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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.
ENORMOUS quantities of tubular condensers, of all kinds of specifications, are now being used in apparatus for the Services—of which we, of course, make our share. Only a very few are left over for ordinary commercial work, and if we are to make any broadcast receivers at all, we must economise in them.

We have made several circuit changes in the various receivers so as to save "tubulars," and one typical change, which saves two condensers, is illustrated in the diagrams above.

Fig. 1 shows the A.V.C. and cathode bias systems of a standard type of A.C. superhet using separate cathode bias circuits in the ordinary way.

Fig. 2 shows the A.V.C. and bias system of the new scheme. The

This negative bias is decoupled by the usual A.V.C. decoupling and fed on to the grids of $V_1$ and $V_2$, making the cathode bias unnecessary. The earthy end of the volume control is returned to the negative side of $R_2$, and the voltage across $R_2$ provides the bias voltage for $V_2$.

The anode current of $V_4$ passes through $R_1$ and $R_2$, and it is therefore necessary to arrange the $50 \mu F$ condensers $C_1$ and $C_2$ so that the audio-frequency voltage built up across $R_1$ and $R_2$ from the audio-frequency components of $V_4$ anode current shall be a minimum and so produce a negligible amount of feed-back into the grid and cathode circuit of $V_3$.

The student of design will realise that while, with normal cathode bias systems (as in Fig. 1), the valves are to a large extent "self-regulating," with the new scheme, the bias is fixed by the total anode current of the receiver, and in consequence there will be wider variations in valve gain from set to set. Apart from this, however, the change involves no loss in performance or reliability—and it certainly enables us to avoid using components which have an even more vital job to do elsewhere.
Broadcast Receivers of the Future

Progress Along Less Stereotyped Lines

Much ingenuity has been displayed by broadcast receiver designers in the past in producing more or less elegant variations of basic circuit arrangements—notably of the four-valve-plus-rectifier superhet. No doubt records have shown that the introduction of a new model, or perhaps more accurately a new variation, had a tonic effect on the flagging curve of sales, but we believe that even before the war radical changes were overdue. A more exacting type of set buyer, with clear-cut ideas as to what he wanted, was coming forward. Here we are thinking not only of typical readers of this journal, but also of those more critical members of the general public who took their broadcasting seriously.

An analysis of about 1,000 circuit diagrams representative of commercial broadcast receiver design over the period 1929-1939 has led the authors of a recent paper' presented before the I.E.E. to the following conclusion: "Design has been influenced to a great extent by the fact that the sales market consisted of a large majority of purchasers of first receivers. This has rather tended to over-emphasise the accessory circuit (which can be made a good selling point) at the expense of basic design and the potential user's needs. With market saturation approaching, replacements must become a larger and larger proportion of the total sales, and this should give the designer an opportunity of producing receivers calculated to fulfil the more exacting requirements of the user."

It is evident that there will always be a demand for the simpler mass-produced set, but the authors (all Marconi engineers) are right in envisaging an increase in the number of buyers who will only be satisfied by sets with a specialised performance in one direction or another. The demand for high-quality reproduction and for long-range sets of the communication type has been in evidence for some time.

The present hiatus in the production of broadcast sets and the diversion of designing talent to fresh fields may well produce for the post-war revival something radically better than "cold cabbage warmed up." Certainly the time is opportune to take stock of progress up to the present, and to make plans ahead.

What form will the broadcast set of the future take? The answer will depend to a large extent on the nature of the transmitters and the wavelengths on which they work. Selectivity, for example, is almost as much a quality of transmission as of reception, and is of such importance that we feel justified in dealing with that aspect of the subject alone at some length elsewhere in this issue.

"Cooked" Transmission Technique

There is also room for closer collaboration between transmitter and receiver designers if better quality of reproduction is to be obtained. The introduction of "pre-emphasis" for high notes in the transmitter and a reciprocal "de-emphasis" following the same law in all receivers would help to reduce background noise, while complementary degrees of compression and expansion would add greatly to the realism of a transmission such as that of the full orchestra, which covers a wider volume range than can be handled by present-day transmitters without encroaching on background noise at minimum or overloading at maximum.

Far from having reached a state of finality in design, we may reasonably look for a flood of new ideas and a major advance in broadcasting technique when social and economic life is once more stabilised. The perceptible slowing up of progress in fundamental design immediately prior to the war was the result of reaching limitations imposed by the present system. Ultra-shortwave broadcasting in this country and frequency modulation in America were symptomatic of the need for breaking fresh ground. The foundations of real progress will depend upon the realisation that broadcasting must be viewed as a complete communication system and not as a chain of separate units engrossed in their own special problems.
Selectivity is not determined exclusively by the circuit properties of a receiver. Harmonic distortion in the transmitter can have a significant effect, particularly in relation to sideband splash. The geographical and frequency distribution of stations are equally important.

The overall selectivity curves of a receiver, while helpful to the designer in checking calculations, are not by themselves a criterion of the performance which the set will give under listening conditions. To be in a position to estimate the degree of encroachment of unwanted transmissions on a desired programme, one must know not only the frequency distribution and relative field strengths of the transmitters at the place where the receiver is installed but also the nature of the sideband spectrum radiated by the interfering station.

These points are brought out very clearly in a paper recently presented before the Institution of Electrical Engineers. The state of the "Broadcast Receivers": A Review by N. M. Rust, O. E. Keall, J. F. Ramsey, M.A., and K. R. Sturley, Ph.D.

The authors found that the R.M.A. and I.R.E. two-signal selectivity tests using an interfering ether on the medium-wave band in the London area under normal conditions is graphically illustrated by a graded field strength chart reproduced in Fig. 1. This gives some idea of the formidable task which the receiver is called upon to perform, but does not tell us the exact nature of the interference which will be met with between stations in individual cases. Neither is this question answered by an inspection of the selectivity response curves of the receiver itself.

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A Survey of the Problem as it Affects the Whole Broadcasting System

modulation frequency of 400 c/s gave little indication of receiver service under listening conditions, and it was decided to make investigations of "interference protection" on a wider basis. Accordingly tests were made under four separate headings:

(1) Two signal interference measurements using an interfering carrier modulated over a range of 0 to 20 kc/s.
(2) Measurement of the interference output frequencies.
(3) Cathode-ray tube examination of the interference output.
(4) Listening test.

The receiver employed had a linear frequency response up to 5 kc/s, and the distortion was 1.0 per cent. (including the signal generator) for an output of 1 watt. The distortion in the AF stages was less than 1 per cent., and a two-tone test gave a residue of 2.5 per cent.

Sideband Interference

First, the receiver was adjusted to give an output of 1 watt at certain values of desired carrier, modulated 30 per cent. at 400 c/s. Then the interfering carrier (derived from a signal generator with 1.25 per cent. distortion at 30 per cent. modulation) was switched on, and modulated continuously from 0 to 20 kc/s. Measurements of the interfering modulation being taken at the receiver output.

The results are shown in Fig. 2 (a) for carrier spacings of 15 kc/s and 18 kc/s and desired and undesired carrier strengths of 100 and 10,000 µV respectively. The dips in the curves represent positions at which zero beat tones are observed. These occur when the interfering modulation frequency is a sub-harmonic of the carrier spacing.

It will be observed that the interference increases with the modulation frequency, and near to the wanted carrier would be higher under working conditions than is shown by the curves. This is due to the action of AVC, which is able to operate on the steady modulation products derived from the test interference, but would not respond to the transient high-frequency side bands resulting from the average programme.

Most of these sidebands are harmonics of the modulation frequency in the transmitter, and the interference is particularly serious when the normal pass-band of the receiver is entered. The distortion present in the signal generator used for the tests (1.25 per cent.) is comparable with that of high-grade broadcast stations where 1 per cent. for 30 per cent., and 4 per cent. for 90 per cent. modulation is a serious concern. Nevertheless, the interference produced can be serious even with 3- or 4-channel separation, and it will be seen from the results given in the table that the harmonic sidebands of a desired 100 µV carrier may equal the fundamental sidebands of a desired 100 µV carrier.

Harmonics in the transmitter may originate at audio frequency in the modulator or sub-modulator, or at radio frequency in the RF stages, and may be restricted by a low-pass filter in the AF stages or a band-pass filter between the RF power stage and the aerial. Filters of the latter type are difficult to design for use in transmitters, but to test the efficacy of both types of filter the test signal generator was fitted with a low-pass filter between the AF oscillator and the modulator, having a normal cut-off at 5 kc/s and an attenuation of 80 db. above 7.5 kc/s; also an elementary RF band-pass filter of ±7.5 kc/s pass range attenuating frequencies outside ±15 kc/s by 20 db. The results obtained are shown in Fig. 2.

The frequency composition of the interference output was then analysed in tabular form, and charts were prepared which indicate the degree of interference likely to be experienced under service conditions. In preparing these charts the relative strength of the different frequency components of the orchestra were taken into account. The dotted line in the top left-hand corner of Fig. 3 shows the general decrease in

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Selectivity—amplitude with frequency, and the average slope has been fixed by the straight line which represents the fundamental sidebands present in the transmitter when a 75-instrument orchestra is playing at "maximum" level. Similar curves were prepared for "most probable" orchestral level and "average conversational" level. The horizontal scale at the top shows frequency difference from the unwanted carrier, and, on the vertical scale, sideband levels are referred to the carrier, 100 per cent. modulation being assumed.

A chart representing an average receiver is shown in Fig. 4. This is to the same scale as the transmitter chart of Fig. 3 and shows a response range of ±5 kc/s. The downward sloping lines give the sideband frequency distributions corresponding to 50 per cent. and 10 per cent. modulation, and the noise level is arbitrarily fixed at 30 db below 30 per cent. modulation level.

The receiver chart should be drawn on transparent material, and when placed over the transmitter chart the degree of probable interference can be visualised. Thus in the left-hand dotted position in Fig. 5 the station separation is 9 kc/s, and the carrier levels are equal. Interference is almost entirely due to the fundamental sidebands of the unwanted transmitter, which produce an equivalent modulation of between 30 and 60 per cent. In the other position, where 15 kc/s spacing is assumed and the wanted carrier is 30 db below the unwanted carrier, interference is due to harmonic sidebands and is equivalent to modulation of about 10 per cent. This interference occurs, in the second example chosen, only when the fundamental modulating frequencies are developed in the region of 6.5 to 10 kc/s for second harmonic and 4 to 8.3 to 6, and 2.5 to 5 kc/s for third, fourth and fifth harmonics respectively. It is for this reason that programmes predominating in low tones (the organ, for instance) give comparatively little sideband splash.

From further tests the writers conclude that unnecessary harmonic sidebands can give a transmitter an effective modulation range of 30 to 50 kc/s, and that the interference from this source can cause first order effects which are independent of cross modulation and distortion in the receiver itself.

Listening tests with the interfering carrier modulated by a speech amplifier confirmed that sibilants as represented by the word "street" caused greater interference than the long vowels in "radio."

Depth of Modulation

Some interesting results were obtained from cathode ray observations of the modulation depths at the detector. The RF signal was applied to one pair of plates and the AF signal to the other pair, resulting in a trapezoidal shape during modulation. London Regional showed an average modulation of 20-50 per cent., but 50 per cent. was frequent and 100 per cent. not uncommon.

High modulation occurred on sustained vowels and explosive sounds; modulation on sibilants rarely exceeded 50 per cent. Radio Normandie gave average modulation depths of 50-100 per cent.
**Selectivity**

The transient nature of sideband interference was clearly shown by tuning the receiver to a locally applied carrier of about 100 µV adjacent to London Regional. The interference modulation was on occasion equivalent to 500 per cent., and these high levels produced a harsh and raucous output.

Referring back to the state of affairs depicted in Fig. 1, the prevalence of interference is not remarkable in view of the considerations put forward by the authors. They suggest that a solution may be found in the re-allocation of wavelengths and the method of "group allocation put forward as far back as 1928," and frequently advocated in this journal receives their support. If instead of 12 separate channels each of 9 kc/s nominal width the spectrum of 108 kc/s allowed to Great Britain under the Montreux Plan were divided into two bands, one near the high frequency and the other near the low frequency end of the medium-wave band, 5 kc/s single sideband transmission could be used for speech and 20 kc/s double sideband for programmes calling for a high degree of fidelity. Any required combination could be made in each band between the limits of 21 speech and two high-fidelity channels. The authors conclude that "for a given total frequency spectrum allotted to a country, group allocation permits the most economical programme-frequency distribution and goes far towards the elimination of station interference if the conditions for transmitter and receiver design cited above are fulfilled. Immediate general acceptance of the principle is unlikely owing to the special technical problems involved, but future developments along these lines are possible."

**Receiver Design**

So much for the wider aspects of the selectivity problem. On the detailed improvement of selectivity in receiver circuits the paper has many useful suggestions to offer. The section dealing with distributed selectivity, and adequate selectivity before the detector is essential.

"If it can be assumed that all amplifier stages preceding the detector have linear characteristics, the overall selectivity curve determines the resultant interference, and the selectivity distribution over individual stages is not important. For RF stages having non-linear amplifying characteristics it is essential to obtain the maximum possible selectivity between the aerial and the first RF valve, since the ratio of interference to desired signal is greatest here."

"In the superheterodyne receiver the frequency changer becomes the important position, for the IF amplifier usually has a narrow pass-band."

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Selectivity—

ing circuits, and it is therefore imperative that the selectivity of the former should be adequate. A frequency changer and detector are necessarily non-linear devices, but an RF amplifier is only non-linear when distorting."

Band-Pass Filters

Dealing with band-pass circuits, the authors emphasise that the shape of the response curve is quite as important as the band width. Simple tuned coupled filters tend to give considerable variations in the pass-band if the attenuation outside the band is to be adequate. A filter designed to overcome this difficulty is outlined in Fig. 7. Here rejection circuits are included to produce dips, usually located at 0 kc/s from the mid-frequency, and thus to suppress heterodyne whistles as well as increasing the sharpness of the cut-off.

Unfortunately, in circuits of this type high attenuation at the dip frequency is obtained at the expense of performance outside these frequencies, and better results are obtained by a combination of the filter with an over-coupled band-pass transformer. A practical circuit of this type which is easy to adjust is shown in Fig. 8. The choke does not enter into the filter circuit, but is necessary to supply HT voltage to the anode of the preceding valve. The authors are of opinion that "design technique is ahead of present-day requirements when the limitations imposed by the transmission of unnecessary harmonic sidebands is considered. As an experimental check on this statement four receivers were constructed with the following features:

(a) Homodyne.
(b) Four tuned RF stages.
(c) Superheterodyne with aperiodic RF input and an IF of 1,600 kc/s

Wireless World

Fig. 7.—Band-pass circuit including rejection circuits designed to improve selectivity outside the pass-band. The side dips are usually located 0 kc/s from the mid-frequency.

(d) Superheterodyne with highly selective RF and IF stages.

Comparative tests showed that the major cause of interference was sideband splash, which masked receiver non-linear effects and resulted in approximately similar performance from all receivers, which had approximately the same audio response range. The only noticeable difference was that the quality of the homodyne receiver was superior to that of the others, whilst the tuned RF receiver had a low noise-level.

"Interference protection must therefore be considered as a characteristic of the whole communication network, involving transmitter as well as receiver selectivity, and such factors as wavelength allocation. A solution to the problem requires international agreement on transmitter sideband restriction and wavelength allocation."

Taylor Model 81A

Universal Meter

This instrument fully justifies its name, for in addition to direct measurements of voltage current and resistance it may be used for capacity and inductance in conjunction with a separate adaptor (Model 311), and will also show changes of AC volts in terms of decibels.

The basis is a 0 to 250 micro-amp meter with a rectifier for AC measurements, an internal battery for resistance and a series of shunts and multipliers selected by rotary switches, giving over 50 ranges.

Six concentric scales are marked on the meter dial, the outer one (resistance) being 31-in, long, and the inner (decibels), 1-in. The shortness of the lower scales is to some extent offset by the fineness of the pointer.

We checked the instrument against laboratory sub-standard meters and found agreement within the reading error at full deflection and scale errors not greater than 3 per cent, at intermediate points. To compensate for the rectifier characteristics at low inputs, a separate calibration is provided for AC volts from 0 to 2.5. This range was found to be accurate within the reading error over its whole length. The meter movement had a perfectly dead beat action with no overshoot.

Readings of standard resistance values agreed to within 5 per cent, or less after allowance had been made for the resistance of the external leads.

All the range selector switches worked positively and did not cause any variation of reading when moved slightly to test their contact resistance. The makers have wisely excluded the 10 amp range from the switching and provided separate input plugs for this range. Shrouded plug was also available for the 1,000 volt range.

The instrument is provided with three test leads, two with crocodile clips and one with an insulated test probe. A press-button switch is used for meter protection. This may be depressed permanently by rotating through a right angle.

The workmanship is of a high standard throughout, and the polished bakelite case is provided with a carrying strap and rubber feet on two sides. The price is £13 15s., and the makers are Taylor Electrical Instruments, Ltd., 410/122 Montrose Avenue, Slough, Bucks.

A more sensitive instrument (Model 81c) with many additional ranges is available at £18-18s.
Wireless in the R.A.O.C.

Testing and Repairing Equipment:
The Training of Personnel

By MAJOR W. T. COCKING,
A.M.I.E.E., O.M.E. (Wireless), R.A.O.C.

The Royal Army Ordnance Corps is associated in the minds of most people with guns and ammunition, and there are many who do not realise that these essentials of modern warfare form but a part of its activities. To-day the word "ordnance" really means munitions of war, and as these now include almost anything, so the scope of the R.A.O.C. is indeed wide.

The Corps is concerned with the supply and maintenance of equipment of all kinds, and is divided into two sections; there is the stores side, concerned with the supply of everything from a tank to a gas mask, and there is the engineering side, which looks after repairs and maintenance. On both sides wireless is of considerable importance, partly because it is so widely used in the modern army and partly because it demands specialist personnel. On the one hand the R.A.O.C. supplies wireless equipment of all kinds to those units, such as the Royal Corps of Signals, which operate it in the field, and on the other hand it carries out the more serious of the repairs which are inevitably necessary after repairs and maintenance. On both sides wireless is of considerable importance, partly because it is so widely used in the modern army and partly because it demands specialist personnel. On the one hand the R.A.O.C. supplies wireless equipment of all kinds to those units, such as the Royal Corps of Signals, which operate it in the field, and on the other hand it carries out the more serious of the repairs which are inevitably necessary from time to time.

It should be understood that in addition to purely wireless apparatus, allied equipment is dealt with by the same departments. Thus, a wireless repair workshop does not confine itself only to wireless sets, but handles field telephones and other equipment of similar nature.

For obvious reasons little can be said about the equipment, and it is sufficient to point out that the wireless apparatus includes transmitters and receivers ranging from the older well-tried designs to the complex systems evolved by modern technique.

Skilled personnel is clearly necessary for the repair and overhaul of such apparatus, and the main work is done in permanent workshops, which are well equipped with testing apparatus and receivers ranging from the older well-tried designs to the complex systems evolved by modern technique.

The maintenance of communications is a vital necessity in modern warfare, and in the case of the Army it is the Royal Army Ordnance Corps which is responsible for all major repairs to wireless equipment. In this article the wireless work of the R.A.O.C. is described both in its main function of effecting repairs and in its secondary activity of training the necessary personnel.

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for ganging, a beat-frequency audio oscillator, and a crystal calibrator or wavemeter.

On arrival in the workshop for repair a wireless set is first given a visual inspection to ascertain its mechanical condition. The controls are all tried and any mechanical defects are first put right.

Calibration is necessary for Army sets, and the workshop must thus have means of measuring frequency accurately. Following the usual practice, sets and wavemeters are calibrated from shop standards, which are frequently checked by a primary standard having an accuracy rather better than 1 part in 10^5.

All work is not done in a fixed work-

shop such as has been described, and mobile workshops are also employed. A mobile workshop consists of a lorry fitted out in a manner very similar to that of a test room. The lorry is completely screened and just as fully equipped as one of the test rooms of a main workshop. Similar types of test apparatus are fitted and a high standard of accuracy in measurement is obtained.

**Travelling Workshops**

The lorry is equipped for minor mechanical repairs and carries a stock of spare parts, so that if necessary quite a lot can be done in the way of repairs. It is usually more economical of time and labour for repairs to be done at a main workshop, however, and the mobile test room is used largely to determine the condition of sets in the hands of units.

The test apparatus carried is largely AC operated, and wherever possible the lorry is connected to an AC supply. Everything can be worked from batteries, however, and the lorry can function as an independent unit far away from any supply mains.

All this test equipment would be of no use without the right men to operate it. In the main workshops both civilians and military are employed and in wartime the latter usually predominate. The workshop is in charge of an officer who is a wireless specialist. Under him come Warrant Officers and N.C.O.s, who are usually Armament Artificers' (Wireless), tradesmen and, if there are civilians employed, a civilian foreman.

R.A.O.C. personnel are grouped

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In a wireless repair workshop. This is where the mechanical part of repairing wireless apparatus is done; the shop is well equipped for such work, and is well lighted, warm and airy.

When in mechanically good condition the set is passed to a test room, where it is checked for electrical faults and adjusted. It then passes to the "Out Inspector," who checks it to ensure that its performance is up to standard. The set is tested on "Receive" for sensitivity, selectivity, image interference (in the case of superheterodynes), frequency calibration, A.V.C., etc., and on "Send" for output, modulation, frequency calibration again and so on.

The limits are quite close and no set can get through the tests unless it is in really first-class condition. With such precision methods the chance of a fault escaping detection is negligible and it is frequently possible to catch a defect in the process of development. In its early stages, for instance, a fault may cause no symptoms beyond a small reduction in sensitivity, which would not be noticeable in normal operation, or even with the usual somewhat rough and ready tests used in broadcast set repair.

When such an effect is noted during the Army test procedure, however, its cause is sought and remedied. In this way many major breakdowns in operation have undoubtedly been prevented.

A high standard of accuracy of cali-
Wireless in the R.A.O.C.—

according to their trade, and it is usual to have a number of storemen and clerks, who usually range from privates to a corporal or a sergeant, while those employed on wireless repairs are wireless mechanics.

There are three grades of wireless mechanic and the rank is usually that of private, although corporals and sergeants are to be found, and lance-corporals are not uncommon. Men are graded by means of a trade test and receive tradesmen’s rates of pay according to their grading.

The lowest grade, Class III, is normally employed on bench work in carrying out the mechanical repairs to apparatus. The next grade, Class II, is often similarly employed, but normally on work demanding a higher standard of skill. This grade may also be used on fault-finding and set testing, if particularly able.

The highest grade, Class I, usually does only the most-skilled bench work and is generally occupied with set testing. In most cases, however, set testing and fault-finding are carried out by Staff Sergeants, who are

General view in a training school. In this part of the building students work with apparatus, handling testing and measuring instruments as well as wireless sets.

Armament Artificers specialising in wireless. The Warrant Officer, who is also an Armament Artificer (Wireless), may be a Sergeant-Major (Class I) or a Quartermaster-Sergeant (Class II). In the normal course of events his duties are as much administrative as technical and he will probably only carry out any work on a wireless set himself when any special difficulty crops up. He will, for instance, investigate a fault which has eluded his subordinates.

Officers’ Duties

The officer in charge of the workshop is a wireless specialist and is frequently an Ordnance Mechanical Engineer (O.M.E., for short), 4th Class, with rank of lieutenant. In some cases he is an O.M.E. 3rd Class or even 2nd Class, with rank of Captain or Major respectively. His duties include the administration of the workshop, making arrangements with other units for the repair and inspection of their equipment, giving advice and assistance on technical matters to any who need it, the investigation and repairs of defects which could be remedied by a change of design, and so on. In addition, he is the final court of appeal to his subordinates in any technical difficulty and must always be prepared to undertake fault-finding and set testing himself.

For all ranks the work is of an interesting kind and is performed under good conditions. Workshops are necessarily dry and warm, but even in mobile test lorries steps are taken to alleviate the worst of the vagaries of the climate.

In addition to the repair and maintenance of wireless and telephone equipment, the R.A.O.C. carries on the training of wireless personnel. Training, indeed, forms an exceedingly important branch of its activities.

Wireless World

Anyone with an adequate knowledge of wireless, or who is considered to be able to acquire an adequate knowledge after training, can join the R.A.O.C. After the usual preliminary military training, he is given a trade test to determine the extent of his wireless knowledge. If he does sufficiently well in this test he is, after a short course on Army apparatus, classified Wireless Mechanic, Class III or Class II, according to his ability, and he receives the appropriate higher rate of pay.

Should he fail in the test, but show sufficient knowledge to make it likely that he would reach the standard of Wireless Mechanic Class III after training, he will be listed as a Wireless Mechanic (unclassified). He will then go on a course of instruction lasting some five months. After this he will be trade tested again and he should now qualify at Class III standard. He will then be posted to a workshop or other unit, where he will be employed at his trade.

After he has gained experience and acquired new knowledge in the course of his work he can be again trade tested and graded Class II if his ability justifies it. Theoretically, after gaining still more experience he can reach Class I standard, but in wartime he is liable to miss this rung of the ladder and go straight on to the next step.

Any man who at any time passes his trade test as Class II or Class I can be recommended by his commanding officer for Armament Artificer (Wireless). He may be a new recruit fresh from his initial military training or he may be an old-stager. That makes no difference; all that is necessary is that he should have the proper qualifications.

The technical requirement is more than a mere pass in the trade test for Wireless Mechanic Class II; he should have a knowledge of wireless theory

Prospects of Promotion

On being recommended for an Armament Artificer (Wireless) a man goes on a special technical course lasting about three months. At the end there is an examination. If he passes this and his conduct has been such as to confirm the earlier recommendation he becomes a Staff Sergeant with effect from the date of his entry on the
Wireless in the R.A.O.C.—

The training of Armament Artificers and O.M.E.s is carried out at the Military College of Science. Both have courses of a similar nature, but for the O.M.E.s the longer of the two courses takes place at a training centre. This photograph shows a lecture in one of the classrooms of a training school.

An Armament Artificer's course begins with Armoury work at one of the technical training centres. Here the Artificer sees and handles the Army wireless sets and Army equipment. He is initiated into the mysteries of their construction. A final test follows the course, and he is ready for duty as a Wireless Mechanic.

The Armament Artificer's course again and passed the final examination.

At the present time there is ample scope for the right type of man in the R.A.O.C., and no one with the necessary qualifications or the ability to learn can complain of lack of opportunity. If a man enters the Army with the technical knowledge needed to take the Armament Artificer's course, he can be a Staff Sergeant within about five months.

Promotion to higher rank is necessarily slower and depends largely upon ability and experience, but the opportunity is there. There is, too, always the possibility of promotion to commissioned rank. Suitable men or N.C.O.s are picked out and sent to an Officer Cadet Training Unit and afterwards commissioned.

Qualifications for Commissions

Suitable men are still needed as officers and can be enlisted straight from civil life. The technical requirements are a thorough knowledge of wireless theory and practice, and an applicant should have had some recognised training or apprenticeship. He must possess a degree or its equivalent he is normally commissioned as a Lieutenant O.M.E., 4th Class, but otherwise as a 2nd Lieutenant.

After passing through an O.C.T.U. he is commissioned and then goes on to a five months' technical course on which his wireless theory is brushed up and he becomes familiar with the Army wireless and telephone equipment. There are various examinations during the course and if he passes these successfully he is posted for duty as an O.M.E. (Wireless).

For all ranks both training and subsequent work are of an interesting nature and appeal particularly to those who have been engaged on wireless work in their civilian life. Not only is it in the national interest that all wireless men entering the Army should be engaged on technical work, for they require less training than the non-technical, but it is in their own interests. For the duration of the war they will still be engaged at their normal work, even if under somewhat different conditions, with the result that when peace comes again they will be in an ideal position for the resumption of their civilian activities. They will be technically up-to-date and the possessors of a large amount of practical experience. Many who return to their old jobs will be far more efficient than they were before the war.

In conclusion, a few words about technical training methods may be of interest. The Wireless Mechanic starts his training with a 16 weeks' course at one of the technical training centres. During this time he is taught how to use and look after tools—a part of the course which includes filing, drilling, tapping and soldering—elementary wireless theory, and simple fault-finding. Throughout the course every effort is made to link theory with practice.

When he has successfully passed the examination at the end of this basic course, he goes to another training school for a period of some six weeks, where he is initiated into the mysteries of Army equipment. Here he sees and handles the Army wireless sets and telephones and becomes familiar with their construction. A final test follows the course, and he is ready for duty as a Wireless Mechanic.
Propagation of Short Waves

II.—Choosing the Best Wavelength

By D. W. HEIGHTMAN

In considering reception from (or, transmission to) any part of the world we have to bear in mind the fact that the signal travels in a straight line, in the horizontal plane, between the transmitter and the receiver, i.e., over the "great circle" distance. Unless one has previously studied the matter it is often found that one has quite wrong ideas as to the true directions of many of the more distant parts of the world. It comes as a surprise, for instance, to many people to learn that the true direction of New Zealand from this country is north-east.

Fig. 1 gives approximately the correct directions and distances from London of some of the well-known broadcasting centres in various parts of the world. A globe or great circle map such as that published by The Wireless World are useful to have by one for reference in this connection.

Certain of the more distant countries such as New Zealand and Australia can be communicated with both ways round the world. In the case of these two countries signals may come in from north-easterly directions or from south-westerly directions. The direction adopted depends on the most suitable distribution of daylight over the signal path at the desired time of communication. This matter, of course, becomes important when directional aerials are used.

Reverting to the main topic, from Part I it was seen that, in short-wave reception or transmission, we have to arrange the frequency and aerial directivity to suit (a) existing conditions in the ionosphere and (b) the distance and direction over which it is desired to communicate. Because (a) varies from hour to hour, particularly from day to night, with the season of the year, with the sunspot cycle of eleven years and occasionally due to the irregular nature of the sun's radiation, it is not possible to formulate exact rules to suit all communication requirements. Nevertheless, it is now possible to forecast, with reasonable accuracy, optimum frequencies for any particular distance, direction and time, assuming that no ionosphere disturbance takes place and that average conditions prevail.

The accompanying table represents an attempt to provide data in fairly convenient form on the optimum frequencies for use in this country at various times and seasons. The optimum frequencies represent values about 15 per cent less than the maximum usable frequency.

Sunlight and Darkness

For long-distance reception in this country there are three main directions to be considered independently, i.e., easterly, particularly between east and north-east; southerly, which includes all directions south of east or west and westerly, particularly between west and north-west. These divisions are necessary because of the different distribution of sunlight or darkness over the different signal paths. Southerly directions present more reliable conditions due to the more even distribution of sunlight north-south than east-west (also due to the fact that the signal paths are far removed from the earth's polar regions).
Propagation of Short Waves—
Over easterly or westerly paths part of the signal route may be in sunlight and the remainder in darkness, so that at one end of the route we may have a high optimum frequency and at the other a low frequency. To cover the whole route a frequency between these two extremes has to be used. Under some conditions no communication over such a route is possible because the low frequency signal necessary at one end is rapidly attenuated on reaching the daylight end of the circuit.

The seasonal variation in ionosphere conditions is allowed for in the table by the division of the year into winter, equinoctial and summer months. The figures given represent average values for this year (1941), which is a little more than half-way between sunspot maximum and sunspot minimum years. At the sunspot minimum, expected to occur about 1943, the optimum frequencies will be about 85 per cent. of the values given, while at the next sunspot maximum, due about 1947-8, the optimum frequencies will be approximately half as much again as the values given. For example, in the winter afternoons of 1947 we can expect the optimum frequency over distances of 3,000 miles or so to the westward (U.S.A., etc.) to be about 30 Mc/s instead of 20 Mc/s, as at present, while, in the next year or two, this value will probably drop to about 17 Mc/s. Intermediate years will, of course, give intermediate values which will be fairly easy to arrive at, if we remember that sunspot maximum values are nearly twice those at the sunspot minimum and that the average sunspot cycle is eleven years.

Interpreting the Data
In using the table of optimum frequencies it can be assumed that the values given under "E", "S", and "W" will be reasonably accurate for directions between east and north-east and west and north-west respectively. Directions between south-east and east and south-west and west will generally have values intermediate between those given for "E" and "S" and "W" respectively. The figures given under "S" will be reasonably accurate for directions between south-east and south-west, it being remembered that, while the SE direction will "open up" earlier in the day, the SW direction will continue "open" when, with the approach of night, the SE route has closed for the higher frequencies. Distances and times not given in the table, of course, require interpolation of values intermediate between the two nearest values given.

Since the earth, at any particular time, is only affected by radiation from the central zone of the sun, there is a tendency for good, poor or disturbed conditions to re-occur at approximately 27-day intervals. This period is, of course, the time required for one rotation of the sun. The rule only holds good, however, if no alterations have taken place on the sun during its rotation.

Due to the fact that signals generally travel over several constantly varying paths in their passage through the ionosphere, considerable trouble is experienced with fading, the received signal being the result of the additive or neutralising effects of the several waves actually arriving at the receiving aerial. It has been found, for instance, that transatlantic signals arrive over three or four main paths at vertical angles of between 10 deg. and 30 deg. A wave travelling over a slightly shorter path will arrive at the receiving aerial a fraction of a second sooner than a wave which has followed a rather longer path. Hence the waves will be out of phase and interfere with one another. In the worst case, seldom met in practice, the waves will be of equal strength but opposite phase, thus cancelling each other so that no signal appears at the receiver input.

Overcoming Fading
Beyond using a well-designed AVC system and an aerial giving the best possible pick-up, there is little that the ordinary listener can do to combat fading. In elaborate systems, for commercial use, etc., there is available the diversity method where two or more aerials, spaced some distance apart (ten wavelengths or more) are used. The outputs of the two aerials are combined in a dual receiver, and, as a signal will seldom be zero at the two aerials at the same time, it is possible to maintain a more level output. In the complicated MUSA system used by the G.P.O. the aerials and receiver are arranged so that a very sharp vertical directivity is obtained. In this way reception can be concentrated on one main signal path, thus largely cutting out the other interfering waves arriving at different angles.
Propagation of Short Waves—

A form of fading, known as selective fading, also causes distortion of telephony signals. A modulated (telephony) carrier wave actually consists of the main carrier frequency plus extra side frequencies (side bands). (E.g., suppose a single pure 5,000-cycle note is being transmitted on a 15-Mc/s carrier; we shall then have radiated frequencies of 14,995, 15,000, and 15,005 kc/s.)

These side bands can fade independently of the main carrier and also, since they are of slightly different frequency, travel over paths of slightly different length, resulting in their arrival at the receiver in a different order. 

The receiver by the shortest route transmitter, and in this way causing their arrival at the receiver in a different length, resulting in a frequency, since they are of slightly different order of the main carrier and also, frequently signals, especially from powerful transmitters, are receivable within the skip distance. These signals are due to a variety of causes, some known and others at present being investigated, but as they are generally unreliable and of low intensity they need not be considered in detail here.

Echo Effects

While a signal generally reaches the receiver by the shortest route from the transmitter, it can, under certain conditions, also travel in the opposite direction round the world. As the round-the-world signal has a considerably longer distance to travel it arrives at the receiver a fraction of a second after the short-path signal, thus causing echo effects. The time delay for a signal which has travelled completely round the world is of the order of one-seventh of a second. Occasionally signals are observed which have travelled round the world two or more times. Suitable conditions for echo signals occur when the distribution of ionisation is fairly uniform over the whole round-the-world path. These conditions are satisfied over different paths according to the time of day and season of the year. For instance, in the winter mornings a signal can leave this country in a north-easterly direction, travelling over northern Russia, where it is midday, Siberia, Japan, and thence to the South Pacific, where it is summer midnight, and returning over South America and the Atlantic, where dawn has already broken. Stations located in countries around this round-the-world path will all exhibit echo effects to a greater or less degree.

Echo effects are avoided the extreme variations in optimum frequency, from complete darkness to broad daylight, obtained over east or west paths. During the winter in the northern hemisphere the South Pole is illuminated throughout the 24 hours, so that, even though it be midnight in the southern hemisphere, a signal route passing fairly near to the South Pole will only have to pass through a twilight zone and no complete darkness. (See Fig. 2.) Similarly, in the northern summer the North Pole is illuminated throughout the 24 hours and in the early summer mornings the echo path then is to the north-west, via North America, and back via South Africa. Several other round-the-world echo paths exist for various times and seasons, but the above examples should serve to illustrate the requirements for such a route.

BOOKS ON WIRELESS

Issued in conjunction with "The Wireless World"

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<td>7/6</td>
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<td>&quot;RADIO INTERFERENCE SUPPRESSION,&quot; by Gordon W. Ingram, B.Sc.</td>
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<td>8/-</td>
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<td>&quot;THE WIRELESS WORLD&quot; GREAT CIRCLE PROJECTION MAP</td>
<td>2/- Post free</td>
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ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1
Economies in Receiver Manufacture

By “SERVICE”

Broadcast receiver manufacturers are finding it more and more difficult to maintain the pre-war elaboration of their designs, and many changes are to be found in the sets which are now, or will shortly be, marketed.

Many readers of The Wireless World, especially those who are service engineers, use manufacturer's service manuals giving technical information concerning their receivers with circuit diagrams, valve current and voltage tables and lists of components. The data provided in these publications is generally very accurate, but future issues of these manuals dealing with wartime productions may have to be regarded more as guides rather than authoritative sources of information as to what will be found in the receivers. If manufacturers cannot maintain their stocks of a certain part used in the receiver during the assembly of the instrument they will have to switch over to a suitable substitute, and even then supplies of the substitute may give out before full production has been completed, necessitating a further change.

Thus, for any particular component given in the spare parts list there may be three different types, any one of which may be found in the receiver under examination. Similarly, if a component part becomes faulty beyond repair, and a replacement has to be ordered, quite a different looking accessory may arrive from the manufacturer and the service engineer may have to use his initiative as to the best way of incorporating it in the receiver. Manufacturers will, naturally, try to keep their customers informed of such changes, and parts which are sent out as substitutes will probably be accompanied by special instructions stating how they can be used in place of the original part.

Sacrificing Appearance

Another aspect is the condition in which spare parts may be delivered. Manufacturers are having to conserve their material to the utmost, and with the reduced sales cost of production must be kept as low as possible. Many parts that are returned for replacement will have to be repaired, but it is quite likely that they will not acquire the finish and brand new appearance given to them in normal times. If the component is technically sound it must be accepted as being a standard replacement.

With regard to the influence of the war on the type of receiver which will be manufactured for the duration, cabinet work will be the most obvious evidence of the difficulties with which set makers are grappling. The lack of proper wood from which cabinets may be economically mass produced has forced a number of manufacturers to go over to bakelite cabinets for home markets. (Timber for cabinets of export receivers is available under Government permits to manufacturers.) This has made quite a change in their standard of reproduction due to the different acoustic properties of plastic material. This is accentuated by the very small loud speaker units which are being produced for reasons of economy. It is not that the quality is poor, but it is probably below the very high standard for which some of the larger manufacturers were renowned.

Shortage of timber will certainly affect radio-gramophone production as so much more is used in these large instruments than in table models. Where manufacturers are able to obtain a certain amount of timber it is quite likely that they will use it all on their radio-gramophones and employ bakelite for table receivers. Even so, the production of anything like normal quantities of radio-gramophones will be quite out of the question, and it is probable that a simple record player housed, perhaps, in a bakelite cabinet will be offered to those who desire to have record reproduction in the home.

Smaller Motors

The subject of radio-gramophones brings up the question of motors. These components incorporate a fair amount of iron and copper and designers are searching for methods by which this can be reduced. They will undoubtedly bring out smaller types if at all possible, at least for radio-gramophones if not for automatic record player mechanisms which require a more power-saving device.
Economies in Receiver Manufacture—

ful driving unit. For straightforward turntable driving quite small, high-speed motors are effective, and with suitable gearing power units such as are used for tuning and wavechange motors in the more elaborate type of receiver may be found to have sufficient torque for driving the turntable at a constant speed.

Bakelite Chassis

Economy in metal will mostly be manifested in the design of the chassis itself, and a major saving is effected if a metal chassis can be dispensed with and a bakelite one substituted. The employment of a bakelite or wood framework as a foundation for the chassis is being seriously contemplated by some manufacturers.

A general trend towards the simplification of wartime receivers will help in this direction, because the circuits will be straightforward, with quite average sensitivity, and should allow of the very minimum of screening. With a carefully considered layout it is possible to dispense with screening for such items as IF transformers and provide merely a thin bent screen, chiefly to shield the transformer from adjacent wiring and components, instead of totally enclosing it, as is usual, in a screening can.

Resistance capacity coupling in the AF circuit will save another small transformer, while the use of metallised valves will do away with valve screening cans.

Tons of valuable aluminium have gone into the making of tubular electrolytic condensers in the past, and it is quite likely that this familiar component will be supplied only in cardboard containers in the future.

Some manufacturers are considering the production of a receiver which will remain their standard "line" for the duration of the war, in order that they may have as wide a market as possible with the minimum of design and layout expense. It will, most likely, take the form of an AC/DC receiver, which has a great advantage over an AC model where economy of metal is concerned, as it has no mains transformer. By employing a line cord for the mains voltage-dropping resistance the heat from this necessary component can be kept outside the cabinet, which can thus be of smaller dimensions. As to the smoothing circuits, the majority of mains supplies in this country are of good quality and do not need the high order of smoothing facilities incorporated in most receivers to give a low hum level. Smoothing circuits may be quite satisfactorily cut down by using smaller chokes (or loud-speaker field coils) and condensers, the argument being that the receiver is a wartime standard article which will give good results on standard mains under standard conditions of aerial and earth. Any particular set of adverse conditions must be dealt with individually, and extra smoothing incorporated at an appropriate charge.

As an example of wartime receiver production, one well-known manufacturer has brought out a model in which several of the above-mentioned economies have been effected. The new Murphy ADQ4 is the first receiver manufactured by Murphy's to have a bakelite cabinet, and its designers have, with great intrepidity, eliminated the long-wave range and confined the receiver to the reception of short and medium waves. There is not much of interest on the long-wave band in these times, and the saving in coils and switching is well worth while. Such items as the tone control and extra loud-speaker switches have been deleted, and there is no IF filter in the aerial circuit.

It is to be expected that other manufacturers will follow this lead, and service engineers will at least have some reason to be thankful for conditions which have produced a more simple receiver for them to get used to in these difficult times.

The Wireless Industry

TWO very informative instruction manuals have recently been issued by A. C. Cossor, Ltd., Highbury Grove, London, N.5. They deal with the Model 3389 AC impedance bridge and the Model 3339 double-beam oscillograph. In addition to operating instructions for the particular instruments concerned, there is much useful general information on measurement technique in a number of applications. The price of these manuals (one copy being supplied with the instrument free) is 1s. 6d. for the Model 3389 and 2s. 6d. for the Model 3339.

Varley Dry Accumulators, Ltd., By-Pass Road, Barkingside, Essex, have prepared a list of the principal portable receivers indicating the type of dry accumulator which is applicable in each case.

The Tin Research Institute, Fraser Road, Greenford, Middlesex, have prepared a comprehensive technical booklet (Publication No. 102) on "Hot Tinning," and the processes involved in the hot dipping of ferrous and non-ferrous articles. The scope of the work is wide and covers all classes of manufactured articles.

The new address of Stratton and Co., Ltd. (Eddystone), is Lapsworth Court, Old Warwick Road, Lapsworth, Warwickshire.

A treatise on flexible remote controls has been issued by The S.S. White Co., of Great Britain, Ltd., St. Pancras Way, Camden Town, London, N.W.1. Manufacturers of special receivers will find all the technical information on the mechanical properties and application procedure which may be required in adapting controls of this type to their needs.

Cossor Model 74 — A Correction

Will readers kindly note that the Cossor Model 74 reviewed in our last issue was incorrectly described in the title as Model 74A.

MARCH, 1941.
The last Bush receiver to be reviewed in this journal was the PB63 (February, 1940 issue), in which permeability-tuned push-button circuits were provided for six stations—two on long and four on medium wavelengths. Since that time the public interest in long waves and, to a certain extent in medium waves, has diminished, and the demand is for a set which will give, in addition to the Home and Forces programmes, a good performance on short waves with the maximum possible ease of handling.

The PB73 fits neatly into this scheme of things. Two push-buttons are retained for pre-setting to any station lying between 325 and 550 metres on the medium-wave band, and four are used to select the short-wave broadcast bands on which the most interesting transmissions are to be found.

Each of these bands is expanded to the full depth of the tuning scale, and there is ample room for the calibration and naming of individual stations on adjacent channels. Continuous tuning is retained over the medium- and long-wave ranges, and the remaining two push-buttons are used to switch-in these bands.

Circuit.—A single-tuned circuit precedes the frequency changer. On medium and long waves it is tuned by the main gang condenser, but on
short waves it is pre-set by trimming capacities to the mid-point of each band, the aerial damping being sufficient to ensure wide-enough coverage. The aerial section of the push-button switch also includes contacts for the separate scale lamps used on each waverange, but these have been omitted to simplify the circuit.

A frame aerial consisting of a few turns in series with a small RF choke is mounted horizontally on the underside of the roof of the cabinet. It terminates in plugs which fit into the normal aerial and earth sockets.

The frequency changer is a triode hexode, and on medium and long waves the oscillator section makes use of a parallel-fed reaction circuit. When the medium-wave pre-set station buttons are depressed, the tuning condenser is disconnected and the circuit is tuned by switching an inductance in parallel with the main silvered-mica tuning condensers. Both primary and secondary circuits in the output transformer are tapped down for the AVC and signal diode circuits.

AVC is delayed and is applied to the frequency changer, and IF stage on medium and long waves, but only on the IF on the short-wave bands. Resistance coupling follows the triode section of the detector stage, and tone control is applied in the anode circuit of the pentode output valve. A centre-tapped capacity filter is connected across the mains input to the set.

Performance. — The sensitivity on all four short-wave bands is amply sufficient to make the most of any signal above the prevailing noise level, and American stations can be received with ease. Thanks to the bandspread circuits, the tuning is free from effort as it is on the medium waveband, and the accuracy of station calibrations is sufficiently close to eliminate any ambiguity as to the identity of adjacent stations.

Reception on the medium- and long-wave ranges is unusually clear and free from self-generated whistles. The background noise between stations is low, and there is no trace of mains-borne interference. Selectivity is everything that is should be, and there can be no doubt that the radio performance in general is sufficiently advanced to meet not only immediate conditions but those which may be expected to prevail immediately after the war.

The quality of reproduction is good, and the normal setting of the tone control with maximum high-note response gives a good balance of tone at average volume levels. When the volume is tuned up to maximum, there appears to be some increase in the proportion of high frequencies, and the tone control can then be used with advantage to restore the balance.

Construcational Features. — The chassis is deep, and accommodates the gang condenser below the main deck, where it is kept free from dust. It is mounted on the right of the coil assembly, which can be removed as a single unit together with the push-button switch rack. The scale frame is of substantial construction, and the design is well thought out, from the point of view of even illumination over each scale.


WAVERANGES

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<th>Medium</th>
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<td>24.85 - 25.8 m</td>
<td>31.85 - 32.85 m</td>
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<tr>
<td>Long</td>
<td>19.8 - 20.1 m</td>
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(Including Purchase Tax)
THE WORLD OF WIRELESS

THE RADIO INDUSTRY
R.M.A. Activities in 1940

The busiest year in the history of the Radio Manufacturers' Association was reviewed at its annual general meeting held on January 24th, at which the chair was taken by Mr. M. M. Macqueen in the absence of the president, Lord Hirst. The report of the Executive Council, in which considerable space is devoted to reviewing the position regarding the supply of raw materials and export, reveals the importance of these two aspects of the Association's work in the present emergency. Mr. Macqueen recalled that the wireless industry was beaten by only a few days by the motor industry in approaching the Board of Trade on the question of the supply of raw materials.

Space will not permit more than a few extracts from the report, which ran into many thousands of words.

Export.—During the year 120,000 receivers were built for export. It is planned to produce approximately 230,000 receivers during 1941, and specifications are being prepared for a cheap two-valve local-station receiver to be marketed in India at a landed cost of 4.

Modern Tendencies in the Design of British Battery-Fed Receivers.

Imported Apparatus.—Following representations by the Association to the Board of Trade and the Treasury, importations of radio apparatus and parts have been prohibited except under a Board of Trade licence.

Substitutes.—Materials. When it was realised that aluminium would cease to be available for condenser vanes, it was proposed that sheet zinc be adopted, with brass as an alternative.

FM STATIONS

New System of Call Signs

The U.S. Federal Communications Commission has adopted a system of call signs for frequency-modulated transmitters which indicate the frequency employed and the geographical position of the transmitter.

The first letter in the call will be K or W, indicating West or East respectively. This will be followed by a number between 42 and 50, which will indicate the second and third figures of the frequency in kilocycles.

The first figure of the frequency is always four, as FM frequency allocations range from 42,000 to 50,000 kc/s, with 200 kc/s separation. The call ends with a letter or letters which denote the city in which the transmitter is located. To identify educational stations E will be used.

The reason for employing K and W to indicate West or East is that they are two of the three international prefix letters assigned to the U.S.A. The third is N, which is reserved for the U.S. Navy and coastguards.

THE WORLD OF WIRELESS

PAN-AMERICAN NETWORK

C.B.S. Enterprise

A FUNDAMENTALLY new scheme in overseas broadcasting is announced by the Columbia Broadcasting System following a seven weeks' tour of investigation by Mr. William S. Paley, president, to determine what C.B.S. could do to further the U.S.A.'s "good neighbour policy" with Central and South America.

Having proved conclusively that the short-wave transmission of N. American programs through Latin America was not sufficient, since most listeners in those countries tune to their local stations just as they do in the U.S., a C.B.S. Latin-American network was formed. This network, which will cover eighteen of the twenty South American Republics (Haiti and Honduras are not yet included), will consist of 39 medium- and 25 short-wave stations. The short-wave transmissions are intended to serve the interior.

This network will be made possible by the opening of two new 50-kW short-wave transmitters WCBX and WCRC. The transmissions, which will be radiated from an aerial system consisting of eight directional arrays, will be picked up on special receiving equipment at each group of stations and rebroadcast.

The Latin-American stations have agreed to rebroadcast the C.B.S. programs for at least one hour a day. The arrangement is reciprocal and the C.B.S. has, therefore, undertaken to rebroadcast program originating in the Latin-American countries.

WHITHER AMATEUR RADIO?

"This war, like the last, is giving a tremendous stimulus to technical advances in radio communication," writes the editor of the official journal of the Canadian Operators' Association. He foresees an overwhelming rush into amateur radio after the war of men who have become proficient in radio communication while on active service.

The possibility that some commercial interests may seize the opportunity of claiming amateur frequencies for their "supposedly more valuable services" is stressed by the writer. "The most cogent argument in our favour," he says, "will be the record of services that we have been able to render through our training as radio amateurs...."
will take the place that they should occupy in Empire and world communication, and the British Empire Radio Union will exist in fact as well as in name."

**BRIT. I.R.E. AND I.W.T.**

**Plans for Combining Forces**

**FUSION** between the Institute of Wireless Technology and the British Institution of Radio Engineers was, in principle, agreed upon at a joint meeting of the two societies held on January 18th. Certain technical and legal matters outstanding are to be settled by a Committee on which both bodies are represented, and it is expected that the fusion will be completed by March 31st.

According to a statement issued jointly, the objects of the two institutions being similar, fusion should strengthen the work of each body in fulfilling its purpose.

The offices of the combined body are at Duke Street House, Duke Street, London, W.1.

**MURPHY SERVICE TRAINING PLAN**

The task of maintaining some nine and a half million domestic receivers with a trained personnel seriously depleted by the calls from the services is the tough proposition facing dealers' service departments in 1941.

Having tried with little success to conduct a short training course for juniors last year, and realising that in the present emergency the chief drawback to standard correspondence courses for servicemen is that they take many months to complete, Murphy Radio is negotiating to conduct, at a reasonable price, a condensed course concentrating on the essential theory required in practical servicing.

**VALVE PROGRESS**

Mr. W. J. Picken, the new chairman of the I.E.E. Wireless Section, in his inaugural address, recorded the growth of the section from 529 members in 1930 to 1,133. His address was on the history of the development of the transmitting valve. The advantages of air cooling were stressed, and Mr. Picken said, "The highest power cooled-anode valves will soon be available for cooling either by means of water or by means of forced air." Remarking that the evolution of the transmitting valve is often influenced by that of the receiving valve, Mr. Picken said, it is to be hoped that it will not be forced to follow the receiving valve as it goes merrily along adding electrode to electrode.

**RECONDITIONED RECEIVERS**

**Purchase Tax Position**

A recent announcement by H.M. Customs and Excise defines the position of second-hand or reconditioned receivers. No tax is chargeable on such sets where transactions are between retailers and their customers. Where a retail branch of a registered firm of manufacturers "acquires a set from a customer, reconditions it to an extent not involving manufacture, and resells it retail," no liability for tax is involved.

Any chargeable parts or materials used in the reconditioning will normally have been taxed at an earlier stage.

**NAZI WIRELESS TRICKS ?**

**A.R.R.L. Warns U.S. Amateurs**

The following message, intercepted by a reader, has been passed on to us. It was received from W4PB on about 14,32 Mc/s on January 19th. "D" is, of course, the international prefix for German stations.

QST de W4PB = N1918; W4PBck76: official A.R.R.L. message; West Hartford, Conn.; January 13, 1941—To All Radio Amateurs—W2KYT advises that a phoney station on 7,090 kc/s signing K4KP is D4TKP stop he believes that HR1AT is also another D station stop separate advices indicate a 14-Mc/s station signing K4ARR to be D4ARR stop the League cautions all United States amateurs to be wary of calling or working any stations that may turn out to be in foreign lands because of certainty of FCC difficulty from any violations of order number 72.

**NEWS FROM GREECE**

News of the war in Albania and the situation in the Balkans can be heard each evening in an English bulletin broadcast from Athens. It is radiated by the courtesy of Cable and Wireless from the company's transmitter on a frequency of 9,935 Mc/s (30,160 metres) beamed on Great Britain.

The transmission, which is from 8.40 to 9 p.m. B.S.T., opens with the Greek National Anthem, which is followed by the British National Anthem. The news begins at 8.45.

**WAR is the significant call sign of the United States War Department's Net Control Station.** By recently exchanging messages with W1AW, the headquarters station of the American Radio Relay League, WAR inaugurated a schedule for contacts with amateurs on 4,025 and 13,320 kc/s at specific periods. It is hoped that the scheme will "foster closer relations between the Signal Corps and the radio amateur for mutual benefit."

**W.B.C. OVERSEA TRANSMISSIONS**

Further developments in the B.B.C. Oversea Service were introduced on February 16th, and the service will be still further extended early in March. There are now in effect six oversea services from this country operating for a total of 54 1/2 hours a
day. In September, 1939, only nine foreign language transmissions were radiated by the B.B.C.; now 32 are being heard in the homes of the transmitter, too, has been greatly increased.

The service is now split up as follows:
2. Second World Service, 2 hours daily. Broadcasts daily in Hindustani and Afrikans, weekly in Burmese and Maltese, and occasionally other languages, such as Malay. There are also regular broadcasts in English for Indian listeners.
3. Main European Service, 20 hours daily, carrying broadcasts in German, French, Italian, Dutch and Flemish and the languages of Central Europe.
4. Second European Service, 5 hours daily, for broadcasts to Spain and Portugal, the Scandinavian countries and the Balkans.
5. Latin-American Service, 4 hours daily, for broadcasts in Spanish and Portuguese to South America.
6. Near East Service, 21 hours daily, for broadcasts in Arabic, Persian and Turkish.

FROM ALL QUARTERS
America's Receiver Output
American radio manufacturers produced eleven million receivers during 1940, which was two millions more than in the preceding year. The Institute of Radio Engineers announces that 52 per cent of the year's total were table models and 48 per cent car radio receivers. An increase in the popularity of console radiograms, which account for 7 per cent, is noted. According to our U.S. correspondents, Radio To-day, there are one thousand and sixty-four radio manufacturers in the States.

A Unique Verification Card
A New Zealand correspondent of our contemporary, The Australasian Radio World, has received a novel verification from station KGIR on a sheet of copper. The station, which operates on 1340 kc/s but will soon change to 1370 kc/s, is situated in Butte, Montana, U.S.A., which is the centre of the largest copper mining district in the world. A minute copper buffalo was also received.

B.B.C. Short-wave News
Broadcasts of News in English in the European and World Services of the B.B.C. take place at the times (B.S.T.) given below. In the majority of cases transmission is made on all the short-wave bands appropriate for the time of day, though a smaller number of channels is used for the European bulletins, the times of which are marked with an asterisk. The station, WSM, has been granted a 20-kW FM licence for an area covering 16,000 square miles.

Refractions
"Crowd emotions are rare in broadcasting, but individual reactions are often intense. A misspelling in a newspaper passes without comment, but a mispronunciation on the wireless is sometimes taken as a personal affront," said Mr. F. W. Ogilvie, director general of the B.B.C., at the Manchester Luncheon Club.

Halcyon Days
Mr. A. D. Gay (GGNF), in his presidential address before the Radio Society of Great Britain, referred to the halcyon days of amateur transmitting when wave-lengths descended to 45 metres. "The process of calibration in those days was," he said, "to adjust one's transmitter and call test. If no reply was received that day, the same performance was repeated the next day, slipping the tuning, and so on until you effected contact with some other luny soul who was striving to establish communication!" Mr. Gay has for the last ten years been calibration manager to the Society.

W.O. Trainees for R.A.F.
Boys having taken the course at civil wireless schools licensed by the G.P.O. and municipal technical colleges will in future be accepted if suitable, by the Royal Air Force as wireless operators from the age of 17½. A remuneration for tuition fees up to £4 can be claimed by the entrant.

"Wireless World" Bound Volumes
Our publishers advise us that copies of Volume XLVI of The Wireless World are available bound complete at a cost of 2s., including postage. Copies of the index to the volume (November, 1939, to December, 1940) are still obtainable at 7½d. each, post free, or with binding case for 3s. 10d., post free. Readers copies will be bound for 8s. plus od. for return postage of the completed volume.

American Servicemen for England?
The suggestion has been put forward by a correspondent of The Wireless and Electrical Trades that American radio engineers might be invited to work in this country during the war to assist dealers who are finding it difficult to carry on as a result of the shortage of servicemen. Some of the obstacles pointed out by The Wireless World to this idea are whether American engineers would be allowed to work in this country; their willingness to do so and whether dealers would be in a position to pay the comparatively high rates of pay commanded by American radio engineers in their own country.

MARCH, 1941.
asked to appeal for old mackintoshes and pieces of thick woolen material and fur, which should be sent to 801, Hool House, Dolphin Square, London, S.W.1. It is gratifying to learn that 16,534 woolen garments were despatched to Signal Units from the inauguration of the fund in November, 1939, to December 1st, 1949.

It should be noted that at this time of the year changes of wavelength are frequently made and readers are, therefore, advised to try alternative

R.C.A.

In his annual statement, Mr. David Sarnoff, president of the Radio Corporation of America, stated that in 1941 national defence will continue to be "the number one programme of the laboratories and manufacturing plants." He announced that a demonstration of large-screen television in a New York theatre would be undertaken early this year.

This is the title given to a little booklet issued by the R.C.A. to 100,000 service men and dealers to assist them in adjusting the push-button controls on 10,000,000 domestic receivers when 77 of America's 862 medium-wave stations change their frequencies on March 29th, in accordance with the North American Regional Broadcasting Agreement.

### NEWS IN ENGLISH FROM ABROAD

#### REGULAR SHORT-WAVE TRANSMISSIONS

<table>
<thead>
<tr>
<th>Country : Station</th>
<th>kc/s</th>
<th>Metres</th>
<th>Daily Bulletins (B.S.T.)</th>
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</thead>
</table>
| America
| WXBE (Bound Brook) | 11.775 | 25.48 | 8.0 a.m.; 10.5. |
| WBOS (Mills) | 6.130 | 31.95 | 10.45 |
| WCBX (Wayne) | 9.080 | 31.09 | 10.45 |
| WSYX | 11.830 | 25.30 | 6.0 a.m. |
| WBOX | 20.920 | 11.830 | 6.0 a.m. |
| WGEA (Schenectady) | 31.48 | 11.830 | 10.5. |
| WGEA (Schenectady) | 31.48 | 11.830 | 10.5. |
| WFTT (Pittsburgh) | 15.400 | 9.0 | 10.5. |
| WBBU (Boston) | 15.400 | 9.0 | 10.5. |
| WRUL | 15.400 | 9.0 | 10.5. |
| Australia
| V1LD (Sydney) | 8.0 | 5.1 | 10.5.
| V1LQ | 8.0 | 5.1 | 10.5.
| V1LQ | 8.0 | 5.1 | 10.5.
| V1LQ | 8.0 | 5.1 | 10.5.
| V1LQ | 8.0 | 5.1 | 10.5.
| V1LQ | 8.0 | 5.1 | 10.5.
| V1LQ | 8.0 | 5.1 | 10.5.
| China
| XBYC (Chungking) | 7.508 | 39.00 | 10.30 |
| Finland
| OFD (Lahti) | 6.120 | 49.02 | 10.30 |
| OFD | 6.120 | 49.02 | 10.30 |
| OFD | 6.120 | 49.02 | 10.30 |
| OFD | 6.120 | 49.02 | 10.30 |
| OFD | 6.120 | 49.02 | 10.30 |
| OFD | 6.120 | 49.02 | 10.30 |
| Greece
| Athens | 9.095 | 30.19 | 8.45 |
| India
| VUD3 (Delhi) | 8.900 | 31.80 | 4.50 |
| VUD4 | 8.900 | 31.80 | 4.50 |
| VUD3 | 8.900 | 31.80 | 4.50 |
| Iran
| EQB (Teheran) | 9.545 | 48.74 | 7.30 |
| Japan
| JTVW (Tokio) | 7.257 | 41.84 | 9.0 |
| JZI | 9.528 | 41.84 | 9.0 |

### REGULAR LONG- AND MEDIUM-WAVE TRANSMISSIONS

<table>
<thead>
<tr>
<th>Country : Station</th>
<th>kc/s</th>
<th>Metres</th>
<th>Daily Bulletins (B.S.T.)</th>
</tr>
</thead>
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| Portugal
| R.1 | 6.120 | 30.00 | 10.30 |
| Rumania
| Radio-Romania | 10.0 | 10.15 |
| Bucharest | 8.0 | 10.15 |
| U.S.S.R.
| Moscow | 17.2 | 10.15 |

All times are p.m. unless otherwise stated. * Saturdays only. † Saturdays excepted. ‡ Sundays only. ‡ Sundays excepted.

MARCH, 1941.
Ganging with the Beat Oscillator
Substitute for a Signal Generator

By E. L. THOMAS, B.Sc., A.C.G.I.

The beat oscillator (BO) of a superheterodyne receiver consists essentially of a circuit which can be made to oscillate at approximately the intermediate frequency (IF) of the receiver. The output of this oscillator is electrically coupled to the detector circuits. If the receiver is accurately tuned to a steady unmodulated carrier, then the beat note which is heard in the phones or speaker has a frequency equal to the difference between the BO frequency and the IF. It is usual to provide a control to vary the BO frequency by a few kc/s on either side of the IF, so that when CW signals are being received the pitch of the note may be suitably adjusted.

In order to consider how the test signal may be obtained we will consider a superheterodyne receiver with an IF* denoted by f, and tuned to a signal having a frequency f1. The frequency changer oscillator (FCO) of the receiver will normally be operating at a frequency f0, where \( f_0 = f_1 + f \). If now some of the FCO output is mixed with that of an oscillator working at IF, then the resultant will contain the following frequencies: \( f_0 \), \( f_1 \), \( f_0 + f \), and \( f_1 - f \). \( f_0 + f \) can be rewritten as \((f_1 + f_0) + f \), or \( f_1 + 2f \), which is the second-channel frequency. \( f_1 - f \) can be rewritten as \((f_1 + f_0) - f \), or \( f_1 \), which is the frequency to which the receiver is tuned. This means that, no matter to what frequency the receiver is tuned, it is always possible to obtain automatically a signal which is exactly in tune. If this signal can be controlled and applied to the receiver input, it can be used to gang and track the RF circuits in the same way as the output of a signal generator of conventional type. It is shown below that there are certain advantages to be obtained by using this self-generated test signal in preference to that from an external source, particularly at high frequencies. All that is needed, then, is an IF oscillator, which can be the BO of the receiver, a mixing device, and an attenuator.

Unwanted Frequencies

Of the four frequencies which appear in the output from the mixer, only the component of frequency \( f_0 \) is actually required. If the other three components are allowed to pass through the receiver, overloading or a spurious reading of the output meter may be produced, and it will then be impossible to trim the receiver circuits accurately. The possible effects of these unwanted components are therefore considered in turn. (1) \( f_0 \): At low frequencies, where the percentage difference between \( f_0 \) and \( f_1 \) is large, this component will be considerably attenuated by the RF circuits of the receiver. At high frequencies, however, where the percentage difference is small, it may reach the IF valve at an appreciable level, but it appears in practice that it is unlikely to cause any trouble. (2) \( f_1 + 2f \): This component will be attenuated by the RF circuits in the same way as an external signal of second-channel frequency. (3) \( f_1 \): The IF component will also be attenuated by the RF circuits, but the attenuation will increase with the frequency to which the receiver is tuned. When this component reaches the IF circuits it will be amplified in the same way as a genuine signal, and if it is strong enough it may cause the IF valves to overload. This component can be used for lining up the IF circuits if necessary.

A receiver of the communications type is always provided with a BO for CW reception, and if this is set to zero beat it can be used as the IF oscillator. Fig. 1 shows in schematic form how the system can be applied...
Ganging With the Beat Oscillator — to such a receiver. The only additions to the original circuit are the mixer and the attenuator.

The mixer valve can be of any type which is normally used in the FC stage of a receiver, but the circuit must be arranged so that the proportion of wanted component at the anode of the valve is as high as possible. This condition is realised when the output from the IF oscillator or BO is fed on to the grid of the oscillator section, and the FC oscillator connected to what is normally the signal grid. The wanted output can be controlled by adjusting the input from the IF and FC oscillators, or by applying bias to the valve.

A filter must be inserted between the mixer and the receiver input in order to attenuate the IF component. The filter need only be of simple form, and a single circuit tuned to the IF is usually sufficient.

The attenuator controls the amount of the test signal injected into the receiver. The ideal type would be a proper resistance attenuator, but for a limited range of control a variable resistor or a differential condenser is fairly satisfactory (see Fig. 2).

Need for Modulation

If the receiver is provided with a tuning indicator which operates from the detector or AVC circuits, then the test signal need not be modulated. However, the receiver is to be ganged with the aid of an audio output meter, then the test signal must be modulated at an audio frequency. The most convenient place to introduce this modulation is in the mixer.

This system can be applied to the alignment of a receiver in two ways — either as a small portable unit which can be used with any receiver, in the same way as a signal generator, or it can be incorporated as a part of the receiver BO. Suitable circuits will now be described.

Fig. 3 shows a practical circuit which is suitable for a portable unit. Excluding a power unit or batteries, all the components can be assembled in a box not larger than 6in. x 4in. x 4in. There are only three controls: the attenuator, a switch to select either RF or IF output, and a modulation on-off switch.

A triode heptode is used as a combined mixer and IF oscillator, the triode section acting as a tuned grid oscillator in conjunction with the circuit L2C2. The signal grid of the valve is connected through a small blocking condenser to a flexible lead, which in use is clipped on to a point on the FCO circuit of the receiver under test. The output from the anode of the valve is taken via a resistance attenuator to an output lead, or to terminals. A filter circuit, L2C2, tuned to the same frequency, is inserted between the valve and the attenuator when using the RF output, but it can be switched out of circuit when an IF signal is required.

Both the RF and IF outputs can be modulated by an AF oscillator which is connected to the signal grid of the heptode. This oscillator consists simply of a small pilot type neon lamp (with the internal ballast resistance removed), the resistance, R2, and the condenser, C3. The values of R2 and C3 are chosen to give a suitable modulation frequency. The modulation is controlled by a switch, S.

If the circuit is only to be used with receivers which are provided with beat oscillators, then the IF oscillator is unnecessary, and that part of the circuit to the right of the dotted line in Fig. 3 can be dispensed with. The point “a” should then be connected to the “hot” end of the BO tuned circuit.

Built-in Test Set

The same circuit can be incorporated in a communications receiver, if the output is suitably switched, to serve as BO, and also to provide RF and IF test signals. A suitable arrangement is shown in Fig. 4. When the circuit is used as a BO, a variable condenser should be connected in parallel with C, to control the pitch of the beat note.

The point on the FCO circuit to which the connection “b” should be made will probably have to be determined by experiment. In the original circuit sufficient coupling was obtained by connecting to the earthed side of the FCO gang condenser section.

Wireless World

MARCH, 1941.
Ganging With the Beat Oscillator—

The procedure to be adopted in lining up a receiver by means of a circuit such as that described above is as follows: Throw the switch to the frequency of the test signal is directly determined by that of the FCO, it will alter by exactly the right amount to compensate for the pulling.

![Diagram](image)

If the circuit is built into a receiver as in Fig. 4, it can be used in the normal way as a BO for CW reception by throwing the switch to "BO."

**Wireless World**

"IF" and turn the BO control to the zero beat position. Then set the attenuator to give a suitable input to the receiver, and adjust each of the IF transformer trimmers in turn for maximum output. Next, throw the switch to "RF," and the RF circuits can be tracked and ganged in exactly the same way as with a conventional signal generator, but without the trouble of having to reset the generator dial for each frequency. The ganging can be checked continuously throughout each wave-range by simply setting the receiver tuning to any frequency and adjusting the appropriate trimmers.

**Freedom from Pulling**

One great advantage of the system is the apparent absence of "pulling" of the FCO, which is usually troublesome at frequencies above about 20 mc/s. The reason for this is that as the signal grid circuit of the FC valve is trimmed through resonance, it slightly alters the frequency of the FCO circuit, making the correct setting of the trimmer very difficult to determine. But since

Inexperienced to judge the quality of a negative, and where many are handled a method whereby it can be instantaneously viewed as a positive is not without its advantages.

The illustration shows the basic arrangement. Two cathode-ray tubes, CR1 and CR2, are set up, and have their deflecting plates paralleled and connected to the double time-base. Their other electrodes, except their grids, can be run from a common HT supply.

A bright raster is produced on the screen of CR1 and focused by the lens through the photographic negative A on to the photo-cell. This cell feeds into an amplifier, the output of which is applied to the grid of the tube CR2.

The negative is scanned by CR1, and the picture is reconstructed on the screen of CR2, where it can be a negative or positive according to the phase of the amplifier output. Synchronism is inherent, and any desired number of frames and scanning lines. As the picture is a "still," there is no reason why fluorescent screens of long persistence should not be used; the requirements are obviously less exacting in this respect than in a television receiver or ordinary oscilloscope.

**Club News**

**Ashton-under-Lyne and District Amateur Radio Society**

Headquarters.—Beaconsfield Club, Stalybridge Road, Ashton-under-Lyne, Lancs.

Meetings.—Wednesdays and Fridays at 7.30 p.m.

Hon. Sec.—Mr. K. Gooding, 7, Broadbent Avenue, Ashton-under-Lyne, Lancs.

The society's activities have been resumed in new club rooms. More classes are being held in which use is made of headphones and a valve oscillator in a two-way system. The club's receiver is being converted from AC to DC.

Messrs. W. P. Green and J. Cropper are to continue their series of lectures on the principles and design of the superhet.

**Viewing Photographic Negatives**

The cathode-ray tube is continually being put to new uses, and the possibility of using it to create a positive image of a photographic negative has been invented by M. P. Rubert. It is often difficult for the inexperienced to judge the quality of a negative, and where many are handled a method whereby it can be instantaneously viewed as a positive is not without its advantages.

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**SHORT-WAVE BROADCASTING STATIONS**

**Arranged in Order of Frequency**

<table>
<thead>
<tr>
<th>Station</th>
<th>Call Sign</th>
<th>Metres</th>
<th>kW</th>
</tr>
</thead>
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<tr>
<td>British Overseas Service</td>
<td>GSC</td>
<td>9.580</td>
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<td>Melbourne (Australia)</td>
<td>VLF</td>
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**MARCH, 1941.**
19-Metre Band (15.100-15.350 Mc/s)

<table>
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<th>Mc/s</th>
<th>Metres</th>
<th>kW</th>
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<td>Quito (Ecuador)</td>
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<tr>
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16-Metre Band (17.750-17.850 Mc/s)

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<th>Station</th>
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<th>Mc/s</th>
<th>Metres</th>
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<td>20.38</td>
<td>20-100</td>
</tr>
</tbody>
</table>

Short-Wave Receiving Conditions

short-wave receiving conditions were moderately good during the first week of January, but afterwards were variable throughout most of the remaining days of the month. Ionosphere storms were in evidence from January 16th to 28th inclusive; these may serve as a guide when considering the possibilities of reception from places not too remote from those specified. Attention is drawn to the fact that a number of factors, as, for example, transmitter power, efficiency of aerials at both the transmitting and receiving end, and ionosphere abnormalities, may often result in better reception being obtained on wavebands other than those quoted. All times given in this report are GMT on the 24-hour clock notation.

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<th>Metres</th>
<th>kW</th>
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<td>18.710</td>
<td>19.09</td>
<td>20-100</td>
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Science and the War

It is a far cry—however far that may be—from the desert warfare of the last great conflict to that of the present one—and in no respect is the contrast more marked than in the methods of transport and attack. In those far-off days the camel with its self-contained fuel supply held the position occupied to-day by tanks, armoured cars and motor lorries.

Even then, however, wireless played a leading part, and many of you may recollect my publishing the accompanying photograph of myself fitting some of these ships of the desert with the very latest in wireless equipment, complete with earthing plate, securely embedded by the army veterinary corps in the water in the camel's hump.

Most of the brass-hats and other high dignitaries of the scientific departments of the Admiralty, War Office and Air Ministry are diligent, if furtive, readers of _The Wireless World_, and no doubt many of them read some time ago of my idea of using a mixture of hydrogen and oxygen instead of petrol as a fuel for my car, because the exhaust is, of course, water, and if directed at the ground will short-circuit the tyres and so form an automatic car-radio earth.

Apparently as a result of reading about this idea of mine, it occurred to a very august personage at the War Office that if hydrogen were used instead of oil as the motive power of tanks, it would solve a good many transport problems, for, unlike oil, it is lighter than air, and so the more cans of it you load on to a transport wagon the lighter does the wagon become. The more that is loaded on to it, therefore, the more it is capable of taking; in fact, it would be a sort of first-cousin to perpetual motion were it not for the fact that eventually the lorry becomes so light that it tends to take to the air.

Even now, however, you have probably not grasped what is the greatest of all advantages of using hydrogen as a fuel for driving tanks across the desert. It is simply that, since the exhaust is water, there is an unlimited supply of fluid for cooling, not only to the engines but the gun barrels also. It is not even necessary to provide a radiator to enable the same water to be used continuously, as fresh water is available in unlimited quantities. Finally, of course, the exhaust is used as drinking water for the troops.

Man-Power Problem Solved

SUPPOSE that many of you, like myself, spend a good deal of time in fire-watching these days, even if it is only the sitting-room fire. Personally speaking, I volunteered for the job a long time ago, as I could see plainly that compulsion was in the offing. I have for the most part been watching over some repulsive-looking bungalow growths erected in the horrible pseudo-Tudor style so beloved of builders of the baser type, and I am sorry to say that, so far, not a single fire bomb has fallen among them.

Doubtless, this is because enemy airmen, if they really can see in the dark, as some people allege, are unable to believe that these repellent doss-houses are intended for human habitation.

If a fire bomb did fall amongst them I should be sorely tempted to fill my stirrup pump from my petrol tank, and only the fact that the stuff is rationed prevents my doing so. However, the real reason why I am bringing this subject up is that I wish to draw your attention to a piece of bureaucratic stupidity akin to that which in the last war caused sun helmets to be served out to the troops stationed in the Manchester area.

I had not been on duty many days before I realised what a colossal amount of man-power was being wasted, 99 per cent. of which could be saved by the use of well-known wireless principles. I speedily set to work, therefore, to construct a number of completely self-contained flea-power ultra-short-wave transmitters, complete with photocells, my idea being to place one of these in the room of each bungalow on the estate as well as at various vantage points in the roadway. My plan was to tune each transmitter to a slightly different wavelength so that it would operate the appropriate receiving circuit at the local A.R.P. post, and so indicate exactly where the bomb had fallen. This would have enabled the number of watchers to be reduced to one.

I was fully prepared to deal with intelligent technical doubts and queries concerning my scheme, but not the plethora of pettifogging objections which I actually received, including such a flimsy and typically bureaucratic excuse that no appropriate forms existed which could be filled up in order to transmit the idea to the proper authorities. Needless to say, to the official mind, the filling up of a form is an absolutely indispensable preliminary to all of life's activities, including that of being born, for which I understand a permit is now necessary from the Ministry of Supply, as a high Government official has discovered that the stork is a bird of definitely German origin.

Fire watching.

I cannot help feeling, however, that the real reason for the rejection of my idea is that, owing to the drastic driving of man-power it would bring about, my scheme would seriously endanger the position of many petty jacks-in-office "dressed in a little brief authority," to whom the war has been such a Heaven-sent opportunity.
UHF Oscillator Stability

Points in the Design of Superhet Receivers for 40 Mc/s

THE vogue for push-button tuning has taught designers a good deal about oscillator drift on medium and long waves, and many of the expedients which have been employed to overcome this trouble are applicable to the short and ultra short wavelengths.

It is well known that a rise in temperature causes an increase of both inductance and capacity in ordinary circuits with a consequent lowering of frequency. Humidity also tends to reduce the frequency as the dielectric constant of air (in condensers and between wiring) increase as the water vapour content rises.

Certain ceramic materials have a zero temperature coefficient and some a negative coefficient, and by including condensers with these dielectrics as part of the total tuning capacity, exact compensation for temperature changes can be made as far as capacity is concerned. The inductance temperature coefficient can also be neutralised at one frequency and made negligible over a small band of frequencies, such as the television range, if it is reasonably small to start with.

Inductance Stabilisation

Methods of reducing the positive temperature coefficient and a number of other useful hints on UHF oscillator design in general, are given in a paper recently published by S. W. Seeley and E. F. Anderson. It is pointed out that the increase in inductance is due chiefly to expansion of the wire and a consequent increase in the size of the coil. By using wire drawn from 'Invar' or 'Nilvar,' a 36-64 nickel-iron alloy having a very small coefficient of expansion, coils can be constructed with an inductance change of less than one part in a million per degree Centigrade.

'Nilvar' wire is hard and difficult to wind, but if ceramic formers of a low coefficient of expansion are employed it is not difficult to wind mechanically stable coils. The real snag is the high electrical resistance of the wire which gives a Q of only 10 compared with 180 for similar coils.

wound with copper. Fortunately, this drawback is easily remedied by coating the wire with copper and this does not alter its mechanical properties. A coating 0.0025in. thick on 0.058in. diameter Nilvar wire gave a Q equal to solid copper, and a temperature coefficient of inductance so small as to be difficult to measure—considerably lower than $1 \times 10^{-4}$ per degree C.

When circuits have been stabilised, changes in the operating conditions of the associated valve become the predominant factor. The input capacity, for instance, may increase as much as 0.04 µF during the warming up period, and in a 40 Mc/s oscillator with a total tuning capacity of 40 µF a drift of as much as 20 kc/s may be experienced. This can be reduced by increasing the total tuning capacity and reducing inductance, but at ultrahigh frequencies there is a limit to the amount by which the L/C ratio can be reduced without prejudicing the strength and stability of oscillation.

advantage of this method is that the mixer grid will be sensitive to signals at approximately 0.5 and 1.5 times the desired signal frequency. These are at wider intervals than normal image frequencies, but reasonably good pre-selection is nevertheless essential in the RF stage. Against this may be set the fact that the oscillator frequency is less affected by the tuning of the RF circuits. Also, less of the oscillator voltage appears on the signal grid through stray couplings.

The conversion gain does not necessarily suffer with half-frequency injection, and in pentagrid mixers is nearly equal to normal frequency operation if an adequate oscillator voltage is applied.

Typical Circuit

The circuit of an oscillator-mixer stage exemplifying the various principles involved is shown in Fig. 1. It will be seen that the oscillator functions at quarter frequency and the injection is at half frequency, the harmonic being selected by a tuned transformer in the oscillator anode circuit with a bandwidth covering 20-21 Mc/s.

One way of circumventing these difficulties is to tap the grid down the coil, but this necessitates extra contacts if wavering switching is required. Another method is to operate the oscillator at a sub-multiples frequency, when the input capacity variation can be swamped by a much larger total tuning capacity. The disadvantage of this method is that the mixer grid will be sensitive to signals at approximately 0.5 and 1.5 times the desired signal frequency. These are at wider intervals than normal image frequencies, but reasonably good pre-selection is nevertheless essential in the RF stage.

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The oscillator coil consists of seven turns of copper-plated Nilvar wire on a $\frac{1}{8}$in. former, the winding length being approximately 1 inch. The cathode tap is 3 turns from the earth end of the coil. With the major portion of tuning capacity in the form of a zero temperature coefficient fixed condenser, the contribution of the...
UHF Oscillator Stability—

The tuned circuit to the drift is negligible and the responsibility for the observed frequency deviation is shared by the valve and the push-button selector switch. This was included for experimental purposes and was of the conventional type with phenolic insulation. Ceramic insulation is preferable, but until switches of this type are made the drift can be reduced by connecting the band selector switches across a part of the tuned circuit. Thus if it is across half the coil, the effect of the capacity change is reduced to a quarter of its original value, which may be as much as 0.2 μF for a 30°C temperature change with phenolic insulation.

Fig. 2 shows the frequency drift of the circuit with valve and switch variations uncompensated. Curve B compensated by negative temperature coefficient condenser. The positive change in IF is due to the oscillator being on the low frequency side of the signal.

BOOKS RECEIVED

MURDER AND MERCY. By Reginald Cartwright. A great deal has been written during the past few months about the campaigns in Finland, Norway and France, much of it in the nature of personal experiences and eye-witness accounts by people on the spot. The present account, written by an American citizen attached to an ambulance unit, presents the whole subject in such a very readable and refreshing manner, however, that this book is lifted high out of the category of "yet another book of war experiences," and we make no excuse for drawing attention to it. The dispatches contained in this little volume first appeared in The Autocar and are now published in book form at the special request of readers.

The whole of the profits from this book are to be handed over to the Red Cross Fund.

The Autocar Handbook, 5th edition. By the Technical Staff of The Autocar. The new edition of this motorists' vade-mecum has been brought completely up to date and is full of information both in domestic and abroad. Price 1s. 6d. net.

TO CYCLISTS! Your wheels will NOT keep round and true unless the spokes are tied with fine wire at the crossings AND SOLDERED. This makes a much stronger wheel. It's simple—with FLUXITE—but IMPORTANT.

FLUXITE GUN

The Autocar Handbook, 2nd edition. By W. O. Manning, F.R.Ae.S., and the Technical Staff of Flight. Interest in aircraft and flying has, for obvious reasons, now become very general, and this book is equally suitable for satisfying the desire for information possessed by the average man-in-the-street and for providing a useful groundwork of knowledge for the youth who is contemplating entering the R.A.F. It assumes no prior knowledge, and deals in simple language with the whole question of “how it works,” the function of each part of a modern machine being clearly explained.

FLUXITE LTD.

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ALL MECHANICS WILL HAVE

FLUXITE

IT SIMPLIFIES ALL SOLDERING
Vibratory HT Generators

Compensating for Wear of Contacts

It is fairly safe to assume that the vibratory HT generator, if only for its cheapness as compared with other methods of "stepping-up" DC voltages, will continue to be popular. A growing application is in battery-driven broadcast receivers for export, in which the sole source of current supply is a 6-volt accumulator, HT being supplied through a vibrator. Although there have been no spectacular innovations of late, work on vibratory generators has been going on steadily since their inception, and an interesting development was introduced in the laboratories of the German Telefunken Company shortly before the war.

As the efficiency of vibratory HT generators is largely dependent on the ratio of closing to opening time of the working contacts, it will be appreciated that, when these become burnt, the contact gaps widen, the efficiency of the unit falling after about 1,000 hours' use by from 80 per cent. to 50-70 per cent.

Telefunken engineers found that this disadvantage could be overcome, in the type of unit which is energised through a separate circuit (instead of through the operating contacts), by increasing the energising current to the magnet coil to increase the amplitude of the reed, thus increasing the closing time of the contacts.

The accompanying diagram shows how this can be done. The positive side of the LT battery is connected through main switch S and switch S1 to the reed F, which is energised by the magnet coil E and vibrates between contacts K1 and K2 connected across the primary of the transformer T. The centre tap of the primary goes to LT negative. The load W can be disconnected from the transformer secondary by switch S2.

One end of the magnet coil E goes to the energising contact Ke, the other end going to LT negative via the adjustable resistance R.

The coil E is so proportioned that, when the unit is new, it exerts sufficient influence on the reed for maximum efficiency even with resistance R set at a high value. Later, when the working contacts become burnt, the resistance can be reduced to increase the energising current through the coil, thus increasing the reed amplitude, and, therefore, the closing time of the contacts.

A meter M in parallel with switch S1 is used for checking the excitation of the magnet coil.

Switches S1 and S2 are mechanically coupled, and may be controlled by a push-button so arranged that, when it is pressed, the meter is in circuit, and the load is disconnected from the transformer secondary. The resistance R is adjusted with the push-button depressed, the operation of the converter being restored automatically when it is released.

If desired, a portable meter may be used with a plug and socket arrangement so designed that switches S1 and S2 are opened by inserting the meter plug.

The resistance R can be shunted across the magnet coil, instead of having it in series. Alternatively, it can be dispensed with by having a number of tappings on the magnet coil, provision being made for connecting any of these tappings to the DC supply as required.

LETTERS to the EDITOR

The Editor Does Not Necessarily Endorse the Opinions of His Correspondents

Colour Television

I feel that the article on Baird Colour Television in your February issue was over-enthusiastic; perhaps unwittingly so. This criticism, since I have seen no actual demonstration, is based on the fact that the system is reported to be of the two-colour variety.

Your contributor says: "Mr. Baird uses only two colours, red and blue-green, since he has discovered that this combination gives, with the type of photo-electric cell used, the same results as would be obtained with three separate filters." (My italics.) Now, this last statement definitely cannot be correct. Only if the colour of the light-spot itself were capable of change could such a result be obtained (by the use of wide-cut filters). With a light-spot of fixed characteristics only a limited analysis and synthesis can be carried out with two complementary filters.

Exactly the same problem is encountered in colour-film work, and anyone interested in colour-television would do well to read Klein's "Colour Cinematography." Of particular interest in the present case is Major Klein's comparative table of Colours of Original against Colours Reproduced by a two-colour process. This shows that not only are nearly all colours distorted, but that the yellows and violets are completely absent, as no combination of blue-green and red-orange can give these colours.

I would suggest several reasons why your contributor overlooked these flaws. (1) Although necessarily inaccurate, the process probably gives a pleasing coloured picture—so did the earlier Technicolour and Multicolour two-colour processes. (2) The subjects televised would appear to have been chosen to minimise these faults. Note that the girl's hair was red—the only hair colour reasonably reproduced—blonde hair would have appeared a pale greyish-orange. (3) There is a psychological tendency for the eye to overlook these defects (a mixture of simultaneous contrast and wishful thinking)—see Klein.

But though the eye tends to overlook these defects, there is no basis for accepting them. The ear is an equally accommodating instrument, and yet...
Letters to the Editor—

we strive for high quality in radio because, although it is possible to get a good semblance of speech and music from a limited frequency range, the makeshift can always be recognised as unnatural. The same is true of two-colour systems, though we may not know what is wrong, we feel that the result is untrue to the original.

F. C. ARNAUD,
Sub-Lieut. (E) R.N.V.R.

[Our contributor writes: It must be admitted that Mr. Arnaud is correct in his statement that a truer colour rendering is obtained with a three-colour process than with a two-colour system. The net result, however, is of such a standard that deficiencies in colour rendering are overlooked.

Mr. Baird, in his earlier work, used three filters, but latterly employed the two-filter process, the use of which enabled greater detail to be transmitted within the available waveband, any inferiority in colour rendering being more than compensated for by the increased definition. The aim was to get the best final result within the waveband available.

While dealing with the subject of the Baird Colour System, I should like to point out that the system of scanning employed was demonstrated by Mr. Baird eighteen months ago (The Wireless World, August 17th, 1939), the receiver employing a cathode-ray tube in conjunction with a revolving colour disc. A year later a similar scanning system, using a CR tube and colour disc receiver, was shown in the U.S.A. and greeted as a new discovery.—Ed., W.W.]

The Future of Amateur Radio

My attention has been drawn to an article by "Navigator" which appeared in the February, 1941, issue of your journal.

The author of this article has completely ignored the existence of a national organisation—namely, the Incorporated Radio Society of Great Britain, which has for nearly 27 years maintained the most cordial relations with the G.P.O. and other Government authorities on behalf of the organised radio amateurs of Great Britain.

These relations have been maintained since the outbreak of hostilities, and, as a matter of interest, various questions concerning the future of amateur radio (including the reissuing of licences after the war) were discussed as recently as last December.

Many of the plans suggested by your contributor have been considered in the past by the Council of the R.S.G.B. Frequently such plans have been brought forward by our Provincial District Representatives as an expression of local feeling or opinion.

It is incorrect to suggest that the status of amateur radio immediately preceding the war was "none too high." The Society has concrete evidence that the movement was held in high esteem in spite of "indiscretions" by a very small minority. We would remind your contributor that the R.S.G.B. was closely associated with the organisation of the Royal Naval Wireless Auxiliary Reserve and the Royal Air Force Civilian Wireless Reserve.

Since the commencement of the war the Society has received many expressions of appreciation from the fighting services for the way in which radio amateurs are helping the war effort.

Had your contributor read the annual reports of the Society, which are published in The T. and R. Bulletin, he would have seen that they have covered many of the points raised by him. He would also have realised that there has always been in existence a virile organisation which has worked to uphold the interests of all British radio amateurs.

A. D. GAY,
President, Incorporated Radio Society of Great Britain.

After "Navigator's" excellent opening gun, perhaps the following comments would be of interest.

The main menace to amateur existence will be removed when those governments which oppose personal freedom have been subjugated, but a secondary menace will remain. Various interests will probably reopen their barrage against us.

It has been proved to the Services that the amateur operator has skill and initiative far above the average. We can hope for the support of the Services. What we do not want is a "committee—given full powers to advise [sic] the G.P.O." What we do want is a group of competent people of standing who are prepared to fight hard for the amateur. We have for far too long accepted the role of foundling, existing by charity. Britannia, not the G.P.O., rules the waves. We are free citizens of a free land, paying taxes for the support of that land (and the G.P.O.). Let us hope that the rigours of war will cause the orphan to grow and lose his foundling outlook.

As "Navigator" says, the public

MARCH, 1941.
Letters to the Editor

and the Press have viewed the amateurs with suspicion. True!—and the amateur’s own fault. On several occasions scurrilous anti-amateur paragraphs have appeared in the Press. No one hits back; no attempt has been made to “sell” the amateur. It would be well even now if the Press could be furnished with particulars of the amateur’s part in this war.

It is reasonable that the amateur should not do Traffic Handling to the detriment of the country’s Income. When we have victory it is certain that the Empire stations will be on the air before the European ones. It is certain that—as the troops go home—their bands will be more Empire stations on the air. In that interim period contact by amateur radio would tend to cement friendships formed under arms and act as another bond of Empire solidarity. Might not third-party messages, when purely “greeting” nature be allowed?

Finally, let us give up the pious “experimental” hypocrisy. Let us be respected as pursuing a fascinating and difficult hobby and let us insist on the same recognition and consideration—through a strong and efficient organisation—as any other group of common interest.

One thing is clear—the terms of our existence will depend on our own courage and forcefulness. The old “pre-Munich” attitude will leave us as badly off as before. G2” was.

As a pre-war transmitting amateur I found the article by “Navigator” in your February issue very interesting.

Many of his suggestions for post-war amateur radio are indeed excellent, especially the proposal to introduce a stricter licensing test in order to obtain a radiating permit.

Perhaps the following ideas of mine will be of interest:

(1) Artificial aerial licences to be issued as before. Much experimental work can be done at this stage.

(2) No “intermediate” stage necessary before full radiating licence, but all holders of the latter should pass a morse test at 18 w.p.m., and a reasonable exam. in radio theory and practice.

(3) Initial power (input) of transmitters to be 15 watts, rigidly adhered to.

(4) Use of telephony to be restricted to the 1.7-Mc/s, 3.5-Mc/s, 28-Mc/s and 55-Mc/s bands.

(5) New licence holders to use CW only for first three months. Permission to be obtained from G.P.O. to use telephony after the first three months of operation.

I agree with “Navigator” that there is little use for Traffic Handling in this country and that our stations should remain experimental. Finally, let us hope that we do not lose too many of our precious kilocycles, and that the best use be made of what we retain.

R. L. FLUCK (ex G4AY).
Tunbridge Wells.

Having read the article by “Navigator” on the above subject, I am in agreement with almost everything he says. However, as the question of Traffic Handling has been raised, I feel I would like to make a few observations on this subject.

Traffic Handling as it exists in the U.S.A. would not be tolerated by the British Post Office, neither do I think it would be popular here, but I am of the opinion that after the war the Post Office would do well to consider allowing messages to be sent provided they were from one amateur to another, and concerned with purely amateur topics. An illustration will make this clear. A in London wishes to make a schedule with B in Birmingham at, say, 2230. A works C (a Birmingham station not far from B) during the afternoon. A originates a message which C handles. This procedure would save much needless calling (and hence unnecessary interference), and would be of great use to members of genuine experimental groups like the R.E.S. of the Radio Society of Great Britain.

Wireless World

MARCH, 1941.
Letters to the Editor—

as Radio Mechanics as appealed for through The Wireless World, and would find it a great asset to be able to pursue our hobby during our leisure hours in camp.

D. McDonald. (Leading Aircraftman R.A.F.) [Apparatus addressed care of this office will be forwarded.—Ed.]

**Bomb Blast Damage**

A service engineer to a "radio hire service" in this heavily bombed locality, my experience of damage to broadcast receivers has been fairly comprehensive, and may be of interest to others.

I have found that, with one exception, receivers installed on the ground floor have had the cones "sucked out" instead of "blown in," whereas in upstairs rooms the effect has been just the reverse. In all cases the receivers themselves (including the valves) have resisted the blast.

In one particular instance, a chair was blown into the cabinet, severely damaging the front, but even here the speaker was the only damaged component.

E. M. Sparks.

Bristol.

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**RANDOM**

**The Modern Dry Cell**

LIKE me, you may have been struck by the remarkably good lasting powers of the dry cell of to-day, or whether it forms part of an HTB or of a flashlamp refill. Our manufacturers have certainly learnt a thing or two about dry cells in the last few years, and even under war conditions they are producing batteries whose performances are infinitely better than those of the 1920's and the early 1930's. Just how bad some of the dry batteries of those days were it's difficult to realise now. In lab. tests I used to take the "cut-off" EMF as 0.8 volt per cell, regarding a battery as finished when the voltmeter gave such a reading. I can remember standard-capacity HTB's which gave out in less than a week when run for 3 hours a day under a nominal load of 10 milliamperes. As the EMF fell the current of course fell, and even under war conditions they have certainly learnt a thing or two about dry cells.

**Depolarising Does It**

The improvement in dry cells is probably due very largely to research into the action of the depolariser. That action has really two aspects, which may be termed the working and the resting. If a cell is wanted for brief, rather heavy loads with long intervals between the periods of use, the depolariser does not need to have any very rapid action; during the few seconds in which it is at work there is not time for the accumulation of hydrogen bubbles round the central carbon rod to raise the internal resistance to a figure that will prevent the delivery of the needed current. An accumulation does occur, but the slow acting depolariser has plenty of time to deal with it in the long rest period that follows. One of the chief uses of the dry cell in its early days was for working electric bells, and here you have just those short working periods followed by long rests. Again, the first small dry cells made were intended for supplying current to flashlamp bulbs. And in those days flashlamps were flashlamps; one switched them on only for a second or two at a time. The coming of the wireless set called for quite different work on the dry cell used as part of its HTB: the cell was asked to deliver small currents for long periods on end. Old hands will remember that used to make us HTB's of flashlamp refills, soldered in series, and that, even under the very small loads imposed by the sets of those days, they didn't last long. A quick-acting depolariser, with a long, useful life, was needed. It forms part of the dry cell of to-day, and that is one of the secrets of its far better performance.

**Useful Bits and Pieces**

**THOUGH** I clear out my workshop and lab. junk from time to time, I must confess that I still...
Random Radiations— have drawers full of tobacco and cigarette tins containing small parts such as we used to buy when Lisle Street was in its radio heyday, and we made many of our own receiving set components. I have never had the heart to give these away. There was always a feeling that they would come in useful, and I must say that it has been justified. Often I’ve been able to make a repair because I had something that would just fit in, and do the job. The other day the contents of my tins of bits and pieces found a new and unexpected usefulness. Certain gunnery problems demanded for their rapid solution the use of pivoted radial arms moving over scales. We made the scales and the arms easily enough, but what about the pivots and the bearings for them to work in? Nothing was available for the purpose, but I was just going home for a short leave, and it struck me that I might find something in those tins. Sure enough I did. For the pivot pins I selected a handful of the studs with which we used to make multi-point switches. These have small cylindrical heads and 4 BA shanks about an inch long. And the bearings? I had plenty of small metal bushes but none was of the necessary wobble-free fit. Then I found some small single plugs and sockets. The plugs were of no use as pivots for various reasons, but the shanks of my studs were a beautiful fit for the sockets. Better still, the latter were threaded 0 BA on the outside and had thin hexagon tops. They could therefore be screwed into the wood on which the scales were mounted and driven home almost flush. My pivots and their bearings, contrived from old wireless small parts, have proved completely successful. I’m thinking that these apparently useless things might one day come in handy has been amply justified.

The Cheering Short Waves
If ever you’re feeling a bit down in the dumps, just switch on your set, turn to the short-wave range, and twiddle knobs until you find a United States station sending out its war commentary. It’s one of the most cheering experiences I know. Out American—I was going to say friends but they are more than that—kingsmen show in every sentence of such a broadcast how wholeheartedly they are with us, and how determined they are that no effort shall be spared to give us the supplies, the munitions, and the ships that we need. At such moments one realises not only the fullness of their support, but also what a grand thing it is to be able, by means of the radio receiver, to tune in the cheering words of a speaker thousands of miles away on the other side of the world. I like, too, to hear their replies to correspondents in this and other countries. They show how fully Americans appreciate what we are doing. I don’t often waste time on the bombast and the clumsy distortions of facts put out by Rome and Berlin. But occasionally one can get a good laugh out of them. Haw! Haw! gave us one the other night when in one sentence he foretold our coming extinction at the hands of his fellow Huns, and almost in the next warned British workers that after the war the British capitalist (who would presumably be liquidated or in a concentration camp, if the first prophecy came true) would still be up to his old evil tricks!

USW
NOT long ago the Signals people installed an ultra-short-wave radio set for my use, and you can imagine what a joy it has been to give it even the limited employment for which it is intended. I wish it could have been handed over to me for more general work, for it would be nice to see whether or not USW DX is what it was in the days before the war. But beggars can’t be choosers, and I’m jolly glad to have it, even if I mustn’t use it for discovering if the old remembered transmitters are still at work or not. One supposes that American police chiefs still call all cars and that ‘hams’ in far parts of the world still conduct long and earnest conversations in the jargon of their kind—I’m sure that there are few things more to be caught, could I but cast the USW net. Well, I must possess my soul in patience and solace myself with dreams of the wonderful forward steps made by the transmitters ‘below ten’ that I shall find once I can turn the knobs of my own ultra-short-wave receiver again.

All-day Wireless
WE’RE queer folk with our wireless; and none of us is queerer than Thomas Atkins of the present day. In the hut which serves my crowded as an officers’ mess we have to ensure that things are as quiet as possible during the mornings up to lunch time, for there are always two or three of us then trying to sleep off the effects of a whole night spent on duty. The cooks and batmen have a wireless set in the kitchen, which, unfortunately, is in the same corridor as the sleeping quarters. I’ve impressed upon them the importance of keeping (a) the volume control reasonably near the minimum end of its travel, and (b) their door shut during the mornings. They’re grand chaps and in other ways they look after us splendidly; BUT they seem unable to live without wireless as a background—no matter what is coming through—from the moment broadcasting starts in the morning until they go to bed at night. Believe it or not, I’ve gone into the kitchen and found the loud (the very loud) speaker delivering the news in Dutch! They begin by keeping the volume humbly low. Then they start chattering amongst themselves. Someone can’t hear well enough. He gives the VC knob a tweak. The volume from the loud speaker increases. The human talkers raise their voices in order to make themselves heard. The would-be listener again adjusts the volume control. In self-defence the talkers talk more loudly. And presently there builds up a babel of noise that permeates the hut and wakes every sleeper. It’s done quite unconsciously. The talkers talk against the wireless, and anyone who wants to listen to the broadcast programme finds the loud speaker’s output drowned. Naturally he assumes that the sound level is low and turns up the wick. And so it goes on.
ELECTRON MULTIPLIERS

THE Figure shows an electron multiplier in which the various target electrodes are so arranged and shaped that the passage of the main discharge stream through the tube is controlled from one target to the next, without the use of any auxiliary electron lens or magnetic focusing. The electron assembly includes a photo-electric cathode C at one end and a collecting anode A at the other end of the tube. Between them are a series of approximately L-shaped "target" electrodes T which are arranged in upper and lower lines so as to form displaced "mirror images" of each other. These are biased with progressively increasing voltages tapped off, as shown, from a common potentiometer R.

In operation, light from a lamp L shines through a transparent extension S and so as to form displaced "mirror images" of each other. These are biased with progressively increasing voltages tapped off, as shown, from a common potentiometer R.

In operation, light from a lamp L shines through a transparent extension S on to the photo-electric cathode C. The secondary electrons so produced are directed upwards and strike against the first of the upper-line targets T. Thereafter, owing to the shape of the targets, the main discharge stream follows the path shown by the arrowed line, until the amplified current is finally drawn off from the anode A into the load resistance M.

Any positive ions that may be produced by the impact of the electrons will tend to flow against the main stream. They are collected and removed by the longer limbs of each of the targets, which helps to ensure a strictly linear relation between input and output.


TELEVISION RECEIVERS

INSIDE OF being fixed, the focusing coil of a cathode ray tube is mounted on a gimbaling bearing which is fixed, in turn, to a rubber bush or support carried on the glass neck of the tube. The gimbaling bearing allows the coil to be moved slightly in the lateral direction, or to be rotated or "tilted," sufficiently to ensure that the " raster " or scanning field is correctly centred on the fluorescent screen of the tube. Once the correct adjustment has been found, the coil is firmly clamped in position.


SECONDARY-EMISSION ELECTRODES

provided a common supply of secondary electrons, under bombardment, for instance in an electron multiplier, the "target" electrodes are usually coated with a film of silver-oxide and caesium. Such films are, however, liable to fall off in sensitivity under the action of the heat produced by the impact of the primary electrons; they are also adversely affected by any molecules of oxide that may be liberated from an oxide-coated filament.

According to the invention, both these defects can be avoided by replacing the caesium by beryllium, which is first deposited in vacuum on a foundation plate of nickel and then subjected to heat treatment. When so prepared the sensitive layer will emit from four to five secondary electrons for each primary electron that strikes against it.

The British Thomson-Houston Co., Ltd. Convention date (Germany) January 18th, 1938. No. 533982.

ULTRA-SHORT-WAVE SIGNALLING

It is known that ultra-short-wave signals can be received at distances in excess of the so-called " optical " range, though in general such reception will fluctuate considerably in strength. At the same time it is desirable, for the sake of economy, to be able to " service " as great an area as possible from a single transmitter so as to minimise the number of relay stations required, say, to distribute a television programme over a given area.

Field-strength fluctuation is mainly due to variations in the intensity or height of the ionosphere or HAVIS layer—a factor which can to some extent be offset by a suitable choice of either the working wavelength or of the vertical angle at which it is radiated, or of both.

The invention is concerned with a system in which the transmitter radiates a "test" wave on a frequency which differs from that used for the signal proper. At the distant receiver a comparison is made between the "test" wave and the signal wave, and an automatic indication is given as to which wave comes in best from time to time.

The personnel at the transmitter is thus kept informed how to vary the operating wavelength—or its vertical angle of radiation—so as to ensure the best possible working conditions.


PERMEABILITY TUNING

A VARIABLE permeability unit, for tuning the RF circuits of a wide-band amplifier, is designed to possess a high initial ratio of inductance to resistance, and to maintain the same degree of selectivity over the whole tuning range.

As shown in the Figure, the coil is wound in biconical form, the magnetic core being made in two parts, one fixed and one movable. The " fixed " part of the core consists of two flanges C, D secured to the inside of each former, whilst the movable part consists of two end-pieces A, B, both of these being recessed at R so as to slide over the fixed flanges.

The fixed magnetic flanges C, D ensure a high initial inductance-to-resistance ratio for the coil, which is maintained.
Recent Inventions—
as the outer members A, B are closed in
to increase the flux as the tuning point
is varied up the wavelength scale. The
device is stated to combine constant
selectivity with uniform gain, as the
dynamic resistance remains practically
the same for all adjustments.

Johnson Laboratories Incorporated
(assignees of W. A. Schaper). Convention
date (U.S.A.) November 20th, 1937.
No. 521862.

MANIPULATING AN ELECTRON
STREAM

The electron stream flowing through a
discharge tube is subjected to an
oscillating electric field which has the
effect of varying the velocity of the
individual electrons so as to bunch or
group them together at definitely spaced
points along the length of the stream.
In this condition the stream is passed
through a second oscillating electric field,
where an interchange of energy takes
place.

The process is applied to the genera-
tion or amplification of waves having a
frequency in the order of a thousand
million cycles a second. More partic-
ularly it is stated to overcome the diffi-
culties associated with "active-glit" or "losses
when discharge tubes are used for
handling oscillations of so high a fre-
quency that the " transit time " of the
working electrons is comparable with the
time cycle of the oscillations being
amplified or generated.

The periodic bunching of the electron
may be likened to a "stationary wave"
set up along the stream. Since the
latter is moving bodily, the arrange-
ment simulates an alternating current
from which energy can be absorbed at a
frequency corresponding to that of the
stationary wave system.

The Board of Trustees of the Leland
Stanford Junior University of Cali-
fornia (Assignees of R. H. Lyman),
Convention date (U.S.A.), October 21st,
1937. No. 523712.

AIRCRAFT NAVIGATION SYSTEMS

A NUMBER of short-wave radio trans-
mitters B1, B2, B3, Fig. 1, are
arranged so as to form a route to be flown,
so that in combination with marker beacons
A1, A2, they can be used to guide a
plane along an accurate course MN,
such as is shown in Fig. 2, say for the
purpose of avoiding some obstacle that
may lie in the direct path from one
point to another.

Each of the transmitters radiates two
"overlapping" beams, Fig. 3, one of
which is modulated, say, with the Morse
signal A and the other with the Morse
signal N. The dots and dashes merge
together into a single continuous note
only along the zone shown shaded in
Fig. 3. If the pilot departs from this
central zone, the signals break up and
are heard in their distinctive Morse se-
quence. The shaded zone in Fig. 3
marks out the course MN in Figs. 1
and 2.

At points near the limits of reception
from each of the transmitters, a short-
wave "marker" beacon Ax, A2 radiates
a beam directed vertically upwards.
Each marker transmits a distinctive
signal so that as the plane flies over
the pilot knows his precise location along
the line of route. If desired, each of
the transmitters may also radiate dis-
tinctive "complementary" signals, such
as A and N, or T and E, or F and L, so
as to give the pilot additional evidence
of his position at any given time.

Standard Telephones and Cables, Ltd.
(Assignees of Le Materiel Telephonique
Soc. Anon.). Convention date (France)
March 12th, 1938. No. 526318.

ELECTRONIC AMPLIFIERS

The flow of electrons through an
evacuated tube can be controlled by
the static field from a grid, or the stream
may be constricted into a beam, and then
deflected to one side or other so that it
either hits or misses the output anode.
As a refinement of the latter process, the concentration of the beam can be varied in its passage through the tube so that more or less of it will pass through an aperture
electrode on the way to the output
electrode.

According to the present invention, a
number of concentrating electrodes are
placed along the path of the electron
stream, and control voltages are applied
to them so as to vary the stream con-
tcentration and thus force more or less
of the electrons to strike against a target
electrode which is maintained with a sub-
stance having a high coefficient of
secondary emission. In this way the
amplification is made to depend upon the
number of primary electrons which
impact against the specially coated part
of the target or output electrode.

Telefunken Ges. für drahtlose Tele-
graphie m.b.h. Convention date (Ger-
many) January 28th, 1938. No. 524417.

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

AUTOMATIC FREQUENCY-CONTROL

If a voltage is applied between certain
semiconducting substances, placed
in close contact with each other, it is
known that a marked adhesion occurs
between them. This so-called Johnsen-
Rahbeck effect is believed to be due to
the molecular attraction that is brought
into being between too close-set surfaces
by an applied voltage. Since any
decrease in the space between two di-
electrics necessarily affects their con-
denser value, the phenomenon in ques-
tion offers the possibility of using a
change of voltage to produce a corre-
sponding change of capacity.

According to the invention, the
Johnsen-Rahbeck effect is utilised to
apply automatic frequency control to a
wireless receiver. A condenser is made
the place of the ordinary fluorescent
screen, or by the film of collection on a
finely polished plate of aluminium, over
which a thin foil of metal is placed. The
condenser is in series with the main tuning condenser of the
local oscillator of a superhet set.

A discriminator circuit of known type is
used to derive a voltage representative
of the initial error in tuning, and this
voltage is applied to the Johnsen-
Rahbeck combination so as to alter its
effective capacity to the degree neces-
sary to apply the required tuning
correction.

Marconi's Wireless Telegraph Co.,
Ltd.; N. M. Rust; J. D. Brailsford;
A. L. Oliver; and J. F. Ramsay.
Application date, November 12th, 1938.
No. 524073.

VISUAL SIGNALS

The signals used in telewriting or in
picture telegraphy are recorded in
permanent or semi-permanent form on
a special crystalline screen, which takes
the place of the ordinary fluorescent
screen of a cathode-ray tube. The pic-
ture is formed by scanning the special
screen with a beam of ultra -short-wave
light, or with X-rays, the effect of which
is to cover the normally transparent
screen with small "opaque centres," fol-
lowing the track of the scanning
beam. An image is produced because
the degree of opacity varies with the
intensity of the scanning beam. Once
the picture has been formed it can be
photographed direct from the screen, or
projected as an image on to a separate
screen outside the cathode-ray tube.
When desired, the picture image can be
removed by rescanning the crystalline
screen, or by the application of heat or
an electric field.

The screen is made of crystals of an
alkali halide such as sodium chloride or
sodium iodide, the theory being that
the short-wave scanning beam injects
electrons into the existing crystal
lattice, which thus form "opaque centres" of permanent or semi-per-
manent duration.

Scophony, Ltd., and A. H. Rosenthal.
Application date, June 24th, 1939.
No. 524520.

MARCH, 1941.
The ROLLS-ROYCE of BUZZERS is the CAMBRIDGE - TOWNSEND D. G. S. A. — M. A. Perfect for Waveformers, ideal for signals. High note model. Dia-

phragm blade. Platinum Contacts. The smallest Buizer possible.

10/-

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30 ohms, 15/-.

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30,000,000 ohms, 50£.

Electro-Magnet, Self-

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1,000 ohm model in square ebonite case, 6£.

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15. £.

20. £.

25. £.

30. £.

50. £.

100. £.

for use with D.C. or A.C., 10£.

5. £.

10. £.

15. £.

20. £.

25. £.

30. £.

50. £.

100. £.

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1,000,000 ohm model in square ebonite case, 10£.

100,000,000 ohm model in square ebonite case, 50£.

1,000,000,000 ohm model in square ebonite case, 100£.

for use with D.C. or A.C., 10£.

5. £.

10. £.

15. £.

20. £.

25. £.

30. £.

50. £.

100. £.

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class 44 lbs. 10 watt M.C. Speaker. Permanent Magnets at manufacturer's price.

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200 Watt, Full Wave Speaker, field supply unit 25/-, with valve.
200 Watt, Complete Thordarson 310, £25 0 0.

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Ode
Partridge
No. 5

TEE-DOODLE-OO

By R. KEEN, B.Eng.

WIRELESS

MARCH, 1941.

FINDING

The radio waves perhaps they find
The Axis propaganda staff
Just when we start a -listening in
The Forces programme every night
What is it that keeps coming thro'
Tee-doodle-oo, Tee-doodle-oo,
Will cause no springing in our planks.
And leave the Huns to rule the world.
That flags now flying will be furled
If he would cause us such distress
To him must come another guess,
Which permeates this queer old land.
The spirit and the heart so grand
Who thinks to weaken by this plan
He is indeed a stupid man
Are smoother than the Channel kind.
We hear a liquid rippling sound
With ears well back, all set to grin,
And interferes without respite ?
So-!
What every Briton knows is true,
Have set in verse without mistake
Now we who Chokes and such like make,
Ask Musso how he likes his clout.
Ours will be spelt H -E -L -L
We promise you a rousing Heil.
Across the channel to this Isle,
" Tee-doodle-oo " just when you like
To us.-" Bobs," 59, Chinglord Mount Rd., E.4. [9424

MARCH, 1941.

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Providential in Radio Telegraphy and Telegraphy for Aircraft

City and Guido Telecommunications

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Age

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Owing to War Conditions this business is now transferred to:
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Terms: Cash with Order

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(This advertisement continued in column three.)
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UNIVERSAL AvoMeter, 40-46 range, first-class condition.

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MacLachlan and Co., Strathclyde.

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CATHOLIC Ray Oscilloscope, preferably商用3559, or similar.—Apps, stating condition and price, to Easter Ignition Co., Bamber Bridge.

TYPION


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