full rated output (8.6 W) with a peak input to the first grid of 17 mV.

The resulting amplifier is very quiet, even without feedback, the only screening required being on the high-potential lead to the first grid.

It was decided that, for the purpose in view, an input of 0.14-V peak could be afforded for full output. This implies a voltage gain of 133 from input to output-transformer secondary, in comparison with the full gain of 1105. Consequently, the feedback factor ("β") for this condition comes out at 0.0066. This is applied from the output transformer secondary via R_{29} and R_{30} in parallel with R_{28}, and R_{32} in the first grid circuit, in the "normal" position of the tone-control switches.

To raise the treble, R_{32} is shunted as required by C_{17}, C_{18}, C_{19} or C_{20}, thereby decreasing β with increase of frequency, the lower limit being set by R_{31}.

To raise the bass, R_{28} is shunted as required by C_{13}, C_{14}, C_{15} or C_{16}, thereby increasing β with increase of frequency, the upper limit being set by R_{30}. The lower limit of β being set in each case by R_{28}.

β is arbitrarily limited between 0.001 and 0.0455 over the range 32 to 16,000 c/s, giving a range of approximately 26 db for bass and treble "lift." In the "normal" position of the tone-control switches, the gain is substantially "flat" between these limits.

It was not considered advisable or convenient to use a "continuous" form of tone control, since this involves dial calibration or uncertainty as to the "normal" setting. Furthermore, fine settings are not usually required, the effect of "lifts" of 2 or 3 db being aurally inappreciable under normal listening conditions.

The values of the tone-control capacitances within the range used can be varied according to individual preference.

An unusual feature of this form of tone control is that the treble lift operates at a low-impedance level, where the effect of stray capacitances is negligible, while the bass lift, which is less sensitive in this respect, operates at a high-impedance level. Though no screening or other precautions are used in the wiring of the β-circuit, no trace of hum or noise is introduced.

An effect of tone control generally which seems to have escaped comment is that even when the average gain of the amplifier over the whole frequency band remains constant, the operation of the tone control gives a *subjective* impression of change of gain, owing to the fact that the impression of *power* in the sound output is contributed preponderantly by the lower frequencies (below about 400 c/s).

A screened low-impedance input transformer is provided for matching appropriate programme sources.

There is one precaution to be observed when using the high-impedance input. This input must "see" not less than 0.25 MΩ, or the feedback and tone control will be affected. This can be avoided if the earthy side of the programme source is connected to the top of R_{32} instead of to the chassis (as indicated by the dotted line). In the latter case the impedance of the source is immaterial, but amplifier and source must not have a common earth.

[1] Known colloquially as a "long-tailed pair."

The design of the β-circuit would be simplified if an additional high-impedance winding[2] were employed on the secondary side of the output transformer, or the feedback taken from the primary side; but in the latter case the corrective effect of the feedback upon the output transformer frequency characteristic would be lost.

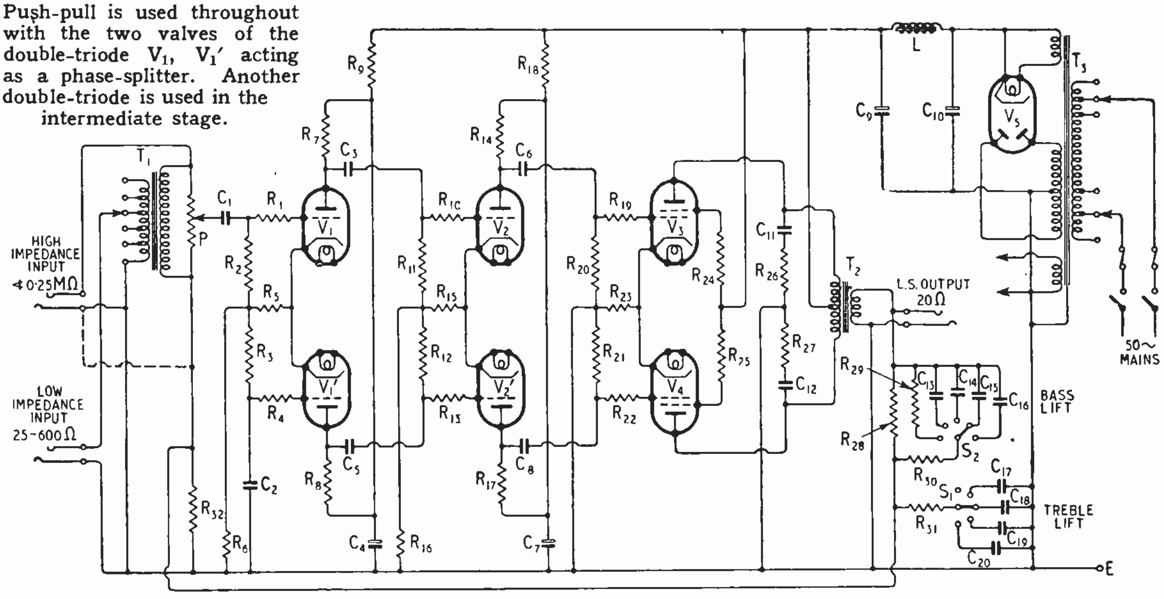
The simplification in design arises from the fact that if the gain between the feedback points is made high enough, the gain when feedback is applied is simply proportional to $1/\beta$, and is, in fact, approximately $1/\beta$. The amplifier described herein does not meet that criterion, but the use of higher-gain stages (e.g., substituting higher-gain double-triodes, such as the ECC35) or using a high-impedance tertiary winding on the output transformer would meet the case. It was not done in the present case because amply sufficient gain was available for the purpose in hand. The main objects to be attained were the provision of a really quiet amplifier with a convenient and efficient form of tone control.

The power-supply part of the circuit is simple and conventional, since the amplifier is not "fussy" in regard to smoothing.

Component Values.

P	0.25 MΩ	C_{16}	500 pF, Mica.
R_1, R_4, R_{10}, R_{13}, R_{19}, R_{22}	10 kΩ, ¼-W.	C_{17}	0.02 μF, Paper.
R_2, R_3, R_{11}, R_{12}	1 MΩ, ¼-W.	C_{18}	0.05 μF, Paper.
R_5, R_{15}	470 Ω, ¼-W.	C_{19}	0.1 μF, Paper.
R_6, R_{16}, R_{18}	10 kΩ, ½-W.	C_{20}	0.25 μF, Paper.
R_7*, R_8*, R_{14}, R_{17}	47 kΩ, ½-W.	T_1 =	Miniature, screened, line-to-grid transformer, to match 25-600 Ω on input.
R_9	22 kΩ, ½-W.	T_2 =	Output. 22 : 1 push - pull, (C.T.) to match 10,000 Ω (anode-to-anode load resistance) to 20 Ω (speaker). Primary total inductance, ≮ 60 H.
R_{20}, R_{21}, R_{28}	0.47 MΩ, ¼-W.	T_3 =	Standard type of mains supply transformer; Primary — 200-250 V mains; Secondary 1, (H.T.) 250 V, 125 mA rect. output; Secondary 2, (L.T.) 6.3 V, 4.0 A; Secondary 3 (Rect.) 5.0 V, 2.5 A.
R_{23}	90 Ω, 1-W.	L =	10 H at 120 mA.
R_{24}, R_{25}	100 Ω, ¼-W.	Valves.	
R_{26}, R_{27}	4.7 kΩ, ½-W.	V_1, V_2	Mullard, type ECC32.
R_{29}	0.22 MΩ, ¼-W.	V_3, V_4	Marconi, type KT61.
R_{30}	22 kΩ, ¼-W.	V_5 =	5Z4G.
R_{31}	22 Ω, ¼-W.		(Or others of same characteristics.)
R_{32}	1 kΩ, ¼-W.	S_1, S_2	5-position switches ("Oak," Yaxley, or similar).
* Should differ in value by about 5%, R_8 being the higher value.			
C_1, C_2, C_3, C_5, C_6, C_8	0.1 μF, 350 V.		
C_4, C_7	8 μF Electrolytic, 275 V.		
C_9, C_{10}	8 μF Electrolytic, 400 V.		
C_{11}, C_{12}	0.01 μF, 500 V.		
C_{13}	50 pF, Mica.		
C_{14}	100 pF, Mica.		
C_{15}	200 pF, Mica.		

Push-pull is used throughout with the two valves of the double-triode V_1, V_1' acting as a phase-splitter. Another double-triode is used in the intermediate stage.



[2] "High-Quality Amplifier Design," by P. J. Baxendall, *Wireless World*, January, 1948, Vol. 54, p. 2.

ADDENDUM—Basis of Design.

Final Stage.—2 KT61 valves in push-pull. Maximum output, 8.6 W into 10,000 Ω, for 14-V push-pull peak voltage on grids. The peak voltage across the load is therefore 415 V and the stage gain 29.6. The transformer-secondary output voltage is therefore 18.6 V peak.

Intermediate Stage.—The difficulty about deriving the value for the gain from the normal expressions lies in the doubt in regard to the mutual conductance of the valve under the actual working conditions. The effective mutual conductance under working conditions is about 0.8 of the rated value (2.3 mA/V) giving a stage gain of 20, if we allow a little for the reduction in effective anode voltage due to the common cathode resistor.

First Stage.—For the "Schmitt" type of phase-splitter with approximately equal anode loads, the gain is approximately $g_m R_7/2$, which for a working g_m of $0.8 \times 2.3 = 1.84$

Quiet High-gain Amplifier—

mA/V, and effective R_7 of 44.8 kΩ (0.047 and 1 MΩ in parallel) comes out at 41.

The disparity in the two anode loads, to give equal voltage output, $R_7/R_8 = 1/(1 + g_m R_c)$ where $R_c = R_5 + R_6$, which comes out at ≈ 5%. This can be got by choosing two resistors of the same nominal value differing by this amount.

Total Gain.—The total gain therefore approximates to 2.43×10^4. The gain from input grid to output transformer secondary is 1,105.

Feedback.—Total voltage gain required = 133. Therefore $1 + A\beta = 1105/133 = 8.3$, and $A\beta = 7.3$, where "A" is the "undoctored" gain, 1105; whence $\beta = 0.0066$.

With both tone control switches in the "normal" position,

$$\beta = \frac{R_{32}}{R_{32} + \dfrac{R_{28}\,(R_{29} + R_{30})}{R_{28} + R_{29} + R_{30}}} = 0.0064,$$

giving a consequent gain of 137, which is near enough, with commercial values for the resistors.

With the "bass lift" operative, the maximum value of β approaches

$$\frac{R_{32}}{R_{32} + \dfrac{R_{28} \cdot R_{30}}{R_{28} + R_{30}}} = 0.0455,$$

with a consequent gain of 22 at the treble end of the scale; while the gain at the bass end is decided by β approaching the value $R_{32}/(R_{32} + R_{28}) = 0.0022$, with a consequent gain of 322, a total "lift" of approximately 23 db.

With the "treble lift" operative, the maximum value of β is the "normal," 0.0064, as can easily be seen, with the normal gain. The minimum value of β is given by an approach to the value

$$\frac{\dfrac{R_{31} \cdot R_{32}}{R_{31} + R_{32}}}{\dfrac{R_{31} \cdot R_{32}}{R_{31} + R_{32}} + \dfrac{R_{28}\,(R_{29} + R_{30})}{R_{28} + R_{29} + R_{30}}} \approx 0.001,$$

with a consequent gain of 525, giving a total "lift" of approximately 11.7 db.

The total range of gain operative for tone control is therefore from 22 to 525 (voltage ratio) = 27.5 db.

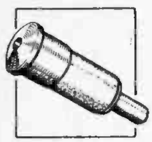
New-look Crystal Sets

Use of Radar-type Detectors

By R. G. HIBBERD, B.Sc., A.M.I.E.E.

(Research Laboratory, British Thomson-Houston Co.)

THE modern version of the crystal detector was developed during the war and was successfully used in most centimetric radar and communication receivers. It is mechanically more stable than most valves, and, unless misused will maintain its adjustment and sensitivity indefinitely. Type CS7A is a silicon detector, similar to the radar type and, now that it is available for more general use, many radio men may like to try crystal receiver circuits once more. These notes are intended to re-introduce the subject to old and new readers.



The B.T.-H Type CS7A silicon detector, here shown full size.

At the outset, it must be emphasized that for good crystal reception, the best possible material is recommended for each individual component—aerial, inductance, 'phones, etc. Half measures will only lead to disappointment.

Since a crystal receiver can do no more than convert the signal power supplied by the aerial into audio output power, a really efficient outdoor aerial, in conjunction with a low resistance earth is essential for good results.

The aerial should be as high as possible—preferably not less than 30 feet, with a "roof" length of the order of 70 to 100 feet. Care should be taken with the lead into the house to prevent any shunt leakage at this point. The earth wire should be as short a possible, using a heavy gauge wire solidly bonded to an earth plate, a rod buried in damp soil, or to a rising main water pipe; the joints in each case being protected from corrosion.

In the design of a crystal receiver, the objective, as stated above, is to convert the modulated R.F. power, developed in the aerial, into audio power for the headphones, as efficiently as possible. Thus, the various matching adjustments are all made to give optimum power transfer. The series tuned acceptor circuit is probably the simplest and most convenient circuit for ensuring maximum power transfer from the aerial, and the recommended basic circuit uses this as shown in Fig. 1. In order fully to appreciate the points involved in the design of the circuit, consider the equivalent circuit shown in Fig. 2. For the purpose of these notes, an aerial can be considered as an ideal generator in series with the capacity to earth of the "roof" of the aerial (C_a) and the effective series resistance of the aerial (R_a). The receiver is represented by the capacity C and inductance L in series with two resistances, r being the RF resistance of the inductance and R the reflected crystal load resistance. At resonance, the inductance L resonates with the effective capacity of C and C_a in series, and we are left with the condition shown in Fig. 3. For

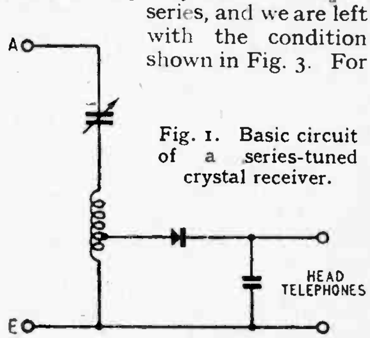


Fig. 1. Basic circuit of a series-tuned crystal receiver.

maximum power into R we must make $R = R_a + r$, the power then developed in R being $\dfrac{e^2}{4(R_a + r)}$. This shows the need to keep the aerial resistance R_a and the coil resistance r as low as possible.

For a given inductance, the reflected crystal load resistance R can conveniently be adjusted to the value required to complete the power match by selecting the correct step-down ratio for the crystal tap on the inductance.

The selectivity of the receiver will depend upon the effective Q of the combined aerial and loaded tuned circuit. This will be equal to $\frac{\omega L}{(R_a + r + R)}$, or in the matched condition $\frac{\omega L}{2(R_a + r)}$. Thus, by keeping the aerial resistance and coil resistance low, we not only help the sensitivity, but the selectivity also. We must not expect "superhet" selectivity with a single circuit crystal receiver. For example, a good aerial will have an equivalent series resistance of about 30 ohms, and a 300-μH inductance with a Q of 150 at 1 megacycle will have a resistance of 12 ohms, giving an overall circuit Q, at 1 megacycle, of 24. For quarter power response this gives an off tune selectivity of ± 20 kc/s at 1 Mc/s.

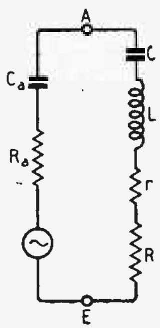


Fig. 2. Equivalent circuit of Fig. 1.

A slight complication, arising in connection with the crystal match, is that the crystal resistance varies with the applied signal voltage. For instance, at low signal levels, the crystal resistance will be of the order of 10,000 ohms, but with high signal levels it may be down to the order of 3000 to 5000 ohms. Thus, it will be seen that the correct matching-in of the crystal depends upon the aerial resistance, the tuned circuit Q value, and the received signal strength, and so for the best possible results with a particular installation, the position of the crystal tap on the inductance should be adjusted for maximum output under final operating conditions.

However, this adjustment is not very critical, and for general use it has been found reasonable to specify the crystal match for low field strengths—of the order of a few millivolts per metre, assuming a good aerial and a circuit Q of about 100. The actual crystal resistance under these conditions will be of the order of 10,000 ohms and the optimum crystal tap will be between 20 and 25 per cent of the total turns up from the earthed end.

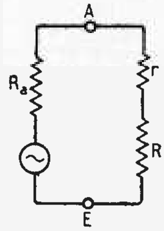


Fig. 3. Equivalent circuit showing condition at resonance.

The question of the crystal resistance varying with applied voltage also affects the audio match from the crystal to the headphones. The output impedance may be from 10,000 ohms to 3000 ohms depending upon the signal level. Now, standard high-resistance headphones, such as the B.T.-H. "Lightweight" 'phones, with a D.C. resistance of 4,000 ohms, have an impedance, at 1 kc/s, of about 22,000 ohms. Thus, one pair of these headphones will not use the total power available. However, it is more than likely that with most crystal receivers, more than one pair of 'phones will be required, and then, with several pairs connected in parallel, the output match will be more nearly correct. If it is required to obtain the best possible output with a single pair of 'phones, an improvement can be effected by connecting the two earphones in parallel instead of in series. This will bring the impedance down to the correct order. A step-up output transformer could be used, but there will, of course, be losses in the transformer that will tend to offset any improvement.

In making the following suggestions it is assumed that, in the first instance, readers who wish to experiment will prefer to start with available components. For instance, many will have, somewhere a 0.0005-μF variable condenser, for a series tuned circuit.

The inductance should be about 300μH for the medium waveband and about 4 mH for the long waveband. The actual tuning range obtained will depend upon the capacity to earth of the aerial system, which is effectively in series with the tuning capacitance across the inductance.

The inductance should be constructed to have a high Q value. For the medium waveband, an inductance consisting of 100 turns of 0.036-in enamelled copper wire on a 3-inch diameter paxolin former will have a Q of 170 at 550 kc/s and 140 at 1000 kc/s. For the long waveband, the inductance must be basket or sectionally wound and lower Q values will result. A condenser of the order of .002 μF should be connected across the output 'phone terminals, to complete the R.F. circuit through the crystal. To assist in carrying out any adjustments, such as determining the correct crystal tap, it is sometimes convenient to connect a 0-100 microammeter in series with the 'phones.

From practical tests carried out with several aerial systems and receivers, it appears that satisfactory crystal reception should be possible from any of the B.B.C. 100-kW transmitters up to about 80 miles distance. At 50 miles from Droitwich, the Midland Home programme can be received at sufficient strength to feed four pairs of headphones for comfortable listening.

Frequency Test Records

A NEW set of frequency test records has been issued by the Decca Record Co., 1-3, Brixton Road, London, S.W.9. The characteristics are:—

K.1802. Gliding tone record, range 14,000 to 10 c/s to Decca "ffrr" characteristics.

K.1803. Side A: Gliding tone 14,000 to 3,000 c/s, constant velocity.

Side B: Gliding tone 3,000 to 10 c/s, constant velocity to 300 c/s, constant amplitude 250 to 10 c/s.

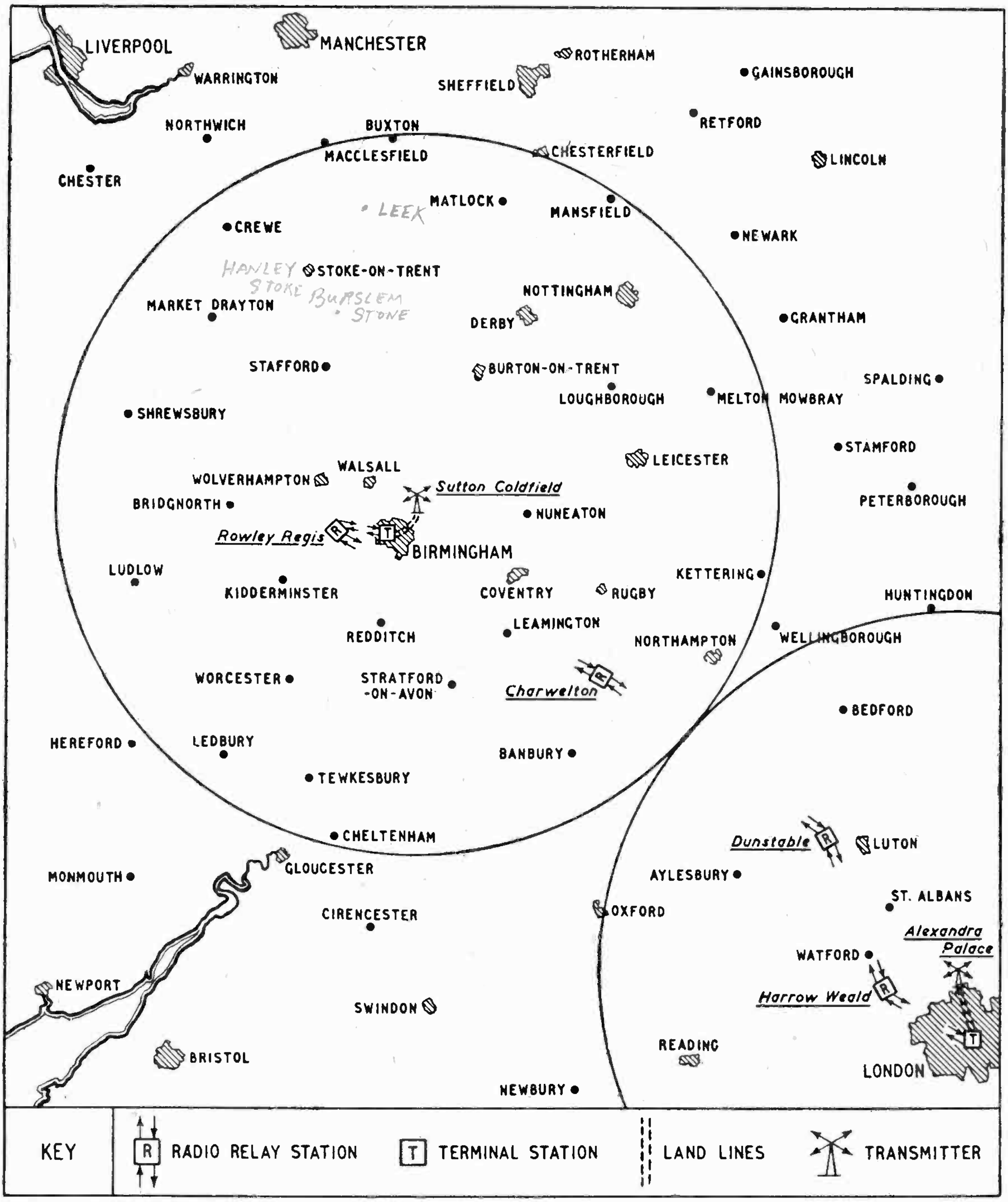
K.1804. Side A: Steady tone in bands, constant velocity, 14,000 to 5,000 c/s.

Side B: Steady tone in bands, constant velocity, 4,000 to 400 c/s, constant amplitude 250 to 30 c/s.

Particulars of relative recording levels are given in decibels on the labels.

The cost of each record is 6s 10d, including purchase tax.

MIDLAND TELEVISION



Some idea of the anticipated 50-mile radius service area of the Midland television transmitter, now being built at Sutton Coldfield, will be gained from this map on which is also shown a segment of the area served by Alexandra Palace. The disposition of the radio link system between London and Birmingham is also indicated. The terminal stations are at the Museum (London) and Birmingham telephone exchanges. *(Based on a Geographia map.)*

Dynamic Distortion Detector

Monitoring Device for Broadcast Transmitters

By R. DANZIGER

NORMALLY, broadcasting transmitters are not located close to the studios. If suddenly a distortion appears, it takes considerable time to locate the unit (in studio or transmitter) introducing the distortion. Generally, such a distortion is located on the transmitter side by an operator comparing the input from the studios and the output of the transmitters aurally, by means of headphones. When he has found out which of these is distorted, the fault has to be searched for at the studios or the transmitter respectively. The function of the dynamic distortion detector is to take over this rather tedious task and to give an immediate indication of the faulty unit, by comparing input and output electronically.

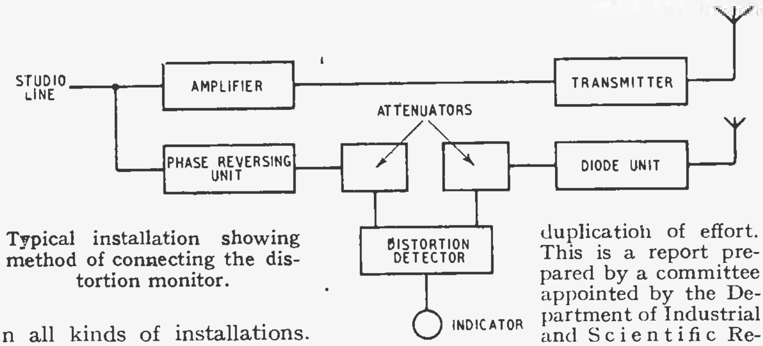
The dynamic distortion detector is based on the principle that two voltages of the same magnitude and waveshape, but of opposite phase, cancel out when applied to a common circuit. The input and the output of a transmitter should be of the same waveshape. If, therefore, both are applied over suitable attenuators (in order to obtain the required magnitude and phase shift) to the grid of a high-mu valve biased to "cut off," there will be no change in the anode current of the valve. If, on the other hand, the A.F. undergoes any undue variation in the transmitter which causes a distortion in the waveform, the two voltages do not cancel out, a voltage is developed across the grid leak, anode current starts to flow and the meter shows a deflection. This deflection shows that the distortion is caused by the unit to which the detector is connected. If, however, the distortion is at the other unit, the detector will show no deflection at all, as the input and output applied to it are equally distorted, i.e., of equal waveshape. Hence, by observing the detector at the instant the distortion is heard, the unit introducing it can be determined immediately. If required for quantitative measurements, the instrument may be calibrated against a standard distortion meter, to read percentage distortion.

The main advantage of the instrument is that it can be permanently connected to a working unit, the quality of which has to be observed continuously. With standard distortion meters, tests can be carried out only when the unit is not required for its normal work, and no continuous check is possible. The dynamic distortion detector makes it possible even to anticipate serious breakdowns by observing a deteriorating distortion factor.

The unit, being small and cheap, can be easily incorporated in all kinds of installations. It has many applications and is of special value in equipments where the time spent on fault location must be kept at a minimum, like transmitting stations, cinemas, recording studios, etc. The diagram gives an example of distortion location in a broadcasting station with only one distortion detector in use. The detector is connected to the input from the line on the transmitter side, representing the input to the transmitter and, via a diode unit, to the output of the transmitter.

If a distortion is heard, and no deflection is observed on the detector connected across the transmitter, the fault is in the studio. If, on the other hand, a deflection is observed while a distortion is heard, the cause is inside the transmitter. A distortion detector connected between the output of the microphone amplifier and the output line amplifier in the studio would give opposite results, i.e., a deflection only if the distortion results from the included studio equipment.

To reduce the time of fault tracing still further, several additional distortion detectors can be connected, for example, across line amplifier, sub-modulators, modulators, etc.



Typical installation showing method of connecting the distortion monitor.

Preventing Wasted Effort

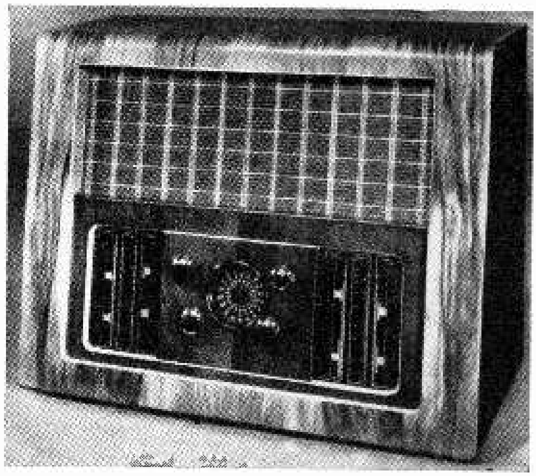
Organization of Radio Research

A RECENT publication, "The Fundamental Research Problem of Telecommunications" (H.M. Stationery Office, 1s 6d), appears as a result of a virtually new development in the organization of radio research which might well prevent duplication of effort. This is a report prepared by a committee appointed by the Department of Industrial and Scientific Research in 1946 to provide for exchanges of ideas and experience between industry and Government departments with the aim of establishing the basic problems that will require investigation during the next few years. The committee appointed nine working parties to deal with: Wave Propagation, Line Propagation, Valve Fundamentals, Properties of Materials, Contact Phenomena, Circuitry, Luminescence, Photo-emission and Television Appraisal. Like the committee itself, the working parties comprised representatives of both industry and Government establishments. Summaries and the full text of each party's report are given in the book.

TEST REPORT

Bush Model EBS4

Export Table Model Receiver

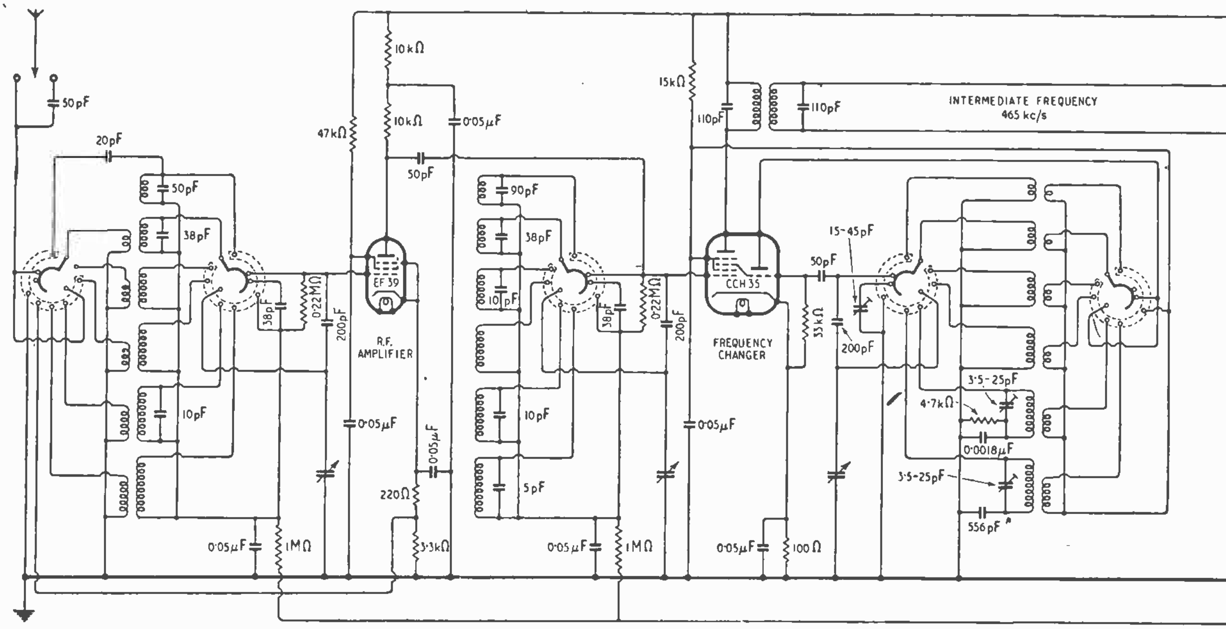


DESIGNED specially with an eye to the export market, the emphasis in this receiver is on short-wave reception. There is no long-wave range, but coverage is continuous from 10 to 560 metres. The Bush "Teleflic" system of station logging has been included and is a great asset on short waves.

Precautions taken to make the set proof against tropical conditions include special treatment of the cabinet wood, and the use of a rotproof woven plastic loudspeaker grille.

Circuit.—A stage of R.F. amplification precedes the frequency change on all six wavebands. On four of the wavebands, fixed capacitors in series with each section of the three-gang condenser give bandspread tuning. Full A.V.C. is applied to the R.F. valve and frequency changer as well as to the I.F. stage.

The audio-frequency section includes the Bush "Bifocal" feature which is a form of tone-compensated volume control in which the audio-frequency response is wide for powerful stations and narrow for weak stations which may be near the level of background noise. The method of operation appears to be as follows. Feedback is applied from the cathode circuit of the output valve to a point in the grid circuit of the penultimate A.F. stage through an R-C filter network which cuts bass and top. The effect on the output is, of course, the reverse, namely, a rise at both ends of the frequency scale. The amount of feedback depends on the setting of the



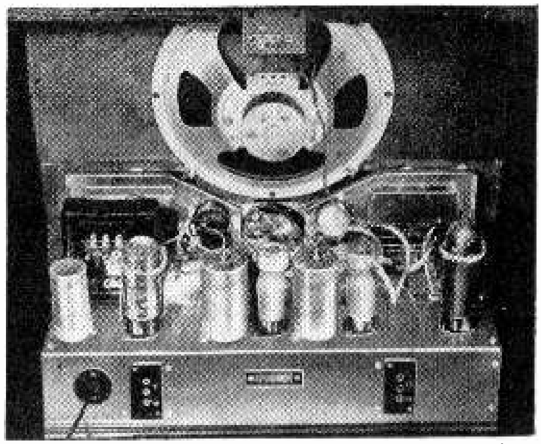
Complete circuit diagram of Bush Model EBS4. A half-wave rectifier supplies the H.T. current and the valve heaters are connected in series across part of the H.T. secondary winding.

volume control which forms a potential divider through the diode load and feed condenser to earth. Feedback is greatest when the volume control is at minimum, i.e., on a powerful scale station.

The power supply circuit in this A.C. set is unconventional. The valve heaters are connected in series across a tapping on the mains transformer secondary and the rectifier is half-wave. Presumably this circuit is adopted to rationalize production; an A.C./D.C. version is also made.

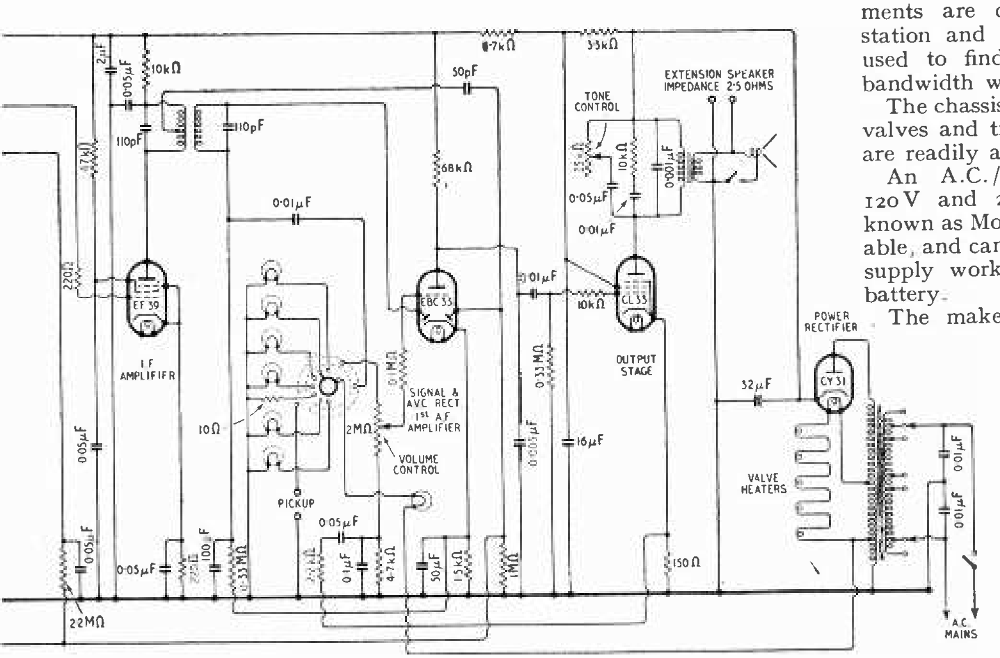
Performance.—The sensitivity and signal/noise ratio are good on all waveranges and should suffice to give a good signal from any transmission whose field strength is above the prevailing atmospheric noise level.

Stability of tuning is of a high order and short-wave stations are accurately located by the code associated with the logging device. There is no drift with temperature and setting is the same at the end of an hour or so as when the receiver is first switched on.



FEATURES

Circuit:	Superhet for A.C. supply; five valves and rectifier.
Waveranges:	10-15m, 14.3-20.7m, 20.7m-32m, 31.6-50.8m, 46-160m, 160-560m.
Mains supply:	100-130V, 200-250V, 40-100 c/s.
Consumption:	40 watts.



Quality of reproduction reaches a high standard, and there is ample volume. We thought the top rather peaked with the tone control set for full frequency range, but that is probably a matter of taste. Our preferred setting of the tone control for both speech and music was approximately half-way between minimum and maximum.

Constructional Details.—The "Teleflic" logging system consists of a pair of revolving discs driven from the tuning control and provided with a series of narrow radial slits which are illuminated from behind. The spacing of the slits differs in the two discs and the apertures coincide only at one point, which progresses round the dial as the discs turn. There are two rows of slits, and the inner circle moves one segment for every revolution of the outer slit. The inner circle is lettered A to S and there are 18 outer numbered apertures, giving a total of 342 non-repeating combinations over any one waverange. On the shortest wavebands it was found that the discrimination was just about equal to the bandwidth of a station; on medium waves, four or five segments are covered by a local station and the device could be used to find the centre of the bandwidth with accuracy.

The chassis design is simple and valves and trimming adjustments are readily accessible.

An A.C./D.C. version (100-120 V and 200-250 V, 60 watts) known as Model EU4 is also available, and can be run by a vibrator supply working from a 6 V car battery.

The makers are Bush Radio, Power Road, Chiswick, London, W.4.

"Television E.H.T. Supply": A Correction

In Part 1 of this article in the April issue the peak inverse voltage was shown incorrectly in Fig. 1 (b). The "10 kV peak" should have been shown as existing between the rectifier filament winding and the transformer core.

In Part 2 (May issue) it should have been made clearer that in the derivation of equation (1) from the preceding expression the assumption is made that the values of the capacitances C_2, C_4, . . . C_n are suitably graded along the chain. A misprint occurred in equation (1), the numeral 1 being used instead of I.

Short-wave Conditions

April in Retrospect : Forecast for June

By T. W. Bennington and L. J. Prechner (Engineering Division, B.B.C.)

DURING April the average maximum usable frequencies for these latitudes decreased during the day and increased somewhat during the night in accordance with the normal seasonal trend. These variations should continue until about the end of June.

Communications on frequencies higher than 35 Mc/s were very infrequent, but New Zealand was worked fairly regularly by amateurs on 28 Mc/s for an hour or so around 2300 G.M.T.

There was much less ionosphere storminess in April than in March. Ionosphere storms occurred on 1st-3rd, 7th, 12th and 23rd-24th. None of them could be classed as very severe. Of the several "Dellinger" fade-outs which occurred, that at 1215 G.M.T. on the 20th appears to have been the most severe.

Forecast.—It is probable that during June daytime M.U.F.s will continue to decrease and should reach their annual minimum towards the end of the month. Night-time M.U.F.s should continue to increase, reaching their highest values for the year during the month.

Daytime communication on very high frequencies (like the 28 Mc/s band) is not likely to be very frequent, but over many circuits fairly high frequencies, like 17 Mc/s, will remain regularly usable till midnight. During the night frequencies lower than 11 Mc/s will be seldom required, and 15 Mc/s may remain usable through the night on many circuits.

For medium distances—up to about 1,800 miles—the E or F_1 layers will control transmission for considerable periods during the day. In such cases daytime as well as night-time frequencies should be higher than in May.

Sporadic E is usually very prevalent in June, and so on many occasions (which it is, however, impossible to predict) communications over distances up to 1,400 miles may be possible by way of this medium on frequencies greatly in excess of the M.U.F.s for the regular E and F layers. For example, frequencies as high as 60 Mc/s may be occasionally reached, but only for a very short time.

Ionosphere storms are not usually common in June, and relatively undisturbed conditions may be expected. At the time of writing it would appear that storms are more likely to occur during the periods 1st-4th, 11th-12th, 16th and 19th-20th .

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

	(All times G.M.T.)		
Montreal :	0000	15 Mc/s	(19 Mc/s)
	0200	11 ,,	(15 ,,)
	1200	15 ,,	(19 ,,)
Buenos Aires :	0000	17 Mc/s	(22 Mc/s)
	0100	15 ,,	(19 ,,)
	0700	11 ,,	(16 ,,)
	1000	17 ,,	(25 ,,)
	1400	21 ,,	(27 ,,)
	2100	17 ,,	(22 ,,)
Cape Town :	0000	17 Mc/s	(22 Mc/s)
	0100	15 ,,	(19 ,,)
	0500	17 ,,	(24 ,,)
	0800	21 ,,	(27 ,,)
	2100	17 ,,	(23 ,,)
Chungking :	0000	11 Mc/s	(16 Mc/s)
	0400	15 ,,	(19 ,,)
	2200	11 ,,	(16 ,,)

New Book

Microwave Mixers. By Robert V. Pound. Pp. 374 + xvi; 221 figures. McGraw-Hill Publishing Company, Aldwych House, London, W.C.2. Price 33s in U.K.

RADAR development during the war years brought to the fore the importance of inherent circuit noise in receiver design. This is because the amplitude of man-made static is negligible at microwave frequencies. The design of the first stage, which is a crystal mixer in a superheterodyne receiver for microwaves, is of overriding importance from the point of view of maximum conversion gain and minimum noise. This book discusses very fully the sources of noise; and it describes the application of local oscillators, waveguide and coaxial line. TR and Anti-TR gas switches, mixers of various design, and I.F. pre-amplifiers, in mixer circuits which are intended to give maximum signal/noise factor in a radar receiver. The book also includes a very informative discussion on automatic frequency control, and concludes with a brief chapter on measurements of microwave mixers.

Small cartridge-type crystal detectors, now well known, are used almost exclusively as first detectors in receivers for 10-cm and 3-cm wavelengths. This book reviews the properties of these crystals, and describes extensively the design principles of mixers which incorporate them. It is significant that, as the result of the intensive crystal, mixer, and I.F. amplifier development which occurred during the war years, the signal/noise factor of receivers for frequencies in the region of 3,000 Mc/s to 10,000 Mc/s is as good now as that for frequencies of a few Mc/s.

The designer of a radar receiver is presented with a peculiar problem in that he always has available an outgoing (transmitted) signal. He may or may not have an incoming (received) signal, but his receiver must be fully operative. Thus, A.F.C. is now commonly used, and the receiver is locked in frequency to the outgoing signal. This book, in addition to the discussion of mixer design principles, also describes multiple waveguide and coaxial-line mixer circuits for use in A.F.C., and signal and beacon reception. The use of the magic-T in mixer circuits is also described.

Waveguide and coaxial-line circuit design always resolves itself ultimately into a problem of the mechanical dimensions of the parts from which it is to be fabricated. It is pleasant to find in this book an appreciable number of diagrams in which exact dimensions and mechanical tolerances are given.

Unfortunately the book is not well written. It contains much needless repetition, and the subdivision of subject matter would merit considerable revision. The repetition, the mixing of subject matters, and the author's style of writing, make the book not easy to read.

This book is Vol. 16 of the M.I.T. Radiation Laboratory Series on radar and related techniques. It describes only the American developments and does not refer to the British, which are quite their equal on crystals, valves, and waveguide circuits. Nevertheless, the experienced reader will be able to sort out for himself very useful references for his work. Because of the style of writing, however, the beginner in the subject will need to study the book carefully in order to grasp the salient features of the subject.

L. W. B.

Single-diaphragm Loudspeakers

By
A. CECIL BARKER

Obtaining Wide Frequency Response and Effective Damping

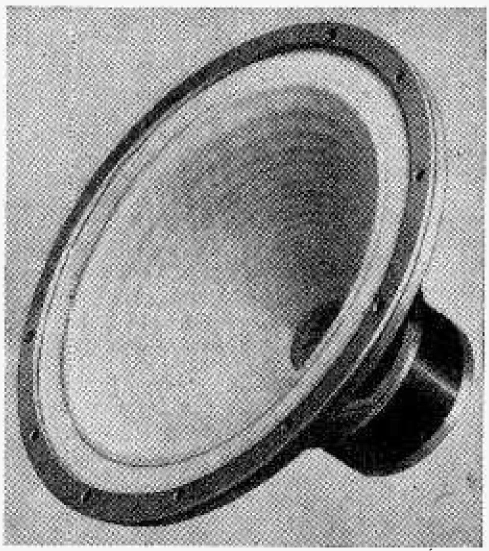
AS the results of experiments extending over a number of years, the writer has developed a single-diaphragm loudspeaker unit which appears to offer advantages over twin-diaphragm "tweeter" techniques, particularly in avoiding the impression of added or "disembodied" top.

A beginning was made by tackling the moving coil itself, for, unless this could be modified so as to provide an essentially flat frequency characteristic, there would be little hope of improvement by altering anything else. A moving coil should live up to its name at all frequencies, but, due to its large effective mass at high frequencies, the conventional rigid or "solid" coil cannot do so, particularly when it is also required to provide a powerful drive lower down the frequency scale.

In America a moving coil was used having two sections mechanically and electrically in series, but with a resilient coupling (compliance) in the form of a crimp in the coil former between them, and a capacitor connected across the section remote from the cone. The results proved that the desired extension of frequency range was possible. Different values of shunt capacity and number of turns on the two sections were tried by the writer, but the best result was obtained by a dead short-circuit across the high-frequency section, which thus derived its current from the other section by induction only. The shunt capacity was removed and it was at once apparent that an entirely novel form of drive had become possible.

Coil Construction

The shorted high-frequency section obviously resolved itself into a single turn which, fashioned as a short, thin aluminium cylinder, superseded the conventional paper coil former. Outside this a lightly stretched thin rubber band provided the compliance, with the main coil finally wound over all. The optimum proportioning of electrical and mechanical components so closely interrelated presented a problem, but the extension of the extreme top, together with a marked improvement in general smoothness, were apparent even when the proportions were a long way from optimum.



This form of drive has already been described (*Wireless World*, March 6th, 1936), but a brief outline of the manner in which it is believed the system functions will not, perhaps, lack interest.

The composite coil consists of two conducting elements: the primary or main coil into which the input is fed, and a light closed-turn secondary in which current is induced by the primary without any other electrical connection. A thin layer of resilient material between them forms the mechanical connection, and the compliance so formed permits a slight relative movement between them at high frequencies, which is imparted to the vertex of the cone, to which the secondary is rigidly attached. The response obtainable at high frequencies can be modified to a considerable degree by variation of the compliance within fairly wide limits.

As the frequency falls and the movement of the primary increases, the importance of relative movement is progressively diminished, until the secondary is carried by the primary as though there were no compliance. It is to be noted, however, that at the lower frequencies the secondary must not be regarded as just an added mass or a convenient coil former, for, indeed, its function, although changed, is no less important than at higher frequencies. It is generally accepted that a high degree of magnetic damping in the drive is essential in the interest of good definition and transient response. The degree of damping introduced by the secondary in cutting the magnetic field is, in fact, very great, and, therefore, it is not surprising that practical results show a most marked improvement by its inclusion. As a case in point, a given cone assembly has a very pronounced fundamental resonance when driven by a conventional coil, but, by substituting the form of drive under consideration, this resonance is almost extinguished, so great is

Single-diaphragm Loud Speakers— the damping imposed by the secondary. In addition, of course, the top response is extended far beyond the original limit and the whole texture of the reproduction appreciably clarified.

Cone Shape

Having produced what appeared to be a much superior drive, it was logical to turn attention to the cone, and here was encountered a fascinating, though somewhat bewildering, problem. A little consideration shows once again that a yet undiscovered material is required for the ideal diaphragm, which might well take the form of a disc of suitable size having no mass and infinite stiffness! But, alas! a choice must be made from existing materials, approaching each virtue in some degree, and the shape of the diaphragm will inevitably be determined largely by the conflict between inherent lack of stiffness on the one hand and mass on the other.

In the adoption of some kind of conical shell having an apical angle of about 90 deg may be seen the logical compromise between a disc and a cylinder, where the requirements are maximum area, maximum stiffness and minimum mass for a given size of cone. There seemed no reason why such a conical shell of about 10in base diameter should not form the basis of the contemplated new diaphragm to realize the capabilities of the new coil. No longer would it be necessary to adjust the stiffness to bolster up the response at frequencies above the point at which the mass of the older solid coil starts to reduce output; rather would it appear an advantage to explore the possibility of adjusting mechanical transmission loss for flexural waves in the cone itself, so that something approximating to a correct termination at all frequencies might be achieved.

For the purpose of this research it was assumed that the best method of termination might be by absorption, so that for all the upper register the attenuation should be sufficient, somewhere between the coil and the surround, to avoid any reflection back to the coil. Should a strong reflection arrive in phase with the coil motion, not only would the sound output be considerably increased, but worse, a train of undamped oscillations would be whipped up, due to stored energy at the point from which reflection occurred, the whole reproduction being coloured thereby. If on the other hand, the reflection arrived at the coil out of phase, the output might be reduced, but the coloration would persist with the possibility of some ugly harmonics added.

As a first approximation a number of circular parallel corrugations equally spaced was impressed in a cone of a hand-made drawing paper. The idea of such corrugations was by no means new, but the transmission loss seems to be under better control than in a plain cone and the response curve also showed some improvement, the peaks and the dips being reduced. It was felt however, that with the new drive, an altogether different material with a higher natural transmission loss might be sought. Cones were made up from a variety of materials from among which a special grade of linen blind fabric was selected as providing a high loss in its original state, but being capable of considerable modification in this respect by doping and other means. It was found possible to produce an improved cone with this material, using cellulose lacquer as a stiffening medium.

Damping at the Rim

A further improvement was achieved by modifying the corrugations so that the spacing between them increased logarithmically towards the cone base. Mention should be made here of the further problem of the cone surround, the arrangement of which has a decided bearing upon, and is in fact part of, the problem of correct termination. It is considered that if the cone is not mechanically terminated or is insufficiently damped at the rim, reflection will be fed back into the cone, giving rise to further coloration.

A small number of speakers was produced by hand and supplied to certain individuals and research laboratories, with whom the writer has been in close association for a considerable time, and it is appropriate to acknowledge the keen interest and friendly criticism which played no small part in furthering the effort. Before making the loudspeaker generally available certain modifications in production methods had to be faced, not only to increase output but to secure uniformity in performance. Fortunately certain forms of recently introduced phenolic resins provided an answer, not only to the provision of suitable cone forming moulds, but also to a more satisfactory stiffening medium, providing a nearer approach to correct transmission loss when applied to the cone linen before mentioned. It is interesting to note that while the quest for the ideal cone material continues this fabric still offers the best, though by no means final, solution.

Laboratory v. Listening Tests

It may be noticed that little mention has been made so far of any serious laboratory tests. This is not because such tests have been neglected, for, on the contrary, some of the most highly developed test gear has been available. Rather is it because results obtainable for any speaker are still open to various interpretations. As an example, apparatus for measuring the response curve must be most carefully taken in still, open air, remote from any possible reflecting surfaces. A steady-state response curve alone tells only part of the story, and it is remarkable at first sight that two speakers giving very similar curves often sound quite different.

It can be expected that a speaker passing an exacting listening test will have a good response curve, but there is no certainty that a nice-looking curve anticipates a satisfactory listening test, for, curiously enough, some imperfections which can be easily measured are not audible whilst others which are audible are most difficult, if not impossible, to investigate, even with the most elaborate physical equipment available to-day.

Concentrated effort is being devoted to the problem, and it is thought possible that an objective specification may, in time, be evolved for a high-grade loudspeaker. At the present the only absolute comparator is a keen and trained ear.

Television Receiver Construction

Answers to Some Builders' Queries

SINCE the description of the *Wireless World* Television Receiver constructors have raised a number of queries about minor difficulties which they have encountered and modifications to the design which they propose to make. There are surprisingly few such difficulties and none of common occurrence, but for the convenience of builders some of the more important points raised are listed below:—

Synchronizing

Line Scan.—Picture locks in, but a vertical black bar appears near the right-hand edge with what should be the left-hand side of the picture on its right. The cause is inadequate sync pulse amplitude on V_1, Fig. 1, Part 5. Check the waveform at the "Line Sync" terminal; it should agree with Fig. 3 (a), Part 4, and be of 80-V amplitude. If it is too small, check V_1, Fig. 1, Part 4, but in this case the frame sync will probably be affected also. If the amplitude is sufficient, check C_1, Fig. 1, Part 5. Occasionally an increase of C_1 to 30 pF is desirable.

Frame Scan

(a) Picture Cut-Off at Top.—There may be also a horizontal bright line across the top of the picture. The usual cause is a leaky coupling capacitor C_7, Fig. 1, Part 4.

(b) Picture Cramped at Bottom.—This is usually due to a faulty valve V_4 or resistor (high) R_{19}, Fig. 1, Part 4, but can also be caused by low capacitance in C_8, C_9.

(c) Picture Displaced Upwards.—When this is too much to be corrected by adjusting the focus coil, the cause is excessive leakage in the electrolytic capacitors C_8, C_9, Fig. 1, Part 4.

Line Scan

(a) Vertical Bright Line on Left of Picture.—The line is usually about one inch from the left-hand edge of the picture and indicates a scanning waveform like that of curve C, Fig. 3 (a), Part 5. It is caused by inadequate damping of the deflector circuit. Check C_8, Fig. 1, Part 5. Check that the line-scan output transformer laminations are not less than 0.02in thick. The grade of iron also has an effect, and an extra damping resistor should be tried across the transformer secondary. Adjustments should initially be carried out with a picture not wider than 6in, since it is impossible to avoid the bright line if V_3 is driven too heavily.

(b) Left-Hand Side of Picture Folded Over.—This is the opposite of (a) and indicates a wave form like curve B, Fig. 3 (a), Part 5. It is caused by excessive damping of the deflector circuit. Check C_8, Fig. 1, Part 5. Check that the transformer laminations are not much greater than 0.02in thick and that an unsuitable grade of iron has not been used.

(c) Picture Width Insufficient.—If the maximum width is about 6in, check V_2 and V_3, Fig. 1, Part 5. A few short-circuited turns on primary or secondary of the line-scan transformer, or in the line deflector coils, may be responsible. If the maximum width is 2-3in only, a short-circuit between layers in the transformer is the probable cause.

(d) Blue Glow in Line-Scan Output Valve.—This is normal and indicates no defect. It does not indicate a soft valve. The glow in a soft valve is purple rather than blue.

Receiver

(a) Insensitivity and Negative Picture.—At normal Contrast Control setting no picture is evident but the raster synchronizes normally. When Contrast is turned up considerably a negative picture is obtained with erratic synchronizing. The trouble is a faulty diode V_5, Fig. 1, Part 7.

(b) Instability.—As in any R.F. amplifier this occurs if stray couplings are excessive and the usual remedies are applicable. It is necessary for the aerial feeder to be of the coaxial type, or for the last ten feet or so near the set of a twin-wire feeder to be screened. The cross-screens in the chassis should be carried down to the chassis as closely as possible with cut-outs to clear the valveholders. Great care must be taken to ensure that all chassis connections are good.

Modifications

(a) Use of 12in Tube.—In general, this entails no changes. The usual tube is proportionately longer than the 9-in type so that the deflection angle is the same, and if E.H.T. is unchanged the scan current needed is not altered. Because the picture is bigger it will not be so bright, but will be adequately so for most purposes. It is not practicable to increase E.H.T. without extensive re-design, because the use of a higher voltage would necessitate more scan-current.

(b) Use of Alternative Deflector Coils.—This is not recommended if E.H.T. is taken from the fly-back. The design of deflector coils, line-scan transformer, line time base and E.H.T. supply are closely inter-related and changes in one part may involve extensive re-design. If an alternative E.H.T. supply is used it becomes much easier to use a different scanning coil, but the transformer must always be chosen to suit the coil. Even then the change is not one recommended to the inexperienced.

(c) Use of Alternative E.H.T. Supply.—There is no objection to this, and the only change needed is the omission of R_{15}, R_{17}, C_9, C_{10}, C_{11}, W_1, W_2 in Fig. 1, Part 5. The alternative supply should not exceed 5.5 kV, otherwise there will be difficulty in obtaining a wide enough picture.

Constructional Data

Hartley-Turner Technical Bulletins. No. 1: 25-W Amplifier and Power Unit. No. 2: T.R.F. Unit. H. A. Hartley Company, Ltd., 152, Hammersmith Road, London, W.6. Price 10s each.

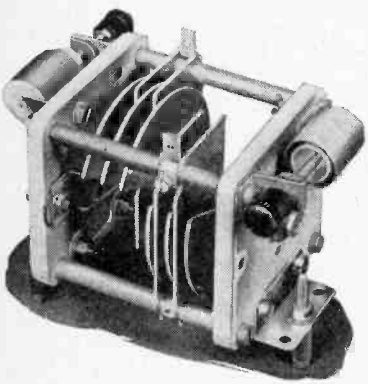
These pamphlets contain constructional details of equipment, including circuit diagram, chassis drilling, wiring and sub-assembly drawings. A list of parts and instructions for building are included. No. 1 covers a 25-W amplifier comprising a pair of tetrode output valves in push-pull fed from a cathode-follower type phase-splitter and preceded by two RC-coupled stages. Bass lift is included for gramophone use. No. 2 describes a radio unit covering the medium waveband only and giving switch selection of three stations in that band as well as continuous tuning. There are two R.F. stages with three tuned circuits and an "infinite input impedance" detector.

Manufacturers' Products

Transmitting Capacitor

A NEW variable split-stator capacitor of 25pF per section and incorporating two small neutralizing capacitors has been added to the range of transmitting components made by Stratton & Co. Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 1. The main application is in low-power V.H.F. transmitters using triodes, the neutralizing capacitors providing a variation of 1.5 to 7pF.

Ceramic end-plates are used and the two sections are staggered so as to permit a 180-degree rotation for minimum to maximum capacitance.



Eddystone 25+25pF V.H.F. transmitting capacitor with two neutralizing sections.

A hairpin wire, having two alternative fixing positions, makes contact with the rotors and alternative contact points are also available for the stators. The overall size is 2½in × 3¼in × 4¼in and the price is 39s 6d.

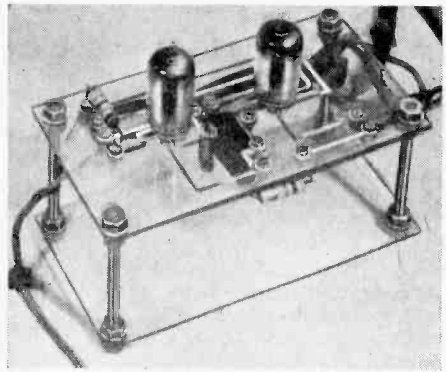
Printed Circuits

A SILVERING process which is applicable to many kinds of insulating materials including plastics such as polystyrene and polyethylene has been developed by Ward, Blenkinsop and Co. Ltd., 6, Henrietta Place, London, W.1.

The colloids employed are known as Elargols and contain a very high percentage of pure silver. They are available as liquids, pastes or powders and application is by printing, brushing or spraying.

The printing process has been developed with particular regard to its use in the production of radio apparatus and some examples, including a complete receiver and a gramophone amplifier, were shown and demonstrated at the British Industries Fair at Olympia.

Another example was a 0.0005in thick polyethylene strip, silvered on one side, for use in the construction of fixed capacitors.



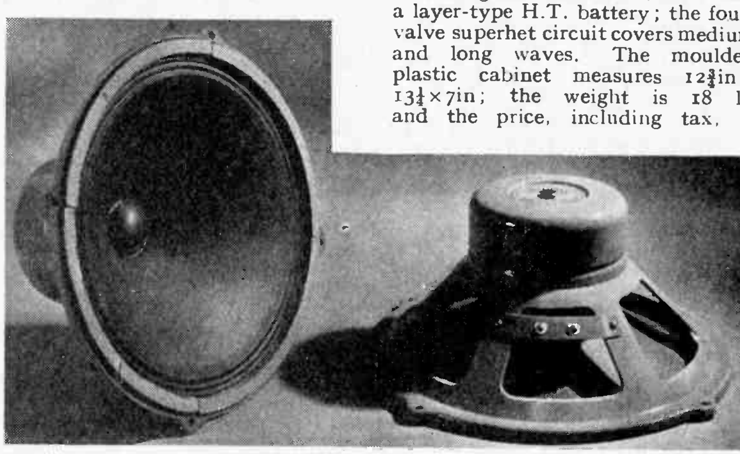
A two-stage gramophone amplifier with all wiring printed in Elargol.

Grampian P.M. Loudspeaker

DESIGNED for high-quality reproduction up to peak powers of 15 watts, the Grampian Type 3512/15 loudspeaker has a curved-sided diaphragm 10in in diameter with a domed dust cover at the apex. The 1¾in speech coil, with large diameter rear suspension, has the standard nominal impedance of 15 ohms. A ring-type Alcomax magnet provides a flux density of 14,000 gauss and is enclosed at the back by a metal cover.

The chassis is an aluminium casting of rigid construction, and the whole assembly is well adapted for heavy duty either in radio-gramophones or high-grade P.A. equipments. The quality of reproduction is well balanced and the high frequency response above 7,000 c/s is adequate without tending to over-emphasize background noise. There is also little evidence of focusing of high frequencies on the axis of the diaphragm, possible as the result of using a convex surface at the apex. In general, the design seems well fitted for obtaining the best possible reproduction in a wide variety of applications.

The makers are Grampian Reproducers, The Hanworth Trading Estate, Feltham, Middlesex, and the price is £6 10s.



Grampian Type 3512/15 P.M. loudspeaker for radio-gramophones and high-quality P.A. work.

Domestic Receivers

IN collaboration with the makers of Challen pianos, A. C. Cossor, Highbury Grove, London, N.5, have produced a new range of broadcast receivers in high-grade console cabinets. The receiver chassis is basically the same as the 5-valve Model 487 A.C. and is rated for an output of 2¾ watts from a 6V6 valve with negative feedback. The sound from the loudspeaker is projected upwards and reflected forward from the lid of the instrument. Prices (including purchase tax) range from £41 10s to £60, according to the cabinet finish.

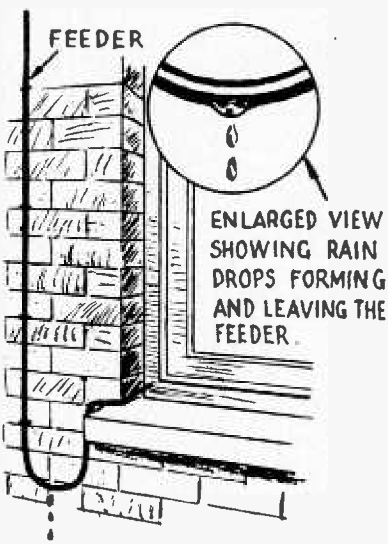
A battery working life of over 250 hours is claimed for the latest G.E.C. Portable (B.C.4941), which uses all-glass miniature valves and a layer-type H.T. battery; the four-valve superhet circuit covers medium and long waves. The moulded plastic cabinet measures 12¾in × 13¼ × 7in; the weight is 18 lb and the price, including tax, is £22 5s 10d. The makers are the General Electric Co., Magnet House, Kingsway, London, W.C.2.

THE "BELLING-LEE PAGE"

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

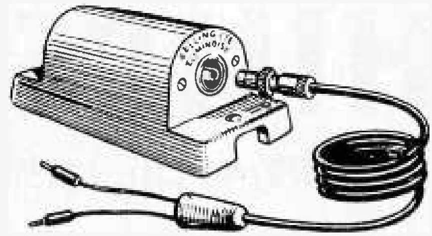
Coaxial Drain Pipe ?

Recently we have had two complaints of water entering a television receiver via its co-axial*1 cable. In one case the water was running down the outside of the cable, and, because of the manner of installation, was carried into the house. Our installation department invariably bring cable in as illustrated i.e. looped so that external water runs off. This should be done with every type of cable.



In the second case the co-axial feeder really was acting as a pipe, with a good head of water too.

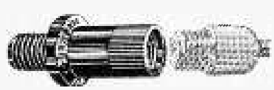
In the centre of the bakelite insulator of the "Belling-Lee" television aerial*2 there are two terminals. Two sealing sleeves cut from plastic material and approximately 3/16in x 1/8in are supplied and should be slipped over each terminal stem before insertion in the appropriate hole. We wish to emphasise this, as these small sleeves are frequently overlooked or ignored, and if co-axial cable is being used, water may enter the cable and run down the inside and into the receiver. It will be obvious that in such a case the looping of the cable before entering would have no effect as the water would syphon round the bend.



Burnt-out "Eliminoise" Transformers.

Referring back to the question of burnt out "Eliminoise"*3 on A.C./D.C. receivers where we wrote that this would happen if the *isolating* capacitor was omitted or had broken down, a reader from Tunbridge Wells asks if a capacitor can truly "isolate" against A.C. Of course he is quite right, a small current does flow, but at 250 volts A.C. using an 0.01μF capacitor, this current is just under 10 milliamps. Such a current would not harm an "Eliminoise" winding, nor would it be really dangerous to life.

If the capacitor breaks down, then the "Eliminoise," if fitted is burnt out, or the receiver becomes a very dangerous appliance in the home or elsewhere. We did discuss the possibility of inserting a fuse link in the "Eliminoise." But surely the correct position for the fuse is in the receiver. Why should we increase the cost of the "Eliminoise" to make up for the shortcomings of the set.



Ignition Interference.

The campaign for the fitting of distributor suppressor*4 to motor vehicles to prevent their interfering with television reception is producing important results. Most really big transport organisations are co-operating. It is rather more difficult to obtain co-operation from private users, tradesmen, etc. We know of one Televiewer in Bedfordshre who having spent an odd hundred guineas on a television receiver and aerial could not enjoy a picture because of interference from passing cars. He purchased fifty distributor suppressors which he gave "gratis" to all his neighbours, and to other car owners normally passing his house, tradesmen's vans etc. Now he considers his total expenditure well worth while. He is fortunate in not living right on the Brighton or Portsmouth roads.

Facing facts, the manufacturer, and his agent the retailer of television receivers, are the people who stand to gain most from the fitting of distributor suppressors. Is it asking too much to suggest that dealers on the fringe areas such as Reading, Tunbridge Wells, etc., try and persuade their business neighbours,

P.S.

Did you know? A motor car can seriously interfere with electronic research and television reception. Fit a "Belling-Lee" suppressor L.1274 or L.630 to the distributor lead. Costs 1/6d, does not affect engine performance, and helps an industry.

This is a reproduction of a "letter-sticky" that we are using on all our out-going correspondence...

the garage proprietors, to co-operate in which is, to them, such an important matter? After all, if most vehicles *garaged* in these towns were fitted with a one and sixpenny suppressor, a surprising number of television receivers might be sold, with a unit value of from £50 to £100, and a largely increased satisfied audience, paying for a television licence which goes towards an improved service to everybody interested. Reader is *your* car suppressed ?

★ 1. **L600.** Belling-Lee co-axial cable, **1/6** per yd.

★ 2. **"Viewrod"** (Regd. Trade Mark).
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★ 3. **"Eliminoise"** (Regd. Trade Mark).
Anti interference aerial.
L308/K complete kit **£6/6/-.**

★ 4. Distributor suppressors,
L1274 Fits in the H.T. lead,
L630 Screw type, **1/6** each.

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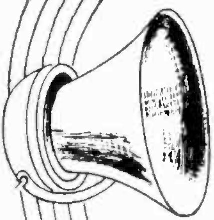

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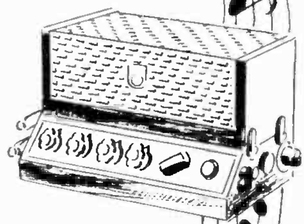

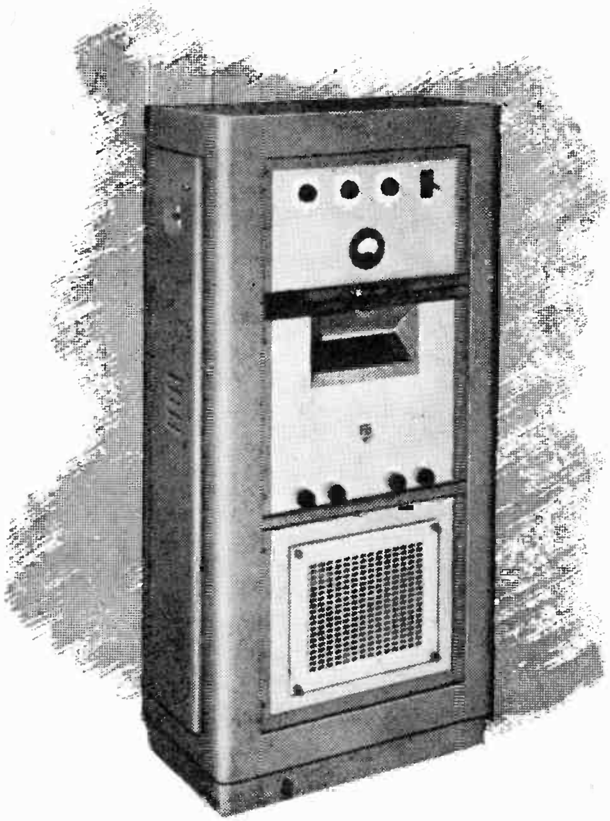

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Reducing F.M. Band-width

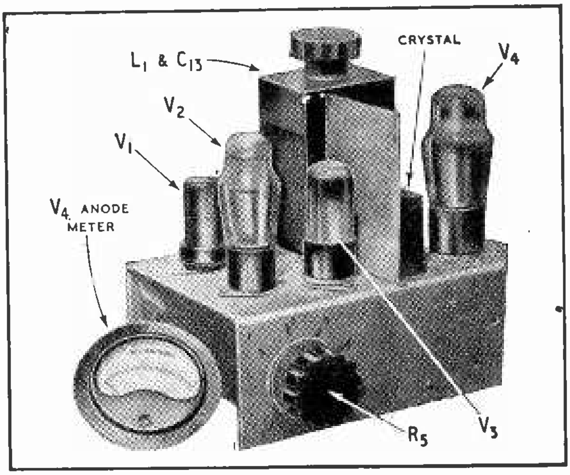
Crystal-controlled Reactance Modulator Unit

By A. G. CHAMBERS, A.M.Brit. I.R.E.

NARROW-BAND frequency modulation has been brought into the limelight during the latter part of last year by the American amateurs. Its advantages over both A.M. and normal F.M. for communication purposes are: (a) Less interference, due to its narrow band-width; (b) it overcomes interference with broadcast receivers, and (c) if there is an F.M. receiver at the other end, overall reduction in noise.

Many people are of the opinion that as straight F.M. occupies a large band of frequencies, there is no place for narrow-band F.M. for communication purposes. Actually, narrow-band F.M. occupies less space than a 100 per cent modulated A.M. transmission, and, when crystal controlled, has a high carrier frequency stability.

In straight frequency modulation the output is made to vary about the mean carrier frequency at a rate corresponding to the audio frequencies of the modulator; this rate is called the frequency deviation, and is limited only by the pass band of the speech amplifier. In narrow-band F.M., the audio pass band is limited not in the amplifier, but in the first R.F. stage of the initial carrier. This pass band, better known as the frequency deviation, is normally expressed in kilocycles, being equal to the difference between the carrier frequency and either the highest, or lowest frequency reached by the carrier as it moves up or down with modulation. With straight F.M., the frequency deviation ratio can be as high as 5; which means that the carrier occupies a large number of frequencies. Narrow band F.M., on the other hand, is limited to a deviation ratio of 0.5, and still retains all the advantages of a fully modulated F.M. carrier. Obviously, one would not use this type of transmission for anything but voice frequencies. For music,



This annotated illustration shows the location of the valves, crystal and coil assembly on the crystal-controlled F.M. unit

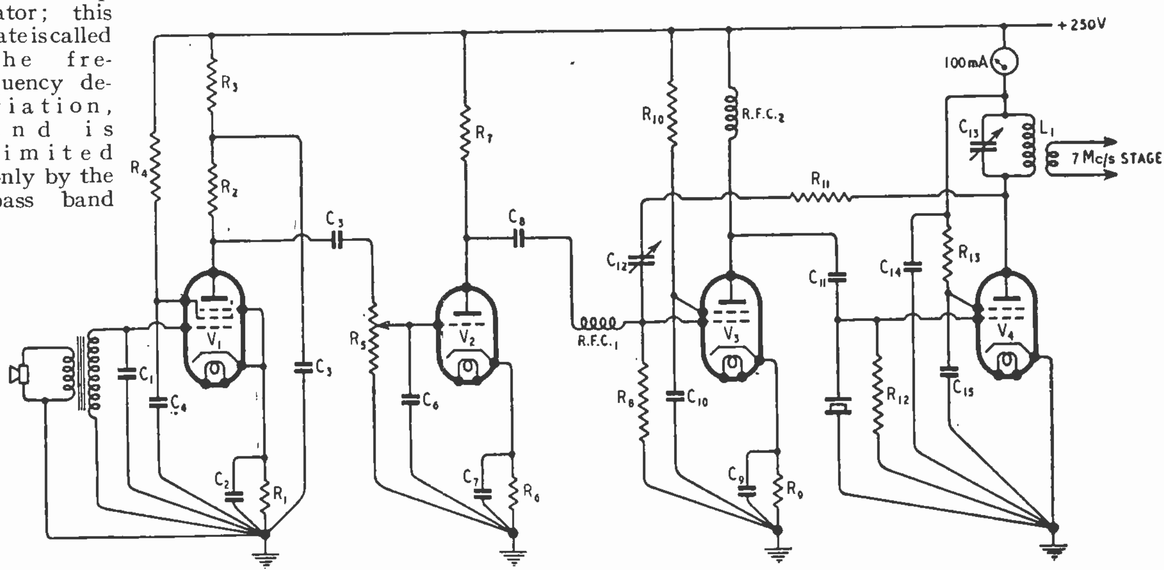


Fig. 1 Circuit details and component values for the narrow-band crystal-controlled F.M. unit. The function of the individual stages is explained in the text. Values of the components are given at the end of this article

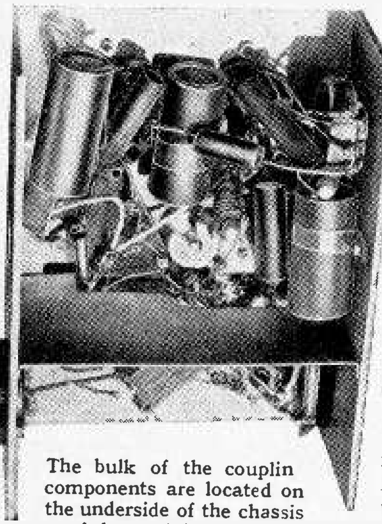
Narrow-band F.M.—

and where good quality is required, full F.M. would have to be used.

The unit to be described weighs only 2 lb. It uses a 3.5 Mc/s A.T. cut crystal, which, when used in the 28-Mc/s amateur band, gives a deviation of 1,600 cycles, or a deviation ratio of approximately 0.5, based on an upper audio-frequency limit of 3,000 to 4,000 cycles.

The Modulator Unit

The modulator shown in Fig. 1 and the accompanying photograph may be considered in three distinct sections. V 1 and V 2 comprise the audio section, V 3 is the modulator and V 4 the crystal oscillator. All are distinct



The bulk of the couplin components are located on the underside of the chassis of the modulation unit

units and should be screened from each other. V 1 and V 2 work as straight audio amplifiers, using a moving-coil microphone. A crystal microphone may be substituted by removing the input transformer and taking the grid of the 6SJ7 to earth through a 5-Megohm grid leak. The output of the audio amplifier is taken from C8 and passed into the modulator via an R.F.C.1, a 2.5-mH choke.

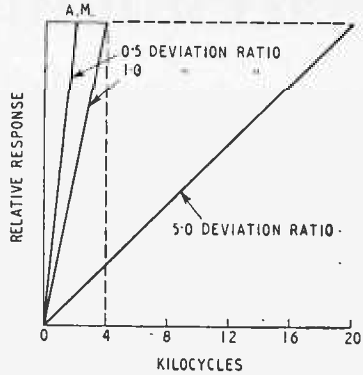
V 4 is a standard crystal oscillator using a 6V6. From the anode of this stage a small amount of R.F. is taken through R 11 and C 12 and fed back into the grid of V 3, where it is mixed with the audio component. V 3 is a reactance modulator. Audio voltage supplied to the grid of this valve (another 6V6), swings the anode positive and negative, it is there by-passed via R.F.C.2 and the H.T. to earth and does not reappear at C11. The R.F., however, supplied through C 12 is swinging in phase with the modulation and acts as a variable reactance through C 11 across the crystal. The crystal frequency is thus made to deviate from its fundamental in phase with the modulation. Whilst R.F.C.1 and R.F.C.2 could be identical it might be advisable to make R.F.C.2 slightly larger in order to prevent the likelihood of parasitic oscillation in V 3.

The output of V 4 may be coupled into any transmitter, which is normally 7-Mc/s crystal controlled, by removing the crystal and substituting link-coupling from the new unit into the old 7-Mc/s crystal stage.

The chassis measures 6in × 8in and is built up from a piece of ⅛in aluminium bent to the depth of 2in. The layout of the components is important and the annotated illustration should be followed carefully. V 3 is totally screened from V 4 both above the chassis and below. C13 and its associated coil L 1 are placed in a totally enclosed can. This rather drastic screening is necessary in order to keep the R.F. out of the A.F. section which would inevitably result in amplitude modulation.

The unit was tested in two separate stages. The audio first, by substituting an A.F. choke for R.F.C.2 and taking the anode of V 3 through a 1-μF condenser to a loudspeaker. Valves V1, V2 and V3 were then removed and V 4 tested as a normal crystal oscillator. The unit was then tested as a whole.

Tuning is very critical and the use of a monitor is essential while carrying out the operation. The writer recommends that calibrated dials be placed on R 5 and C 12 for quick reference while tuning. There is only one correct setting which gives good speech quality, C 13 should be set slightly on the high-frequency side of the minimum anode current point, and then R 5 and C 12 set so that maximum deviation takes place



Relative band widths in kc/s for different deviation ratios using frequency modulation. The band width of a typical communications system using A.M. is also shown

without any movement in the needle of the V 4 anode current meter. When these controls are incorrectly adjusted the crystal goes out of oscillation on loud passages of speech, resulting in choppy and distorted quality.

One-point earthing is recommended throughout, with the screen of the microphone cable taken to the same earth as R 1, C 2, C 3 and C 4. This helps to keep the R.F. where it should be.

The unit has been in use at this station (ZB1AB) with a fair degree of success: better results would have been possible if there had been more stations with F.M. receivers.

It has been reported that male voices are received better than female voices when using this system of modulation, whereas with A.M. it is very often the reverse. It gives confirmation to the claim for very narrow band transmission as the characteristically higher pitch of the female voice is subject to greater high-frequency attenuation and so loses more in intelligibility.

Component Values.—R_1, 1000 Ω; R_2, 220 kΩ; R_3, 22 kΩ; R_4, R_8, 500 kΩ; R_5, 1 MΩ; R_6, 1.5 kΩ; R_7, R_{10}, 100 kΩ; R_9, 470 Ω; R_{11}, 470 kΩ; R_{12}, 5 kΩ; R_{13}, 10 kΩ; C_1, C_6, 500 pF; C_2, C_7, 50 μF; C_3, 0.03 μF; C_4, C_5, C_8, C_{10}, 0.01 μF; C_9, 50 μF; C_{11} C_{14}, C_{15}, 0.001 μF; C_{12}, C_{13}, 50 pF (trimmers); V_1, 6SJ7; V_2, 6C5; V_3, V_4, 6V6.

WORLD OF WIRELESS

Broadcasting in Europe ✦ Component Industry ✦ Marine Radar ✦ "Business Radio" Applications

EUROPEAN WAVELENGTHS

THE committee of representatives of eight European countries set up by the Atlantic City Conference to prepare a draft plan for the allocation of medium and long waves to broadcasting stations in Europe was unable to agree on a complete plan at its first series of meetings. Alternative plans have, therefore, been sent to the interested countries who are asked to submit their observations. These observations will be examined by the committee, which includes delegates from the U.K., France, Belgium, Netherlands, Sweden, Switzerland, U.S.S.R. and Yugoslavia, at its second meeting to be held this month.

The European Regional Broadcasting Conference at which the plan prepared by the committee is to be presented is scheduled to be held in Copenhagen in June.

The British representative on the committee is L. W. Hayes, chief of the B.B.C. Overseas Engineering and Information Department.

R.C.M.F. REPORT

SOME interesting facts and figures are given in the fifteenth annual report of the Radio Component Manufacturers' Federation. Over 250,000,000 major components were produced last year for the radio industry alone. If the current year's programme of set manufacturers—providing for 1,400,000 receivers for the home market and 400,000 for export, 100,000-120,000 television sets and up to 300,000 car radio receivers—is fulfilled the component section will be called upon to increase its output by 10 per cent.

This demand of set manufacturers is less than two thirds of the total commitments of the component industry. The rest is absorbed by direct export and by other sections of the radio and electronic industry. The "ham" market—largely supplied by the U.S. before the war—has increased tenfold and is now valued at £250,000 worth of components a year.

In view of the widening field of operation of the component industry, including broadcast equipment, telecommunications, diathermy, and scientific and industrial apparatus, it is suggested that "electronics" might be substituted for "radio" in the title, as the latter has "become more restricted in its interpretation and is now popularly regarded as relating principally to broadcast transmission and reception."

EXPORT RECORD

THE value of British radio equipment exported in January, was £1,151,954, an all-time record. The previous highest monthly total (last December) was £1,018,000.

The figures given by the Radio Industry Council show that receivers accounted for £457,266; components and sound reproducing equipment, £303,182; transmitters, navigational aids and industrial electronic equipment, £231,128 and valves £160,378.

OUR COVER

P.A. SPEAKERS installed at Wembley Stadium for the Olympic Games form the subject for this month's cover illustration. The two upper loudspeakers, each fitted with 12-watt units, have been installed to compensate for the absorption of "top" by the crowd. They are connected to the amplifier via a bass-cut circuit and a multi-tapped transformer and can be controlled independently of the main 25-watt twelve-inch cone-type units. Philips Electrical has fitted twelve standards around the arena.

MOBILE STUDIO, containing (right) E.H.F. frequency-modulated equipment for linking outside broadcasts with the main studio, recently shipped by Marconi's to Brazil. Similar equipment is installed in the studios in Recife to provide a link with the transmitters which are located some distance from the city.

MARINE RADAR SPEC.

A REVISED specification for marine radar equipment has been drawn up by the Ministry of Transport in consultation with the Post Office, Admiralty, manufacturers and shipping interests.

To encourage the production of equipment complying with this specification, manufacturers have been informed that, so far as can be foreseen, the Ministry will not revise the specification until some years' operational experience has been gained. A Certificate of Type-Testing for marine radar equipment complying with the specification will be issued by the Ministry.

A booklet entitled "Marine Radar: Performance Standards" containing the new specification which supersedes all previous U.K. specifications for mercantile marine radar equipment, is published by H.M. Stationery Office, price 4d.

The booklet also includes a "List of Additional Facilities," which is intended to acquaint users with some of the extra features and ancillary devices which can be made available in radar sets, and a "List of

World of Wireless—

Recommended Practices," intended to draw attention to various aspects in design.

MORE "BUSINESS RADIO"

HISTORY in newspaper reporting was made by Kemsley Newspapers when their reporters used Marconi E.H.F. mobile radio to convey their stories of the Wembley Association Football Cup Final and the Royal Silver Wedding procession to the head office. The equipment included a lightweight "pack" set used by the reporter linking him with a 10-watt mobile transmitter-receiver installed in a car providing the final link between reporter and office. Kemsley Newspapers are the first to make use of the P.M.G.'s radio facility for the Press.

Another use of "business radio" is announced from Norwich, where the cars of maintenance engineers of the city electricity supply have been equipped with G.E.C. F.M. radio telephones. The main station, located in the City Hall on the tower of which is erected the aerial, has a range of 25 miles. The station is remotely controlled by land line from the electricity offices about half a mile away.

SAFETY AT SEA

SOME 250 delegates from 31 countries are meeting in London for the International Conference on Safety of Life at Sea. The purpose of the Conference is to examine the provisions of the 1929 Convention in the light of the experience of the past 20 years, and of the progress that has been made in scientific aids to navigation. The question of the extent to which radio telegraphy and telephony should be obligatory in passenger and cargo ships, and the technical requirements for emergency equipment are being discussed.

SUPPRESSING INTERFERENCE

THE Radio Industry Council in pursuance of its campaign for the voluntary suppression of interference with television is giving a series of demonstrations on the fringe of the television area. Representatives of motor car and sparking plug manufacturers, hauliers, G.P.O. and B.B.C. were present at a recent demonstration at Penn, Bucks.

The importance of suppression is stressed by a senior signals officer of the Ministry of Civil Aviation who states that radar and radiophone services on which the safety of aircraft largely depends in bad weather can be rendered unusable by a single "unsuppressed" engine running near the equipment.

SHIP-SHORE RADIOPHONE

AN experimental radiotelephone service between ships operating in the Thames—between Chelsea Bridge and Southend—and telephone subscribers living within a radius of 15 miles of the Woolwich telephone exchange is to be opened at the end of the year. It will operate on a frequency around 160 Mc/s.

Ship owners wishing to participate in the service will have to make their own arrangements for equipping their vessels. The apparatus will be subject to type-approval by the Postmaster General and will require to carry a P.M.G. licence.

The charge for a three-minute call will be 2s 6d.

N.P.L. INVITATION

EACH year during June the National Physical Laboratory holds an "open day" to which representatives of industrial organizations are invited. In order to give firms who have not previously received invitations an opportunity of sending a representative to see the wide range of scientific research and investigational work undertaken at the laboratory a number of invitations are being reserved for postal applications.

The industrial "open day" will be held from 2.30 to 6.0 on Monday, June 21st. Accredited representatives of industrial organizations are invited to apply for tickets to the Director, N.P.L., Teddington, Mddx., by June 5th.

RADIO FOR LIGHT AIRCRAFT

A DEMONSTRATION was given recently at Southend Municipal Airport of the new E.H.F. radiotelephone equipment which is being made by E. K. Cole, Ltd., for use in light aircraft. The employment of miniature components and valves has enabled the complete aircraft set with its 16 valves to be condensed into an extremely small unit weighing only 12 lb. It is hoped to give a full description in our next issue.

CONTROL PANEL on the Ekco E.H.F. airport installation at Southend. Transmitters and receivers are above the writing shelf and all power supplies are below.

B.I.F.

OVERSEAS visitors to the B.I.F. had the opportunity of seeing television in comfort. In addition to the facilities afforded on the stands of manufacturers a number of centres in and around London were reserved by B.R.E.M.A. for their exclusive use.

The various sections of the radio industry were well represented at the Fair, but there was not much new equipment shown. One or two set manufacturers had new overseas models on show. Hearing aids and measuring instruments were exhibited on a number of stands in the scientific instruments section. The central stand in this section was devoted to a demonstration of apparatus for televising films. This Cintel display gave visitors an opportunity of seeing 405-line transmission of films on 20in tubes, providing a picture 16in × 12in. The control equipment incorporates a 15in picture monitoring tube and a small waveform monitor.

HISTORIC APPARATUS

CONCERN has been expressed by the Radio Section of the I.E.E. that so many examples of experimental gear of comparatively modern origin are in danger of being lost to posterity.

It is urged by the Institution that all such apparatus should be preserved, as much of it may prove to be of historic value as the forerunner of great developments. Where practicable it should be offered to the appropriate museum or to the I.E.E.

NAVAL TERMINOLOGY

ALTHOUGH, as yet, unofficial, the Navy's proposal to standardize the words used to describe the various uses of radio are noteworthy. It is suggested that the term "radio" should cover "all uses of the ether—communications, radar, navigational aids, etc."

One of the main branches of the radio tree will be "wireless" which is intended to cover all forms of radio communication. From this branch will come "voice" (replacing R/T), "television" and "telegraphy." The latter will be further split into "morse" and "teleprinter."

It is stated in *The Communicator*—the journal of the Communications Branch, Royal Navy—that it is hoped to achieve inter-Service agreement.

PERSONALITIES

H. de A. Donisthorpe has been elected president of the Radio Industries Club for 1948-49 in succession to J. H. Williams, who is now chairman. **A. J. Dew** is the new vice-president. Mr. Donisthorpe had been chairman of the committee for ten years, and Mr. Dew vice-chairman for seven years until 1947.

H. de A. DONISTHORPE (G.E.C.), Radio Industries Club's new president.

S. Erickson has joined Burndept, Ltd., as chief design and development engineer. He was formerly with G.E.C.

J. P. Page, who joined Beethoven Electric Equipment, Ltd., from Philco Radio and Television Corp. in February, 1946, has been appointed general manager.

IN BRIEF

An increase of nearly 40 per cent in the number of television licences during the first quarter of this year is shown by the March figures—45,550 compared with December's 32,700. The number of broadcast receiving licences (including television) in force in Great Britain and Northern Ireland at the end of the quarter was approximately 11,189,700 compared with 11,057,000 in December.

The Valve's Ancestors.—Although it has no direct connection with our art, the "Darkness into Daylight" exhibition, now running until September at the Science Museum, London, S.W.7, is not without interest for wireless people. It marks the centenary of electric lighting, and gives more than a suggestion of how the early valves were evolved from the electric lamp. Many of the exhibits trace the development of the filament lamp, but the section dealing with the evolution of fluorescent lighting is of special technical interest.

Gee Coverage.—Details of the service provided by the seven Gee chains in the U.K. and Europe are given in a notice to airmen, No. 163 (1948), issued by the Ministry of Civil Aviation. The pamphlet includes operational data, coverage map and tabulated geographical positions of the 30 stations comprising the chains.

P.T. on P.A. Gear.—Attention is drawn by the Commissioners of Customs and Excise to the fact that, although amplifiers are not chargeable with Purchase Tax, where a gramophone is housed in the same cabinet as an amplifier tax is payable on the combination as a complete gramophone. Similarly, a cabinet containing an amplifier, a wireless receiver of the domestic or portable type and a gramophone is chargeable as a whole with tax as a radio-gramophone.

Waste Paper.—Considerable leeway has yet to be made up if the target of 100,000 tons of waste paper is to be reached by July in response to the appeal of the Waste Paper Recovery Association. Although paper is not a staple requirement of the radio industry, it is the medium through which technical developments are made known.

Midland Television.—With the extension of television to the Midlands, the Television Society has formed a Midland Centre with headquarters in Birmingham. It is planned to hold monthly meetings, particulars of which are obtainable from the lecture secretary, Dr. W. Summer, 169, Mary Vale Road, Bournville, Birmingham, 30.

Radio Control.—A London Section of the Radio Controlled Model Society has been formed and monthly meetings are being arranged. The first meeting was held on May 9th, at the St. Ermin's Hotel, Caxton Street, S.W.1. Further details are available from Lt. G. C. Chapman, R.N., Pine Corner, Firwood Rise, Heathfield, Sussex.

Naval Communication Officers.—Under a recent Admiralty Order the rank of Warrant Communication Officer has been introduced and replaces that of Signal Boatman and Warrant Telegraphist.

British Wireless Dinner Club.—A. J. Gill was in the chair at the twenty-fifth annual dinner of the Club. The principal guest was Sir Vincent de Ferranti. The founder of the Club, Air Comdre. Blandy, who broke a sequence of regular attendances by being absent from last year's dinner, was also present. The honorary secretary of the Club is Capt. M. A. Bulloch, Connaught House, 63, Aldwych, London, W.C.2.

F.M. or A.M.?—During the discussion by members of the London Students' Section of the I.E.E. on "Will F.M. supersede A.M. for broadcasting?" it was considered that while F.M. is more desirable, much opposition would be encountered from the general public because of the high cost of the change-over.

School Radio.—Provision is made in the 1948-49 estimate of the Essex County Council for the installation of broadcast receiving equipment in another 120 schools at a cost of £6,000.

"Wireless Servicing Manual."—A third printing of the 7th Edition of this book has just been made. Copies are obtainable from booksellers or direct from our Publishers. Price 10s 6d; by post 10s 11d.

Television Aerials.—We have received a copy of a report issued by the American Radio Manufacturers' Association on the installation of television receivers in blocks of flats, etc., using a distribution system from a central receiving aerial. It is a brief non-technical survey.

I.E.E. Radio Section.—According to figures published in the 1947-48 annual report of the I.E.E., the Radio Section has the largest membership of any of the four specialized sections. Membership on March 31st totalled 3,875.

I.E.E. Progress Reviews.—Among the list of reviews covering the progress in various sections of the electrical and allied industries to be published during this year by the I.E.E. are reports on Radio Telegraphy and Telephony, Broadcasting and Television, Electronics (including the photo-electric cell), and Cathode-Ray Developments.

Grimsby Radio Engineers.—Meetings of the Association of Grimsby and District Radio Engineers, the object of which is to further the development of servicing technique, are held monthly. Membership is confined to those gainfully employed in radio servicing. Details are obtainable from the joint secretaries of the Association, 268, Victoria Street, Grimsby, Lincs.

Change of Address.—The Technical and Commercial Radio College of Parkstone, Dorset, has moved to King Edward Avenue, Aylesbury, Bucks.

Not Yet Available.—We are informed by Macmillan and Company, the publishers in the U.K. of "Ultra- and Extreme-Short Wave Reception" (reviewed in our March issue), that copies are not yet available here. The U.K. price has not yet been fixed.

A. J. SMITH (Plessey), elected chairman of the R.C.M.F. for 1948/49.

Electron Microscopy.—A Summer School in electron microscopy will be held in the Cavendish Laboratory, Cambridge, from August 18th to 24th. It is intended for those who have some familiarity with the electron microscope and who are already, or in the near future will be, operating it in physical, chemical or biological laboratories. A syllabus is obtainable from G. F. Hickson, M.A., Secretary of the Board of Extra-Mural Studies, Stuart House,

World of Wireless—

Cambridge, to whom completed application forms should be returned not later than June 12th.

FROM ABROAD

French F.M.—It is stated by the International Broadcasting Organization (O.I.R.) that Radiodiffusion Française is erecting two more experimental F.M. transmitters. A 250-watt station is already operating on 59 Mc/s at Romainville. The 500-watt station in Paris will operate on 56.2 Mc/s. The frequency of the 800-watt transmitter for Lyons is not given. The construction of fifteen 5-kW F.M. stations is planned for the next five years.

Long-distance Television Link.—Plans have been made in the U.S. to lay a television cable linking the cities of Buffalo, Cleveland, Toledo, Chicago and St. Louis The 2,000-mile circuit will provide two-way working between the last four cities.

Easier Viewing.—The cathode-ray tube in the latest Crosley (American) television receiver can be swung through an arc of sixty degrees in the horizontal plane, thereby enabling the screen to be viewed without moving the set or the viewer's position.

Canadian Television.—According to our Canadian correspondent a television transmitter is being built in Montreal which it is planned to have in operation by the late summer.

International Show.—The international broadcasting exhibition, organized by the Czechoslovak Broadcasting Corporation (Czechoslovensky Rozhlas) under the auspices of the International Broadcasting Organization, opened in Prague on May 15th.

Danish Television.—An experimental television station is being erected in Copenhagen by Philips of Eindhoven. It will operate on 567 lines.

Poland.—Work will begin this year on the construction of a new central radio station in Warsaw which will have a power of 200 kW. Equipment has been manufactured in Czechoslovakia.

Canadian Trade Fair.—A number of British radio equipment manufacturers are exhibiting in the radio section of the Canadian International Trade Fair which opens in Toronto on May 31st.

Davy - Faraday Exhibition.—The work of Davy and Faraday is the subject of an exhibition staged at the Palais de la Decouverte, Paris. It has been organized by the University of Paris with the collaboration of the I.E.E., the Royal Institution, and the Science Museum.

Pakistan Amateurs have been allocated call signs, AP1, AP2, etc., according to the area in which the transmitter is licensed.

INDUSTRIAL NEWS

R.C.M.F.—Representatives of the following member firms have been elected to serve on the council of the Radio Component Manufacturers' Federation for the year 1948/49: Automatic Coil Winder, B.I. Callenders, British Moulded Plastics, British N.S.F., Garrard, Hellermann, Morgan Crucible, Plessey, Reliance Electrical Wire, T.C.C., T.C.M., and T.M.C.

British Moulded Plastics.—New London offices and showroom have been opened by the company at 37, Portman Square, London, W.1. The Regent Street office is now closed.

R.I. Clubs.—In his annual report the chairman of the Radio Industries Club stated that membership of the seven affiliated clubs throughout the country totals 1,360. In addition to the parent club in London with a membership of 667, there are now clubs for Scotland, Wales and Monmouthshire, Merseyside, Midlands, West Riding of Yorkshire, and Manchester.

B.E. Africa.—Sole agency for radio equipment in British East African territory—Kenya, Uganda, Tanganyika and Zanzibar—is sought by Kassamali Suleman Megji of Mombasa. A representative of the company, J. K. Suleman, is in this country for a short time. His address is 14, Arlington Street, Piccadilly, London, W.1.

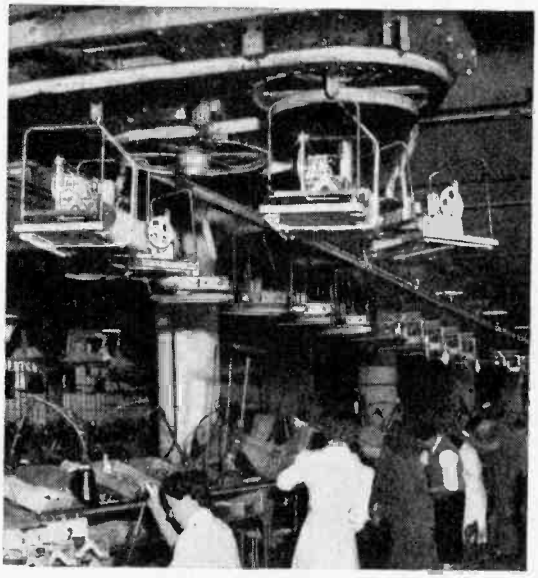
Pye-Marconi instrument landing equipment is being installed at Jersey airport. It includes ABAS, which is a British version of the American SCS.51 system required by I.C.A.O. regulations to be installed at all international airports. Marconi E.H.F. direction-finding equipment is also being installed. This is capable of remote operation from distances of up to 30 miles over normal telephone lines.

Vitavox.—Sole British rights for the manufacture of Klipschorn dual-channel loudspeakers developed by Paul Klipsch, of Hope, Arkansas, U.S.A., have been obtained by Vitavox, Ltd. The instruments will be manufactured jointly by Vitavox and the John Compton Organ Co., Ltd.

Mullard Electronic Products, Ltd., is the new name adopted by Mullard Wireless Service Co.

Murphy Radio has formed a new company in South Africa for the production of receivers in the Union. It is registered as Murphy Radio (South Africa) Proprietary, Ltd., and will be established in Johannesburg.

Amplivox. — The telephone number of the works of Amplivox, Ltd., Abbey Manufacturing Estate, Mount Pleasant, Wembley, Middlesex, has been changed to Wembley 5906/7.



MECHANICAL HANDLING is employed in the E.M.I. factory at Hayes to speed the conveyance of assembled sets. The first National Mechanical Handling Exhibition, to be held at Olympia in July, is being organized by our associated journal *Mechanical Handling.*

Dulci Co., Ltd., informs us that the trade mark "Dulci" has been registered in the company's name.

Cossor Radar.—A list of nearly seventy ships in which Cossor marine radar equipment has been installed is given in *Cossor Marine Radar*, the quarterly review of radar and its application to shipping which is being issued by Cossor Radar, Ltd., Highbury, London, N.5.

MEETINGS

British Institution of Radio Engineers

Midland Section.—"An Automatic A.F. Response Curve Tracer," by G. L. Hamburger, on May 28th at the Technical College, The Butts, Coventry, at 6.30.

Institute of Physics

Electronics Group.—A discussion on "Substances of High Permittivity," on June 12th in the Lecture Theatre of the London School of Tropical Medicine and Hygiene, Keppel Street, London, W.C.1, at 2.30.

Electronics Group.—A discussion on "The Application of Electron-Multipliers to Spectroscopy," on May 28th, at the Institute of Physics, 47, Belgrave Square, London, S.W.1, at 2.30.

Electrical Trades Union

London Meeting.—A discussion on "Post-war Electronic Developments and their Effect on the Future of the Industry," on June 21st in Room 11, The Friends' House, Euston Road, London, N.W.1, at 7.

Phase

What Does It Really Mean ?

By "CATHODE RAY"

(Concluded from page 190 of May issue)

PERHAPS we had better tackle some of the questions that arise from the British Standard ideas about phase difference mentioned in the previous instalment. First, why "usually expressed as a time . . ." if phase is not a time? Well, a bricklayer (joking apart) is not paid just for putting in time on the site. The amount of work he does is not time. But it is usually expressed as a time. The time can be used as a measure of his work, but it assumes the laying of a certain number of bricks per hour. If that rate is altered, the amount of work alters, even though the time is the same. Similarly a phase difference can be expressed as a time, but only if the period (or frequency) is known; if the period changes, the phase represented by a given amount of time changes too, as we saw with the radar echoes.

The rule about both periodic quantities having to have the same period or frequency is one which I am quite happy to join Van der Pol in contradicting. The only excuse I can see for it is if for "phase difference" you substitute "constant phase difference."

What about the angle? And why sinusoidal variations? These two queries go together, and involve us at last in the slightly more mathematical aspect of the matter. While it is true that (except for the brief digression into Fig. 3) we have defiantly been selecting non-sinusoidal waveforms for our consideration of phase and even of phase difference, and have been getting away with it so far, there is trouble lurking in wait for us. It comes into the open directly we pass any fancy waveforms through reactive circuits.

Fig. 5(a) is an example of waveform which, if not quite like that which we have been used to in Figs. 1 and 2, is fancy enough to illustrate the difficulty. Suppose it is an alternating voltage applied to a condenser; what is the current waveform like?

Applying the principle shown in Fig. 3 (which is confirmed by all the textbooks) that the phase

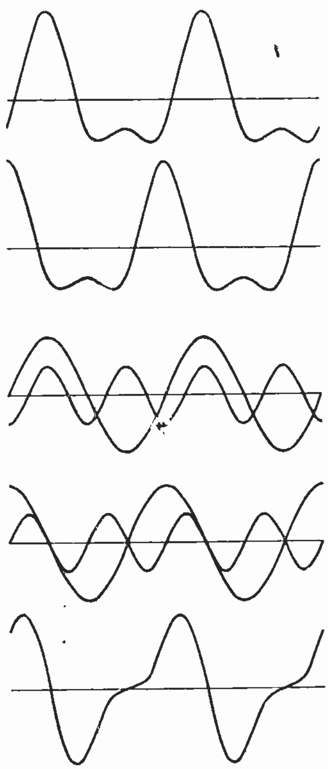


Fig. 5. Shifting waveform (a) 90° forward in phase gives either (b) or (e), according to whether the shift is applied to the wave as a whole or to its component sine waves (c). The latter is the way that agrees with experiment; so, to avoid confusion, the meaning of these shifts is rightly confined to sinusoidal waves.

of the current is a quarter of a period ahead of the voltage, and still having in mind what we have been doing with Fig. 2, we might shift Fig. 5(a) one quarter of a period forward, to the left, and point proudly to Fig. 5(b). If we were to try it in the lab., however, there would be a marked discrepancy between Fig. 5(b) and the actual current waveform.

There was a reason for carefully choosing a sine waveform in Fig. 3. *It is only sine wave voltages that give condenser currents having the same waveform.* And if the current wave has not the same form as the voltage, there is no use trying to compare their phases. We have already discovered that in Fig. 1. The whole idea of phase shift, applied to Fig. 5(a) or any other non-sinusoidal form, just breaks down in practice, easy though it may look on paper.

The way out of this fix was shown by Fourier, when he announced that any periodic waveform whatever could be analysed into harmonic sine waves. So we can break down Fig. 5(a) into its component sine waves, which individually are subject to the Fig. 3 procedure and other simple mathematical treatment, and the results can then be stuck together again to make up the whole current wave. (An interesting example of this method, applied to a square wave, was published in the Dec., 1945, *Wireless World*.)

Doing this with Fig. 5(a) we find that although it looks rather lumpish it is really (owing to my cunning forethought) a very simple combination of only two sine waves, a fundamental and second harmonic, shown as Fig. 5(c). Now we can shift each of these ahead by a quarter of a period (according to its own measure), as in Fig. 5(d), and add them together to give Fig. 5(e), which is obviously a different shape from (a) and (b). But it is the shape one would get if the actual current in a real condenser

Phase—

were plotted; and that is the decisive test.

The B.S. advice to confine phase comparison to sine waves is now seen to be wise, because phase comparison of other waves is ambiguous. It seemed quite natural to us for phase shift to mean one thing in Fig. 2 and Fig. 5(a) and (b), but nature gives it quite a different meaning, as shown by Fig. 5 (a) and (e). Since we can't force nature to fit in with our abstract ideas of phase, however simple and attractive they may seem, it is advisable to make our ideas about phase fit in with nature. Otherwise one would never know what sort of phase shift was meant when a complex waveform was involved.

So much for the reason behind the sinusoidal* rule. Now lastly, what is this about angles?

We have seen that expressing phase difference as a time is (although, according to B.S., "usual") an indirect system which is likely to mislead and confuse one's ideas of phase. Yet it seems rather weak to refer to a phase of ¾ or 0.75 or even 75 per cent. There is a natural craving for named units (as can be judged from a glance at any comprehensive table of weights and measures). One could arbitrarily divide one whole period into any number, say 100, units, and call them Ferrantis, after the noted A.C. pioneer. But as it happens there is a measure which has the advantage of not being arbitrary, but intimately bound up with the mathematics of the whole business. It is no doubt familiar to most readers, but a little revision may clinch the matter.

* This is the correct word to use when referring to the *shape* of a wave. A cosine wave is sinusoidal, because it has the same shape as a sine wave; but it is a common habit, of which I am guilty, to speak of "sine waves" meaning their shape, regardless of phase, and not intending to distinguish them from cosine waves.

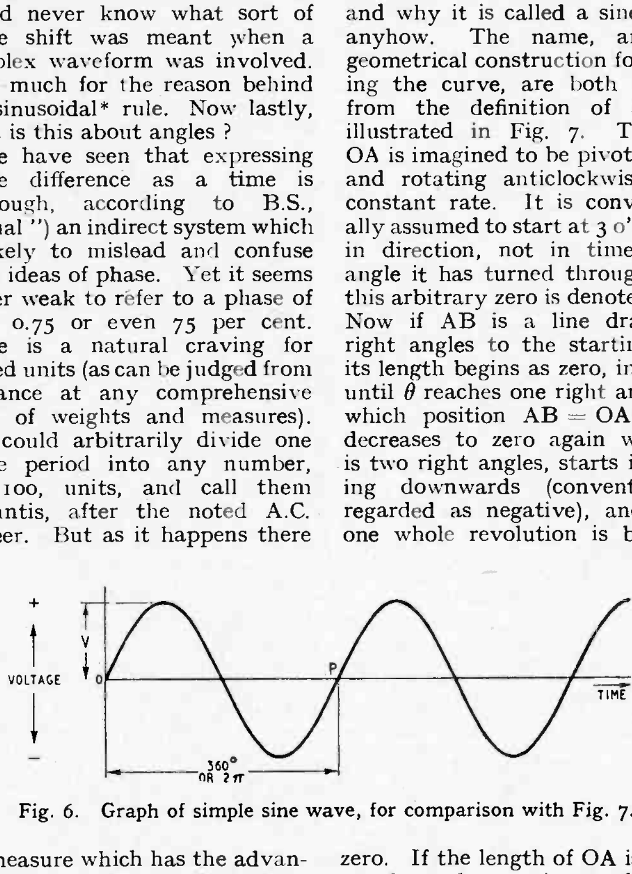


Fig. 6. Graph of simple sine wave, for comparison with Fig. 7.

We have been obliged by inexorable natural laws to relate phase differences to one particular form of wave, of which Fig. 6 is a typical sample, shown beginning from zero voltage at zero time and continuing indefinitely at a constant frequency. Being a sine wave, it must (following Fourier) also be a single frequency. Although it is labelled voltage it might equally well be current, magnetic flux, height above mean sea level of a man overboard in a gale, or any of lots of other things that habitually vary in this wavy manner. The uninitiated might wonder how to draw such a wave with accuracy, and why it is called a sine wave, anyhow. The name, and the geometrical construction for drawing the curve, are both derived from the definition of a sine, illustrated in Fig. 7. The line OA is imagined to be pivoted at O and rotating anticlockwise at a constant rate. It is conventionally assumed to start at 3 o'clock—in direction, not in time. The angle it has turned through from this arbitrary zero is denoted by θ. Now if AB is a line drawn at right angles to the starting line, its length begins as zero, increases until θ reaches one right angle (at which position AB = OA), then decreases to zero again where θ is two right angles, starts increasing downwards (conventionally regarded as negative), and after one whole revolution is back at zero. If the length of OA is made equal to the maximum distance of the wave in Fig. 6 from the zero axis—the horizontal straight line—then the varying length of AB is equal to the height of the wave at all other points during its cycle. Since the maximum height of the wave represents the peak voltage, usually denoted by V, and the height anywhere represents the instantaneous voltage, v, the lengths of OA and AB also represent V and v respectively. And as the ratio $\frac{AB}{OA}$ is named the sine of the angle θ, so that AB = OA sin θ, it is natural to refer to Fig. 6 as a sine wave. Translating

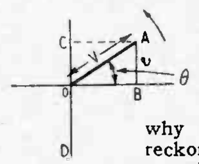


Fig. 7. Showing how a sine wave is generated by a rotating vector, and hence why it is logical to reckon phase in angular measure.

AB = OA sin θ into the voltages they represent, we get

$$v = V \sin \theta.$$

One complete revolution of OA corresponds to one complete cycle of the wave, and as an angle equal to one revolution has for ages been divided into 360 degrees, these are convenient subdivisions for the period of a wave in either diagram, even although in the Fig. 6 form of diagram a period is represented as a straight line instead of an angle.

Most of the books, however, use an alternative angular measure, with π in it. This may seem unnecessarily mysterious, but is actually a more sensible scale of angles. Whereas 360 is just a number that was thought of in the mists of antiquity, for no really fundamental reason, there are plenty of quite good mathematical reasons for making one revolution equal to 2π, or just over 6, radians* For one thing when A makes one revolution, the length of its journey is 2π times its distance from the centre, O.

So half a period is commonly called π, a quarter period $\frac{\pi}{2}$, and so on.

I hope it is now clear that there is a complete link-up between the two types of diagram. Both can be used to represent the oscillating voltage, because both are based on the physical fact that in simple oscillation the voltage (or whatever it may be) varies in proportion to the sine of a steadily increasing angle. The steadily increasing angle, of course, represents what we are supposed to be

* A radian is the angle subtended at the centre of a circle by an arc of the circumference equal in length to the radius.

talking about—the phase. So we have the interesting result that the instantaneous voltage is equal to the peak voltage multiplied by the sine of the phase (in angular measure). Hence the value of the apparently obscure habit of reckoning phase in terms of angle. We have only to know the manner in which the phase angle varies in order to know the voltage (or whatever it is) at all moments. That is what is expressed by the equation we arrived at a little while back :

$$v = V \sin \theta$$

The normal manner is for the phase angle to increase uniformly with time. So in place of θ we may put what is mathematically called a function of time. If f is the number of periods or cycles per second, and 2π is the angle in radians of one period, then obviously the angle that OA turns through in one second is $2\pi f$, and in t seconds it is $2\pi ft$. That is the derivation of the familiar equation

$$v = V \sin 2\pi ft.$$

in which the $2\pi f$ is often abbreviated as ω, giving

$$v = V \sin \omega t.$$

Of course one must not expect this to be much help in calculating what the instantaneous voltage will be, say, half an hour after switching on an oscillator. One would have to know the frequency with extraordinary accuracy to be sure of the all-important fraction of a cycle over and above the (possibly) billions that had gone before. And a real oscillator would hardly have started off from scratch just as in Fig. 6. Even in theory, it is the odd fraction of a period that is generally the focus of interest, so quite often one sees the sin θ form. The objection to the θ form, however, is that (as we have seen) every different period of frequency has a different scale of θ, so that it is rather muddling when there is more than one frequency at a time. That is why, to avoid any misunderstandings, each is reduced to a common variable—time—by bringing in its frequency and 2π.

There is just a little more to be explained, especially if you look up Van der Pol and find his mathematical definition of phase doesn't exactly fit anything we have had yet. Looking again at Fig. 7, where we saw that the length of AB represents v, we can see that if CA is drawn parallel to OB, then CO equals AB, so also represents v. CO is usually described as the projection of AO on the vertical axis. It seems natural to relate a vertical distance such as this with the vertical oscillation of the graph in Fig. 6. But for certain mathematical reasons there is often a preference for the projection on the horizontal axis. This, of course, is OB in Fig. 7. Now $\frac{OB}{OA}$ is the *cosine* of θ. So OB = OA cos θ. This represents a wave exactly similar to the sine wave of Fig. 6 except that it starts a quarter-cycle later, from its maximum value instead of zero ; like the current wave in Fig. 3 (OB is *positive* when B is at the *right* of O, and vice versa.)

You can easily see this by turning the whole diagram, Fig. 7, one right-angle *clockwise*, when AB and OB, or sin and cos, become interchanged. That shows, too, how the cos form can be used not only to represent a wave starting at maximum, but can also represent a wave starting at zero, as in Fig. 6. All one has to do is rotate the diagram one right angle clockwise, that is to say, subtract $\frac{\pi}{2}$ from θ. It amounts to making the rotating vector OA in Fig. 7 start with a quarter of a revolution handicap, from the position OD. The formula now becomes

$$v = V \cos \left(\omega t - \frac{\pi}{2}\right).$$

Then at the start (t = o) the angle is $-\frac{\pi}{2}$; and, as one can see from Fig. 7, the cos of $-\frac{\pi}{2}$, the projection of OD on the horizontal axis, is zero, which agrees with the wave in Fig. 6. At the time corresponding to quarter of a cycle from the start, $\omega t = \theta = \frac{\pi}{2}$ the whole angle is therefore zero (as it obviously is when OD has moved round to OB) and its cosine clearly equals 1. So v = V ; also in agreement with Fig. 6. And so on. On the other hand, if we have a cos formula and want

Phase—

to change to sin, we just *add* $\frac{\pi}{2}$.

Obviously either sin or cos form can be used to specify a wave starting from any other handicap. A wave starting from negative maximum could be written cos $(\omega t \pm \pi)$ or sin $\left(\omega t + \frac{3\pi}{2}\right)$ or sin $\left(\omega t - \frac{\pi}{2}\right)$. And similarly for intermediate angles. So the whole angle is made up of two parts; one ($\theta = \omega t$) that varies with time, and the other the fixed handicap or start, which is generally denoted by ϕ, or sometimes ψ. The whole angle $(\omega t + \phi)$, which is a measure of the "stage or state to which the operation has proceeded"—is the phase. To avoid a $\frac{\pi}{2}$ or 90° ambiguity, it is necessary to agree as to whether the sin or cos form is to be used. Van der Pol favours cos.

If there are two or more periodic quantities, each with its own ϕ, the phase difference at the start

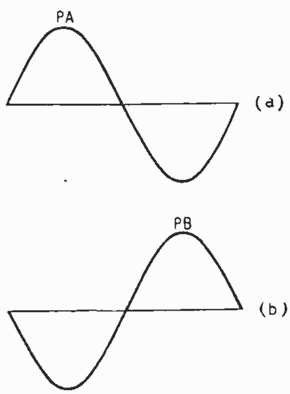


Fig. 8. One cycle for each phase in a push-pull circuit. PB corresponds in phase to PA; but this does not have to imply that there is a time lag in the signal.

is indicated by the difference in ϕ. If the different periodic quantities have the same frequency, then $2\pi ft$ at *any* time must be the same for both, so the starting phase difference continues unchanged. But if the frequencies are different, θ increases more rapidly for a high frequency than for a low, so the phase difference continually increases. Which is just what we found by a different route, in Fig. 4 (b) of the previous instalment.

If, perchance for the first time, you now understand what cos $(\omega t + \phi)$ really means in connection with oscillations, you are all set to tackle the theory of such things as modulation, sidebands, beat frequencies, and frequency changing.

But if your interests do not incline towards mathematical theory, you may care to note how the ideas of phase developed herein can be applied to a controversy that arose some time ago in this journal. Some people object to the statement that in a push-pull amplifier the output from one valve, say Fig. 8 (a) is 180° out of phase with the output from the other, Fig. 8 (b). The objection springs from the belief that a phase difference is necessarily a difference in time, so cannot be applied to a case like this where there is obviously no relative displacement in time between the two actual outputs. But, as we have seen (for example in Fig. 3), phase is not a time but just an identifiable part of a waveform, and the parts of two waveforms that correspond in phase (such as PA and PB) do not have to correspond in any other way, such as being due to the same instantaneous cause. If the objection is pressed by pointing out that (for example) Fig. 5 (a) shifted 180° in phase is not the same as Fig. 5 (a) inverted—well, we have already seen that that argument is a fallacy, based on the obvious but wrong meaning being given to phase difference between non-sinusoidal waves. If the wave is analysed as in Fig. 5(c) the objection collapses.

Societies and Clubs

SINCE publishing the list of active radio groups in the British Isles in our March issue we have received details of a number of additional clubs and these are given below. Arranged in alphabetical order under towns, the name of the club, and in some cases the club call sign, is followed by that of the secretary, from whom further particulars may be obtained.

AYLESBURY

Aylesbury and District Radio Society*.—J. G. Penrice, 31, Prebendal Avenue, Aylesbury, Bucks.

BIRMINGHAM

Solihull Amateur Radio Society.—H. C. Holloway, 20, Danford Lane, Solihull, Warwick.

South Birmingham Group of the R.S.G.B.*—T. F. Higgins, G8JI, 391, Rednal Road, Northfield, Birmingham, 31, Warwick.

Smethwick and District Wireless Society (G2GX/P).—Major G. A. Swinnerton, G6AS, 23, Hawthorn Croft, Quinton, Birmingham, 32, Warwick.

BOURNEMOUTH

Bournemouth and District Amateur Radio Club* (G3AYG).—T. C. White, G3XP, Chester House Hotel, Chine Crescent, Bournemouth, Hants.

BURTON

Burton and District Radio Society.—E. B. Hardy, Hill Cottage, Dunstall, nr. Burton-on-Trent, Staffs.

BURY

Bury and District Radio Society* (G3BRS).—R. H. McVey, 46, Holcombe Avenue, Elton, Bury, Lancs.

CHIPPENHAM

Chippenham and District Short-Wave Club.—W. A. Henson, G3DGG, 12, Filton Way, Chippenham, Wilts.

CLECKHEATON

Spen Valley Radio and Television Society. W. C. Longman, 16, Victoria Terrace, Cleckheaton, Yorks.

DERBY

Derby Wireless Club.—R. H. Hodgkinson, Field House, Duffield Road, Allestree, nr. Derby.

DUNFERMLINE

Dunfermline Radio Society*.—C. A. M. Clackson, GM8KR, 24, Blake Street, Brucefield, Dunfermline, Fife.

LONDON AND DISTRICT

City and Guilds Radio Society† (G5YC).—R. A. Chell, City and Guilds College, South Kensington, London, S.W.7.

South-West Essex Radio and Scientific Club.—K. R. Goodley, 34, Blenheim Avenue, Valentines Park, Ilford, Essex.

OXFORD

Oxford and District Amateur Radio Society.—R. H. Clifton, G3CGU, 86, Victoria Road, Summertown, Oxford.

RETFORD

Retford and District Amateur Radio Club.—H. White, G3BTU, 39, Trent Street, Retford, Notts.

SUNDERLAND

Sunderland Radio Society* (G3CSR).—J. Rose, 34, Dundas Street, Sunderland, Durham.

SCARBOROUGH

Scarborough Short-Wave Society.—P. B Briscombe, G8KU, 31, St. John's Avenue Scarborough, Yorks.

WARRINGTON

Risley Radio Society‡ (G3CIC).—F. W. D Rouse, G3LZ, 3, Derwent, Damhead Hall Warrington, Lancs.

WESTON-SUPER-MARE

Weston-Super-Mare Group of the R.S.G.B.—W. C. Holley, G5TN, 252, Lockin Road, Weston-Super-Mare, Som.

WORCESTER

Worcester and District Amateur Radic Club*.—J. Morris-Casey, G8JC, at Brook hill Farm, Ladywood, Droitwich, Worcs.

* Affiliated to the R.S.G.B.

† Membership restricted to members o the City and Guilds College.

‡ Membership restricted to Admiralt employees.

NEWS FROM THE CLUBS

Aylesbury.—Re-formed some twelve months ago, the Aylesbury and District Radio Society now meets on the first Thursday in each month at the Café Paris, Aylesbury. Sec.: J. G. Penrice, 31, Prebendal Avenue, Aylesbury, Bucks.

Birmingham.—At the meeting of the Slade Radio Society on May 28th, P. A. Wigglesworth, of Mullards, will speak on transmitting valves. On June 11th there will be an exhibition and demonstration of members' gear. Meetings are held on alternate Fridays at 8.0 in the Parochial Hall, Broomfield Road, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23, Warwick.

Bournemouth and District Amateur Radio Club now has its own premises in St. Clements Road, Upper Parkstone, where meetings are held on the second and fourth Tuesdays of each month. A 150-watt transmitter (G3AYG) has been installed. Sec.: F. C. White, G3XP, Chester House Hotel, Chine Crescent, Bournemouth, Hants.

Burnham (Som).—Regular meetings of the Burnham and Highbridge Amateur Radio Society are now held on the first and third Mondays of each month. Sec.: T. N. Carter, G3BPV, c/o Post Office Radio Station, Highbridge, Som.

Dagenham.—A new club has been formed in this part of London. The South-West Essex Radio and Scientific Club, as it is called, meets on Wednesdays at 8 at Valence House, Dagenham. Sec.: K. R. Goodley, 34, Blenheim Avenue, Valentines Park, Ilford, Essex.

Derby.—The Derby Wireless Club, which was founded in 1911 but has been inactive for some time, has been re-formed and now meets on the first Saturday in each month at 7.15 at the Derby Technical College. Sec.: A. W. Elliott, 46, Robin Croft Road, Allestree, Derby.

Dunfermline.—Membership of the Dunfermline Radio Society is confined to members of the R.S.G.B. Meetings are held on the last Thursday of each month at 7.30 in the lounge of the Royal Café, Dunfermline. Sec.: C. A. M. Clackson, GM8KR, 24, Blake Street, Brucefield, Dunfermline, Fife.

Grimsby.—A member of the Grimsby Amateur Radio Society, R. Jennison (G2AJV), has won an Eddystone "640" receiver in the essay competition organized by the manufacturers. His subject was "Applications of the new microwave amateur radio channels." Meetings of the club are held at 7.30 on Thursdays at 115, Garden Street, Grimsby. Sec.: R. F. Borrill, G3TZ, address as above.

Harrow.—E.H.F. problems will be discussed at the meeting of the Radio Society of Harrow on June 1st. A demonstration lecture on quality reproduction will be given by a representative of Goodmans, Ltd., on July 13th. Meetings are held fortnightly at 7.30 at the Northwick Tea Rooms, 206-208, Kenton Road, Harrow. Sec.: J. E. Pikett, 93, Whitmore Road, Harrow, Mddx.

Jersey.—Visitors to the Channel Islands are welcomed at the weekly meetings of the Jersey Radio Society which are held at Monaco, St. Saviour's Road, Jersey, on Tuesdays at 7.30. Sec.: E. Banks, GC2CNC, 7, Royal Crescent, Don Road, St. Helier, Jersey.

Nottingham.—A field-day has been organized by the Nottingham Short-Wave Club for May 29th-30th. The annual contest for the club trophy will be held during July. The club meets on Mondays at 7.15 at 23, Gamble Street, Nottingham. Sec.: J. Rowbottom, 9, Mansfield Street, Sherwood, Nottingham.

Oswestry.—Most of the members of the Oswestry and District Radio Society, among whom are twenty-six transmitters, are technicians at the nearby G.P.O. radio station. Meetings are held on alternate Tuesdays at 7.30 at Oswestry Technical School. Sec.: A. D. Narraway, G2APW, "Lamorna," Pant, nr. Oswestry, Salop.

Oxford.—Meetings of the Oxford and District Amateur Radio Society are held on alternate Wednesdays at 7.30 in the Club Room, Magdalen Arms, Iffley Road, Oxford. Next meeting June 9th. Sec.: R. H. Clifton, G3CGU, 86, Victoria Road, Summertown, Oxford.

Peterborough.—The new headquarters of the Peterborough and District Radio and Scientific Society at 61, Padholme Road, was officially opened on May 22nd. In addition to the weekly lecture meetings on Thursdays at 7.30 instruction classes for prospective transmitters are held on Wednesdays at 7.30. Sec.: S. Woodward, 72, Priory Road, Peterborough.

Retford.—Two meetings are held each week at the headquarters of the Retford and District Amateur Radio Society which was formed at the beginning of the year; on Mondays the general meeting preceded by morse practice, and on Fridays instruction classes. H.Q.: 8a, Bridgegate, Retford. Sec.: H. White, G3BTU, 39, Trent Street, Retford, Notts.

South Shields.—A transmitting licence has now been granted to the South Shields Amateur Radio Club with the call G3DDI. The club meets on Fridays at 7.30 at its new headquarters, Trinity House, Laygate Lane, South Shields. Sec.: W. Dennell, G3ATA, 12, South Frederick Street, South Shields.

Stoke-on-Trent.—"Radio through the Ages" was the theme of the radio exhibition recently held for three days by the Stoke-on-Trent Amateur Radio Society. The local Police and Territorial Army Units demonstrated some of their equipment during the exhibition, the object of which was to show how amateur activities in the past helped in the development of present-day radio. Meetings of the society are held on Thursdays at 7.0 at the Tabernacle Church, High Street, Hanley. Sec.: D. Poole, G3AQW, 13, Oldfield Avenue, Norton-le-Moors, Stoke-on-Trent, Staffs.

Unbiased

By FREE GRID

Myriacycles and All That

THOSE of you who sometimes find time to read more highbrow literature than the latest betting forecasts will recollect that the great Dr. Johnson is alleged to have said in that firmly dogmatic manner with which he covered up so many weaknesses of the flesh "Women are nails in the coffin of man." I have little doubt that there are very few of you married men who have not at times heartily agreed with him.

Most men are, of course, their own executioners in marital matters due solely to youthful inexperience of life. Only the other day, I heard of a young fellow who is actually permitting, if not actively encouraging, the future source of his indigestion to assist him in studying Greek, a knowledge of which is necessary for his intended vocation. He little knows what trouble he is laying up for himself, for Greek is the one language in which the human emotions can be adequately expressed; and by emotions I don't only mean the so-called tender ones which lead men to try to write poetry but the

Youthful inexperience of life.

more violent kind which leads to what is usually described on the charge sheet as a breach of the peace.

When, therefore, the occasion arises, as it most assuredly will, that the domestic millpond is ruffled by something more than a gentle zephyr, he may find himself echoing the famous words of the poet which were later borrowed and adapted by a hymn writer, "Peace, perfect peace, with loved ones far away."

This brings me to the *pièce de résistance*. A reader has sent for my attention a very grave question of technical nomenclature, namely, what Greek word can be used to serve as a unit describing "thousands of megacycles" which in these days of E.H.F. we need so badly. It must be Greek, of course, if we are to retain the word "cycle." I cannot, therefore, agree with an Editorial suggestion in the American journal *Tele-Tech* (December, 1947) which would have us talk of "begacycles" because of the neat alliterative relationship

million : billion : : mega : bega

(In the U.S.A. a billion=10^9 and not 10^{12} as over here).

The whole trouble has arisen because of our slipshodness of years ago in ever permitting the use of the word "mega" which, unlike "kilo," has no numerical significance. My own suggestion is to start off at 10,000 megacycles and simply call it by the euphonious word "myriacycles" which no technical man would ever confuse with its literally accurate meaning of 10 kilocycles. Alternatively, again starting at 10,000 megacycles (10^4 megacycles), the logarithmic base of 10 is sufficiently obvious to allow us to refer to this value as one tetracycle; 1,000 tetracycles could be called one heptacycle and so *ad infinitum*.

Our Poor Relations

RECENTLY Mrs. Free Grid commented rather tartly on the deplorable slackness exhibited by so many men, including myself, who go about with their hands in their trousers pockets. She quite failed to see that what she termed slackness was a necessity for most men and could be easily cured if their womenfolk would now and again sew on a few sorely needed buttons. This matter is so vital that I don't hesitate to say that the women of the world have it in their power to nip all wars in the bud by ruthlessly cutting off the brace buttons of their menfolk at the first sign of trouble as no man can fight with his hands in his trousers pockets.

Unfortunately for the world, however, women are singularly lacking in technical knowledge in matters belonging to the male sphere and that is why I think the Government is making a mistake in directing its appeals to save electricity and gas mainly to the so-called weaker sex. Mrs. Free Grid, for instance, has the firm idea that radio is the main source of electricity consumption in the house and recently arrived home with one of those midget "personal portables" which seem to be coming into prominence nowadays. Her idea was that what she called a "teeny-weeny set like this" could well take the place of my own 20-valve personal all-mains receiver and effect a great saving in the electricity bill. So, in one sense,

Deplorable slackness of men.

it would but she seemed to have no idea of the number of her "teeny-weeny" sets I would have to use to give me the power output to which I am accustomed. She had not considered the enormous increase in electrical energy which the makers of the midget batteries would have to use in their factories if they were to keep one regularly and adequately supplied with their products.

I do think, however, that the greatest mistake the Government makes is to try to get women to read their electricity meters. It is not a straightforward task even for a man, owing to the hopelessly old-fashioned nature of the average instrument which is quite faithfully represented on the posters admonishing us to save fuel. It is the electrical manufacturing industry that is responsible for these antique monstrosities which are slavish copies of a gas meter and employ separate dials for "hundreds," "thousands," and so on. No motorist, or even pedal cyclist, would tolerate this complicated and time-wasting system in his mileage-recording instrument. The strangest part is that for some years "see-at-a-glance" electricity meters of the cyclometer type have actually been produced and yet the gas-meter sort is still being turned out. Nobody likes to see even his poor relations go about in old-fashioned apparel and so this matter directly concerns us radio men. May we hope for an explanation?

LETTERS TO THE EDITOR

Negative Feedback and Distortion ♦ Volume Expansion Developments ♦ Long-distance Television

Amplifiers with Negative Feedback

I WOULD like to draw your attention to a possible source of distortion in amplifiers using a high degree of negative feedback: overloading of the *early* stages of the amplifier at the very high or very low frequencies.

The action of negative feedback is to reduce the effective signal applied to the first stage to a small fraction of the total signal input. Thus, the signal input required by an amplifier may be (say) 1 volt, but if the amplifier uses 20 db of feedback the signal fed back is 0.9 volt, and the effective signal applied to the first stage is only 0.1 volt. The amplifier is normally designed to operate with this effective signal, and no stage is overloaded by it.

If a 1-volt signal at a frequency (either very high or very low) outside the frequency range of the amplifier is applied to the input terminal, the output from the amplifier is very small and the signal fed back (which opposes the input signal) is also very small, with the result that the effective signal applied to the first stage is very little less than the total input signal. For example, if the gain of the amplifier mentioned above is 20 db down at the frequency in question, the signal feed back will be only 0.09 volt, leaving an effective signal of 0.91 volt applied to the first stage; i.e., *nine times its normal input.*

This increased signal will be unlikely to overload the first valve, as, although it is nine times the normal signal, its absolute magnitude is still quite small. But, unless it is considerably attenuated between the first and second stages, overloading of the valves in the second stage is almost certain. And, once a valve is driven on to a level part of its characteristic curve (i.e., beyond cut-off or saturation), no amount of negative feedback can cure the distortion. Although the signal causing the overloading is well outside the audible range, signals of any other frequency present at the same time will also be distorted; moreover, if the frequency of the signal causing overloading is below audibility, its harmonics, produced by the overloading, will be audible.

The use of negative feedback extends the effective frequency range of the amplifier. It is possible for this type of distortion to be caused by a signal which is within the frequency range of the amplifier as so extended. For example, if a 1-volt signal is applied to the amplifier mentioned above, at a frequency at which the gain of the amplifier (as extended by the feedback) is only 1db down, the signal fed back will be about 0.8 volt: the effective signal applied to the first stage is then 0.2 volt; i.e., twice the normal signal.

The remedy is two-fold. One coupling element is (in an amplifier using a high degree of negative feedback) generally designed to have a much greater attenuation at the high and low frequencies than the other coupling elements; this coupling should be placed as near to the input of the amplifier as possible. Secondly, the range of frequencies present in the input signal should be restricted to frequencies with which the loudspeaker is capable of dealing—frequencies outside this range will not be heard, anyway!

Incidentally, I have found that, with any given output transformer, a higher degree of negative feedback can be used without any sign of high-frequency instability if a small capacitor is connected in parallel with the feedback resistance between the output transformer and the cathode of the first valve (R_{25} in the circuit diagram on page 161 of the May, 1947, issue of *Wireless World*). The value of the capacitor depends on the output transformer; with a good one of low leakage inductance, it should

Letters to the Editor—

be such that the time constant, CR_{25}, is about 0.25 microsecond. The effect of this condenser is to advance the phase of the signals fed back, at the higher frequencies, and so to raise the frequency at which the phase lag (due to the output transformer and stray capacities in the amplifier) becomes sufficient to convert the negative feedback into positive feedback.

HOWARD BOOTH.
London, S.W.9.

Surgeless Volume Expansion

THE lack of correspondence on volume expansion lately prompts me to report some progress. There being no specific answer to my plea for a solution to the problem of anode current "surges" superimposed on the signal (Correspondence, May, 1944), some combining of published circuits was attempted; this seems to have provided a satisfactory solution to the problem and one now has a volume expansion unit which can be followed by an amplifier with the performance of those described in *Wireless World* recently.

Under the title "Variable Slope with Constant Current" (*Wireless Engineer*, Jan., 1944) a useful property of pentode valves is described, ". . . that when the anode current is varied by negative voltage applied to the suppressor or outer grid the actual cathode current is not modulated." The article goes on to describe the circuit devised to provide radial deflection of oscillograph beams, but it occurred that the same principle might usefully be applied to the variable gain valve in a volume expander by connecting a similar "auxiliary" valve with the "expander" valve having its screen grid connected to the expander valve anode, thus maintaining constant current in the circuit even though the anode current by itself surges with varying bias on the suppressor grid and hence varies gain.

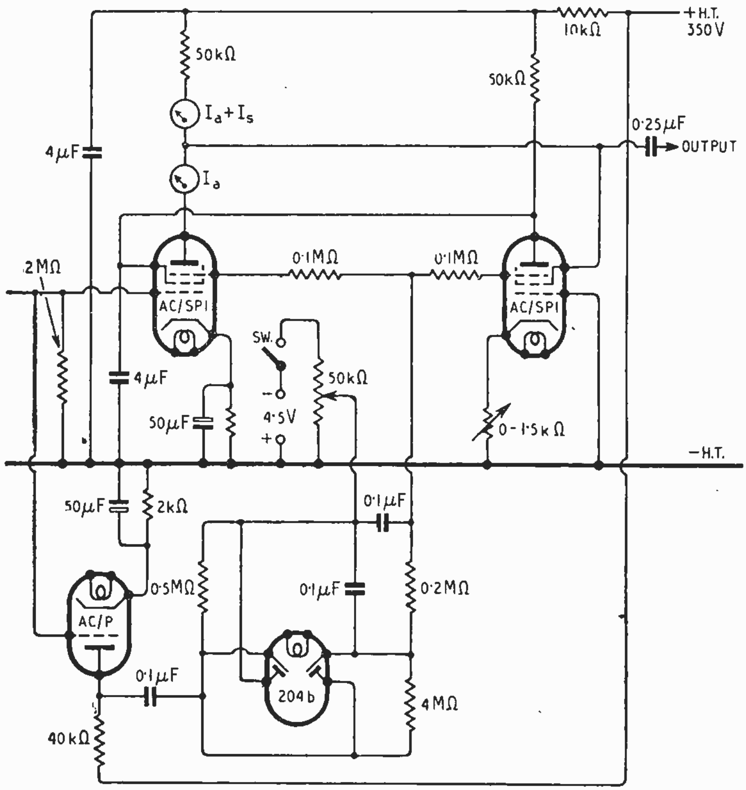
It seemed reasonable to connect both valves to similar anode-plus-screen loads, the auxiliary valve anode and the expander valve screen being bypassed to earth, suppressor grids together to the variable bias, auxiliary valve grid to earth and, to provide compensation for individual valve variations, separate cathode resistors, the expander valve one bypassed, the auxiliary valve one adjustable. The varying suppressor-grid bias circuit is basically the one described in *Wireless World* for April, 1946, but at the signal level used by the writer a low-gain valve can be used. Expansion control is conveniently provided by an initial suppressor-grid bias provided from a potentiometer across a three-cell dry battery; opening the battery circuits removes the bias and hence provides full gain (i.e., no expansion) when required.

The combined circuit is as shown in the diagram. It was found that adjustment of the auxiliary valve's cathode resistor readily prevents any "surging" when I_a+I_s is about twice I_a at full expansion. Several AC/SP1 valves have been tried and in all cases surgeless operation could be obtained by adjustment of bias; varying supply voltages had a slight effect; e.g., a change of H.T. supply from 300 to 400 volts gave a "surge" at full expansion of about 0.05 mA but this could be corrected by adjustment of the cathode resistor to the auxiliary valve. In practice, the variations in mains supply voltage over some weeks have not made adjustment necessary.

Measurements of input and output voltages and waveform examination showed a gain of some 30 times at full expansion, an "expansion" of about 17 db and no (visual) distortion with inputs of up to ¼ volt at any frequency from 20 to 16,000 c/s. In practice the required expansion range is obtained by adjusting the standing bias to give a no-signal anode current on the expander valve of from 0.5 to 1.5 mA, giving maximum expansions of:—

Initial I_a:	0.5	0.8	1.0	1.2	1.5 mA
Expansion:	17	12	9	6	2 db

Listening tests over several weeks suggest that my difficulty of May, 1944, has been overcome by these "borrowings" from those with the wit to devise the circuit dodges required; I am in-



Volume expansion circuit suggested by A. A. Tomkins

deed indebted to them and to your contributors and correspondents on this fascinating subject, and I feel that when the knowledgeable ones have corrected my inexpert adaptations the arrangement will prove a useful one. May it prove satisfactory "in reverse" too (i.e., as a compressor) so that transmissions might be controlled to some known law. A. A. TOMKINS.

Birmingham, 11.

Magnetic Recording Tape

THE Chief Engineer of the B.B.C., writing in your April issue on magnetic tape standards, mentions in particular a recommendation (May, 1947) that a size and tolerance of 0.245in plus or minus 0.005in be adopted with the intention of standardizing the maximum tape width at ¼in.

My firm are licensees for Great Britain of The Brush Development Co., of Cleveland, U.S.A.; I would like to draw attention to the tolerances adopted by that company, who are probably the largest producers of magnetic tapes and magnetic recording machines, particularly the "Soundmirror" variety, which is in common use in a great number of countries. The Brush tape is cut to a width of 0.242in plus or minus 0.004in, giving a maximum width of 0.246in. The clearance in their tape guides is 0.255in plus or minus 0.002in, thus giving a minimum tape clearance of 0.007in. The proposed British tape width would only give a minimum clearance of 0.003in when used in the American heads, and this would probably cause jamming in use.

In view of the desirability of making tapes as interchangeable as possible, we feel it would be advantageous to adopt the Brush standard width and tolerances or, alternatively, to work to finer limits of, say, 0.243in plus or minus 0.003in, thus satisfying both conditions.

E. B. ANGOLD,
Chief Engineer,
Thermionic Products, Ltd.
London, S.E.11.

Long-range Television

SEVERAL of your correspondents have claimed that good television reception has been obtained well outside the service area, but only one reader has given any indication of the consistency of his reception (*Wireless World*, Sept., 1947).

It would be interesting if other claimants could give more details of whether they experience fading and for how long the picture can be held at reasonable entertainment value. I have been experimenting at Bristol, about 110 miles from Alexandra Palace, and although reception is possible at times, it is extremely uncertain. On one evening in the recent warm spell, reception at full entertainment value was possible from 8.10 to 10.15 p.m., the picture remaining steady and there being very little fading on the sound. This was an exceptional evening, and as a general rule a maximum of about fifteen minutes is about all that can be obtained before the signal starts fading and the picture starts "pulling on whites" because the black level is too low to cut off the sync separator. A log has been kept in an endeavour to determine the weather conditions which are suitable for reception, but so far the only preliminary conclusion reached is that reception is not possible either in wet or windy weather. In fine spells reception is sometimes possible, but the best reception appears to occur immediately prior to a break in the fine weather. This appears to agree with the explanation of unorthodox propagation given by T. W. Bennington in *Wireless World* of May, 1944, and also reported at the Radiolocation Convention.

The set I am using is home constructed and has two R.F. stages (EF54), mixer and oscillator (EF50, P61), three IF stages (SP61), diode detector (EA50), and one VF stage (SP61) feeding a 9in magnetic tube (CRM91). The sound is extracted at the cathode of the frequency changer and has two IF stages. The noise level will not permit the addition of further stages. The synchronising separator and time bases are similar to the *Wireless World* design modified to suit the valves available. The aerial system consists of an aluminium dipole and reflector at one-eighth spacing with a coaxial feeder.

H. W. N. LONG.

Bristol, 4.

Random Radiations

By "DIALLIST"

Mass Produced

THERE USED TO BE JOKES, accompanied by pictures of someone doing a kind of Laocoön act in a mazy entanglement, about the far-from-wireless-ness of the wireless receiver. I never thought to see a wireless set that really was wire-less; yet to-day I'm using one in my home which literally has not an inch of wire in the whole of its innards. It is one of the little machine-made Sargrove two-valvers, which I asked to have on loan for a while to see what it could do. The set is about the size of a mantelpiece clock—8½ inches high, by 7 inches in width and 4 inches in depth overall—in fact, if the circular loudspeaker grille had figures round its circumference, it would look exactly like a clock. This little model is intended for the reception of either of two local medium-wave programmes at will. It has only three controls; an on-off switch, a two-position selector switch and a volume control. Actually there is a fourth, the reaction control, at the back of the set; but as this is adjusted once and for all and then locked it can hardly count as a control in the ordinary sense. As you probably know, these little sets are mass produced by moulding grooves and other depressions into a plastic blank, filling these with sprayed metal, grinding off the surplus metal and finally spraying with some form of varnish. The very few big components, such as the electrolytic smoothing capacitor and the loudspeaker, are simply eyeletted to metal-filled grooves which form the appropriate leads.

Does It Work?

The model I have contains two of Sargrove's own valves with their 55-volt heaters "wired" in series. It can be connected direct to either A.C. or D.C. 110-volt mains. My supply is 200-V and the required dropping is done by means of a line-cord containing a suitable amount of resistance. Does it work? It does. The quality would perhaps not satisfy such connoisseurs as Mr. V**gt—but then, of course, it's not meant to. This model is really intended to be used for local station reception by the man-in-the-street in parts of the world where pay-packets are so light that wireless sets in general—and certainly mains receivers—have till now been but dreams to him. Used with quite a modest aerial (it does not require an earth connection) it brings in either of the Brookmans Park transmissions at a range of 20 miles odd with ample volume when the volume control is in the midway position between "min" and "max." There should, I feel, be a real future for a set of this kind in countries of the Middle East and the Far East, and probably in many other parts of the world. Sargrove is not stopping at the two-valver; I've just opened a letter telling me that he will soon have a superhet in production.

What's Ahead

Meantime I've had an interesting piece of news about further possible developments in the mass-production line. Jackson Burgess, head of the Burgess Battery Company, told me about it during a recent crowded flying visit to this country. From him I learned that the Dupont Company of America is in course of developing, or may even have developed, what he described as a "silver ink."*

This is a fluid of the consistency of normal printing ink, but having a high colloidal silver content. Applied to any kind of insulating surface and allowed to dry off it forms a coating with excellent conducting properties. If a similar "Eureka" resistance ink can be produced (and there seems to be no reason why it should not), it may shortly be possible to print working circuits of radio receivers, to say nothing of other electrical apparatus, as rapidly as the pages of *Wireless World* are printed now. When this happens there's more than a possibility that even the most complicated communication receivers, or televisors—or even radar sets—could be built up at small cost from numbers of individual printed panels, interconnected by metal distance rods. An astonishing prospect! Amongst other things, servicing would become just too simple; having tracked down your fault to one particular panel, you pull it out, throw it into the dustbin and replace it with a new one costing about fourpence!

A Useful Tool

HAVE YOU, I WONDER, come across a good type of small table-vice, which is now to be seen in some of the toolshops? Most of us who do any small wireless, electrical or other handyman jobs about the house know the need for a small vice with a firm grip which can be fixed in a jiffy to bench or table and as quickly removed when it is no longer needed. I had a little beauty, but during the recent spot of bother, when I was away on Army service, it was borrowed by an alleged friend, who succeeded in breaking it, apparently by the exercise of brawn unallied with brains! For the last couple of years I have sought to replace it during visits to the toolshops. At first it was "Sorry, no small vices"; then came the period when there were meagre supplies of such tools, unacceptable either because they were fantastically expensive, or because they were so roughly and inaccurately made that no fastidious workman could have held up his head had they formed part of his equipment. Recently, I saw in the window of a toolshop a small table-vice priced (believe it or not) at seven shillings. It looked good and I went in to investigate—and soon came out minus 7s but plus one very useful tool. It's called the Indian. Don't write and ask me where to get it, but inquire at your own toolshop. This vice has parallel-action jaws 1⅜ inches wide. It clips firmly on to bench or table top and its usefulness is enhanced by the fact that the jaws have a maximum gape of 2½ inches. Its weak point is that, except for the screws, it is made of a rather soft aluminium alloy. I got over this by making push-on covers for the jaws from pieces of sheet steel.

French Televisors

THOUGH PARIS has had a regular television service for some time, I haven't until lately seen any television receivers announced by French radio manufacturers. However, a recent issue of *La Radio Française* contains particulars of a series of no fewer than six models by the Ontra company. They are table models and consoles with 18-cm or 22-cm C.R. tubes. The two simplest types are for the vision channel only; but an ingenious adaptor makes it possible to use an ordinary "broadcast" receiver for reproducing the sound. This receiver is tuned to 1,500 kc/s (the frequency of the Eiffel Tower transmitter) and the adaptor is then connected between its input terminals and the television aerial. The adaptor is a frequency changer, whose output is matched to the average input impedance of a broadcast superhet at 1,500 kc/s. I'm not sure that any of our manufacturers who want to turn out a vision receiver at rock-bottom price mightn't do well to give this idea attention. Unless my

*A similar British product is referred to on p. 220

memory is at fault, some of them did try something of the kind before the war, but they didn't get away with it because only a 2½-inch or 3-inch tube was used for vision. I've an idea that a set on these lines with, say, a 7-inch tube might go rather well in some quarters.

As regards television transmitters, France has drawn up a useful programme for completion in the next five years. New stations are projected for Paris, Lyons and Marseilles. A super-high definition chain is also likely to be constructed and public receiving theatres, with full ciné-sized screens, are planned. France has actually gone a long way in the development of big-screen television. Her mobile television outfit, which has recently been touring Belgium, Holland and Scandinavia, works on 819-lines.

MANUFACTURERS' LITERATURE

Illustrated leaflet of record player units and "Baffiette" extension loudspeakers from Richard Allen Radio, Caledonia Road, Batley, Yorks.

Catalogue of "Douglas" and "Macadie" coil winding machines from The Automatic Coil Winder and Electrical Equipment Co., Douglas Street, London, S.W.1.

List of Exide batteries for radio, from Chloride Electrical Storage Co.

Illustrated leaflet giving mechanical and electrical data of potential dividers made by Reliance Manufacturing Co., Sutherland Road, Higham Hill, Walthamstow, London, E.17.

Catalogue of "Thermistors" (second edition) from Standard Telephones and Cables, Footscray, Kent.

Catalogue of test instruments including bridges, galvanometers and D.C. amplifiers from H. Tinsley and Co., Werndee Hall, South Norwood, London, S.E.25.

Leaflets describing V.H.F. bridges (Models B701 and B801) valve voltmeter (Type M202), inductance meter (Type M148-2) and transit time meter (Type M34-1) from the Wayne Kerr Laboratories, New Malden, Surrey.

Specification of Visual Alignment Signal Generator Model 1400 from Industrial Electronics, 229, Hall Lane, Edgware, Middlesex.

New brochure on television aerial installation service (including the "Validus" pre-amplifier) from Newhalk British Industries, 69, Hornsey Road, London, N.7.

Catalogue of ex-Government electronic and radio equipment (List No. 4) from Clydesdale Supply Co., 2, Bridge Street, Glasgow, C.5.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

NAVIGATIONAL SYSTEMS

PULSED signals are used to indicate an approach course and also to mark out a glide path for making a blind landing, when requested by the pilot of an aeroplane.

The plane carries a radar set, which interrogates a receiver relay located at the aerodrome. The receiver, in turn, triggers two beacon transmitters through relay lines which include carefully graded delay networks, so that the resulting signals are correspondingly displaced along the time base of the cathode-ray indicator on the plane. One of the beacons radiates a pair of overlapping lobes, which mark out an approach path of known type. The pilot is able to distinguish the lobes owing to the time delay between them, and to fly along the course that keeps the two signals at equal amplitude.

The blind landing beacon consists of two horizontal dipoles set at different elevations above ground. The time delay circuits again allow the pilot to distinguish between the signals from each, and to keep them at equal amplitude, side by side on the CR indicator. The two sets of signals must, of course, be so relatively delayed as to appear at different parts of the time base scale on the common indicator.

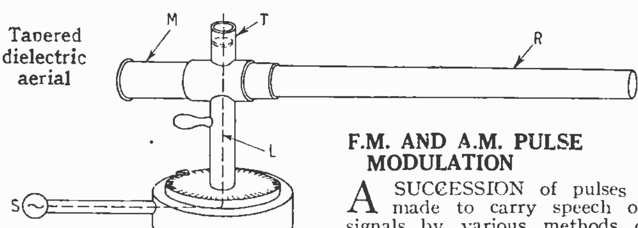
Standard Telephones & Cables, Ltd. (assignees of N. Marchand). Convention date (U.S.A.) September 6th, 1943. No. 590620.

DIRECTIVE AERIALS

THE figure shows a solid rod of polystyrene R, which is properly dimensioned at one end to accept energy of a given wavelength, this being fed to it from a source S through a coaxial line L, including a capped metal sheath M, and a tuned stub T.

The rod R is tapered towards its free end, so that there is a constant leakage of energy in that direction. If the rate of taper is made such that the phase velocity of the guided wave is equal to the velocity of the wave in the free space outside the rod, it is shown that the rod will then act as a highly directional aerial, the maximum sensitivity, both for transmission and reception, being coaxial with the length of the rod. The optimum rate of taper is set out in terms of the dielectric constant and the diameter of the rod, for a given wavelength. In general, the longer the rod the sharper is its directivity. The specification describes various other forms and arrays of leaky waveguides for use as directive aerials.

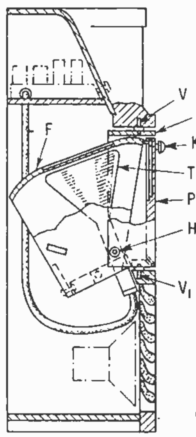
Tapered dielectric aerial



Western Electric Co., Inc. Convention date (U.S.A.), November 28th, 1941. No. 592162.

TELEVISION RECEIVERS

THE cathode-ray tube of a television set is arranged to be completely enclosed by a comparatively shallow cabinet, when out of use, but so that it can be swung forward for viewing, and then swivelled from side to side into the most convenient angle for observation.



(a)

Diagram (a) shows the tube T in its retracted position, mounted in a frame F, which can be swung forward by a knob K, about horizontal pivots H, into the position shown in diagram (b). A pin-and-slot connection R, S allows the necessary relative movement between the frame F and the hinged panel P which carries the knob K. A second frame M, mounted on vertical pivots, V, V_1, then permits the tube to be swung to-and-fro horizontally. The main circuit components are arranged at the top, and the loudspeaker at the bottom of the cabinet, as indicated in (a).

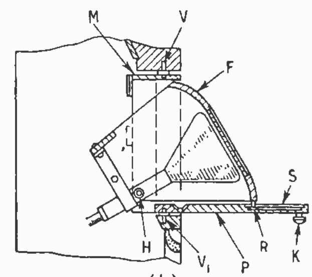
Philco Radio and Television Corp. (assignees of E. I. Harman and D. H. L. Jensen). Convention date (U.S.A.) October 28th, 1943. No. 588722.

F.M. AND A.M. PULSE MODULATION

A SUCCESSION of pulses can be made to carry speech or other signals by various methods of time modulation, such as by making the interval either between successive pulses or trains depend upon the amplitude of the signal voltage. It is also possible to make the amplitude detected by the receiver a function of the shape or phasing of the leading edge only of a pulse in a train of time-modulated pulses.

According to the invention, a carrier wave consisting of pulsed trains of constant duration is first frequency modulated by the signal voltage, and the resulting wave is then applied, in combination with solid pulses of the same constant duration, to a tuned circuit in such a way that the carrier wave of the modulated train passes through zero amplitude simultaneously with the occurrence of the leading edge of a solid pulse. The result is a damped train of waves, which vary both in frequency and amplitude with the applied signal voltage, so that the message they carry can be detected either in a receiver normally designed for frequency-modulated signals, or in one normally designed for amplitude-modulated signals.

Standard Telephones and Cables, Ltd.; P. K. Chatterjea and L. W. Houghton. Application date, December 16th, 1941. No. 591098.



(b)

Adjustable C.R. tube mounting.

SUPER-REGENERATORS FOR F.M.

IT is not possible to apply ordinary super-regeneration to the reception of frequency-modulated signals without detuning the circuit to one side of its selective curve, and so producing a distorted output. At the same time, it is desirable to take advantage of the high efficiency of the super-regenerator on the short wavelengths, and of its known discrimination against impulsive noise interference.

According to the invention, shortwave frequency-modulated signals are passed in parallel through two separate back-coupled amplifiers, one having a response to transients which increases with frequency deviations in a given direction, whilst the frequency characteristic of the other is opposite to that of the first. A common quenching frequency is then applied, either simultaneously or alternately, to both amplifiers to secure the super-regenerative effect, before feeding the combined outputs to a discriminator circuit for demodulation.

Hazeltine Corp. (assignees of B. D. Loughlin). Convention date (U.S.A.) February 1st, 1944. No. 589153.

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

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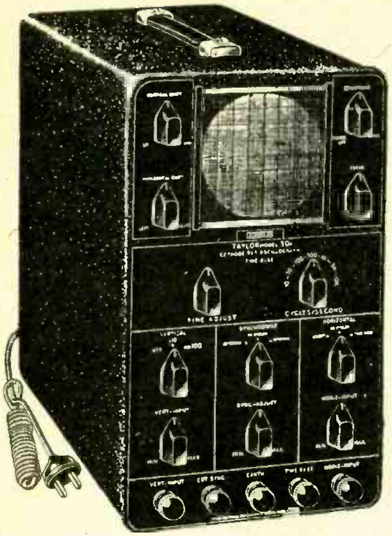

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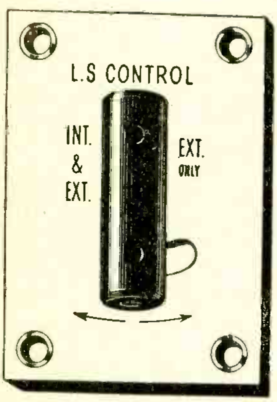

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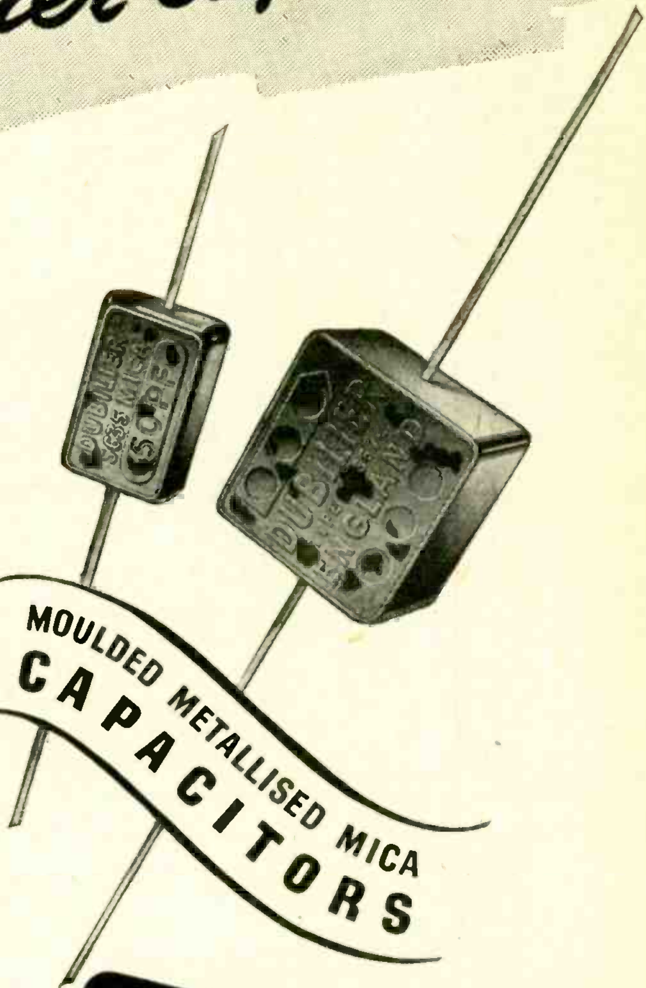

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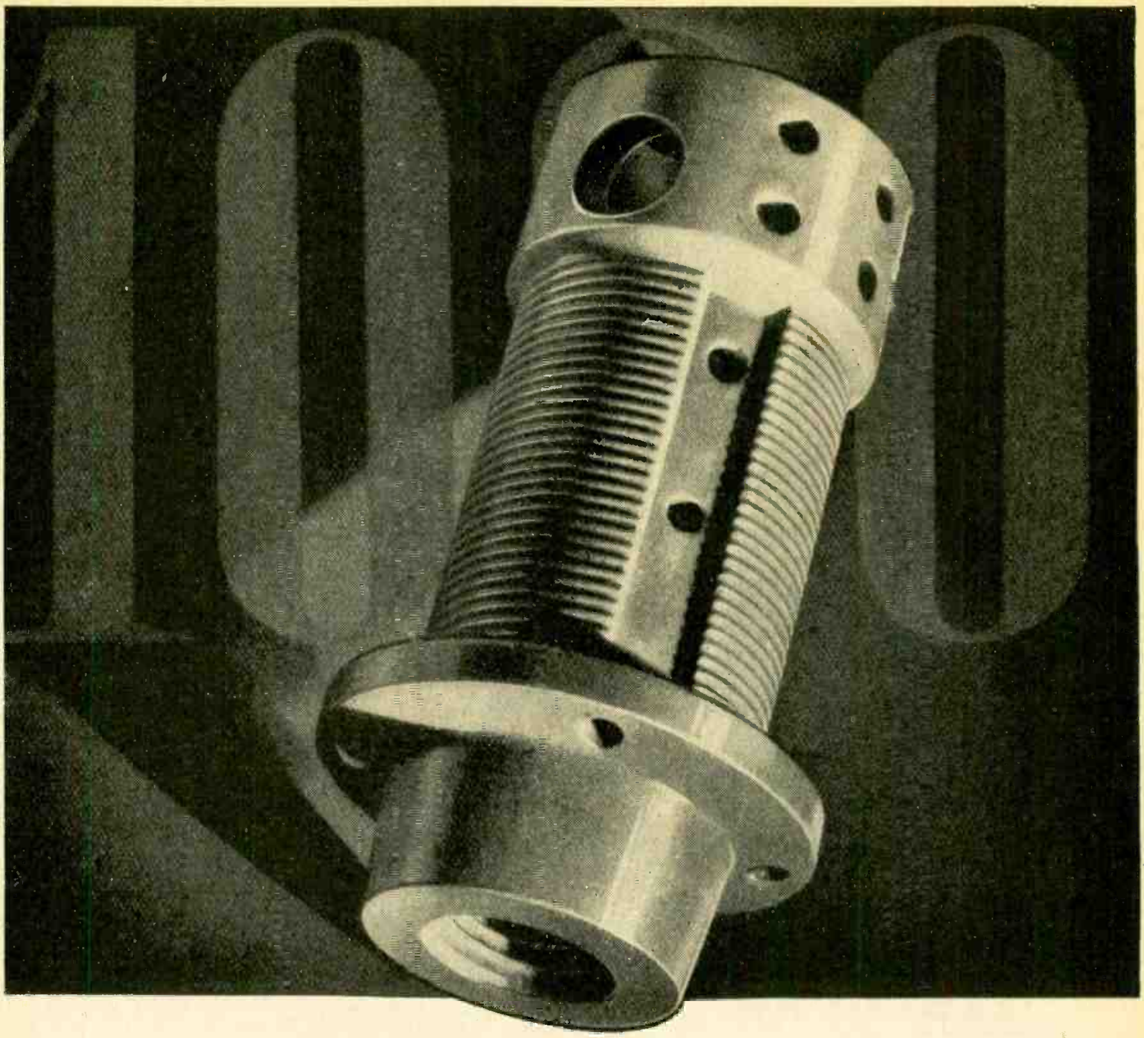

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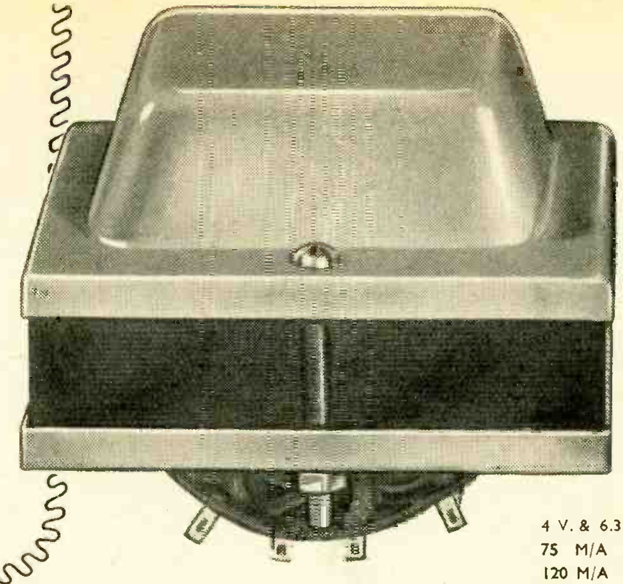

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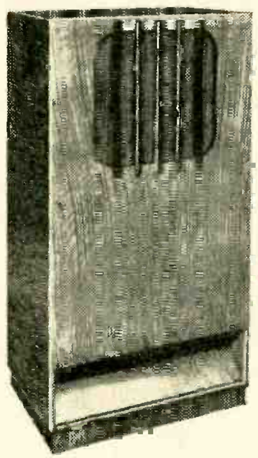

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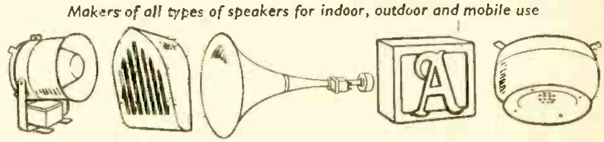

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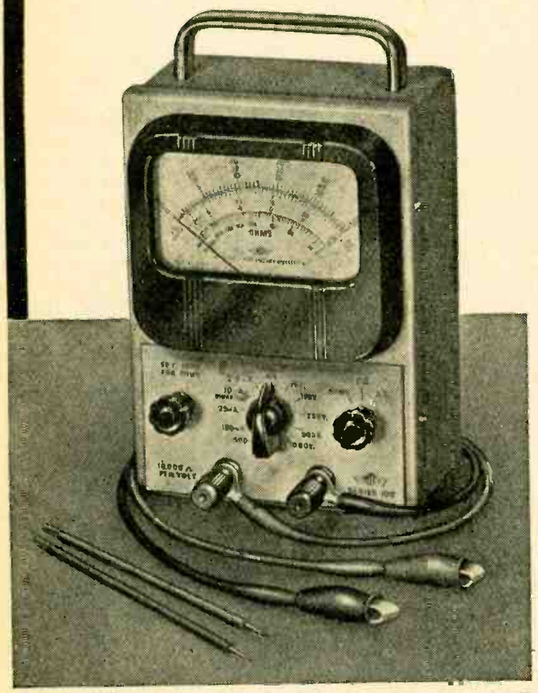

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P.M.G. Certificates for Wireless Operators
City and Guilds Telecommunications
Wireless Operators and Wireless Mechanics, R.A.F.

I.C.S. students for Examinations are coached till successful.

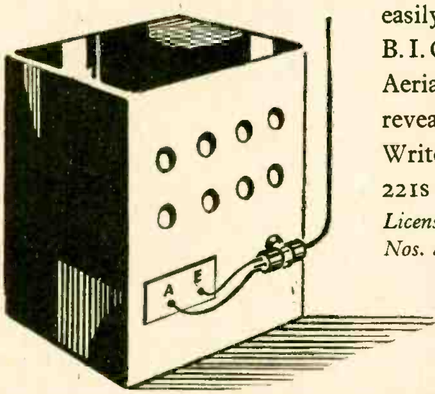
Name .... Age ....

Address ....

ICS

Noises " off " are kept off and man-made static is silenced by B. I. Callender's Anti-Interference Aerial when properly installed. Sizzling, crackling background noises caused by electric vehicles, motor car ignition systems and industrial or medical high frequency equipment—all these are suppressed and a quiet background established for radio programmes. Reception is improved, for a maximum number of programmes can be enjoyed on all wavelengths.

The aerial is a 60 ft. polyethylene insulated dipole type, with suspension insulators and matching transformer. The 80 ft. down lead is a fully screened coaxial cable with polyethylene plugs moulded to each end and is matched to the receiver by a transformer with easily fixed suction mounting.



B. I. Callender's All-Wave Anti-Interference Aerial will give you better listening and reveal many stations you never heard before. Write to-day for the descriptive folder No. 221S on the Anti-Interference Aerial.

Licensed under Amy Aceves & King, Inc. Patents Nos. 413917, 424239 *and* 491220.

B.I. Callender's *All-Wave* ANTI-INTERFERENCE **AERIAL**

BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON, W.C.2

CELESTION

The quality of reproduction secured from Celestion Speakers greatly increases the pleasure of radio in the home.

The model illustrated has an attractively designed Cabinet with a special mahogany finish, it employs an 8″ speaker of high sensitivity and excellent response. It is fitted with a volume control and is one of the finest 8″ extension speakers available.

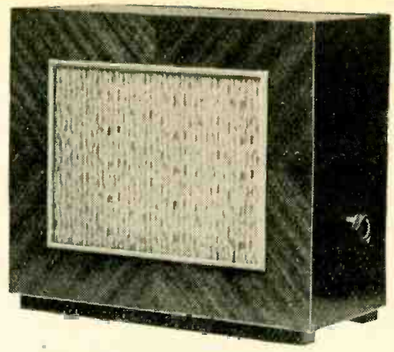
All interested in other Celestion Cabinet and Chassis models should write for Illustrated Brochure "W.W."

WHERE TO BUY CELESTION SPEAKERS

The Public are requested to order from their local Radio Dealer.

Wholesalers are supplied by the Sole Distributors: CYRIL FRENCH LTD., High St., Hampton Wick, Middx. Phone: KINgston 2240.

Manufacturers should please communicate direct with:



STANDARD 8 CABINET MODEL

Mahogany finish

Size: Height 10″ Width 12″ Depth 5½″ PRICE **£3 : 18 : 0**

Price with Universal Transformer £4 : 4 : 0

Technical Details of Chassis Model for use with your own cabinet. Dia. 8″. Baffle opening 7⅛″. Voice coil impedance at 400 cps., 2.3 ohms. Pole dia. 1″. Flux density gauss, 8,000. Total gap flux, 31,000. Peak power capacity 4 watts.

Price less transformer (Suitable for outputs 1–5 ohms.) **£1 : 17 : 6**

Price with Universal transformer (Suitable for all Receivers) **£2 : 3 : 6**

CELESTION LIMITED, KINGSTON-ON-THAMES, SURREY

Phone: KINgston 5656, 7, 8 and 9

• CONSTANT VOLTAGE • POWER SUPPLY UNITS

NEW SERIES 101

Our new Laboratory Power Supplies, Series 101, are based on our well-known Model 101-A, but incorporate a number of improvements and refinements.

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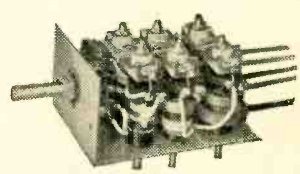
Coils & Packs...

In a variety of combinations from 5 to 2,000 metres with all necessary padding and trimmer condensers. Write for descriptive literature stating your problem.



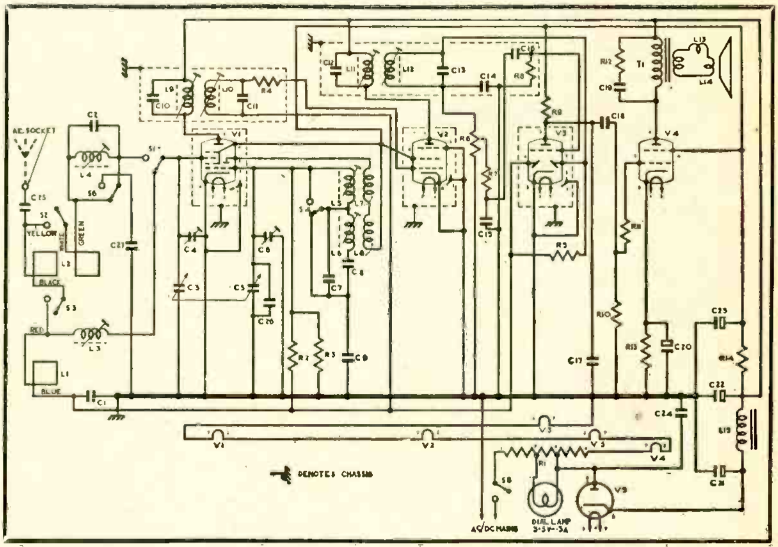
LABORATORY H C Atkins **TESTED**

H. C. ATKINS Laboratories, 32 Cumberland Road, Kew, Surrey.
Richmond 2950

AT 105 S-7

cir-Q-uitry

or...why Ferranti 547



The Input Circuit of the 547 consists of a frame aerial, loading coils, and the tuning condenser. In contrast with the common practice of tuning the frame aerial directly by the gang condenser, the tuning inductance is made up partly of the frame aerial and partly of a loading coil.

This arrangement has three advantages — the 'Q' of the aerial circuit is greater, it is less susceptible to electrostatic interference, and the adjustment of the aerial circuit is more stable.

In a small receiver, the proximity of the chassis causes the frame aerial to have quite a low 'Q'. By reducing the frame aerial inductance to a comparatively low value and restoring the total inductance with a high 'Q' loading coil, the circuit 'Q' can be considerably increased.

For example, if the frame aerial has a 'Q' of 25 and an inductance of ¼ of the total, while the loading coil which comprises the remaining ¾ of the inductance has a 'Q' of 100, the 'Q' of the whole circuit will be 57. Since the inductance of a frame aerial is roughly proportional to the square of the number of turns, a conventional aerial comprising the whole of the tuning inductance would be reduced to ¼ of the whole inductance by halving the number of its turns. The signal pick-up is proportional to the number of turns and hence is also halved. But as 'Q', the circuit magnification, has more than doubled, the sensitivity of the aerial circuit is actually increased.

Reduced susceptibility to electrostatic interference, which comprises the bulk of interference, arises from the low impedance of the frame aerial. In this example pick-up would be about ½ that of a full size aerial.

The aerial now comprises only ¼ of the total tuning inductance, and hence variations in its inductance or self-capacity are much less important. The aerial circuit is thus inherently more stable in adjustment.

In the circuit diagram, the wave-change switch is shown set to Medium Waves. The frame aerial winding L1 and loading coil L3 alone are in circuit. (The contacts S2 and S6 serve to prevent the Long Wave windings resonating on Medium Waves).

On Long Waves, contacts S1 to S6 change over, and all the frame aerial windings are placed in series, while L4 is the loading coil and C27 the fixed trimmer. The small condenser C2 also tunes L4 broadly in the Medium Wave band, causing it to act as a rejector circuit and greatly to reduce susceptibility to Medium Wave break-through. This arrangement is not possible with the conventional circuit.

The Output Circuit of the 547 is worth noting. It delivers over 2½ watts to the 6½ in. dia. loudspeaker. This combination gives an unusually good result for so small a receiver and arises from the high output of the 50L6G valve for quite low anode voltages.

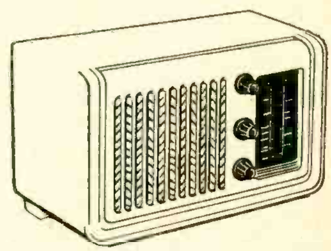


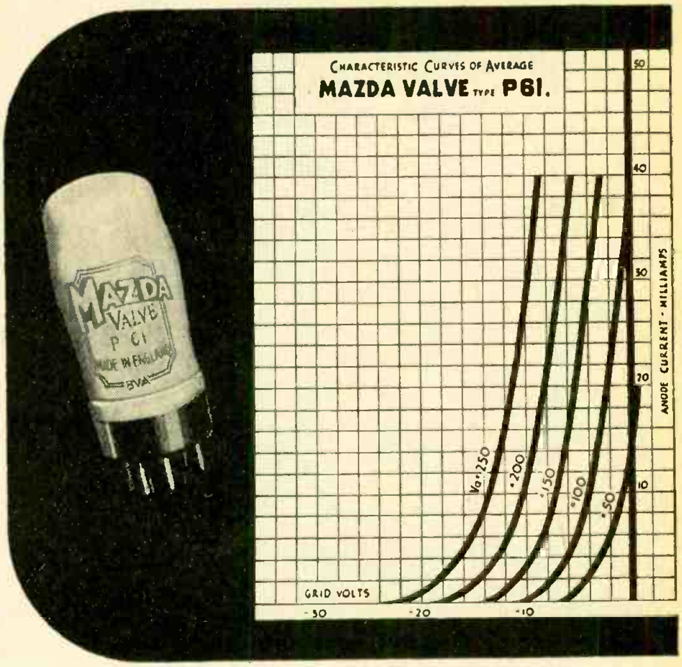
TABLE MODEL 547 receiver, 5 Valve AC/DC Transportable Superhet with built-in aerial. Moulded Cabinet in off white and copper lacquer. Retail price £20 . 19 . 10 (inc. £6 . 5 . 10 tax).

FERRANTI RADIO

Ferranti Ltd MOSTON MANCHESTER 10; & 36 KINGSWAY LONDON W.C.2

MAZDA for Dependability

P.61
A.C. MAINS TRIODE



RATING

Heater Voltage	6.3
Heater Current (amps.)	0.6
Maximum Anode Voltage	250
**Mutual Conductance (mA/V)*	8.0
**Amplification Factor*	17
Maximum Peak Anode Current (mA.) ...	30
Maximum Anode Watts	4.0

*Taken at Ea=100 ; Eg=0.

TYPICAL OPERATION *As an oscillator*

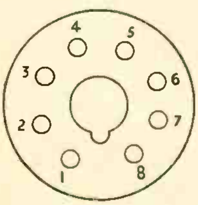
Anode Voltage (approx.)	40
Anode Current (mA.)	4 to 5

INTER-ELECTRODE CAPACITIES

**Anode to Earth*	4.75 $\mu\mu$F.
**Grid to Earth*	7.0 $\mu\mu$F.
Anode to Grid	3.5 $\mu\mu$F.
Cathode to Heater	7.0 $\mu\mu$F.

* "Earth" denotes the remaining earthy potential electrodes and metallising joined to cathode.

BASING



Pin No. 1. Heater.
2. Cathode.
3. Anode.
4. —
5. Control Grid.
6. Metallising.
7. Omitted.
8. Heater.

Viewed from the free end of the base.

GENERAL

The P.61 is an indirectly heated triode particularly suitable for use as an oscillator. The bulb is of small dimensions and metallised. The valve is fitted with a Mazda octal base, the connexions to which are shown above.

Price : 9/6 plus purchase tax

APPLICATION

The valve has been primarily designed for use as an oscillator in television receivers where it is desired to use a frequency changer consisting of an SP.61 with injection into the grid circuit. Under these conditions conversion conductances of the order of 2,700 are obtained with a very much better signal to noise ratio than is obtainable with any other form of frequency changer. It should be realised when designing oscillators for operation at these high frequencies (32 megacycles) that the constants given can only apply to one particular lay-out as very small changes in the disposition of leads or the length of the leads of the oscillator circuit will appreciably affect its performance. This valve may also be used as an oscillator in all-wave receivers where a combined frequency changer is not employed.

MAZDA

RADIO VALVES AND CATHODE RAY TUBES

R.M.59

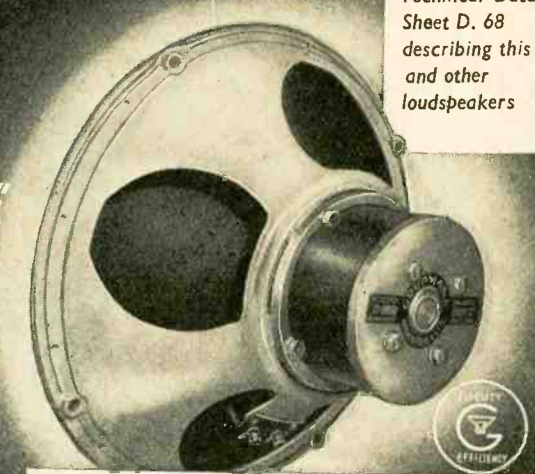
THE EDISON SWAN ELECTRIC CO. LTD., 155 CHARING CROSS ROAD, LONDON, W.C.2

12" P.M.

Write for Technical Data Sheet D. 68 describing this and other loudspeakers

"... undeniably a most successful loudspeaker"

Goodmans 12" P.M. Loudspeaker T/2 is undeniably a most successful loudspeaker. Soundly constructed in every particular, it provides radiogram manufacturers and users of P.A. equipment with a medium-heavy duty reproducer that is robust yet capable of providing a very high standard of reproduction.



GOODMANS *Loudspeakers*

GOODMANS INDUSTRIES LTD., LANCELOT ROAD, WEMBLEY, MIDDLESEX. TELEPHONE: WEMBLEY 4001 (9 LINES)

SPECIFICATION: TYPE T2

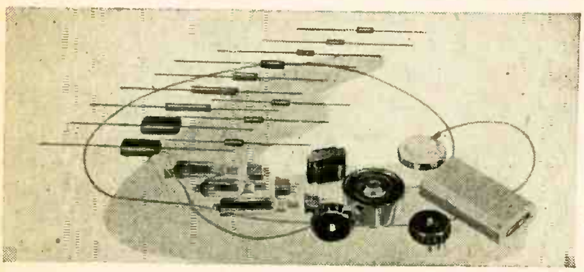
Overall Diameter 12.5/16"	Overall Depth 6.9/16"
Fundamental Resonance	75 c.p.s
Max. Power Capacity	12w. peak A.C. on 4ft. baffle (15w- horn loaded)
Voice Coil Impedance	15 ohms at 400 c.p.s.
Total Flux	145,000 maxwells
Nett weight	12 lbs.

Telegrams: Goodmans. Wembley 4001.

RAYTHEON CONTRIBUTIONS to development of Hearing Aids

More for the Money

IN HEARING AIDS...



In compactness, ease of control, dependability, economy of operation, convenience of servicing, fidelity of tone, and all-round superiority, the Hearing Aid of to-day is far bigger value than that of yesterday. A great contribution to this advance is the reduced battery drain, long life, small size and all-round reliability of the Raytheon Flat Hearing Aid Valve. New production techniques and specially designed valve manufacturing equipment which have made this possible are typical of Raytheon service to Hearing Aid makers and users. Another reason why 90% of all Hearing Aid Tubes in use throughout the world to-day are marked with the name RAYTHEON!

For detailed information on Raytheon Hearing Aid Valves write to Submarine Signal Company (London) Ltd. Artillery House, Artillery Row, London, S.W.1, England, or to:

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The basic design of all Oak switches is one of strength and efficient functioning, including such exclusive features as the double-contact clip and the floating rotor, ensuring self-alignment of each section.

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The only Manufacturers of OAK Switches under Patent Nos. 478391 & 478392

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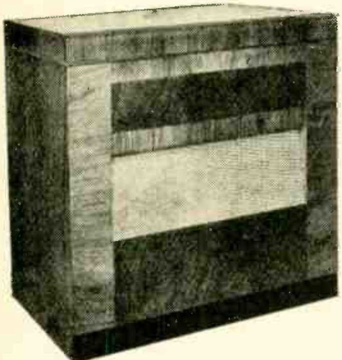
TERMS OF BUSINESS: CASH WITH ORDER OR C.O.D. OVER £1. SEND 2½d. STAMP FOR LIST.

RADIOGRAM CABINETS



RADIOGRAM CABINETS. Dignified appearance and good workmanship. Size 31½in. high, 18½in. deep, 33in. wide. French polished, veneered walnut. Price **£29.** Also available complete with electric motor, auto stop and magnetic pick-up, **£37/18/11.** Ditto, with Rothermel Crystal Pick-up, **£39/12/8.**

SELENIUM RECTIFIERS.

			each	doz.
300v.	60ma.	Half wave ..	5/-	48/-
260v.	30ma.	H.W. or V.D.	3/6	35/-
230v.	30ma.	H.W.	2/6	20/-
450v.	30ma.	H.W. or V.D.	6/6	
500v.	30ma.	H.W. or V.D.	6/6	
700v.	30ma.	H.W. or V.D.	8/6	
900v.	30ma.	H.W. or V.D.	10/6	
1000v.	30ma.	H.W. or V.D.	12/6	
550v.	60ma.	H.W. or V.D.	8/6	
1200v.	60ma.	H.W. or V.D.	15/-	

36v. 75ma. **1/6** each **12/-** per doz.

2v.	¼ amp. ..	2/6	48v.	1 amp. ..	15/-
4v.	½ amp. ..	5/-	100v.	1 amp. ..	18/6
6v.	1 amp. ..	6/6	16v.	4 amp. ..	30/-
12v.	1 amp. ..	6/6	16v.	8 amp. ..	37/6
14v.	2 amp. ..	7/6	30v.	5 A. ..	37/6

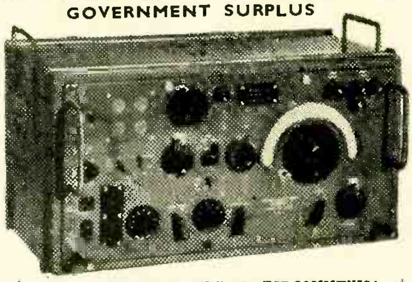
LOUDSPEAKERS BY FAMOUS MAKER.

5in.	P.M.	2-3 ohms.	10/11
6in.	,,	2-3 ,, ...	16/6
8in.	,,	2-3 ,, ...	17/6
10in.	,,	2-3 ,, ...	23/6
12in.	,,	15 ,, ...	85/-
10in. Energised. 2,000 ohm. field		.. ..	25/-

SPECIAL OFFER OF ELECTRIC GRAMOPHONE MOTORS. British made, Rim driven, with 8in. turntables. Fixed speed (78 R.P.M.) for 200-250 volts A.C. only, **£4/19/6.**

OSCILLOGRAPH FOUNDATION KITS. Comprise a transformer giving an output of 800 v., condensers, metal rectifiers, 3½in. Cathode Ray Tube and Base and, L.T. Transformer. **55/-.**

GOVERNMENT SURPLUS



R107. ONE OF THEARMY'S FINEST COMMUNICATIONS RECEIVERS. (See "W.W.," Aug., 1945.) 9 Valves, R.F. amp. osc. Frequency Chapger, 2 I.F.'s.(465 kc.) 2nd Detector, A.V.C. Af. amp. A.C. mains, 100-250v. or 12 v. accum. Frequency range 17.5 to 7 m/cs., 7.25 m/cs. to 2.9 m/cs., 3.05 to 1.2 mc/s. Monitor L.S. built in. Complete. Write for full details. **£16/16/-** complete.

VARIAC TRANSFORMERS, Input continuously variable from 200-250 v. for maintaining constant voltage. Loading 1.65KVA. Output 220 v., **75/-.**

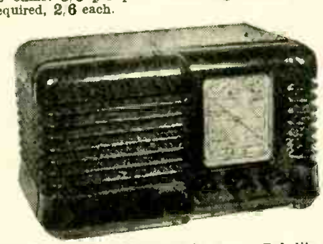
MOVING COIL EARPIECES, comprise a 1½in. moving Coil Loudspeaker fitted with noise excluding rubber caps. Make excellent Mikes, Phones or Speakers, 2/- each, **18/-** doz.

CONDENSERS, 4mfd 750 v.working, **3/3** each, **30/-** doz.

MIDGET ELECTROLYTICS. 16mfd **3/3** each, **35/-** doz.: 16 + 16mf, **5/-** each, **50/-** doz.

OSCILLOGRAPH POWER UNITS. Input 230 v. 50 c. Include transformer, metal rectifiers, voltage doubling and smoothing condensers. Type 409, output 900 v. **25/-.** Type 410, output 1,800 v. **35/-.**

SPECIAL HEADPHONE OFFER. High-grade Double Headphones, using balanced armature units, D.C. Res. 60 ohms. **3/6** per pair. Matching Transformer if required, **2/6** each.



MIDGET RADIO CABINETS in Brown Bakelite, as illustrated, can be supplied for either of the above Midget kits at **27/3,** including Purchase Tax.

ALL-WAVE SUPERHET KIT

ALL-WAVE SUPERHET KIT. A Kit of Parts to build a 6-valve (plus rectifier) receiver, covering 16-50 metres Medium and Long wave-bands. Valve line-up 6K5, 6K7 6Q7, 6J7, two 25A6 in pushpull. Metal Rectifiers are incorporated for H.T. supply. Output impedance is for 3 and 15 ohms. The latest Wearite Coil Pack incorporating Iron Dust Cores is used, making construction and alignment extremely simple. A pick-up position on the wavechange switch and pick-up terminals is provided. A complete kit including valves but without speaker or cabinet. Chassis size 14 x 6in. Overall height, 9in. Price **£11/16/3.** Includes P.T.

Suitable loudspeakers are the GOODMANS 10in. 6-watt P.M. at **47/6,** or for superlative reproduction, the Goodmans 12in. P.M. at **£6/15/-.**

NEW 2-VALVE SHORT WAVE KIT. 16 to 2,000 metres, Switched Coil Pack ready wired and tested. 2 Mazda HL23 Valves, 'Phones, H.T. and L.T. Batteries Condensers, resisters, diagrams and steel case, all ready to assemble, **£3/19/6.**

NEW 1948 MIDGET T.R.F. RADIO KITS with illuminated Glass Dial. All parts including Valves, M/C Speaker and instructions. 3 valves plus Metal Rectifier. 200-557 metres and 700-2,000 metres. 200 to 250 v. A.C. or A.C./D.C. mains. State which is required. Size, 10in. x 6in. x 6in., **£8/0/11,** including Pur. Tax.

NEW 1948 MIDGET SUPERHET RADIO KIT with illuminated Glass Dial. All parts including Valves, M/C speaker and instructions. 4 valves plus Metal Rectifier. 16-50 metres and 200-257 metres. 200 to 250 v. A.C. or A.C./D.C. mains. State which is required. Size, 10in. x 6in. x 6in., **£9,** including Purchase Tax.

An attractive Brown Bakelite Cabinet can be supplied for either kit, at **27/3,** including Purchase Tax.

LOUD HAILERS. Directional pressure operated Loudspeakers with half-mile range with 15 watts input 10 ohms. Principally designed for speech. Bowl Type Projector with fixing bracket. Price **£5.**

PUBLIC ADDRESS HORN LOUDSPEAKERS. Incorporate 8in. Quality P.M. Unit with 3 ohm. Voice Coil. Handles 8 watts. Weatherproof enamelled steel. Size of Mouth. 28½in. x 10½in. Length, 25in., **£3/10/-.**

WHILE STOCKS LAST PREMIER KITS ARE AVAILABLE AT PRE-BUDGET PRICES

FOUR FINE BARGAINS

INDICATOR UNIT, Type 182A, containing tube No. VCR517C and 8 valves, as follows: 3 EF50, 1 5U4, 4 SP61, 11 volume controls, numerous condensers and resistors. Case size: 18in. × 8¾in. × 7½in. The tube used in this unit has the same base connections as the VCR97, if the EHT is kept fairly low it can be used as an oscilloscope or for television. Alternatively it is possible to destroy the after-glow by exposing the screen to a brilliant light for some hours. In any case we think you will agree this is *an amazing bargain* at 39/6, *callers only.* We will demonstrate each tube.

MODULATOR UNIT, Type 155. This unit contains 9 valves, as follows: 1 5U4, 2 U17, 1 MH41, 5 Ediswan V1120B (Output Tetrodes). Two metal rectifiers and numerous other components. Complete in strong steel case, size: 18in. × 8¾in. × 7½in. Price 47/6, *carriage and packing* 7/6.

BLACKOUT UNIT, Type 3. Contains 10 EF50, 2 EB34, 1 Relay, and over 100 condensers and resistors. Complete in case, size: 18in. × 8¾in. × 7½in. A real bargain at 39/6, *carriage and packing* 5/-.

AMERICAN AIRCRAFT RADIO RECEIVER, Type BC 966A. (ABF) Complete with 7 6SH7, (HFPentode) 3 6H6, 3 7193, and motor Generator which can be converted into a very useful motor for operation from AC or DC mains, 230 volts. These are brand new and in maker's crates. Price 39/6, *plus 7/6 carriage.*

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Resistors produced by the cracked carbon process remain stable to ± 1% of initial value.

☆Tolerance ± 1% ± 2% ± 5%

Low temperature co-efficient.

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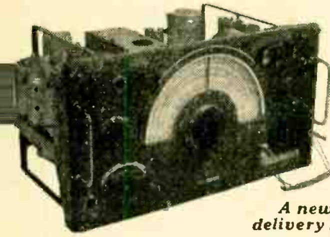
LONDON CENTRAL RADIO STORES

10-VALVE COMMUNICATON RECEIVER—Type R1155



A new delivery!

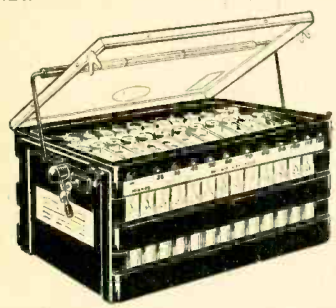
ıse sets are as new. Need only a power pack immediate use (see "W.W." July, 1946). :q. range 7.5 mc/s 75 kc/s in five wavebands. nplete with 10 valves, including magic eye. closed in metal case. Every eiver is aerial tested. Set only **£12.10.0**

nplete with Power-Pack and Loudspeaker, A.C. mains, 200-250 v. **£20**

(Carr. and pkg. 10/6 extra.)

ΙEE with each receiver! Complete circuit, scription and modifications for civil use, re-inted from "W.W." July, 1946.

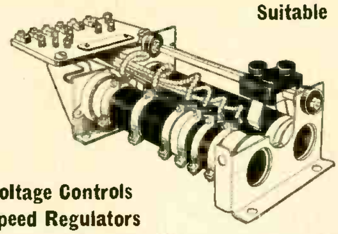
NEW MILNES H.T. UNITS (Everlasting)



ı20 v. 60 mA. Will charge from 6 v. accumulator. *For Callers Only* **67/6**

SLIDING RESISTANCES

Suitable for



Voltage Controls
Speed Regulators

Type 867A (as illustrated). 100 ohms on slider 3 amp. max. Tapped fixed 700, 800, 50, 50 ohms. **21/-** carr. paid.

Type 868A. 450 ohms on slider 2 amp. max. Tapped 200, 200, 200 ohms. **21/-** carr. paid.

Type 866B. 100 ohms on slider 5 amp. max. Fixed 200, 400, 50, 50 ohms. **21/-** carr. paid.

RADAR VIEWING UNITS. Consisting of 6in. diameter Electrostatic C.R. tube, 7 valves including four EF50, potentiometers, resistances and other associated components. In metal cabinet 18×8×7½in. Bargain price **£3.7.6**

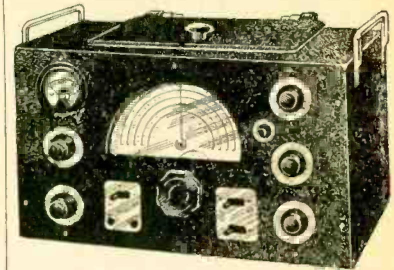
EX-R.A.F. CINE CAMERA, Type G45B. To take 16 mm. film. Fixed focus lens approx. 5 cm., f/3.5. In metal case. Dimensions 12×3½×2in. With 24 v. motor drive. With 12 v. drive, £3. **57/6**

PHOTO ELECTRIC CELLS. Small infra-red image, glass converter tube. Type C.V. 143 50–100 v. Suitable for all purposes. Special price for 2 months only **14/-**
See April issue for illustration.

2-VOLT POWER PACKS complete with Vibrator Output approx. 200 v. 60 mA. Size 9×5×3½in. A first-class job, complete with...... accumulator in carrying case **£3.7.6**
Plus 5/- carr. and pkg.

CHARGING BOARDS, 24 v. 1,260 watts **£4 19 6** Carr. 12/6 extra. *See April advt. for details.*

THE FAMOUS EDDYSTONE 358 COMMUNICATIONS RECEIVER



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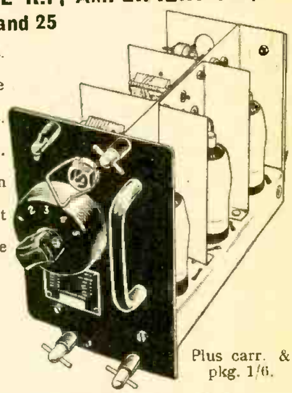
110/125Mc/s. Complete with valves. In metal case. Illustration shows unit with case removed.

16/6



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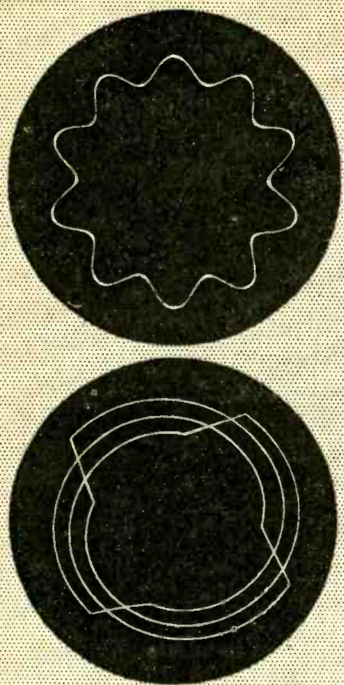

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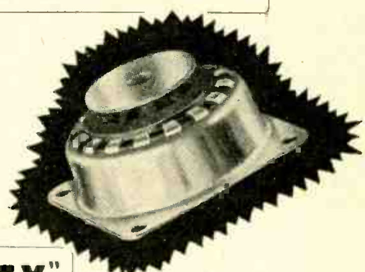

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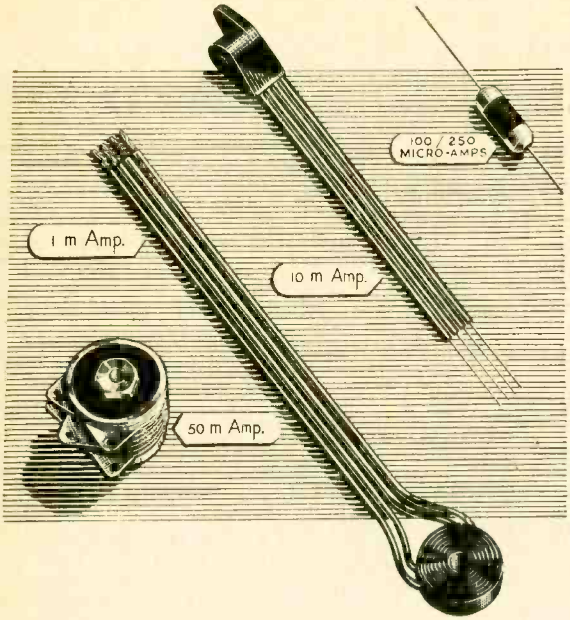
NSTRUMENT RECTIFIERS



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FOR EVERY PURPOSE

The four copper-oxide instrument rectifiers illustrated above are for use with instruments having full-scale deflection of 0.5-1mA; 4-12▪nA; 10-50mA; and of 100-250 microamps.

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Full particulars of frequency ranges, ratings mountings and dimensions are given in our Instrument Rectifier brochure, which is available on request.

SALFORD ELECTRICAL INSTRUMENTS LTD
PEEL WORKS, SILK STREET, SALFORD 3
LANCASHIRE, ENGLAND

Telephone: Blackfriars 6688 (6 lines) *Telegrams: Sparkless. Manchester*

The Type 1684 series of Oscilloscopes is already well known. The new Model retains the desirable features of this series—d.c. shift controls, response flat to video frequencies, d.c. coupled symmetrical amplifiers on both axes, fully-automatic synchronisation of the time base, etc. but incorporates many new features of design, both electrical and mechanical. 1648 D has, in fact, been accorded an enthusiastic reception and despite steadily mounting orders, a three-fold increase in production is enabling reasonable deliveries to be maintained.

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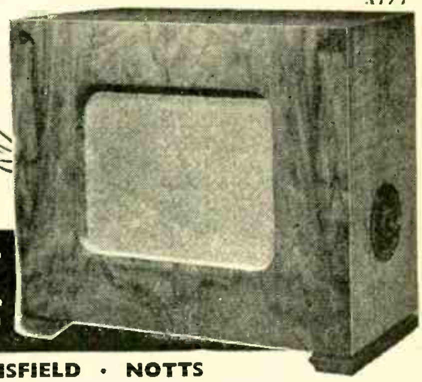
Illustrated is the Stentorian " Cadet " Walnut cabinet, 7″ Unit. £4.0.0 (with transformer £4.10.0) Other models from £1.19.6.



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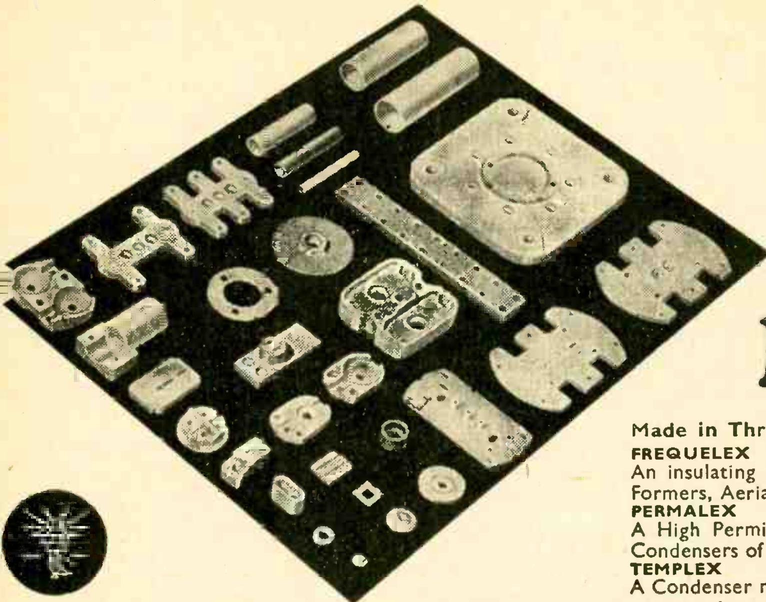

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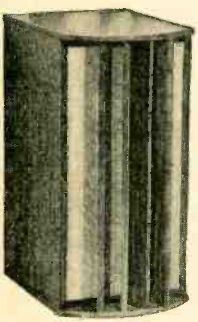

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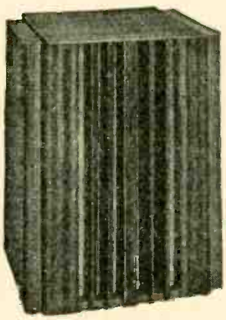

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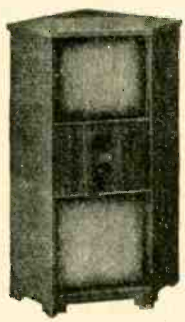

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YAXLEY TYPE SWITCHES. (Revised list, cancels all previous advertisements).
3 pole 3 way 2 wafer, **3/6** each.
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1 pole 4 way 2 wafer }
1 pole 6 way 3 wafer, **3/6** each.
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2 pole 4 way 2 wafer Heary Ceramic (List price is £1.) Our price **5/-**.
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HIGH QUALITY 3 watt Loud Speaker Amplifiers, ex B.B.C. Gain 20 DB. Input impedance 2,400 ohm, Output impedance 11 ohms. in metal cabinet with power pack for operation off 200/250 v. A.C. mains. Circuit comprises ACP driving 2-ACP1 in P.P. These are used for programme quality checking by the B.B.C. and are a bargain at **£4/17/6** plus 10/- Pkg. and carriage.

GENERAL PURPOSE Amplifier. Ex B.B.C. Gain 53 D.B. (± O.1 D.B. between 50-10,000 C.P.S.) Rack mtg. requires separate supply of 250 or 300 v. H.T. and 4 v. A.C. or 6 v. D.C. L.T. Input impedance 600 ohm. Output impedance 600 ohm. 2 7 pin Pentodes ideal for high quality speech amplifier and only **£1/5/0** plus 10/- carriage and packing.

SPARE Ivorine Dials for Class D. Wavemeter, **3d.** each.

SIX Pin Jones Plug complete with cover, **1/6** each. Six Pin Screened Socket Plugs for 1147 A. & B. Rx. Power Input **1/-** each. Four Pin Screened Socket Plugs, **9d.** each.

BRAND NEW Mains Transformers (unshrouded) for making power pack for 1155 Rx etc. 275-0-275 v. 150 m/A, 5 v. 2 amp., 6.3 v. 4/5 amp. output. Input 200/250 v. 50 cycle. These are specially wound to our requirements. Delivery ex stock. Price **42/6.**

WE CAN now supply ex stock most of the range of standard RAYMART products including Rack Panels, 17in. x 10in. x 2½in. Chassis etc. We also stock Q.C.C. Crystals in 1.75 ; 3.5 ; and 7.0 mc's ranges.

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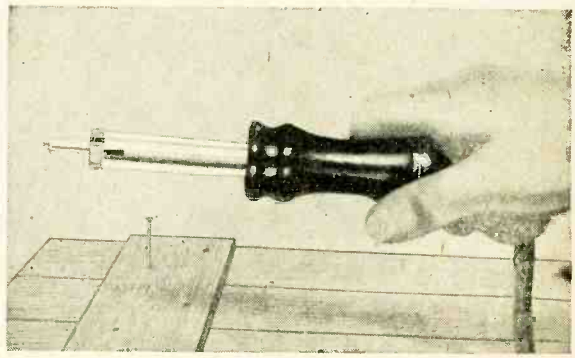

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Element of unique construction ; totally enclosed ; wound on steel tube with air-tight, die-cast case ; withstands the roughest treatment without damage. Instantly detachable and interchangeable copper bits with cam locking.

Ask your Radio Dealer or write direct for full details.

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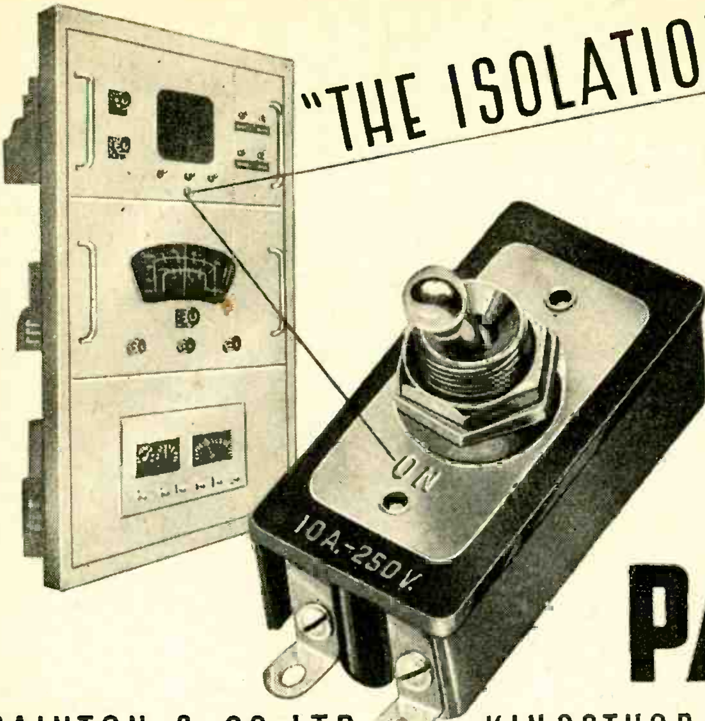
24

"THE ISOLATIONIST"



A selfish fellow this—the iron curtain of radio, never allowing a hint of its business to leak out; making and breaking contact with the positive action of a diplomat saying "No."

Whilst isolationism, so complete, is frowned upon in a human being, it becomes an outstanding feature to be commented upon with pride in a switch of this nature.

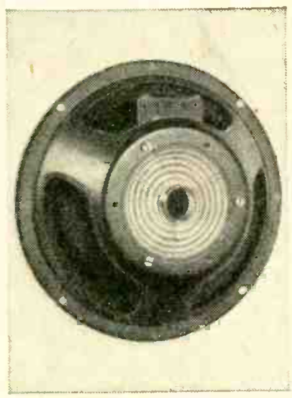
These units are characterised by an exceptionally low and constant contact resistance, and are double pole units rated to operate at 10 amps. 250 volts.

PAINTON

PAINTON & CO LTD KINGSTHORPE · NORTHAMPTON

R&A

'Co-axial Construction . . .'



THE head assembly of the "Series 700" Reproducers comprises the main cone support, the cone, voice coil and centring member assembly. The cone housing itself is a single piece pressing of steel and due to its conical shape and U section arms is of exceptional rigidity; the bore of the rear face, into which the magnet assembly is a sliding fit, being shaved after piercing to a tolerance of ± .005in. In addition to forming the location for the magnet assembly this also forms the location for an assembly jig having a central cylindrical member on which the voice coil former is a sliding fit. This jig remains in position during the assembly of the unit and ensures perfect alignment of the voice coil to the axis of the reproducer, with the result that when the magnet assembly is placed into position and secured by its clamping ring, the voice coil is in its correct position with uniform clearance at all points on its circumference, internally and externally. Frequency response curves of many speakers show a peak of 5 to 10 dB at about 800 to 1200~, followed by a trough of as much as 15 to 20 dB resulting in a strong coloration and lack of balance. Research in our Laboratory has led to a complete understanding of the phenomenon and as a result we have designed a series of cones free from this defect, resulting in a remarkable improvement in the quality of reproduction.

Reproducers & Amplifiers Ltd., Wolverhampton

TECHNICAL TOPICS

for Amplifier designers

● How many watts?

The output power from an amplifier depends on the requirements — the normal broadcast receiver being usually capable of some 2 to 4 watts (assuming a nominal 5% distortion), a good radiogram up to 15 watts and large power amplifiers from 30 watts up to 1 Kilowatt audio power.

It must be remembered that useful ' watts output ' is dependent upon adequate D.C. power input from the rectifier, the available power from an amplifier being limited not only by choice of output valve but also by the voltage and current delivered by the power unit, or rectifier.

With pentodes and tetrodes it is advantageous to maintain constant screen voltage, and with the larger type such as KT66 some form of screen voltage stabilisation is desirable.

At low H.T. voltages, such as in DC/AC amplifiers, a properly designed pentode or tetrode circuit is better than a triode circuit.

Brief data on the ranges of output from different types of valve is given below.

POWER RANGE WATTS	BATTERY VALVE	A/C MAINS VALVE	ASSOCIATED RECTIFIER	DC/AC VALVE	ASSOCIATED RECTIFIER
0.5	KT2	—	—	—	—
1.0	2-KT2	—	—	—	—
up to 2	—	—	—	KT76	U76
2-3	—	KT63	U50	KT33C KT71	U31 U76
3-5	—	KT61 KT66 (Triode connected)	U50 U50	KT33C KT71	U31 U76
5-10	—	2-KT61 KT66	U50 U50	2-KT33C 2-KT71	2-U31 2-U76
10-15	—	2-PX4 2-KT66 (Triode connected)	U52 U52	2-KT33C 2KT71	2-U31 2-U76
15-50	—	2-KT66	U52	—	—

Osram PHOTO CELLS — G.E.C. CATHODE RAY TUBES — Osram VALVES

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

Wireless World

RADIO AND ELECTRONICS

JUNE 1948

38th YEAR OF PUBLICATION

Proprietors: ILIFFE & SONS LTD

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

Editor: H. F. SMITH

Editorial, Advertising and Publishing Offices:
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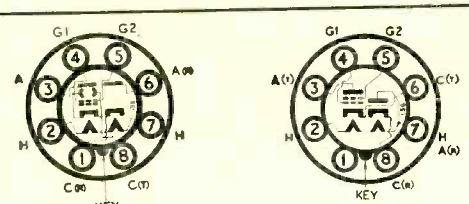
In this Issue

Another word for Service ... BRIMARIZE!

TYPES 117L/M7GT, 117N7GT and 117P7GT are dual purpose valves employed in American "Mains/Battery" receivers, each valve comprising a rectifier and a beam tetrode section in the one envelope. For "Mains" operation the tetrode section supersedes the battery output valve whilst the rectifier section provides the H.T. and L.T. supply.

To Brimarize, replace the rectifier section with a Brimar SB3 and fit a voltage dropping resistor between the H.T. + and L.T. + battery leads. (This resistor must be removed when the set is worked from batteries.)*

The line cord resistance must be adjusted so as to obtain an H.T. supply of 90 volts and this should provide 1.3—1.4 volts across each filament section. A usual value is 800 ohms for a mains input of 230 volts. Modulation hum may be eliminated by extra smoothing. Decoupling the screen grid of the frequency changer will often effect a cure.



TYPE 117L/M7GT — TYPES 117N7GT 117P7GT

TYPE	CHANGE SOCKET CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
	FROM SOCKET	TO RECTIFIER		
117N7GT 117P7GT	Pin No. 8 Pin No. 7	+ ve (Red) Tag — ve (Black) Tag	1. Fit dropping resistor of 1500 ohms 5 watt between HT + ve and LT + ve battery leads. 2. Adjust line cord to give a D.C. H.T. voltage of approx. 90 volts. This should supply 1.3 — 1.4 volts to each filament section. 3. Check smoothing condensers and replace if necessary.	Instant starting and identical volume on both "mains" and "Battery" positions.
117L/M7GT	Pin No. 1 Pin No. 6	+ ve (Red) Tag — ve (Black) Tag		

NOTE: The SB3 is a direct replacement for the rectifier type RD18/9/1 used in the new "Double Decca."

← PUNCH HOLES HERE →

117L/M7GT
117N7GT
117P7GT

★ The Brimar SB3 metal rectifier rated at 250 volts 65 mA. may be obtained from your wholesaler.
List Price - 10/6.

BRIMAR
RADIO VALVES

Punch holes where indicated, cut away this portion and file for reference guide

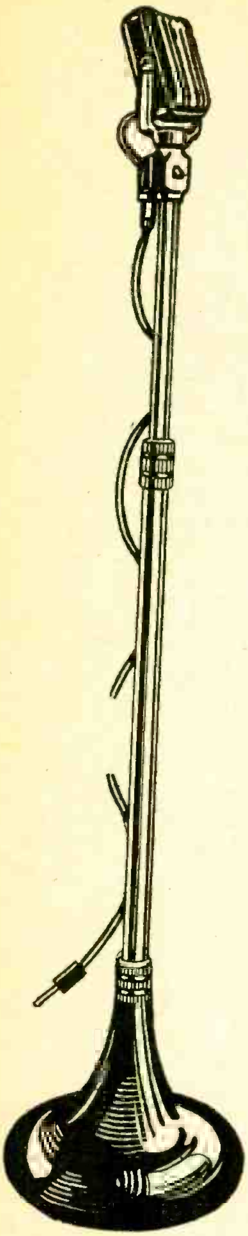
15

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

A SERVICE PLAN FOR PLANNED SERVICE

Virtually Distortionless

A.D/47 AMPLIFIER



This is a 10-valve amplifier for recording and play-back purposes for which we claim an overall distortion of only 0.01 per cent., as measured on a distortion factor meter at middle frequencies for a 10-watt output.

The internal noise and amplitude distortion are thus negligible and the response is flat plus or minus nothing from 50 to 20,000 c/s and a maximum of .5 db down at 20 c/s.

A triple-screened input transformer for 7½ to 15 ohms is provided and the amplifier is push-pull throughout, terminating in cathode-follower triodes with additional feedback. The input needed for 15 watts output is only 0.7 millivolt on microphone and 7 millivolts on gramophone. The output transformer can be switched from 15 ohms to 2,000 ohms, for recording purposes, the measured damping factor being 40 times in each case.

Built-in switched record compensation networks are provided for each listening level on the front panel, together with overload indicator switch, scratch compensation control and fuse. All inputs and outputs are at the rear of the chassis.

Send for full details of Amplifier type AD/47

Vortexion LIMITED

257/261, THE BROADWAY, WIMBLEDON, LONDON, S.W.19.

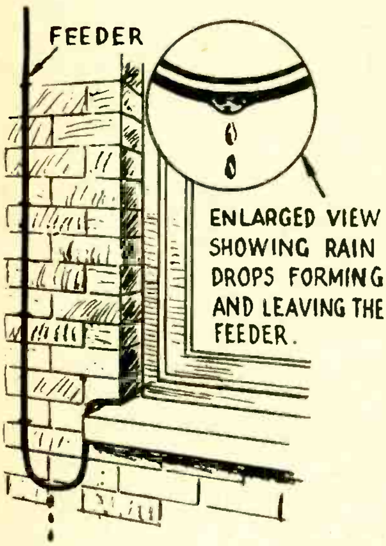
Telephones : LIBerty 2814 and 6242/4.
Telegrams : "VORTEXION, WIMBLE, LONDON."

THE "BELLING-LEE PAGE"

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

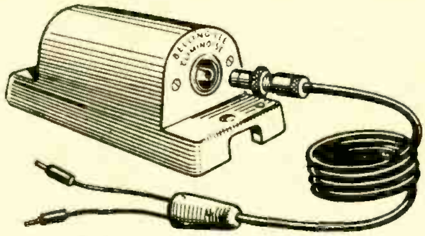
Coaxial Drain Pipe ?

Recently we have had two complaints of water entering a television receiver via its co-axial*1 cable. In one case the water was running down the outside of the cable, and, because of the manner of installation, was carried into the house. Our installation department invariably bring cable in as illustrated i.e. looped so that external water runs off. This should be done with every type of cable.



In the second case the co-axial feeder really was acting as a pipe, with a good head of water too.

In the centre of the bakelite insulator of the " Belling-Lee " television aerial*2 there are two terminals. Two sealing sleeves cut from plastic material and approximately 3/16in x 1/8in are supplied and should be slipped over each terminal stem before insertion in the appropriate hole. We wish to emphasise this, as these small sleeves are frequently overlooked or ignored, and if co-axial cable is being used, water may enter the cable and run down the inside and into the receiver. It will be obvious that in such a case the looping of the cable before entering would have no effect as the water would syphon round the bend.



Burnt-out " Eliminoise " Transformers.

Referring back to the question of burnt out " Eliminoise "*3 on A.C./D.C. receivers where we wrote that this would happen if the *isolating* capacitor was omitted or had broken down, a reader from Tunbridge Wells asks if a capacitor can truly " isolate" against A.C. Of course he is quite right, a small current does flow, but at 250 volts A.C. using an 0.01μF capacitor, this current is just under 10 milliamps. Such a current would not harm an " Eliminoise " winding, nor would it be really dangerous to life.

If the capacitor breaks down, then the " Eliminoise," if fitted is burnt out, or the receiver becomes a very dangerous appliance in the home or elsewhere. We did discuss the possibility of inserting a fuse link in the " Eliminoise." But surely the correct position for the fuse is in the receiver. Why should we increase the cost of the " Eliminoise " to make up for the shortcomings of the set.

Ignition Interference.

The campaign for the fitting of distributor suppressor*4 to motor vehicles to prevent their interfering with television reception is producing important results. Most really big transport organisations are co-operating. It is rather more difficult to obtain co-operation from private users, tradesmen, etc. We know of one Televiewer in Bedfordshre who having spent an odd hundred guineas on a television receiver and aerial could not enjoy a picture because of interference from passing cars. He purchased fifty distributor suppressors which he gave " gratis " to all his neighbours, and to other car owners normally passing his house, tradesmen's vans etc. Now he considers his total expenditure well worth while. He is fortunate in not living right on the Brighton or Portsmouth roads.

Facing facts, the manufacturer, and his agent the retailer of television receivers, are the people who stand to gain most from the fitting of distributor suppressors. Is it asking too much to suggest that dealers on the fringe areas such as Reading, Tunbridge Wells, etc., try and persuade their business neighbours,

> P.S.
> Did you know? A motor car can seriously interfere with electronic research and television reception. Fit a "Belling-Lee" suppressor L.1274 or L.630 to the distributor lead. Costs 1/6d, does not affect engine performance, and helps an industry.

This is a reproduction of a "letter-sticky" that we are using on all our out-going correspondence.

the garage proprietors, to co-operate in which is, to them, such an important matter? After all, if most vehicles *garaged* in these towns were fitted with a one and sixpenny suppressor, a surprising number of television receivers might be sold, with a unit value of from £50 to £100, and a largely increased satisfied audience, paying for a television licence which goes towards an improved service to everybody interested. Reader is *your* car suppressed ?

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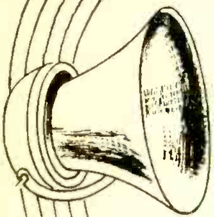

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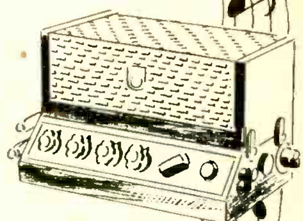

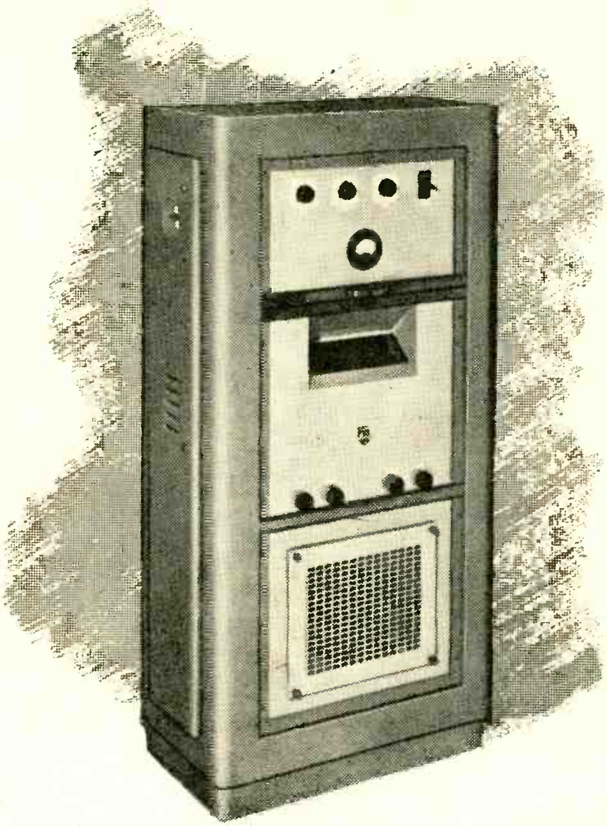

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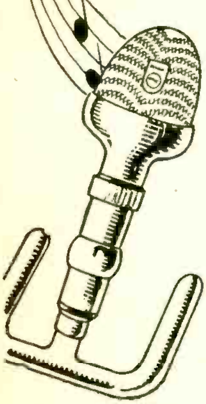

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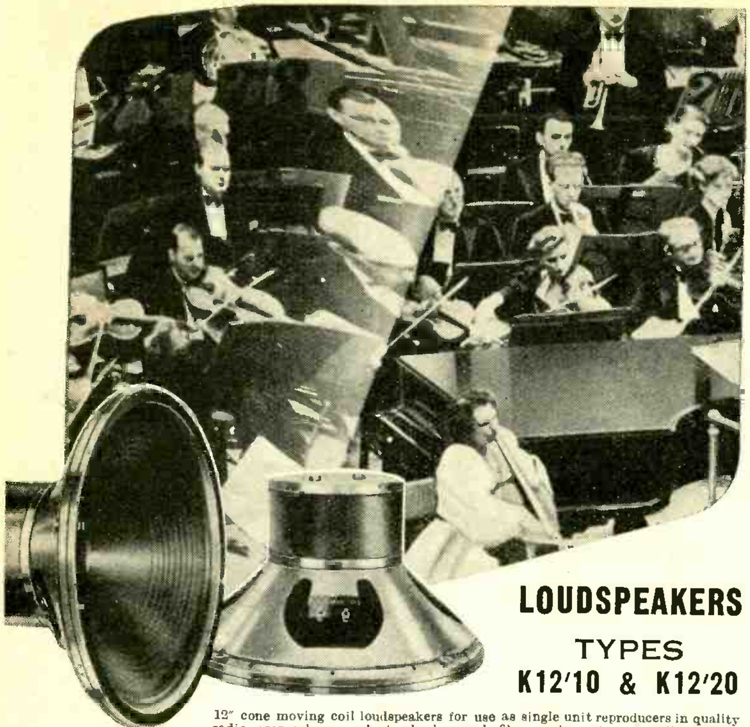

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C 22	5.5	184	2.8	0.44"
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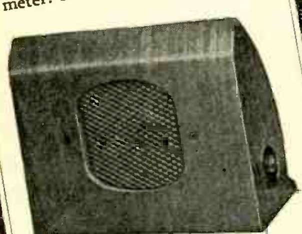

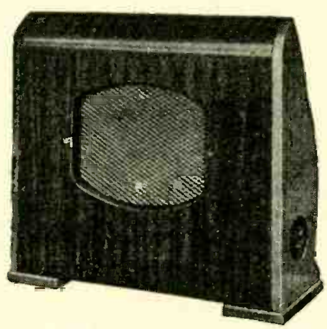

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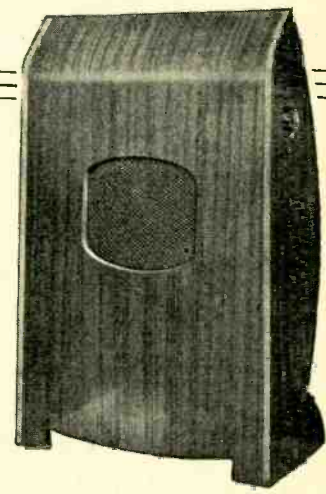

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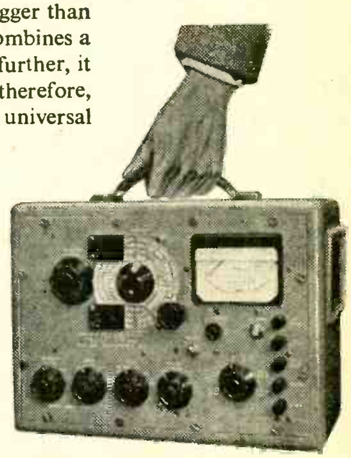

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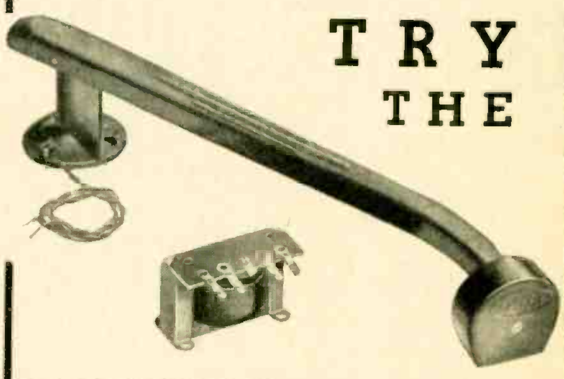

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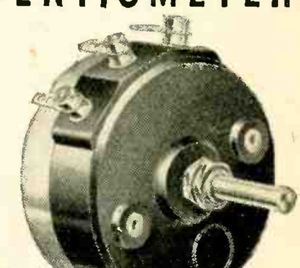

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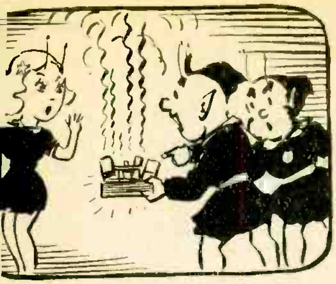

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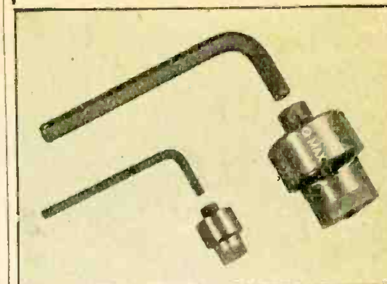

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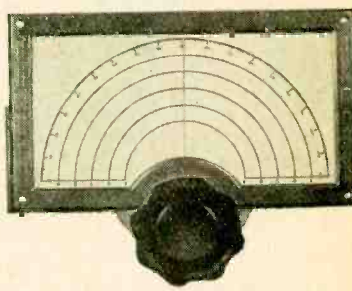

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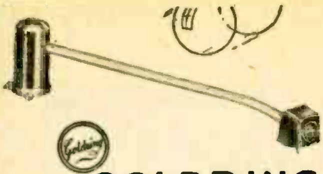

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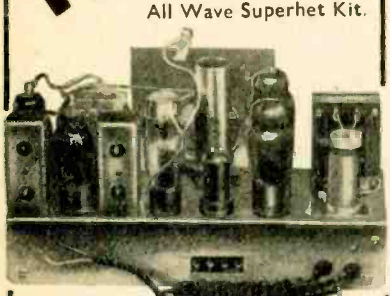

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THIS MONTH'S SPECIAL : 2 "Wireless World" Publications : Television Receiver Construction, 2/6; "Wireless World" Valve Data, 2/-. Hellerman Tool Kit, 25/6. Ex-Govt. 0-1 mA Meters, 2½in. New, 15/-. "Delegate" Universal All-wave Superhet Midget, reduced from **£19 3s. 5d.** to **£15 15s. 7d.** "Tiny Tim" one-valve kit, complete except batteries, **25/-.** "Merlin" Miniature Photo Camera, **27/4.**

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A much improved version of our Corner Cabinet is now available, in either whitewood or walnut veneer. Full details on request. Our Feeder Units and Amplifiers are now available from stock.

A prototype miniature Hi. Fi. receiver and amplifier using button base valves is in course of development and will soon be demonstrated in our showrooms.

Components for the Partridge 15 Watt Quality Amplifier are available from stock.

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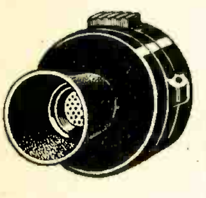
MOVING COIL
HAND MICROPHONES (No. 13)



Bakelite case 2¼" diam. Press-to-talk switch. Soft rubber mouthpiece. Coil 40 ohms d.c. res. Excellent performance. Brand new, in original packing. Including postage, 5/- each, or case of ten for 40/-. Despatched same day.

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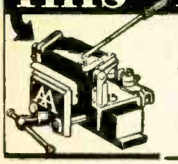

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HIGH "Q" IRON CORED COILS

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AERIAL, H.F. OR OSCILLATOR, short, medium or long wave, size of former 1in. × ⅞in., 3/9 each.
INPUT FILTER, 465 Kc/s., parallel or series tuned, 3/9 each.
I.F. TRANSFORMERS, 465 Kc/s., midget, permeability tuned, size 1in. diam. × 1⅞in. high, 9/6 each.
I.F. TRANSFORMERS, standard, 465 Kc/s., permeability tuned, size 1⅜in. square × 3¼in. high, 8/6 each.
All coils fitted with adjustable iron cores, and supplied with circuit diagram.
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(Established 1929)
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Phone: Tulse Hill 1051/2.

THE College of Aeronautics.—Lecturer in Electronics.
APPLICATIONNS are invited for the post of Lecturer in Electronics. The syllabus to be covered consists mainly of the elements of the subject, with some advanced teaching for specialist students, and the principles of airborne radio and radar equipments. Previous experience of such equipments, and centimetre-wave techniques, is desirable but not essential. There is good opportunity for research into the application of electronic techniques to aeronautical problems. Salary, plus superannuation under the Federated Superannuation System for Universities, according to qualifications and experience.
APPLICATIONS, giving full details of qualifications and experience, should be marked "Lecturer in Electronics," and sent to the Registrar, The College of Aeronautics, Cranfield, Bletchley, Bucks, from whom further information may be obtained. [9929

CROWN Agents for the Colonies.—Applications from qualified candidates are invited for the following posts:—
STAFF required for Joint Posts and Telegraphs Department, East Africa, for a tour of 36-48 months with prospect of permanency. Commencing salary according to age and war service in scale £360 to £540 a year. Cost of living allowance £75 to £187 a year according to salary, dependants and station. Outfit allowance, £30. Free passages. Candidates aged 25-38 must be qualified for one of the following posts:—
(A) WIRELESS OFFICER. — Postmaster-General's First-class Certificate in Radiotelegraphy, the equivalent certificate of the Air Ministry or Ministry of Civil Aviation, or other equivalent service qualifications, together with considerable experience in operation of medium- and high-frequency radio stations. Experience in operation of modern radio and/or radar navigational aids and day-to-day maintenance of modern radio equipment an advantage.
(B) TECHNICIAN. — A thorough practical knowledge of working and maintenance of modern radio equipment. Candidates should preferably have undergone an organised course of works training. Experience in maintenance of modern radio and radar aids to navigation and possession of City and Guilds certificates in radiocommunication desirable. General Post Office employees should apply through departmental channels. Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, and mentioning this paper to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting for (A) M/N/23793 (3B), and for (B) M/N/23813 (3B) on both letter and envelope.

THE PLESSY Co., Ltd., Vicarage Lane, Ilford, have vacancies for senior radio engineers and designers capable of initiating the design of radio and television receiving equipment; suitable applicants must possess adequate technical qualifications and experience of the industry.—Apply, stating age, qualifications and experience to the Personnel Manager. [9903

EXPORT sales manager required by large manufacturer in London area; suitable applicants must have technical knowledge and commercial experience in the light electrical and mechanical engineering field; wide knowledge and understanding of foreign markets absolutely essential.—State age, experience, qualifications and salary to Box 7627. [9962

RADIO Service Engineer required, born wireless enthusiast, of good education who is averse to monotonous dead end jobs and who would like to join up with another in forming own high standard service business in Eastern England, workrooms available, help given in finding living accommodation.—Box 7647. [1014

RADIO engineer required to control, test and repair section of service department in large radio factory, S.E. London area; applicants should have first-class knowledge of servicing, repair of radio, and television receivers; good organiser essential.—Write, stating age, experience and salary required, to Box 7636. [9993

OLD-ESTABLISHED radio component manufacturers desire to engage physicist-engineer with wide knowledge of centimetric wave guide technique and applications; full details, including age, education and previous employment will be treated in strict confidence; the company's own staff are aware of this vacancy.—Box 7234. [9935

TEST and maintenance engineer required by The Morgan Crucible Co., Ltd., Battersea, S.W.11; aged 25-30 with matriculation, City & Guilds certificates or higher National Certificate or equivalent standard; must have practical experience in electrical, radio and electronic test equipment.—Apply in writing, giving details of age, experience, qualifications and salary required to the Staff Manager. [1075

THE Philips Group have vacancies at their Mitcham factory for mechanical engineers with factory and drawing office experience, capable of undertaking responsibility and design of radio and television receiving apparatus; preference will be given to applicants of 28 years and over who have completed a recognised apprenticeship and who are of Higher National Certificate standard of education; salary offered will be according to qualifications and experience.—Written applications to the Secretary, Mitcham Works, Ltd., New Rd., Mitcham Junction. [9930

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OLDCHURCH LABORATORIES
And Now, TEST SET 74

This special-purpose Oscilloscope Unit, which operates from 50 cycle A.C. Mains, can be readily converted to a normal 3 Oscilloscope. It contains 11 valves, plus the tube. Size, 18 by 12 by 9 inches. Price, complete with Modification Data £6 10 0
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We can supply the above, ready converted to the following specification.
Linear Time-Base, 10 cycles to 200 K/c.
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R.1155 Receivers (few only) .. each £6 0 0

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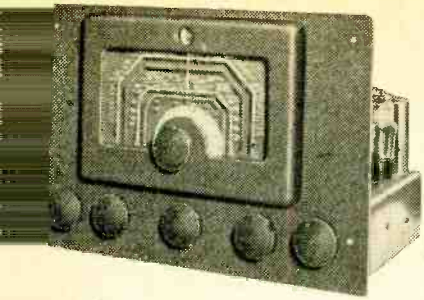

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TYPE 1047 RADIO CHASSIS

This chassis is now available as an AC/DC model, and can also be supplied as a complete Radio Gramophone with twin speakers, acoustic labyrinth, etc., in walnut cabinet by one of Britian's leading designers.

Among its principal features are:—

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- RF amplifier.
- 2 IF stages.
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- Tropicalised components.

Communications enthusiasts should write for details of our 1546 Chassis.

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LASKY'S RADIO

THIS MONTH'S SPECIALS

POWER UNIT TYPE No. 5. Ex-A.M. Brand new, in wooden carrying case. Total weight 80 lbs. Includes 5 rectifying valves, two VU111, two 6X5 and one 5U4G. Two .1 5000 v.w., three .1 4000 v.w., chokes, transformers, etc., etc.

YOU MUST SEE THIS BARGAIN
PRICE **59/6**, carriage extra.

EX-ARMY No. 18 TRANSMITTER/RECEIVER. Receiver is a 4-valve superhet. Transmitter is a 2-valve master oscillator and power amplifier. Frequency range 3–9 Mc/s., C.W., and R.T. Supplied complete with 2 sets of headphones, 1 Microphone, morse key, aerial rods and all valves. Set is completely portable.

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MIDGET CHASSIS. Size; 10¼in. × 4¾in. × 1⅝in. Complete with 5 International octal valve holders (riveted). Constructed of strong metal and ready for making a superhet. **5/6** each, post 6d.

17-VALVE RADAR RECEIVERS. BRAND NEW, AS OFFERED IN "WIRELESS WORLD," MARCH ISSUE. Valve line up, eight EF50, 2 RL37, 1 HVR2, 1 R3, 2 EA50, 1 EC52, 1 CV188, 1 VR507. Dozens of other components, including condensers, resistances, toggle switches, transformers, coaxial connectors, etc., etc. Chassis enclosed in **grey metal cabinet**, size 18in. × 7½in. × 8½in. Approximate weight 28 lbs. The complete receiver is packed in a wooden crate for safe transport, weighing approximately 40 lbs. when packed.

PRICE ONLY **85/-**, carriage 5/- extra.

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PROMINENT engineering firm in the north-west requires radio engineers having substantial previous experience of development and design of C.W. or pulsed apparatus; reply, stating qualifications, experience and salary required.—Box 7621. [9943

LARGE manufacturers in North London require radio engineer for service department; details of education, not below School Certificate standard, technical training and experience, age and salary required to Box 299, c/o Era Publicity, Ltd., 166, Camden High St., London, N.W.1. [9940

PERA requires an instrument designer with electrical and mechanical experience.—Applications, giving full details of experience, qualifications, age and salary required, to the Secretary, Production Engineering Research Association of Great Britain, Staveley Lodge, Melton Mowbray, Leics. [9932

ENGINEER required for laboratory investigation and measurements in conjunction with radio and electronic devices, experience in electron optics desirable, with ability for original design; applicants should have reached accepted standards of education and carry adequate production-design experience; West London area.—Apply, giving age and full details of education and experience, to Box 7645. [1009

TECHNICAL sales representative with extensive knowledge of electronic equipment required by manufacturer in London area; applicants must have technical qualifications to degree standard and must be conversant with current developments.—State qualifications, experience, age and salary required to Box 7623.

DEVELOPMENT Engineer required for work on experimental types of cathode ray tubes; applicants should possess a physics degree and have had practical experience in the design, development and manufacture of cathode ray tubes; London area.—Applications should include details of qualifications, experience, age and salary required, and be addressed to Box 7644. [1008

ASSISTANT laboratory engineer required by capacitor manufacturers, applicants should hold Higher National Certificate in electrical or radio engineering or have similar qualifications and must have experience of industrial laboratory work, knowledge of capacitors preferable but not essential.—Write, giving details of experience and salary required, to A. H. Hunt, Ltd., Bendon Valley, Wandsworth, S.W.18. [9715

TECHNICAL correspondence clerk required for North London manufacturer's radio service department; successful applicant will be required to take a period of training in radio repair work, and to assist in such work when necessary.—Full details of general education, which should be at least to School Certificate standard technical training, experience, age and salary required to Box 300, c/o Era Publicity, Ltd., 166, Camden High St., London, N.W.1.

ELECTRONIC circuit engineers required for research and development work; good academic qualifications and apprenticeship, industrial or research experience essential; knowledge of any of the following subjects desirable: radar and television pulse techniques, centimetric components, time-base generators, a.c. and d.c. amplifiers, feed-back amplifiers, servos, especially low-power electro-mechanical stabilised power supply units, data transmission systems, cable form layouts, some mathematical ability is desirable.—Write, with full details of qualifications, experience, age and salary required, to, Personnel Manager, Sperry Gyroscope Co., Ltd., Great West Rd., Brentford, Middlesex.

SITUATIONS WANTED

TECHNICAL assistant, 33, 3 years radar development, 5 years A.I.D., radar group, seeks executive or technical post.—Box 7688.

EX-RADIO officer, M.N., 1st-class P.M.G., seeks position as laboratory assistant or servicing engineer, radar experience, continuing studies.—Box 7625. [9959

ASSOC. Brit. I.R.E., C. & G. finals, 25, 4 yrs. radio and radar P.O., F.A.A., 2 yrs. instrument dev., seeks technical position with opportunity for foreign travel.—Box 7646. [1013

YOUNG man seeks position with firm on radio and electronic work, 4 yrs.' radio and 4 yrs.' business experience; preferably South-west area; gd. references supplied; able to drive.—Box 7615.

EX-R.A.F. sigs. officer, Assoc.Brit.I.R.E. (27), 10 yrs.' service, still separated from family by 500 mls., seeks prog. sit. in Dundee-Fife area, Scot., or anywhere where acc. available; at present with firm in Essex.—Box 7631. [9976

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RADIO engineer, 21 years' experience, crystal sets to radar including 16mm sound, available take position progressive firm, retail wholesale, manufacturing, North-West London area, capable taking charge, organisation, staff, clerical work, representative, drive, type, keen, ambitious.—Box 7681. [1052

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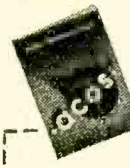

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