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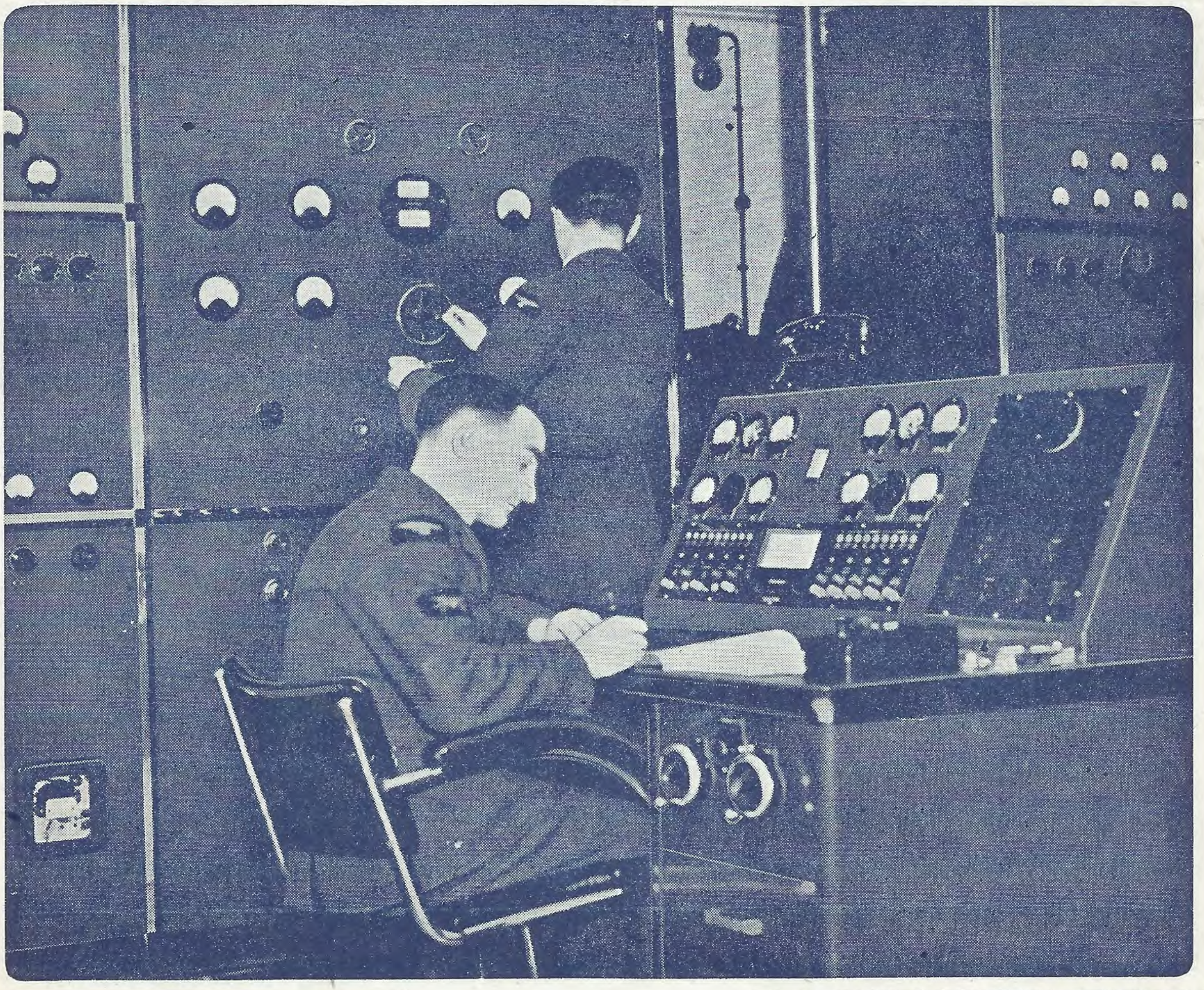
AUGUST 1941



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Wireless World

31st Year of Publication

Covering Every Wireless Interest

AUGUST 1941

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The
Wireless World
COVERING EVERY WIRELESS INTEREST

ESTABLISHED 1911

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Radiolocation

A Major Wireless Contribution to the War Effort

JUST after the July issue of *The Wireless World* went to press the veil that has guarded the best-kept secret of the war was partially lifted. It was then disclosed that a new radio technique was being employed for the location of enemy aircraft.

Here, it would seem, is an answer to the question of how the Royal Air Force was able last summer to beat off so successfully and competently the mass daylight attacks of the numerically superior *Luftwaffe.* At any rate, wireless in its various forms must have been largely responsible for our success. The older and well-known methods of communication operate more powerfully in favour of the defence than of the offence, and, in conjunction with the new technique of "radiolocation," may well have been a deciding factor in the winning of the Battle of Britain. Radiolocation helped us to concentrate our fighter aircraft at tactical points for meeting attacks and prevented extravagant dispersal. It also reduced the need for constant patrolling, with its inevitable wastage of men and machines. Truly, wireless has no cause to be ashamed of its latest contributions to the war effort.

Reflected Waves

What is radiolocation? Reams have been written on it in the lay Press, but, so far as wireless men are concerned, all that can usefully be said about it at present is that it depends for its action on the reflection of electro-magnetic waves from solids (conductors, semi-conductors or insulators). The obvious advantage over conventional means of wireless direction finding, etc., is that it does not depend on emissions from the object (enemy aircraft, etc.) to be located; the exploratory waves to be reflected are under our own control.

The reason why even this meagre amount of information has been disclosed is clear. Men are required in increasing numbers to develop the apparatus, to operate it, and to maintain it. The supply of wireless recruits in this country is not unlimited, and it became necessary to issue an appeal for technicians in the United States. The chance of success of such an appeal was obviously greatly increased by the publicity given to the disclosure of information on our "secret weapon."

Opportunities to Help

The fact that an appeal for American help was necessary gives grounds for serious thoughts among wireless men in this country. It is galling to us to depend on outside aid to a greater extent than is essential in a matter of such importance, and we hope that a supreme effort will be made to tap our admittedly dwindling reserves of suitable man-power. There must be many readers of this journal with knowledge and experience that would fit them for one of the many branches of radiolocation. It is a matter for their own consciences to decide whether their present work is more important. Unless fully convinced that it is, they should offer their services for radiolocation, putting their qualifications fully and frankly before the authorities. Readers in the Forces are reminded that applications for transfer can be made through the usual Service channels.

Unless radiolocation proves to differ greatly from similar branches of our art with which it can be compared, it will in the early stages depend largely for its success on the human element. The right kind of men are wanted, and wanted quickly. For development engineers the scientific attitude towards new problems and methods is more important than long practical training. Operators and maintenance men should be used to thinking for themselves instead of slavishly "following the book."

Minimising Selective Fading

An Experimental Attack on the Problem

By L. A. MOXON, B.Sc., A.C.G.I.

NEARLY everyone is familiar with the unpleasant effects of selective fading. The appalling distortion which occurs when, for instance, the carrier fades out and leaves the sidebands behind will be specially familiar to SW listeners.

This article concerns some experiments recently started with a view to reducing the annoyance caused by this type of fading. Although completion of the work has had to be postponed, some interesting results have been obtained.

Let us examine the problem. An ordinary amplitude-modulated signal comprises a carrier and sidebands. Distortionless reproduction involves maintaining the initial phase and amplitude relationships of the sidebands to the carrier. Now let us consider a signal arriving at the receiver by two or more paths of different length. The signal arriving by one path will be different in phase to that arriving by the other, and the result may be an addition or subtraction of the two parts. For example, if there are two equally efficient paths differing in length by half a wavelength, or any odd number of half wavelengths, the trough of the wave arriving by one path will coincide with the crest of the other. The crest will fill the trough and the result will be a complete absence of wave. This cancellation will only take place at one wavelength, so that it is possible for the carrier to disappear while the sidebands remain, and the effect on quality of reproduction is catastrophic. It is usually of short duration owing to variations of paths.

With large differences in path length quite a small change in wavelength can make the difference between addition and subtraction, so that the fading of the carrier may even be accompanied by a boost of the sidebands. With small differences of path length a carrier fade will be accompanied by a very similar fade of the sidebands as well, and unless the carrier disappears completely distortion will not be evident. The process is really more complicated than this since different frequencies tend to prefer different routes, and the length and efficiency of paths is constantly changing, but the explanation given may be found helpful.

There appear to be two possible lines of attack on the problem: (1) restricting propagation or reception to a single path, and (2) restoring workable relationships between the various side band components and the carrier, in the receiver.

With regard to the possibilities of single-path reception, if the signal is arriving from two widely different directions a simple frame aerial is effective. This is often the case when two synchronised transmitters are being used, an arrangement which tends to cause selective fading by creating differences of path length.

Selective fading is often due to interference between ground and reflected waves, and this also may yield to some extent to the frame aerial treatment, the ground wave being fairly easy to eliminate. In any case of selective fading involving short distances, it seems a likely assumption that if the path lengths are sufficiently different to be troublesome, there will be a substantial difference in angle of arrival which may enable a frame to function.

At the long distances involved on short waves, the problem is very different. The MUSA or Multiple Unit Steerable Antenna system will be recalled by *Wireless World* readers. This very interesting system employs a number of diamond aerial arrays suitably phased, and enables reception to be confined to a very narrow angle which can be adjusted to suit conditions. Involving over 1,000 valves and some miles of aerial, its applications are obviously limited.

We will now consider the possibilities of carrier restoration. The amount of harmonic distortion caused by disturbance of the phase and amplitude relations of carrier and sidebands depends on the percentage modulation. If this is low, the relationships are relatively unimportant. Fig. 1 is a circuit arrangement for using a quartz crystal to boost the carrier and reduce the percentage modulation. It is

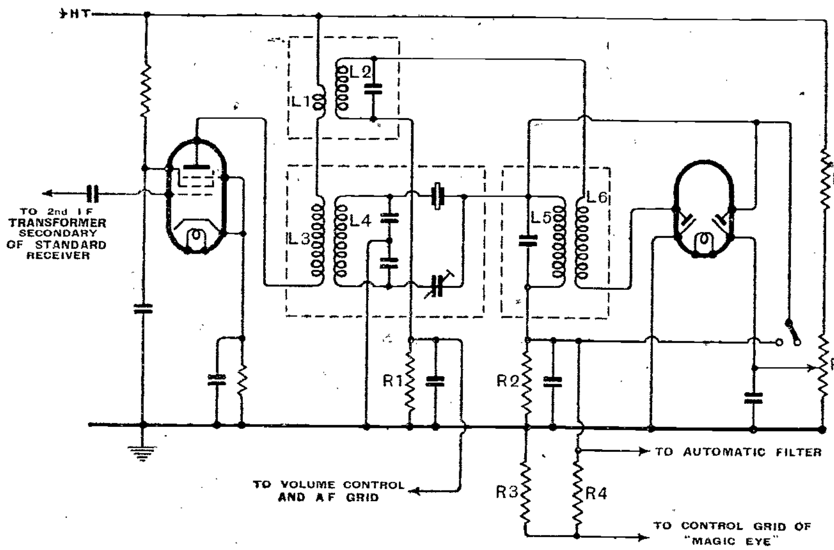


Fig. 1. Carrier boosting circuit. Values of components: L1, small 8-turn coupling coil; L2, 90 μH, shunted by 1350 $\mu\mu$F; L3, L4, L5, L6, 860 μH; R1, 0.2 megohm; R2, 0.5 megohm; R3, R4, 2 megohms; R5, 50,000 ohms; R6, 10,000 ohms.

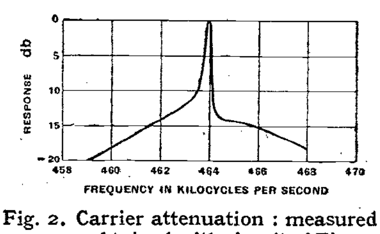


Fig. 2. Carrier attenuation: measured response obtained with circuit of Fig. 1.

adaptable to any receiver having an IF of 465 kc/s or thereabouts, and the principle is as follows. Sideband and carrier voltages exist across L2 and carrier only across L6. The sum of these voltages is applied to the signal (left-hand) diode, and the windings may be proportioned to give a carrier boost of about 5 to 1. This arrangement produced the response curve of Fig. 2. In view of the need for very accurate tuning, the second diode was fed with carrier volts only, slightly delayed, and used to control a "magic eye" tuning indicator. The output of this diode was also available for controlling the automatic filter described later. A switch was provided to cut out the crystal circuit for the purpose of comparative tests. This simple crystal filter was not found selective enough to boost the carrier alone, and it also accentuated the lower modulation frequencies. This did not affect its working as selective distortion of the lower frequencies is slight, but it was found desirable to introduce a compensating bass cut by reducing the value of the AF coupling condenser.

Ideally, a carrier boost of greater than 5 to 1 would be desirable, but it involves some practical snags. Adjustment becomes more difficult, and elaborate bass compensation is required.

This arrangement was inserted in a standard receiver and listening tests carried out. On short wave signals it seemed to show some improvement, but observations were a little inconclusive. There were no suitable medium-wave test signals available at this time.

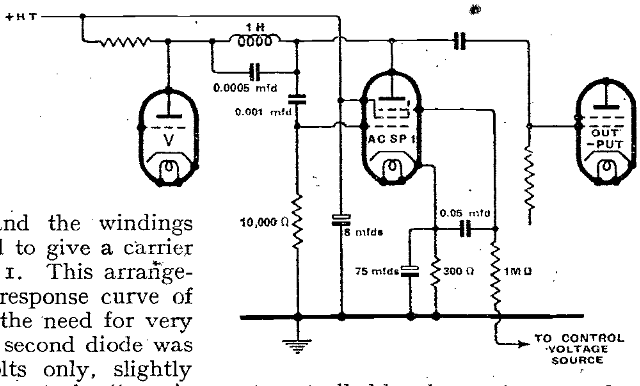


Fig. 3. Voltage-controlled circuit for attenuating high notes. V is the AF valve of a standard receiver.

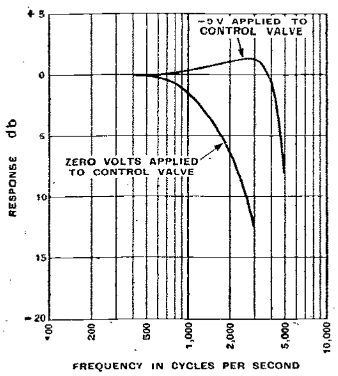


Fig. 4. Response of valve-controlled filter.

The impression was formed that exaggeration of high frequencies during a selective fade was at least as unpleasant as the harmonic distortion. On the assumption that distortion was worst when the carrier faded, a top cut controlled by the carrier seemed to be the next step. The circuit of Fig. 3 was set up, in which a valve acting as a variable capacity controlled the cut-off frequency of a simple low-pass filter. This was arranged to vary the AF response between the limits shown in Fig. 4. By supplying control volts from the second diode (Fig. 1) it was arranged to cut top whenever the carrier faded below a predetermined level controlled by the delay on the diode.

Used by itself, this circuit also gave rather inconclusive results, but in conjunction with carrier restoration a marked improvement was often observable. At least three criticisms of this scheme are possible: (1) The adjustment of delay is critical. (2) It assumes that selective fading always takes place at the same carrier level. (3) It does not appear to distinguish between selective and ordinary fades. There are, however, a number of extenuating circumstances. As the magic eye is controlled by the carrier it is possible to synchronise the operation of the tone control with the fading, by observation. If the carrier partially fades, leaving the sidebands at full strength, these will to some extent supply AVC and restrict the rise in sensitivity of the receiver. The carrier voltage at the point from which AVC is taken is thereby reduced more than would be the case during an ordinary fade, and since it is used, after selection by the crystal, to control the filter, the top cutting is more likely to take place during a selective than an ordinary fade. If it does happen at the wrong time, the result is less irritating than the alternative distortion; further, top cutting during a severe amplitude fade has the advantage of reducing the noise level.

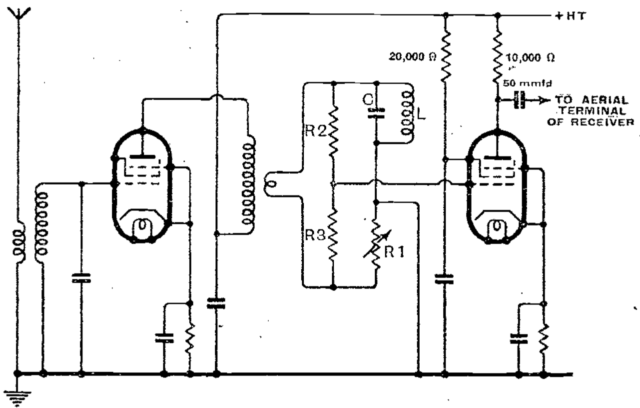


Fig. 5. Circuit for producing artificial selective fading.

For producing the top cut, automatic variable selectivity may be suggested as an improvement over the filter. It involves much more complication, but would have the advantage that it cuts top in the best possible way; that is, by reducing the modulation percentage after this has been increased by the selective fade.

Observations were at first made entirely on short waves, owing to the absence of suitable MW signals. It was very difficult to make reliable observations owing to the erratic nature and brief duration of selective fades. Even the quickest change-over test was apt to be misleading, and the reliable observation of small improvements was quite impossible. To this end a controllable test signal seemed very desirable, and the bridge circuit of Fig. 5 was devised.

Regarding selective fading as the balance of one voltage against another and dependent on frequency, it will be seen that this bridge circuit should have a similar effect on the signal applied to it. At its resonant frequency the circuit LC looks like a pure resistance of value, let us say, R_0 ohms, where R_0 is the product of the circuit magnification or Q, and the reactance of the inductance or capacity (ωL or $1/\omega C$). Balance requires $\omega L = 1/\omega C$ and $\frac{R_0}{R_1} = \frac{R_2}{R_3}$ and can be achieved by adjustment of R, and C. Fig. 6 shows a typical response as measured.

Minimising Selective Fading—

Signals from the local station were fed to the receiver through the bridge network, and a most convincing imitation of selective fading was obtainable by careful adjustment. Distortion was worst when the carrier was suppressed, and it was possible to make speech completely unintelligible. Small changes of C reduced distortion and changed the pitch of the reproduction.

On aural test the crystal appeared to be a complete cure for the artificial fade. This has not been fully explained. Such results would be expected if the crystal exactly compensated the response of the bridge and if the phase distortion introduced by the latter was negligible. Graphical investigation shows that the phase distortion would not exceed 15 per cent. with the bridge as used. This is not serious. On the other hand, from

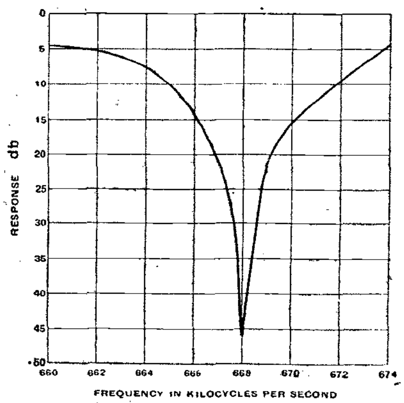


Fig. 6. Measured response of artificial fading bridge shown in Fig. 5.

comparison of Figs. 2 and 6, only partial restoration of the carrier and noticeable emphasis of the higher frequency sidebands would be expected. It is possible that Fig. 6 represents a more accurate balance than was obtained during tests, the adjustment being very critical. If the carrier was boosted sufficiently to keep the modulation below 100 per cent., harmonic distortion would not be serious with the small phase shifts given by the bridge. It is worth note that larger phase shifts, up to nearly 90 deg., can be produced by making R_0 and R_2 large compared with R_1 and R_3.

Difference in phase shift would account for some discrepancy between real and the artificial selective fading, but leaves the difference in frequency distortion unexplained. One explanation is suggested by Fig. 7.

It has already been shown that if a signal arrives at equal strength by two paths, one of which is N wavelengths

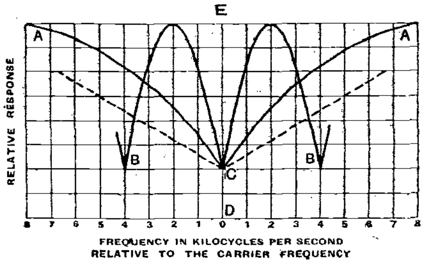


Fig. 7. Showing cancellation of frequencies near the carrier frequency for large and small assumed differences in path length. Difference of 75 kilometres gives BCB; 18.75 km. gives ACA.

long and the other M wavelengths, and if 2 (N-M) is an odd number, the carrier will disappear. It can be further shown that if λ is the wavelength in metres of the signal to which this happens, then at a frequency

$$f_m = \frac{3 \times 10^8}{2\ (N-M)\ \lambda}\ \text{cycles}$$

the waves arriving by the two paths will be in phase and add together. For intermediate values of frequency the resultant of the two paths can be found from a sine curve joining the extremes. This enables Fig. 7 to be estimated, taking the point C as zero. The curve ACA represents a small value of (N-M) λ or difference in path length, and BCB a large difference. With complete cancellation of the carrier, distortion will be more or less equally severe in the two cases, but this is a most unlikely state of affairs. The condition of partial balance can be roughly represented by taking a new zero at D. The experimental curve (Fig. 6) for the artificial fader is also shown for reference. Fig. 7 illustrates the accentuation of the sideband frequencies; the corresponding audio responses, taking AE=4CD as a typical example, and using 1,000 cycles as a reference frequency, are plotted in Fig. 8 (a). The hypothetical case of CD=0 is plotted in Fig. 8 (b). It will be clear that frequency distortion is only severe if (N-M) λ is large, or CD small. The former condition will be quite normal on SW, but it is not simulated by the artificial fader. It tends to give a much more peaky response curve than the latter, and in extreme cases the production of several peaks appears possible. The advantage of limiting frequency response is likely to be greater than with the smoother curves given by the artificial fader or small path differences, especially as these tend to be corrected by the crystal circuit according to the response curve illustrated in Fig. 2.

With large values of path difference, it can be shown that the frequency distortion is accompanied by large phase shifts which accentuate the harmonic distortion. This confirms the observation that a combination of carrier boost and top cutting is essential to make any impression on SW selective fading.

At a late but opportune stage in these experiments the B.B.C. Home Service obliged with some selective fading, and observations were made. Carrier boosting appeared much more effective than on SW, but less so than on the artificial fading. This result was to be expected on the assumption of a smaller difference in path length than that usually obtaining on SW.

Except in extreme cases, ordinary fading can be cured by good AVC. Unfortunately this measure makes selective fading sound worse, because the fading of the carrier increases the sensitivity of the receiver so that the detector receives a full strength, heavily overmodulated, and phase and frequency distorted signal. The result is a loud burst of harsh and unintelligible sound in place of a well-timed reduction in volume.

It is hoped that the foregoing, which makes no claim to being a thorough investigation, may stimulate further thought in an interesting direction. The writer is indebted to Murphy Radio, Ltd., for permission to publish results of work carried out in their laboratory.

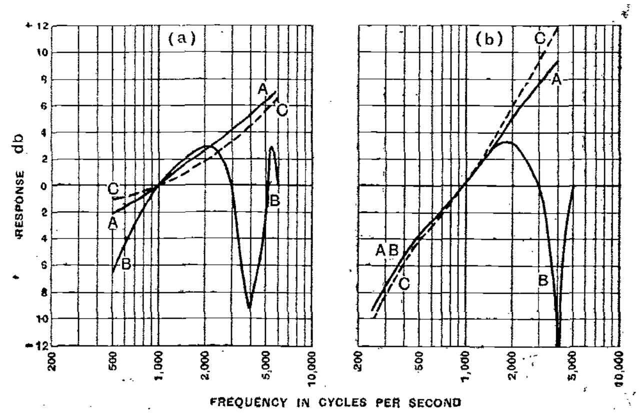


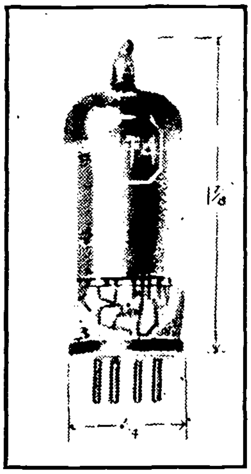
Fig. 8. Audio responses derived from Fig. 7. Small path difference, AA; large path difference, BB; artificial fader CC

The "Personal" Receiver

Commercial Development of the Type in America

POCKET wireless sets have been a perennial source of interest since the early days of broadcasting, and many amateur and professional designs have been described from time to time in this journal, together with accounts of various schemes for providing the police and other services with really miniature receivers.

In America, too, the idea has been kept alive for many years, but it is not until recently that a general public demand has developed for this type of receiver. As the result of the enterprise of a number of manufacturers,



Valves used in American personal receivers have 1.4 volt filaments taking 50 or 100 mA. Separate bases are dispensed with and extensions of the electrode supports serve as base pins.

the attractions of the small battery pocket receiver have been combined with the popular AC/DC midget. Problems of ventilation and heat dissipation have been satisfactorily solved, and a new range of components has been developed specially for incorporation in these sets.

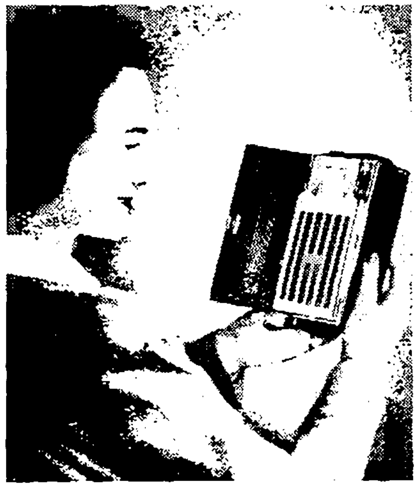
From a review of a number of the leading makes of this new type of set appearing in a recent issue of *Communications*, it would appear that the adoption of the superhet circuit is universal. There are usually four valves plus rectifier, and the types used are the 1R5 pentagrid as frequency changer, 1T4 variable-mu pentode as IF amplifier, 1S5 single-diode-pentode as signal and AVC rectifier and first AF amplifier (usually with high resistance grid leak bias), and 1S4 power pentode in the output stage. The output of this valve is 65 milliwatts with 45 volts HT and 180 milliwatts with 67.5 volts.

These valves are of very small dimensions, and their production has provided the incentive to manufacture other special components of reduced dimensions. The valves are made without the usual bakelite base and wire pins are sealed directly into the glass "button" at the foot of the valve. Special holders are used, and in the case of the frequency changer and IF stages these are generally of the shock-proof type to reduce microphony.

The half-wave rectifier valve generally employed in personal sets is the 35Z5. This is only slightly larger than the receiving valves, and is fitted on a standard small octal base.

The two-ganged tuning condenser occupies no more space than a single section of the standard type of condenser used in an ordinary table model receiver. The spacing between the plates is only 0.008in. Fixed condensers of all types have also been reduced in size, and the midget paper tubulars make use of paper only 0.0003in. thick. They are rated for 120 volts working. Three-section electrolytic condensers with etched plates have capacities on the high voltage side of 20-60 mfd., and on the low tension side for filament by-passing of 100 to 200 mfd. The size of the complete condenser is about the same as that of an 8 mfd. 450 volt standard dry electrolytic.

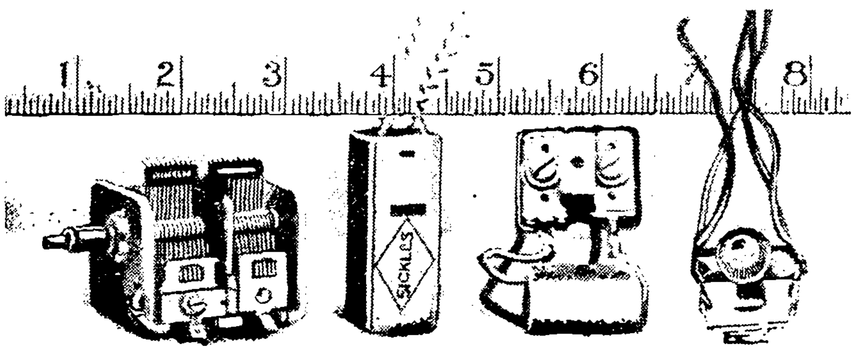
To conserve space IF transformers



are of the "potted" type in which the powdered iron core completely surrounds the coil. Although only about $\frac{5}{8}$in. diameter, the performance is said to be equal to that of standard range IF transformers; the Q of the circuit varies from 80 to 100. To give greater flexibility in layout the trimmers are usually mounted separately from the transformer. One obvious advantage of the potted form of construction is that the external field is reduced to a minimum, and very little screening is necessary.

The problems of switching the filaments in series for mains operation and in parallel for battery working has resulted in the development of special wafer switches, usually operated by means of a lever, thus saving valuable depth.

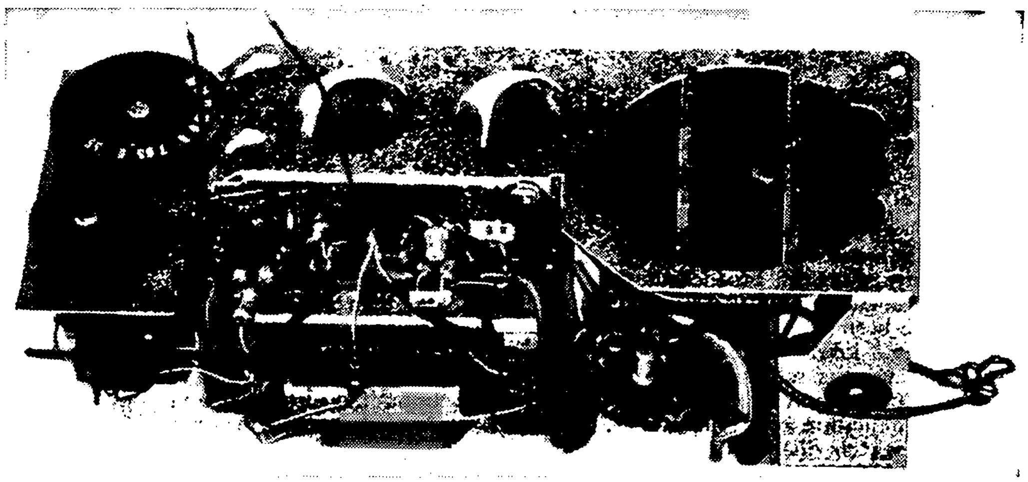
Loudspeakers are of the permanent magnet type with diaphragms of an average diameter of between 3 and



A few of the miniature components designed specially for the new portables.

The "Personal" Receiver

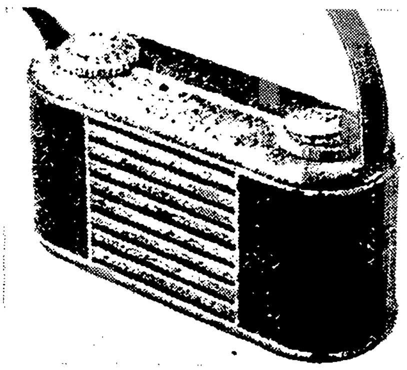
4in., although some types in course of development have elliptical cones 3in. × 2in. Alnico magnets are used and weigh from 1½ to 4 oz. Curiously enough, the output transformers have not been greatly reduced in size, the reason being that efficiency is important



Chassis assembly of the RCA Victor personal receiver.

in order to conserve the small power output available from the final stage.

High tension batteries are either of the 45-volt standard midget type, or the newly developed Ever Ready Type 467 "Mini-Max." This battery has an initial voltage of 67.5 and will deliver from 8 to 11 mA for 40 to 50 hours. Standard flash light cells are used for filament heating. In the smallest 3½ to 4 lb. sets a single cell gives from 3 to 5 hours' service. In the larger sets as many as five cells



The Philco personal portable when closed resembles a miniature camera.

may be used in parallel. In the Motorola SA5, however, the five cells are connected to operate the filaments in series to avoid switching when changing from mains to battery. Normal plug connections are used for the HT battery, but sliding contacts are necessary for the LT on account of the comparatively high current, and the low resistance of the circuit.

The series resistance for mains operation is incorporated in the line cord as in the ordinary midget receiver.

Carrying cases in infinite variety have been designed for these sets, and many of them take their *motif* from the hand camera. The materials used in their construction may be wood covered with fabric, metal (usually aluminium), or plastic mouldings, including polystyrene. In most cases the automatic on-off switch is operated by the lid, but in one or two instances the converse is the case and the spring lid flies open when the switch is operated.

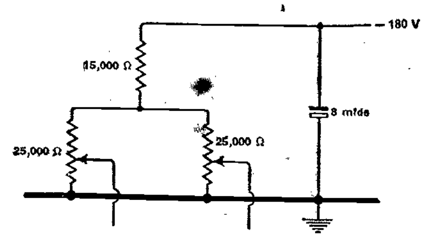
Frame aerials are always wound inside the lid, and in spite of their small size have a higher Q than that of the ordinary portable in which the frame is wound round the outside of the chassis. Litz wire is used and the Q of the circuit is of the order of 140 at the low frequency end and 80 at the high frequency end of the medium-wave band.

Valve Substitution Notes

In view of the probable shortage of DA30 valves in the near future, the Osram Valve Technical Department has advised that the PX25 valve should be used wherever possible for the maintenance of existing amplifier equipment.

When operating under Class AB1 conditions with fixed bias, the power available from a pair of PX25's is 20-25 watts, or only about 3 db. less than that from two DA30's under similar conditions.

The alterations required in the bias circuit connections is quite simple, and consists of reversing the fixed and variable portions of the potentiometer, so that a lower range of bias voltages may be made available.



Modified circuit for supplying fixed bias to PX25 push-pull valves. In the circuit for DA30 valves the positions of the fixed and variable portions of the potentiometer are reversed.

With automatic bias circuits a value of 900 ohms per valve or 450 ohms for a common bias resistor is recommended. Bypass condensers may be electrolytics of 20 mfd., 50 volts working. The power output available with automatic bias is of the order of 15-20 watts.

Another possible alteration concerns the GU1 mercury vapour rectifier, which will shortly be replaced by the GU50. In the latter valve the anode connection is taken to the top cap instead of to pin 1 in the 4-pin base of the GU1. An external connection must therefore be provided from the underside of the existing valve when changing over to the GU50 valve.

Book Received

A Morse Memory Book. By Harold E. Palmer, D. Litt. The international morse code, with methods of memorising it. Although some of the aids to memory described operate through the sense of sight, and so are appropriate only to lamp or other visual systems of signalling, it is stressed that rhythmic methods given should be employed for any form of telegraphy where the sense of hearing is concerned. Pp. 32. Published by Memory Charts, Ltd., 3, Great Winchester Street, London, E.C.2. Price 9d.

Letters to the Editor

The Editor Does Not Necessarily Endorse the Opinions of His Correspondents

Servicing in the Forces and Civil Life

WITH reference to your Editorial in the July issue, I am tempted to observe that any old television pole is quite suitable to beat the backs of the "Radio Service Engineers."

According to your article in the March issue, the Army requirements differ largely from the civilian and, as stated, the mechanical repair of apparatus is, perhaps, the greater part of the work to be done.

The technical standard required of manufacturers of Army and Air Force radio receiving and transmitting sets is very high; electrical faults are likely to be rare, while mechanical faults, due to accidents, are likely to be numerous.

This is exactly the reverse of civilian requirements; on the one hand the Army requires skill with hacksaw, file and drills, while the civilian radio receiving set requires for its repair a suitable cross between a clairvoyant and a wheel tapper.

Taplow, Bucks. G. A. RYALL.

I DO not share the optimism of Mr. Edward Rosen (reported in last month's Editorial) concerning the future of the technical side of commercial radio—or the future of the large number of men now being trained in the Services if they attempt to make their livings in radio after the war. First, judging by past experience, I am not convinced that the trade and industry will have much to offer them. Secondly, Service training is specialised for service equipment, theoretical tuition being merely preliminary and incidental. Good as the training may be for the right type of man, it does not greatly benefit anyone lacking a sound, general education, which most trainees do not possess.

I come in contact with many "radio men" who say—and I don't doubt it for a moment—that they have been "service engineers" for years. But they have only the most elementary and "popular" notion of radio, and have to be shown how to use the most ordinary measuring instruments and to be told what to measure.

It is not their fault. And here I write as one who has been through the mill of commercial radio and does not intend to whitewash it. The business men of radio have neglected the welfare of their technicians and have not provided for the training of new men. The Services are now having to do, in a desperate hurry and with emergency methods and apparatus, something of what the trade and industry ought to have done for their technicians long ago.

I very much doubt whether the status of professional wireless men, or the technical service itself, or the general conditions of the industry, will be improved by the throwing on the labour market, after the war, of hurriedly trained men demobilised from the Forces in large numbers.

W. H. CAZALY.

Radio Ramps

MAY I bring to your notice two forms of wartime racketeering that are adding to the disrepute and suspicion with which the general public already regards radio service work?

First, since replacement valves became scarce certain dealers have been profiteering from the shortage. When a customer wants to buy a new valve they do not refuse to sell or say they have not got the valve; they simply tell the customer that if he cares to hand his receiver in they will "service" it for him. The "service" may consist merely of putting in either a new or second-hand valve and handing the receiver back—with a fat bill far exceeding the cost of the valve. This, of course, is merely a wartime variation of the sort of thing that has blackened radio service work in the past; at a time when radio reception is a vital national service it is inexcusable.

Secondly, although many dealers admit frankly that they can offer neither competent service work (owing to the calling up of their servicemen) nor any guarantee of being able to do any service work at all, they refuse to make available, even to perfectly competent and highly skilled radio men, technical information, such as circuit diagrams and test data, that would enable them to carry out repair work quickly and easily on the sets of their relatives and friends. This dog-in-the-manger attitude is again a matter, nowadays, not merely of "business," but of serious concern to those who might have to rely on national broadcasts for news and announcements of extreme importance. Of course, a service diagram and notes are not absolutely necessary to a properly trained radio engineer, but they do help and might make all the difference when time is short, as it often is when a man is on leave. Is it too much to expect the trade and industry to help the national war effort by giving information generously?

RADIO MAN IN UNIFORM.

Shortage of Recording Blanks

AS the compiler of the Table of Direct Recording Blanks (see June, 1940, *Wireless World*) many enquiries for sources of supply are now being sent to me. May I say here that, unfortunately, no new supplies of blanks whatever are available? The "Simplat" and "Pyral" blanks, stocked by the V.G. Manufacturing Co., Ltd., are unlikely to be obtainable till after the war, and the entire output of the M.S.S. Recording Co., Ltd., is being allocated to B.B.C. and Government requirements, but an effort is being made to produce a certain quantity of discs for civilian users. When available an announcement will no doubt be made in your journal.

If any recordist has found a temporary solution of this disc problem, *e.g.*, a method of removing the surface from old blanks and a formula and technique for re-coating successfully, perhaps he would care to pass on his knowledge to fellow enthusiasts?

DONALD W. ALDOUS.

Torquay, Devon.

BOOK RECEIVED

Handbook of Workshop Calculations. Issued jointly by the Board of Education, and the Ministry of Labour and National Service. This handy little volume is perhaps better described by the title of Workshop Arithmetic, since it provides a concise and practical course in that indispensable subject with particular application to the engineering industry. It contains forty pages of information leading up from elementary arithmetic to the more involved calculations to be found in workshop practice. Worked examples are given at each stage. It is in no sense a mathematical book and is intended chiefly for workers making their first contact with the engineering industry, whether as trainees under the Government's National Service scheme or otherwise.—Price 3d.

Designing Small Portables

Use of High-inductance Tuning Circuits in Simple Headphone Sets

By S. W. AMOS, B.Sc. (Hons.)

THE outbreak of war gave a considerable impetus to the ultra-lightweight receiver, of the type intended for use with 'phones rather than with a loudspeaker. Some ideas which the author has found useful in designing such receivers will be discussed in this article, and, to illustrate the application of the main principle advocated, a set which can be constructed from the contents of the average "junk" box will be described in some detail.

The tuning systems of all receivers are based fundamentally on the simple parallel resonant circuit illustrated in Fig. 1. The impedance offered by such a circuit to a signal at its resonant frequency, known as the dynamic resistance, is given by the expression

$$\frac{L^2\omega^2}{R} \text{ or } \frac{L}{CR}$$

Here L represents the inductance of the coil, C the capacity of the condenser, and R the effective resistance

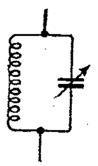


Fig. 1. Most tuning systems are based on this parallel resonant circuit.

of the circuit at the frequency in question. This includes the ohmic resistance, and the resistance due to skin and proximity effects. If, for a medium wave resonant circuit, L, C and R have the fairly conventional values of, respectively 157 μH, 300 $\mu\mu$F and 3 ohms, then the dynamic resistance is given by

$$\frac{157 \times 10^{-6}}{300 \times 10^{-12} \times 3} = 175{,}000 \text{ ohms.}$$

This quantity is a measure of the amplification given by the tuned circuit, and it is at once clear that amplification can be increased by reducing C and increasing L. The product of L and C must, however, remain the same, for the waverange covered by the circuit depends on this product, as shown by the formula $\lambda = 1885\sqrt{LC}$. If, therefore, L is increased five times to 785 μH and C decreased to the nearest practical maximum value of 100 $\mu\mu$F, then the waverange will be unaffected but the dynamic resistance will be increased. How great the increase will be we cannot say, for R, the effective resistance, will naturally be greater for a coil of 785 μH inductance than for one of 157 μH.

Fortunately, however, we can easily eliminate the effects of an increase in R by the use of reaction. A reacting valve behaves as a negative resistance, and as such is capable of neutralising a positive resistance in circuits to which it is connected. Accordingly, if in this high-inductance circuit we reduce R to the same magnitude as in the more conventional circuit, then we should obtain 25 times as much amplification from it as from the other. This represents an improvement in gain of 20Log25 = 28 decibels.

Waverange Restriction

As might be expected, there is a snag in this method of obtaining amplification, and it is connected with the waverange of the circuit. The standard value for the maximum capacity of a tuning condenser, 500 $\mu\mu$F, was originally chosen by designers because, in conjunction with a coil of 157 μH inductance, it enabled the broadcast waverange of 200-550 metres to be covered easily even when all the stray capacities which are inevitably present in any practical tuning circuit are in parallel with it. With a tuning condenser of maximum capacity 100 $\mu\mu$F such as we are now considering, the waverange covered will be less than 200-550 metres, unless the stray capacities can be reduced to a very low amount.

The chief sources of stray capacity are due to the aerial coupling and the minimum capacity of the tuning condenser. By use of a good short-wave component the latter can be reduced to about 7 $\mu\mu$F. Extra capacities due to the valve (if a triode), the self-capacity of the coil, and the wiring amount to some 10 $\mu\mu$F. There still remains the capacity due to the aerial coupling. To realise the extra 28 decibels the aerial coupling must clearly be as good as that employed in conventional tuned circuits, and this means the addition of considerable capacity, possibly as much as 50 $\mu\mu$F, which will reduce the ratio of maximum to minimum wavelength receivable from the normal value of 2.75 to 1.5.

Such a restricted waverange seems at first sight undesirable, but when one reflects that it still permits reception of the Forces programme on 342 metres, and the Home Service on 449 metres, and with extra gain of 25 times, our objections are not so great. Moreover, the author has found that, by using a very loose aerial coupling the waverange 200-550 metres can be covered even with this high-inductance circuit. The coupling was obtained by tapping the coil so that about 1-10th of the total number of turns on the coil were included in the aerial circuit. This means that only 1/100th of the

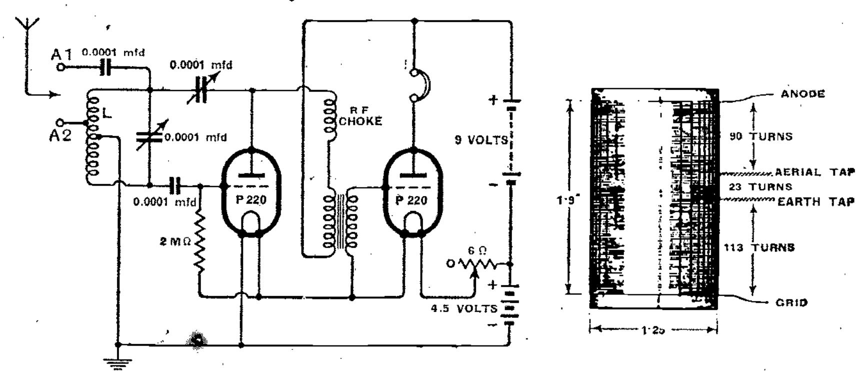


Fig. 2. Complete circuit diagram of the lightweight receiver discussed in the text. Inset is shown winding details of the tuning coil (inductance approximately 800 μH). The wire is No. 36 SWG, enamel covered.

aerial capacity is "reflected" into the tuned circuit, and, as average aerials have a capacity generally less than 300 $\mu\mu$F, then the reflected aerial capacity cannot exceed 3 $\mu\mu$F. This is, however, a very inefficient coupling, and the extra gain of the circuit is largely offset by the losses introduced. Nevertheless, it does permit reception of the entire medium waveband.

Possibly the most convenient reacting circuit for a small portable receiver to operate headphones is that shown in Fig. 2, for this gives good control of reaction at all settings of the tuning control with an HT supply of only 9 volts, which can be obtained from a GB battery. The circuit is open to the objection that both sides of both variable condensers are at high potential with respect to earth, and consequently, to avoid hand-capacity effects, control of reaction and tuning must be carried out by means of earthed shafts connected to the condensers by insulated couplings.

Details of the construction of the tuning coil L, which has an inductance of 800 μH are inset in Fig. 2. With a good outdoor aerial attached at the terminal A1, a waverange of approximately 320-570 metres is obtained, and the Home and Forces programmes could be well received. Using a more conventional two-valve receiver, it was found that the HT voltage had to be increased before satisfactory reaction effects could be obtained, and that, even when this had been done, reception of these two programmes was in no way superior to that given by this receiver. Unfortunately, no means was available of checking whether the calculated improvement in gain of 28 decibels was realised in practice, though there is no doubt that the high-inductance resonant circuit is more sensitive than the more conventional arrangement. It is obvious that the actual waverange receivable with terminal A1 in use depends upon the constants of the aerial-earth system. If the aerial be connected to terminal A2 then the waverange covered is 200-550 metres, though signal strength is much poorer, for the few turns included in the aerial circuit give a resonant frequency much higher than any in the medium waveband. Reception can be improved by connecting a loading coil of about 157 μH in series with the aerial, for this will generally give a resonant frequency situated in the medium waveband. Unfortunately, it may also cause irregularities in the control of reaction. The receiver readings, with the aerial connected to this terminal, are practically independent of the aerial constants.

The AF section of this receiver is perfectly straightforward. The intervalve transformer is a midget component designed for parallel feed connection, but it works quite satisfactorily when carrying the very small anode current of the detector valve. Small 2-volt battery-driven power valves of the P220 type are used for detection and AF amplification, their 0.2-amp filaments being connected in series and supplied with current via a 6-ohm rheostat from a 4.5-volt dry battery. The new 1.4-volt valves could be used here with their filaments in parallel and energised from a single dry cell.

Book Review

Elementary Mathematics for Wireless Operators. By W. E. Crook, A.M.I.E.E., A.F.R.Ae.S. Pp. 63. 42 diagrams. Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 3s. 6d.

THIS is a book of the "Mathematics without Tears" type, designed to help wireless operators with limited mathematical knowledge to solve readily the problems they encounter. It is admittedly a difficult task to write such a book, for the background of knowledge possessed by the reader is largely an unknown quantity.

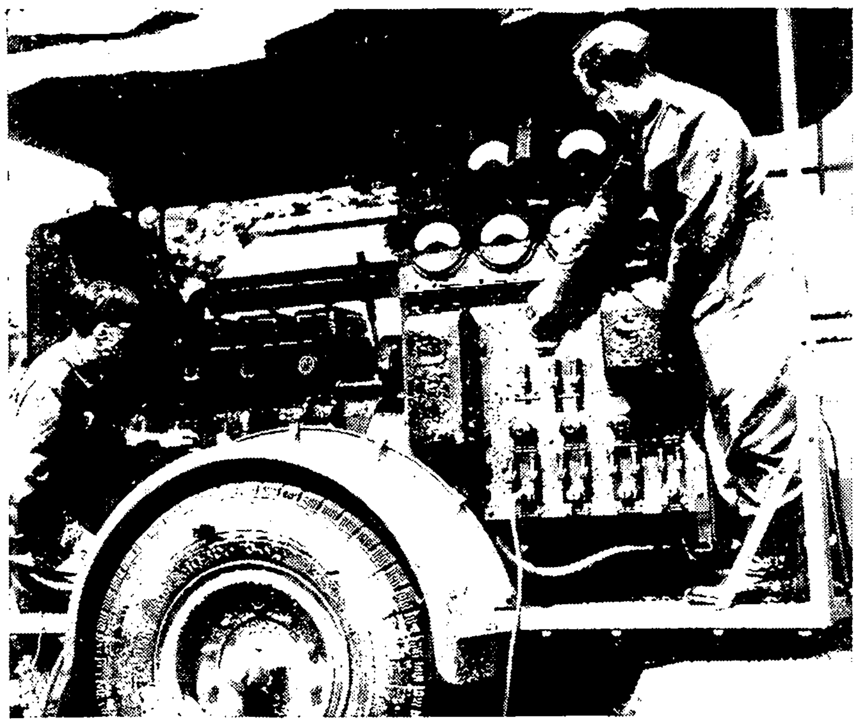
Chapter I deals with brackets, powers and logarithms, and much space is very properly devoted to evaluations by logarithms of the type of expressions obtained by substituting figures for symbols in well-known formulæ.

It is a little surprising to find, in Chapter II, work on the fundamentals of algebra, beginning with symbolism and leading up to rearrangement of algebraic expressions. Parts of this might have been better placed in Chapter I, where so much use is made of formulæ, though it is possible that any such change might introduce further anomalies.

Geometry and trigonometry are introduced in the next chapter, which is followed by Chapter IV on graphs. It is a pity that these two chapters do not contain any numerical examples, which would have made the practical applications of the work immediately obvious to the reader. The final chapter deals with mechanics, simple harmonic motion and the decibel.

The author deserves congratulations on compressing so much material inside 63 pages. There is much useful material in the book and radio operators should benefit from a study of the very many numerical examples which are given in the earlier chapters.

S. W. A.



Wireless technique in the defence of Britain: the Power Generator of a mobile radiolocator.

More Makeshifts —— *Receiver*

By W. H. CAZALY

WHEN replacing the frequency-changing valve in a superheterodyne receiver by one of another type, three factors have to be considered. First, there is the matter of rewiring. Secondly, there are the tracking constants of the oscillator coil group. Thirdly, there is the matter of how the coil group will work with the new valve in producing the required oscillations at the correct intensity.

There is often a fourth factor—the suitability of the valve for use over the frequency range desired. This counts especially on the short-wave bands.

Rewiring is a matter of common sense. Figs. 1 and 2 show how various coil groups can be reconnected to different types of frequency-changer, and the main thing is to arrange the wiring so that the incidental reactances provided by the various leads to the valve electrodes suffer as little change as possible from those present in the original wiring. This means that the wires should take as far as possible the same physical positions as they did with the old valve, and that any lengthening of leads should be carefully considered and arranged so that the extra length of wire is kept well away from earthed parts and from other wiring. In brief, the alterations must be carried out neatly. The oscillator section is one of the touchiest in the circuit, and clumsiness and untidiness in alteration may completely upset its operation.

The tracking of the oscillator group with the signal frequency circuits, as tuning is carried out by the gang condenser over the band covered, is taken care of by the designers of the set. It depends simply on the inductances and capacities involved, and if these are not altered greatly by the rewiring operation, matters can usually be brought back to normal by adjustment of trimmers and padders. A test oscillator is, of course, a great help in such readjustments, but not essential. If a test oscillator is not available it is possible to play about with the trimmers until the best apparent results are obtained, *provided the IF tuning is not upset*. If, therefore, the receiver was working well before the breakdown of the frequency-changer valve, the IF trimmers should on no account be

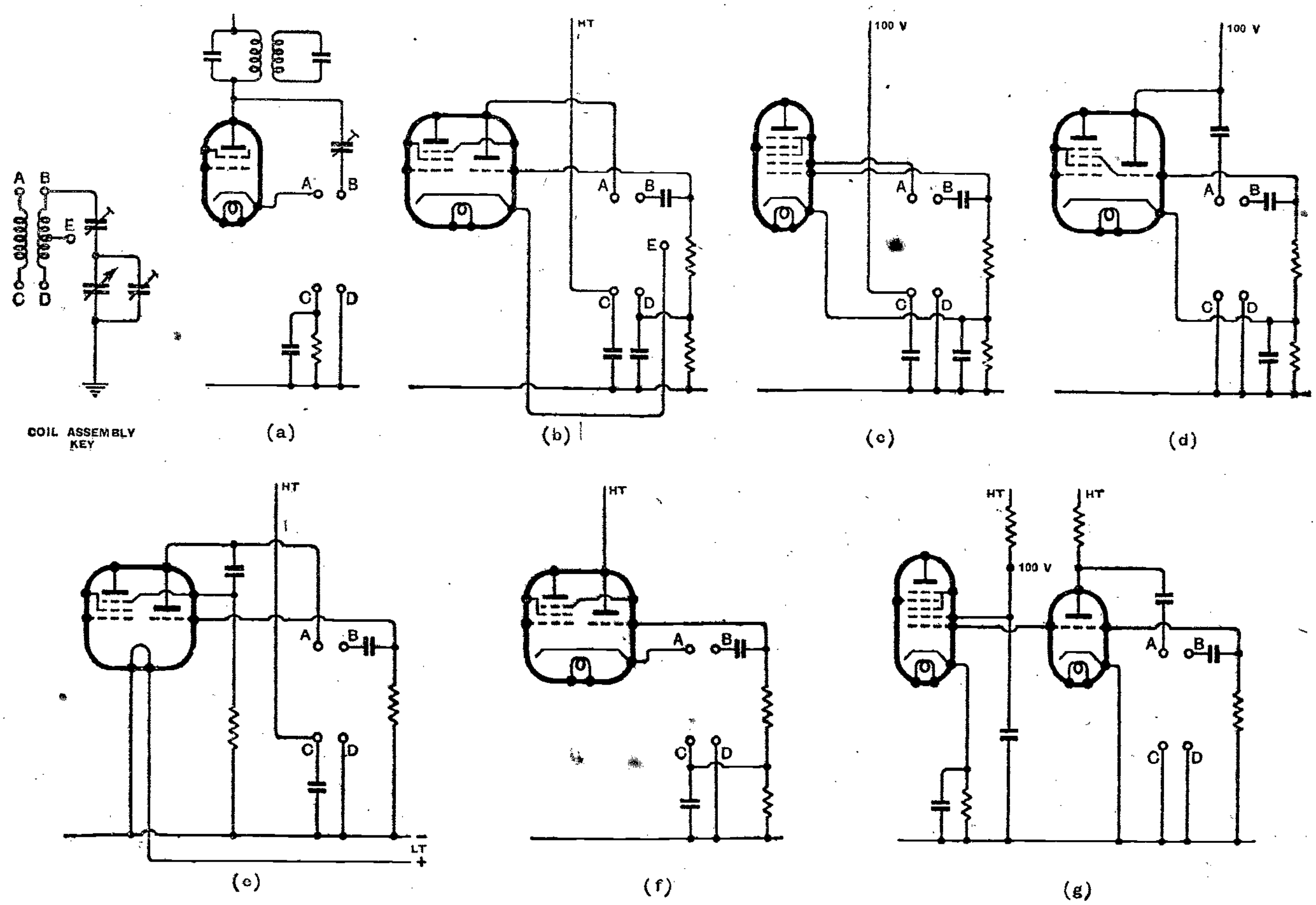


Fig. 1. Circuits employing the two-coil oscillator group. (a) autodyne ; (b) triode-pentode ; (c) heptode ; (d) triode-hexode ; (e) battery triode-pentode (note condenser coupling to pentode suppressor grid) ; (f) another mains-fed triode-pentode arrangement ; (g) heptode with separate oscillator. Battery-fed single-valve mixers use similar coils, but battery autodyne and triode-pentode frequency-changers usually employ a third low-resistance dual winding carrying the filament current, as in Fig. 2.

Maintenance in the Face of Shortages

Improvisations and makeshifts that would hardly be tolerated in peacetime are now necessary for the maintenance of broadcast receivers. In the June issue many general suggestions were given; the present article deals with makeshift replacements of the frequency-changer and power rectifiier

touched; even without manufacturers' service notes it is easy enough to trace out the pre-set condensers of the oscillator coil group and to distinguish between the padders and the trimmers—the former in series and the latter in parallel with the oscillator tuned circuit elements. As a *general* guide it may be assumed that maladjustment of the padder will lead to poor tracking at the lower frequency (longest wavelength) end of the band, and of the trimmer at the higher frequency end. If the inductances are permeability trimmed by adjustable iron-dust cores, they will affect the tuning most at the lower frequency end, while the trimming condensers will have most effect at the other end.

Oscillator Operation

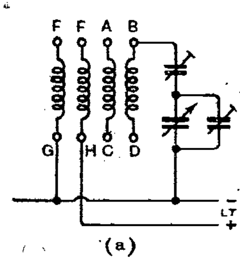
The third factor, involving the behaviour of the oscillator coil group and the new valve as a generator of alternating potentials, is dependent partially on the properties of the valve itself. A change of valves may therefore lead to changes in the intensity of the heterodyning voltage developed, especially at different parts of the frequency band. An ideal oscillator would develop this voltage at a constant intensity — the "optimum heterodyne"—such that it caused the valve to work always on a certain part of its characteristic curve, rather in the same way (to put it very roughly) this bias is applied to an amplifying valve to make it work, or handle signals, about a point approximately midway along the straight part of the Ia/Vg characteristic. It is easy enough to arrange for this at any one frequency, but when a wide frequency band has to be covered by a single tuning condenser, so that considerable changes in L/C ratio occur, the intensity of the oscillations is liable to change. For this reason, oscillators are nearly always steadied by the use of the common grid leak and condenser coupling to the grid coil, so that as the intensity of oscillation tends to increase it is offset by the appearance of an increased negative potential at the grid end of the leak. In this way a fairly constant intensity of oscillation is obtained over a whole band of frequencies.

This can be done with any valve oscillator on its own. But in the case of the single-valve frequency-changer, the negative potentials so developed at the grid of the oscillator section of the valve may affect the behaviour of the signal-handling section. Cases may arise, therefore, when the change-over from one type of frequency-changer to another without any alteration in the oscillator coil group may cause poor performance of the signal-handling section of the new valve. If this is noticeable, or if it occurs over portions of the band covered, it is worth while trying to remedy matters by controlling either the intensity of oscillation or the amount of negative potential developed at the oscillator grid.

Since it is not possible to alter the coupling between the anode and grid coils of the group, all that can be done to alter the intensity of oscillation is deliberately to introduce losses, as, for example, by connecting a resistance of the order of anything from 50,000 to 100,000 ohms across either the grid or the anode coil (whichever is tuned). This will only be of value, of course, if the oscillations are too strong originally; if they are too weak already for the new state of affairs, adding the resistance to the circuit will do no good. This can only be ascertained, in the absence of proper instruments, by experiment. The negative potential developed at the grid of the oscillator section depends partially on the intensity of oscillation and partly on the value of the grid leak. Reducing it in value will have the effect of reducing the negative potential developed for any given intensity of oscillation; but this reduction of the value of the leak, since it is effectively acting as a load on the oscillating circuit, will also tend to reduce the intensity of oscillation. Increasing it in value will lessen the damping on the oscillator circuit, but will increase the negative potential at the grid. Although it is hardly possible, under such circumstances as are being borne in mind, to calculate and predict any desirable change in the value of the oscillator grid leak, it is worth while experimenting with it if the performance of the set seems to be appreciably affected by the change in frequency-changers, in spite of every care having been taken over rewiring.

FC Valve Peculiarities

The peculiarities of frequency-changing valves manifest themselves largely in the form of differences in performance according to the frequency handled. The following hints, as a rough indication of what to expect, may be of service if the experimenter is lucky enough to have a choice of replacement valves: (*a*) The "autodyne" (Fig. 1) is now little used because it is not so easy to maintain oscillation at the higher frequencies, and because a good deal of the oscillator output is conveyed to the signal circuits through valve capacities. It works best at broadcast frequencies. (*b*) The triode-pentode, which is really



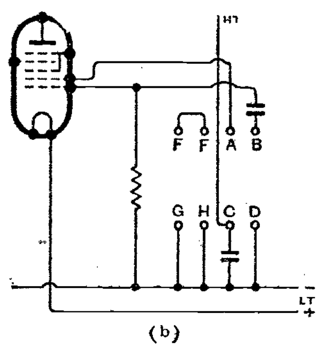


Fig. 2. Diagram (a) shows a coil assembly often used for battery triode-pentode oscillators; (b) is a 3-winding arrangement for battery heptodes.

More Makeshifts—

a two-valve type of frequency-changer, is excellent on broadcast frequencies, but on higher frequencies an undesirable amount of oscillator output appears, as with the autodyne, in the signal circuits, unless (if two separate valves are used) rather elaborate devices are employed to isolate them. (*c*) The heptode is also excellent on broadcast bands, but on the short-wave bands the sensitivity falls seriously below 25 metres or 12 Mc/s, and AVC voltages on the grid cause frequency drift that is troublesome at high frequencies. (*d*) The triode-hexode and triode-heptode are both good at broadcast and higher frequencies, and, on the whole, are to be preferred for modern receivers if they can be obtained. From the above notes, some idea of what to expect from a change of frequency-changer valve can be secured. Admittedly, it is usually a case of Hobson's choice in these days!

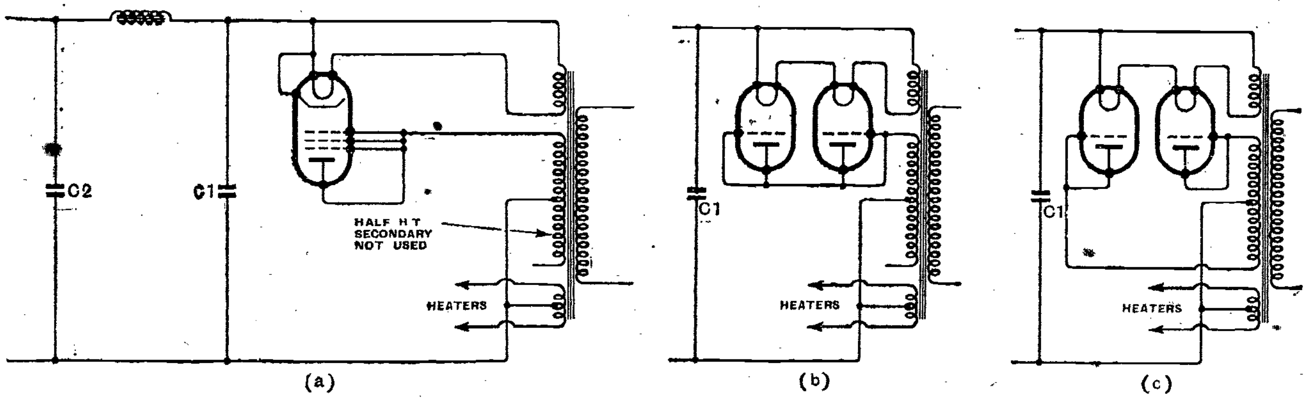


Fig. 3. Pressing odd valves into service as power rectifiers. C1 is the reservoir and C2 the smoothing condenser.

The Power Rectifier

Another troublesome replacement is that of the rectifier in an AC mains receiver. It is often possible, however, to press an old pentode or power triode into service by joining the anode and all the grids, and thus converting it into a diode, as shown in Fig. 3 (*a*). Even battery triodes of the "power" type—and some of the older ones that may be found in the junk box used to pass what would nowadays be considered inordinately high anode current for battery drive—can be employed, if possible in parallel, as shown in Fig. 3 (*b*) and (*c*). Their lives may not be long, but if they serve their purpose during an emergency they will have died honourably. If only one such 2-volt battery valve is available, the filament current from the 4-volt rectifier winding on the mains transformer must be limited by a series resistance—allowing, for the considerable decrease in current taken by the filament of such a valve, a little over for the increased voltage developed across the rectifier winding owing to the lessened load on it.

Certain factors, however, must be borne in mind when making such alterations to the HT supply system. First, unless the arrangement shown in Fig. 3 (*c*) is used, with either mains or battery valves, rectification will become half-wave instead of full-wave, and the output will in consequence contain a higher percentage of ripple than before, and if this gives rise to objectionable hum the smoothing must be increased. This can be done either by increasing the smoothing capacity (C2 in Fig. 3 (*a*))—say, by doubling it—or inserting an extra choke of low DC resistance (say, 500 ohms maximum, and about 8-10 henrys inductance) in series with the existing smoothing choke, which may itself be the field winding of the speaker.

Secondly, without further alteration than replacing the rectifier valve by an emergency valve used as a single diode, the output of the unit will fall seriously. This will be because the power supplied through the rectifier to the reservoir condenser will be available only during one half-cycle—that making the anode of the rectifier positive—instead of during both half-cycles as previously. To make up for this the current passed by the rectifier during the working half-cycle will have to be doubled in order to maintain the charge in the reservoir condenser. Ripple will be increased from this cause, too. And the excessive surge current at each positive cycle will considerably shorten the life of the valve used as a rectifier. It is also possible that the HT secondary winding may be of such fine gauge that the peak current, double the original, may overheat it, owing to the heat generated being proportional to the square of the increase instead of being directly proportional. The same reasoning applies to the primary winding. It is, therefore, inadvisable to effect this sort of conversion in the HT supply section of a receiver unless the mains transformer is of substantial size and can stand a fairly big overload. The output voltage available to feed the valve anode circuits can be raised, if it falls too much for tolerable performance of the receiver, by increasing the capacity of the reservoir condenser—at the expense of the life of the valve unless it is a fairly powerful mains triode capable of passing, say, 100 mA without damage. The inclusion of fuses in the mains input leads is distinctly a safe move, just in case ill-judged arrangements cause danger.

Indispensable for Radio Research

A PAPER on the relative importance of the various scientific periodicals of the world was released by the U.S.A. Navy Department for publication in the *Review of Scientific Instruments* a few years ago. In this the writer mentioned "the valuable abstracts in *The Wireless Engineer*, which alone would make that journal indispensable for radio research."

Our sister journal still maintains this service at the same high level, even in the present difficult circumstances.

In addition to the twenty-three pages occupied by the Abstracts and References section the July issue contains the regular monthly summary of recently accepted wireless patent specifications, and articles on measuring the AC impedance of chokes and transformers, half-wave modulation and the inductance linearised time base. Recently expressed views on the velocity of acoustical and electromagnetic waves are discussed editorially.

The Wireless Engineer, which is published on the first of the month, is obtainable to order through newsagents or direct from our publishers at Dorset House, Stamford Street, London, S.E.1, at 2s. 8d., including postage.

THE WORLD OF WIRELESS

FOREIGN QSL CARDS

Restrictions on Amateurs

IT has been found necessary in the interests of national security to prevent certain information concerning the reception of broadcasts and wireless signals from leaving this country. The public, and in particular radio amateurs and short-wave listeners, are therefore asked not to send to addresses outside Great Britain:

(1) Any correspondence containing references to the reception of wireless signals or speech (other than correspondence addressed to recognised broadcasting stations in friendly countries referring to reception of their broadcasts).

(2) Any QSL or SWL cards (whether the spaces are filled in or left blank) or any letters or cards of a similar kind, or

(3) Any reports prepared by radio correspondents or reporting clubs or societies or the like, containing lists of stations received by their members.

Any correspondence of the kind described above is liable to be stopped by the Censorship Authorities.

It is to be noted that radio trade correspondence, letters between amateurs about set construction or other technical problems, or any other correspondence on radio topics which does not fall within the above description is not affected. At the same time the authorities realise and regret that the application of these rules will interfere with what is in the case of most correspondents a harmless and fascinating hobby, but unfortunately it is possible for information which would be of use to the enemy to be sent out of the country by these means, and this must be prevented. It is suggested, however, that wireless amateurs who wish to keep in contact with overseas friends might adopt a suitable form of wartime radio greeting card, which would state the name and address of the sender, and would not contain any code groups or reports of reception.

When all other correspondence must be written in plain language it seems unreasonable that amateurs should have the privilege of writing in something closely resembling a code, which must greatly increase the work of the censors. The new restrictions set forth above will therefore be accepted readily.

TECHNICIANS FOR RADIOLOCATION

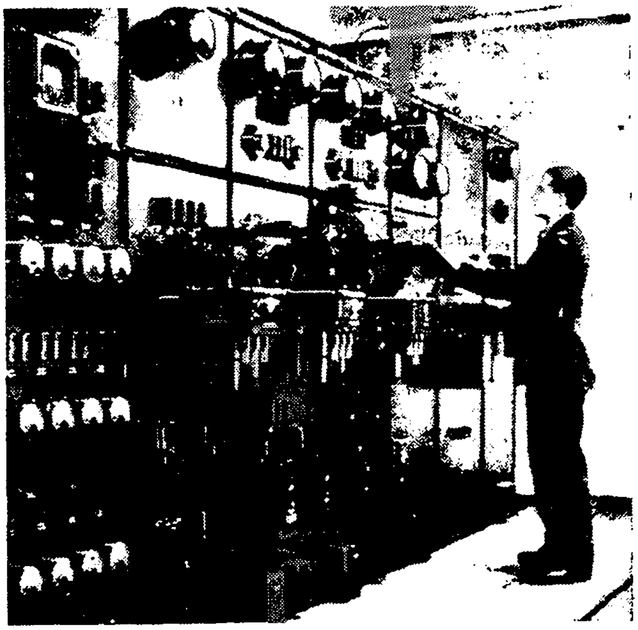
Opportunity for American Wireless Men

THE recently organised Civilian Technical Corps, which offers American men an opportunity for service in England, is a "non-military body of paid volunteer craftsmen in certain skilled trades which has been established by the British Government to maintain and repair the highly technical equipment used by the naval, military and air forces of the British and their Allies." Volunteers accepted for the Corps become paid, non-combatant employees of the Government.

In calling for volunteers, Air Commodore Pirie, air attaché to the British Embassy in the U.S.A., stressed the fact that while technicians in all kinds of trades are needed, the most pressing demand is for both professional and amateur radio technicians for the operation of radiolocators.

Volunteers for duties as radio mechanics, who must agree to serve for three years, or for the duration of the war, whichever is the shorter, must be between 18 and 50 years of age. They will receive free board and accommodation, distinctive clothing with a special insignia and will be paid from £6 to £9 per week, according to grading.

A radio mechanic, whose duties will include the overhauling, maintenance and inspection of complex UHF wireless apparatus, must have a sound working knowledge of radio, both practical and theoretical, and be adept in the use of tools.



The power switchboard of a radiolocation station.

U.S. TELEVISION

FM Sound : AM Vision

THE U.S. Federal Communications Commission recently announced that having found the wireless industry "entirely in agreement that television broadcasting is ready for standardisation," it authorised full commercial operation from July 1st. The standards fixed by the F.C.C. are 525 lines, 30 frames interlaced, with frequency-modulated sound transmission and amplitude-modulated visual signals.

Eighteen frequency channels, each 6 Mc/s wide, have been assigned for the use of television transmitters. They are:—

Mc/s	Mc/s
50—56	186—192
60—66	204—210
66—72	210—216
78—84	230—236
84—90	236—242
96—102	258—264
102—108	264—270
162—168	282—288
180—186	288—294

One channel only will be assigned to each station, which must transmit for a minimum of 15 hours a week.

It is fifteen months since the F.C.C. rescinded its previous order permitting part-time commercial operation of television transmitters. During this stalemate the interest in television has waned considerably. The attitude of the manufacturers towards the latest announcement is, as might be expected, quite the reverse to that of just

The World of Wireless—

over a year ago and is aptly expressed by Mr. Sarnoff, president of the R.C.A., who said "the increasing demands upon our facilities and technical experts made by the requirements of national defence, and the matter of priorities, may affect the establishment of the new service."

METAL RECTIFIERS

I.E.E. Paper and Discussion

AN interesting and informative exchange of views on metal rectifiers took place at a recent meeting of the I.E.E.—the first ordinary meeting to be held at the Institution's London headquarters during the evening for over a year. The discussion followed the reading of two papers. The first paper, dealing with copper-oxide rectifiers, was read by Dr. A. L. Williams and Mr. L. E. Thompson, of the Westinghouse Company, and the second paper, dealing with selenium rectifiers, was read by Mr. E. A. Richards, of Standard Telephones and Cables.

It was made clear that the name metal rectifier is not fully appropriate to either type, since they are not fully metallic. Actually they are devices in which rectification takes place at the contact between two dissimilar substances, one of which is a metal. The action appears to be purely electronic, there being no apparent signs of any chemical change taking place. The exact *modus operandi* is still somewhat doubtful, however. In the case of the copper-oxide type none of the theories so far advanced is fully satisfying.

The copper-oxide type has been in use for some fourteen years, whereas the selenium type has only become prominent in recent times. The G.P.O. and also the B.B.C. use them extensively. One of their principal uses is in apparatus for starting aero engines.

B.B.C. AND AMATEUR BAND

AS a result of correspondence between the Radio Society of Great Britain and the G.P.O., the latter has given an assurance that the B.B.C.'s use of frequencies at the lower end of the 7-7.2-Mc/s amateur band is entirely a wartime measure and that the P.M.G. will "bear in mind the desirability of restoring the band to the exclusive use of amateurs after the war."

The R.S.G.B. understands that the American Radio Relay League is attempting to persuade the B.B.C. to reduce the strength of the signal in the direction of N. America of the transmission in the 7-Mc/s band intended for the Eastern Hemisphere.

NETWORK BROADCASTING

Radical Changes in U.S. Proposed

NEW regulations recently proposed by the Federal Communications Commission will, if adopted by Congress, radically change the entire structure of broadcasting in the United States. "What is to-day the best and freest radio system in the world will," says *Broadcasting*, "begin rotting away—the prelude to a Government-operated system."

Space will not permit a detailed survey of the report, which is the result of a three-year investigation by the F.C.C. and occupies over 150 pages. Suffice it to say that this "network monopoly report," as it is called, will severely shake, if not break up, the very foundation of American broadcasting, i.e., the great nation-wide networks of stations.

B.B.C. WAVELENGTH ALTERATIONS

ONE of the aims of a number of wavelength changes in the B.B.C. European Service made on July 6th is to provide increased signal strength over France. GSE (25.29 m.) is now using an aerial directional over France, which, it is anticipated, will give an improved signal over the southern part of the country. An aerial directional on the whole of North and Central France is now being employed by GRT (41.96 m.).

The wavelengths which are at present in use in the European and World Services for the transmission of news in English and the times (BST—2 hours ahead of GMT) at which they are radiated, are:—

00.00 ...	49.59,* 41.49,* 30.96.*
00.45, 02.00, 02.45, 06.30	31.32, 31.25, 25.53.
08.15 ...	42.46, 31.55, 31.25, 25.53, 19.82, 19.66.
10.00 ...	49.59,* 41.49,* 42.46, 31.55, 25.53, 25.29,* 19.82, 19.66, 19.60.
13.00 ...	31.25, 25.53, 19.82, 16.84, 16.64, 13.97.
15.00 ...	19.82, 16.84, 16.64, 13.97, 13.93.
15.30 ...	49.59,* 41.49,* 25.38,* 25.29,*
18.00 ...	31.75, 25.53, 19.82, 16.84, 13.93, 13.92.
20.00 ...	31.25, 25.53, 24.92, 19.82, 19.66, 16.84.
22.45 ...	31.25, 25.53, 19.82, 19.60.

Wavelengths marked with an asterisk are used in the European Service.

WRCA—WNBI

ACCORDING to *Broadcasting*, the N.B.C., at the instigation of the U.S. State Department, is making preparations to operate its short-wave transmitters for 24 hours a day. Recent experiments, in which the two 50-kW transmitters, WRCA and WNBI, operated simultaneously on the same wavelength, resulted in a signal equal to that from a 100-kW station. It has therefore been decided to use the dual output for at least a part of the N.B.C.'s new international schedule.

AN HISTORIC ANNIVERSARY

A Pioneer Radio Concert

THAT broadcasting is a good deal older than the B.B.C. is called to mind by the fact that it is just over twenty-one years ago since the first "all-star" concert was radiated from a wireless transmitter in this country. It was on June 15th, 1920, that Dame Nellie Melba broadcast from the Marconi Company's station at Chelmsford, the sound of her voice being picked up not only at widely separated places in Europe, but also by ships at sea, most of which had only crystal receivers; some not even having reached that stage were carrying on with the old magnetic detector.

The wavelength used was distinctly long by modern standards, 2,800 metres. The power was fifteen kilowatts, this being not the power in the aerial but the rating of the generator. The concert was arranged by Mr. Arthur Burrows, of B.B.C. fame, and Mr. T. Clarke, of the *Daily Mail*. A full account of this pioneer experiment was published in *The Wireless World* of July 10th, 1920.

FROM ALL QUARTERS

"A Technical Hitch ?"

AN instance of the disorganisation which might be caused by an enemy saboteur was given the other day at Kettering when no fewer than 250 people were cut off from the reception of broadcasting by the act of a man who, in the course of certain "experiments" interfered with wires belonging to the local radio relay service. He was fined £5.

Ship's Emergency Receiver

AN emergency crystal receiver is part of the radio equipment to be installed by the Radiomarine Corporation of America on nearly 100 U.S. vessels now under construction.

London Transformer Products

WE have been asked to announce that Mr. T. S. Worthington, who was an active director of London Transformer Products, Ltd., for seven years, recently rejoined the Navy as sub-lieut. R.N.V.R. for technical duties.

Identifying U.S. Aircraft

AMERICAN aircraft have now been added to the series of identification charts published by our associate journal, *Flight*. Printed on a card measuring 22½in. by 14½in., the chart includes twenty-one different types of aircraft in use by the R.A.F. and Fleet Air Arm. The chart, which costs 1s. 3d., plus postage, which is sixpence for one copy or sevenpence for two copies, may be obtained from *Flight*, Dorset House, Stamford Street, London, S.E.1.

N.B.C. Colour Television

THE N.B.C. gave its first colour television demonstration in New York a few weeks ago. The system employed is similar to that demonstrated by C.B.S., in which the colour scanning is mechanical and is of 120 lines, giving 20 interlaced frames a second.

Cinema Television in New York

A SCOPHONY rear-projection mechanical television receiver with a 10ft. by 12ft. screen is being installed in the Rialto Theatre, New York, which will then be the first American cinema to offer television as well as motion pictures. It is understood the apparatus is similar to that installed in the Monseigneur news theatre, Marble Arch, London, in March, 1939.

Brit. I.R.E.

AT the annual general meeting of the British Institution of Radio Engineers, held on June 28th, Dr. C. C. Garrard, Ph.D., M.I.E.E., M.Brit.I.R.E., was elected president of the Institution. The following were elected by postal ballot as the 1941-2 General Council: Mr. A. L. Beedle, Dr. P. P. Dalton, Messrs. A. G. Egginton, L. Grinstead, G. Lea, W. E. Miller, J. F. Paull, J. A. Sargrove, W. D. Sell, and H. Tibbenham.

I.E.E. President

SIR NOEL ASHBRIDGE, M.I.E.E., controller of the engineering division of the B.B.C., has been elected president of the Institution of Electrical Engineers.

Marconi Memorial in Washington

A MEMORIAL to Marconi is to be erected in Washington, U.S.A. It takes the form of two granite pedestals, the smaller one in the front, which is 7 feet high, being surmounted by a bust of Marconi 3 ft. 8in. high. This pedestal and bust are backed by a wider and taller pedestal which is surmounted by a bronze figure symbolizing electricity.

Netherlands Broadcasting

SINCE the occupation of Holland by Germany the various broadcasting systems, which were under the auspices of a number of different organisations, have been dissolved and replaced by a State organisation. A licensing system has been introduced, the fee being 9 Gulden (approx. 18s. at par.) per annum.

An Appeal

IN an endeavour to raise £50,000 to provide help for the people of the ten worst bombed towns in Great Britain, George Formby, the variety artist, is appealing to all wireless service men and listeners to send him, c/o the B.B.C., London, one shilling.

I.E.E. Wireless Section

No nominations having been received other than those proposed by the Wireless Section committee, which were given in last month's issue, they have been duly elected to fill the vacancies occurring on the committee on September 30th.

The Wireless Industry

DETAILS of a new compact PA amplifier are given in Leaflet No. 28 recently issued by the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2. Known as the "Microgram," this unit is equipped with a gramophone turntable and a transverse-current hand microphone. Independent volume controls are provided, and the two inputs can be mixed if desired. The power output is 14 watts undistorted.

Barimar, Ltd., are now in a position to undertake welding repairs at their new address, Kent House, 22-24, Peterborough Road, Fulham, London, S.W.6.

Standard Telephones and Cables, Ltd., inform us that the Types HS and HSL transmitters can now be fitted with additional units for matching to 600-ohm balanced twin open wire transmission lines.

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
America			
WNBI (Bound Brook)	17.780	16.87	4.0‡, 6.0.
WCAB (Philadelphia)	6.060	49.50	12.45 a.m‡, 1.30 a.m.†.
WCBX (Wayne) ..	17.830	16.83	2.0‡, 3.0†.
WGEO (Schenectady)	9.530	31.48	8.30†, 10.55§‡.
WGEA (Schenectady)	15.330	19.57	1.0, 2.0‡, 6.0, 7.45.
WRUL (Boston) ..	6.040	49.67	12.15 a.m.§‡.
WRUL..	11.730	25.58	12.15 a.m.§‡.
WRUL..	11.790	25.45	9.30‡.
WRUL..	15.350	19.54	5.0*, 6.0§‡, 9.30‡.
WRUL..	17.750	16.90	5.0*, 6.0§‡.
Australia			
VLR3 (Melbourne) ..	11.850	25.32	6.20.
Egypt			
SUX (Cairo)	7.860	38.14	7.50, 11.10.
Finland			
OFP (Helsinki) ..	8.585	34.94	9.20.
OFN	11.980	25.04	9.20.
French Equatorial Africa			
Brazzaville	11.970	25.06	9.45.
India			
VUD2/3 (Delhi) ..	9.590	31.28	2.30, 5.50.
VUD4	11.830	25.36	10.0 a.m., 2.30, 5.50, 7.15.
VUD3	15.290	19.62	10.0 a.m.
Iran			
EQB (Teheran) ..	6.155	48.74	8.30.
Japan			
JZJ (Tokio)	11.800	25.42	11.30.
JLG4	15.105	19.86	11.30.

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
Manchukuo			
MTCY (Hsinking) ..	11.775	25.48	9.0 a.m., 11.5.
Sweden			
SBO (Motala)	6.065	49.46	11.20.
Thailand			
HSP5 (Bangkok) ..	11.715	25.61	1.45.
HS6PJ	19.020	15.77	1.45.
Turkey			
TAP (Ankara).. ..	9.465	31.70	8.15.
TAQ	15.195	19.74	1.15.
U.S.S.R. (Moscow)			
49-metre band.. ..	—	—	11.0, 12.0 midt.
41 „ „	—	—	7.15, 11.0, 12.0 midt.
31 „ „	—	—	10.5 a.m., 7.15, 9.30, 11.0, 12.0 midt.
25 „ „	—	—	2.30, 7.15, 9.30, 11.0, 12.0 midt.
19 „ „	—	—	1.0 a.m., 10.5 a.m., 5.0.
16 „ „	—	—	1.0 a.m., 5.0.
Vatican City			
HVJ	6.190	48.47	9.15.

LONG- AND MEDIUM-WAVE TRANSMISSIONS

Country : Station	kc/s	Metres	Daily Bulletins (BST)
Ireland			
Radio-Eireann ..	565	531	2.40‡, 7.45‡, 11.0‡, 11.5†.
U.S.S.R.			
Moscow 1	172	1,744	12.0 midt.
Bakou	200	1,500	12.0 midt.

It should be noted that the times are **two hours** ahead of GMT. and are p.m. unless otherwise stated. The times of the transmission of news in English in the B.B.C. Short-wave Service are given on the preceding page.
* Saturdays only. § Saturdays excepted. † Sundays only. ‡ Sundays excepted.

Servicing Equipment and Its Uses

Part II.—Test Oscillators

By "SERVICE"

NEXT to the analyser, the service oscillator is the most important piece of service equipment. No modern superheterodyne receiver can be efficiently and quickly overhauled without it, and yet there are many service-men who fight shy of using it, or, if they do employ it in their workshops, do not reap the full advantages of all its applications.

The instrument with which we are concerned is variously called a Signal Generator, Test Oscillator or Modulated Oscillator. All cater for the same need and provide a signal of the required frequency (wavelength), which may be fed into the various circuits of a receiver for test and alignment, but the term Signal Generator is generally reserved for instruments used for more accurate work than servicing. They are larger and not so portable, and have to be looked after if they are to maintain their keen calibration.

The controls of a service oscillator comprise the tuner for selecting the required frequency, the frequency band switch (or wavechange switch, as it would be called in a receiver), and the attenuator which controls the strength of the output from the oscillator, as does the volume control in a receiver.

For the benefit of beginners it may be said that the service oscillator is nothing more than a very small transmitting station, of which the wavelength or frequency may be adjusted; also, the power of the output can be controlled by the attenuator.

A modern all-wave oscillator will cover a wavelength range of from 5 to nearly 4,000 metres so that the short-, medium- and long-wave circuits of a receiver may be trimmed. In addition, the IF circuits of superheterodyne receivers may be adjusted. Frequencies of from 80 to 200 kilocycles (corresponding to long waves of approximately 1,500 to 2,750 metres) are often required for earlier types of receivers.

A typical all-wave service oscillator, with artificial aerial units.

One of the difficulties confronting the newcomer to radio repair work is that the various instruction books which accompany the servicing equipment when it was first purchased cannot be found. He is thus without any guidance as to the best method of using the instrument, and, in many cases, without knowledge of the functions of the various controls. It may be of assistance, therefore, to briefly go through the specification of a typical all-wave oscillator as shown in the photograph, reviewing each control and its function in turn.

First there is the on-off switch to the left by which the valves in the instrument are switched on and off. The oscillator may be mains driven or derive its energy from internal batteries.

To the right of the on-off switch will be seen the wave-range control. In this particular instrument there are six ranges covering from 5 to nearly 4,000 metres.

In the centre at the bottom of the front panel is the modulation control, which allows the signal from the oscillator to be modulated either by the internal circuits of the oscillator or from an external source.

At the extreme left bottom corner will be seen a socket labelled "Ext. Mod." Into this socket may be fed the output from a pick-up or from an audio-frequency oscillator. This signal will be superimposed upon the output from the oscillator just as the programme from a studio is superimposed upon the carrier wave of a broadcasting station.

In some part of the specification of an oscillator it will be stated that a modulated or unmodulated output may be obtained. For everyday servicing where an output meter is used a modulated output is required.

An unmodulated output can only be used with a great deal of disarrangement of the receiver chassis wiring and use of sensitive meters, and this is not worth while unless the outputs from individual RF and IF stages are being investigated. This is seldom necessary for servicing, so that the newcomer need not concern himself about how to employ an unmodulated signal but use a molulated output from his oscillator and an output meter to show him the results of the adjustments to the various trimmers in the receiver.

Reverting back to the modulation control it will be seen that there is a third midway position designated "Audio." When the control knob is in this position the output from the oscillator is a low frequency signal, which can be fed into the pick-up sockets of a receiver or amplifier for testing the AF stages.

The third control at the bottom of the oscillator front panel is the attenuator control. In some instruments a curve is provided with the approximate voltage output of the oscillator plotted against the numbers of the attenuator dial positions, so that for any particular waverange a rough idea of the voltage of the signal being fed into the receiver being tested may be known.

Using the Attenuation

This is a feature which is not only necessary when trimming AVC circuits but is also useful for comparing the sensitivity of a receiver before and after servicing. For the same output from the receiver the attenuator control would be a lower setting after servicing than before, thus showing that the set is more sensitive.

The last control at the bottom of the oscillator is the toggle switch which is labelled "HIGH" and "LOW." This refers to the power of the output in broad terms. When the switch is in the "HIGH" position a very large output is obtained for forcing the signal through circuits which are so badly out of alignment that the normal output from the oscillator would be insufficient to operate an output meter or give any reproduction from the loud speaker. With this high output the circuits can be roughly adjusted or any other investigations made, and the switch can then be adjusted to the "LOW" position which gives a normal output controlled by the attenuator for aligning receiver circuits.

Finally, in the centre of the front panel of the oscillator there is the tuner control which varies the frequency or wavelength of the output between the two extremes of any particular range.

Lying in front of the all-wave oscillator shown in the photograph are two accessories which are known as "dummy aerials." One is for the short-wave ranges, while the other is for the long-wave ranges. As their name implies, they are artificial loads which have the same effect upon the receiver circuits to which they are connected as would a normal aerial, so that the circuits are adjusted under working conditions.

It will be appreciated from the above that what with the controllable output of the service oscillator and the ability to have either a modulated or unmodulated signal that the instrument is very useful for the general investigation of receiver faults.

It is in this sphere that the newcomer can acquire very rapidly a thorough working knowledge of the application and use of the service oscillator, and we will, therefore, consider its application as a fault-finding medium as well as for circuit adjustment.

The first step is to inject an audio-frequency signal into the grid circuit of the output valve, which may often be easily accomplished by connecting the service oscillator between chassis and the grid pin of the valve if this is slightly withdrawn from its valve holder.

If the audio-frequency output from the oscillator is heard at good strength from the loud speaker of the receiver, the associated circuits of the output valve are satisfactory, and the test lead may be disconnected from the output valve and reconnected to the grid circuit of the preceding AF stage. In most modern receivers this will be the triode portion of the second detector valve.

Of course, connecting the lead between the grid of the valve and the chassis may in some instances upset the biasing arrangements, and if a glance at the circuit diagram of the receiver shows that this is so then in the case of the output valve the test may be made between the grid and cathode pins of the valve or the valve holder connections if accessible.

If the signals are still obtainable after the second test, then the output from the service oscillator may be changed to the frequency of the IF amplifier, and this output connected to the various IF stages in turn just as if these circuits were being lined up. It is just as well actually to retrim the circuit while this test is being made, especially if one of the tests fails to produce the signal, indicating that the fault lies between that test point and the previous one.

The reason for trimming an apparently dead circuit is that sometimes the lack of signals may be due to a shorting IF trimmer condenser. Manipulation of the trimmer will often show up the fault by intermittent operation as the trimmer screw is rotated.

Assuming, however, that signals are still obtainable, then the remaining procedure is to carry out the aligning instructions as given in the service manual for the receiver, as this will progressively necessitate the connecting of the output from the service oscillator to the various circuits until the aerial coils are reached. Of course, before this final stage is gained, the fault will have shown up. When it does, and after it has been cleared, it only remains to trim up the circuits from that point towards the aerial terminal for the receiver to be not only up to standard with regard to its ability to reproduce signals but also it will be at its maximum efficiency with regard to circuit alignment.

It is essential to use a specially designed insulated trimming screwdriver when making adjustments to trimming condensers or the movable core of inductively tuned circuits. An ordinary screwdriver with a long metal blade will have such an effect upon the circuit that every time it is taken away after an adjustment is made, the output from the circuit will change and it will be out of alignment.

Notes on Trimming

When the operation and application of the service oscillator has been appreciated by practise along lines suggested above, the thorough trimming of a receiver may be attempted. Manufacturers' service manuals give trimming instructions, or at least essential details concerning the value of the IF and the order in which the trimmers are to be adjusted. The following notes must necessarily be of a general character because different circuits require slightly different procedure.

For the very best results to be obtained from the modern receiver extremely critical balance must be preserved and adjustments must be made to compensate for variations produced by the slight changes in the electrical characteristics of the components.

Any error in the alignment of the tuned circuits of a receiver will result in reduced selectivity and sensitivity, especially at the lower end of the medium-wave scale. For this reason RF ganging adjustments are nearly always made with the receiver tuned to about 220 metres.

The output of the oscillator is taken through a screened lead, and it is not

Servicing Equipment and Its Uses—advisable to lengthen this lead. The "earth side" clip should in most cases be clipped to the chassis of the receiver under test, whilst the "high side" goes to grid or aerial according to the test to be made.

It is of the utmost importance that when working on any receiver connected to DC mains the output lead (chassis side) of the oscillator should be connected to the true earth terminal (if provided) or to the chassis only through the medium of a 0.1-mfd. condenser. If injecting into an anode or the internal wiring of a DC or "universal" mains receiver, it is advisable to insert a 0.0001-mfd. condenser between the high side lead of the oscillator and the receiver. This is to prevent shocks from the mains supply which is connected to the chassis of DC and AC/DC.

Reducing Input

When trimming high-gain receivers it may be found that even with the attenuator at its lowest setting there is too much output from the oscillator. In this case attach the clip of the "high side" lead to the insulation of the wire in question instead of to the actual wire.

Always work with as low an output from the oscillator as possible. When a receiver incorporates AVC the input should be kept low enough to prevent the AVC characteristic from affecting the output from the receiver.

Although the effect of each adjustment may be judged by ear, an output meter will enable greater accuracy to be obtained. It should be connected where advised in the service manual. The ear cannot be depended upon to record slight changes in the strength of output from a receiver and for all retrimming operations an output meter should be used. Modern receivers are so compact that the old practice of breaking into the second detector anode circuit with a milliammeter is not practicable and the use of an output meter connected to the loudspeaker is far more convenient.

An AC voltmeter may be used if no proper meter is available. An output meter is really only an AC voltmeter calibrated in watts. A high-range AC voltmeter or a high-impedance output meter should be connected across the primary of the output transformer while a low range (0-1V) AC voltmeter or low-impedance output meter should be connected across the speech coil of the loudspeaker.

As a receiver is trimmed, its output will increase and the service oscillator attenuator must be adjusted to give a reading of approximately 50mW on a high-impedance output meter or about 0-5V on the low-range voltmeter. The receiver manufacturer's service manual will generally help on this point.

Do not use the visual tuning device of a receiver as an output indicator unless specifically instructed to do so in the service manuals. The AVC may produce misleading indications.

Having discussed the use of the oscillator in general terms, we will consider its application more specifically, starting with a simple TRF receiver. Here the main trouble is likely to be that after roughly trimming the circuits, it may be found that one trimmer is screwed fully home, or fully unscrewed, whereas definite optimum settings are obtainable for the others. If one trimmer has to be screwed up tight, ganging is being attempted with too much trimmer capacity. If this condition is found, unscrew all trimmers slightly and retune to oscillator note (slightly higher dial reading).

Reverse the above proceedings if a trimmer must, in order to balance, be fully unscrewed.

As the trimmers are connected across the tuning coils they cause additional capacity to be added to the tuned circuits and it will be apparent that too much capacity in the trimmers will cause loss of tuning range, i.e., difficulty in reaching lowest wavelength.

If the ganging runs out of step as the wavelength is increased, this may be due to strain in the ganged condensers; see that the fixed and moving vanes are perfectly parallel when fully engaged.

The slit end-vanes of each section of the ganged condenser rotor are cut so that by slightly staggering the sectors a smoothing tuning curve is obtained. If tracking is out of alignment on one section only of the tuning scale this may be due to one sector of an end-vane having been bent out of place.

As the long-wave coils are shorted out when the receiver is operated on medium waves, any adjustments made to the long-wave trimmers will not upset the medium wave ganging. For trimming long-wave coils the receiver and oscillator should be tuned to about 1,200 metres.

The alignment of superheterodynes will now be considered in detail. In this type of set the adjustment of IF circuits must always precede the RF trimming. Where the first valve serves as a combined first detector and oscillator sufficient coupling will be obtained by connecting the output from the oscillator between the control grid of the valve and chassis.

The grid of this valve may be brought out to a terminal on the top of the valve; adequate coupling may be obtained by attaching the oscillator output clip to the insulated portion of cap or lead to the valve.

The order of the trimming adjustments will be along the following lines:—

(1) Set the tuning condenser of the oscillator to the intermediate frequency of the receiver. Reference to the service information issued with the instrument being adjusted must be carefully studied as the frequencies of the primary and secondaries of each IF transformer are sometimes staggered. This is done to make the resonance curve of the transformers substantially flat, which has the effect of improving the quality of reproduction while at the same time preserving the selectivity.

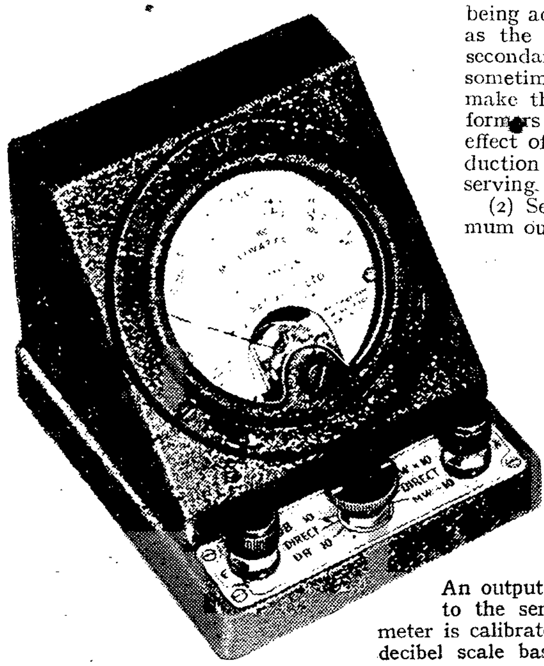
(2) Set the attenuator to give maximum output.

(3) Switch on the receiver and set the volume control to maximum. If the radio instrument is functioning properly a deflection will be obtained on the output meter.

(4) Reduce the output of the oscillator by means of the attenuator until the output meter reading falls to a level where the needle registers about ¼ scale.

(5) Now adjust the secondaries of the IF transformers in the order given in the manual. Always begin by tuning the secondary which is electrically nearest to the second detector valve. If the circuits are to be staggered these coils might be adjusted to, say, 125 kc/s in early types of receivers by means of their trimmers until maximum deflection is obtained.

(6) Next tune the primary coils of the IFT's to, say, 123 kc/s. Again, the coil which is electrically nearest to the output of the receiver must be tuned first. In present-day receivers of the cheaper type, all IF circuits are adjusted to the same frequency—generally 465



An output meter, a companion instrument to the service oscillator. This particular meter is calibrated in milliwatts and also has a decibel scale based on a zero value of 50 mW.

kc/s. This is termed peaking the circuits instead of staggering them. The selectivity of staggered circuits can be improved by peaking them but at the expense of quality.

Turning to the RF circuits, it is important that some form of aerial be connected to the instrument to be re-ganged in order to secure a normal operating condition if no dummy aerial is provided with or incorporated in the service oscillator. Procedure on medium waves will be as follows for most types:—

(1) Loosely couple the oscillator to the aerial lead-in by clipping the output lead of the oscillator to the chassis of the receiver.

(2) Adjust the ganged condenser so that the vanes are disengaged. This does not necessarily mean that the moving vanes will be hard up against the stop position. Consult the service instructions for the receiver in question in order to ascertain the pointer positions and physical position of vanes for a given scale reading.

(3) Switch on the receiver and the oscillator and tune both to 220 metres.

(4) Unscrew the first tuned circuit trimmer to minimum capacity.

(5) Adjust the trimming condenser on the beating oscillator section of the ganged condenser to give maximum deflection of output meter needle. If the oscillator note is heard at two positions when adjusting the trimmer, the position nearest minimum capacity of the trimmer must be chosen.

(6) Check the position of scale pointer to make sure that reading of oscillator and receiver scales agree.

(7) Now tune the service oscillator to give, say, a 250-metre signal. This actual wavelength may vary a good deal, depending on the design of the radio instrument, and the manufacturer's instructions must be followed. Tune the radio instrument to the oscillator signal and adjust the trimmer of the section of tuning condenser which tunes the grid circuit of the RF amplifying valve. Always trim the grid tuning circuit before attempting to adjust the aerial circuit. Adjust trimmer of the second variable condenser section to get maximum response to oscillator signal. Rock the ganged condenser to ensure that the correct position has been obtained.

(8) The aerial circuit trimmer must now be adjusted to give maximum deflection on meter.

Switching over to long waves, tune oscillator to give 1,000-metre signal and adjust the long wave trimmer condenser(s) for maximum output of meter at the same time rocking the ganged condenser. When all trimmers have been attended to go over all the adjustments again in order to check each one.

On short waves the procedure follows closely that described above for MW and LW. Adjustments will be more critical and greater care must be taken in making them. The settings of the oscillator and receiver tuning points will be given in the manufacturer's service notes.

There is one thing which must be looked out for in short-wave circuits and in some medium-wave circuits, and that is inductance trimming. With present-day push-button receivers inductance trimming is generally done by movable iron-dust cores, but where circuits are manually tuned, loops of wire or straight lengths of wire running parallel to each other will sometimes be met with. These should not be tied up or they will probably have very serious effect upon the sensitivity of the circuit at certain points of the waveband. They are generally mentioned in the manufacturer's service manuals and should not be touched unless full instructions as to their adjustments are available.

Random Radiations

By "DIALLIST"

Pooling Service

THE servicing of wireless sets has grown increasingly difficult since the war started owing to the calling up of so many of the men who did the work in peacetime. Hence I'm glad to hear that a start has been made by some wireless dealers in pooling their service jobs. Here's how it works. A group of dealers in one district gets together and establishes central workshops—possibly they use workshops already belonging to one of them if these are big enough. They pool not only their testing equipment and their tools but also their service-men for fitting out and staffing the central workshops. All jobs, except the very simple ones which can be tackled locally, are sent in to the common servicing centre. In this way the best use is made of the available men and equipment. Jobs are done more quickly and more efficiently than they could be if individual dealers with depleted staffs undertook them. I hope that the system will extend rapidly, for I'm sure that it is the best possible way of dealing with the present difficult situation.

Some Extension

ONE small detachment of mine functions about a mile from headquarters. They can't have a broadcast receiver because they are on duty, but I wanted to be able to let them hear such of the news bulletins as came through at times when there wasn't much doing in the way of hostilities. Purely as an experiment, and not expecting any results, I installed a small loudspeaker and connected it direct to the "extension" terminals of the headquarters broadcast set by means of the existing telephone line. As I've said, the distance is a mile or so, which makes the circuit some two miles long, out and home. The telephone line is of the usual Army type, laid across country on the tops of hedges, and so on. Its total resistance is 120-130 ohms. What kind of reception would you have expected from the distant loudspeaker? I'm not going to say that the volume was great—it wasn't. Still, to my surprise, it proved to be sufficient to be clearly audible at 6-8ft. from the loudspeaker. Half a dozen men, in fact, can listen to the news. Naturally, we're constructing a single-valve amplifier for boosting purposes. It will be finished as soon as I can get hold of a suitable output transformer and a few other small bits and pieces. I have them right enough, but they're at my home; so the completion of the amplifier must wait until my next short leave comes along. Meantime, we are not doing too badly with the unboosted signals, and the troops agree that any kind of reception of the news is better than none at all.

Surprises

The receiving set is an Ekco superhet, which has done good work almost since the beginning of the war. Just what the output circuit is I don't know, for the firm doesn't publish details of the innards of its sets—and I haven't had the curiosity to investigate very closely. The distant loudspeaker, though, is of the 2-3-ohm type, and it is connected direct to the telephone line wires without any intervening transformer. I expected that if it worked at all reproduction would be at bare headphone strength. Hence my surprise when the loudspeaker almost lived up to its name. Still, one does get surprises at times in wireless; arrangements that don't look as if they ought to work at all do work—and others that you'd expect to work just don't.

Fifty-six Megacycles

A KIND reader living near Reading replies to the question I asked last month about reports of transatlantic reception at or near the 1939 sunspot maximum. There appears to have been one authenticated instance of reception of a 56-megacycle American station in this country and one of reception in California of a station in these islands. I thought that there were more. Very interesting, in view of the theoretical skip distances given by a correspondent in last month's *Wireless World*, are the records that this reader sends of reception of 56-megacycle signals at places far beyond visual range, but at the same time a long way inside what might have been expected to be the skip area. Amateurs in France, Belgium and Holland worked with their opposite numbers in this country in 1939. My correspondent describes this as an extension of the ground-wave range due to temperature inversion a mile or so above ground level. But what of the reception from Austria and Germany recorded in 1937? Or that from Sweden and Switzerland in 1938? I should not be surprised if history repeated itself to some extent in the matter of the "Below Ten" wavelengths. In not-so-very-old textbooks you may find statements that the short waves, that is those below a hundred metres, were never likely to be of any commercial use for long-distance transmissions. You know the continuation of *that* story! Is it not possible that by a careful choice of frequencies to suit times and seasons the UHF bands may one day play an important part in communications?

HTB's

SOME people tell me that they have difficulty in obtaining high-tension battery replacements, whilst others report no trouble at all. The demand for HTB's has, I believe, gone up greatly since the summer of 1939. There are two reasons for this. More sets are in use in places (or in houses) without mains electric supplies. And most battery receivers (like their mains counterparts) are worked for more hours a day than they were in pre-war times. Actually batteries of standard sizes, shapes and tappings are not unduly hard to come by. Those who complain about difficulties in finding replacements are more often than not owners of receivers—some of old types—which require special HTB's. At one time designers of battery receiving sets had a passion for turning out models requiring odd shapes and sizes in HTB's! When I say "requiring" I don't mean that such batteries are absolutely essential. They must be used if you want to fit them into the cabinet and insist on retaining the existing HT and GB leads and plugs. But as a rule there is little difficulty about altering leads and plugs to suit a standard HTB, plus, if necessary, a separate grid bias battery. And if they won't go into the cabinet? Not much real difficulty here, either. What I have often done is to provide a separate HT and GB battery box, which either lives on top of the cabinet, or, better, goes beneath it, forming a kind of plinth for it to stand on. In these times, when out-of-the-way HTB's are difficult to get, it is probably wise to convert any receiver designed for one of them so that it will work from the standard—and much more readily obtainable—article.

UNBIASED

Diversity Reception at Home

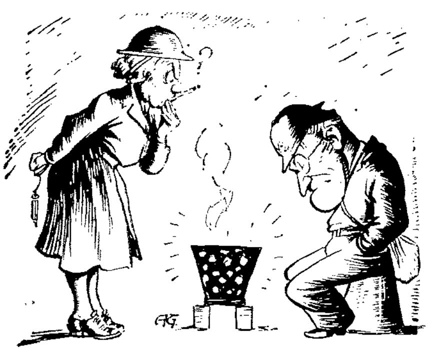
By FREE GRID

IT has often been a source of wonderment to me why people leave their sets on at all hours drooling out the daily doses of dreary dissertation and doleful dirges churned out by the B.B.C. for our alleged edification and entertainment respectively.

It can hardly be laziness or carelessness, for, after all, nobody leaves the water tap running all day.

While on fire-watching duty the other night I was pondering this problem while fitfully dozing in company with the female whom fate and the local warden has decreed shall share my lot on these occasions. Eventually I put the problem to my companion, as I knew her to be a daily-drool addict, and to my surprise she was instantly able to provide me with the answer to the problem.

The reason that people left the set on all day, she said, was not because they liked it, but because it was such a blessed relief when they finally turned it off. When I argued that if



Waiting for Hitler

this were so, surely it would provide still greater relief if they never turned it on at all, she pointed out very logically that unless and until there had been pain or discomfort there was nothing from which to obtain relief.

I must say that this sounded very convincing, even though it rather reminded me of the story of the man in the lunatic asylum who, when asked why he kept on hitting himself over the head with a chunk of wood, gave exactly the same reply.

I suppose it is much the same sort of thing which induces people with an inadequately designed short-wave section to their sets to roam the ether nightly in a vain endeavour to titillate their ear-drums with transatlantic tintinnabulations. The faint cries, all but drowned out by the background of roaring noise, which are emitted by these overstrained sets, has so moved me that for some time past I have been operating a co-operative reception scheme in my neighbourhood which some of you might like to try out in your own districts. Briefly, I have made an arrangement with set owners dwelling within half a mile or so of me whereby all their aerials are coupled by transmission lines to my set on the principle of the MUSA aerials used by the G.P.O. for their "diversity reception" of American transmissions, a system which was described by "Cathode Ray" in the December 8th, 1938, issue of *The Wireless World*. As a result, I am able to supply my neighbours with non-fading and noise-free world-wide programmes by means of ordinary loud-speaker extension leads.

Scientific Slovenliness

I WAS very pleased to read the stern words addressed to his readers by the Technical Editor of *The Wireless Engineer* in a recent issue of that journal in which he severely castigated that large class of people who are addicted to the use of slovenly half-truths like "50 cycles" when they really mean "50 cycles per second." There is far too much of that sort of thing going on, and I have always endeavoured to correct it whenever I have come across it.

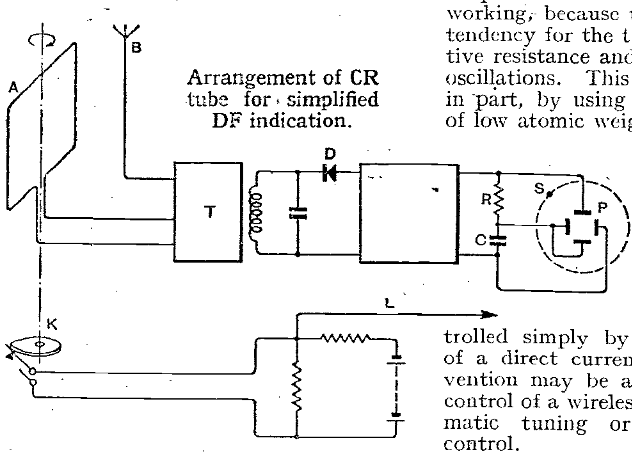
Women are, as might be expected, the chief offenders, and only the other day Mrs. Free Grid provided a striking example of it when she announced that a certain newly released model of the human species in which she is interested weighed seven pounds. My gently worded rebuke, "avoirdupois or troy?" merely provoked an answer which was neither intelligent nor intelligible. It is true that troy weight is seldom, if ever, used for weighing babies, but that is no excuse for omitting the scientifically accurate qualifying adjective, "avoirdupois," any more than it is excusable to omit the adjectival expression "per second" just because it is not customary to plot cycles against minutes or hours.

Recent Inventions

A Monthly Selection of the More Interesting Radio Developments

"VISUAL" DIRECTION-FINDERS

THE object is to show the bearing of a distant wireless transmitter by the position of a single spot of light on the fluorescent screen of a cathode-ray tube. The signal picked up on a frame aerial A, which is constantly rotated at a speed, say, of 20 revs. per second, is combined with that received by a non-directive aerial B, in a tuned circuit T.



Arrangement of CR tube for simplified DF indication.

The output from the latter is then rectified at D and applied, through a phase-splitting circuit R, C, to the deflecting plates of a cathode-ray tube P. In the ordinary way, this would cause the electron beam to trace out the circular path shown in dotted lines on the fluorescent screen, the trace being continuously visible.

According to the invention the continuous trace of light is converted into one single spot S, which appears on the screen at a point indicating the direction of the distant transmitter. For this purpose, a potential sufficiently negative to cut off the electron stream is normally applied to the grid of the C R tube by a lead L from a DC source. The negative bias is, however, removed once in each revolution of the frame aerial by a cam K mounted on the aerial shaft in line with the plane of the windings. Since the position of the spot keeps step with the varying phase of the signal current as the frame aerial rotates, its momentary appearance, when the bias is removed, will indicate both the direction and "sense" of the distant beacon station. The speed at which the spot reappears keeps it constantly visible.

Marconi's Wireless Telegraph Co., Ltd.; C. S. Cockerell and G. P. Parker. Application date, March 14th, 1939. No. 527495.

VARIABLE-INDUCTANCE TUBES

IT is known that a glow-discharge tube shows a marked frequency response to the current passing through it. The reason is that the tube behaves as a resistance connected in series with an inductance, the value of the latter depending upon the direct-current component of the discharge stream. Knowledge of this fact has led to the use of such tubes, say, for regulating the transmission characteristics of a low-pass filter.

The problem is, however, not so simple when it comes to high-frequency working, because there is then a marked tendency for the tube to develop a negative resistance and to generate sustained oscillations. This difficulty is overcome, in part, by using a tube filled with gas of low atomic weight, such as hydrogen, and in part by shunting the tube with a high-inductance coil. The tuning of a high-frequency circuit containing such a combination can then be varied or controlled simply by regulating the value of a direct current fed to it. The invention may be applied to the remote-control of a wireless set, or used for automatic tuning or variable selectivity control.

L. de Kramolin. Convention date (Germany), April 30th, 1938. No. 527649.

PHOTO-ELECTRIC CELLS

THE cathode of a photo-electric cell is coated with an alkali metal and simultaneously bombarded with atomic hydrogen. This is stated to increase its response to the action of light.

The alkali metal may be vaporised and exposed to atomic hydrogen in that state, or the molecular hydrogen may be bubbled through the metal when in a molten condition, and the resulting vapour allowed to expand before being applied to the surface of the electrode. The latter is finally subjected to bombardment by a stream of electrons projected from a "gun" of the kind used in a cathode-ray tube. This is said to increase the sensitivity still further, and also to stabilise the performance of the electrode.

The Board of Trustees of the University of Illinois. Convention date (U.S.A.), January 5th, 1938. No. 527353.

VARIABLE SELECTIVITY

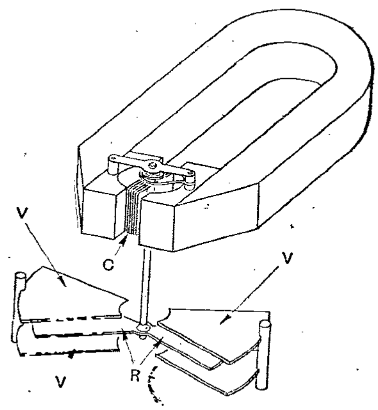
IT is sometimes useful to be able to vary the selectivity of a wireless receiver between what one may call abnormally wide limits. For instance, in certain forms of commercial, as distinct from broadcast receivers, it is an advantage to be able to change from a selectivity wide enough to receive telephony sidebands, to a razor-edge tuning capable of distinguishing telegraphic morse signals against a background of severe interference. Similarly in DF work the band of frequencies required to distinguish the "characteristic" signal of a beacon transmitter is much too broad to allow the best results to be obtained when flying along a beam, or even when taking bearings on the transmitter.

A superhet set is made capable of showing a resonance response of this kind by including in one of the intermediate-frequency stages a special feedback circuit comprising a piezo-electric crystal shunted by an inductance, a capacity and a variable resistance, all in parallel. Preferably the crystal network is inserted on the cathode "leg" of a pentode amplifier, so that the feedback is negative, though positive reaction (through a similar network in the anode circuit) may be used. The selectivity is controlled by varying the shunt resistance.

Marconi's Wireless Telegraph Co., Ltd.; N. M. Rust, and E. F. Goodenough. Application date, 12th January, 1939. No. 527902.

VARYING INTERELECTRODE CAPACITY

DURING the warming-up period which occurs after a valve has first been switched into operation, a gradual change takes place in the interelectrode capacities. Since these are usually in parallel with the RF circuits, a corresponding drift in frequency is likely to occur. The effect has, for instance, been observed to last over a period of 40 minutes, the detuning of the associated circuits being at first rapid, but coming more slowly to a constant value.



Method of compensating for frequency drift.

As a remedy, a thermocouple consisting of two wires of different but suitable material is connected, say, to the anode of a transmitting valve, so that, as the heat increases, a thermoelectric voltage is generated. This is fed to the winding C of a small moving-coil instrument and serves to rotate a pair of rotors R into or out of engagement with stationary vanes V, the combination forming a small condenser which is connected in parallel with valve. The shaft is rotated against a restoring spring, the change in capacity value being arranged to neutralise that due to the heating-up of the valve.

Marconi's Wireless Telegraph Co., Ltd., and G. B. Banks. Application date, April 1st, 1939. No. 527433.

"BUNCHING" ELECTRONS

IN the so-called Klystron generator, oscillations of very high frequency are produced by subjecting the electron stream produced in a discharge tube to the action of a magnetic field, which alternately accelerates and decelerates the speed of the individual electrons, so that the stream takes on a "bunched" formation along its length. In this condition the stream is fed into a hollow chamber which is "tuned" to the periodicity of the bunches. In other words, the chamber acts as a resonator in which the bunches of electrons are converted into electrical oscillations of corresponding frequency.

In order to simplify this process, it is now proposed not only to "bunch" the electrons, but also to draw off their energy, as a radio-frequency current, from one and the same resonant chamber.

The Board of Trustees of the Leland Stanford Junior University. Convention date (U.S.A.) January 22nd, 1938. No. 528041.

RECEIVING SETS

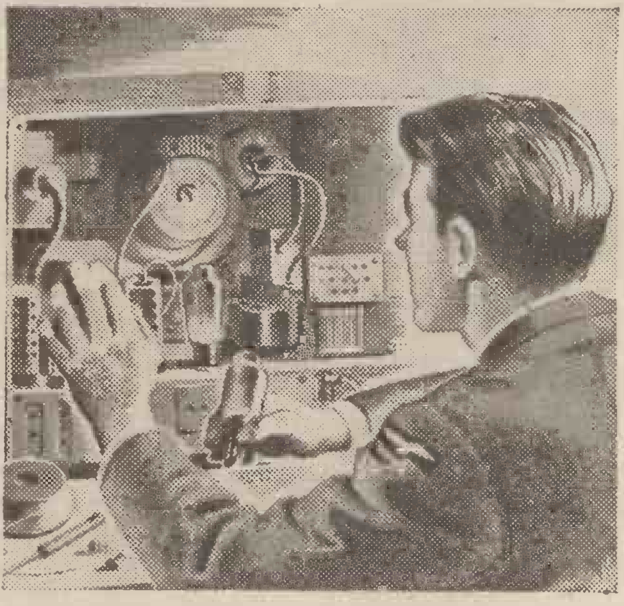
THE chassis of a wireless receiver usually carries component parts mounted both above and below the main supporting platform, the wiring being generally located below. For servicing purposes, it may therefore be necessary to unscrew the chassis from its baseboard or supporting panel, and to remove it from the cabinet.

To avoid this the chassis is hinged, either at its far or near edge, to a baseboard, by pivots which can also slide on inclined guide-rails fixed to the sides of the cabinet. The arrangement allows the chassis first to be withdrawn bodily, and then to be turned to an inverted position, if necessary, outside the cabinet. Or it can, when in the retracted position, be completely removed from the cabinet without having to use a screwdriver or other tool in order more conveniently to carry out any repair.

D. Jackson and Pye, Ltd. Application date, 26th April, 1939. No. 528198.

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.

Let the RAF make you a Radio/Wireless Mechanic



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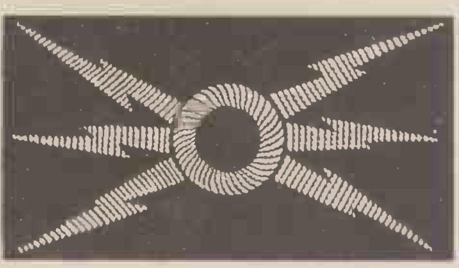

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Wanted

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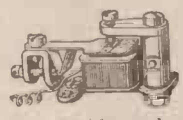

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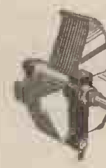

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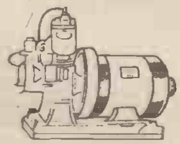

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