

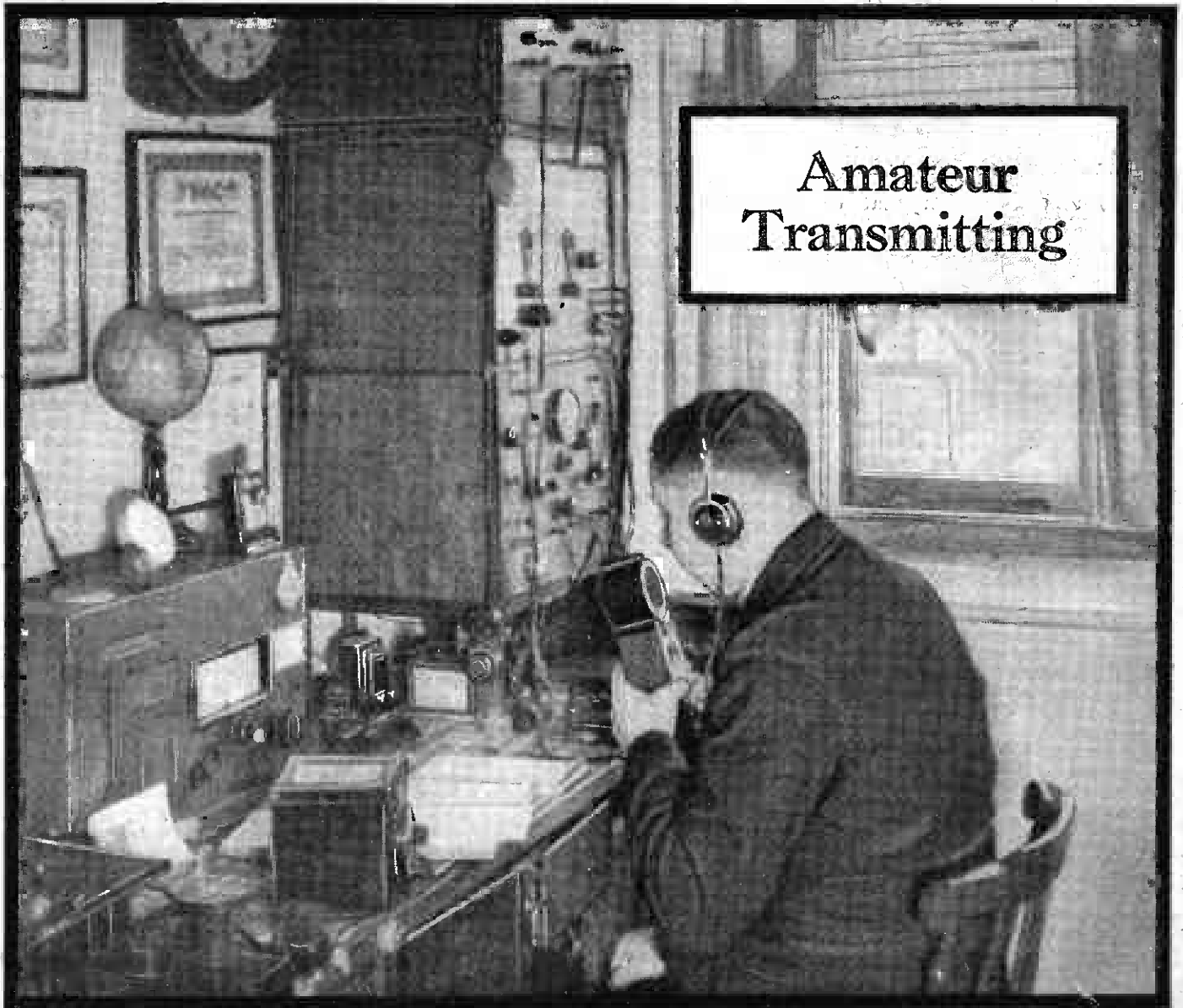
The

Wireless World

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Amateur
Transmitting

The Wireless World

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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.

CONTENTS

	Page
Editorial Comment	1
The Amateur Transmitting Station	-
1—Simple Crystal Controlled Os-	3
cillators	3
Resistance-Capacity Tuning	5
Problem Corner	8
Keeping the Lines in Step	9
Television Programmes	11
Unbiased	12
News of the Week	13
Noise Limiters	15
Armstrong Model AW125PP Re-	16
viewed	16
Letters to the Editor	19
Readers' Problems	20
"Fit and Forget" Valves	21
Random Radiations	22
Recent Inventions	24

EDITORIAL COMMENT

Quality Transmission

Lessons from "Television Sound"

JUDGING both from our own observations and from the opinions of readers, it seems clear that the high quality associated with the sound accompaniment of television is not accounted for solely by the extended range of frequency response which the use of an ultra-short-wave transmitter makes possible. Evidence in support of this argument began to accumulate before the Alexandra Palace transmitter was put into service. For instance, the reproduction from the experimental short-wave transmitter on the top of Broadcasting House showed a marked superiority over that of the same programme from the Brookmans Park station, in spite of the fact that the loud speaker used in the test we have in mind was known to have a sharp cut-off at 6,500 c/s.

phones and amplifiers are used in the television studio and this narrows down the enquiry to the characteristics of the studio itself. Unlike the studios at Broadcasting House, which have been measured, adjusted and made to conform carefully to the latest precepts of architectural acoustics, the television studio, with its multiplicity of scenery, "props" and electrical apparatus, has an extremely complex standing wave pattern which probably accounts for the characteristic quality of television sound. Another difference is to be found in the placing of the microphones which must always be outside the field of view of the camera and several feet from the speaker, who may, therefore, be weaned from the subconscious urge to adopt the crooning manner of speech which the proximity of a microphone seems to engender.

Proposal for a Test

So far as music is concerned, we suggest that a most instructive programme would be an "exchange" concert between the Television Orchestra at Alexandra Palace and a similarly constituted orchestra playing in one of the studios at Broadcasting House. The whole programme would be radiated through the television sound channel, with London Regional transmitting it on the medium waves as a further check. The effects of land-lines and different studio acoustics and technique could then be studied.

Ultra-short-wave quality is not a myth and although there may be an occasional broadcast which is below par there is no mistaking the outstanding quality resulting from the combination of the unique studio characteristics at Alexandra Palace with the wide frequency range of the U-S-W transmitter taking its modulation on the spot.

Land-line Effects?

At the time this was attributed to the fact that the U-S-W transmitter was taking its modulation directly from the studio amplifiers without the intervening land-line to Brookmans Park. However, we can now eliminate the short land-lines in the London area as possible causes of discrepancies in quality, since the recent broadcast by the Director of Television, referred to by a correspondent in this issue, had all the earmarks of television sound quality in spite of the fact that it had to traverse not only the new line from Alexandra Palace to the B.B.C. headquarters at Broadcasting House but also the permanent link from the Broadcasting House control room to Brookmans Park.

We are assured that standard micro-

High-Fidelity Transmission Programmes on 7 Metres

IT is good news that the B.B.C. has decided to radiate either the National or London Regional programme between about 8 and 9 p.m. each evening through the Alexandra Palace transmitter. We hope that this is only a preliminary to a wider use of ultra-short-waves for sound broadcasting.

In view of the discussion now proceeding in our columns on the quality of transmissions on these wavelengths, it is interesting that musical items which stand to gain most from an extended frequency range are to be chosen.

If 7-metre sound transmissions become a regular feature, designers of television receivers will have to consider the question of providing means for switching off the vision section; facilities for doing so are now comparatively rare, but will be necessary in the interests of tube and valve life.

Standardised HT Batteries

Congratulations to the R.M.A.

THE RADIO MANUFACTURERS' ASSOCIATION is to be congratulated on having issued a specification for dry batteries as used in wireless receivers. It is to be hoped that this move will abolish the abuses that undoubtedly exist in certain sections of the trade.

In addition to laying down sizes of cells for batteries of four standard capacities, the specification also sets forth a series of nominal initial voltages that should be sufficient for all ordinary requirements.

Second-hand Sets

The Problem of Disposal

IF you want to buy a new set and take your present one to your dealer, hoping to get an allowance for it, you will probably be sadly shocked at the price he will offer you for it; generally speaking, you will find it far more satisfactory to sell your present set privately before you buy the new one.

The reason is that your set is probably worth much more to a private purchaser than it is to a dealer who may have some difficulty in disposing of it, and, in any case, may have to recondition it before he tries to find a buyer.

There are some wonderful bargains today in sets of a year or two years old which ought to find a market to replace sets of earlier vintage, which, by now, are probably giving very poor service indeed. From the manufacturers' point of view, it is very important that the public should be able to find a market at a fair price for their existing sets, because until they do there is little hope of any large buying of new sets, now that there are very few purchasers who are not already owners of a set of some kind.

Misleading Terms

Everybody's Responsibility

A LETTER published in our Correspondence columns this week draws attention to as pretty an example as could be found of an unfortunate and confusing piece of technical jargon.

The expression "all-mains," which is the culprit, admittedly, had a limited currency in informed wireless circles for a short while during the transition period from battery to mains operation of broadcast receivers. It was then used to describe a set deriving all its working voltages—heater, anode and grid—from the mains, and served to distinguish such sets from others in which an LT accumulator (and perhaps a dry-cell bias battery as well) was retained.

It would now appear that an unfortunate purchaser of a broadcast set, knowing nothing of this fragment of wireless history, assumed the expression "all-mains" to mean that the receiver would work on any type of supply mains, AC or DC. Although we may smile at such a misunderstanding, it is only fair to admit that the purchaser's interpretation of the description was natural enough.

In a new and rapidly growing art such as ours, one cannot be too careful about these matters, and it is the responsibility of everyone to see that our jargon, if it cannot be made comprehensible to the layman, at least will not confuse him.

In this Issue

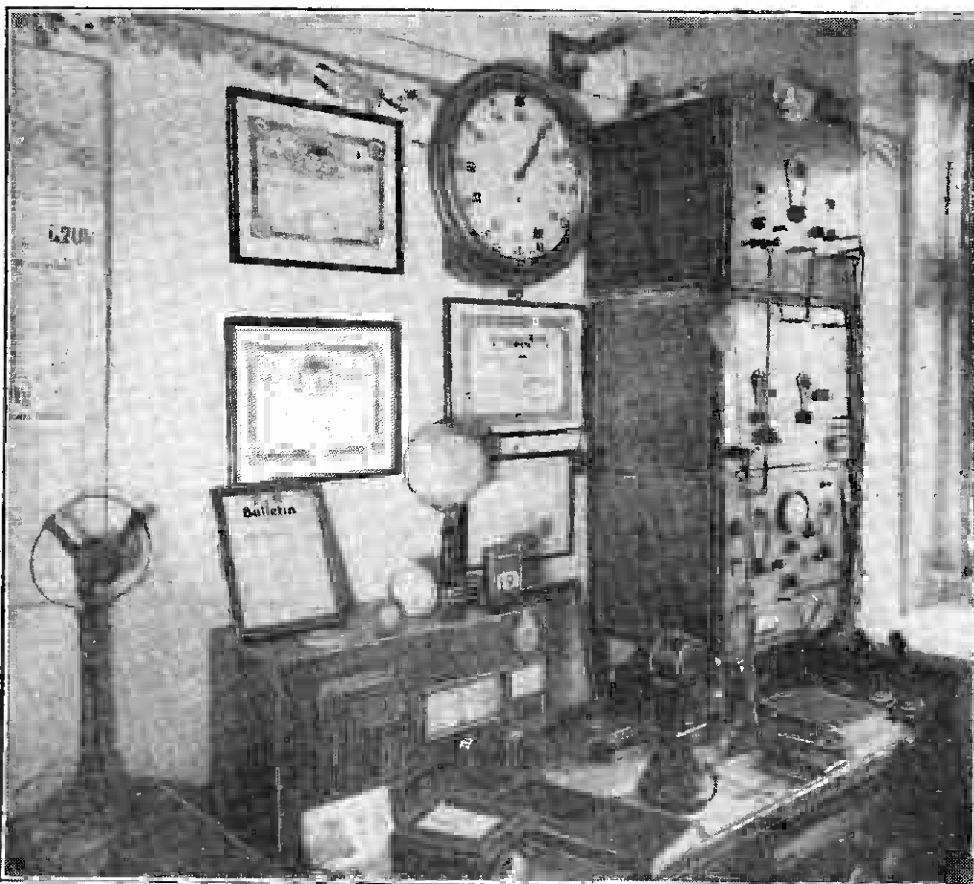
Features for 1939

AS a result of the growing interest in amateur transmission we are publishing a series of articles which will treat this subject for the benefit of readers who have no previous knowledge of transmitting practice. Although dealing primarily with the design and construction of a low-powered amateur transmitter, the articles will also include information on adjustments and operation, as well as on the choice of components and accessories.

For reasons explained in the opening article, which appears in this issue, a start is being made with a transmitter suitable for the 40- and 20-metre wavebands, perhaps the most popular of those open to the amateur. Later, however, it will be shown how the set may be modified for 10-metre working.

Another feature beginning in this issue is of quite a different nature, and is designed to appeal to those readers who wish to test their powers of logical deduction. Would-be solvers of the problems should perhaps be warned that, although the letters addressed to the mythical Henry Farrad are couched in disarmingly simple terms, every word is significant.

Next week's issue will be devoted largely to the subjects of measuring instruments and measurements, and will include a review of apparatus of wireless interest shown at the Physical Society's annual exhibition, which closes to-day.



AMATEUR TRANSMITTING STATION G2UV. This station owned and operated by Mr. W. E. Corsham, at Wembley, Middlesex, normally works on the 14-Mc/s band (21.42-20.83 metres) using both telephony and CW system of transmission. The station can often be heard working in the evenings and most mornings at 9 a.m., at which hour Mr. Corsham usually carries out tests with amateur transmitters in New Zealand.

The Amateur Transmitting Station

Part I.—SIMPLE CRYSTAL-CONTROLLED OSCILLATORS

By H. B. DENT (G2MC)

This is the first of a short series of articles on design and construction, written for the benefit of the would-be amateur transmitter. No previous knowledge of transmitting practice is assumed.

HAVING already discussed the procedure to be followed in applying for a transmitting licence,¹ we now come to what might be described as the immediate post-licence period when the successful applicant is about to build his first transmitter.

At the outset, this will probably be mainly a communication type of set; the experimental apparatus, which may or may not be subsidiary to it, can be evolved later. Exchange of ideas with other amateurs, arrangements for co-operation in future tests and the acquisition of experience in the adjustment and operation of transmitters will be the main purpose for which the set is required. It goes without saying that the newly licensed amateur has by now a reasonably good knowledge of the fundamental principles of wireless transmission, though, so far, he has had no opportunity to put this knowledge into practice.

Since many alterations will certainly be made from time to time, a baseboard layout, with ample space for modifications, is preferable to the less adaptable rack-built assembly. This form of construction might well be deferred until a semi-permanent design has been evolved from the experimental baseboard equipment.

The Best Wavelength

A decision must be made regarding the waveband in which transmission is to be effected initially. Unless there is any special reason why a particular frequency should be chosen then it would be best to build the transmitter for use on one of the lower amateur frequencies, such as 1.7 or 7 Mc/s (160 or 40 metres).

The latter is possibly the better of the two as it is of a sufficiently high frequency to show up defects in the design of the apparatus yet not so high that the beginner is likely to encounter any serious difficulties in obtaining a reasonably good performance from the outset.

The temptation to make the set so that it can be switched from one waveband to another quickly should be resisted, or at least deferred until a little practical experience has been acquired in the adjustment and operation on a single wavelength.

A simple form of construction should be adopted and ample space allowed for

additions and modifications. The licence usually restricts the input to 10 watts; this is not the total consumption of the transmitter, but the power supplied to the anode of the valve that is coupled to the aerial.

There is no restriction on the power consumed by any other stages in the set, so the main concern is to extract as much RF energy as possible from the last valve, i.e., a high efficiency is necessary in order to obtain the best performance with the power permitted. This is of paramount importance in the design of every amateur transmitter, even though it may mean uneconomical operation of stages that precede the final valve.

A single valve functioning as an oscillator would serve the purpose of the RF generator for delivering power to the aerial in a small transmitter, but this arrangement is not very efficient and does not make the best use of the 10 watts available.

Some means must be found to ensure operation on a fixed frequency, or at least to confine the oscillations to the band of frequencies allotted for amateur use, for working outside the authorised band is of all offences the most unpardonable that any amateur transmitter can commit!

Unless some form of frequency control is embodied in the transmitter constant checking of the frequency is necessary, and an accurately calibrated wavemeter becomes an essential part of the equipment.

As it is obligatory for every amateur station to possess a piezo-electric crystal, with either its fundamental frequency or one of its harmonics falling within the band in which transmission is being made, it has become the customary practice to use this crystal actually to control the frequency of the valve that generates the RF oscillations, which may or may not be the valve feeding energy into the aerial.

A quartz crystal having a fundamental frequency of, say, 7.2 Mc/s is less than $\frac{1}{16}$ in. thick and though quartz is a very tough material it could be fractured if the plate is allowed to vibrate too vigorously. This condition might obtain in an oscillator stage with a power input of 10 watts. It has also been noticed that, with moderate high-power oscillators of this kind, the frequency tends to drift as the crystal warms up, the heating of the crystal being due partly to its frictional loss at large amplitudes of vibration and partly to the RF current circulating in the crystal circuit. Actually the two effects are complementary, for it is the RF potential across the crystal that governs its amplitude of vibration.

We therefore arrive at this conclusion: the RF generator when crystal controlled should be operated at comparatively low

power and its output amplified by a stage coupled to the aerial and operating at maximum possible efficiency. In this way we obtain the largest amount of RF power for a given input to the transmitter, and at the same time have a master oscillator which can be maintained at a constant frequency by means of a piezo-electric crystal.

The logical thing to do is to design the crystal oscillator and get this working satisfactorily before tack-

ling the amplifier. For this, a pentode, a tetrode or a triode valve can be used. The choice is not based solely on the relative efficiencies of each type, but consideration ought to be given to possible future requirements as all valves and parts purchased for the first transmitter should be suitable also for any set that might be built in the near future.

Let us say that a beginning is to be made with a 7-Mc/s transmitter. We will naturally want the set to be as flexible as possible so that should a move be made later to the higher frequency bands, such as 14, 28 and possibly 56 Mc/s, some of the parts now being used will be easily adaptable to the new transmitter.

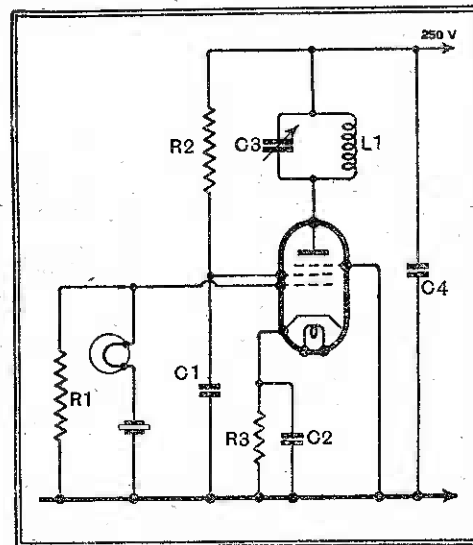


Fig. 1.—The simplest form of crystal-controlled oscillator.

¹ "First Steps to Transmitting," *The Wireless World*, August 11th, 1938.

The Amateur Transmitting Station—

It might, therefore, be a good idea to build the crystal oscillator and the 7-Mc/s power amplifier on separate chassis, for the former at least could be designed now with this possibility in mind without detracting from its efficiency on the initial frequency chosen, and this is quite practical, for all the amateur wavebands are harmonically related.

For operation on any of the higher frequencies the crystal-controlled oscillator can be made to give an output at twice or four times the fundamental frequency of the crystal, and the valves which function best in this way are either pentodes or tetrodes. A typical pentode or tetrode oscillator giving an output at the crystal frequency is shown in Fig. 1; when the circuit L_1, C_3 is tuned to approximately the crystal frequency the valve begins to oscillate, the precise frequency of the oscillations being determined by the crystal and not by L_1, C_3 . The cathode resistance R_3 (shunted by C_2

to by-pass the RF) is included to provide sufficient grid bias to keep the anode current at a safe value when the valve is not oscillating, but when oscillation starts additional grid bias is provided by R_1 . This resistance also serves the purpose of completing the DC path of the grid circuit, as the crystal is a non-conductor, so far as DC is concerned.

When the valve is oscillating the RF on the grid is rectified (the grid and cathode form a diode rectifier) and the DC component flows through R_1 ; the flow of current external to the valve as measured by a meter is from cathode to grid. As the grid end of R_1 is negative in relation to the earthed end the potential difference acts as additional grid bias when the valve is oscillating.

In most oscillators of this kind R_1 is made 50,000 ohms but if for any reason it is necessary to lower it an RF choke should be joined in series with it as this resistance is in parallel with the crystal and if its RF impedance becomes too low the valve will not oscillate.

The small flash-lamp in series with the crystal acts as an indicator of the RF current flowing through the crystal. A low-consumption lamp of, say, the 60- or 100-mA type is best for this position. Normally it should not glow brightly, though a dull glow will not indicate an overload. The tuning of L_1, C_3 governs the amplitude but, as already stated, not

the frequency of oscillations, and the correct adjustment is when this circuit is tuned to a slightly higher frequency than that of the crystal but sufficiently close to resonance to give an adequate RF output

the modifications to the circuit are shown in Fig. 3.

Comparing this with Fig. 1 it will be seen that a tuned circuit L_2, C_5 is now interposed between the grid bias resistance R_3 and its by-pass condenser and the earth line, while the crystal is joined to the cathode end of this circuit. Coil L_1 is replaced by one that tunes with very little capacity in C_3 to the frequency of the harmonic required.

Often C_5 is made variable but it need not be, as once the correct adjustment has been found it can henceforth be left alone. It is only necessary to find the optimum value for L_2 with a fixed capacity at C_5 to ensure the same results. The tuning of this circuit is not critical, and if it is made to resonate at a frequency slightly lower than twice that of the crystal the oscillator functions quite satisfactorily.

A simple way of allowing for this conversion would be to arrange for

L_2, C_5 to plug into a two-pin socket for harmonic operation, and this socket is fitted with a two-pin shorting plug for fundamental frequency operation. This idea has been used quite successfully in several experimental transmitters made by the writer, and a crystal oscillator unit with this feature is shown in the illustration.

It is possible to obtain a modest output at four times the fundamental frequency of the crystal but the power is small and generally one is content to frequency-double only in this stage, when sufficient

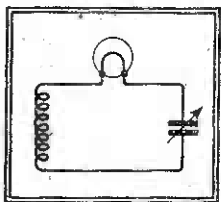
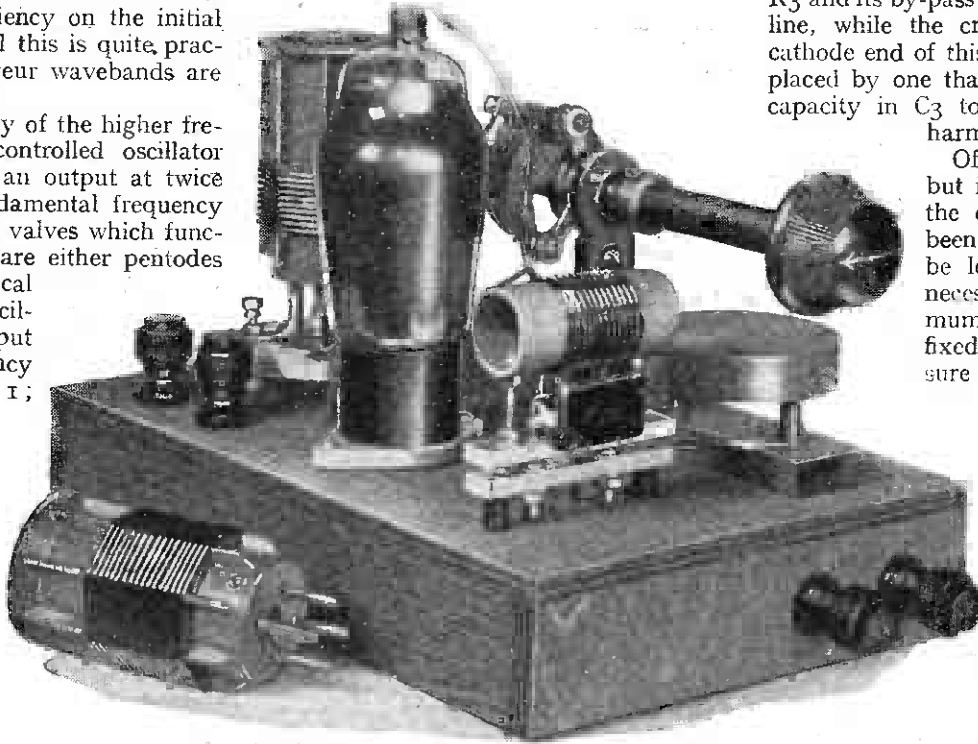


Fig. 2.—Wavelength checking circuit with lamp for indicating resonance.

without excessive current flowing through the crystal.

Various adjustments of L_1, C_3 and of R_2 , which initially should be about 5,000 to 10,000 ohms, according to the type of valve employed, can be tried and the output observed by means of an RF indicator coupled to L_1, C_3 . The simplest form of indicator consists of two or three turns of wire joined to a small flash lamp and mounted on the end of a wood or ebonite rod.

An RF meter with which actual measurements can be made was described in *The Wireless World* of March 24th last and this will be found very useful when adjusting transmitters for maximum power output. An absorption wavemeter with a small flash-lamp joined in series with the coil as shown in Fig. 2 also forms a useful indicator.

If the crystal oscillator is made as a separate unit it is worth while paying some attention to its construction for it will serve for almost any future transmitter working on 40 metres or lower. With this possibility in mind sufficient space should be left on the chassis to accommodate the few extra parts needed to obtain an RF output at twice or four times the fundamental frequency,

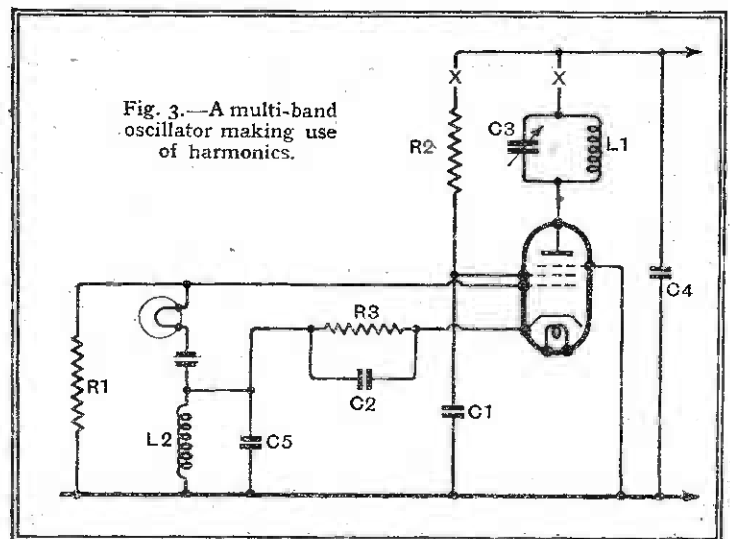


Fig. 3.—A multi-band oscillator making use of harmonics.

power is available to load fully a 10-watt power amplifier.

The screen-feed and the anode-feed leads should have inserted at the points marked X either a jack or a pair of terminals for connecting a milliammeter.

Resistance-Capacity Tuning

STAGES IN THE DEVELOPMENT OF PRACTICAL RESISTANCE-CAPACITY CONTROLLED OSCILLATORS

THE purpose of this article is to recapitulate some of the principles governing the operation of resistance-capacity oscillators and to describe some recent practical developments.

By P. W. WILLANS, M.A., M.I.E.E.

IT has been known for some twenty years that retroactively coupled valve circuits comprising only resistances and condensers can be made to generate oscillations.

The best-known device of this kind is, of course, the two-valve multivibrator of Abraham and Bloch, which generates oscillations of extremely irregular waveform. More recently, circuits have been described which generate or selectively amplify sinusoidal oscillations, and an article on this subject by Colebrook appeared in *The Wireless World* of February 8th, 1935, under the title of "Resistance-Capacity Tuning."

The reason why a multivibrator should work in the way it does has occasioned some theoretical difficulty. At first it was held that there must, so to speak, be a catch somewhere, and that the oscillations could only take place by virtue of the presence of residual inductance in the circuit. The analytical discussion of the multivibrator on this hypothesis was published by van der Pol in a very well-known paper (*Phil. Mag.*, Vol. 2, November, 1926).

In a later publication (*Zeitschrift für Hochfrequenztechnik*, XXIX, p. 114) van der Pol, dealing with an analogous circuit, has presented an alternative explanation, stated to be due in the first instance to Roosenstein, which does not appear to be generally appreciated. According to the views therein put forward, the shunt capacities in a circuit of the multivibrator type may play the same part as an inductance in explaining the generation of

oscillations and, having regard to the dimensions of practical circuits, such capacities come into question before any stray inductance could exercise an appreciable effect.

The bearing of this explanation upon possible developments in resistance-capacity tuning apparatus seems to have been ignored, although the multivibrator itself was known to be capable of critical adjustment so as to generate sinusoidal oscillations. (*W.W.*, loc. cit., also May 14th, 1937, article by Ledward). Until recently, the only practical proposals for this purpose have been along entirely different lines.

It will be convenient to deal with the subject in chronological order and to begin with a short description of some of these earlier devices.

In the article above referred to, Colebrook deals with a proposal, due to van der Mark and van der Pol, to generate sinusoidal oscillations by means of a retroactive arrangement comprising an odd number of amplifying stages with resistance-capacity couplings between the stages and between the first and last valve (see Fig. 1). A fuller description of the working of this apparatus is given in the original paper (*Physica*, Vol. 1, 1934, p.

437) and in British Patent Specification No. 395,596.

To appreciate how this device works we may consider the feed-back lead of the arrangement to be broken at the points X, X, and imagine that we introduce a sinusoidal voltage V_1 at the input of the amplifier and obtain at the output a voltage V_2 which for simplicity's sake we will assume also to be a sine wave.

If the condensers and resistances have fixed values, the same for each stage, the phase of V_2 in relation to V_1 will be governed by the frequency of oscillation.

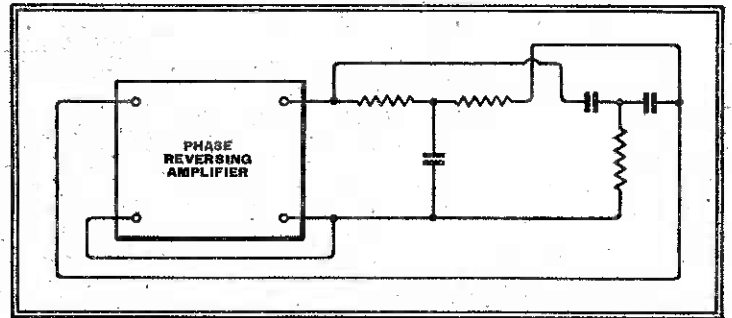


Fig. 2.—Coupling network with resistance-capacity alternators in parallel, due to H. H. Scott.

At very low frequencies the resistance-capacity coupling will advance the phase at each stage by nearly 90 deg., and there will, of course, be a phase-reversal at each stage due to the operation of the valve. The net result will be that the phase will be advanced nearly 90 deg. If progressively higher frequencies are chosen the phase-lead per stage will decrease and a value will be reached at which the total phase-lead becomes zero, and thereafter, for still higher frequencies, changes sign, becoming a phase-lag. The critical frequency is that for which the phase-angle is zero; if at this frequency we adjust the amplification so that $V_2 = V_1$ in magnitude as well as in phase, we may then take away the external source, join up the points X, X, and the amplifier "won't know the difference."

Negative Feed-back Action

The condition for oscillation in any retroactive system is thus that if we divide the retroactive "chain" at any point, a sinusoidal input voltage at this point of some frequency will generate "on the round trip" a voltage equal to and in phase with itself. In the case just considered, the frequency is that for which the phase-lead due to each coupling is exactly 60 deg. For higher frequencies the phase shift of the couplings tends to zero and the overall phase shift thus approximates to 180 deg. As a result of

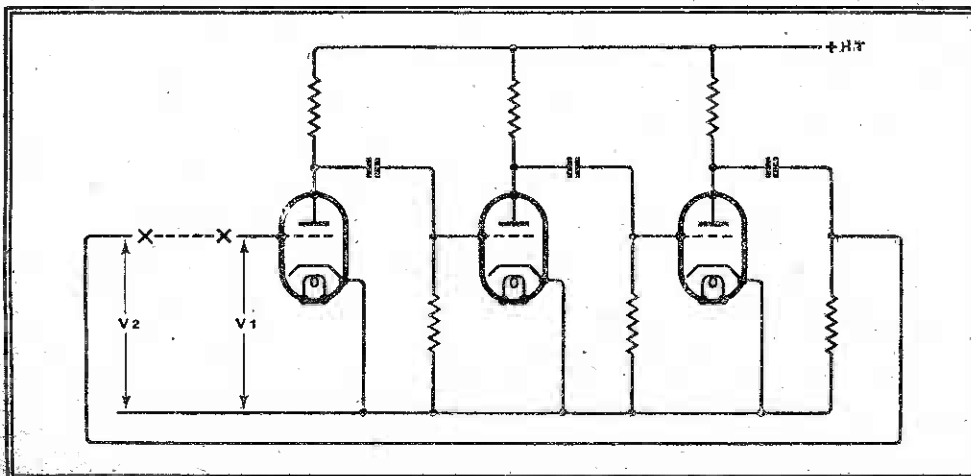


Fig. 1.—Basic resistance-capacity sine-wave oscillator circuit employing an odd number of stages.

Resistance-Capacity Tuning—

the strong negative feed-back action there is no tendency to instability at high frequencies even though the amplification per stage is high.

The undoubted usefulness of such circuits lies in their flexibility and ease of adjustment over a large range of frequencies, also more particularly to the readiness with which oscillations of very low frequency can be generated without the necessity for massive iron-cored inductances, often of dubious quality as regards constancy of value and linearity of wave-form. A further special characteris-

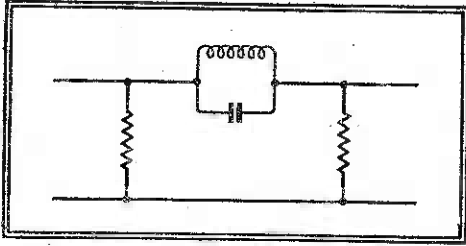


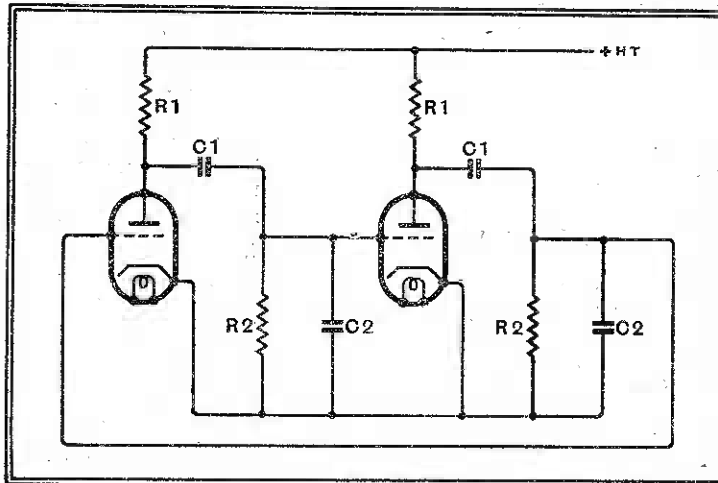
Fig. 3.—Equivalent circuit having same voltage attenuation as Fig. 2, though a different impedance characteristic.

tic of this particular circuit is the possibility of easily obtaining a three-phase supply on any desired frequency.

A further proposal, involving an arrangement giving negative feed-back at all but one frequency, is due to H. H. Scott (*Proc. I.R.E.*, February, 1938). According to this arrangement a phase-reversing amplifier is retroactively coupled by a network consisting of two T attenuators connected in parallel (see Fig. 2).

It can be shown

Fig. 4.—Two-valve multivibrator circuit modified to give sine-wave output.



that such a network (which passes both very high and very low frequencies without attenuation or phase-shift) can be made to give infinite attenuation at a single frequency, so that the amplifier at that frequency has full gain and at other frequencies has a gain which is more or less drastically reduced by the operation of negative feed-back. The voltage attenuation characteristic of the network, subject to the values of the constituent resistances and condensers being correctly related, is the same as that of an equivalent π network, as shown in Fig. 3, although the impedance-characteristic is different. It will, of course, be appreciated that in this figure the inductance and capacity are taken to have zero resistance, thus giving an extinction at the frequency of resonance.

An arrangement according to Fig. 2 can

obviously be adapted to give selective amplification and is stated to have been employed as a harmonic analyser. By the addition of a device giving a measure of aperiodic positive feed-back it can be made to generate oscillations, and a circuit for this purpose is also given in the paper referred to.

With the object of simplifying apparatus of this kind, attention has recently been given to a class of circuit involving an even number of valves or a single valve having a negative slope. The approach to this subject may most conveniently be by way of the multivibrator in the light of Rossenstein's above-mentioned theory.

In Fig. 4 a conventional multivibrator circuit is shown, with the addition of condensers across the grid resistances to represent the valve capacities (assumed to be of small value compared with the coupling capacities). The operation of this circuit as a sine-wave generator may

be roughly understood by considering the effect of the shunt capacity C_2 (which gives an increasing phase lag with increasing frequency) as being balanced at the frequency of oscillation by that of the capacity C_1 (which gives an increasing phase lead). As in the previous case, assuming the system set at the threshold of oscillation, a voltage of the correct fre-

quency applied to the grid of the first valve generates "on the round trip" a voltage equal to and in phase with itself.

An inspection of Fig. 4 indicates that one of the two RC networks is redundant and can be replaced by a coupling which

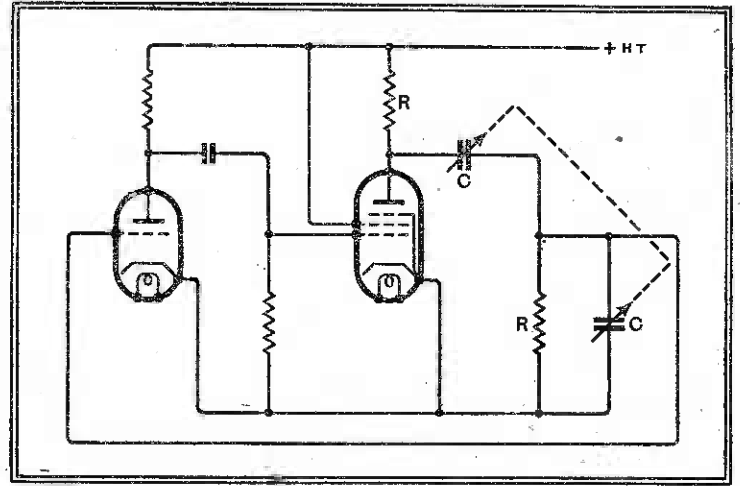


Fig. 5.—Simplified version of the circuit of Fig. 4 with control concentrated in a single coupling.

is made as free as possible from phase-shift. The circuit then takes the form of Fig. 5.

Here, in the first stage of amplification, a normal "aperiodic" coupling is employed. In the anode circuit of the second valve (assumed to be of high impedance, e.g., a pentode) is placed a resistance R coupled by a condenser C to a second equal resistance R shunted by a condenser of equal capacity C . The two condensers are now assumed to be of substantial value in comparison with stray capacities, e.g., they may be air condensers ganged together.

With this arrangement oscillations are generated at a frequency given by $2\pi fRC = 1$, and if the condensers C are simultaneously varied the frequency will vary in inverse ratio. The advantage of such an arrangement is that a very wide sweep of frequency can be obtained by operation of the ganged condenser, unlike the case of a tuned circuit where the frequency only varies as the inverse of the square root of the capacity.

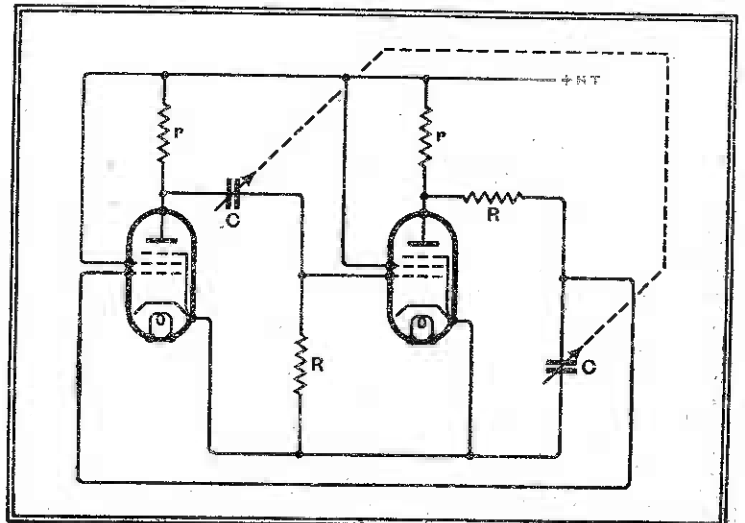


Fig. 6.—Resistance-capacity oscillator due to Dr. N. L. Yates-Fish.

Resistance-Capacity Tuning—

An alternative arrangement giving a similar result is shown, in simplified form, in Fig. 6.

In this circuit (due to Dr. N. L. Yates-Fish) a pair of retroactively coupled valves comprises a phase-advancing stage followed by a phase-retarding stage. At a certain frequency the two effects will compensate for each other; assuming, in the figure, that the impedances of the valves are high in comparison with the feed resistances r , the frequency of oscillations for weak retroactive coupling is given by $2\pi f(R+r)C = 1$.

A Practical Oscillator

Development work has proceeded on both of these two circuits primarily with the object of obtaining an oscillator of wide frequency range, low harmonic content, constant output and reasonably good frequency stability. An oscillator operating on the lines of Fig. 6 has been brought into commercial form in conjunction with Messrs. Muirhead and Co., and is now on the market.

Dealing with this type of circuit first of all, the values of the components are determined by the possible values of the condensers C , and it has been found that air condensers of some 1,000 $\mu\mu\text{F}$ maxi-

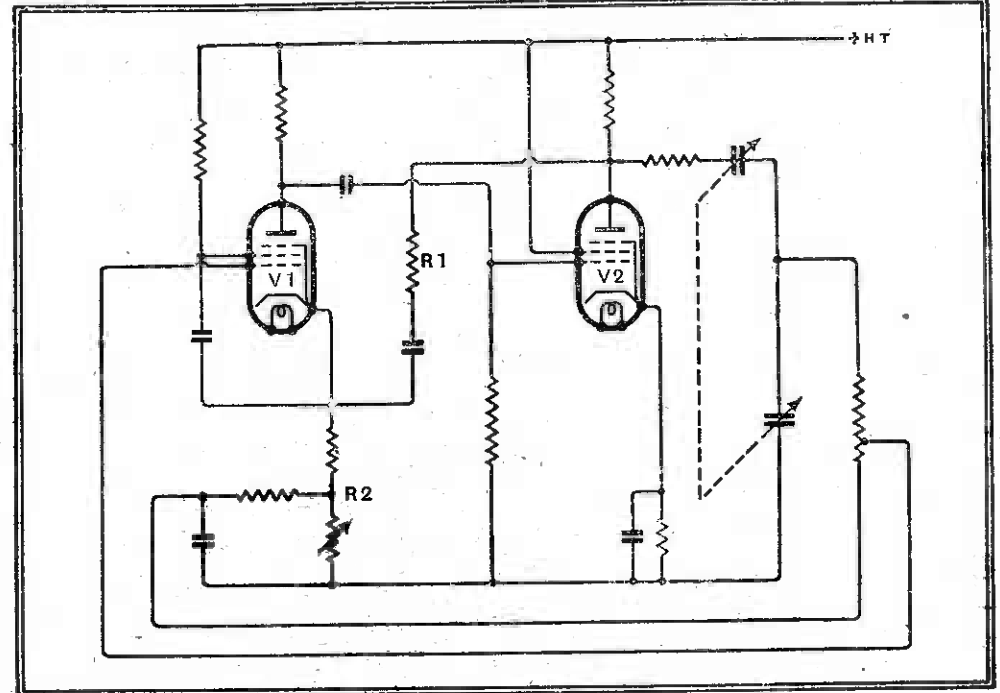


Fig. 8.—Circuit of Fig. 5 with negative feed-back. Oscillations at a frequency of one megacycle have been obtained with this arrangement.

imum value are the largest that can conveniently be constructed in double-gang form.

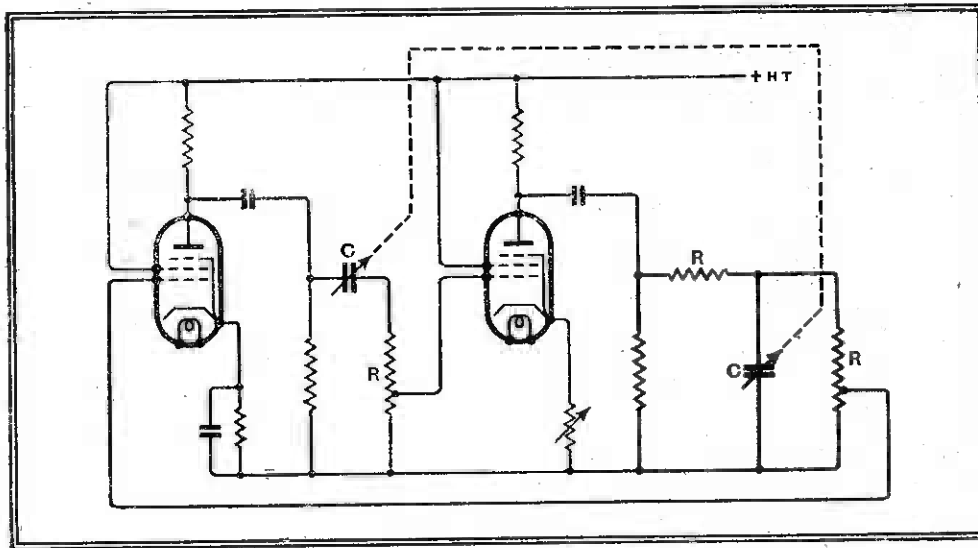


Fig. 7.—Potentiometer grid connections lessen the effect of valve capacity at the high frequencies.

If we allow of a capacity-variation of 10:1 over the practical working range of the oscillator (considering one value of R) we arrive at a minimum value of 100 $\mu\mu\text{F}$ at the top frequency of the range. It is highly desirable that the capacities of the valves should be prevented from affecting the frequency of oscillation, and if this is to be done it is manifest that a modification of Fig. 6 will be necessary. Since there is amplification to spare if modern mains valves are employed, it is possible to use a "tapped-down" grid connection at each stage on the lines of Fig. 7.

It will be noted that a supplementary ("aperiodic") resistance-capacity coupling is provided between the anode of each stage and the grid of the next; this is essential in the one case to block off HT and in the other is provided to protect

the air condenser from HT voltage. An additional resistance is provided across the second condenser to operate as a potential divider; it can readily be seen that, as far as phase-shift is concerned, this merely alters in effect the value of the series resistance of Fig. 6, while, of course, it enables the grid connection to be tapped down on this stage as well as the preceding, where there is already a shunt resistance for the purpose.

In practice all three resistances are made equal and are tapped in the approximate ratio of 10:1. In the oscillator referred to the values of these resistances are varied by means of a switch so as to give three frequency ranges, namely, 20-200, 200-2,000 and 2,000-20,000 cycles per second, with generous overlaps.

A two-stage power amplifier is used in this arrangement which gives an output up to 2 watts with harmonic content of the order of 1½ per cent. The output of the oscillator is substantially constant over each range of frequency.

Reaction may be controlled by a series negative feed-back resistance in the cathode circuit of one valve, the power output being taken from the other, which is set to oscillate over a range of its characteristic, where there is a "point of inflection" in the region free from grid current. As a result of this arrangement the oscillations build up to a stable value without any grid current slowing, and careful adjustment of the grid-bias resistance enables the second harmonic to be reduced to a negligible percentage. The figure of harmonic content above cited is almost entirely in respect of third harmonic.

With this type of oscillator great care has to be taken to preserve the constancy of the voltage supply to the oscillator valves, particularly the first. In the absence of such a precaution the amplitude of oscillations tends to be somewhat unstable, although the frequency is very little affected by mains fluctuations; the requirements of the case can, however, readily be met by the use of neon stabilisers available on the market. (For further details of this type of circuit see British Patent Specification, No. 489,849.)

The circuit of Fig. 5 has not so far been embodied in any general-purpose instrument, though it has found application to one or two particular problems. One of the advantages of using a single network of the kind shown in this figure is the fact that it permits the employment of an amplifier stabilised by negative feed-back. A circuit arrangement for this purpose is shown in Fig. 8.

Referring to this figure, the two-stage resistance-coupled amplifier is stabilised by a feed-back connection consisting of a

Resistance-Capacity Tuning—

resistance R_1 connected (*via* a blocking condenser) between the anode of the second valve and the cathode of the first valve, together with a second resistance R_2 between cathode and earth of the first valve. Part of this resistance (next to the cathode) is fixed in value so as to give a constant grid bias through the decoupling circuit as shown in the figure; the other part is left variable for the purposes of reaction control.

The amplification of the arrangement (provided the "natural" gain per stage is sufficiently high) tends to $\frac{R_1 + R_2}{R_1}$, and the

impedance of the valve V_2 is effectively very low. Variations in this impedance will have only a negligibly small effect on the frequency of oscillation if the resistances of the network are given a reasonably large value.

Another feature of this circuit is bound up with the action of the negative feedback in giving a high input impedance to the amplifier, as a result of which it is no longer necessary to "tap down" on the output resistance of the network to the same extent. The higher the tapping

point the less is the amplification required to make the circuit oscillate, the greater therefore the possible negative feed-back and the higher the input impedance. While it can be shown that this increase of input impedance is not enough entirely to offset the effect of moving the tapping point up as described, there is no doubt that the troubles due to the grid circuit load on the network are greatly reduced by this arrangement.

A circuit of this type has been made to generate oscillations of over a megacycle in frequency.

In conclusion, it is worth remarking that circuits on the lines of Fig. 5 can be made to work with a single valve if the arrangement is such that a negative slope is obtained. One of the most efficient devices for this purpose is a valve comprising a stage of electron multiplication in which the auxiliary cathode current flows in the reverse sense and increases in that sense with increase of grid potential. It is open to question, however, whether the simplification due to the use of one valve offsets the advantage of stability obtained by the negative feed-back circuit previously described.

provided by parallel connection of cartridges arranged in the form of a squirrel-cage, the cartridges forming the bars of the squirrel-wheel while the ends consist of metal discs or flat cones, bearing a terminal at the centre and mounting clips around the edge.

PROBLEM CORNER—1**Test Your Powers of Deduction**

ATTACHED is a letter received by a certain Henry Farrad, who has the reputation among his friends of being able to solve their radio problems, even though through ill-health he is unable to examine them on the spot. Here is an opportunity to test your powers of logical deduction. What would you diagnose in this case, for instance?

221, Horns Crescent,
Ramsgate.

Dear Henry,

INDDED up by going in for the motor-tuned push-button model you recommended, and had good fun with it until my Yorkshire wife complained that there wasn't a North Regional button. Never satisfied with the wonders of science, these women! However, after an hour or two's study of the book of instructions I felt confident enough to tackle the job of altering one of the original buttons to North Regional by shifting the tie-clip affair round the semi-circular bar at the back.

I flattered myself I had made a good job of it, and so it seemed at first; but in the middle of a programme that evening it sort of dissolved into a speech by Hitler or something of the sort. Another time, during a concert, a French announcer mysteriously came on the scene. I tried to make out to Edie that it was part of the B.B.C.'s plan to broaden our minds; but she looked up the *Radio Times*, and that excuse didn't go.

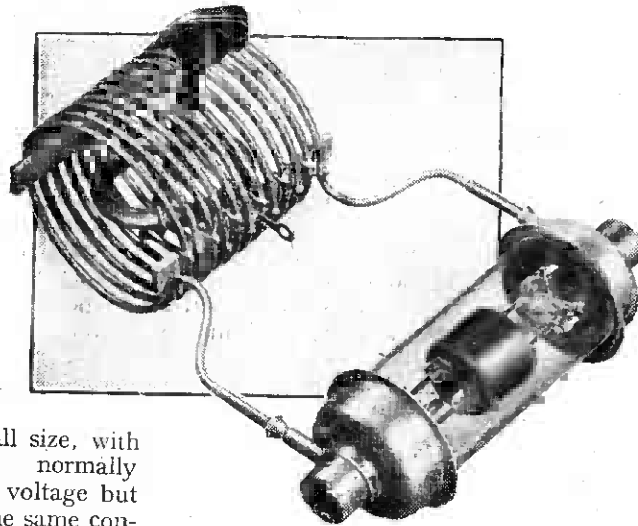
At the moment I am suffering from what the Chinese call loss of face. Have you any suggestions, old man?

Yours ever,
Arthur.

How did Henry Farrad account for the trouble, and what did he suggest? Turn to page 19.

**Vacuum
Cartridge
Condensers**

FOR USE IN
TRANSMITTERS



AN air condenser of small size, with closely spaced plates, normally "flashes over" at moderate voltage but if placed in a high vacuum the same condenser becomes useful at high voltage, providing that the solid insulation necessary to keep the elements in place can stand up to its job. Briefly, this is the principle behind the Eimac vacuum cartridge condensers, recently introduced in America.

The actual condenser, consisting of two concentric cylinders of tantalum, is suspended centrally in an evacuated cylinder of hard glass, capped at either end by a metal "hat" which serves as a terminal. The rolled brim serves to equalise the electrostatic field near the glass, while the small crown of the hat permits connection to be made by a clamp or by a spring clip such as that used to hold cartridge fuses.

Though the volume of the condenser proper is approximately one cubic inch, a peak voltage rating of 32,000 (for radio frequencies) is given by the makers, Eitel McCullough, San Bruno, California. The 32,000-volt rating must be abandoned if

the condenser is to be used at DC or at audio frequencies, since cold emission may then cause serious leakage or even flashover. The voltage at which this takes place depends upon a number of factors. The condensers here described are not recommended for DC use at voltages above 7,500. In passing, it is also of interest that the 32,000-volt radio-frequency rating does not of itself define the permissible plate voltage of the associated vacuum tubes, but things fall out so that for wavelengths under 100 metres it is improbable that the rating will be exceeded for anode inputs of one kilowatt per condenser cartridge. The cartridges are available in capacities of 6, 12, 25 and 50 micro-microfarads, all with the same overall dimensions, which approximate to 2½ in. by 6½ in. This is materially less than the space requirement of an equivalent air condenser. Capacities larger than 50 micro-microfarads are readily

The Wireless Industry

A LEAFLET just issued by Philips Lamps, Ltd., 145, Charing Cross Road, London, W.C.2, describes three special Philips receivers, of which limited numbers are available through appointed dealers. These models, known as Types 361A, 362B, and 771A, are essentially short-wave sets, but also cover the medium broadcast band. No provision is made for long-wave reception.

Belling-Lee sparking plug and distributor suppressors have been reduced in price from 2s. 6d. to 1s. 6d.

New descriptive literature regarding the Simplat direct sound recording system is available from the V.G. Manufacturing Co., Ltd., Gorst Road, Park Royal, London, N.W.10.

The word "Cinevision," used by "Free Grid" in our issue of December 15th as a general term, is actually the registered business name of Cinevision, electrical and cinema engineers, of 10, Thorpe Mews, Kensington, London, W.10.

Keeping the Lines in Step

TIME CONSTANTS OF COUPLING CIRCUITS

ALTHOUGH the choice of components for the scanning and synchronising circuits in a television receiver appears to be a straightforward matter, the values of capacity and resistance chosen have a marked effect on the steadiness of the frame at the commencement of the scan, and certain values of time constant will result in a lateral displacement of the first few lines of the frame.

The time constants in question are those of the scanning circuit considered as a whole, and the synchronising circuit when capacity coupling is used to apply the sync pulse to the grid of the discharge valve. In Fig. 1 a typical circuit for electrostatic scanning is shown, the total effective time constant being that of the condenser C1 and resistance R1, and the amplifying stage including C2 and R2. The grid of the gas-triode T can be connected to the synchronising circuit through the condenser C (shown dotted) or directly to the point AB. The nature and shape of the synchronising pulse applied to the grid depends on the point from which it is derived and the time constant of the components C and R if these are included.

The diode load resistance may be considered as the first convenient point from which to take the pulses, as the voltage variations across the load are proportional to the vision signal and related to the DC component. A method of using this voltage pulse has already been described,¹ but under certain conditions it may not be possible to obtain perfect synchronisation. For example, with low values of signal potential across the diode load the sync pulse (being only 30 per cent. of the total value) may be still further reduced in amplitude owing to the non-linearity of the diode characteristic at low inputs.

This may reduce it to an effective value of 15-20 per cent., which will be insufficient to keep the picture in step if the bias of the gas-triode is altered by fluctuation of the mains voltage.

A second point is that, since the diode

load is common to both line and frame separator circuits, it is necessary to ensure that the current taken by the grid circuit of the line-scanning generator does not produce an impulse in the diode load which will trip the frame-scanning generator. This would upset the interlacing.

The current in the diode load during the discharge period of the line scan circuit could be minimised by the use of a high resistance in series with the grid of the gas-triode, but the value of this is limited by the necessity for preserving the steep front of the pulse. It is usually necessary to compromise between a suitable value of series resistance and reduction of the diode load resistance until the voltage developed is low enough to avoid interference with the frame synchronising.

Direct Coupling

If the VF stage is directly coupled to the diode load, as is usually the case, advantage may be taken of the gain of the amplifier by taking the pulse voltage from the cathode load resistance at the points marked AB in the circuit of Fig. 1. As in the case of the diode load resistance, it is possible to connect the grid of the discharge valve directly to the cathode resistance of this stage and obtain a pulse of some seven or more times the amplitude of that across the diode load. With this

It is well known that the steadiness of the television picture depends on the maintenance of the line synchronising pulses during the frame pulse. In this article, the effects of variation in the line pulse are discussed and the importance of the circuit constants is shown in relation to the initial lines of the frame.

latter must be kept within definite limits for reasons which will be seen later.

Although the pulse voltage is higher, there are still one or two objections to the use of this arrangement. The discharge valve bias may be derived from a different source of HT from that of the VF stage. If this is so, there is a double possibility of variation in the HT voltage upsetting the adjustment and causing the gas-triode to trip at the wrong point. The variation in the cathode current of the VF amplifier follows a 3/2 power law with variation in HT voltage, while the grid bias of the discharge valve is usually a linear function of the HT in the scanning circuit. A fluctuation in the mains voltage, therefore, will not affect both sides of the circuit equally, and there is a tendency for the balance of potentials to be upset. The steadiness of the circuit can be assured by stabilising the screen supply of the VF stage and by deriving the bias of the gas-triode from the same point, but this involves the extra expense of a stabiliser and "bleeder" circuit and a consequent waste of current.

The third method of obtaining the pulse is by interposing a condenser between the source of sync potential and the grid of the discharge valve, which avoids the necessity for back-balancing the DC potentials and reverts more closely to the conditions obtained with the diode load resistance. At the same time, a wider tolerance is permissible in bias fluctuation owing to the greater pulse voltage available from the VF amplifier stage. The introduction of this con-

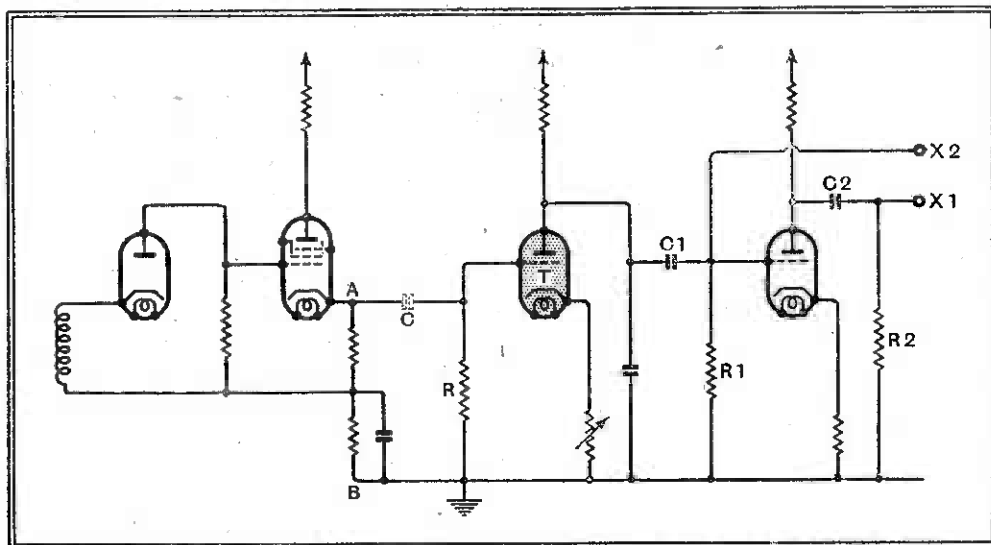


Fig. 1.—The detector and VF stage of a television receiver is shown here, together with an outline of a saw-tooth oscillator and amplifier.

direct connection there are two potentials to balance—the grid bias of the discharge valve and the DC potential across the cathode resistance.

For satisfactory synchronising the peak of the pulse voltage developed across the

condenser may modify the shape of the pulse applied to the scanning circuit to a degree depending on the time constant of the condenser C and the grid leak resistance R (Fig. 1).

The modifications to the pulse are shown

¹ The Wireless World, July 21st, 1938.

Keeping the Lines in Step—

in the diagrams of Fig. 2. At the top are shown the standard line pulses at the end of a frame, the frame pulse being broken up by a series of eight half-line pulses having as their object the keeping in step of the lines during the frame fly-back. For the frame shown in Fig. 2 (a) the lines are synchronised by the leading edges of the pulses marked *a, b, c, etc.*, pulse *b* corresponding to the leading edge of the frame pulse. In the odd frames the line is kept in step by the edges *b', c', d', etc.*

In the first cases described, where the impulse is applied to the grid of the discharge valve by direct connection, this diagram correctly represents the shape of the pulse, but with condenser connection the mean level of the half-line pulses will vary to a degree depending on the time constant of the coupling circuit. With a very high value of time constant the conditions approximate to the original direct connection, but with a lower value the level of the half-line pulses will gradually decline as shown

displacement of the lines is to be avoided. Turning to the scanning circuit itself, we may now see the effect of the overall time constant on the scanning during the frame pulse. The saw-tooth developed across

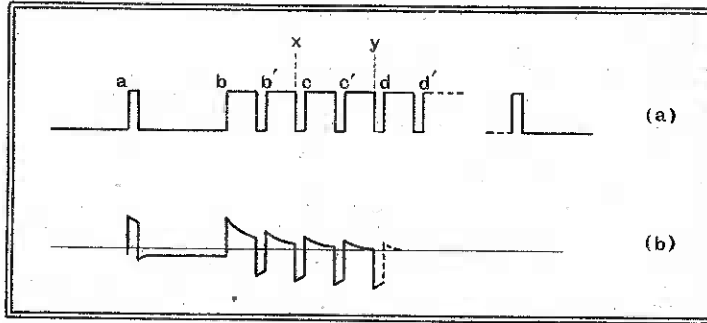


Fig. 2.—The sync pulses take the form shown at (a) when the DC component is retained, but change as in (b) when a resistance capacity coupling is adopted.

the output is shown in Fig. 3 for two values of time constant. If the half-line pulses are of sufficient amplitude to trip the line scan at every half-line throughout the frame fly-back, the saw-teeth will diminish to half amplitude during this period, as shown in (a). If the time constant of the circuit CR is sufficiently high, the mean potential level will drop immediately, as shown, and will remain steady until the resumption of the full-length scan. With a lower value of time constant, however,

the mean level will creep up during the half-line pulses, as in (b).

At the end of the frame pulse the saw-tooth curve representing the full scan will then be displaced upwards owing to the rise of the mean level, and several lines will be scanned before the saw-teeth fall back to their original height.

This effect can be seen on a raster in which the brilliance has been increased until the top black border is visible on the screen. The first few lines of the frame will appear displaced to the right of the vertical edge as though

first visible lines. Further, if the amplitude of the sync pulse is such that the discharge valve only trips occasionally on the half-lines the top edge of the frame will "flutter."

Since the amount of displacement of the initial lines depends on the effective time constant of the scanning circuit it is possible to determine this so that the recovery takes place during the black lines and the visible lines are in correct position. For a single stage a time constant of 0.0013 sec., for example, will give maximum displacement of the visible lines in the frame, and is therefore the value to be avoided. To obtain correct position of the visible lines it is necessary to ensure optimum displacement on the black lines, as the rate of return to normal also depends on the time constant. Fig. 4 shows two extreme cases, the first representing a wide displacement of the first few lines followed by a rapid return to normal, and the second a less displacement resulting in a longer delay.

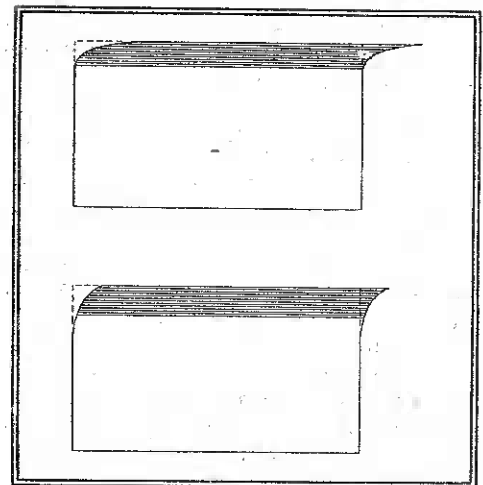


Fig. 4.—The change in amplitude shown in Fig. 3 causes a displacement of the upper lines of the raster as shown here.

The first condition is obviously preferable from the appearance of the visible frame, it being quite immaterial how far the initial lines of the frame are displaced. The relation between the time constant and the displacement of the lines is shown in the curve of Fig. 5. The displacements have been calculated for a 12in. electrostatic tube giving a picture with a 10in. side. Owing to limitations in the ampli-

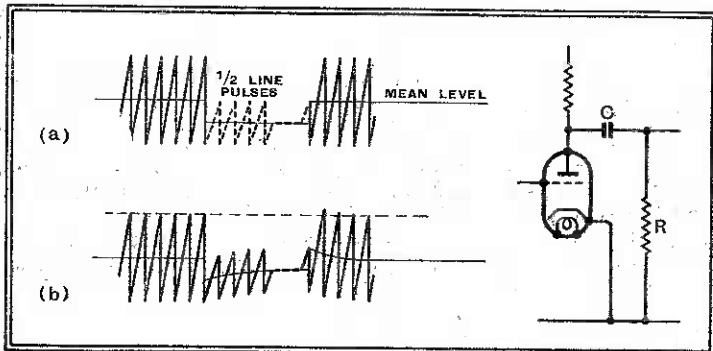


Fig. 3.—With a large time constant in the time-base amplifier coupling, the output saw-tooth waveform is like that shown at (a), but with a moderate value of time constant it is more nearly like (b).

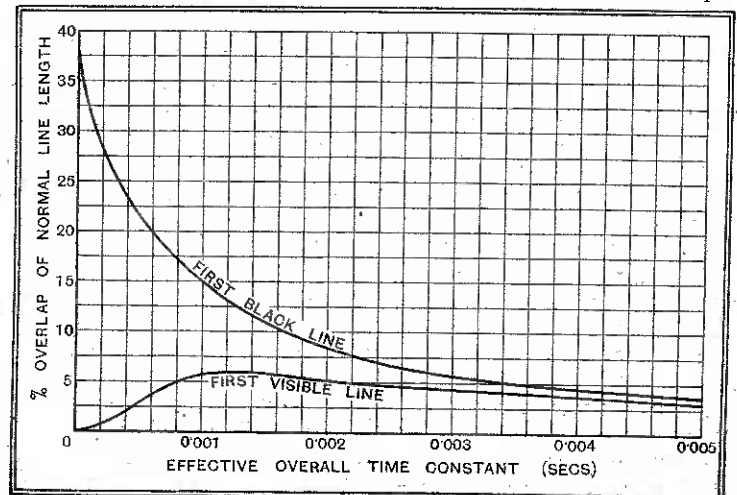
in the diagram of Fig. 2 (b). If the amplitude of the frame pulses is smaller than that of the normal line pulses, then a reduction of the sync signal below a certain value will allow the line scan generator to "run free," that is, to become unsynchronised.

Line Displacement

This will be shown on the raster by a displacement of the initial lines of the scan to the left, the degree of displacement depending on the relative "free" speed of the scanning generator and the frequency of the sync pulses. In extreme conditions where there is a wide difference between the natural frequency of the scanning generator and the sync frequency, the line will not resume normal running until after the frame pulse has ceased. The adjustment of the scanning speed with low value of sync pulse is thus very critical if some

has been increased until the top black border is visible on the screen. The first few lines of the frame will appear displaced to the right of the vertical edge as though the rectangle were curling over at the top edges. Since the first few lines of the frame are black lines this effect might not be considered important, but in certain cases the displacement of the initial line of the frame may be such that there is still a displacement of the

Fig. 5.—These curves show the relation between the line displacement and the time constant.



Keeping the Lines in Step—

fier circuit and the curvature of the bulb, the initial line may not necessarily conform to the dimensions given by the curve, but the proportionality holds good, and

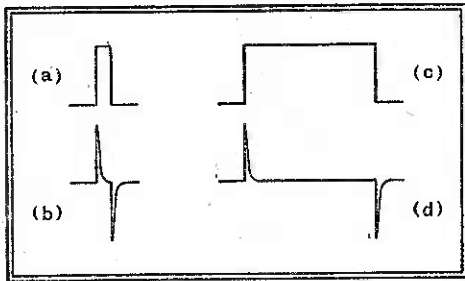


Fig. 6.—Square pulses of the form shown at (a) are changed to the form of (b) after passing through a circuit of low time constant.

can be checked by reducing the raster to smaller dimensions.

The advantage of choosing a time constant to give minimum visible displacement consistent with preserving the shape of the saw-tooth is that a greater tolerance in sync pulse amplitude and bias voltage variation is permissible.

With regard to the sync impulse circuit it has been shown that unsatisfactory results are obtained with a "medium" time constant, but it does not necessarily follow that a very high value is required. On the contrary, it has been found that a very low value has several advantages, as will be seen from Fig. 6. If a low capacity of, say, 20–50 μF ., is employed in conjunction with a resistance of 5,000–25,000 ohms, the reactance of the condenser is large compared with the resistance and the current flowing is approximately proportional to the rate of change of the input voltage.

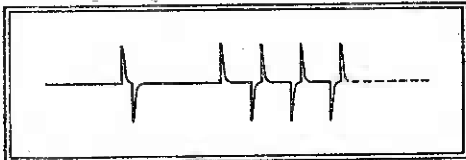


Fig. 7.—The waveform shown in Fig. 2 (a) becomes changed to this peaky form after passing a circuit of low time constant.

The voltage across R (Fig. 1), which is the voltage applied to the grid of the discharge valve, is therefore a maximum at the commencement of the pulse, and falls to zero when the condenser is fully charged. If the time constant is sufficiently low, this fall will take place during the pulse, as will be seen from the figure. When the pulse ceases, the applied voltage falls and the condenser discharges, giving rise to a pulse of voltage in the reverse direction across R.

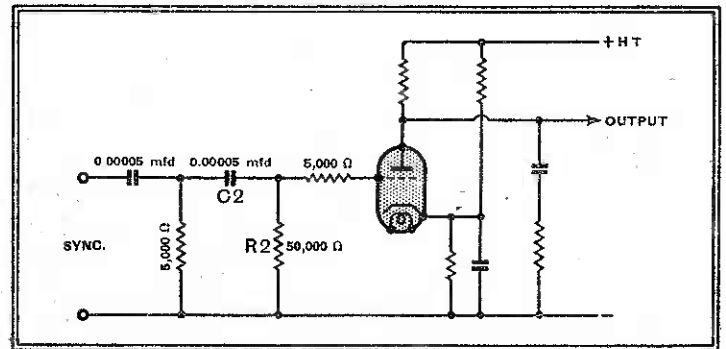
After the initial "kick" has taken place the mean level of potential remains at zero for the greater part of the duration of the line pulse, and it will, of course, remain at zero for a pulse of longer duration—the frame pulse, for example. This is shown in (c) and (d) of Fig. 6. From this it will be seen that even without a DC connection to the grid of the discharge valve the pulses required for keeping the line in step during the framing pulse can be made to maintain

their correct level, and there will be no tendency for the mean potential to wander. This is shown in Fig. 7.

Another advantage which this form of synchronising circuit has over the DC connection is that with the latter it is not always possible to guarantee that the line-scan generator will trip on the same edge of the framing pulse each time. In Fig. 2 the voltage at x is nearly sufficient in amplitude to trip the discharge, and any momentary fluctuation in HT or bias will trip the scanning generator.

Fig. 8 shows the connections to the grid of a standard gas-triode scanning generator for producing the sharp pulse. The amplifier has been omitted, as this is of the conventional type. The recommended resistance in the grid circuit of a Mazda T41 thyratron is 30,000–50,000 ohms. If this were connected directly in the grid circuit there would be a tendency to bend the line pulse and destroy the sharpness of the peak. To avoid this, the actual grid series resistance is made 5,000 ohms, and the low resistance of the sync pulse circuit is isolated from the grid by the net-

Fig. 8.—This diagram illustrates the recommended method of coupling to a gas-triode so that a suitably low time constant is obtained.



work C2R2 shown. This maintains the sharpness of the pulse, and still provides a high resistance in the grid circuit.

In a frame scan generator, using an "integrator" type circuit, the extra network is not necessary, and the sync pulse can be fed to the grid through a 0.1 μF . condenser with a grid series resistance of 50,000 ohms and a grid leak of 20,000 ohms.

Television Programmes

Sound 41.5 Mc/s Vision 45 Mc/s

An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. to 12 noon each weekday.

THURSDAY, JANUARY 5th.

3, Jack Jackson and his Band. 3.30, Gaumont-British News. 3.40, 205th edition of Picture Page.

9, O.B. from Olympia of the Bertram Mills' Circus. 9.30, Starlight—Gene Sheldon, comedian. 9.40, British Movietone. 9.50, 206th edition of Picture Page. 10.20, News.

FRIDAY, JANUARY 6th.

3-4.30, J. M. Barrie's play, "Mary Rose"; cast includes Frank Cellier, Dame May Whitty, Peggy Ashcroft and Esmond Knight.

9, "Footwork." A demonstration of American dancing for English ballrooms. 9.20, Film: "The Ice Man." 9.30, Circus O.B. from Olympia. 10.10, News Map—8, The Mediterranean. 10.30, News.

SATURDAY, JANUARY 7th.

2.10, Rugger O.B. from Twickenham; England v. The Rest. 3, Circus O.B. from Olympia. 3.20, Gaumont-British News. 3.30, Alfredo and his Gipsy Orchestra.

8.30, Final Circus O.B. from Olympia. 9.10, "Grandfather's Follies," cabaret from Grosvenor House. 9.40, British Movietone. 9.50, "Looking Backwards," a programme of historic B.B.C. records. 10.5, Cartoon Film. 10.10, Music Makers—Eunice Gardiner, pianoforte. 10.20, News.

SUNDAY, JANUARY 8th.

3, "Fantastic Garden," a song, dance and orchestral programme, including Joan Collier and Wendy Toye. 3.30, Cartoon Film. 3.35, The Jacquard Puppets, presented by John Carr. 3.55, Jane Carr.

8.50, News. 9.5-10.35, Theatre Parade.

MONDAY, JANUARY 9th.

3-4.30, "Middle-Class Murder," a play adapted by Diana Hamilton from a novel by Bruce Hamilton.

9, The Lambeth Walk. Representatives from Lambeth will demonstrate how it should be danced. 9.30, British Movietone. 9.40, "Schubert Night," based on incidents from the life of the composer, with Harold Child as Franz Schubert. 10.10, News.

TUESDAY, JANUARY 10th.

3, Western Cabaret, including Bill Campbell

and his Hill-Billys, Evelyn Dall and the Carson Knife-Throwers. 3.45, Fashion Parade.

9, Fashion Parade. 9.15, Golf demonstration by Ernest Bradbeer. 9.30, Gaumont-British News. 9.40, Cartoon Film. 9.45, Ernest Milton and Esmé Percy in "The Tell-Tale Heart," by Edgar Allan Poe. 10.10, News.

WEDNESDAY, JANUARY 11th.

3-4, "Bees on the Boatdeck," a farcical tragedy in two acts, by J. B. Priestley.

9, Heath Robinson Again. 9.10, British Movietone. 9.20, "Campbell of Kilmhor," an incident in the pacification of the Highlands after the rebellion of 1745. 9.45, Film: "Sky High." 10.10, Music Makers—Florence Hooton, 'cello. 10.20, News.

The Wireless Engineer

THE more advanced readers of *The Wireless World* are reminded that the beginning of a new year is a good time to start reading *The Wireless Engineer*, a technical monthly publication with features of special interest to those engaged in wireless in a professional capacity. In addition to technical articles dealing mainly with new developments, each issue contains a unique service of Abstracts and References to the radio literature of all countries, so that no matter what your specialised interest may be you will find a reference to every article on that subject published anywhere in the world and in most cases a fairly complete summary of the article is given.

Each December issue contains a complete index to the Abstracts and References which have appeared during the year.

The price of *The Wireless Engineer* is 2s. 6d. per copy, 2s. 8d. by post or 32s. post free per year.

Unbiased

Modernising Wireless

THE pearl which the Editor cast among us the other week (Opus No. 1007, December 15th) concerning the position of the loud speaker interested me greatly. Briefly, he looked forward to the relief from bondage which the development of motor-tuning has brought within our reach. Hitherto, we have been compelled either to have the loud speaker bellowing right up against our ears or to put the set on the other side of the room and be content with jumping up like a jack-in-the-box every time we wished to change the programme.

As the Editor rightly remarked, it is but a step from the present push-button arrangement to one where the buttons are mounted in a small unit suitable for attaching to the arm of a chair, and some firms are already taking this step. This means that we can have the set at the far side of the room and the push-button unit on the arm of our fireside chair, but it is here that the Editor and I definitely part company. If the set could be banished to the far side of the room why not banish it from the room altogether leaving only an extension loud speaker there?

The logical position of the receiver is near the place where the down lead enters the house, which, in most cases, is at the back. By moving the set to this position, the problem of aerial efficiency and also of interference elimination would be very greatly simplified. The best place for the



???

set would probably be in the loft among the water tanks and other necessary but cumbersome contraptions. The extra cost of the remote-control arrangements would be offset by the saving of the cost of an elaborate cabinet.

At present it is too little realised that one of the reasons why people don't buy new sets more often is that they find it more and more difficult to get one to tone with the furnishing scheme of their rooms. Having found one after laborious search they are naturally reluctant to enter upon the wearisome search again. My proposals would eliminate all this heartbreaking business and would also enable people

By FREE GRID

to choose sets on their technical merits alone and not be influenced by cabinet design as is undoubtedly the case to-day.

Hydrodiathermy

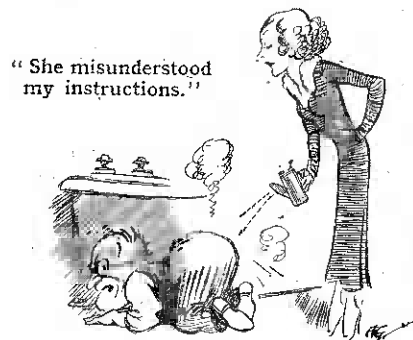
UNLIKE the majority of you, my conscience did not permit me to spend the recent period of festivities in Bacchanalian revels, and while you were all busy laying the foundations for future digestive troubles and setting a bad example to the children, I was hard at work in my laboratory endeavouring to work out a system of applying the principles of wireless to the thawing of frozen water-pipes.

As many of you will know, ordinary heat waves are nothing more than wireless waves of extremely short length, the figure actually being somewhere in the neighbourhood of one ten-millionth of a metre. Now even amateur wireless transmitters have not yet employed these truly short wavelengths though doubtless they will do so when the P.M.G. and the B.B.C., following their practice of bygone years, grab the result of their labours on the present amateur bands and force them to go still lower.

We have, however, all used these wavelengths in an endeavour to heat our bodies, but some time ago a research worker like myself discovered that, by using somewhat longer waves he could produce some remarkable effects. He could, in fact, cause the waves to pass right through the outside of the body without causing any heating effect until they reached the internal organs at which they were directed. By juggling with his controls he found that he could vary the distance over which these waves travelled before they produced this heating effect and so could warm up any part of his innards he wanted to. This new discovery was labelled with the name of diathermy and is widely used to-day, and it is my task to apply what is really only ultra-short-wave wireless to the problem of thawing the pipes.

Now I suppose that in the pre-Christmas cold spell all of you experimented with blow-lamps and made the same discovery that I did, namely, that the lead covering of the pipe melted long before the ice inside it, with disastrous consequences; at least, I should have made this discovery if I had proceeded far enough with my experiments as I have since found out by mathematical analysis of the problem.

Actually my use of the direct ray was cut short by a French maid whom Mrs. Free Grid has recently taken into her employ. It was, I fear, solely owing to the regrettable paucity of my knowledge of the French language that she misunderstood my instructions concerning the direction in which she should have pointed the blow-lamp she was holding, with the result that I had to suspend operations.



It is an ill wind that blows nobody any good, however, for if it had not been for this unfortunate contretemps caused by the French maid I should not have been inspired to enter upon my present research work and I am, therefore, showing my gratitude to her in proper fashion by taking her to see the pantomime, "Aladdin and his Wonderful Lamp," in order to impress the importance of the incident on her mind.

Meanwhile, my experiments are going ahead and I hope soon to have something to put before you which will make plumbers as out of date as a woman's last year's hat.

The B.B.C.'s Negligence

THE many diverse aspects of the B.B.C.'s psychological make-up have always amazed me. In some things they mollycoddle and spoon-feed listeners in a truly grandmotherly fashion, while in other ways they are as callous and inhuman as a New Guinea headhunter. For years past they have radiated super-accurate time signals not once, but many times throughout the day and yet, so far as I can recollect, they have never once bothered to radiate figures whereby we can check and adjust our barometers.

Everybody knows that these devices are provided with an adjusting screw which has of necessity to be attended to when the instrument is first put into use. It is useless to point out in the B.B.C.'s defence that the readings vary according to the locality. They do not vary by any margin that matters over the London district, for instance, and yet no barometric adjusting figure is ever given out from Brookmans Park, although we have time signals *ad nauseam*.

In my own case, it does not matter a jot as I invariably carry a mackintosh and umbrella, but I have known many unfortunates who have been soaked to the skin and caught pneumonia all because of the criminal callousness of the B.B.C. in this matter.

NEWS OF THE WEEK

MORE B.B.C. STATIONS?

Bournemouth Will Not Go Yet
DESPITE South Coast listeners' fears, the Bournemouth transmitter is to be retained for some time after Start Point comes into action. Although the new Devon station will have a power of 100 kW, which should bring the whole of the South Coast as far as the Isle of Wight into its service area, there remains a doubt which can only be settled after practical tests.

Meanwhile three other districts are hoping for new B.B.C. stations. East Anglia, with Norwich as its centre, looks eagerly towards Portland Place for a relay station of at least 5 kW. Aberystwyth has reached the stage of clamouring for a transmitter, and residents on the South Coast east of the Isle of Wight are wondering when they will have a "Start Point" of their own. They will certainly not have a 100 kilowatt station, but it is understood that the Corporation is considering the possibility of erecting a relay in the Portsmouth area. This would fill in the blind spots in the Isle of Wight and help listeners who are screened from the Brookmans Park transmitters by the South Downs.

S-W STATION AT SAN FRANCISCO FAIR

Service to the Orient

THE new General Electric station which, as stated in last week's issue, is being erected on Treasure Island, the site of San Francisco's World Fair, has been allotted the call sign W6XBE. It is being built in the Fair's electrical building, and will be open to inspection.

It will transmit to the Far East, from midnight to 6 a.m., E.S.T., programmes originating at the Fair as well as those of the Red and Blue networks of the N.B.C. Of the two frequencies to be employed, that of 9.53 Mc/s will be used when the path between the transmitter and the destined listening points is entirely dark, and that of 15.33 Mc/s when the path is partly light and partly dark.

This 20-kW transmitter, which, it is hoped, will be completed for the opening of the Fair in February, will, with its beam concentrated within an angle of 30 degrees, provide reception in Manila from 4 to 10 p.m.; in Tokyo from 5 to 11 p.m.; in Calcutta from 1 to 7 p.m.; in Shanghai from 4 to 10 p.m., and in Sydney from 6 p.m. until midnight.

B.B.C.'s APPEAL TO THE TREASURY

Sir Oswald Stoll Draws Comparisons

"THE B.B.C.'s financial difficulties are almost a case against Entertainment Duty," said Sir Oswald Stoll in his annual report to shareholders, when he compared the financial conditions of broadcasting and of Stoll Theatres Corporation, whose shareholders have gone without dividends for nine years, although £3,000,000 has been paid to the Government since the inception of the Entertainment Tax.

He went on to say that the B.B.C.'s confidential report to the Government would probably contain a demand for the refund of the £1,100,000 which the Treasury had deducted from radio licence revenue last year. It would also be suggested that as the Treasury had benefited to the extent of £12,000,000 from radio licences during the lifetime of the B.B.C. and has done nothing in return for it, a

Treasury grant of £2,000,000 should be made to meet B.B.C. development.

"There is a decline in the profits of the B.B.C.," remarked Sir Oswald, "no doubt due to its shortage of cash by reason of the increase in the number of licences not being maintained and the fall in the profits of its publications, falling income and rising expenses. The B.B.C. is also to demand payment from State funds for certain State services rendered by the B.B.C."

It is perhaps permissible to regard the sum of money retained by the Treasury from wireless receiving licences as a hitherto unsuspected form of entertainment tax; Sir Oswald Stoll boldly expressed the opinion that, so far as it affects the living stage, the tax must inevitably be abandoned by the Government.

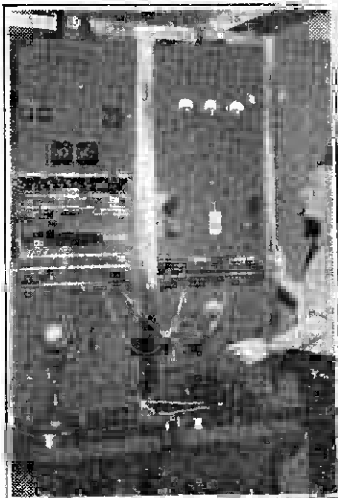
U.S.A. GOVERNMENT BROADCASTS

Transmissions from the White House

THE White House, Washington, the U.S.A. Government headquarters, is now fitted

have cost about \$100,000, will be operated by the recently created Radio Section of the Department of the Interior. The function of the Section will be to co-operate with the various Bureaux and Divisions of the Department of the Interior and the Public Works Administration for the dissemination of Government news.

From the studios will be twelve programme lines, which will link them with the various transmitting stations or networks, and twelve lines for communication between the studios and the stations from which the programme is being put "on the air." It will also be possible to radiate by line to the Government auditorium in the building a programme origin-



GOVERNMENT BROADCASTS in the U.S.A. will emanate from two studios built in the White House, Washington. A staff group is seen here in the larger studio and the chief engineer is examining control-room equipment.



with two broadcasting studios which should soon be available for use. These studios, which

ating in the studios or vice versa for transmission to a radio station.

LORD SELSDON

His Work for Television

IT is with regret that we record the death of Lord Selsdon, at the age of 61, on December 27th. His associations with wireless had been more or less continuous since 1924 when, as Sir William Mitchell-Thomson, he was appointed Postmaster-General. It will be recalled that it was during his term of office that the first B.B.C. charter was issued.

Lord Selsdon, who was the



LORD SELSDON at the opening of the Alexandra Palace television transmitter on November 2nd, 1936.

first Baron, the title having been conferred on him in the New Year Honours of 1932, will undoubtedly be remembered by the wireless fraternity for his work as Chairman of the Television Advisory Committee. He was also on the Ullswater Broadcasting Committee.

A Television Committee was appointed by the Postmaster-General, Sir Kingsley Wood, in 1934 under the Chairmanship of Lord Selsdon, and its report was issued on January 31st, 1935, when the present Television Advisory Committee was set up to advise the P.M.G. on points arising in connection with the initiation and development of the broadcast television service. It was largely due to Lord Selsdon's efforts that the Alexandra Palace station was opened in November, 1936, and that the English television service is what it is to-day.

TRANSATLANTIC TELEVISION

London Transmission Seen in New York

AT the R.C.A. receiving station at Riverhead near New York, engineers have at intervals during the past few weeks received the vision transmission from the B.B.C. station at Alexandra Palace. The picture was on several occasions

News of the Week—

clearly distinguishable, notably on November 3rd, when individual items in the 187th edition of Picture Page were verified.

It is interesting to note that the comparative intensity of the sound and vision transmissions varied considerably. On some occasions, the 17-kW vision signal was much weaker than the 3-kW sound signal and vice versa.

The great circle distance between London and New York is approximately 3,300 miles.

TELEVISION-TELEPHONE TEST
TO BE REPEATED

MR. GERALD COCK, B.B.C. Director of Television, intends to repeat the experiment of December 23rd, in which he spoke directly on a telephone before the Emitron camera to viewers who rang him up with questions regarding the television service.

Sixteen questions were answered in thirty-five minutes, but judging by the spate of correspondence since received, fifty or more intending enquirers must have been disappointed.

B.B.C.'s ANTI-FROST MEASURES

IF, as the weather experts predict, more heavy frosts are coming before Spring, every B.B.C. transmitter will be prepared and so, it is hoped, avoid a failure similar to that experienced at Brookmans Park during the recent severe weather.

Hitherto, the practice has been to drain the water from valve-cooling systems on cold nights. In future, however, the water will be kept circulating, the temperature of the water being taken every half-hour. Should the temperature drop below safety level, the transmitters will be started up on low power.

During cold spells, therefore, staff will be on duty throughout the twenty-four hours.

PIRATE TRANSMITTER IN
GIBRALTAR

THREE officers of the Spanish Republican Navy, including the Captain of the destroyer *José Luis Díez* (which was subsequently grounded during an action in the Straits last Friday), were fined £25 each with the alternative of six months' imprisonment when they pleaded "Guilty" at the Gibraltar Police Court to being concerned together in using within Gibraltar a wireless telegraphy transmitter. The apparatus, which was installed in a car, was detected by three soldiers of the Royal Artillery.

NEW YEAR HONOURS

Awards for Wireless Services

QUITE a number of names familiar in the wireless world were to be found in the New Year Honours List. Sir Frank Smith, K.C.B., C.B.E., D.Sc., LL.D., F.R.S., Secretary of the Department of Scientific and Industrial Research, who has served as Chairman of the Technical Sub-Committee of the Television Advisory Committee, has become a G.B.E.

Mr. Cecil Graves, Deputy

Director-General of the B.B.C., who, during the interregnum between Sir John Reith's departure and Mr. Ogilvie's arrival as D.G., bore the burden of responsibility, becomes a K.C.M.G. Mr. Ralph Wade, Director of Office Administration at the B.B.C., receives the O.B.E. Miss Cecil Dixon, the well-known solo pianist on the staff of the B.B.C., receives the M.B.E.

FROM ALL
QUARTERS

Mr. S. de Laszlo

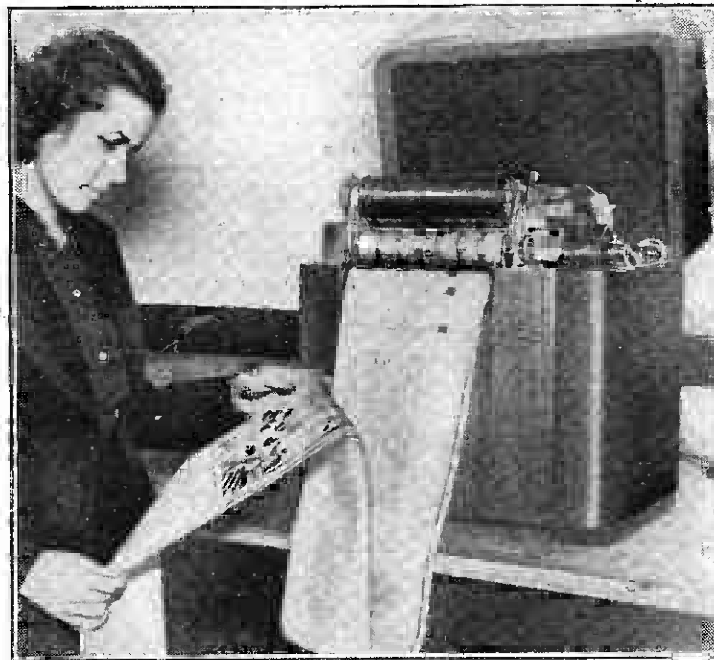
WE extend our sympathy to Mr. Stephen de Laszlo, of Hivac, who was severely injured and his wife killed when, on Friday last, they were involved in a car crash on the London-Newmarket road.

Short Waves from Luxembourg

RADIO LUXEMBOURG has been authorised by the Government of the Grand Duchy to transmit on short waves.

Scophony for America

MR. S. SAGALL, managing director of Scophony, who recently completed an American tour, which was made with the object of establishing a Scophony television company there, stated on his return to London that his next visit to the U.S.A. this month would be to complete the negotiations. A station working on the British Scophony system is expected to be installed in New York, and an expression of confidence in this project and in the future of American television was passed at the Company's annual meeting held in London last week.



THE RADIO EDITION of the *St. Louis Post Despatch* being received on an R.C.A. set. Each of the nine pages of the first edition took fifteen minutes to receive. The system of transmission is that an ordinary printed copy of the edition is placed on a cylinder which, revolving seventy-five times a minute, is scanned by a small beam of light, the reflected light actuating a photo-electric cell.

Television from Coliseum Stage

TELEVISION will invade the music hall for the first time on January 13th, when an hour's excerpt of Doorlay's Christmas Rocket will be televised direct from the stage at the Coliseum. Reversing the usual procedure, Frederick Grisewood, the commentator, will "cue" the producer when he wishes to speak, and the sounds from the stage will then be faded down to enable the commentary to be clearly heard.

Signaller's Award for Bravery

SIGNALMAN PETER HEATON, Royal Corps of Signals, has been awarded the Military Medal for gallant and distinguished service in Palestine. He continued to send and receive wireless messages with complete disregard to danger which increased with the development of the action. Although he was unable to vacate an exposed position, all messages got through efficiently.

State Station Advertising

THE acceptance of advertisements by French State stations is illegal, but the Government station, Radio Algiers, is obliged to resort to publicity since its annual allowance of 750,000 francs is only enough to cover half its expenses.

Dutch Wavelength Changes

UNTIL the end of 1938 the four main broadcasting organisations in Holland shared the available wavelengths for quarterly periods. As the result, however, of a recent conference of the organisations concerned for the first three months of this year, the allocation of wavelengths will be as follows:—

A.V.R.O. and V.A.R.A., 1,875 and 301.5 metres.

K.R.O. and N.C.R.V., 415.5 metres.

Police Wireless

FOLLOWING last week's announcement that Denmark had taken the first step towards the equipment of her police with wireless comes the news that the Government and the Copenhagen Municipality had provided sufficient subsidy to enable the city's Police Force to order a central police transmitter and transmitter-receiver equipment for a number of cars.

Greetings from Trawlers at Sea

WICK radio station began receiving telegrams for delivery on Christmas Day as far back as the beginning of December, and more than 5,000 Christmas greetings were sent by crews of trawlers at sea. As many as fifty messages were sent by some trawlers, and thirty or forty messages from one vessel was quite common.

Historical Recordings

A PROGRAMME of historic B.B.C. recordings will be described by Mr. H. Lynton Fletcher, Chief of the B.B.C. Recorded Programmes Service in the Television programme on Saturday at 9.50 p.m. The collection of recordings now exceeds 5,000 and is the biggest and most comprehensive in the world. It contains a tribute paid by Mr. Gladstone in 1897 to the then new invention of the gramophone, serenades to posterity by Henry Hall, and rhetorical speeches by the dictators.

Portrait of Marconi

FOLLOWING its custom of issuing annually a portrait of a pioneer in the field of electrical communications, the Bureau de l'Union Internationale des Télécommunications has just produced an engraving of the late Marchese Marconi. Proofs on heavy paper can be obtained by sending 2.50 Swiss francs to the Bureau at Effingerstrasse 1, Berne, Switzerland.

N.R.E.A.

THE National Radio Engineers' Association has moved to a new office at 71, Moorgate, London, E.C.2, and future correspondence should be sent to the Secretary at that address. The Association is holding a lecture at the Orange Tree, 234, Euston Road, London, N.W.1, on Wednesday, January 11th at 8.30 p.m., when Mr. Parr of Ediswan will be the speaker.

Noise Limiters

By D. P. TAYLOR

SUPPRESSING INTERFERENCE IN THE RECEIVER

MOST modern communication type receivers incorporate some form of noise suppression circuit, the function of which is to reduce the effects of unwanted noises such as atmospherics, switch clicks, motor car ignition, etc. Such noises, whilst of very short duration, usually have a peak amplitude many times greater than the desired signal.

The noise impulse is rectified and used to supply negative bias to certain valves

much of its advantage if the noise impulses cause overloading of the earlier stages.

Two circuits of this kind are shown in Fig. 2. In the arrangement (a) the noise suppressor is connected directly in the output of the final valve and is particularly suitable for receivers which are normally used with headphones. It will be seen that a double-diode is used as a noise rectifier, the two diodes being connected in reverse directions across the headphones. For this reason it is essential to use a valve having two separate cathodes.

The two anodes are at a potential of 1.5 volts negative with respect to their cathodes, this initial bias being obtained from two small batteries. When the amplitude of the desired signal is less than this initial bias the anodes of the diodes will not go positive, and in this condition the valves will be non-conductive so that normal reception will in no way be impaired. However, when a loud noise peak occurs its amplitude will be sufficient to cause the anode of one of the diodes to go positive with respect to its cathode and the impedance of this diode will fall to a value of a few hundred ohms, thus effectively short-circuiting the headphones for the duration of the noise pulse.

The two diodes are necessary to ensure that the headphones are short circuited for both negative and positive cycles of the noise peaks, for if a single diode were used approximately half the noise only would be reduced.

If this type of circuit is used the headphones cannot be joined in the anode circuit of the last valve or the silencer will not work, but they must be connected in parallel with the diodes by using a choke-

CERTAIN types of interference which are particularly troublesome on the short- and ultra-short-waves can be made less objectional by including a noise silencer in the receiver and a scheme which commends itself by virtue of its simplicity is described in this article.

condenser output circuit as shown in Fig. 2 (a).

The circuit of Fig. 2 (b) is a modification of the one just described, the suppressor circuit being inserted in the anode circuit of the detector, or the second detector in the case of superheterodyne receivers. It will be seen that the only additional components necessary are a centre-tapped low-frequency choke and a double-diode valve.

A valve having a common cathode is satisfactory in this case. The initial bias may be obtained if desired from a single dry cell connected between the cathode of the rectifier and the earth line of the receiver, the negative pole of the battery being earthed. Alternatively the dry cell can be eliminated by obtaining the initial bias from the cathode circuit of the AF amplifier or output valve.

A small variable resistance of 50 or 100 ohms joined in series with the normal bias resistor, as shown in the diagram, will supply the volt or so required. In this arrangement the positive and negative noise peaks cause the appropriate diode to become conductive and so short circuit the output of the detector valve. The two arrangements described are particularly effective in reducing the effects of motor car ignition on the short- and ultra-short-wavebands.

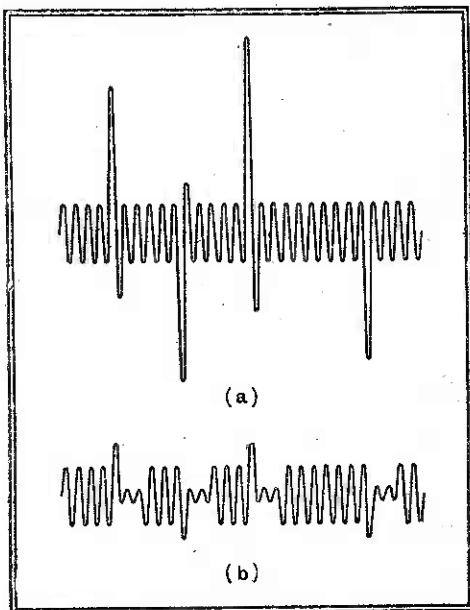


Fig. 1.—In (a) is shown high peaks of noise superimposed on the received signal while in (b) the amplitude of these peaks has been reduced by means of a noise silencer.

in the receiver (usually the IF amplifiers). In this way the receiver is rendered insensitive for a very short period whilst the noise is present. As shown in Fig. 1 this has the effect of replacing the noise peaks by "holes" in the signal, which, being of very short duration, do not appreciably affect the quality, and so the average signal-noise ratio is considerably improved. This effect, which is hailed as a new discovery, is actually only an improvement of the balanced-crystal circuit used in the pre-valve days of marine communication to combat atmospherics.

Unfortunately it is by no means easy to add an arrangement of this kind to an existing receiver as it involves designing circuits of suitable time-constant to prevent the IF stages remaining inoperative for too long a time, and in any case it is only applicable to superheterodyne receivers.

It is, however, comparatively simple to add a noise suppressor to the AF stages of a receiver, and this will prove very useful, though such an arrangement will lose

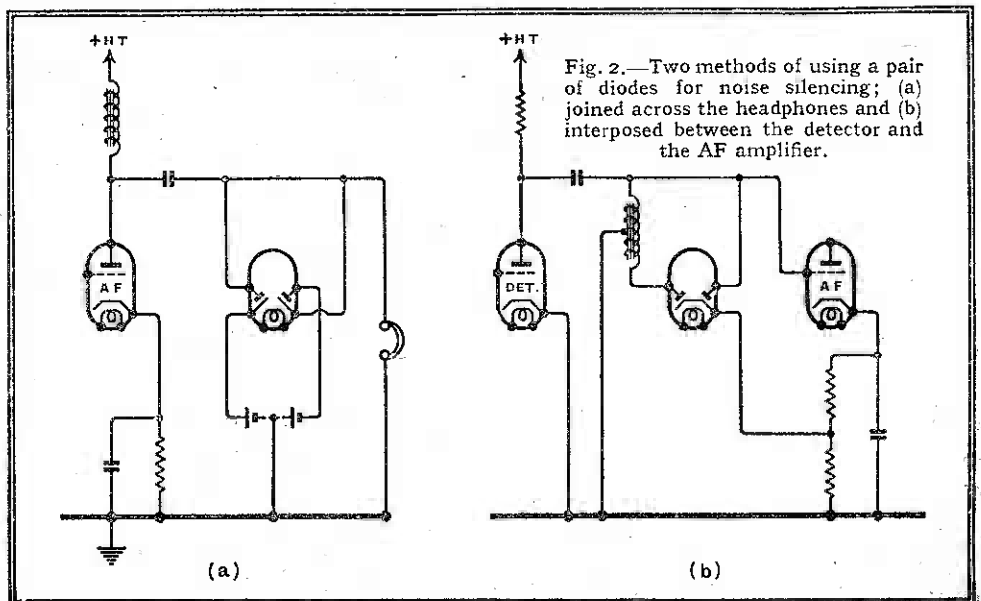
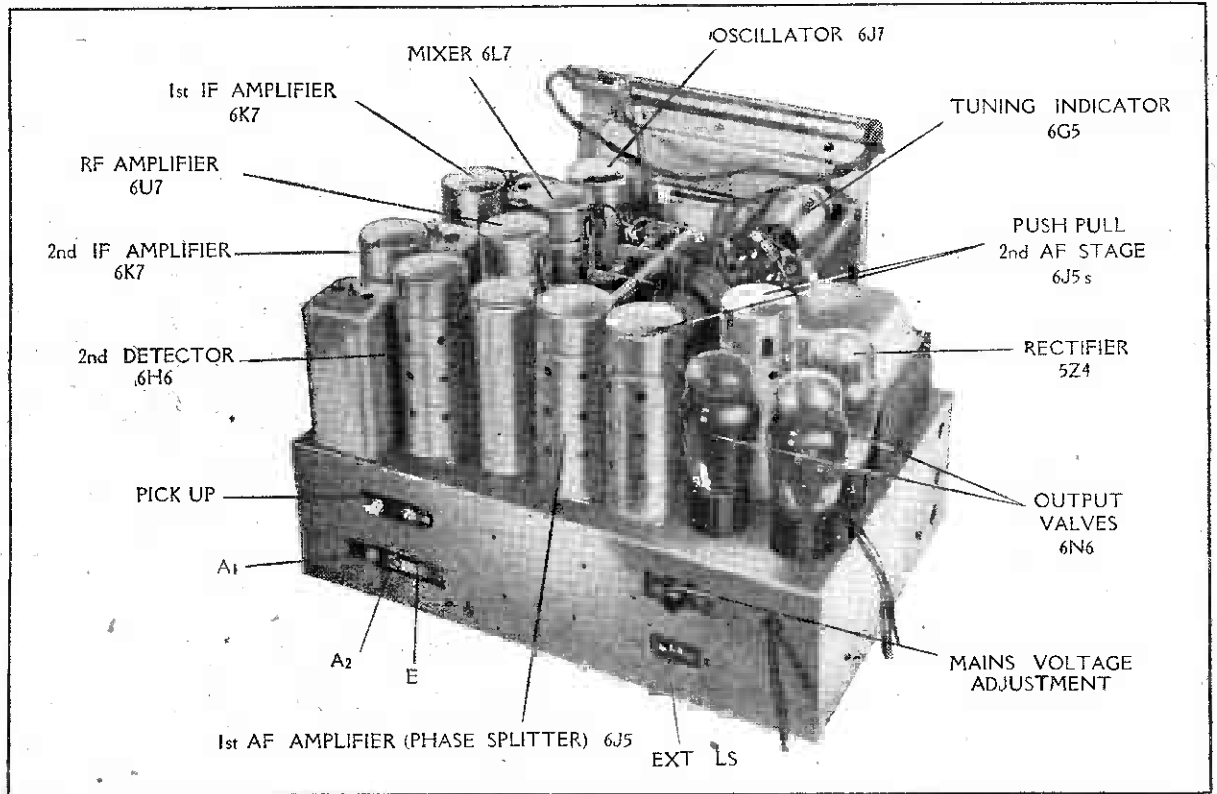


Fig. 2.—Two methods of using a pair of diodes for noise silencing; (a) joined across the headphones and (b) interposed between the detector and the AF amplifier.

exception of the necessary break between the medium- and long-wave ranges to avoid the 470 kc/s intermediate frequency. The oscillator tracking is good and the sensitivity is unusually well maintained throughout the whole range of the receiver. Wherever one decides to search for stations, whether it be the 13-metre band at the lower extremity of the range, the so-called "trawler" band or the long waves, one finds the same characteristic

A deep and compact chassis gives unusually good rigidity. The tuning scale is printed on glass and indirectly illuminated by a tubular reflector along the top edge.



vitality which betokens an RF stage and two good IF amplifiers pulling their whole weight.

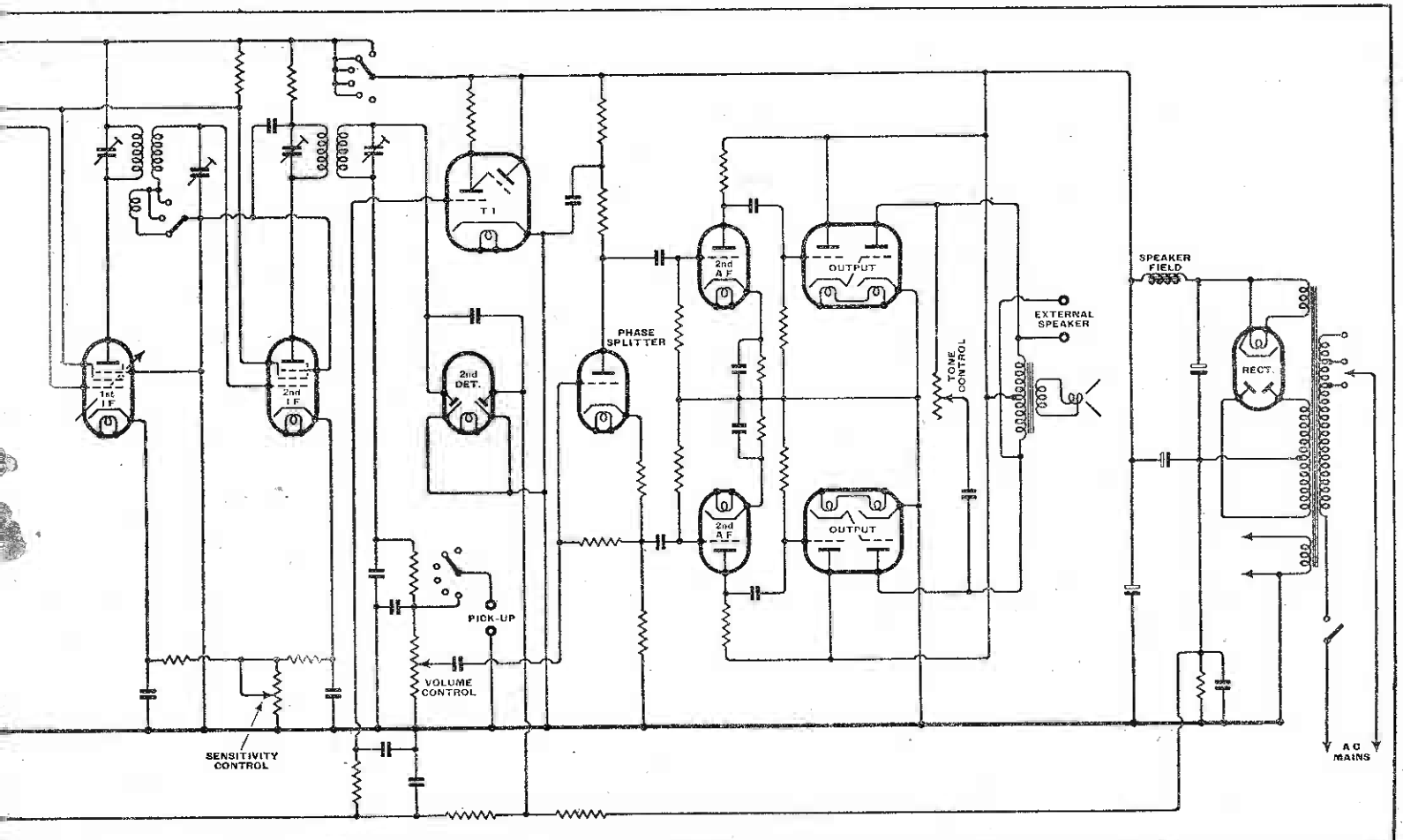
We had no difficulty in logging American broadcasting stations on the 13-, 16- and 19-metre bands at the appropriate times, and comparison with ordinary all-wave sets leaves no doubt that the

AW125PP is worthy of classification with the "communication" type receivers as far as sensitivity is concerned.

The three degrees of selectivity give clearly defined increases in band width. They have been well chosen, the intermediate position giving just the required balance between selectivity and quality

for general listening, the right-hand position an unrestricted top register for local station reception and the left-hand position keen selectivity which enables one to get well within one channel on either side of the London Regional transmitter before the side bands begin to appear.

On long waves separation of the



Armstrong

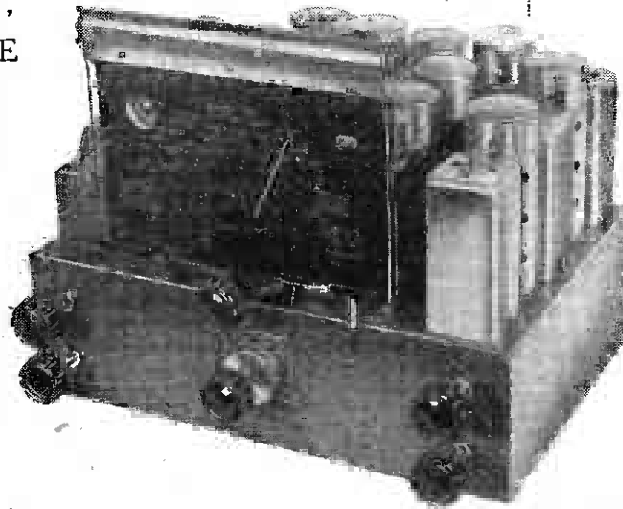
MODEL
AW125PP

A POWERFUL, YET COMPACT,
12-VALVE SUPERHETERODYNE

IN compiling the specification of this receiver the makers have drawn upon the salient features of both long-range communication sets and quality amplifiers for local station reception. By judicious selection and rejection of "frills" the circuit has materialised in a chassis which can be produced with British valves and components throughout at an attractive price without sacrificing anything on the score of efficiency in the first essentials of performance.

The makers are justified, too, in showing pride in the mechanical construction of this set. Every detail of the assembly and wiring is neat and workmanlike, the controls are smooth and well graded. The grey enamelled base and natural finished aluminium cans give just the right degree of neatness in appearance without unnecessary showmanship.

A radio-frequency amplifier follows the aerial circuit, which is suitable for dipole or ordinary aerial and earth systems. It is in operation on all five wavebands. Frequency-changing is effected by separate mixing and oscillator valves, the latter



FEATURES. — *Waveranges.*— (1) 12.5-35 metres. (2) 30-95 metres. (3) 80-250 metres. (4) 200-550 metres. (5) 750-2,000 metres. *Circuit.*—RF—mixer—osc.—two IF amplifiers—double diode 2nd det. and AVC rect.—phase splitter—push-pull intermediate AF ampl.—push-pull output stage. Full-wave rectifier. *Controls.*— (1) Tuning. (2) Volume. (3) Sensitivity. (4) Selectivity. (5) Waverange. (6) Tone and on-off switch. *Price.*—(Chassis and valves less loud speaker) £17. 17s. *Makers.*—Armstrong Manufacturing Co., 100, St. Pancras Way, Camden Town, London, N.W.1.

being a pentode connected as a tetrode.

There are two IF-stages with variable coupling in the first and second transformers. The three degrees of selectivity are obtained by switching in one tertiary winding for the intermediate position and both for broad tuning and maximum frequency response.

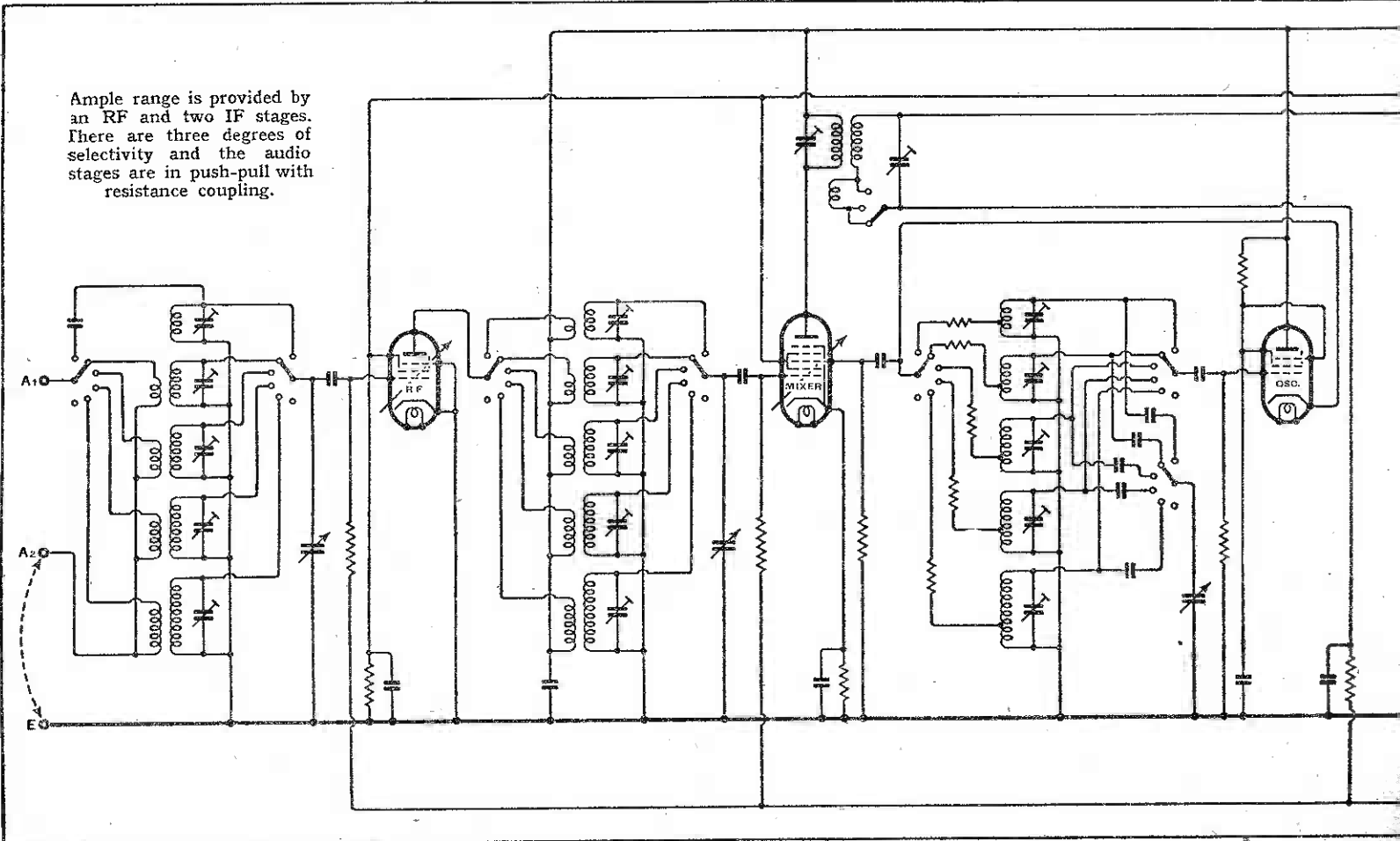
A double diode is used for second detection and AVC rectification, the bias being applied to the RF, mixer and first IF stages. The initial bias on both IF valves

is variable and constitutes the sensitivity control.

Following the signal rectifier is a triode phase splitting valve to which the pick-up input is also applied. Contacts on the wave-range switch disconnect the pick-up sockets when receiving radio signals and the leads from the turntable may, therefore, be left permanently connected.

Triode valves with resistance coupling are used in the penultimate push-pull stage and the output valves are of the internally coupled double triode type. The tone control circuit is connected across the output anodes. The wavelength coverage is continuous with the

Ample range is provided by an RF and two IF stages. There are three degrees of selectivity and the audio stages are in push-pull with resistance coupling.



Armstrong Model AW125PP—

Deutschlandsender from Droitwich and Radio-Paris requires no skill in the handling of the controls, and the performance on this band is exceptionally good with ample sensitivity in reserve and very little background noise. The tone control is not required to compensate for deficiencies in the radio-frequency side of the set and may be left in a position which suits the particular loud speaker in use.

Ample Volume

Any good loud speaker with a 1,000-1,250-ohm field and centre-tapped output transformer matched to 8,000 ohms may be used, and the one supplied for test with the chassis was a Celestion with a 13½-inch diaphragm which was able to do justice to the wide frequency range of the receiver. The volume control is smooth and the output stage accepts all that the set will give it without showing distress. A momentary test up to full volume on the local station failed to reveal any marked threshold of distortion, though judging from the sound level the output must have been very close to the rated upper limit of 10 watts.

Except for one whistle at 370 metres on the medium-wave band the set was free from self-generated interference and there was no objectionable second channel break-through on the lowest short-wave

range. Mains hum could be detected only during unmodulated periods on the local station.

Full marks are due to the designer for the skill with which a 12-valve circuit has been compressed into a chassis very little bigger than that of the average 5-valve superheterodyne. The breadth is 12½ inches and the depth only 9 inches. True, the height is one or two inches above the average, but this is an advantage as it obviates the whip which is so difficult to avoid in a shallow chassis of greater area.

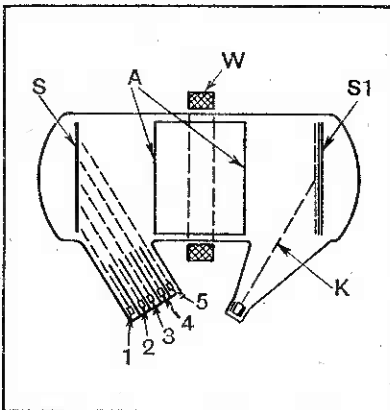
The tuner unit with separately screened compartments is mounted immediately below the tuning condenser and the two-speed tuning control and waverange switch are conveniently adjacent. The remaining pairs of controls are closer together, but have been arranged so that the least accessible knobs are those associated with subsidiary functions.

Most people who buy a chassis of this type do so with the intention of installing it in an existing cabinet or in a new one of special design. They will undoubtedly be attracted to this receiver by its compactness, which allows much more scope for originality than chassis of conventional proportions. They need have no fear that any sacrifice in performance will follow their choice, particularly if the first consideration is a really lively performance on all wavelengths.

Expansion and Contraction

A CATHODE-RAY "CONVERTER"

THE use of secondary emission, particularly in what may be called cathode-ray technique, is opening up a new field of research to those with an ingenious turn of mind. For instance, the strange-looking tube shown in the Figure (Patent 488605) will operate to reduce the actual duration of a message, by contracting or speeding it up before transmission, and then restore it to normal



A five-channel tube for expanding or contracting the duration of signals.

length at the receiving end. Or it can be used to lower the acoustic frequency of a signal at the transmitter in order to

lessen the effect of atmospheric disturbance *en route*, and will afterwards restate the original frequency.

Another interesting point is that television and sound signals can both be sent out simultaneously on the same carrier wave, and then separated at the receiver, before being fed to the loud speaker and viewing-screen respectively. In each case the effect depends upon controlling the relative speed of scanning two separate screens mounted at opposite ends of the same cathode-ray tube.

The particular construction shown is designed to handle five different signals simultaneously. These are applied to modulate five different electron streams 1 - - - 5, the idea being to make the "complex" of signals leave the tube as a continuous sequence, so that they can then all be applied to one amplifier, or fed into the same transmission line.

Each of the modulated streams 1 - - - 5 is deflected horizontally only, and moves always along the same line of a sheet-metal screen S. The resulting secondary electrons are focused by a cylindrical anode A and magnetic winding W on to the opposite screen S₁, which is of the mosaic-cell type, so that it sets up a "charge image" of all the original signals. This is then scanned, from the

opposite end of the tube, by a single electron stream K, which is deflected both horizontally and vertically, and at such a speed that it covers the whole of the screen S₁ in the time taken for each of the streams 1 - - - 5 to complete one horizontal line on the screen S.

In this way the five simultaneous signals are converted into a single-line sequence. Any given message does not leave the tube as complete and consecutive, but parts of it are sandwiched between parts of the other messages. These parts can, however, be pieced together, in their proper order, by using a similar tube, with the screens S and S₁ reversed at the receiving end.

News from the Clubs

Golders Green and Hendon Radio Scientific Society

Headquarters: Regal Cinema, Finchley Road, London, N.W.2

Meetings: Second and fourth Wednesdays of the month at 8 p.m.

Hon. Sec.: Lt.-Col. H. Ashley Scarlett, 60, Pattison Road, London, N.W.2.

The following programme has, so far, been arranged for 1939—

January 11th.—Lecture by Mr. Alexander Black: "Troubles of a Television Receiver, and Remedies."

January 25th.—Lecture by Mr. E. Dedman: "Quartz Crystals."

February 3rd.—Annual Club Dinner.

February 8th.—Illustrated lecture by Mr. A. E. Watkins: "Colour Photography."

February 22nd.—Lecture by Mr. J. C. Emerson: "Practical Radio Measurements with Special Reference to Decibels and Antennators."

March 8th.—Lecture by Mr. Alexander Black: "Microphones."

March 22nd.—Lecture by Mr. G. Parr: "Electro-Physiology."

April 12th.—Lecture by Mr. D. N. Corfield: "Cathode-ray Measurements."

April 26th.—Annual General Meeting.

May 7th.—40-Metre Field Day.

May 21st.—40-Metre Annual Open DF Competition.

June 18th.—5-Metre Field Day.

July 2nd.—5-Metre Field Day.

September 10th.—5-Metre Competition.

Cardiff and District Short-Wave Club

Headquarters: Toé H Rooms, Crown Court, Duke Street, Cardiff.

Meetings: Thursdays at 8 p.m.

Hon. Sec.: Mr. H. H. Phillips, 132, Clare Road, Cardiff.

New club premises have been obtained at a rental of 2s. 6d. per meeting and the first meeting there will be held on January 5th. The "News-Reel," which is the official organ of the Club, is to be continued experimentally for a further two issues. It is published every two months.

The following programme has been arranged:—

January 12th.—R.S.G.B. Meeting.

January 19th.—A visit to the Hamfest of the Blackwood Radio Club.

January 26th.—A talk entitled "Problems," by Mr. R. T. Matthews.

February 2nd.—Question Time.

February 9th.—A talk entitled "Research Problems," by Mr. H. H. Phillips.

February 16th.—R.S.G.B. Meeting.

Morse instruction classes will be held at 7.30 p.m. on every meeting night.

Croydon Radio Society

Headquarters: St. Peter's Hall, Ledbury Road, South Croydon.

Meetings: Tuesdays at 8 p.m.

Hon. Pub. Sec.: Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

An enjoyable evening of recorded music was provided by Mr. H. G. Saiter on December 15th. The reproducing apparatus had been specially assembled by Mr. Glaisher and Mr. Dives. The pick-up was a crystal one and the loud speaker was a Blagnavox 33 fed by a PX4 valve which gave an output of 2 watts. The two amplifying stages were RC coupled.

Morse instruction classes will be held at 7.30 p.m. on every meeting night.

Radio and Physical Television Society

Headquarters: 72a, North End Road, London, W.14.

Meetings: Fridays at 8.15 p.m.

Hon. Sec.: Mr. C. W. Edmans, 15, Cambridge Road, North Harrow.

On December 16th a party of members paid a visit to an exhibition of students' work at the Borough Polytechnic. After visiting the electrical workshops and laboratories, the party made its way to the Radio Section. Apart from amateur-constructed apparatus, there were several instruments, including cathode-ray oscillographs and gauging-oscillators, made by A. C. Cossor, Ltd.

Readers' Problems

A Selection of Queries dealt with by the Information Bureau, and chosen for their more general interest, is published on this page.

Crackles

FOR some time past crackling noises have been heard in the loud speaker of an AC receiver whenever it was subjected to the slightest vibration and sometimes this was accompanied by flickering of the dial lamp.

Recently the lamp failed to light and it is noticed that the crackling now only appears if the set is moved or the table on which it stands is given a sharp blow. We are asked for an explanation and the most likely cause of the crackling, as when the chassis is removed for fitting a new dial lamp the defect can be remedied.

From the description provided by our enquirer, we are inclined to believe that there is nothing really wrong with the set, save that the dial lamp has become loose in its holder. The intermittent contact was responsible for the crackling, and now that the lamp has become so loose that it fails to light, the crackling only occurs if the set is given a jolt sufficiently violent to make a momentary contact.

Possibly the dial lamp can be screwed in tightly without removing the chassis, but the set must be switched off before this is done, as the hand might come in contact with a valve cap or other high voltage lead and a severe shock obtained.

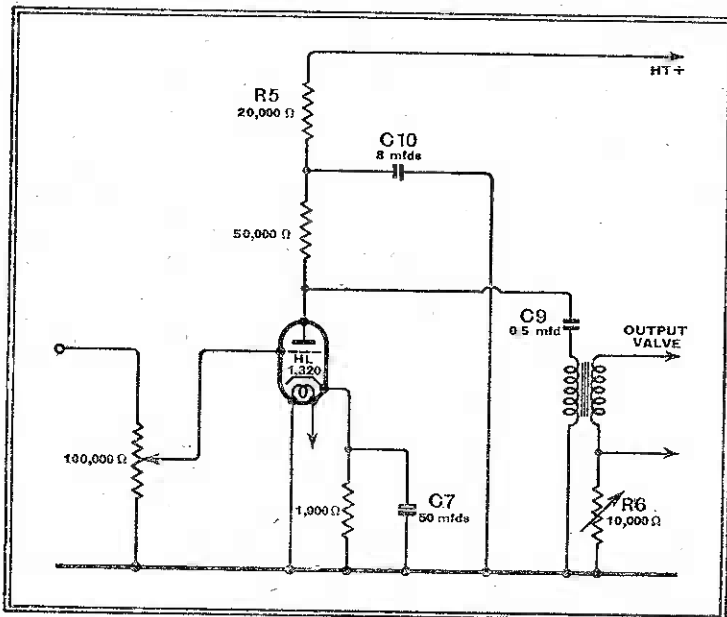
Universal Gramophone Amplifier

ASSISTANCE is required in building a small gramophone amplifier for AC/DC operation. The unit must be simple and, if possible, limited to two valves.

Though we have not given full constructional details recently of a universal gramophone amplifier, the AC/DC Local Station Receiver described in *The Wireless World* of January 20th, 1938, can be quite easily adapted for use as a gramophone amplifier.

If the RF circuits are omitted and the first valve given a little more negative bias, the set becomes a two-valve amplifier. Actually, a few minor changes would be desirable;

By rearranging the first stage of the AC/DC Local Station Set as shown it becomes a universal gramophone amplifier.



and it is suggested that the first stage be modified as shown herewith. In this circuit a volume control of 100,000 ohms is included in the input circuit, and while this

will suffice for many magnetic type pick-ups, if the makers of the actual pick-up to be used recommended a different value, then it should be used.

It might be of interest to mention that a pentode with negative feed-back was used in the output stage of this set. The amount of feed-back can be varied. R6 being the control. In this skeleton circuit the references used in the original circuit are retained where no change is made in the value of the components.

Push-pull Output Stage for All-wave Battery Set

IT is desired to convert the output stage of the All-wave Battery Set described in our issues of October 27th and November 3rd last into push-pull, using a pair of triode valves available. The existing intervalve transformer will be replaced by a push-pull type, and we are asked to give the value of the grid bias resistance as well as for a criticism of the proposed changes.

The valves it is proposed to use require a grid bias of -32 volts and an anode potential of 200 volts for maximum power output. Even assuming a lower HT voltage is to be used, the required input to the push-pull stage will probably be of the order of 40 volts RMS, whereas in the original form an input to the final stage of between 6 and 7 volts RMS only is required. As this is but one-seventh of what will be required for the push-pull stage it will be necessary to provide some additional AF amplification, and this could be obtained by fitting another PM2 HL valve in the existing output position and resistance-capacity coup-

ling it to the preceding AF amplifier. This can be followed by the push-pull stage.

We do not think it desirable to obtain grid bias for the PP stage from a resistance

between HT- and ET-, as the HT battery will have to be increased by the amount of the grid bias, namely, by 30 volts. A separate grid bias battery is preferable. It must also be remembered that the proposed changes will upset the grid bias voltages throughout. However, automatic grid bias for all but the new output stage can be obtained by replacing R14 by a resistance of about 30 ohms and omitting R15. The actual value of R14 will depend on the total current taken from the HT battery and it will have to be found experimentally.

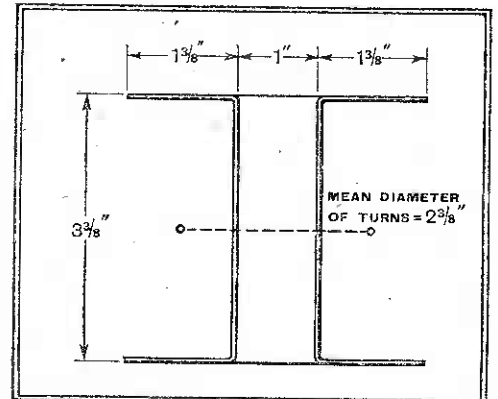
Rewinding LS Field Coil

WE are asked if it is possible to convert a low-resistance field winding on a loud speaker into a high-resistance one of about 1,250 ohms. The bobbin measures 3 3/8 in. long, has a rim diameter hole in the centre and the outside diameter is 3 3/8 in. The energising power needed is 15 watts.

Such rewinding can, of course, be done, and the size of wire and the number of turns can be found from Abac No. 27 (b) in *The Wireless World* Radio Data Charts by adopting the following method:—

Calculate the current in the coil, then find a gauge of wire to safely carry this current and calculate the quantity required to give 1,250 ohms. The next step is to find by calculation how much space the winding will occupy.

Fifteen watts dissipated in a resistance of 1,250 ohms gives a current of 0.11 amp.,



Dimensions of the bobbin which is required to be re-wound for a resistance of 1,250 ohms.

and the optimum size of wire, calculated on a current density of 1,200 amps. per square inch of copper, is found from the Abac to be 0.0112 in diameter, the nearest standard gauge being No. 32 SWG.

Now, the resistance of this size of copper wire is 262 ohms per 1,000 yards, so that 4,800 yards will be needed to give 1,250 ohms.

From a scale drawing of the bobbin shown in the figure it can be found that the mean diameter of the turns, assuming the bobbin is wound full, will be 2 3/8 in.; therefore, the length of one turn will be 7.4 in., so that 4,800 yards of wire represents 23,000 turns. If DSC wire is used, this will occupy 4 sq. in., and, as the bobbin provides 4.6 sq. in., there is ample space available.

It is fortunate that in this case the optimum size of wire can be used as if it had been found to occupy more space than is available then the next smaller size would have to be used. Likewise, if it did not completely fill the bobbin the actual resistance would be less than the calculated value and a larger size of wire would be required.

"Fit and Forget" Valves

By "CATHODE RAY"

THE very early broadcast receivers were the production engineer's nightmare; Heath Robinson himself would have been hard put to it to caricature them. They were liable to "go off" if any unauthorised person approached within two yards. When they did get to the stage, at which they could be *manufactured* at all, only instrument makers—used to delicate individual work—would tackle it. Very much "cleaning up" had to be done before they could be shot off conveyor belts in thousands per day.

So far as the sets proper are concerned they have now reached the stage of being a reasonable factory job. And then the whole idea is spoilt by plugging in the valves.

Oh, I know valves are turned out of factories by the hundred-million. So, too, millions of motor vehicles depend on toothed wheels going in and out of mesh while in motion in order to change gear, though in principle the thing is a mechanical atrocity. As some Frenchman remarked philosophically, "It is brutal, but it works."

Miracle of Manufacture

It is marvellous that valve manufacture has been put on a mass-production basis when it involves pushing bits of heat-softened glass into the right-shaped blobs to hold up bits of wire that hold up more blobs and more bits of wire with filaments and grids and plates on the ends of them that ought to be kept within a thousandth of an inch or so of the correct spacing from one another; then bracing them up with bits of mica—a vermin-ridden mechanical material if there ever was one—to keep them from flopping against their glass bulbs—another rotten mechanical medium—because the whole contraption is stuck precariously on the top of a glass perch or pinch, a relic of electric lamp days that has never been outgrown. Such lack of confidence is there—justifiably, no doubt—in the result that they are fitted to the set by plug and socket so as to allow of frequent replacement with a minimum of effort. After that is done, a top connection has to be made, with a tin hat as a crown, and a screened flexible lead waves in the breeze between it and the nearest coil can, offering a variety of weak links in the chain.

Of course, the black side of the picture is slightly exaggerated here; but it is a fact, to which dealers and servicemen will testify, that valves are the most vulnerable

department of a radio receiver, that many break or get damaged before ever they reach the set, and that the associated fittings—sockets, top caps, screws, RF leads—are frequent sources of trouble in such matters as poor earthing contact, broken signal connection, or loss of tuning through shifting stray capacity.

We are not yet in sight of doing without valves altogether, but there does seem to be some prospect of future types being more mechanical and workmanlike jobs. Various types of metal valves have appeared from time to time; but, although it is quite a good move to substitute unbreakable material for the glass envelope, this accounts for a much smaller proportion of breakages than might be supposed. I have very rarely known the glass bulb of a valve to break; in fact, once or twice when I have tried to break it with a hammer I have found it incredibly difficult. But I have known many valves to sustain grave internal injuries by a slight fall or jar.

So I am very interested in designs that are now appearing on the Continent—some in glass and some in metal—in which the old "pinch" construction has been abandoned in favour of mounting the electrodes on short, stout props directly on a circular base plate. The sketch here shows by contrast the general idea and the obvious mechanical and electrical improvements.

Another feature common to some of these new Continental valves, and also to some in America, is the abolition of the top connection. I am sure valve makers must hate to have to stick a metal cap on the top of a glass bulb, make good electrical connection with an electrode below it and ensure a perfect vacuum-tight joint. I know I have had lots that give trouble here. But the *external* connection from this cap is, mechanically and electrically, thoroughly bad. It must be well screened, it must be flexible, it ought to introduce little capacity, and what capacity there is

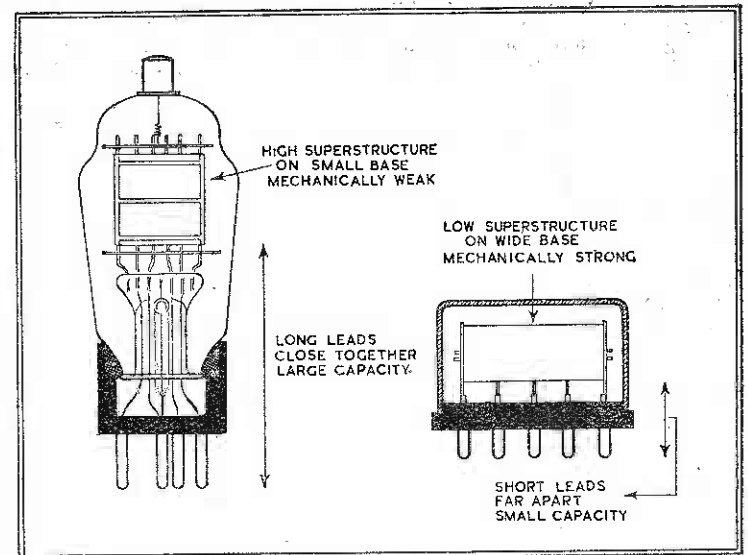
should be absolutely constant—conditions that flatly contradict. When the valves are removed—if they are—for transport, these leads and their screening hats must be lashed carefully to something to prevent them from knocking about. On the other hand, if all connections are brought out at the base of the valve, these undesirable features are immediately abolished, appreciable cost is saved, construction is more neat and rigid, wiring is all below deck, and tuned circuits are rendered better and more stable. The maintenance of screening in the valve itself and its pins is more difficult, but evidently from the success of these new designs is quite practicable.

Non-replaceable Valves

Having got so far in making the valve a real job, why not do it thoroughly and get rid of the valve socket? Solder the valve right in like any other component!

When the storm of shouting has died down I will answer the questions in strict rotation. Afraid valves are not reliable enough to fix permanently? I remember thinking that way about resistors around 1927. One had been so used to plugging them into clips so that they could be instantly replaced when they varied or broke down that the idea of soldering them right in seemed to be daring and novel, almost foolhardy. Isn't it about time valves were reliable enough? With the improvements in design already well over the horizon

WHY NOT ABOLISH THE PLUG-AND-SOCKET FITTING?



The present-day type of valve compared with "Cathode Ray's" idea of the valve of the future. It is suggested that the pins might be replaced by soldering lugs or some permanent form of connection.

they ought to be. Even present valves, accidents apart, normally last long enough for the receiver in which they reside to become obsolete. Valve makers' statistics show that 80 to 90 per cent. of valve faults in service are *mechanical*, not electrical. So if the valve is made a sound mechanical

"Fit and Forget" Valves—

job it ought to be as reliable as the other components that are soldered in. Electrolytic condensers have a finite life, but does anybody mount them on plugs for ease in replacement?

Then I think I caught a growl from a group of valve makers. What would happen to the replacement business? Valve lives are already too long for us. Oh, yes? But what would we think of, say, a transformer manufacturer if he grumbled because his products were so free from breakdown that his business in replacements was worth nothing?

Then *why shouldn't* valves be plugged into sockets as at present? It is very convenient for changing them. No doubt, but if these new valves prove to be all they appear to be we hope they will rarely need changing. It is quite common for condensers, resistors, transformers and volume controls to require changing; but would a set-maker take kindly to the suggestion that all these components be provided with sockets to facilitate the process? He would grumble about the expense and the general

slackness from a mechanical point of view. Therefore, the abolition of valve sockets ought to be welcomed by him, for it cuts out the cost of sockets, eliminates the risk of broken socket contacts and bad connections between socket and pin; it gives a better job with no fear of valves falling out; and it solves the multiplication of socket types problem. I visualise the set of the future with small squat metal valves screwed firmly down on the chassis, no top connections, no microphony, no large quantities of valves returned for mechanical faults.

In the old days of motoring, whenever anything went wrong with the works one yanked out the sparking plugs and examined them, and probably tried new ones. That is like the present era in radio. A prominent sparking plug manufacturer emphasised the reliability of his products by the slogan, "Fit and Forget!" But the valve manufacturers at present emphasise the unreliability of their products by advertising campaigns to encourage replacement. Will they follow the example of the sparking plug people?

We've had something of the same kind in sound receivers, though in that case, thanks largely to the work of *The Wireless World*, the position has to a great extent cleared itself up without the need for any definite action on the part of the R.M.A. There still remain, though, some points upon which that body should lay down the law. We now use the term "rectifier" only for the valve whose function is to convert AC from the mains into DC. The demodulating valve which precedes the audio-frequency stages of a receiver is always called the detector. But we are still not quite happy about the one which comes just before the IF stage of a superhet. If it's a combined oscillator and detector we call it a frequency changer; but we have to fall back on "first detector" if there's a separate oscillator valve.

More Reforms Needed

And there are other things here and there in the wireless set which are crying out for standard names. At present, for instance, a superhet with three amplifying departments can be described as having high-frequency, radio-frequency or signal-frequency, intermediate-frequency and either low-frequency or audio-frequency amplification. Of these the terms high-frequency and low-frequency are perhaps the most unfortunate, for they can be used in an absurdly confusing variety of ways. Who, for instance, can wonder that the beginner is puzzled when he comes across such phrases as "high-frequency end of the medium-wave band," "a low intermediate-frequency," or "a high audio-frequency"? Wouldn't it be better if we all adopted "signal-frequency," "intermediate-frequency," and "audio-frequency" for the amplifying stages of the receiver?

Random Radiations

By "DIALLIST"

Something Standardised

IF valves can't be standardised (and there's very little hope of that now), it's a comfort to hear that the R.M.A. has evolved standard specifications for HT batteries. In future they are to be of four classes—A, B, C and D. For each class the height and diameter of the cells are laid down and the gauge of the metal used for the cans. Better still, a system of minimum outputs per cell has been adopted. For class A this is 2,200 milliwatt-hours, 2,500 for class B, 3,000 for class C and 6,000 for class D. These milliwatt-hour outputs correspond to 1,750 milliamp.-hours, 2,000 milliamp.-hours, 2,400 milliamp.-hours and 4,800 milliamp.-hours respectively. The standardisation scheme should end once and for all certain abuses which have long been the bane of the battery user.

An End to All That

When valves such as the old "R" and the "Ora" were the only ones available, the HT current consumption of all sets was minute and the only kind of high-tension battery needed was one made up of cells similar to those that had already become more or less standard for flash lamp batteries. As time went on HT loads became heavier and batteries of greater capacity made their appearance. As is the case now, under standardisation, there were four main groups of cell sizes, though some of these were different from the ones now adopted, and, beyond that, some firms of battery makers had their own particular sizes. At first the four classes were known as Standard, Double Capacity, Triple Capacity and Quadruple Capacity, though sometimes triple-capacity batteries were described as "Power" HTB's and quadruple capacity as "Super-Power." As no standards were laid down, it wasn't long

before terms such as power, treble capacity and so on began to be used very loosely. I've seen, in fact, alleged super-power batteries made up of cells whose volume was only one-third greater than that of standard cells.

Plain Sailing Now

Perhaps the worst feature of all, so long as HTB's remained unstandardised, was the absence of any check on the quality of the component cells. As there were no accepted performance minima, anyone who chose to do so could market a battery which, though it invariably bore a gaudy label describing it as the world's best, might be made up of cells of the poorest possible quality, only partly filled, and separated from one another by wretchedly bad insulating material. Some of the batteries sold were almost incredibly bad. I remember one brand described as specially designed for loads up to 15 milliamperes which proved under test (eight were obtained direct from the makers, so that they should be perfectly fresh) to have an average service life of ten days when run for three hours a day with a nominal 10-milliampere load! We can now, I hope, regard all such abuses as things of the past. When you buy an A, B, C or D battery you will know what you are getting for your money.

Television, Too

ANOTHER much-needed reform is the adoption by all-makers of television receivers of one and the same set of technical terms and of names for the various controls. It has been distinctly confusing in the past to have a variety of names for the same thing and worse still to find makers using one term to mean two quite different things.

The Toughest Nut

IF the R.M.A. is really going to get down to the business of standardising radio terms wouldn't it be well to have a shot at finding an answer to one of the most important of all questions? Won't it try to tell us just what a valve is. The American R.M.A. made an attempt some time ago, but it wasn't a very successful one, for it left all kinds of loopholes. American manufacturers, for instance, are completely within their rights when they include in the number of valves given in a set's specification as many mains rectifiers as there may be, the tuning indicator, tubes used purely for AVC purposes, and so on. Some of ours do likewise, and it's not at all satisfactory that they should. To the mind of the purchaser the number of valves in a receiver should give a definite indication of its performance as regards selectivity, sensitivity, and volume. The R.M.A. would be doing a good service to the public and to its own members were it to lay down that the word valve preceded by a number in descriptions of sets should refer only to tubes acting upon the signal as detectors or amplifiers in the direct path between aerial and loud speaker.

U.S.-W Quality

IN a recent issue of *The Wireless World* Mr. R. G. Young had some criticisms to offer of those who speak in glowing terms of the quality obtainable from high-fidelity, ultra-short-wave transmissions such as those from the Alexandra Palace of the sound accompanying television. From his own experience he suggests that this alleged quality is largely a myth. I must be one of those on whom Mr. Young is sharpening his axe, for

Random Radiations—

more than once I've spoken of U-S-W high quality in these notes. Let me assure Mr. Young that I'm with him all the way when he asks, "Is it not a fact that the AF side of the average televisior is sadly neglected . . . ?" It is; and no one is going to suggest that, however good the transmission, an indifferent sound receiver can do it justice. Of course it can't; I've heard reproduction from sound-and-vision receivers for which rotten is the politest descriptive adjective that occurs to me. But it can be exceedingly good, and it has been my good fortune to listen to one or two magnificent instruments.

The Quality Question

The whole question of quality in reproduction is most perplexing. Mr. Young's strictures could equally well be applied to the average broadcast receiver, for how many of them do justice even to the medium-wave and long-wave transmissions? Between ourselves I don't think that the average listener cares the proverbial two hoots about quality, being satisfied so long as speech is intelligible and music recognisable as such. This is perhaps not so surprising as it might seem at first in an age whose most popular purveyors of alleged music try quite deliberately to produce distorted and ugly sounds. I can't, myself, see the slightest point in having a quality receiver if it is to be used mainly for the reception of dance music of the more eccentric kind. In fact, as there seems to be such a vogue for hideous noises it is possibly not unreasonable to suppose that a modicum of distortion introduced by the receiver adds to the general effect and so increases the pleasure of the listener who likes that kind of thing. Anyhow, the set maker has to cater for a public which is not enthusiastic about quality; hence it's natural that in producing cheaper and cheaper receiving sets and televisors he should reduce manufacturing expenses by not spending more than he can help on the AF side.

The Sticky Meter

YOU remember I referred a week or two ago to a letter from a reader who said that if he switched off all the lights in his house the load of about 50 watts imposed by an AC mains receiver wouldn't make the recording disc of his supply meter revolve. Another reader reminds me that, according to the regulations of the Electricity Commissioners, a supply meter is not required to register until a certain percentage of its full load is reached. If, therefore, the maximum load imposed by the household circuits is heavy, a large meter is fitted, and this may not register a drain so small as 50 watts. This suggests a new series of experiments with the domestic meter. Those interested may care to discover by experiment what is the largest load that can be imposed without causing the meter to charge it against you! So far as I can see, mine seems to be regrettably sensitive—but then I don't use electricity for heating, so my maximum load isn't a very big one.

Vision or Jamming?

AN Edinburgh reader tells me that he, too, has noticed the curious noises in the neighbourhood of the Deutschlandsender's channel, which a ship's radio officer thought might be due, if you remember, to Russian experiments with television. My Scottish correspondent, who is also a keen amateur

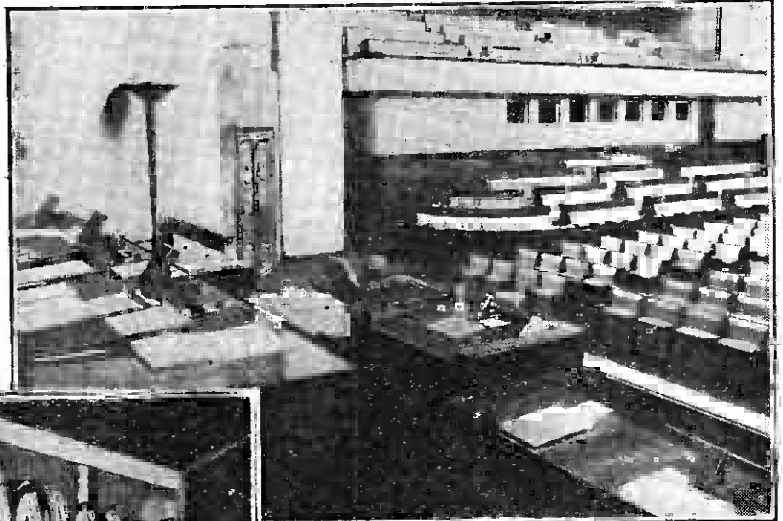
transmitter, has no doubt at all that it was an attempt at jamming. And, talking about jamming, did you happen to listen to the German short-wave transmissions on the afternoon of Christmas Day? Somebody

was trying at one time to jam them on every single channel. So far as reception in this country was concerned, the jamming wasn't very successful, though it may have been more effective nearer to its place of origin.

**Broadcasting and the League of Nations
FACILITIES FOR THE RADIO REPORTER**

IN the new League Assembly building, on the shores of the Lake of Geneva, the main assembly hall has been equipped with fourteen commentators' or reporters' cabins. Each of these is fitted with ear phones and a microphone, seven of the cabins being used by radio reporters and seven by film operators.

MICROPHONES are unobtrusively fitted to the desks on the President's dais. The windows of the seven radio reporters' cabins can be seen on the far side of the hall.



CONTRAST this view of one of the new radio reporters' cabins with . . .

Two of the photographs reproduced here contrast the facilities afforded to radio reporters in the early days of the League in the Salle de Réformation and those which are available in the new building.

The output from each of the five speakers' microphones, which are inconspicuously incorporated in the desk on the dais, passes to a mixing panel and so to the League broadcasting station, Radió Nations, at Prangins, the trunk lines to outside broadcasting stations, the disc recording room or to the talking film equipment. A feature of the in-

stallation is that a constant line output of six milliwatts is provided.

The speakers' microphones are faded in and out by officials in a control booth, where they also regulate the volume of the

PA equipment in the hall, which seats over 15,000 people, and throughout the building. To facilitate the control of the volume in the hall four listening points are included where operators can signal to the main control booth the required increase or decrease by means of a rotary switch which varies the length of light in a neon tube on the desk of the operator.



. . . this picture of Mr. Vernon Bartlett peeping through a hole in the curtain behind the President's table in the Salle de Réformation in 1929 in order to give British listeners an eye-witness account of the League proceedings. Mr. A. R. Burrows, Secretary General of the U.I.R., who arranged the League relays for all countries, is seen talking to Mr. Bartlett.

Recent Inventions

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

MECHANICAL MUTING

THE idea of muting the loud speaker, during the process of tuning, by means of a switch operated from the control knob, is already known. The invention describes a convenient way of doing this.

The main tuning control knob K drives a slow-motion gear G which is mounted on a leaf-spring S attached to the panel at F. The

one-twentieth the working wavelength above ground level.

Telefunken Ges für drahtlose Telegraphie M.B.H. Convention date (Germany), October 29th, 1936. No. 491127.

AUTOMATIC VARIABLE SELECTIVITY

THE filament of a small electric flashlamp shows a higher ohmic resistance when hot than when cold. This non-linear response has already been used to regulate the effective coupling between the band-pass circuits of a wireless receiver, and, therefore, the overall selectivity of the set. For instance, the two tuned circuits, L, C and

to give automatic regulation of selectivity. This avoids unnecessary amplification and simplifies automatic volume control.

N. V. Philips Gloeilampenfabrieken. Convention date (Germany), December 3rd, 1936. No. 491183.

TIME-BASE CIRCUITS

THE ordinary low-pass filter used for separating the line and frame synchronising impulses in television does not give satisfactory results when applied to interlaced scanning. The difficulty is due to the fact that alternate frames contain half-line intervals, in order to ensure correct interleaving.

According to the invention the line and frame impulses are applied simultaneously via the terminals T, T₁ to the grids of a triode-hexode valve V and drive them in the positive sense, the picture signals meanwhile driving the

cast signals. In practice, however, the method is found to introduce certain forms of distortion which are difficult to eliminate at the receiving end.

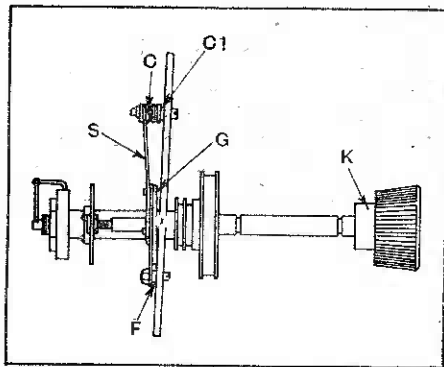
The invention discloses a method of modulating in which the signal frequencies are distributed in an uneven or asymmetric manner between the two sidebands. This allows the middle and outer parts of one of the sidebands to be suppressed, before the signals are radiated, and so appreciably restricts the space they occupy in the ether. The new method of modulation allows of distortionless reception, and increases the normal standard of selectivity.

P. P. Eckersley and R. E. H. Carpenter. Application date, March 1st, 1937. No. 491093.

FLUORESCENT SCREENS

THE fluorescent screen of a cathode-ray tube is usually made by coating either the bulb end of the glass tube, or a separate backing-plate, with a thin layer of luminescent material mixed with a suitable binder, so that the coating adheres firmly to the surface.

By contrast it is now proposed



Muting switch operated by pushing in the tuning knob.

upper end of the spring S carries a contact C which is normally held slightly away from a second contact C₁.

In operation, when the knob K is grasped to tune the set to a new station, it is first slightly depressed so as to bring the two contacts C, C₁ together. This "mutes" the loud speaker and prevents interstation noise. When the indicator needle shows that the required station has been tuned in, the knob is released and the contact C automatically springs back to bring the loud speaker into action. A delay circuit may be added to prevent any noise being heard should the knob be momentarily released during the tuning operation.

The General Electric Co., Ltd., and W. H. Peters. Application date, April 22nd, 1937. No. 491463.

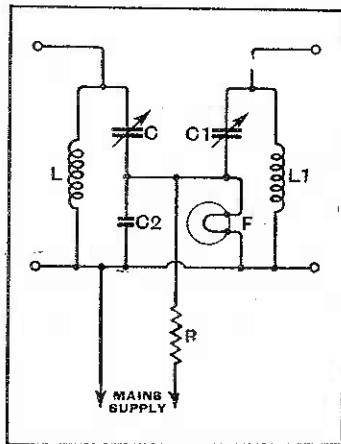
DIRECTION-FINDERS

TO eliminate night-effect, two frame-aerials are spaced apart with their windings fixed in the horizontal plane, and are mounted so that they can be rotated about a common centre. Or, instead of using only two frames, two pairs of frames may be arranged at right angles to each other. The signal voltage from each frame is fed to a common receiver in opposition to that from its "opposite number."

An advantage of the combination is that it removes two of the false zeros given by the known use of similar but vertically arranged pairs of frame aerials. Since the system responds only to horizontally polarised waves it should be erected at a height of at least

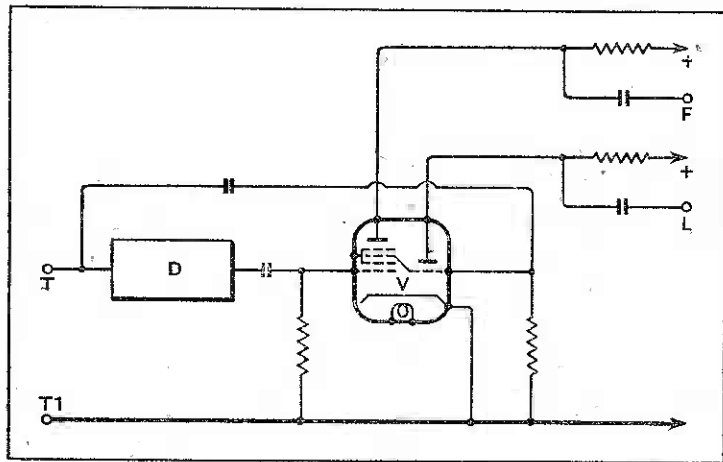
L₁, C₁ are coupled through the condenser C₂, which is arranged in parallel with a small flashlamp F. When the filament of the latter is cold, its resistance is of the order of 10 ohms, which practically short-circuits the coupling condenser and so loosens the coupling between the two circuits; on the other hand, when the filament is hot, its resistance is high and the coupling is tightened up. If the rectified carrier-current is passed through the lamp, the coupling will accordingly be loose for a weak signal, so as to give high selectivity, and tight for a strong signal, giving a wider pass-band and better quality.

According to the invention, an



Lamp as an automatic variable coupling control.

auxiliary biasing current, derived from the supply mains, is fed to the lamp F through a resistance R, in order to cut down the strength of signal current required



Separating line and frame synchronising impulses.

grids in the opposite or negative sense. A delay network D is interposed in one of the leads, and the valve V is initially biased so that it will only pass anode current during the period of overlap of the frame impulses, which are then passed via the terminal F to the saw-tooth oscillator. The line impulses are passed directly via the output terminal L to a separate oscillator.

The delay introduced by the circuit D is such that the line pulses are always separated and never overlap, while the frame impulses are only effective when they do overlap so as to produce a corresponding grid voltage.

E. L. C. White. Application date, March 10th, 1937. No. 491728.

TRANSMITTING SYSTEMS

IT has already been proposed to economise space in the ether by cutting out one of the two sidebands used in transmitting broad-

to cover the curved surface of the glass bulb with a loose mass of powdered fluorescent material, sufficiently deep to form a smooth plane surface. This means that the bulb must be used in the inverted position, so that the powder is kept in position by gravity, the picture being viewed either from above or through a reflecting mirror.

There are certain compensations for this apparent handicap. In the first place, a thicker layer of fluorescent material can be used under these conditions, with a corresponding increase in the amount of light given off. In the second place, if the scanning beam should inadvertently be allowed to burn the sensitive material, the damage can be made good simply by shaking or tapping the powdered material until it forms a new surface.

The General Electric Co., Ltd.; L. C. Jesty; and J. Sharpe. Application date July 19th, 1937. No. 491748.

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PHYSICAL SOCIETY'S EXHIBITION

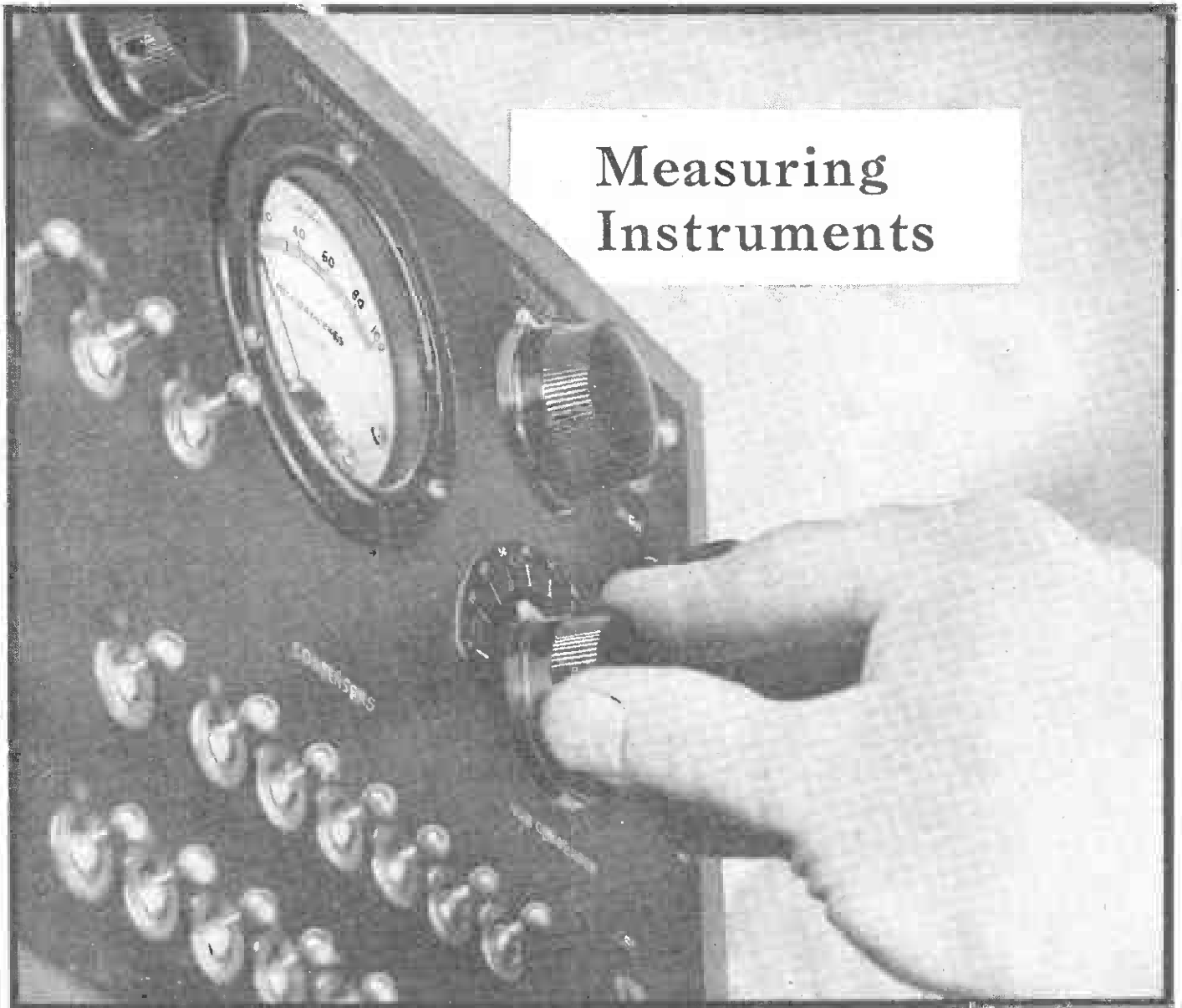
The

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Wireless World

THE PRACTICAL RADIO & TELEVISION JOURNAL

Thursday, January 12th, 1939.



Measuring Instruments

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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.

CONTENTS

	Page
Editorial Comment	25
Measuring Iron-Cored Inductances	27
Television Programmes	29
Output Transformers	30
The Amateur Transmitter II	32
Random Radiations	34
"The Monitor"	35
Problem Corner II	37
Big Screen Television	38
Letters to the Editor	38
News of the Week	39
Physical Society's Exhibition	41
About Instruments	45

EDITORIAL COMMENT

Television Enterprise

Danger of Over-ambition

WE know that television is still a pioneering effort and that in the opinion of those responsible for its conduct it is still an experimental service. We are prepared, and the public, too, is prepared, we believe, to make the fullest allowance for occasional technical breakdowns which must inevitably occur from one cause or another in these early days.

We doubt, however, if a satisfactory excuse can be found when transmissions are attempted in the ordinary service programme times which are so pre-doomed to failure that we should have thought the most modest attempt at a rehearsal would have revealed the fact.

These comments are prompted particularly by the deplorable exhibition, judged by television's own standards, of the transmission the other evening of "Twelfth Night." Lighting was so inadequate that it was often difficult even to make out anything beyond the bare fact that a play was in progress. The speech, too, was disappointing and we were led to assume that the positioning of the microphones was too dependent on the positions of the players.

In these early days of television the B.B.C. must assume that every programme is being viewed for the first time by many prospective owners of sets, and on their reaction to their first performance will depend the rate of progress of television popularity.

We would urge that every performance given should be up to a reasonable standard. Many performances will soar far above that standard but none should fall below it where a rehearsal

would have given the necessary warning and indicated whether the lighting and other conditions, probably, in the case of a theatre performance, not capable of being controlled by the B.B.C., offered possibilities for a satisfactory transmission.

Motor Car Interference

Setting an Example

THE attention of all readers is directed to a letter appearing on another page, in which a plea is made for the voluntary suppression of motor car ignition interference. It is suggested that all wireless people should set an example to the general public by fitting to their cars and trade vehicles, etc., the suppressors necessary to prevent interference with television reception.

The suggestion is an admirable one, and should evoke a wide response. We feel, however, that there would be an even wider response if more information were available on the effect on engine performance of fitting suppressor resistances. There is a widespread impression that suppression is harmful, although we believe its effect is actually negligible on the vast majority of vehicles. The point is, however, that precise information, which we feel must be available, has not been published. The necessary data can only be obtained by collaboration between manufacturers of cars and car equipment and wireless engineers. We believe that a vast amount of work on these lines has already been done.

There are several other related matters about which the release of information seems to be long overdue. The suppression of ignition systems from the point of view of avoiding interference

with external receivers is a different (and in some ways easier) problem from that arising when a car is to be fitted with a built-in receiver. We understand that British cars exported to certain enlightened countries in which anti-interference legislation is in force have been adequately suppressed by the fitting of a simple choke. Such a device, though presumably effective up to the required standards on normal short wavelengths, is probably inadequate at television frequencies, but we believe that a somewhat similar method, and one that has no effect whatever on the engine performance of any car, has been developed. The public will not take kindly to the idea of suppressing their cars, whether voluntarily or under legal compulsion, until the fullest possible information on all aspects of the matter has been made available.

Apart from the question of interference with television and ultra-short waves, the widespread suppression of motor car ignition systems would have a highly beneficial effect on short-wave reception generally. Wavelengths below, say, 20 metres are at present almost useless to a listener living near a main road.

Early Wavelengths

Why 600 Metres?

SPEAKING the other day before the Institution of Electrical Engineers, Sir Noel Ashbridge, Chief Engineer of the B.B.C., confessed to casting covetous eyes

on the 600-metre wavelength, which is ideally suited to broadcasting. He went on to express admiration of the insight of the pioneers who chose this wavelength for their early work, and at the same time wondered what considerations led them to decide on such a relatively "non-round" figure. Five hundred metres, for example, would have been a more obvious choice.

So far as we know, this interesting point has not been authoritatively settled. One school of thought maintains that the wavelengths used in this country (where the commercial uses of wireless were first developed) were rated at the round figures of 1,000 and 2,000 feet. When coupled circuits came into use the typical aerial of the period could not be adapted very efficiently to radiate on 1,000 feet, and so the 2,000ft. wave became standardised. When the new method of communication became international, this figure was converted into the nearest round number in metres.

Another school of thought maintains that the pioneers, with prophetic foresight, had already adopted the practice of thinking in terms of frequency. It would hardly be possible to have rounder figures than 1,000,000 c/s (300 m.) and 500,000 c/s (600 m.).

Wireless was first developed for marine communication, and we are inclined to think that the natural wavelength of a ship's aerial probably had something to do with it. The average wirelessly equipped ship of the period would have an aerial that radiated efficiently on 600 metres.

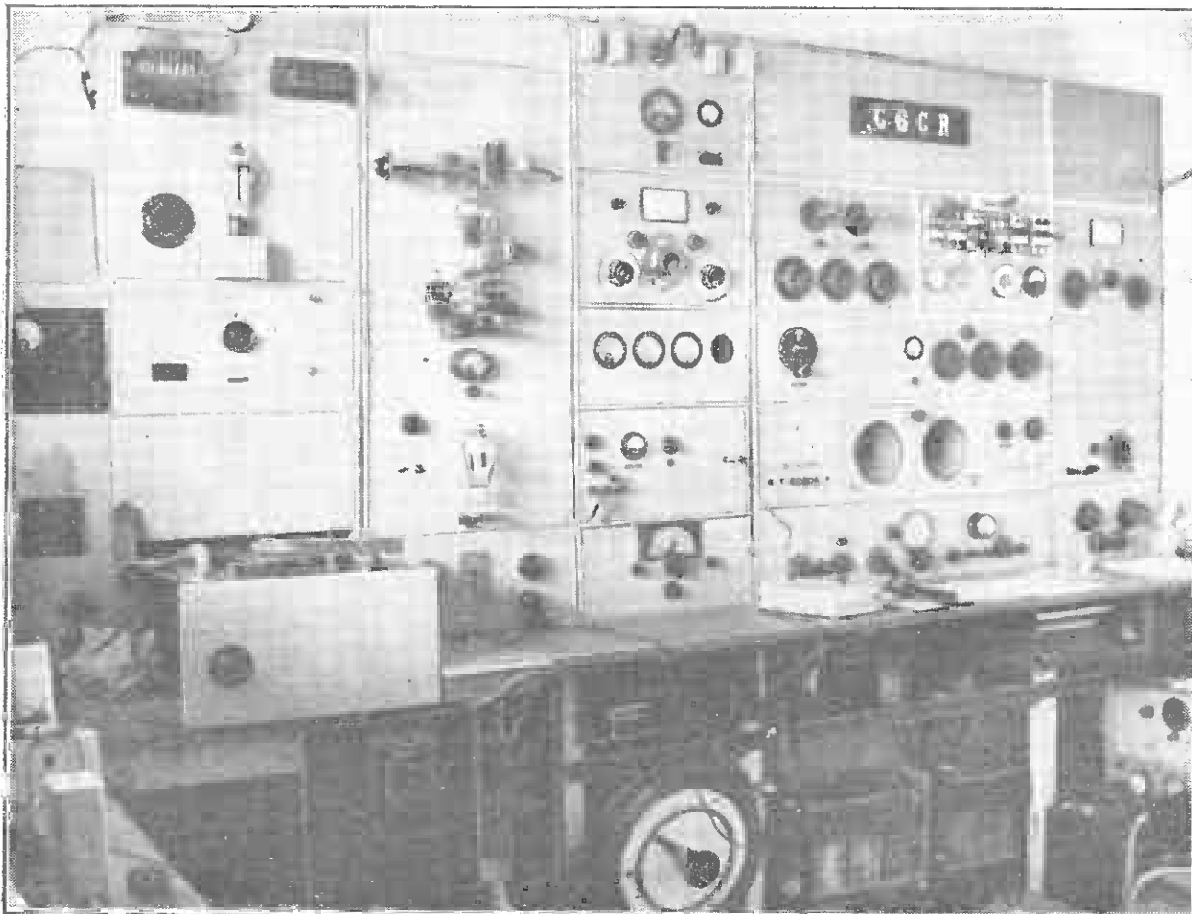
Power Supply Companies

Obligations to the Listener

OUR French contemporary, *L'Haut-Parleur*, raises the question as to whether the power-supply companies ought not to do something to assist listeners in return for the very considerable revenue which they derive from them in respect of the consumption of power from the mains. Apparently it is not at all uncommon for certain districts in France to have their power supply cut off for several hours now and again on Sundays in order that repairs may be carried out at the power station, and it is chiefly for abatement of this nuisance that our contemporary pleads so earnestly.

We are fortunate in not being worried with this particular trouble in England, but at the same time there are one or two things which our power-supply companies might do to benefit a most important section of their customers. At one time the wireless listener was not *persona grata* with the supply companies, for in the days when sets took only their HT supply from the mains, the very small load was sometimes not even sufficient to register fully on the meter of the heating circuit to which listeners usually attached their eliminators. Things have improved since then, but, even so, the attitude of the supply companies is perhaps best described as tolerant rather than friendly.

It is difficult to estimate accurately what annual revenue is now paid by broadcasting to the supply companies, but it is certainly by no means an inconsiderable sum. Although a fair number of the nine million listeners use battery sets, it must not be forgotten that accumulators have to be charged from the mains. If we assume that each of the nine million sets takes an average of 50 watts for four hours a day, and that the average cost of a unit is a penny, there is something like three million sterling going into the pockets of the power-supply companies, in addition to the revenue which they obtain from supplying current to the B.B.C. It would certainly seem that the least thing they could do would be to keep household mains free from interference as far as it lies in their power, and also to provide their consumers with a more constant voltage than is customary in some districts.



AN AMBITIOUS AMATEUR TRANSMITTING STATION. G6GR, owned and operated by Mr. E. L. Gardiner at Northwood, Middlesex, can be heard working telephony and CW on most of the amateur bands, 1.7, 14, 28, 56, and 112 Mc/s. The station is usually in action on Sunday mornings conducting tests on the 1.7 Mc/s band. Frequent late evening transmissions are worked on 56 Mc/s.

Measuring Iron-Cored Inductances

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

HOW to extend the usefulness of the capacity and resistance bridge, described in "The Wireless World" of June 16th, 1938, by providing means for measuring the inductance values of such iron-cored components as chokes and transformers

A FEW months ago¹ the writer gave constructional details of a handy mains-driven bridge for measuring resistances and capacities over a very wide range. Readers who have kindly written to report on it have expressed great satisfaction, notably with its cheapness, ease in construction and use, and utility. The one serious drawback, no doubt, is that although it enables coils of high inductance to be compared or transformer ratios to be measured it does not include actual inductance measurement. Now the measurement of RF coils, say from 1 microhenry to 1 henry, is outside the scope of such a simple arrangement. The design of a bridge to cover this range of inductance as well as resistance and capacity may appear in a later article. But in the meantime here are particulars of a slight elaboration of the original C and R bridge that brings within its scope iron-cored inductances such as transformers and chokes. It is described in the form of a simple adaptor whereby owners of the original type of bridge can use it for AF coils, but it will be obvious that if the bridge itself is yet to be made it is a simple matter to incorporate the inductance feature in the design by using one of the spare poles on the range switch.

Uses and Limitations

Before going any farther it would be as well to state the limitations of the device. It is not intended for precision measurement. For servicing or for component checking in the laboratory one is generally satisfied to know the inductance of iron-cored AF coils within about 10 per cent. The useful range is approximately 1 to 1,000 henrys. But it is available only when the ratio of resistance to reactance at 50 c/s is fairly small. Therefore air-cored coils are generally excluded, even when within the stated range of inductance. Whether the coil being tested fulfils this condition or not is indicated by the test, which is therefore particularly useful for detecting such faults as shorted sections of winding. Typical questions that can be quickly answered by means of it are:—

Is this unlabelled smoothing choke 10 H or 20 H?

A CONVENIENT METHOD WHICH IS AVAILABLE WITH SUPERIMPOSED DC

How much does the inductance drop when 40 mA. DC is carried?

Here is an intervalve transformer marked 1:3 ratio, but what value impedance is it designed to work from, and is it intended for direct or parallel feed?

This receiver is distorting; is it due to shorted turns in the output transformer?

The principle is illustrated in Fig. 1, in which the new portion is drawn in heavy

of the coil is higher than normal in iron-cored coils, and the reading of R_1 cannot then be relied upon. Unless the coil is of an unusual type such a low ratio of inductance to resistance is generally a symptom of short-circuited turns or other serious fault such as a bad joint.

Component Values

As is shown in the Appendix, the method depends on the shunt paths formed by the reactances L and C being high compared with the portions of R_1 — ra and rb . To cover the most useful range of inductance this leads to a value for R_1 of the same order as that of the main potentiometer; in fact, it is convenient to make R_1 and R_2 both 500 ohms, which results in all four bridge arms being equal. That is the condition for maximum sensitivity of a bridge, so that the resistance balance is very sharp. But because the reactances must be relatively high the inductance balance obtained by adjusting the slider position on R_1 is relatively broad, particularly for large inductances. At 1,000 henrys, such for example as the secondary of an intervalve transformer, the balance point can only be judged very approximately. In fact, to get useful results it is almost essential to increase the sensitivity of the detector somewhat. This can easily be done by means of a high-ratio transformer, which may be of quite an inexpensive grade because even if the inductance of the primary is only a few henrys it is good enough.

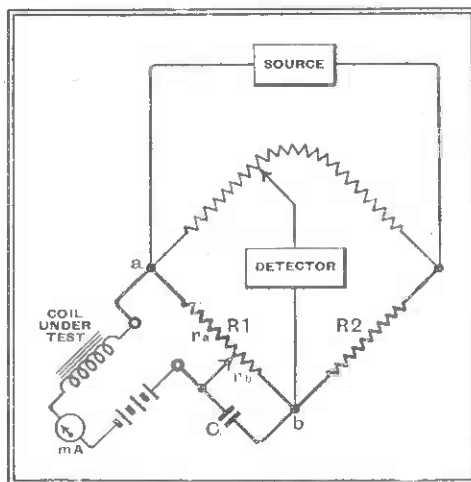
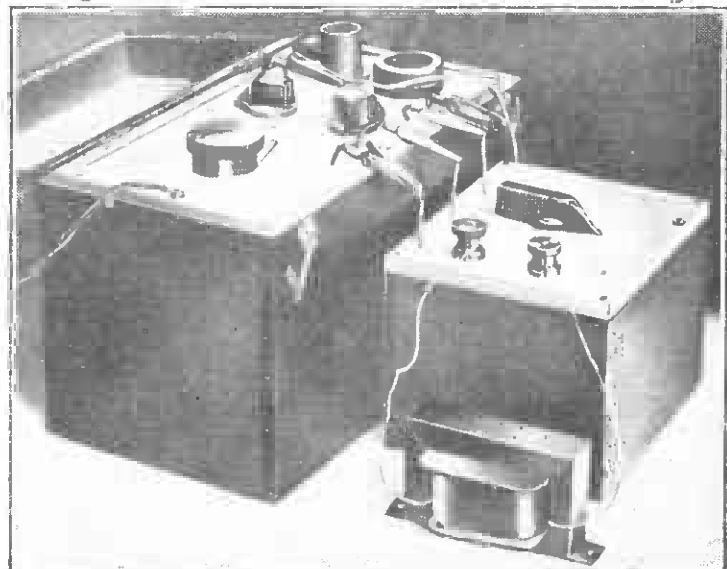


Fig. 1.—Illustrating the principle of the method of inductance measurement. The extra parts are in heavy line. The battery and milliammeter are used for supplying polarising current, if desired.

line. R_1 is a potentiometer, which is the calibrated element. R_2 is preferably equal to R_1 in resistance. With the slider of R_1 at b so that the condenser C is inoperative, the main potentiometer of the bridge is set to balance. The coil to be measured is then connected, and the slider of R_1 reset to restore balance. To obtain a sharp balance it may be necessary to adjust the main potentiometer, but if such adjustment exceeds 2 or 3 per cent. it is a sign that the resistance



The inductance adaptor in use, connected to the C & R bridge.

¹ The Wireless World, June 16th, 1938.

Measuring Iron-Cored Inductances—

It is also shown in the Appendix that at balance the inductance L in henrys is equal to $\left(\frac{ra}{rb}\right)^2 \cdot \frac{I}{4\pi^2 f^2 C}$. Balance thus depends on the square of the frequency. As frequency controlled AC mains are held at 50 c/s to a much greater accuracy than is necessary for the present purpose there is no difficulty about frequency errors; but harmonics are liable to be troublesome by obscuring the balance. So a further refinement consists of a condenser across the secondary of the transformer, to by-pass all frequencies above 50 c/s. Using the specified type of transformer, the optimum value is about 0.02 mfd.

To provide a useful range of measure-

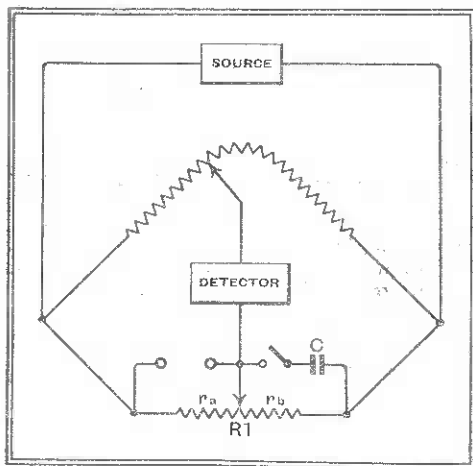


Fig. 2.—Method of calibrating the potentiometer R_1 in henrys: using the original bridge.

ment, C may be 0.25 mfd, and should be of reliable make. It can be checked, of course, on the main bridge. Assuming it is near enough to its rated capacity, and that π^2 is 10, the formula reduces to

$$L = 40 \left(\frac{ra}{rb}\right)^2 \text{ henrys}$$

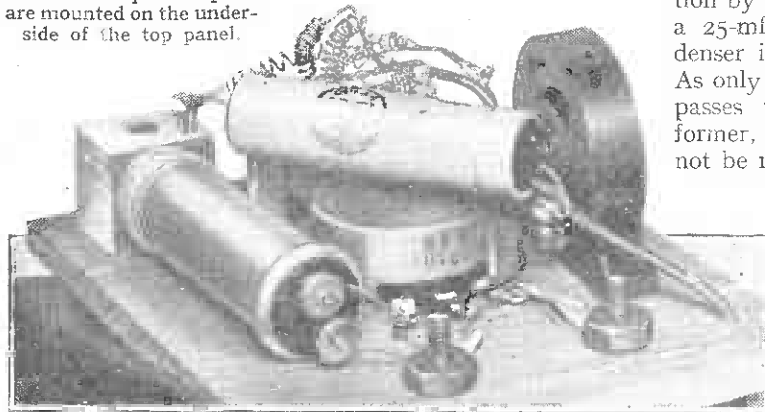
R_1 can therefore easily be calibrated in henrys, using the main bridge, which is calibrated in resistance ratios. Fig. 2 shows the connections (and disconnections) for this purpose. To ensure that the calibration does not come out reversed, if the "R" ratios scale is used on the main bridge the portion ra should be connected to "C and R" and rb to "MATCH." The range switch must, of course, be set to "MATCH"; and the slider of R_1 goes to the red terminal of either "MATCH" or "C and R." A convenient method is to set 40 on the B scale of a slide rule above 1 on the D scale. This means that when the main bridge potentiometer is set to 1 on the resistance scale, and balance is obtained on R_1 , the latter setting should be marked 40 henrys. For 60 henrys look below 60 on the slide rule and read 1.225, which is the next setting for the resistance scale; and so on. For convenience, a table of the main points is given.

R_2 may be about 12 yards of 40 SWG Eureka wire wound on a small strip of insulating material, and can also be adjusted to exact equality with R_1 on the

main bridge. Equality is not at all essential but gives the advantage that normally the main bridge is set at exactly 1, and the departure due to the resistance of the coil being tested can easily be observed.

The full circuit diagram of the adaptor is shown in Fig. 3, and the photographs

All the component parts are mounted on the underside of the top panel.



show how it can be laid out. Note that no pretensions to a high standard of instrument-making are claimed. But it serves the purpose. The four connections to the bridge may be merely wire ends which can be gripped by the crocodile clips marked in Fig. 3 (where the essentials of the original bridge circuit are also shown to make the arrangement quite clear).

Ratio on "R" scale	Corresponding calibration of R_1
0.16	1
0.22	2
0.32	4
0.50	10
0.71	20
1.00	40
1.58	100
2.24	200
3.16	400
5.0	1,000

To measure inductance with DC present, a battery and milliammeter are simply connected in series with the coil, as shown in Fig. 1. Usually it is not important that the DC should be accurately adjusted to some particular value, and tappings every

3 or even 6 volts are sufficient adjustment; and about 30 volts total is enough for most purposes. The bridge can take 100 mA. or even more for the short periods required for taking readings. To prevent part of the DC from passing through the primary of the LF45 transformer and reducing the sharpness of balance indication by saturating the core, a 25-mfd. electrolytic condenser is shown in Fig. 3. As only a portion of the DC passes through the transformer, the condenser would not be necessary if a large-

cored transformer were used. The "L" terminals must be marked to ensure that the polarising battery is connected the right way round for this

condenser. Strictly an electrolytic condenser should not be used on AC alone, but as the apparatus is normally always operated near balance the AC component through the electrolytic condenser is quite negligible.

As a Single Unit

Fig. 4 shows how things might be arranged if the inductance facility were built into the bridge. A double pole switch is shown for disconnecting the inductance arms when not in use, in addition to using a spare stud on the range switch, because although it would be possible to do without the extra switch there would be two disadvantages. The R_1 and R_2 arms connected permanently would somewhat reduce the source voltage available for resistance and capacity measurement. And it would be necessary either to dispense with the electrolytic condenser by using a non-saturating transformer or to use two 50 μ F condensers back to back, because a considerable alternating voltage would be applied to it during C and R measurement.

Another refinement is R_2 . The resist-

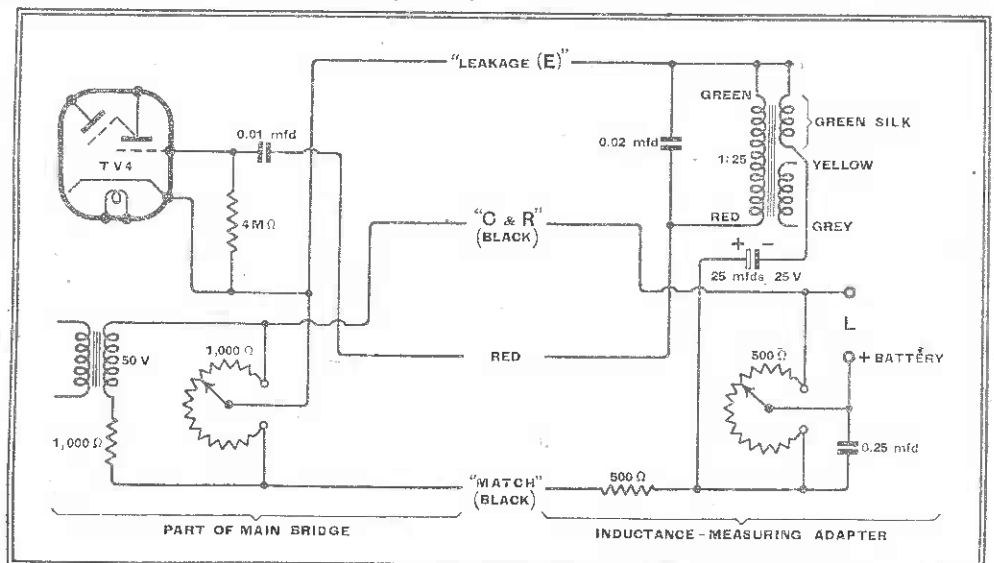


Fig. 3.—Full circuit diagram of the inductance-measuring device, showing how it is connected to the original C & R bridge. The 1:25 ratio transformer is a Bulgin Type LF45.

Measuring Iron-Cored Inductances—

ance balance is so sharp that it may be found difficult to adjust the main potentiometer finely enough. Adjustment is much easier if 10 or 15 ohms of the R2 arm is made variable.

The same difficulty is liable to arise in connection with R1, and some care must

cellent sharpness of balance possible with the "Magic Eye" indicator by using a larger and more precise component than that originally specified for the main potentiometer, the Reliance Manufacturing Company (Sutherland Road, London, E.17) have co-operated with the author in producing a 2½-in. diameter potentiometer

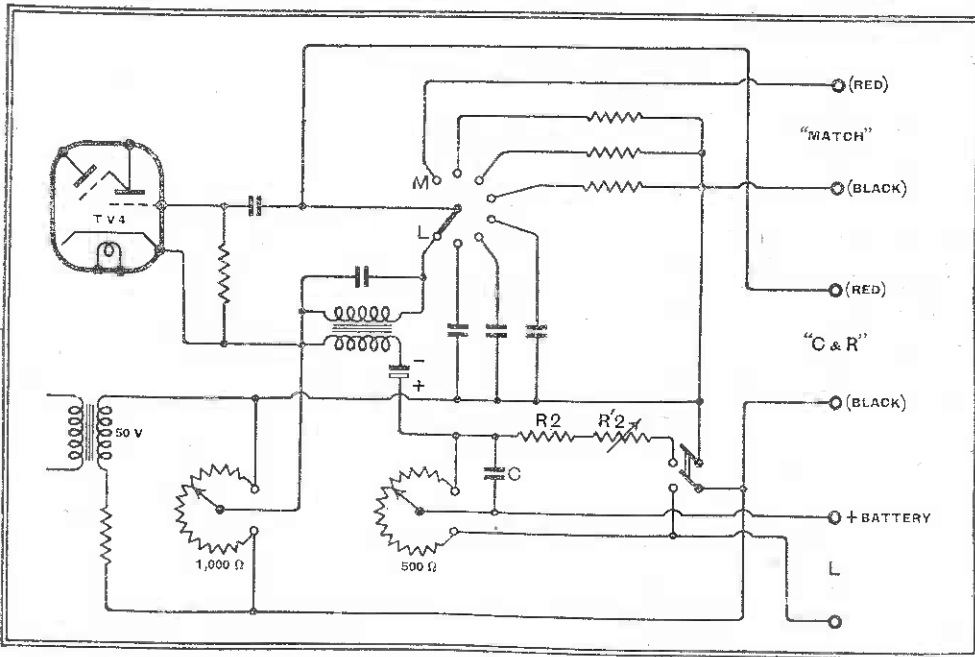


Fig. 4.—Showing how the inductance feature can be built into the original bridge circuit.

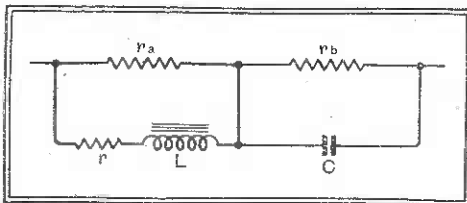
be devoted to the choice of this component. In an ordinary wire-wound 500-ohm potentiometer the resistance of one turn of wire is usually of the order of 2 ohms, and however good the sliding contact may be it is inevitable that while it is being adjusted the resistance of the whole potentiometer varies by this amount due to successive turns being short-circuited by the contact. The equality of the four bridge arm resistances, together with the 1:25 step-up to the detector, makes the bridge so sensitive to resistance balance that the inductance balance is seriously obscured by a resistance variation of the order mentioned. One solution of the difficulty is to use a suitable type of non-metallic potentiometer element. A 500-ohm type "P" linear carbon potentiometer made by the Morgan Crucible Co., Ltd. (Battersea Church Road, London, S.W.11) has been found to be satisfactory for this purpose, as the resistance alters to a negligible extent with small angular movements of the control. Carbon elements are, of course, not so stable in value as wire-wound, and vary with temperature; but unless heavy polarising current is passed through the ra portion for an unnecessary length of time the ratio of resistance (on which the calibration depends) ought not to alter enough to vitiate the readings, which are not of great precision in any case. And, of course, it is always possible to check the calibration quite easily against the main bridge potentiometer.

For the benefit of any who are not happy about composition elements in measuring apparatus, or who (with more reason) wish to take advantage of the ex-

meter with two-hole fixing (advisable in a calibrated component) designed for the lowest practicable resistance per turn, and fitted with a special steel contact shoe giving approximately radial line contact. It is, therefore, particularly suitable for measuring instruments.

APPENDIX.

DERIVATION OF FORMULA FOR INDUCTANCE.



The reactances of L and C respectively are $X_L = \omega L$ and $X_C = -\frac{1}{\omega C}$ (where $\omega = 2\pi f$). Then if r (the resistance of the coil) is neglected, the inductive reactance in series with ra that is equivalent to XL and r in parallel with it is

$$\frac{ra^2 X_L}{ra^2 + X_L^2}$$

If ra is small compared with XL, this simplifies to approximately $\frac{ra^2}{X_L}$. Similarly the equivalent series reactance of the condenser is approximately $-\frac{rb^2}{X_C}$.

When the bridge is balanced, the total reactance is zero, i.e., approximately

$$\frac{ra^2}{X_L} = \frac{rb^2}{X_C}$$

$$X_L = \left(\frac{ra}{rb}\right)^2 \cdot X_C$$

$$L = \left(\frac{ra}{rb}\right)^2 \cdot \frac{1}{\omega^2 C} = \left(\frac{ra}{rb}\right)^2 \cdot \frac{1}{4\pi^2 f^2 C}$$

ERROR DUE TO RESISTANCE OF COIL.

If r and L are transformed into equivalent parallel elements across ra, the equivalent parallel reactance, say XLI, is $\frac{r^2 + X_L^2}{X_L}$.

This is the apparent reactance of zero power factor (or resistance) giving the same balance on the bridge (neglecting the reduction in ra due to r, the parallel equivalent of r).

Therefore the factor by which L is apparently increased by the existence of r is

$$\frac{X_{LI}}{X_L} = \frac{X_L^2 + r^2}{X_L^2} = 1 + \frac{r^2}{X_L^2}$$

approximately $= 1 + (\text{power factor})^2$.

So if the power factor of the coil at 50 c/s is 0.1, the error due to resistance is only about 1 per cent. The power factor can be as much as 25 or 30 per cent before the error is serious for most practical purposes. Simultaneously a slight shift in resistance balance is necessary to compensate for the reduction in ra due to r.

Television Programmes

Sound 41.5 Mc/s. Vision 45 Mc/s.

The National or Regional programme will be radiated on 41.5 Mc/s from approximately 7.45 to 9 p.m. each day.

THURSDAY, JANUARY 12th.

3, 8th edition of "Re-View," songs and scenes from bygone shows. 3.30, 207th edition of Picture Page.

9, "Western Cabaret" 9.45, 208th edition of Picture Page. 10.15, News.

FRIDAY, JANUARY 13th.

3, Henry Hall and his Orchestra. 3.30, "O Mistress Mine," an anthology of love scenes.

9, Doorlay's Christmas Rocket. O.B. of the first act from the London Coliseum. 10.5, British Movietonews. 10.15, A Darts Match: B.B.C. v. Press Club. 10.30, News.

SATURDAY, JANUARY 14th.

3, C. H. Middleton 3.10, Cartoon Film. 3.15, Punch and Judy, by Hector F. Seager. 3.20, British Movietonews. 3.30, "Schubert Night," with Harold Child as Franz Schubert. 9, Bebe Daniels and Ben Lyon. 9.15, "Middle Class Murder," a play adapted from a novel by Bruce Hamilton. 10.45, News.

SUNDAY, JANUARY 15th.

3, O.B. from Watford Junction, L.M.S. Railway. 3.35, "La Meri,"—dances of all races. 8.50, News. 9.5, Talk. 9.20, Cartoon Film. 9.25-10.25, "Hansel and Gretel."

MONDAY, JANUARY 16th.

3-4.30, "Square Pegs," a comedy by Lionel Brown.

9, Guest Night—4. 9.30, Gaumont-British News. 9.40, Chopin Recital by Niedzielski. 9.50, Cartoon Film. 9.55, Demonstration of Catch-as-Catch-Can Wrestling. 10.10, News.

TUESDAY, JANUARY 17th.

3, Cabaret. 3.40, Gaumont-British News. 3.50, Talk by Reginald Arkell.

9, Speaking Personally—Laurence Housman. 9.10, British Movietonews. 9.20, "Bees on the Boat Deck," by J. B. Priestley. 10.20, News.

WEDNESDAY, JANUARY 18th.

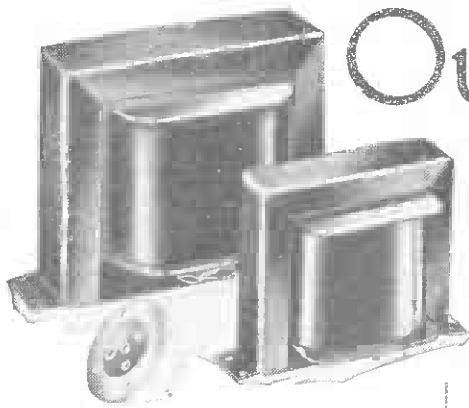
3, Friends from the Zoo, presented by David Seth-Smith. 3.15, British Movietonews. 3.25, Cartoon Film. 3.30, "La Chauve-Souris" in selections from their repertoire.

9, Bridge Demonstration, by winners of the Portland Club Cup. 9.10, Friends from the Zoo. 9.25, Cartoon Film. 9.30, "Re-View" (as on Thursday at 3 p.m.). 10, Gaumont-British News. 10.10, Segovia, guitar. 10.20, News.

Output Transformers

THE EFFECT OF RESISTANCE

By N. PARTRIDGE, B.Sc., A.M.I.E.E.



The DC resistance of the windings of the smaller transformer is twice as high as that of the larger.

AS the author points out, the classical formula commonly used in calculating the matching of a loud speaker to an output valve is at best an approximation, and as the effect of resistance in the matching transformer is not taken into account, may lead to appreciable errors.

THE output transformer has always been a favourite topic for discussion, especially amongst those who have an inclination towards high-quality reproduction. General knowledge on this subject can be summed up under two headings:—

(a) The response must be level, or nearly so, over the audible range of frequencies. This is attained by an adequate primary inductance and a minimum leakage inductance.

(b) The turns ratio must be adjusted to suit any particular case, and can be calculated from the formula:—

$$\text{Turns Ratio} = \frac{\sqrt{\text{Optimum Load of Output Stage}}}{\sqrt{\text{Speaker (or Load) Impedance}}} \dots (1)$$

To the majority of readers it will come as a mild shock to learn that a component in which the above conditions have been rigidly maintained can still be very inefficient, and that it may mis-match the output stage to a considerable extent.

The formula (1) for determining the ratio has been used so often and for so many years that one has ceased to bother about its origin. The tendency is to accept it as a mathematically exact statement whereas it is only an approximation, and a very rough one at that. To clarify the issue it will be necessary to go back to the beginning of transformer theory.

It can be proved that in the case of a

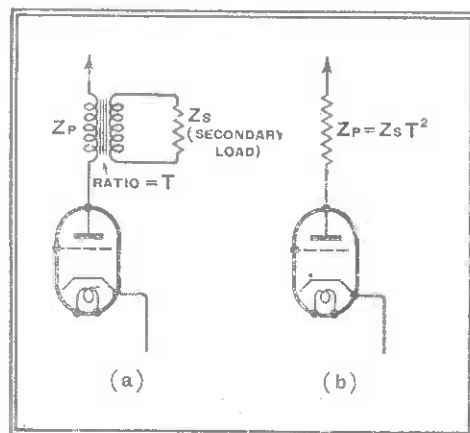


Fig. 1.—Output circuit with a perfect transformer: diagram (b) represents the equivalent circuit.

inductance and zero iron and copper losses the ratio of the primary and secondary voltages will be equal to the turns ratio. This relationship is exact, and can be relied upon to any number of significant figures.

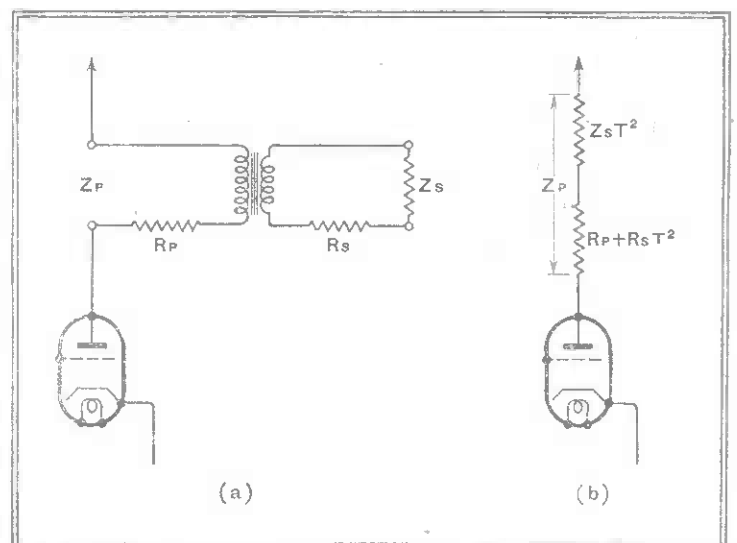
Since the hypothetical transformer has no losses the input power will be equal to the output power. It is therefore possible to deduce that:—

$$\text{Turns Ratio} = \frac{\sqrt{\text{Apparent Impedance of Primary}}}{\sqrt{\text{Impedance Connected to Secondary}}}$$

This statement is again a precise one since no approximations have been made so far.

However, a perfect transformer does not exist, and losses must occur in the process of transferring power from primary to secondary. The resistance

Fig. 2.—Illustrating a practical case; Fig. 1 has been modified by the inclusion of the inherent resistance of the transformer windings in the circuit.



of the windings is responsible for a large proportion of these losses in the average output transformer, and a study of its effect in practice is not without interest.

Equivalent Circuits

Consider the diagram of Fig. 1 (a). Let the ratio of the turns on the primary of the transformer to the turns on the secondary be T, and let a load of Zs ohms be connected to the secondary. If the transformer were perfect the secondary load would be reflected in the primary, increased or diminished in proportion to the square of the turns ratio. The valve in the anode of which the transformer is

operating would not distinguish between the arrangements of Fig. (a) and Fig. 1 (b), where the anode load is a simple impedance of ZsT² ohms.

Fig. 2 (a) shows a modified diagram in which the resistances of the windings have been included. The external secondary load has been called Zs as before, while Zp represents the primary impedance as measured across the primary terminals.

The corrected impedance in the secondary circuit is Zs + Rs, and the reflection of this in the primary will be (Zs + Rs)T². But we have Rp between the primary terminals in addition to the reflected load, and hence the actual impedance presented to the valve circuit will be:—

$$\begin{aligned} Z_p &= (Z_s + R_s)T^2 + R_p \\ &= Z_sT^2 + R_sT^2 + R_p \\ &= Z_sT^2 + (R_p + R_sT^2) \dots (2) \end{aligned}$$

The algebra is not very profound, but it serves to show how Zp can be split up into

two parts as illustrated in Fig. 2 (b). One part is the reflected load one would expect from a perfect transformer (ZsT²), and the other is the correction made necessary by the resistance of the windings (RsT² + Rp). The practical importance of this correction will depend entirely upon its magnitude compared with that of the uncorrected version. Before giving typical examples the theory can usefully be taken a stage further.

Rearranging formula (2) it can be shown that:—

$$T = \sqrt{\frac{Z_p - R_p}{Z_s + R_s}} \dots (3)$$

This means that in order to obtain a re-

theoretically perfect transformer with an infinite primary inductance, zero leakage

Output Transformers—

reflected load of Z_P between the primary terminals of an output transformer when a load of Z_S is connected to the secondary, the turns ratio must be calculated by (3) and *not* by (1) if account is to be taken of resistance losses.

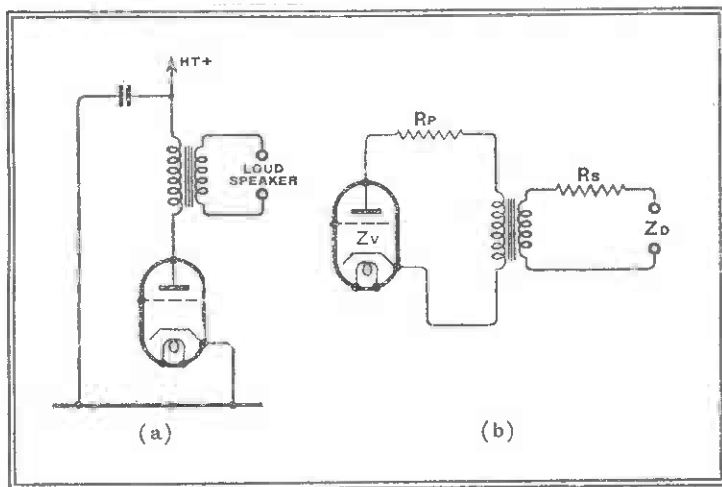
Another useful form in which the equation (2) can be written is:—

$$Z_S = \frac{Z_P - R_P}{T^2} - R_S \dots \dots \dots (4)$$

which gives the correct secondary load impedance when the valve optimum load (Z_P) turns ratio (T) and the resistance of the windings are known.

Turning again to Fig. 2(b), if we assume Z_S to be purely resistive and ignore iron losses, it is easy to see what proportion of the

Fig. 3.—The typical output stage of (a) has been rearranged in (b) for more convenient consideration of speaker damping.



output from the valve actually reaches the load (Z_S). The efficiency expressed as a percentage will be:—

$$\text{Efficiency} = \frac{Z_S T^2}{Z_S T^2 + (R_P + R_S T^2)} \% \dots \dots \dots (5)$$

Two examples will now be examined. The first a straight output transformer as shown in Figs. 1(a) and 2(a), and the second a push-pull type. It is to be expected that the former will prove inferior to the latter because the polarising current necessitates an air gap in the magnetic circuit which in turn will require more turns and consequently higher resistance to restore the inductance.

Example 1. The following figures have been taken from the catalogue of one of the better class component manufacturers. Ratio 1 : 1, primary resistance 380 ohms, secondary resistance 400 ohms, recommended for use with a valve having an optimum load of 2,500 ohms.

From the usual formula (1) it would be expected that a speaker of 2,500 ohms impedance would give the correct optimum load of 2,500 since the ratio is unity. But applying the corrected formula (2) we find that:—

$$Z_P = 2,500 \times T^2 + (400 \times T^2 + 380) = 3,280 \text{ ohms.}$$

Thus instead of the valve operating with a load of 2,500 ohms, as would ordinarily be assumed, its actual load is 3,280 ohms. The valve is mis-matched by 31 per cent.

Applying formula (4) we can calculate what speaker impedance should be used with this particular transformer to give the correct load of 2,500 ohms.

¹ Throughout these examples the speaker impedance has been treated as a pure resistance. Strictly, it should be represented by a complex quantity and the calculations performed vectorially, a process too complicated for the present purpose.

$$Z_S = \frac{2,500 - 400 \times T^2}{T^2} - 380 = 1,720 \text{ ohms.}$$

If a speaker of 1,720 ohms impedance is used so that the valve functions under the optimum condition the efficiency will be (from (5)):—

$$\text{Efficiency} = \frac{1,720 \times T^2}{1,720 \times T^2 + (380 + 400 \times T^2)} = 69\%.$$

Example 2. To illustrate how these figures work out in the most favourable circumstances, one could not do better

than turn to the now classic design published in *The Wireless World* of September 8th, 1933. Data as follows:—Ratio 25.8 : 1 (for 15-ohm speaker), resistance of primary (by calculation) 480 ohms, resistance of secondary (by calculation) 0.83 ohm, optimum load 10,000 ohms anode-to-anode.

Proceeding as before, the matching is correct if resistance is disregarded. Substituting in equation (2) the actual primary impedance is found to be 11,000 ohms. The valves are therefore mismatched by 10.3%.

The correct speaker impedance required to give an anode load of 10,000 ohms would be (from (4)) 13.5 ohms, and using a speaker of this value the efficiency would be 90%.

So far the transformer has been considered only as supplying power from the valve to the speaker. But very often the reverse process occurs. When a speaker resonates the valve acts as a shunt across it, absorbing power and hence damping the resonances. This aspect has received attention recently in connection with negative feed-back.

Fig. 3 (a) shows a typical output stage which is seen arranged in more convenient form in Fig. 3 (b). To determine the damping resistance Z_D across the speaker it is necessary to calculate first the reflected value of $Z_v + R_p$, Z_v being in this case the AC resistance of the valve (not its optimum load), and to add to this the resistance of the transformer secondary R_s which is in series with the reflected impedance:—

$$Z_D = \frac{Z_v + R_p}{T^2} + R_s \dots \dots \dots (6)$$

Using the figures given in the first numerical example above and taking the

Ferranti LP4 as the valve (AC resistance = 980 ohms) we obtain:—

$$Z_D = \frac{980 + 380}{T^2} + 400 = 1,760 \text{ ohms.}$$

Had the transformer been without resistance the AC impedance of the valve (980 ohms) would have been reflected directly across the speaker which would have been 2,500 ohms, and therefore shunted by 0.39 of its nominal impedance. In the practical case the damping resistance is increased to 1,760 ohms, and, as has been shown, the correct speaker impedance, is reduced to 1,720 ohms. The ratio of damping resistance to nominal impedance is approximately unity, or about 2½ times greater than formula (1) suggests: Damping will evidently be less efficient and resonances more noticeable.

It seems that resistance in an output transformer is undesirable on all counts, and that it should be kept as low as possible relative to the nominal impedances of the windings. Failing this inefficiency results, a correction must be made to the ratio as ordinarily calculated, and speaker damping is materially reduced.

A lower resistance means heavier gauge wire with greater bulk and higher cost. In connection with this the accompanying photograph is instructive. The two transformers illustrated are electrically identical in all respects except the resistance of the windings. The larger one is one-half of the resistance of the smaller one. The relative weights and costs are approximately in the proportion of 2 : 1 respectively.

The Radio and Telecommunications Engineer's Design Manual, by R. E. Blakely, D.Sc. Pp. 142+viii. Published by Sir Isaac Pitman and Sons, Ltd, Pitman House, Parker Street, Kingsway, London, W.C.2. Price 15s.

THIS is essentially a reference book and consists largely of tables and formulæ. It opens with a section dealing with attenuation methods, and the necessary formulæ for calculating the resistance values are given for potentiometers and for constant-impedance attenuators of the π and T types and the balanced π and T types, as well as the lattice kind. In addition to formulæ, tables of resistance values for various degrees of attenuation and impedance are given. RF attenuators are treated.

Further chapters deal similarly with air- and iron-core inductances, condensers and transformers. Audio-frequency sources are described and circuits are given of many types of beat-frequency oscillators. Radio-frequency oscillators then come under consideration and are followed by a short section on valve voltmeters. Valve-testing, bridges and factory test gear are included.

A surprising omission is any reference to the calculation of the coil inductance and padding condenser for the oscillator circuit of the superheterodyne, especially as the calculation of the plate shape for the special "superheterodyne type" gang condenser is dealt with.

In dealing with transformers, one or two errors occur in the formulæ. In equation (84) 10^{-5} should be 10^{-8} and equation (86) should be multiplied by 10^8 to obtain the correct answer. W. T. C.

The Amateur Transmitting Station

Part II.—CONSTRUCTION AND ADJUSTMENT OF THE CRYSTAL OSCILLATOR

Station

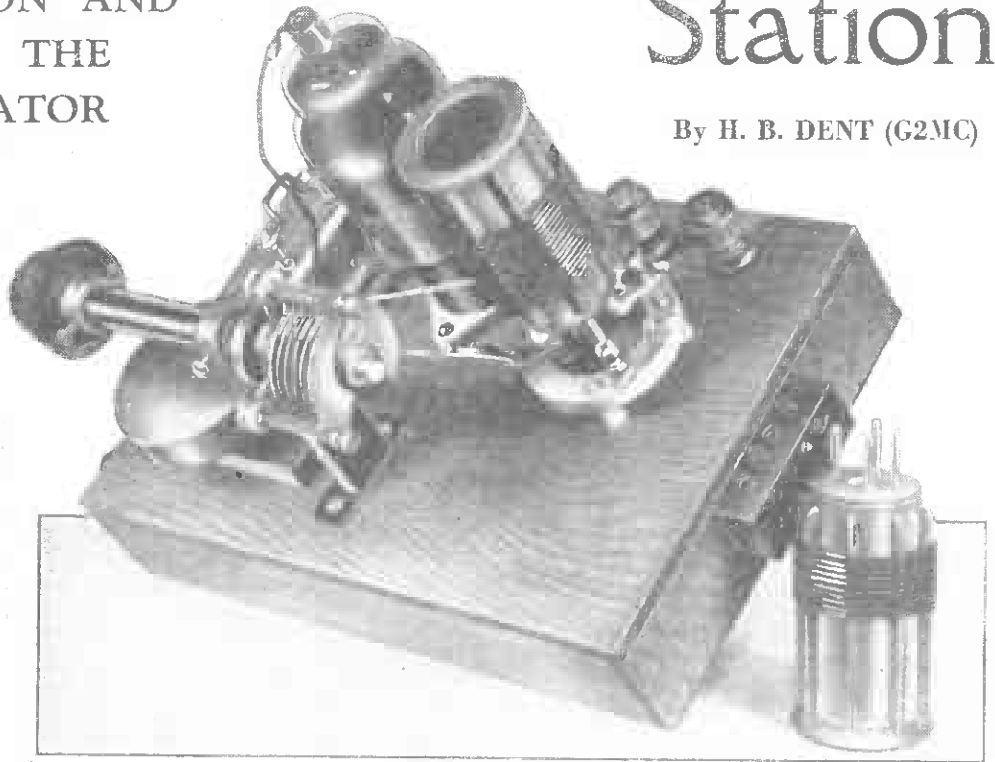
By H. B. DENT (G2MC)

HAVING discussed the requirements of the crystal oscillator and now reached a decision regarding the actual circuit that will be used, the next step is to put these ideas into practical form. First we have to find a suitable valve.

The circuit arrangement of Fig. 3 in Part I is generally known as the Tritet, and, as will be seen, makes use of a pentode valve. If it is to be used with the anode circuit always tuned to a harmonic of the crystal, any ordinary AF output pentode could be employed, and, provided the screen voltage is kept down to about 150 volts or so, and an eye kept on the flash lamp in series with the crystal when adjusting the cathode circuit, this type of valve is quite satisfactory as a low-power master oscillator.

Owing to the rather high anode/grid capacity of such valves special care has to be taken when the stage is operated with the anode circuit tuned to the fundamental frequency of the crystal, as the power in the grid circuit which is fed back via the anode/grid capacity of the valve may prove more than the crystal will handle with safety.

In a crystal oscillator that is to be used for fundamental as well as for harmonic operation, a valve with a low anode/grid capacity is preferable, but this need not be quite so small as in an RF pentode, and, provided it does not exceed about



*I*N the previous instalment the design of a crystal oscillator for controlling transmitter frequency was discussed. The present article describes the construction of the unit and gives detailed instructions for adjusting it for maximum RF output on both fundamental and second harmonic frequencies.

low-power transmitter and modulated for telephony transmissions applied to the suppressor grid. Quite a small modulator valve would thus serve for this purpose. In the crystal oscillator this grid is joined to the earth line and not to the cathode.

The circuit finally chosen for the crystal oscillator illustrated here is in all its essentials the same as Fig. 3 previously mentioned, the only difference being that two 0.1-mfd. mica condensers are joined from the heater pins on the valve-holder to the earth line, while plug and socket connections are employed for the cathode coil assembly. With these modifications the circuit takes the form of Fig. 4.

The oscillator could be built on either a metal or wooden chassis, the choice being left to the constructor. The writer has found wooden chassis generally more convenient, though less attractive in appearance, for experimental apparatus, as they are not only easier to make but changes in the position of components and additions are more quickly effected. When it comes to building a transmitter that is not likely to require any alteration, then a metal chassis can be used. So far as the writer's station is concerned this condition seems no nearer realisation than it was eighteen years ago, but that is possibly beside the point.

With regard to Fig. 4, it will be seen that the lamp, hitherto shown in series with the crystal, has been omitted, as with the Tungram APP4g valve the power in the grid circuit under the condition of operation shown never reached a value likely to prove harmful to the crystal.

This unit can be assembled on a chassis

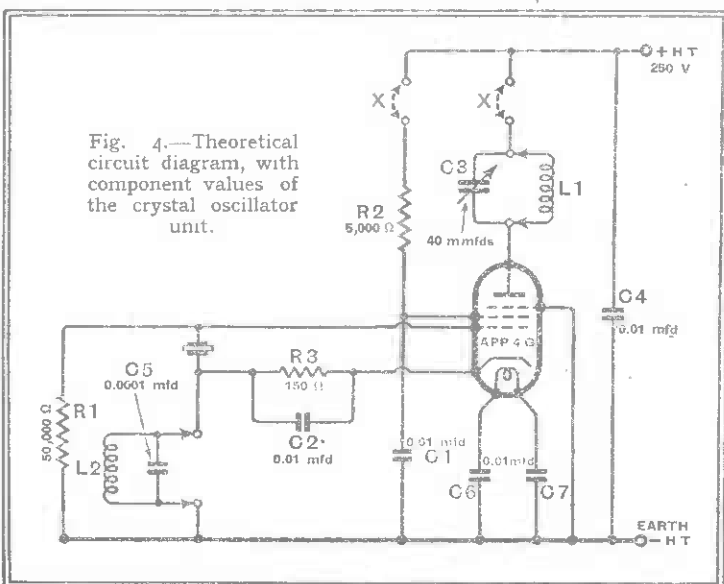


Fig. 4.—Theoretical circuit diagram, with component values of the crystal oscillator unit.

valve has a top grid connection, and is, in fact, designed for use in RF circuits of this and similar kinds. It has a four-volt heater, a standard 7-pin base, and the base connections conform with those of an RF pentode, not an AF pentode, which fact must be borne in mind when wiring up the valve-holder. Another interesting fact is that the suppressor grid is brought out to a

base pin, and not internally connected to the cathode, as in the ordinary AF pentode.

The advantage of this is that the valve could be used as the final amplifier in a

base pin, and not internally connected to the cathode, as in the ordinary AF pentode.

The Amateur Transmitting Station—

measuring 6in. x 9in. x 1½in. deep without crowding of the components. All the resistances and small fixed condensers are accommodated below the chassis, with the exception of R1, which was more conveniently mounted on top.

As its construction is perfectly simple and straightforward, a detailed description is unnecessary, but a little space might be given to the cathode coil assembly, L2, C5 of Fig. 4, and the coil L1 for fundamental and harmonic operation, also a few words regarding the crystal.

Crystal Frequency

So far as the crystal is concerned, a specimen ground for the 40-metre band is employed, its actual frequency being 7.12 Mc/s. Crystals for transmitters can be obtained either totally enclosed or mounted in an open-type holder. The former is to be preferred, and, although the totally enclosed holder costs a few shillings more than the open type, the extra expense is fully justified by the better condition in which the crystal is kept.

The choice of the crystal frequency is rather important, for, although the amateur wavebands are even multiples of each other, they are not all of the same width. Thus, it would be possible for a crystal to have its fundamental frequency in one waveband but with some of its even harmonics falling outside the edges of the higher frequency bands.

So far as the 7-Mc/s band is concerned, if we decide on a frequency somewhere between 7,020 and 7,150 kc/s, we may rest assured that all the even harmonics will fall well within the amateur bands with the exception of the five-metre one, for it appears that new licences now permit the use of 58.5 to 60 Mc/s only. A 7-Mc/s crystal with a harmonic in this ultra-short waveband would need to have a frequency between 7.31 and 7.5 Mc/s and this is outside

minated at the former but threaded through holes and brought out for connection to a small sub-base. This gives a coil of about 2.3 microhenrys inductance.

The sub-base consists of a strip of Trolitul 2½in. long x ¾in. wide x ¼in. thick, on which are mounted two Clix ½in. diameter coil pins. The sub-base is fixed to the Paxolin former by short lengths of 6BA screwed rod. A mica dielectric condenser of 100 mmfds. is included in the assembly and is soldered across the two ends of the coil just above where they join to the pins.

A strip of Trolitul of the same size used for the coil was employed for the base. This has two Clix sockets to fit the pins. The shorting plug to replace the coil assembly when a 40-metre output is required can be made up from another piece of Trolitul with two pins joined together by a length of wire.

Eddystone DL9 plug-in coil formers with the ribs threaded 14 t.p.i., this being the standard threading, were used for the 7- and 14-Mc/s anode coils.

For the former 17 turns of No. 18 SWG enamelled wire were used, but No. 20 SWG would probably answer just as well and will be easier to wind and thread through the base pins. This coil has an inductance of 8 microhenrys.

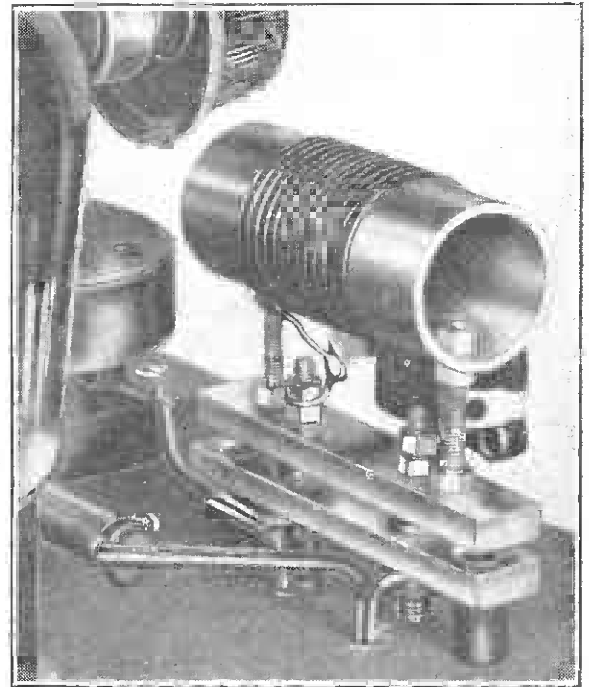
The 14-Mc/s coil is wound on a similar former, its inductance being 3½ microhenrys, and the winding consists of ten turns of No. 18 or No. 20 SWG enamelled wire. The turn spacing is, of course, 14 t.p.i. in both cases.

Terminals are included in both the screen grid and anode circuit HT supply leads so that the currents flowing in these

circuits may be measured and the performance of the oscillator checked from time to time. Of course, sockets or jacks, according to one's particular preference, could

of the crystal, the screen current will then be found actually to exceed the anode current.

This condition will not necessarily give the greatest RF output, and often the oscillator shows signs of instability, for if a load, such as an absorption wavemeter or a loop with a lamp in series, is coupled to



Close-up of the plug-in cathode coil-condenser assembly, comprising L2 and C5.

L1, C3, the extra capacity thrown across the circuit by the proximity of the external circuit will cause the valve to stop oscillating.

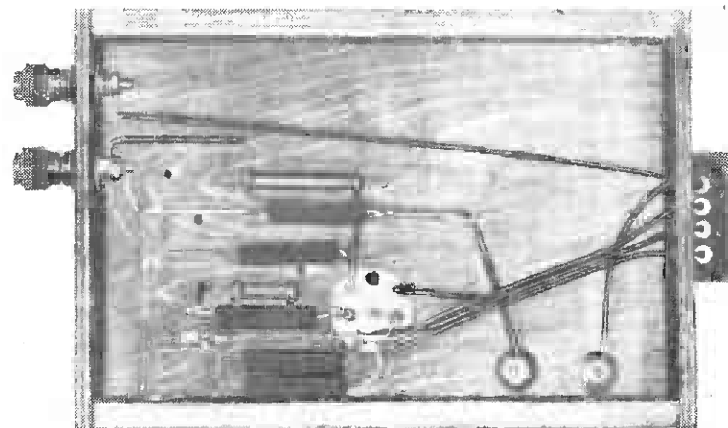
The best adjustment is when L1, C3 is tuned to a slightly higher frequency and with the anode circuit passing between 12 and 15 mA, the screen circuit meter reading between 8 and 9 mA. This, of course, with no power taken from the anode circuit.

Now, when power is taken from the anode circuit, there will be an increase in the anode current, and a few experiments will show that this increase depends on the amount of RF energy extracted from the anode circuit. If an absorption wavemeter be used, various degrees of loading can be effected by tightening and loosening the coupling, and it will be instructive to notice the effect these changes have on both the anode and screen currents.

The current circulating in the external load circuit will be more than an ordinary flash lamp will stand, so that when maximum loading tests are being carried out, a larger lamp, such as a 3-watt car bulb, should be used.

Having found all one needs to know for the time being with the 40-metre coil in L1 position, the tests can be repeated with the valve functioning as an oscillator-doubler. The cathode coil unit is inserted and the 20-metre coil fitted in the anode circuit.

It will now be found that the screen and anode currents have changed slightly in value, the anode current having increased to about 17 mA, while the screen current



Underside views of the crystal oscillator unit; all resistors and fixed condensers are mounted below the baseboard.

the limits of the 7-Mc/s amateur allotment.

The plug-in cathode coil unit L2, C5 (Fig. 4), consists of a Paxolin former 2in. long and ¾in. in diameter, having 13 turns of No. 20 SWG enamelled wire, spaced to occupy a length of one inch, this spacing being equal to the diameter of the wire. The turns are held in position by a spot of Duofix under each turn as the winding is put on. The ends of the coil are not ter-

be employed just as well for this purpose.

With L2, C5 removed and the shorting bar in its place, and the 40-metre coil plugged into L1 position, the anode current of the valve when not oscillating is about 30 mA. Its screen current is 4 to 5 mA. When oscillation starts, the anode current falls to 12 mA, and it can be reduced to a very few milliamps, if L1, C3 is tuned exactly to the resonant frequency

The Amateur Transmitting Station

has fallen to between 5 and 6 mA. These are only approximate values, as they will vary slightly with different valves.

Another point that will be noticed is that the RF output is not appreciably less on 20 metres than it was on 40 metres, showing that this circuit is a particularly efficient one for second harmonic generation.

Now, with a lamp in the wavemeter capable of handling the full RF output, the coupling should be progressively tightened while the lamp brilliancy is being observed. It will be seen that up to a certain point the brilliancy increases with coupling, but beyond this point it begins to decrease, and if the coupling can be made tight enough the valve will stop oscillating.

There is, therefore, an optimum coupling for maximum RF output, a fact that should be borne in mind when later coupling the oscillator to the power amplifier or any intermediate stages that may be used.

These tests will prove very instructive and enable a thorough understanding of the operation and adjustment of this part of the equipment to be obtained. Thus, the beginner should not be in too great a hurry to get the transmitter into action, for the time devoted to these early experiments will be well repaid in the end, as it will result in a high standard of efficiency in the finished transmitter.

Random Radiations

Ingenious

AN American set that I have recently tested contains a useful arrangement which I don't remember seeing before. It is a communication receiver and it must, therefore, be designed for use in all emergencies. Should the AC mains supply give out it can be worked from stand-by batteries in a very simple way. The cable normally connecting the power pack to the receiver proper is removed, and in its place a second eight-way colour-coded cable is attached. The set can now be operated direct from a 6-volt LT accumulator and either a primary or a secondary high-tension battery of 270 volts. This strikes me as an idea that might very well be adopted by other firms which make sets with separate power units. It is always useful to know that batteries can be pressed into service if mains supplies give out—or if you want to work the set in a place where there is no source of AC.

Steel Tapes at Home

"WHAT a pity it is," writes a South Elmsall reader, "that the steel-tape method of recording cannot be made a cheap, commercial proposition. Think of the advantages of being able to record automatically by means of a time switch a programme to which you weren't able to listen direct. You could then play it over at your leisure at another convenient hour. There may, of course," he adds, "be snags of which I'm not aware." I am afraid that there are, for any kind of steel-tape recording apparatus capable of giving worth-while

Parts for the Crystal Unit

- 1 7-pin chassis valveholder Eddystone No. 1075
- 1 4-pin baseboard valveholder Eddystone No. 949
- 1 Variable condenser 40 m-mfd., C3 Eddystone No. 1129 or Premier Tto 40T.
- 1 Insulated adjustable condenser bracket Eddystone No. 1007
- 2 Four-pin 1½ in. diameter 8-ribbed formers, threaded ¼ in. t.p.i. Eddystone No. 936
- 5 0.01 mfd. fixed mica condensers, C1, C2, C4, C6, C7 Dubilier Type 691W or T.C.C. Type M
- 1 5,000 ohms resistance, 1 watt, R2
- 1 50,000 ohms resistance, 1 watt, R1
- 1 150 ohms resistance, ½ watt, R3 Erie, Dubilier or Bulgin
- 1 0.0001 mfd. fixed mica condenser, C5 Dubilier Type 690W or T.C.C. Type M
- 1 Quartz crystal and holder, enclosed type Quartz Crystal Co.
- 1 Extension spindle
- 1 Knob
- 1 Chassis (½ in. plywood) 6×9×1½ in.
- 4 Insulated terminals Belling Lee Type "B"
- 1 Four-way connector Bryce
- 1 Length Paxoline tube 2 in. long×½ in. outside diameter
- 1 Valve top connector Clix
- 2 ½ in. inside diameter sockets Clix
- 4 ½ in. resilient pins, ends screwed 6BA Clix
- 2 Pieces of Troital 2½×¾×¼ in. Premier Small quantity No. 18 SWG En., No. 20 SWG En., No. 16 SWG tinned copper wire, screws and insulated sleeving
- 1 APP4g valve Tungram

By "DIALLIST"

results must be a large, elaborate and expensive affair. It is, of course, possible that some much simpler method will be evolved, but at present this kind of recorder is certainly not suitable for becoming part of the domestic equipment. I have an idea that there's another snag, too; I am not sure that you can legally record any of the B.B.C.'s programmes, at any rate for subsequent reproduction.

Hearing is Believing

Many of us, though, have probably used recordings of some kind to convince sceptical friends that we have really accomplished the marvellous feats that we recounted in the days when wireless was young. I can remember being flatly disbelieved when I told friends long before the days of short-wave broadcasting that I'd heard speech and music from the United States on my receiver. As the thing could then be done only in the chilly winter small hours, one couldn't induce them to come and hear for themselves. In self-defence I made some recordings with the dictaphone, and with the help of these was able to re-establish my reputation for veracity.

The Electron Microscope

YEARS ago I remember hearing an enthusiastic radio man prophesy that one day we should obtain from telescopes and micro-

scopes a vastly greater amount of magnification than lenses can produce, by using electron tubes and valve amplifiers. And now comes the news from America that the thing has been done by Dr. Zworykin, whose name is familiar to all who follow the progress of radio. As yet I've had no technical details, but the newspaper reports say that at a recent demonstration by two scientists minute objects such as certain of the smallest microbes were shown magnified to a degree far beyond anything that the most powerful microscope can accomplish. It is stated that a single atom was shown as a circular patch about an inch in diameter, but I find it difficult to believe that can have been just one atom—it may have been one of the larger molecules. One infers from the report that a cathode-ray tube was used and that the images were projected on to its fluorescent screen just as they are in a television. Dr. Zworykin is said to have stated his belief that he had not yet approached the possible limits of magnification and that there was no saying how far the human eye might not be enabled to probe by electronic methods into the world of almost infinitesimally minute things that has hitherto been beyond its ken.

What They Do for Us

VACUUM tubes are already doing astonishing things for us in ordinary life and in industry. The work that they do in the industrial field is very little known except by specialists responsible for developments in that direction. Would you have believed, for instance, that the photo-cell and the valve amplifier play an important part in the high-speed manufacture of paper bags? Into the bag-making machine is fed a roll of paper already printed at the right intervals with the lettering that is to appear on the bag. The machine folds the paper into a tube, cuts off the length needed for each bag and snips, folds and pastes in the ends. One big difficulty in the past was to make the cutters work always at the right instant. The paper, you see, might stretch or "creep," with the result that after a bit bags began to be turned out with the lettering all astray. The problem was solved by printing a spot at exactly the place where the cut should be made. The light focused on to a photo-cell is intercepted by the spot and down come the cutters. They can't operate unless the paper is just in the right position.

Other Jobs, Too!

Sorting dried beans at almost incredible speeds, testing fixed resistors and condensers in the factory and rejecting those which are either above or below the tolerance limits, controlling the machines which wind the finest wire on to reels at a speed of nearly a mile a minute, regulating the temperature and the humidity of factories, grading cigars according to their colour, bringing huge crucibles of molten metal to rest within a fraction of an inch of the proper spot for pouring, and matching colours far more exactly than any human eye can do the job are just a few of the tasks that the valve, with or without the photo-cell to aid it, now does for us. Little did Crookes, Fleming, de Forest and others concerned with the early history of the vacuum tube and the valve realise what their discoveries were going to give to humanity in the years to come.

"The Monitor"

BY THE RESEARCH DEPT., McMICHAEL RADIO LTD.

AN INSTRUMENT FOR GIVING AUTOMATIC INDICATION OF FREQUENCY DRIFT

TO maintain a high degree of tuned circuit stability has long been a desirable aim, and much development work has been expended in this direction. With the introduction of push-button receivers, and especially those incorporating signal-seeking circuits, this aim is no longer desirable but essential.

Once the operation of setting up the receiver to a given frequency has been concluded, that frequency must be held to within a few hundred cycles, irrespective of temperature or humidity variation. Even the normal "warming-up" drift must be controlled to within these limits. Apart from the variations that could take place due to mechanical shock or vibration, temperature is the controlling factor of frequency drift.

Under normal conditions, and provided reasonable care is taken with the disposition of the essential components, the variation of inductance with temperature is only of importance to designers of precision high-frequency measuring apparatus. The problem that confronts the designing of a commercial radio receiver is the change of capacity with temperature.

A recent article¹ described certain of these changes in detail. It also referred to the method generally adopted for measuring the oscillator frequency drift on a complete receiver, namely, to beat

¹ "Temperature and Humidity," by A. W. Scott, *The Wireless World*, September 29th, 1938.

AFTER frequency stability in a receiver has been achieved by suitable design, it is still necessary to see that models as they leave the production line maintain the required standard. Time tests over long periods can be made without constant attention by means of the simple piece of apparatus described in this article.

the output of the receiver oscillator against the fundamental or harmonic of a crystal oscillator and measure the change in the beat frequency that takes place as the receiver warms up.

To be of any real value these results must be noted over a time cycle of at least four hours, preferably longer, and a number of such runs must be made in order to obtain the mean.

The measurement of "drift" in the intermediate frequency circuits of the receiver is not quite such a straightforward matter. It is well known that change in the tuning capacity of these circuits results in an asymmetric response curve or, if a signal of known frequency stability is injected, in a variation of the output voltage.

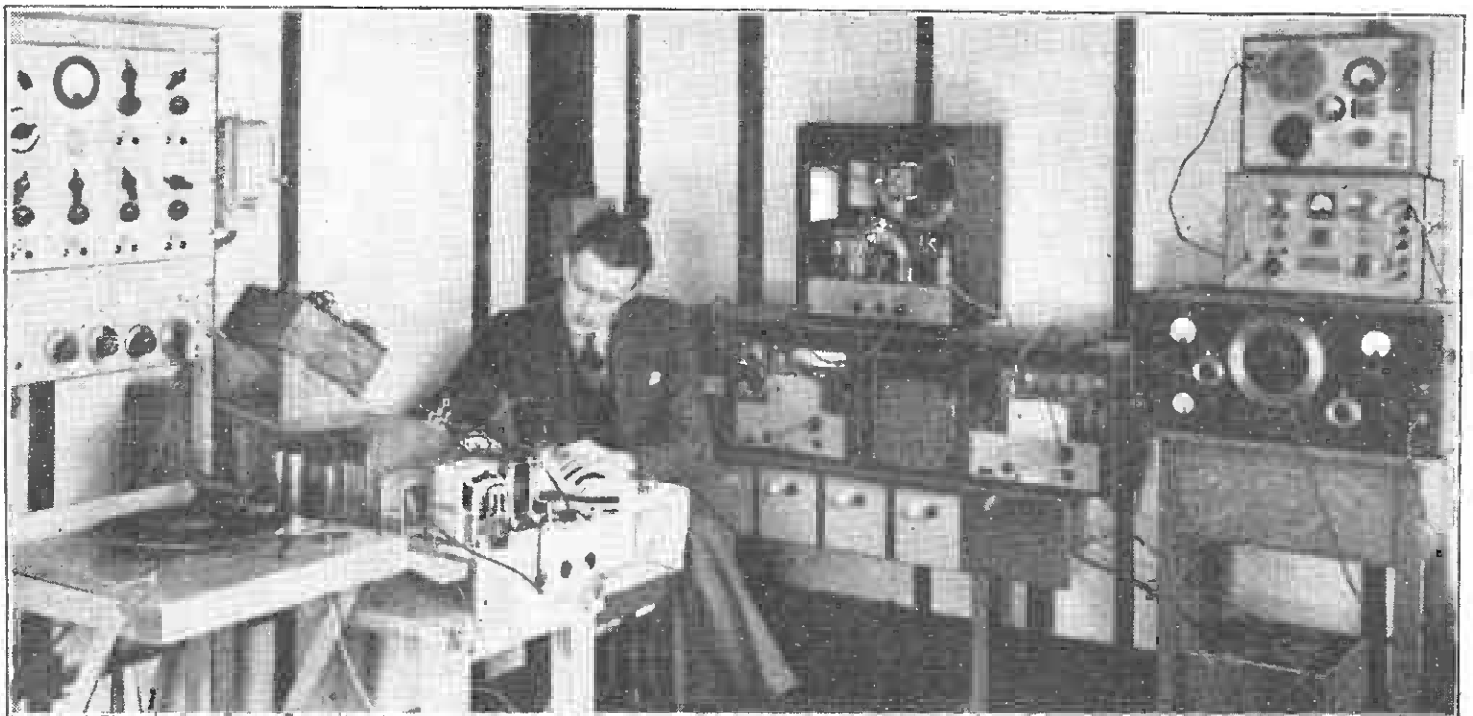
To measure this change, therefore, a signal of known stability must be injected, and the change in frequency of

the input signal necessary to correct for the variations in the output voltage plotted against the time cycle. Alternatively, the "top" of the response curve could be plotted at given intervals of time. This latter method is extremely tedious, as anyone who has plotted response curves will agree, and unless extreme care is taken, repeat curves under identical conditions can show more variation than can be produced by the most wayward condenser.

A further method is to disconnect the trimming condensers from their respective inductances, and, as the receiver warms up, to measure the change of capacity *in situ*. Knowing the percentage change of capacity, the change in the intermediate frequency circuits can then be predicted.

All these methods are extremely tedious and entail many weeks of labour. Nevertheless, this work must be carried out if the completed receiver is to function satisfactorily in service.

The problem becomes really terrifying (to the engineer allocated to the job) when it is realised that these checks must also be carried out on a certain percentage of the production models, in order to ensure that the degree of stability originally determined is being held. It was the vision of the laboratory gradually being submerged under an ever-increasing number of receivers awaiting test that led to the development of "The Monitor."



Four "monitors" in action in the laboratory. The panels are let into the front of the bench immediately behind the observer and each is fitted with a pilot light. On the right is the signal generator with stabilised power supply and wavemeter for checking kilocycles off tune.

The "Monitor"—

It was decided that some method must be devised whereby a complete receiver could be switched on for the given time cycle, and that if during that period the frequency drift of either the oscillator or the intermediate circuits increased beyond permissible limits, some automatic indication should be given.

The most promising line of attack seemed to be to make use of the variation in output that results from "drift," and the circuit shown in Fig. 1 was finally developed. The operation of this circuit is not immediately obvious, and it has, therefore, been divided into two essential parts and redrawn in Figs. 2 and 3.

Dealing first with Fig. 2, it will be seen from this that V2 is used in a bridge circuit, with the anode load and the potentiometer across the HT supply, as the remaining arms, the relay taking the place of the more usual galvanometer.

Bridge Stability

The resistance arms of the bridge are fixed in value, and so balance can only be obtained by adjusting the valve impedance. The obvious method of varying the valve impedance is to vary the initial potential on its grid, and use is made of the volts developed across R6. This voltage is negative with respect to the cathode, and is applied to the grid via the high resistance potentiometer, R3. Under the conditions of balance the relay is inoperative, but so soon as the valve impedance is varied, an out-of-balance current flows through the relay and causes it to operate. In order that no unstable operation should take place, the HT potentiometer, formed by R4, R5, R6, was arranged to carry a current drain of some 48 mA. (The total HT current is 52 mA.). It is, therefore, entirely independent of any anode current variations of V2.

Referring to Fig. 3, it will be seen that an audio-frequency input applied across the primary or the transformer is fed via the secondary to the diode rectifier, V1, the rectified signal appearing across the load resistance, R2. The voltage across

the load resistance can be stepped up by increasing the ratio of the input transformer, and may rise to quite a high value, 100 volts or more. To prevent any

signal has increased or decreased in amplitude; the valve impedance is changed, and so by upsetting the balance of the "bridge" operates the relay.

It will be seen that this device is dependent on the amplitude of the change from the steady state and not on the ratio of change. The sensitivity can be varied by changing the ratio of the input transformer or by controlling the amplitude of the input signal. For example, an input of 10 volts which varied in amplitude to 9.4 volts could, by a 10:1 input transformer,

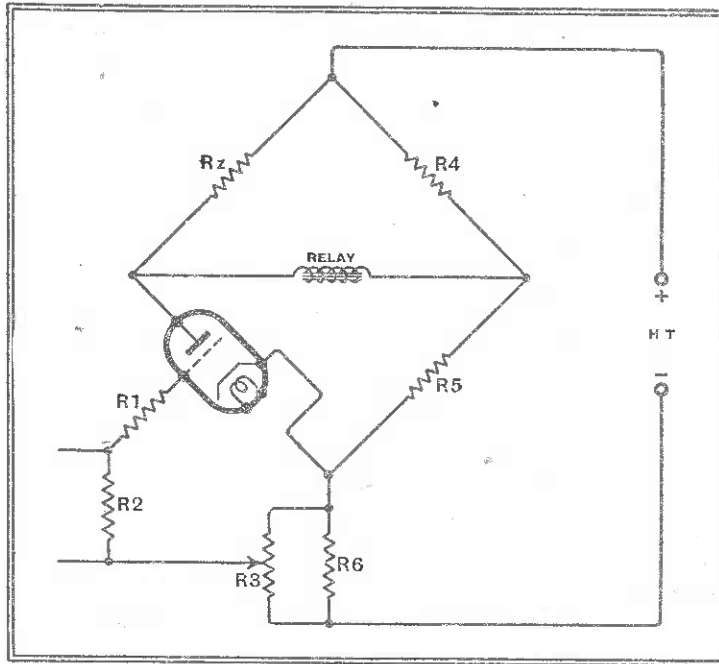


Fig. 2.—Schematic arrangement of second stage showing essential elements of the balanced circuit.

possibility of heater-cathode insulation troubles the diode has therefore been inverted and the cathode earthed.

As will be seen from Fig. 1, the voltage developed across the load resistance of the diode is also fed to the grid of V2, and is positive with respect to the cathode of V2. This voltage, therefore, tends to "back off" the negative voltage applied by R3.

In order to prevent any possibility of large positive voltages being developed on the grid of V2, a high resistance, R1, is connected in series, thus acting as a grid current limiter.

We have, therefore, a circuit, such that an AF voltage applied to the primary of the input transformer produces a positive voltage on the grid of the balanced valve. This positive voltage can be "backed off" by the application of negative volts until the valve impedance is such that the bridge balances. So long as the input voltage remains constant, the balance remains undisturbed.

Immediately the input voltage varies, the voltage across the grid-cathode of V2 becomes either less or more negative, dependent upon whether the input

produce a change in the rectified output of from 100 volts to 94 volts.

If this same voltage were attenuated by 6 db., the rectified output would change from 50 volts to 47 volts. Assuming that a change of 6 volts on the grid of V2 was required to operate the relay, then for

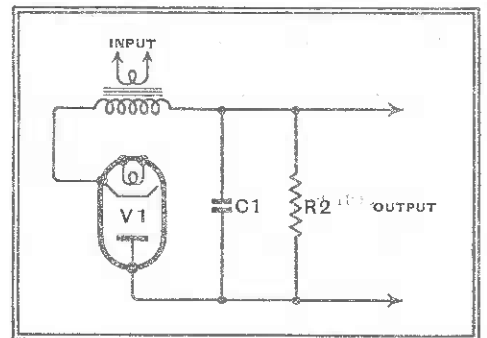


Fig. 3.—In the rectifier stage the diode is inverted to relieve the heater-cathode insulation of the high input voltage.

this new condition a change in the input of from 10 volts to 8.8 volts would be required.

In practice, a signal at the intermediate frequency, modulated at 400 cycles, is injected into the frequency-changer grid. The output from the receiver is picked up from the low impedance external loud speaker sockets and fed to the primary of the input transformer.

The volume control of the receiver and the bias potentiometer of the control tube are then adjusted so that the relay operates when the intermediate frequency drifts beyond the permissible limits, the setting of these two controls being readily checked by de-tuning the input signal the desired number of cycles off resonance.

With frequency drift of a very small magnitude, or when over-coupled high

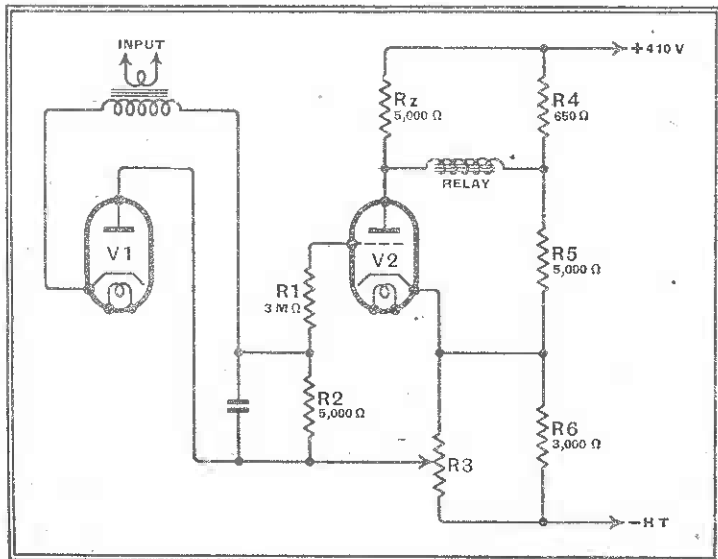


Fig. 1.—Complete circuit diagram of "The Monitor." The values are chosen to suit a Mazda Vg14 in the first stage and a Mazda AC/HL in the second. A relay having a resistance of 1,000 ohms and operating on 3 mA. is suitable.

The "Monitor"—

fidelity IF circuits are being observed, it has been found advisable to tune the input signal on to the side of the resonance curve, the slope of the curve providing very large changes in output for very small increments of frequency. By this means it is possible to adjust the device to respond to frequency differences of 100 cycles or so.

Checking Oscillator Drift

Frequency drift of the receiver oscillator is checked by injecting a signal frequency into the frequency changer grid, and again relying on the variations that are produced on the rectified intermediate frequency output voltage, due allowance being made for the variations that are produced by the IF circuits alone.

It must be remembered that this equipment was designed primarily for sample checking production receivers. For more precise work on oscillator frequency drift, it would be necessary to feed the intermediate frequency through a separate amplifier known to be highly stable, in order that any changes recorded could quite definitely be said to be due to the oscillator drift only.

The beauty of this instrument is that the receiver under test can be switched on, the instrument set up for the relay to operate by a deviation from resonance of a predetermined number of cycles, and no further attention given to it until the relay, operating either a bell or buzzer, gives notice that the receiver has drifted beyond the specified limits.

Another use for this instrument is the checking of receivers suffering from intermittent "fading." This particular fault is an extremely difficult one to diagnose, as quite often the receiver has to be run for some considerable number of hours before any loss of gain results. This means that the receiver must be left running on a programme and constant attention given to it. Quite often it happens that the fault will develop and

then rectify itself without the service engineer being aware of the fact.

When using "The Monitor" for this purpose, a signal of reasonable stability is injected into the aerial terminals of the receiver and the sensitivity adjusted, such that a change in the receiver gain of at least 3-4 db. is necessary before the relay operates. As soon as the gain increases or decreases above these limits, the relay will operate the warning signal.

The constants that are shown on the circuit diagram in Fig. 1 are the values that were found suitable for the particular tubes that were used and in order that standard components available from production receivers could be employed. Since the instrument functioned satisfactorily in this manner, no further work has been spent on development. There are, however, several modifications that immediately suggest themselves, but these are largely a matter of individual requirements and the components that may be available.

PROBLEM CORNER—2

Test Your Powers of Deduction

HERE is another of the many letters received by Henry Farrad from friends who are in difficulty with radio problems. Readers may care to test their powers of logical deduction by diagnosing the trouble from the information supplied.

The Hollies,
Sharpley, Herts.

Dear Farrad,

I have been having some trouble with my set lately. Unless there is a fairly strong station it sounds quite dead; weak stations are either missing altogether or distorted. And the volume control has become terribly noisy; I can hardly touch it without crashes from the loud speaker. The valve marked AC2/P2n (I don't know which one it is on the diagram) seems to get hotter than usual if I have been running it at full volume for a while. I enclose a circuit diagram I cut

out when this model was reviewed in *The Wireless World*.

Hoping you will be able to spot the trouble as usual,

Yours, ever,
John Frickton.

How did Henry Farrad trace the fault? Solution on p. 44.

News from the Clubs

Croydon Radio Society

Headquarters: St. Peter's Hall, Ledbury Road, South Croydon

Meetings: Tuesdays at 8 p.m.

Hon. Pub. Sec.: Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

Next Tuesday, January 17th, Mr. F. G. G. Davey, of E.M.G. Hand-Made Gramophones, Ltd., will lecture on "The Design of a Communication Receiver."

The fixture card for the second half of the present season will be available shortly.

Radio Physical and Television Society

Headquarters: 72a, North End Road, London, W.14.

Meetings: Fridays at 8.15 p.m.

Hon. Sec.: Mr. C. W. Edmunds, 15, Cambridge Road, North Harrow.

The first meeting of the second half of the season will be held to-morrow evening (Friday) at 8.15 p.m., when Dr. C. G. Lemon will lecture on "Surface Tension and Experiments in Bubble-Blowing."

Robert Blair Radio Society

Headquarters: Robert Blair L.C.C. School, Blundell Street, London, N.7.

Meetings: Wednesdays and Thursdays at 8 p.m.

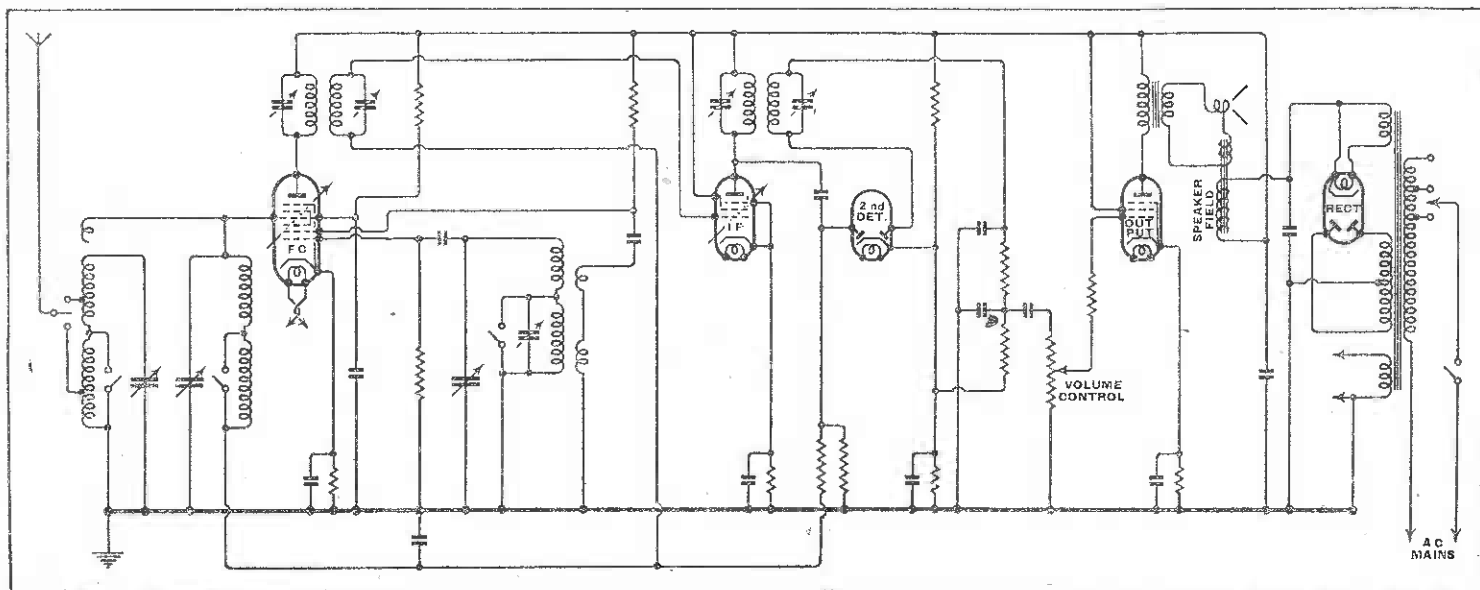
Hon. Sec.: Mr. W. H. C. Jennings, 82, Craven Park Road, London, N.15.

At the recent social the premises were packed to capacity. As a result of the satisfactory finances of the Society a test bench is under construction and cathode-ray apparatus is being acquired. An VA licence (2BYK) has been granted, and it is hoped eventually to have a full licence. The membership fee is 1/3 per term. Morse code classes are held.

The Wireless Industry

THE British wireless industry has been accused of apathy towards the overseas broadcast receiver market, but such reproaches clearly do not apply to the G.E.C. Mr. Roy Moxham, of that firm, has just completed a round-the-world tour of investigation into radio reception and market conditions, covering 56,000 miles in nearly a year.

With regard to the reference in our issue of December 29th, 1938, to "Cellophane," it should be made clear that the word is the registered trade mark of British Cellophane, Ltd., and not a generic term for transparent cellulose sheet.



The circuit diagram of John Frickton's receiver.

Big-Screen Television

A SCANNING "SHUTTER"

IN the standard type of television receiver the electron stream of a cathode-ray tube is used to build up the picture on a fluorescent screen, in light which is admittedly of a low order of brilliance. Attempts have, from time to time, been made to use the electron stream to better advantage, either by making it produce a brighter picture, or one which is not necessarily restricted in size by the dimensions of the cathode-ray tube.

For instance, it is possible to replace the fluorescent screen by a plate of metal which is made so thin that the impact of the scanning stream produces patches of incandescence representing the picture details. Since the intensity of incandescence is greater than that of fluorescence, a higher degree of optical enlargement can then be applied to the picture before it is projected on to the final viewing-screen.

Alternatively, instead of depending upon the scanning stream to create the light by which the picture is seen, it can be used to control the passage of light from an arc lamp or other independent source of high illumination. In this case the lamp and the viewing screen are both located outside the cathode-ray tube, so that they are not restricted by the size of the latter. A recent development on these lines is illustrated in the Figure (Patent 490981).

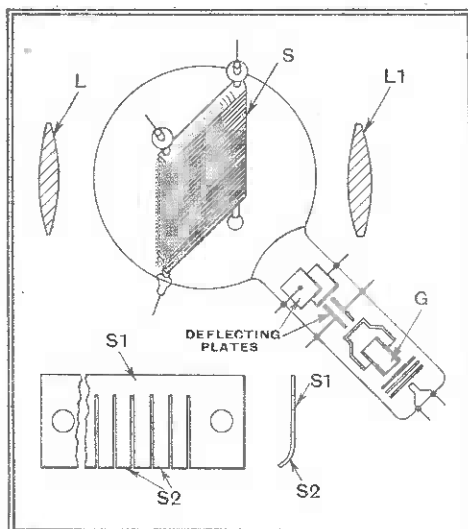
A powerful light from an external lamp is focused by a lens L on to a special form of "light shutter" S which takes the place of the usual fluorescent screen inside the cathode-ray tube. Under the action of the scanning stream from the gun G of the tube the "shutter" is periodically opened and closed to allow the passage of rays which correspond in intensity and position to the light values of the original picture. The emerging light is projected through a lens LI on to an external viewing-screen.

Venetian Blind Principle

The shutter S consists of a series of "bimetallic" strips which are strung over insulated spacing-pieces. As shown separately, each strip S1 is divided by transverse slits S2 which, in effect, resemble the prongs of a comb. The prongs of each comb are bent over at the end and slightly overlap the neighbouring comb, so that the arrangement resembles a Venetian blind or shutter which normally prevents the passage of any light.

The impact of the scanning stream of electrons from the gun of the tube serves to raise the temperature of the bimetallic shutter S from point to point. The resulting expansion causes each prong to curl outwards and to pass a certain amount of light through to the viewing-screen. The amount of light depends, of course, upon the force of the scanning

impact which, in turn, is controlled by the strength of signal applied to the control grid of the cathode-ray tube. The bimetallic strips are made sufficiently thin to respond promptly to small differences in temperature, and to cool down equally rapidly, within the time allowed by the framing frequency.



A television receiving system in which the scanning stream is caused to control the passage of light through a shutter.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Oscillation Nuisance—New Style

THE growing practice of listening to television sound seems to have one drawback, at any rate when the listening is done with the cruder type of receiver.

My reception of vision and sound has been spoiled several times lately by somebody searching for television sound signals with an oscillating receiver. The picture remains normal, but various patterns are superimposed on it.

P. SCALES

Wembley Hill.

Ignition Interference: A Plea for Voluntary Suppression

EVERYONE who has had experience of television appreciates the menace of interference, 90 per cent. of which is due to motor vehicles. It is probably the worst handicap to television expansion.

We have promises that Government department vehicles will soon be suppressed, and we hope that motor manufacturers will shortly follow suit voluntarily, without waiting for legislation. Can we in the radio industry help to make motorists suppression-conscious and spend a few shillings on their cars to help televiewers? We think we can. Anyway, it is always good to practice what we preach and do our own little bit to help start and push this ignition suppression snowball.

To this end we and other suppressor makers have decided to reduce the price of plug and distributor suppressors from a

small-quantity price of 2s. 6d. each to a mass-production list price of 1s. 6d. each. Next, we have issued a rule that every one of our representatives fits suppressors to his car, and, further, that suppressors are fitted by every employee who makes use of the firm's car park.

We have written to every dealer on our list within the television area urging them to fit suppressors to their service vans and to insist that every car belonging to the staff is suppressed.

We would like to make the following additional suggestions:—

That all manufacturers of television receivers insist that their staffs and representatives fit suppressors on their cars.

That they all press home the point with dealers.

That dealers be asked to drive home the point to their television customers, and to sell each customer a set of suppressors. By making the television user realise the importance of suppression they will talk about it to their neighbours, and so the campaign will spread.

We would also like the B.B.C. to issue a rule that all their vans and employees' cars are suppressed, and then tell the tale on the air, both from the B.B.C. and in picture form from Alexandra Palace.

If such a scheme as this was possible, and we cannot see why not, it is an essential point of it that where the fitting of car suppressors can be controlled that the long view be taken and everybody under the control be brought in; e.g., because some of our representatives work in Scotland, that is not taken as an excuse from fitting suppressors; their cars come to London now and then.

N. DUNDAS BRYCE,

Enfield.

Beiling and Lee, Ltd.

Short-range Fading

THE fading of the London National transmitter as experienced by your correspondents, Messrs. Clack and Drinkwater, is, I believe, fairly common knowledge.

Without having seen any very deep explanation for its behaviour, I have formed the opinion long enough ago to accept it as a conviction that the trouble is due to the synchronisation of the North with the London National.

On such comparatively high frequency it is reasonable to suppose that if one listened to North alone (assuming London not working) there would be quite a good deal of the usual type of fading and distortion after dark.

If, then, one made this an additive or subtractive effect in conjunction with the London station, it would naturally appear that London was the offender.

This may sound much too elementary an explanation, but it is so far the only one I know of that supplies a reasonable answer to what is a common occurrence.

Maidstone.

P. H. EARL.

REGARDING the correspondence on the above subject, I am deeply interested to note the very localised behaviour of reception.

After some years of experimental reception of distance on the 20-metre amateur band, I hold the view that, given normal ionosphere conditions, local variation of signals may, in many cases, be traced to the change of atomic structure within the area of the reception aerial.

Others, whilst admitting the scientific basis of this, prefer to think the effect negligible. F. G. H. MACRAE, F.R.S.A.
Potters Bar.

NEWS OF THE WEEK

NEW AERIALS FOR BOUND BROOK

Directional Changes by Press-button
THE greatly increased activity of the National Broadcasting Company of America in the field of international short-wave broadcasting is shown by the introduction of two new aerial systems for the 25-kW stations W3XAL and W3XL at Bound Brook. Using a principle known as "phase shifting," the N.B.C. engineers are constructing fixed aerials capable of swinging radio beams over South America through an angle of 20 degrees at the mere touch of a push-button.

It is estimated that the gain in signal strength provided by the new directional aerials will be fifteen times that of a non-directional aerial.

N.B.C.'s International Division, which is responsible for all transmissions destined for overseas, now broadcasts sixteen hours a day in six different languages through the two short-wave stations W3XAL and W3XL.

B.B.C.'s ADVICE TO EMPIRE LISTENERS

Valve Noise or Atmospheric?

THE B.B.C. is discovering that, although many overseas listeners have really up-to-date receivers, a large number are bewailing the perversity of atmospheric conditions because their sets are of early vintage.

The advantages of the 1939 short-wave receiver over its predecessors are being drawn to the attention of the Dominion and Colonial Press, and it is hoped that many of their readers will be persuaded to buy 1939 models.

Overseas listeners are being reminded that much of the noise which they attribute to atmospheric is introduced by the valves. In the latest valves this noise has been considerably reduced. Overall performance is being improved, too, by a further reduction in the small capacities between the valve electrodes. Selectivity, the B.B.C. points out to its overseas listeners, is being improved by the more general use of iron-cored IF transformers, and reproduction quality is enhanced by the use of negative feedback.

The B.B.C. engineers also advise those troubled by persistent interference to arrange the first tuned circuit of the receiver so as to permit the easy connection of a feeder-line from a remote or noise-reducing aerial.

ALUMINIUM TRANSMISSION CABLE

Reduces Losses to a Minimum

AMERICA'S first aluminium concentric aerial feeder cable is being installed at the N.B.C. station WTAM at Cleveland, Ohio. The conductor, regarded as an important improvement over wire lines suspended by poles, limits power radiation to the aerial itself, eliminating spurious radiation of harmonics from the transmission line. Energy loss due to heat generation has also been reduced to a minimum.

The cable, which is 460 feet in length, connects the transmitter building with the neighbouring aerial. Filled with compressed dry nitrogen gas to exclude moisture and maintain uniform characteristics, the cable rests on rollers to permit expansion or contraction. Although required to handle an output of only 50 kilowatts, the cable has a safety margin up to 1,200 kilowatts, which should keep transmission losses to a minimum. Outside diameter of the cable is 3½ inches, and the interior tubing is of half-inch diameter.

A new type of coupling does away with soldering and facilitates rapid repair work. Only 1,000 lb. of aluminium were required for the line, which would have needed 3,000 lb. of copper.

MERCHANT SHIPPING WIRELESS TELEGRAPHY

THE Board of Trade announce that revised Statutory Wireless Telegraphy Rules made on December 15th, 1938, came into force on January 1st and replace the previous Rules dated November 1st, 1932.

The changes in the requirements under the new Rules are of a technical character arising from the decisions of the International Telecommunications Conference which was held at

B.B.C. ENGINEERING

Sir Noel Ashbridge's Survey

A TRANSMITTER can now be so good that "nobody could tell by ear the difference between input and output," was one of the statements made by Sir Noel Ashbridge, Chief Engineer of the B.B.C., who on January 4th surveyed (in a paper read before the I.E.E.) some problems of broadcasting that have not yet been solved.

With regard to the selection of sites for broadcasting stations at least one important advance has been made. By a study of the subsoil it is at least possible, if not to say the site will be a good one, to say it will be bad!

Sir Noel expressed surprise that so few receivers have adequate provision for adjusting selectivity. Without it no set can at the same time do justice to the B.B.C.'s transmissions and be suitable for long-distance reception. He did not regard contrast expansion as likely to be satisfactory until the transmitters were automatically contracted; a measure of automatic contraction is already used at the B.B.C. Empire station.

Discussing the extension of the television service, Sir Noel favoured the use of cables rather than wireless links as more reliable, less clumsy, and, above all, occupying no other space.

SOUTH AFRICA ON THE SHORT WAVES

New ZRH and ZRK Schedules

THE South African Broadcasting Corporation recently commenced short-wave operations on a revised schedule and would be pleased to receive reception reports, which should be addressed to the Corporation, P.O. Box 4559, Johannesburg. Imperial reply coupons, or, in the case of countries outside the Empire, International coupons, should be enclosed.

The S.A.B.C. operate four short-wave stations, ZRH and ZRK with a power of 5 kW, ZRJ with 200 watts and ZRD with 300 watts. Station ZRH, which is situated at Robert's Heights, near Pretoria, works on the following schedule (G.M.T.):

	9.523 Mc/s (31.5 m.)	6.007 Mc/s (49.94 m.)
Sundays	10.30-12.00	14.00-17.00
Weekdays	10.00-12.30	17.15-20.15 04.45-05.50 15.00-20.30

The G.M.T. schedule of station ZRK, at Klipheuwel, near Cape Town, is:

	9.606 Mc/s (31.23 m.)	6.0975 Mc/s (49.2 m.)
Sundays	08.30-09.30 or 09.00-10.00 10.30-12.00	17.09-20.00
Weekdays	14.00-16.45 04.45-05.50 08.20-12.20 14.00-16.45	17.00-21.00

The schedules of the two low-power transmitters are not given, but the frequencies of ZRJ, near Johannesburg, are 6.0975 Mc/s (49.2 metres) and 6.007 Mc/s (49.94 metres), and those of ZRD, Durban, are 9.7529 Mc/s (30.75 metres) and 4.8764 Mc/s (61.5 metres).

THE FOREIGN LANGUAGE BULLETINS

FROM people living on the Continent we have heard already that the London Regional's seven o'clock news bulletins in French, German and Italian were attracting more and more attention



HOLLYWOOD BROADCASTING HOUSE of the N.B.C. where all operating activities are carried out on one floor level. Made possible by the large area of the site, the architectural layout of the four large auditoriums built side by side is strikingly apparent from the air. All roofs are aluminium coated for the reflection of the hot Californian sun rays.

News of the Week—

amongst foreign listeners. Further proof was forthcoming in the number of letters that the B.B.C. received from Germany asking for the time to be altered, since when given at seven o'clock the German bulletin clashed with the local one. It has now been altered to 7.15, which should be a better time.

The Italian bulletins were not well received in Italy on 342.1 metres. They are now to be given by GSA only on 49.59 metres (6.05 megacycles). The French and German bulletins will also go out from GSA, the former at 7 p.m. and the latter at 7.15 p.m.

N.P.L. RADIO DEPARTMENT

DR. R. L. SMITH-ROSE has been appointed Superintendent of the Radio Department of the National Physical Laboratory, which includes the Radio Research Station at Slough and the Department at Teddington. He joined the staff of the N.P.L. in 1919 as a member of the Electricity Department, and later formed the nucleus of the wireless division of that department, conducting investigations on thermionic valves, radio reception and direction finding. Later research has included the measurement of electrical constants of the ground and their influence on the propagation of waves—especially those below ten metres.

Following the formation of the Radio Department in 1933, Dr. Smith-Rose became Principal Scientific Officer under Mr. R. A. Watson Watt, who was Superintendent, and has been in charge of both the Teddington and Slough divisions of the Department since Mr. Watson Watt left in 1936.

PROF. E. V. APPLETON

THE KING has approved the appointment of Prof. E. V. Appleton as successor to Sir Frank Smith, who is retiring at the end of this month, as the Secretary of the Committee of the Privy Council for Scientific and Industrial Research.

Prof. Appleton, who is forty-six, is best known to *Wireless World* readers for his valuable and original work in the investigation of the upper atmosphere. He has, since 1936, been Jacksonian Professor of Natural Philosophy at Cambridge University, and is Chairman of the National Committee for Radio Telegraphy and President of the International Union for Scientific Radio Telegraphy.

Sir Frank Smith, who was awarded the G.B.E. in the New Year Honours, is relinquishing his post three years earlier than the compulsory retiring age of sixty-five, and we understand

that he is to become adviser on scientific research and develop-



Professor E. V. Appleton, D.Sc., LL.D., F.R.S.

ment to the Anglo-Iranian Oil Company.

**FROM ALL
QUARTERS****Italian People's Set**

A THREE-VALVE People's Set for medium-wave reception, costing 430 lire (app. £4 10s), is being manufactured in Italy as the result of a conference between "Radio-Rurale" Society, the Italian P.M.G. and Minister of Propaganda, the E.I.A.R. and manufacturers. This move is one more step in the drive to popularise wireless in Italy, where the total number of licences issued up to December 10th was 1,005,090. Of this number 5,060 are issued free to war-wounded and invalids.

Aberdeen Reduces Sound Bounce

A new departure in the orchestral studio in the B.B.C.'s new Glasgow Broadcasting House is the provision of an "inverted-V" roof, rising to a height of eleven feet above the ceiling level. Some 400 sq. ft. of the roof has been lined with rock-wool blankets an inch thick. An open-grille ceiling allows free passage for sound waves. The design aims at avoiding repeated reflection of sound between ceiling and floor.

Short Waves in Burma

FOLLOWING the success of the scheme in India of using the short waves for rural broadcasting, the Burma Government has erected a 10-kW station at Rangoon with the object of covering the whole country. It is at present testing on 49.94 metres.

Television in Italy

CONSTRUCTION was recently begun on Italy's first television transmitter, which, it is expected, will start test transmissions within the next two months. The transmitter is at Monte Mario, near Rome, where the experimental ultra-short-wave Rome station is built. Monte Mario is linked with the E.I.A.R. studios in Rome by cable, so that it will be possible to use these for the performance of the television programmes.

LICENCES IN INDIA

PIRATES, like the poor, are always with us, and not with us only, but in India, too, judging from the following extract from the latest issue of *The Indian Listener*:—

"After seeing some of his (the commentator's) correspondence which runs to some two hundred letters a day, we wonder once again, how many more radio sets there really are in the Bombay Presidency besides those twenty thousand on which licences are paid. Somehow or other, licences have got to be paid if Indian broadcasting is to succeed, and with that end in view All-India Radio will in the week beginning January 16th inaugurate the first of a series of anti-piracy drives with detector vans throughout India. We do not want prosecutions and fines; we only want licences to be paid."

"They say. What do they say...?"

"WHEN the first jump outwards can be made in television, I think there is little doubt that it will be to the Midlands."—Mr. F. W. Ogilvie, B.B.C. Director-General at the B.B.C. Exhibition at Leicester.

"The man in the street pays 10s. for his licence and gets about 1s. 6d. value for it"—Sir Thomas Beecham in the presence of Mr. F. W. Ogilvie at the Dinner of the Incorporated Society of Musicians.

"No pleasure can last several hours each day; for some people the radio ceases almost at once to become a pleasure and becomes a craving."—Dr. Georges Duhamel, Editor of *Mercure de France*.

Radio Relays

THE P.M.G. has announced that during a recent period of twelve months the number of subscribers to the broadcast relay exchanges in England increased by 2,130. They now represent 2.85 per cent. of the total number of wireless receiving licence holders, or about one in thirty-five.

I.E.E. Dinner

THE annual dinner and reunion of the Institution of Electrical Engineers will be held at Grosvenor House, London, on Thursday, February 9th.

Obituary

Mr. S. de Laszlo.—It is with regret that we record that Mr. Stephen de Laszlo passed away last Saturday, January 7th, as the result of injuries received in a motor accident on December 30th when his wife was killed. Mr. de Laszlo, who was thirty-three, was a director of Hivac and Celestion.

Mr. C. A. Hiscock.—The tragic death of Mr. C. A. Hiscock, who was found shot in his motor car at Hinxton (Cams), last week, is another serious loss to the world of radio. He was about forty and was a director of Invicta Radio, Our Radio and United Radio Manufacturers. He had recently been appointed a director of Pye Radio.

Sir John Reith's Present

ALTHOUGH Sir John Reith signified on his departure from Broadcasting House his unwillingness to accept a staff presentation, the B.B.C. Club considered itself to be at liberty to choose a farewell gift for its first President. The gift, which has been graciously accepted, is a Queen Anne design silver inkstand and cigarette box, with engravings of the old Savoy Hill headquarters and Broadcasting House on the lid.

Australian-American Radio Link

THE first conversation over the new direct wireless telephone link between Australia and the U.S.A. took place between Sir Ernest Fisk, at the Beam Wireless Office, Sydney, and the vice-president of the American Telephone and Telegraph Company, New York.

Isle of Man Radio Telegrams

WITH the object of obviating the delay which is at present experienced in sending messages to and from the Isle of Man, a Post Office Wireless Station is to be erected on the island at Crag-Na-Baa to supplement the submarine telephone cable and short-wave wireless telephony station.

Recording and the C.B.S.

By the purchase of the American Record Corporation the Columbia Broadcasting System of America takes over the manufacture and distribution of many well-known records, including Brunswick and Vocalion. The record exchange agreement with Columbia Graphophone Company and E.M.I. of London will be maintained.

Wireless for the Blind

FRENCH postal authorities have issued a new 90 centimes stamp which has a super tax of 25 centimes. Profits arising from the sale of this stamp will go to the French Wireless for the Blind Fund.

C.B.S. Network Expands

EIGHT new stations joined the C.B.S. network during 1938, bringing the total number of stations affiliated with the C.B.S. to one hundred and fifteen. More than fifty per cent. of these undertook extensive construction programmes which included increases of power and the installation of vertical-type aerials.

The Listeners' League

THE Listeners' League, which was incorporated the Wireless League, the Wireless Association of Great Britain, the Radio Association and the Listeners' Association, was wound up on December 29th. When notified of this, members were invited to join a new organisation, to be known as the Listeners' Service Bureau, which is being conducted by the Wireless Retailers' Association.

What Next?

THE recent reception of the Alexandria Palace television transmission in Guernsey, Channel Islands, has prompted a French Press Agency to issue the following:—

"This reception justifies the hope that very soon a good part of France will receive the television of the London station."

The Physical Society's

COMMERCIAL MEASURING INSTRUMENTS FOR RESEARCH, PRODUCTION AND SERVICING

Exhibition

A YEAR'S work in instrument design has produced not only detail refinements in standard laboratory signal generators but one or two special instruments devised for the production testing of push-button receivers and for development work in television apparatus. It would seem, however, that the greatest activity has been in connection with measuring instruments rather than "sources." In particular, a considerable increase in the number of valve-operated measuring instruments was noted, and cathode-ray methods of indication for bridges and zero adjustment in beat oscillators were widespread. Also, after a year or two of comparative stability in design, there were a surprising number of new moving coil pointer instruments and galvanometers.

The whole of the Cambridge Instrument Co.'s exhibit was devoted to meters and galvanometers. The well-known L type Unipivot series has undergone important changes in the magnet system which have resulted in a two- to four-fold increase of sensitivity. In the case of the new Type LY a current of only $6 \mu\text{A}$ is required for full-scale deflection. Only slightly less sensitive is the Type LX, which gives full-scale deflection for $10 \mu\text{A}$ with a 1,000-ohm coil and a $100 \mu\text{A}$ with a 10 ohm coil. Another new instrument is the Type T, which is a double-pivot version of the Unipivot galvanometer, and is designed for high accuracy as a portable sub-standard.

Many of the Cambridge moving-coil instruments are now fitted with magnetic cushioning. The pivots are mounted in a brass spindle passing through the soft-iron cylindrical centre pole of the meter. At each end of the tube is fixed an iron disc which causes the coil assembly to float in the field of the permanent magnet. By this means shocks in a vertical direction, such as might be given when the meter is placed on a table, are absorbed without affecting the alignment of the coil in the air gap.

Improvements in magnetic alloys have also resulted in the production of a permanent-magnet Einthoven string galvanometer, which is only a fraction of the size of the original electro-magnetic type. The fibre case is accurately interchangeable and

frequencies of 50, 100, 800 and 1,000 c/s. Mechanical tuning is possible over a range of a few cycles, and a remote twenty-point tuning and sensitivity control is available. The 50-cycle model is also produced in a form known as the "Spot" galvanometer in a metal case with self-contained lamp



Avo low-capacity Ohmmeter.

and scale. The sensitivity is 15 mm per μA and the mechanical tuning range is $\pm 5 \text{ c/s}$.

The optical system in the Tinsley portable galvanometer, with self-contained lamp and scale, has been improved, and the taut-suspension galvanometer has been redesigned and has been given a seven-fold increase of sensitivity. It can be supplied in a neat cast metal housing or without its case for incorporation in test apparatus.

Another useful self-contained galvanometer was to be seen on the stand of British Physical Laboratories. The scale of this instrument is mounted inside the wooden box and is viewed through a long mirror



Salford Thermionic Test Set.

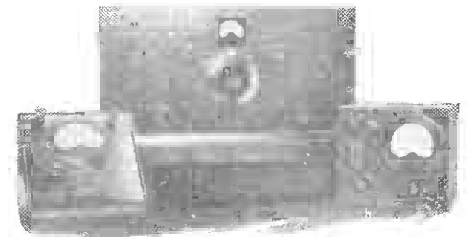
near the lower edge. With this system the relative illumination of the light spot and scale is independent of the light intensity in the room. Another advantage is that the scale is at table level, and there is thus much less fatigue in taking a series of readings when the galvanometer is used in association with other instruments of the horizontal type.

Multi-range moving-coil instruments for the service-man were well in evidence, and included the well-known Weston E772 analyser, the Avo series, and a range by Clough Brengle, shown by Leland Instruments. Among the latter the Type 120 (20,000 ohms per volt) is a good example. There was also a new model, the Type 185 (2,000 ohms per volt) which included a range for the measurement of capacities.

A new Avo instrument of special interest

THE twenty-ninth annual exhibition of scientific instruments and apparatus was held under the auspices of The Physical Society at the Imperial College of Science and Technology, South Kensington, on January 3rd, 4th and 5th.

to service-men and others is the low-capacity Ohmmeter. It is similar in size to the DC Avominor, and has two ranges of 0-20 and 0-500 ohms. The scale graduation is expanded towards the zero end, and at the lower range half-deflection corresponds to about 2 ohms, so that it is possible to estimate resistances down to approximately 0.1 ohm. The principle of operation is interesting, and it involves the use of a meter with a right-hand zero. Thus zero resistance on the left-hand end of the scale represents full-scale deflection of the meter (3 mA.



Everett Edgcumbe beat-tone oscillator, power level meter (left) and micro-wattmeter.

from a self-contained $1\frac{1}{2}$ -volt cell with on-off switch). The external resistance acts as a shunt to the meter, and results in a reduction of current with corresponding left to right movement of the needle.

Miniature instruments of the horizontal and flush-mounting type were shown by Ferranti and Salford Electrical Instruments, the latter including a series for high-frequency measurements with special dust-cored current transformers. Ernest Turner Electrical Instruments have introduced some new miniature horizontal edgewise dial meters of the moving-coil type with scale lengths of just over two inches, and some attractive panel-mounting meters with edgewise illuminated dials. Another new development is the introduction of a range of compact shunts and series resistances in which the elements are moulded in solid bakelite and resemble small tubular condensers in appearance. Some impressive-looking 6-inch panel-mounting meters of the type used in some of the B.B.C. transmitters were also a feature of this stand.

Although intended primarily for power supply work, the flat scale edgewise instruments shown by Nalder Bros. and Thompson are of interest, the mechanism employed is suited for use with other horizontal or panel-mounted scales.

Among special-purpose meters were noted a centre-zero voltmeter developed by the Baldwin Instrument Co. and designed to



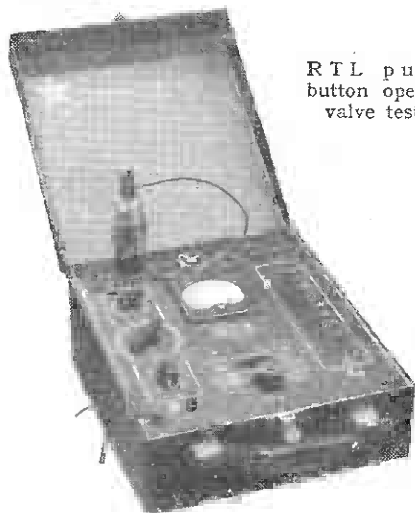
Cambridge "Spot" vibration galvanometer.

is constructed of a material with negligible temperature coefficient.

The new range of "Pot" vibration galvanometers has sensitivities up to 90 mm. per μA at 1 metre, and are obtainable for

The Physical Society's Exhibition—

measure mains fluctuation. The mains are balanced against a neon stabilised source and the instrument is capable of indicating a change of ± 1 per cent. for full scale deflection



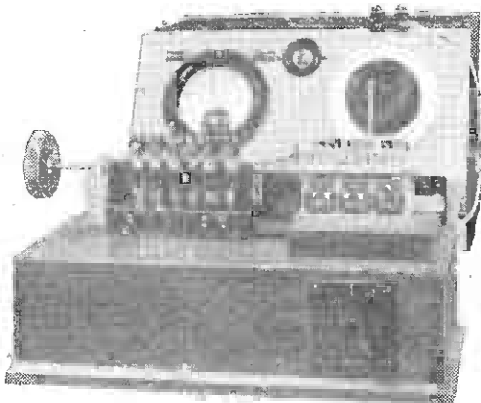
RTL push-button operated valve tester.

On the stand of Everett Edgumbe an interesting electrostatic voltmeter for use at radio frequencies was noted. This has a capacity of only $5 \mu\text{F}$, and has two ranges of 0.5 and 0.25 kV on its eight-inch scale.

Elliott Bros have developed a range of long scale moving-coil instruments having dial diameters of 2 1/2 in up to 36 in and an angular deflection of 250° . They were also showing a neat portable millivolt potentiometer designed for checking thermo-couples. It has two ranges of 0.30 and 30.60 mV, and a calibrated dial in which a 2-mm. division represents 0.01 mV. The instrument includes a standard cell and suspended pointer galvanometer for calibration.

For some purposes valve apparatus is taking the place of galvanometers and sensitive voltmeters, as it is less likely to be damaged by overloading. In general a valve voltmeter preceded by a stage of amplification is employed, and the Salford Thermionic Test Set is a good example. It will measure DC currents from 10^{-7} to 1 amp and AC up to 20 Mc/s over a range of 10^{-1} to 1 amp. The voltage range for AC or DC is 5 mV to 500 volts.

Another sensitive valve voltmeter incorporating a multi-stage pre-amplifier is the Ballantine Model 300, shown by Leland Instruments. This has a range of 0.001 to 100 volts, which may be extended up to



British Physical Laboratories variable condenser ganging bridge.

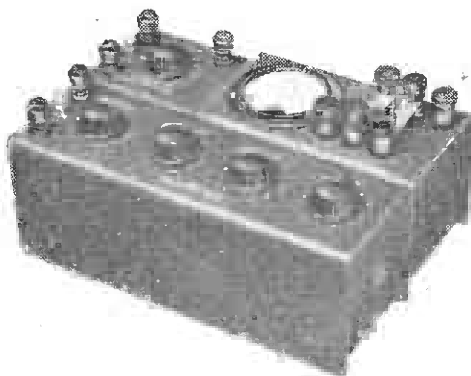
10,000 volts with an external unit. The scale is calibrated both in volts and decibels, the latter scale being linear. The

sensitivity is such that it can be converted to a noise meter by connecting a microphone to the input terminals. The frequency range is substantially flat to 100 kc/s.

The Muirhead Type 1A is also an amplifier-detector capable of measuring very small input voltages and powers, and gives a measurable response for an input of 4×10^{-11} W. Its frequency response with direct grid connection is flat within ± 2 db. from 30 c/s to 200 kc/s. Neon stabilisers are used in the power supply.

A sensitive micro wattmeter for general communication engineering work has been produced by Everett Edgumbe. It has a range of 0.20,000 W in three ranges, and the first 1/2 in. of scale on the lowest range corresponds to approximately $10 \mu\text{W}$. The power output meter, also a recent product of this firm, has four ranges with maxima of 5, 50, 500, and 5,000 mW, and an impedance matching transformer with a range of 2 to 12,500 ohms.

New valve-operated test instruments shown by Salford Electrical Instruments included a heterodyne universal tester and a new "Q" meter. The heterodyne tester is used for the rapid comparison of condensers and inductances, and consists of a beat oscillator, one element of which is controlled by the component under test. Percentage errors are read off the scale of a condenser which is used to adjust to zero beat, judged aurally from the self-contained loud speaker. The universal "Q" meter has a frequency range of 100 kc/s to 5 Mc/s, and in addition to indicating the "Q" factor of coils between 10 and 500, can be used for inductance measurement (two ranges, $1 \mu\text{H}$ to $5 \mu\text{H}$ and $5 \mu\text{H}$ to 25 mH),



Bridge components assembled on the Muirhead "Munit" system.

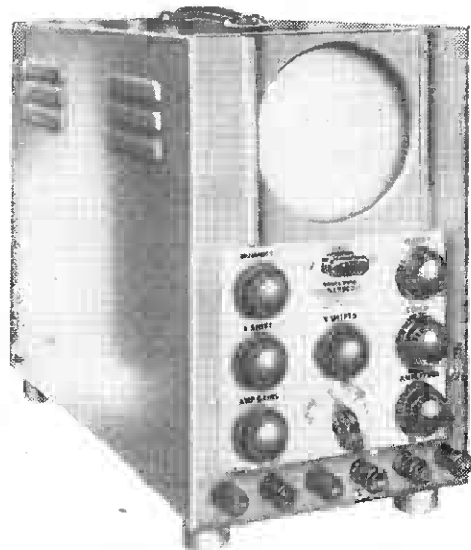
condenser values ($3 \mu\text{F}$ to $500 \mu\text{F}$), power factor, distributed capacity of coils, etc.

An instrument devised solely for the measurement of power factor in condensers at RF under mass production conditions has been produced by British Physical Laboratories. Comparison is made between the condenser under test and a standard condenser of negligible power factor in series with a variable resistance. There are five ranges, and the test frequency up to 1,600 μF is 1 Mc/s and up to 3,000 μF , 500 kc/s. This firm has also introduced a new 50 c/s capacity bridge with a range of 0.01 to 10 μF , and a variable condenser ganging bridge in which the indicating meter deflects in opposite directions for errors above or below standard. Both these instruments employ a "magic-eye" indicator to show that proper contact has been established with the test component—a useful feature under production test conditions.

A very useful impedance bridge was noted on the stand of Leland Instruments. This

is the Clough Brengle Model 130 which, in addition to covering three ranges of capacity up to 100 μF and resistances up to 10 M Ω may also be used to determine transformer turns ratios and also power factors of condensers. It is AC mains operated. Another interesting piece of test apparatus on this stand was the RTL valve-tester with push-button selection of the electrode connections. The instrument is suitable for American and octal bases, and has neon indications for shorts and open circuits—also a phone jack for noise tests.

The Automatic Coil Winder Co. have just completed and were showing for the first time a test bridge for capacities between



Cossor Model 3339 cathode-ray oscilloscope.

10 μF and 10 μF and resistances between 10Ω and 10 M Ω . It may also be used for measuring the power factor of electrolytic condensers, and the valve voltmeter indicator may be disconnected for use externally.

The Sullivan-Griffiths direct reading precision inductance bridge appears in improved form, and attachments are available for the measurement of capacity and of iron-cored coils with superimposed direct current. Temperature compensated inductances are used, and the accuracy is 0.1 per cent. or 0.02 μH over a range of $30\text{--}130^\circ\text{F}$.

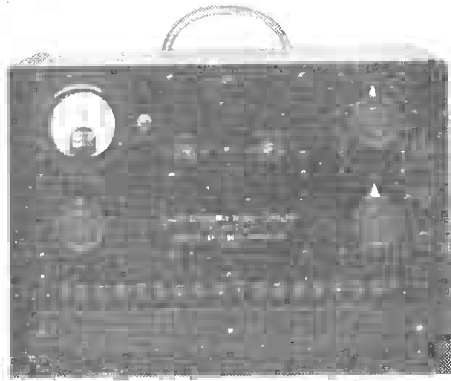
Muirhead's now make a capacity bridge (Type 10A) in portable form. The range is from a few micro-microfarads to 1,000 μF , and the power factor balance is calibrated in two ranges in terms of R_0C . Over most of the range the accuracy is within ± 1 per cent. The source is from 50-cycle mains through a double-screened transformer, and a cathode-ray indicator is used for balance. With the "Munit" system of screened unit decades, ratio arms, etc., bridges with a variety of circuits can be rapidly assembled.

Marconi Ekco were showing a new series of bridges for the measurement of balanced and unbalanced RF impedances at frequencies up to 20 Mc/s. In the universal impedance bridge (TF373) by the same firm accurate direct readings of C, L, R, coil magnification and power factor are obtainable. The seven decades include a continuously variable dial, and comparative readings may be taken to 0.1 per cent., while the absolute accuracy is ± 1 per cent. A single switch knob selects the appropriate bridge, power supply and indicator circuits.

Cathode-ray indicators are used to show balance in a majority of the bridges at this year's show. Generally it is an ordinary receiver-type tuning indicator, but a full-

The Physical Society's Exhibition—

sized tube is used in the Marconi-Ekco Phase Discriminating Visual Detector. The horizontal plates are connected to the AC bridge source, and the vertical pair take their



Marconi-Ekco Type TF492 for push-button receiver testing.

voltage through an amplifier from the opposite diagonal of the bridge. The result is an ellipse the length of one axis, which indicates the out-of-balance voltage and the inclination of the axes the phase.

A similar method of analysing balance is employed in the Cossor Model 3387 bridge circuit tester. The oscilloscope is the new Model 3339, which uses a 4½ in. single- or double-beam tube. There are two amplifiers, which may be used separately for each beam or in cascade on a single beam. A level response up to 2 Mc/s with a magnification of 500 is given by each amplifier; in cascade the corresponding figures are 100 kc/s and 3,000. A complete assembly for pressure-recording work on aero engines with a new contact-breaker suitable for speeds up to 6,000 breaks per minute, and a complete portable cathode-ray cardiograph, were shown on this stand.

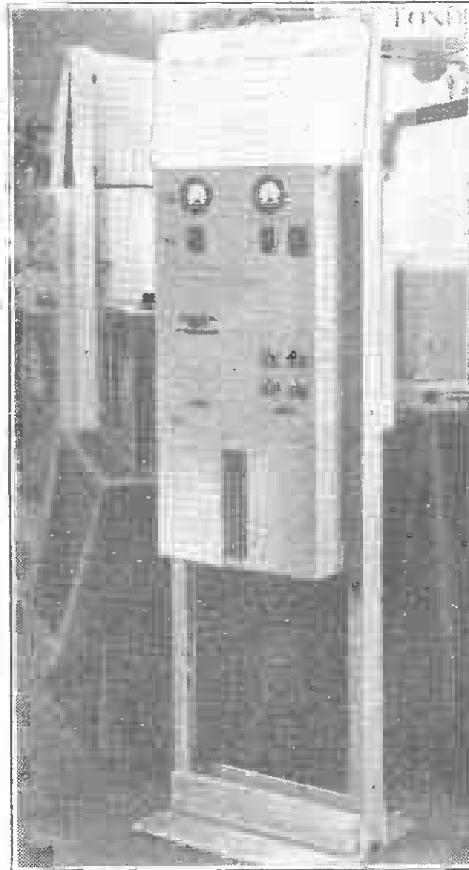
Other interesting applications of the cathode-ray tube were the Ediswan-Walter electro-encephalograph for recording the minute electrical impulses of the brain, and an experimental mariner's compass shown by Henry Hughes. A special low-velocity tube has been developed for the latter purpose in which the electron stream is easily deflected by the earth's magnetic field.

Developments in signal generators and other sources for communication measurements have been along the lines of detail refinement. A very wide selection of laboratory and service types by Ferris and Clough Brengle was shown by Leland Instruments, and one of the most useful is the Ferris Model 22A, which bridges the gap between service oscillators and the more expensive laboratory types. The frequency range is 85 kc/s to 25 Mc/s, and the scale is directly calibrated with an auxiliary control for selectivity measurements. For production

testing the Ferris Model 20A signal generator has eighteen spot frequencies each with its own interchangeable coil unit. Selection is by a rotary switch, and the range is 100 kc/s to 25 Mc/s. The output attenuator is calibrated in microvolts.

Marconi-Ekco have developed a signal generator (TF492) for the testing and servicing of push-button receivers. It provides sixteen frequencies anywhere between 100 kc/s and 25 Mc/s modulated at 400 c/s and selected by push-buttons. Special attention has been paid to frequency stability, and the RF output is independent of the frequency. For television development work the TF410 video oscillator should make a wide appeal. It covers a range of 10 c/s to 2 Mc/s, and has two output ranges from 1 mV to 1 volt and 1-10 volts according to the output impedance. It operates on the heterodyne principle and is energised from AC mains.

The Boonton Type 140A beat-frequency generator shown by Leland Instruments is another wide-range instrument covering frequencies from 20 c/s to 5 Mc/s in two bands overlapping at 30 kc/s. The flexible output



Sullivan-Halsey precision beat frequency oscillator.

circuit includes a monitored attenuator or a transformer operating up to 30 kc/s

Sullivan, in collaboration with Mr. R. J. Halsey of the Post Office Research Section, has produced a precision high-frequency heterodyne oscillator on the lines of the Ryall-Sullivan oscillator. The range is 0-160 kc/s and the output is level within 0.1 db.; the frequency stability is better than 1 cycle per day. It may be obtained with either a logarithmic or linear frequency scale.

The resistance-capacity variable frequency oscillator of Muirhead, shown in the development stage last year, has been completed. It covers 20 c/s to 90 kc/s in four

ranges, and has a harmonic content of the order of 1 per cent. which is constant with frequency. Harmonics above the third are negligible.

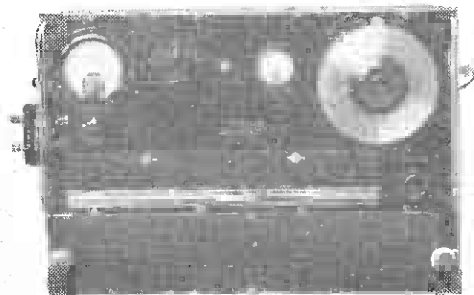
A very practical beat-oscillator for the checking of loud speakers has been introduced by Everett Edgcombe. It has an output of 2 watts over a range of 50-10,000 c/s, and incorporates an output valve voltmeter. Terminals are provided for energising the field of the loud speaker under test.

The "Audiograph" described in this journal on March 17th, 1938, is being made under licence in this country by Marconi-Ekco, and a finished model was shown in operation. It is certainly a compact and robust instrument by comparison with the complicated gear usually employed for taking loud speaker curves.

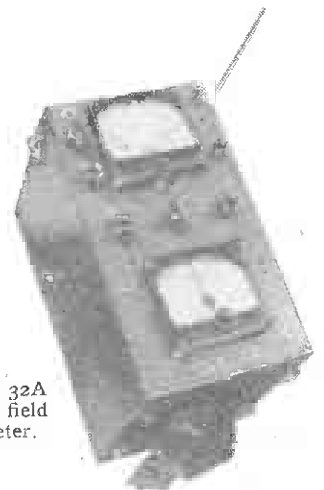
The same firm were showing a new wave analyser (TF455) working on the heterodyne principle. A bridge circuit is used to balance out the fundamental, and the harmonics are selected by a two-stage crystal filter with a flat top 5 c/s wide to facilitate adjustment. It operates from self-contained batteries, and may be used for modulated radio signals as a distortion-free detector is included.

For research into interference and propagation problems, Marconi-Ekco have produced two new field strength measuring sets. The Type TME18 covers the range 150 kc/s to 23 Mc/s on interchangeable frame aerials, and is virtually direct reading, the calibration being provided by a substitution signal from a stable internal oscillator. For ultra-short-waves, the Type TME14, covering 3-15 metres, has been designed. The substitution method is again employed, and the unit, which is mounted on a calibrated 360-degree tripod head, may be used with dipole or frame aerials.

An extremely compact field strength and interference measuring set was shown by Leland Instruments. It is the Ferris Model 32, and measures only 7½ in. x 12½ in. x 9½ in. Battery, AC mains or 6-volt vibrator power packs are made to clip to the base, and a telescopic vertical aerial is provided. The meter is calibrated directly both in microvolts and db, and may be used as a two-terminal voltmeter for external measurements. A uniform continuous frequency spectrum generator is included for calibra-



Marconi-Ekco Type TF455 wave analyser.



Ferris Model 32A noise and field strength meter.

tion for noise measurements. The range is 1 μV to 0.1 volt in two stages.

Transmission equipment was well represented on the Standard Telephones stand, and an experimental USW oscillator working at 250 Mc/s was demonstrated in con-

The Physical Society's Exhibition—

junction with Lecher wires and neon tube indicators. New development valves for USW work included the Type LS486 and LS445, the latter suitable for frequencies up to 300 Mc/s. Another item of interest to transmitting engineers was the portable OB amplifier built into a small suitcase and

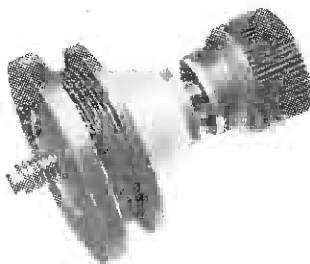


suitable for the suppression of the initial current surges in pilot lamps in DC/AC sets, for the protection of electrolytic condensers, and in conjunction with iron wire barretters for current regulation.

Salford Electrical Instruments were showing a range of "Gecalloy" dust cores, including the latest types for screw adjustment. They have also developed a well-designed HF terminal for use in valve voltmeters, etc. Ceramic insulation is employed and the capacity to earth is only 2.5 μF . Suitable for working voltages up to 1,000 AC, it has a resistance of 10^{11} ohms dry and 10^{10} under conditions of 80° humidity. The power factor is 5×10^{-4} at 1 Mc/s.

The British Electrical Resistance Co. have developed a range of completely shrouded slider type rheostats which conform to Home Office regulations and are suitable for use in factories and schools. They were also showing an insulation test set in a metal case for wall mounting incorporating an HT

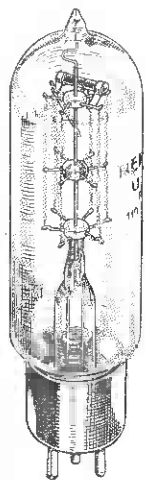
(Left) A valve oscillator functioning at 250 Mc/s (1.2 metres) was demonstrated by Standard Telephones and Cables.



Salford ceramic terminal for RF measuring instruments.

designed to operate from a 6-V car battery. A large section of the stand was devoted to selenium rectifiers and the applications of quartz crystals to radio frequency control.

Components and materials of wireless interest were well distributed among the firms showing at the exhibition this year. One of the most interesting developments was found on the Erie stand, where examples of the applications of "Urdox" resistance elements were explained. Resembling in appearance small carbon stick resistances, these elements are composed of



"Urdox" negative temperature coefficient resistances for protecting pilot lamps, electrolytic condensers, and improving the characteristics of barretters.

a mixture which includes the dioxides of titanium and magnesium. They combine a high negative temperature coefficient with small heat capacity, and are pre-eminently

transformer and potentiometer continuously variable from 0-2,500 volts, a suitable circuit-breaker, and an indicating valve voltmeter. Their rotary type resistances are now available with vernier adjustment, consisting of a single turn slide wire operated by a knob concentric with the main control.

Permanent magnets for every conceivable purpose were shown by Darwin's, and one of the latest developments is an edgewise ring type for focusing the electron beam in cathode-ray tubes.

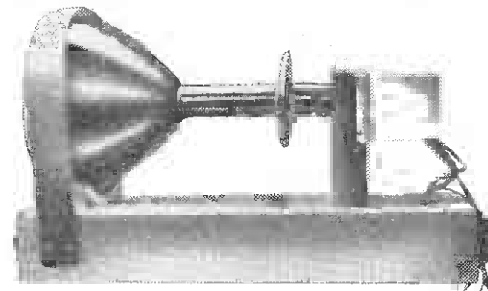
Bakelite products are widely used in the radio industry, and examples of some of the applications included insulating varnishes and anti-corrosive primers suitable for treating chassis and metal parts.

Although not strictly of wireless interest there are always numerous examples at this exhibition of the use of radio technique in allied physical subjects. The detonation meter shown by Mullard, for instance, uses a flashing CR tuning indicator to signal the onset of "pinking" in petrol engines, a high-pass filter being employed to segregate the high-frequency components generally associated with that phenomenon. Salford Electrical Instruments were showing a layer-thickness meter for non-magnetic coatings on magnetic bases, and British Physical Laboratories an electrical method of measuring the muzzle velocity of shells depending upon the charging at constant voltage of a condenser over a short time interval.

In the Standard Telephones watch rate timer the impulses from the escapement are picked up by a microphone, and appear as indentations on a rotating circular image on

the screen of a CR tube. By comparison with a standard watch, the performance can be checked and adjusted in less than a minute.

The Automatic Coil Winder and Electrical Equipment Co. have developed a dual spindle machine similar to the Douglas No. 6 winder, and were also demonstrating an in-



Darwin permanent magnet "electron lens."

genious experimental machine for winding toroidal coils.

In the Research Section two of the largest exhibits were arranged by the Post Office and the National Physical Laboratory to show various aspects of their work. The former included apparatus for the measurement of the characteristics of coaxial cables and a neat demonstration of the effect of negative feed-back in amplifiers. The acoustics section of the N.P.L. exhibit included Rayleigh disc apparatus for the absolute calibration of microphones and a Freystadt cathode-ray spectrometer showing simultaneously the energy levels in the various component frequencies of a complex noise.

The research departments of the leading electrical firms were also well represented and the G.E.C. exhibit included a neat method of exploring magnetic fields by a small rotating search coil driven by a synchronous motor and a broad-band response curve spanning circuit for testing television circuits over a range of 40 to 50 Mc/s.

The large attendance on the opening day was a measure of the importance which this Exhibition has assumed among the technical personnel of the industry.

HENRY FARRAD'S SOLUTION

(See page 37)

AS his friend was evidently content to listen for considerable periods in spite of the trouble, the set must have been working tolerably well on the stronger stations. Yet it is completely dead to weak stations. This would not be caused by partial failure of a valve or other part, which would more or less affect all stations, but sounds more like negative bias on the signal diode, giving a QAVC or muting effect. Signals that are not much stronger than necessary to overcome this bias would have only the peaks rectified and therefore would be distorted. The only way this bias is likely to occur accidentally is by short-circuiting of the condenser separating the diode load resistance from the volume control, which is negative relative to the detector cathode. Current would then flow from this cathode to the earth line via the volume control; and this accounts for the noisiness of the volume control, for moving it towards maximum volume would reduce the grid bias on the AC2/Pen output valve, and slight irregularities in the usual carbon control would be amplified. It also accounts for the valve overheating when near maximum volume, because it would then pass abnormally heavy anode current.

About Instruments

By "CATHODE RAY"

THE Physical Society's Exhibition has this much (but no more) in common with a Bond Street jeweller's shop, that it is an entrancing place to visit if one is quite content to do no buying. The general impression gained is of the vast variety and costliness of the articles displayed. (The Exhibition being sponsored by a learned society, you must not expect to find the cost element vulgarly displayed as if it were a common shop; and the stand attendants are obliged to affect a deeply shocked expression if you ask the price of anything, but if you press the point they may surreptitiously pass you some leaflets in which the prices are unobtrusively filled in by hand, or at least promise to write to you about it when they get back into the commercial atmosphere of their own offices.)

It is true that only a millionaire could succeed in buying one of everything, but it is not true to conclude that for the impecunious enthusiast the purchase of any instruments is an unwarrantable extravagance, or that the prices charged are excessive. The more specialised apparatus is necessarily expensive, because the demand is limited and the cost of development must be spread over few units. But instruments of general usefulness, like multi-range meters and servicemen's signal generators, are now produced in sufficient quantities for the value for money to be very good indeed.

It is not uncommon for enthusiasts to spend £30 or £40 or more in a year on components, amplifiers, valves, loud speakers, and so forth, in efforts to get better results; whereas the diversion of a fraction of this amount to the purchase of instruments, and some time devoted to mastering their proper use, would show up unsuspected causes of bad results and confirm or dispel suspected ones; and, incidentally, give a much clearer understanding of the whole business.

Cheap Cathode-Ray Gear

Being what I am, I am itching to break forth into a paean in praise of the cathode-ray tube as an unrivalled means of finding out what's what, but the Editor warns me to keep off this particular subject for the moment, so I restrict myself to the one remark that really useful cathode-ray equipment is possible at a cost of £3 to £4, inclusive of tube, and less still if an old receiver power unit lies in the junk box.

Meters have a good claim to be considered first, because, as their name signi-

fies, their purpose is to measure, and "to measure is to know." That is a wise saying, but like most wise sayings it is foolish to go by it too literally. Meters are certainly indispensable in testing all radio and kindred apparatus (to say nothing of the increasing variety of domestic electrical appliances, which go wrong sometimes), they are component parts of most specialised instruments, and don't go badly out of date.

But one warning I would issue is against trying to economise. Cheap meters are not always robust, and expensive meters fragile; on the contrary, some of the good-class instruments are much less easily damaged than the junk type, which, apart from its probable inaccuracy and

example, if a 350-volt power unit has a total resistance, due to smoothing choke, rectifier, power transformer, etc., in the region of 1,000 ohms, a voltmeter with 100,000 ohms on the 500 volt scale, or 200 ohms per volt, is just about good enough. But in measuring the voltage actually reaching the anode of a valve, the resistance is likely to be much greater owing to decoupling or coupling resistors. In exceptional cases it might be as much as half a megohm, which would make things very difficult (unless the valve it is feeding has a comparatively low resistance); but suppose it is 50,000 ohms. The voltmeter ought to be 5 megohms. Very few of them are. A good standard for this type of voltmeter is 1,000 ohms per volt, so it would be necessary either to try to read on a 5,000 volt scale (if any), or to put up with a much bigger error than 1 per cent., or to find out from other data what the error is and allow for it.*

MEASUREMENTS—MEANS AND METHODS

variability, is usually liable to that very irritating defect of sticking. The temporary spasm of pain occasioned by doing without something else in order to find the price of a higher grade meter than the one first thought of is fully compensated throughout the rest of one's life by the more satisfactory service given. The temptation to buy three junk meters instead of one good one is strong—I have succumbed to it and I know. You have been warned.

Then it is not enough to apply a meter, without regard for possible limitations. Even if it is accurate, that is no guarantee that the readings are what you want to know. An example of this is the oft-stressed need for voltmeters of high resistance. Cheap moving-iron voltmeters of the "watch" pattern usually have a resistance of only a few ohms per volt, which is another way of saying that they draw a lot of current—perhaps 100 milliamps—from the circuit to which they are applied. That is all very well for car batteries, which think nothing of such an amount of current, but in circuits where perhaps it is more than the maximum current available, and the resistance of the supply is more than that of the voltmeter, it is obvious that connecting the meter is bound to drop the voltage far below the working level. To keep the error from this cause down to the region of 1 per cent., the voltmeter resistance should be something like 100 times the resistance between it and the source of volts.* For

In view perhaps of the frequent need for measuring voltages in high resistance circuits in television receivers, there have recently been offered instruments with much higher resistances such as 20,000 ohms per volt. As the full-scale current taken is only 50 microamps, such instruments can be used for measuring very small currents as well. For very high voltages, 1,000 and over, the best sort of voltmeter is one that takes no current at all—the electrostatic type.

AC Measurements

That is one way in which it is possible to go wrong by using an unsuitable meter, or not paying regard to its limitations. Another is in the matter of AC. We all know that the only type of meter worth considering for general purposes on DC is the moving coil. Passing from DC to AC, the situation is complicated at the start by the question of frequency. The electrician's AC voltmeter had to work only on 50 cycles, or at any rate below 100, and could draw any current within reason. Neither of these conditions holds good for most of our purposes; and the moving-coil meter being unapproachable for excellence by any purely AC type, the next best thing is to rectify the AC conveniently by a metal rectifier, and use the moving-coil instrument. A great advantage is that modern rectifier meters can be used over the whole range of audio frequencies.

There are little complications, however, which it is occasionally important to

*For full explanation see note at end of this article.

About Instruments—

remember. The first is that the resistance of a rectifier meter is not quite the fixed and definite thing it is on any given range in a DC instrument. Below 5 volts its resistance begins to rise appreciably, and below one or two volts rises quite a lot, and at the same time the scale becomes more crowded. One incidental effect of a rectifier is that harmonics are produced; and sometimes when making measurements on distortion in amplifiers one may be led right up the garden unless this fact is borne in mind. The comparative rarity of such an effect makes it the more unexpected if it does happen to crop up.

A rather more important matter is the error due to waveform. There is not time for me to embark here and now on an explanation of peak, mean, and RMS values, so if you are not clear about them you will just have to accept it meekly that it is possible for three meters to be giving different readings all at once on an AC circuit and for all to be right. The reading given by a rectifier-type meter, which is approximately the mean value, agrees with the generally used RMS value only when the waveform is pure. So readings taken in a power unit or other places where it is far from pure are likely to be different by 10 per cent. or more.

One of the great advantages of the rectifier meter, as I mentioned just now, is that it is suitable for measuring audio signal voltages. The most obvious use is for indicating output, especially when lining up sets that are not fitted with

tuning indicators. The exact tuning point is indicated much more accurately than can be determined by ear. Connecting the meter across the moving coil of the loud speaker is the simplest method, because external loud speaker terminals are usually provided. If the output impedance is 10 to 15 ohms, this is quite satisfactory; but nowadays an impedance of about 2 ohms is general, and a reading of only 1 volt indicates an output of 500 milliwatts. It is better to work at a considerably lower signal level—to spare one's ears and to avoid flattening the response by bringing the AVC into action. So a fairly sensitive meter is required. Alternatively the meter can be connected across the primary of the transformer, and then the voltage reading is, of course, much higher. As the DC drop across the transformer is likely to be considerable, a condenser of perhaps 1 mfd. should be put in series with the meter.

Regulating Oscillator Output

Sometimes a rectifier meter is useful for regulating the signal from an audio source—such as that provided by most signal generators—and if the intention is that the signal should be undistorted the meter should be replaced by an equivalent plain resistance when not actually taking readings on it, because of its introducing harmonics.

A particularly valuable use for the sensitive meter that forms the basis of extra-high-resistance voltmeters is measuring the current in the load resistance of a diode

detector (see Fig. 1). This is very helpful in fault-tracing and design-checking, for the signal level at the detector is one of the most important data. The ordinary milliammeter is not sensitive enough.

For the built-in signal strength indicators, which in "communication" receivers are usually known as "R-meters," a very sensitive meter is not necessary, as it is usual to connect it to show the anode current to one or more of the valves controlled by AVC (Fig. 1). Another advantage of this arrangement is that the relation between deflection and signal strength is a rough approximation to logarithmic, and goes farther towards covering the very wide range of signal strengths than a uniform scale could possibly do.

The use of a moving-coil meter in the circuit of a detector valve is exactly what is known as a valve voltmeter, except that in the latter the valve is part of the measuring instrument instead of part of the thing being measured. Nevertheless, by careful design the effect of connecting the valve right into the RF circuit being measured can be made remarkably small compared with other sorts of instruments. One way of doing this is to mount the valve on the end of a flexible metal tube. Acorn valves are the best for this purpose, especially at ultra-high frequencies, but as they are very fragile and expensive it is well to remember that some modern triodes (as well as pentodes, etc.) are provided with a top cap connection for the grid, and lend themselves very well to this "probe" arrangement. The only other things to be mounted in the head of the probe along with the valve are the by-pass condensers for providing short RF paths from anode and "earthy" input terminal to cathode.

Choosing a Valve Voltmeter

The advice to study the characteristics of instruments carefully before making a selection applies emphatically to valve voltmeters. There are several general types—anode bend, auto-bias, grid current, slide-back, amplified diode, etc.—each with innumerable variations and each with advantages and disadvantages. Some cover a wide range of voltage, some read low voltages, some read peak or mean or RMS values, some have particularly high input impedance, and so on. The choice depends on the sort of thing you want to use it for most.

Nearly all valve voltmeters make use of a moving-coil meter of some sort, and if you possess a good one it is probably economical to make the rest of the instrument with terminals for connecting the meter, but, of course, it is not quite so convenient to use as a self-contained instrument, and for some tests the good meter may be wanted elsewhere at the same time. I, personally, prefer to look on a valve voltmeter not so much as an accurate measuring instrument—for there are so many factors affecting the reading that it is very difficult to maintain really high accuracy—but as an indicator. For

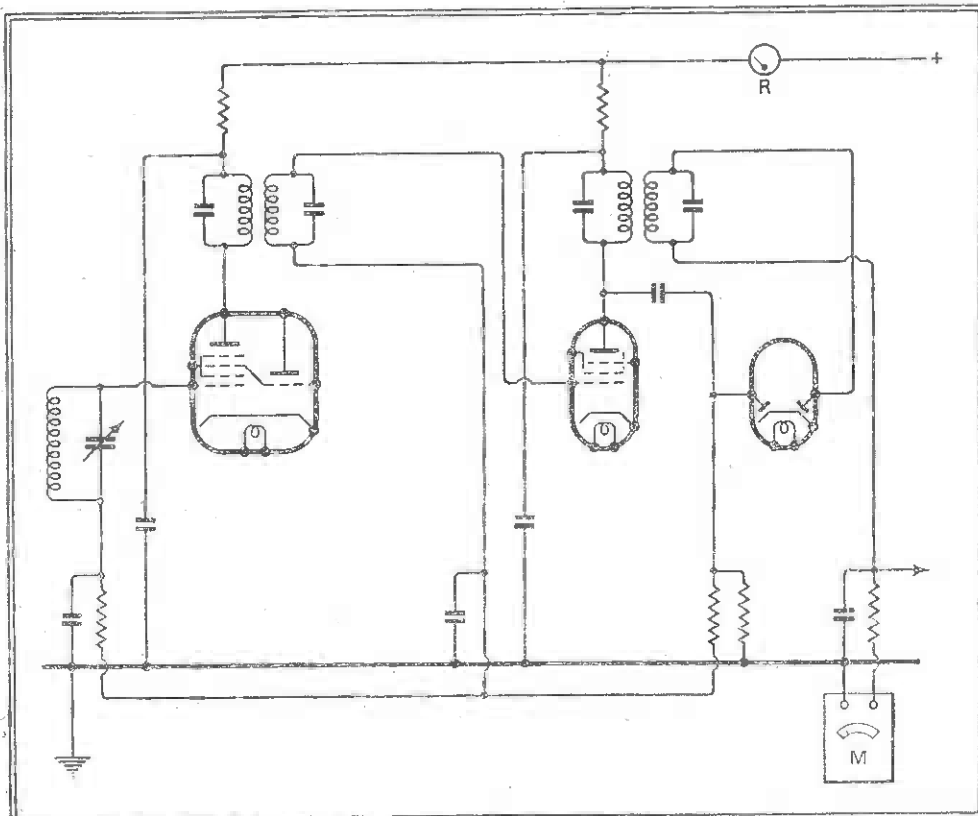


Fig. 1.—The new extra-high-resistance voltmeters are really microammeters, and can be used for measuring the rectified signal voltage at signal or AVC diodes. The meter is connected at the earth end of the load resistance (shown at M) and the reading in microamps multiplied by the load resistance in megohms gives the voltage. As an arbitrary indicator of signal strength over a wide range a milliammeter R connected in the anode supply line to AVC controlled valves is useful. To include weak signals it is better if the AVC is not delayed.

About Instruments—

example, in measuring amplification the most obvious method is to read the signal voltages at the input and output and divide

survey." Judging from letters I get, many people under-estimate what is involved even in a serviceman's generator. It consists of a valve oscillator, adjustable to cover all the usual wavebands and modulated by a fixed note, usually something between 400 and 1,000 c/s. So far so good; there is no immense difficulty. In days

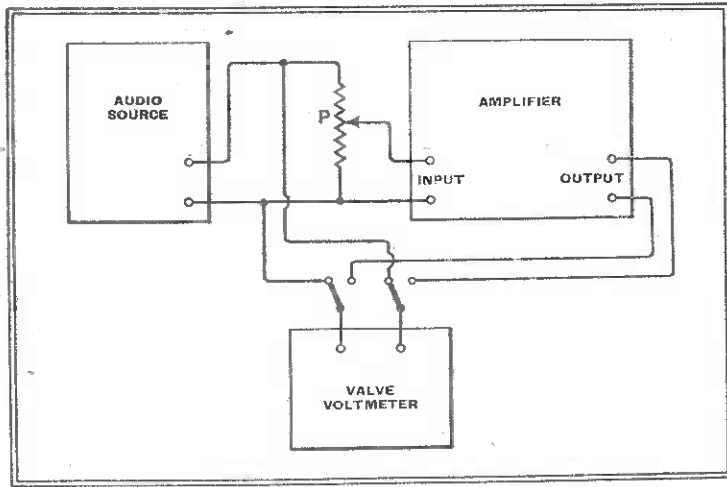


Fig. 2.—A valve voltmeter need not be accurate or even calibrated at all for measuring amplification if a calibrated potentiometer P is available. The valve voltmeter is just used to show when the voltage is the same in both positions of the switch.

the latter by the former. Although this sounds straightforward enough, in practice the input voltage is often too small to measure directly; and, anyway, the two voltages will probably be of very different magnitude, which is a condition likely to involve most of the errors that are going. A better method is to use the valve voltmeter for seeing when the voltages at each end of the amplifier are equal, the actual voltage applied to the input being stepped down by a potentiometer, which is a much simpler and more reliable thing than a valve voltmeter. The valve voltmeter then need not even be calibrated, and its errors are of no consequence (see Fig. 2). Actually, it is very useful to have it calibrated in volts, but the general idea I am trying to emphasise is that where there is the choice it is better to depend on items such as potentiometers which have less about them that can change.

There are few things more useful for general experimenting and testing than calibrated resistances and capacities. Very accurate ones cost a lot of money, of course; but the better grades of rotary potentiometer, preferably of larger diameter than ordinary volume controls, and with reliable contact arms and end connections, can be calibrated on a bridge—borrowed, if necessary—and can be used either as known variable resistances or for tapping off a known proportion of a voltage across the end terminals. Condensers that do not shift their capacity under the stress of time and temperature are now sold quite cheaply, as a result of the demand for push-button receivers, and a box containing a number of values selectable by a switch saves a lot of time when finding the right capacity for a certain place in a circuit.

For servicing or experimenting a practically indispensable piece of equipment is a modulated oscillator, or signal generator. I do not say standard signal generator, because instruments truly worthy of that name tend towards the millionaire class and are therefore (again quoting the high-brow writers) "not within the scope of this

gone by everybody had something of this sort and called it a wavemeter. It was never actually connected to the receiver being tested; what the receiver picked up came by stray coupling or radiation. The only way of controlling the strength was to shift it to and fro along the bench or turn it round. Even although the only purpose was to measure the wavelength, this method of control often left much to be desired. And now that measuring wavelength is only incidental to the main purpose of lining up and checking the sensitivities of sets, it is essential to have a definite connection between signal source and receiver and means of adjusting the strength over a wide range. The wide range control is a knotty problem in itself, especially at very high frequencies, because unauthorised capacities and inductances, which insist on being present in actuality though not in the circuit diagram, tend to have more effect on the results than the resistance elements that are supposed to do the job. Secondly, it is no use being able to reduce the output to 1 microvolt for testing sensitive receivers if 100 microvolts are picked up by direct radiation. So the signal generator must be very carefully screened. And, contrary to many people's ideas, this is more than just putting everything inside a metal box. It is astonishing how much can leak out of a lid joint or the control spindle holes.

Of course, the generators that are sold at around £10 are not perfect in all respects, but some of these cheap instruments are wonderfully good, and in view of what I have just explained are better value than perhaps many people suspect. When considering buying one, a revealing test is to connect it to the most sensitive receiver available and at various frequencies to note whether by adjusting the generator output to "zero" the signal can be made to disappear.

Even those few makes of the cheaper sort that are calibrated in microvolts must not be expected to be highly accurate. It would be quite good, for example, if a nominal 10 microvolt signal were actually

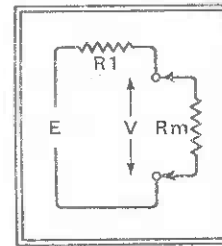
14 at one end of a waveband and 25 at the other. What is more important is that the output at any frequency should always be closely the same, so that sets can be compared with one another. It is also rather important that the percentage modulation should be reasonably constant, and should be neither too small nor too large; 30 per cent is the usual standard.

Laboratory signal generators cost about ten times as much, because it is very expensive ensuring an accurately calibrated output, modulated at a known and controllable depth, at all frequencies now in general use.

Though not essential for servicing, a beat-frequency oscillator covering the whole range of audio frequencies is the most valuable equipment for the quality enthusiast. But perhaps I had better stop before this takes on the covetousness-provoking character of the Physical Society's Exhibition catalogue.

NOTE ON VOLTMETER READINGS.

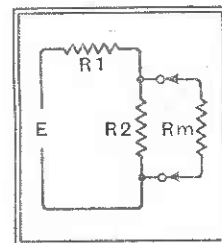
If E is the voltage (EMF) at the source and R1 the resistance between the source and the voltmeter (represented by Rm), then if there is no load resistance the true voltage across the points where the measurement is made is the full E volts, but drops to, say, V volts when the meter is connected.



To find the true E from the meter reading V—

$$E = \frac{V(R1 + Rm)}{Rm}$$

For V to be 99 per cent. of E, Rm must be 99 times R1.



Example: Suppose R1 is 25,000 ohms, and the voltmeter reads 68 volts on a 100-volt scale and has a resistance of 1,000 ohms per volt. Then Rm is 100,000 ohms. So $E = \frac{68 \times 125,000}{100,000} = 85$

When the voltage is measured across a load (call its resistance R2), then the true voltage across R2 (call it V1) is $\frac{ER2}{R1 + R2}$. When the voltmeter is connected the reading is, say, V2.

To find the true voltage $V1 = V2 \left(\frac{R1R2}{Rm(R1 + R2)} + 1 \right)$

For V2 to be 99 per cent. of V1, Rm must be 99 $\left(\frac{R1R2}{R1 + R2} \right)$, that is to say, 99 times the resistance of R1 and R2 in parallel.

Example: Suppose a 15,000-ohm triode is fed through a 50,000-ohm coupling resistance and a 25,000-ohm decoupling resistance (R1 is therefore 75,000 ohms), and that the voltmeter reading across the valve is 38, using the same meter and range as in the previous example. The true voltage across the valve is

$$V1 = 38 \left(\frac{75,000 \times 15,000}{100,000 \times 90,000} + 1 \right) = 38 \times 1.125 = 43$$

3/6/3/39

NEW LOCAL-DISTANCE CIRCUIT

The **Wireless** **World** **6^D**
THE PRACTICAL RADIO & TELEVISION JOURNAL

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CONTENTS

	Page
Editorial Comment	49
Improved Hearing Aid	51
Electrostatic Scanning	53
New Local-Distance Circuit	54
Problem Corner III	56
Broadcasting in Iceland	57
Unbiased	58
Designing a Filament Transformer	59
Short-Wave Therapy	60
Television Programmes	60
Magnetic Tuning and Single-Span	61
Letters to the Editor	64
News of the Week	65
Television Topics : Negative Ghost Images	67
Graphs : Choosing the Scales	69
The Amateur Transmitting Station III—Power Amplification	71
Random Radiations	73
Recent Inventions	74

EDITORIAL COMMENT

Broadcasting

Private Enterprise or Government Control ?

THE debate before the microphone arranged by the B.B.C. last week, in which the relative merits of conducting broadcasting as a private enterprise financed by advertising or giving a monopoly to one concern, as in the case of our own Broadcasting Corporation, with comparative freedom in the matter of choice of programme material but financed and indirectly supervised by the State, was one of the best of the series of debates of this nature.

The subject has been so much discussed and written about already that it was not to be expected that any new arguments could be produced from either side in this debate ; but whilst none of the arguments were new, some of them were certainly made more effective by being put in a new order of relative importance.

It was interesting to note how much stress the supporters of private enterprise laid upon the need for competition in broadcasting and on filling the programme hours with the maximum amount of entertainment and popular material such as organisers of public entertainment in other spheres would set out to achieve. It was just this urge to please all the time which the Opposition, supporting the case for the present B.B.C. monopoly, regarded as likely to have a detrimental effect on the utility of broadcasting as a public service. The existence of a monopoly enabled the B.B.C. to compile programmes on the broadest possible lines to meet the need for entertainment, instruction and education. Educational matter would have little place in broadcasting programmes which were competing for the favour of the

maximum number of listeners, and if the compilers of programme matter were not disinterested. If influenced largely by the dictates of commerce, many programmes would tend to withhold information from the public or present information in a biased way in order to favour some type of merchandise, the sale of which might be impaired if entirely impartial information, such as the B.B.C. is able to give, were restricted.

The ideal in broadcasting programmes would seem to call for every individual in the broadcasting organisation regarding himself as a servant of the public in the highest sense of service, and entirely uninfluenced in the choice of programme material by any other considerations, whether commercial or political and with a Board of Governors consisting of persons selected for their integrity and impartiality.

Noises and Voices

A Test of Quality

A BROADCAST of quite outstanding interest is to be given by the B.B.C. on Sunday afternoon, January 29th, at 5.20, on the Regional and Empire wavelengths. A "Noises and Voices" competition will be conducted with two teams of listeners who will be asked to identify a large variety of sounds which will be broadcast to listeners at the same time.

Apart from the popular interest in such a programme, it should prove very valuable as a check on the performance of receivers. We think that the competition should receive the widest possible publicity in advance, because it will enable hundreds of thousands of listeners, who have no satisfactory means of estimating the reproduction quality of their sets, to form a very

good idea of deficiencies from which the sets may be suffering. If all the sounds broadcast can be easily identified on the receiver it would be pretty safe to assume that there is nothing much wrong with the quality of reproduction which the receiver is giving. If the sounds are distorted in reproduction, then listeners will have real difficulty in identifying them. When this proves to be their experience they can take it that it is high time their sets were overhauled to ascertain the cause of the distortion.

We know that an enormous number of sets in use to-day, either by reason of old age or neglect, are giving atrocious quality which is an insult to the B.B.C. transmissions, but most of the owners of these sets have grown accustomed so gradually to the deterioration which has set in that they are quite unaware of how much they are missing.

Let January 29th then be an occasion for enlightenment, and where the tests reveal the necessity for it, a resolution for 1939 to make our receivers more worthy of the quality of the transmissions we receive.

No Finality

Always Something New

THE technical progress of wireless has been so spectacular during the past fifteen or twenty years—and especially since the advent of broadcasting—that we are all inclined, if a week or two passes without the announcement of some advance of obviously fundamental importance, to say that something approaching finality has been reached.

During the last few years progress has been slower than before, but were it not for the pace that has been set, it would still be regarded as rapid and in most other fields of human endeavour would be so considered.

The whole matter was summed up very ably in a recent speech by Mr. David Sarnoff, head of the American R.C.A.

and N.B.C. He said: "... radio has never ceased to be a pioneer. The day may come eventually when its pioneering work is over, but it is a day I do not expect to live to see. Whenever we seem to have learned to extract the utmost usefulness from one portion of the radio spectrum, another part of the band looms up—first in theory, then as a subject for experiment, and finally as a practical medium of public service."

It is certain that no one connected in whatever capacity with the technicalities of wireless can yet afford to relax his efforts in the quest of knowledge. If he does, he will very soon find that his knowledge has become out of date.

Remote Tuning Control

Induction and/or Radiation?

WHEN push-button tuning first became general as an adjunct to broadcast receivers we welcomed it at least as much for the possibilities it offered in the way of remote control as for its own intrinsic attractions. From many points of view the single-unit form in which the receiver of to-day seems to have finally become standardised is far from ideal, especially with regard to convenience in operation. In this respect a remotely controlled set—but not necessarily controlled from another room, of course—is certainly superior to a single-unit receiver with built-in controls of the ordinary kind.

With regard to the details of remote control, special interest attaches to the recently developed "wireless" systems (the term "wireless" is here used in its widest sense) if only for the intriguing and ingenious nature of these devices.

One type of remote tuning control unit which has especial attraction on the score of flexibility comprises what is virtually the oscillator section of a superheterodyne receiver, removed from the main chassis and worked at a distance. These

systems start with a strong advantage over those which must be coupled to the receiver by a long trailing cable, but they are, however, open to objection on the score of interference, as they can be strong radiators in the range of broadcast frequencies used by other receivers.

In the latest Philco system, described elsewhere in this issue, these difficulties are ingeniously overcome (1) by operating a relay system on a single frequency; that employed is outside the broadcast range, being actually between the medium- and long-wave bands; (2) by using a frame aerial of small dimensions compared with the wavelength, so that the radiated field is small compared with the magnetic induction field which extends to $\frac{1}{4}$ th of a wavelength from the aerial; (3) by suppressing the electrostatic induction field within that distance.

Within the range of action of the control unit the coupling is purely inductive and any charges of interference by radiation outside that range might well be met by a challenge to "produce the body," for the radiation would not only be extremely attenuated but also horizontally polarised and, therefore, less likely to be detected by sets operating from an ordinary aerial system.

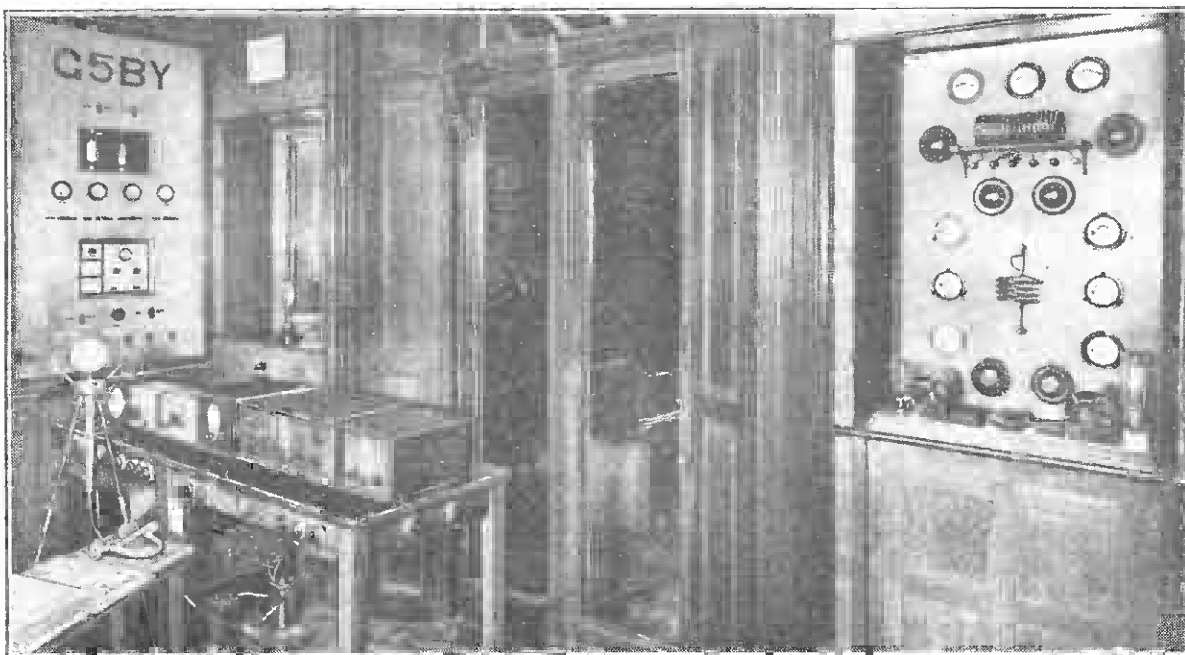
Broadcast Licences

Still No Saturation

FOR more years than we can remember the pessimists have asserted that the annual increase in broadcast licences could not be maintained at anything like the figures to which we have become accustomed. "Flattening of the curve" is an expression heard so often that one has almost accepted its early realisation as inevitable.

It would be idle to deny that, at last, the rate of growth has begun to decline, but the falling-off is not nearly so marked as we have been led to anticipate. The position, as shown at a glance by

a graph published elsewhere in this issue, is a very healthy one. True, the curve is beginning to flatten, but it still shows a decided upward tendency.



AMATEUR TRANSMITTING STATION G5BY owned and operated by Mr. H. L. O'Heffernan at Croydon. Several experimental transmitters are used and the station can be heard on the 7, 14, 28 and 56 Mc/s wavebands. The main 250-watt transmitter is seen on the right, with receivers, monitors, modulation panel and controls for all transmitters on the left. The station works most weekday evenings at 22.00-23.00 hours on 56 Mc/s.

Improved Hearing Aid

DIFFERENTIAL MICROPHONE : DRY-BATTERY LT SUPPLY

By
T. S. LITTLER,
M.Sc., Ph.D.



SOME time ago¹ the writer described in these columns a hearing aid making use of the Siemens Neophone transmitter as a microphone for operating a two-valve amplifier. Much interest was shown in this instrument, not only by *Wireless World* readers, but by a number of commercial firms. The present article describes a hearing aid which is an improvement, in three ways, on this earlier model. It makes use of an improved microphone, is considerably smaller and lighter, and the filament consumption is so small as to allow dry batteries to be used economically.

In the present instrument the microphone used is the Siemens type 500 differential transmitter. Its improvement over the previous Neophone type lies in the fact that it is operated on the push-pull principle with consequent reduction of amplitude distortion. Also, as the input to the microphone transformer is in push-pull, or used in a bridge circuit, no direct current flows through the primary, and a small Mumetal-type can be used, as there is no risk of saturation of the core.

The theoretical circuit of the hearing aid is given in Fig. 1. The output of the microphone transformer is fed to a two-valve amplifier consisting of a Hivac XSG valve resistance-capacity coupled to a Type XP of the same make. The input circuit is interesting in that a centre-tapped transformer is dispensed with, and direct current is prevented from flowing through the transformer by means of the two 50-mfd. electrolytic condensers as shown. The ballast resistance R5, of 30 ohms, is advised by the microphone makers for stabilising purposes. The makers also point out that this transformer

THE deaf-aid amplifier described in this article has been made as small as possible having regard to the need to use readily obtainable components. As it is operated entirely by dry batteries, it may safely be carried without special precautions, while a replacement LT battery is obtainable from any wireless or cycle shop.

anode resistance of about half a megohm and a screen grid resistance of two megohms in the first valve circuit, an amplification of about 30 times is obtained. This amplification is almost uniform from about 300 c/s to about 8,000 c/s. The amplification of the second stage depends on the load in the anode circuit, which in this case is a moving-iron telephone, and it increases at the higher frequencies. It is very important that the screen grid be decoupled by a condenser whose impedance is small in comparison with the two-megohm resistance, otherwise the screen current causes an out-of-phase EMF on the screen grid. The feed resistance and condenser can be dispensed with if a high-tension battery with separate tapping is used.

The circuit has inherent automatic volume control due to the screened grid circuit, and is such that the amplification is reduced considerably when there is between 1 and 2 volts AC drop across the half-megohm anode resistance. As a result it is not possible to get more than about 10 volts AC across the output telephone, and uncomfortable levels of sound are not obtainable. It is possible to shout into the microphone without a feeling of discomfort in the listening telephone, although the effective amplification for weak sounds is of the order of 45 decibels in the middle of the speech range.

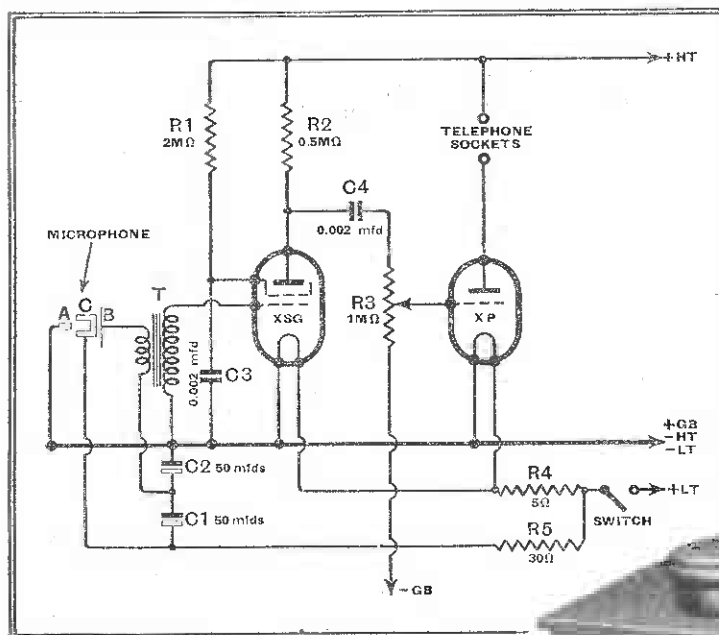
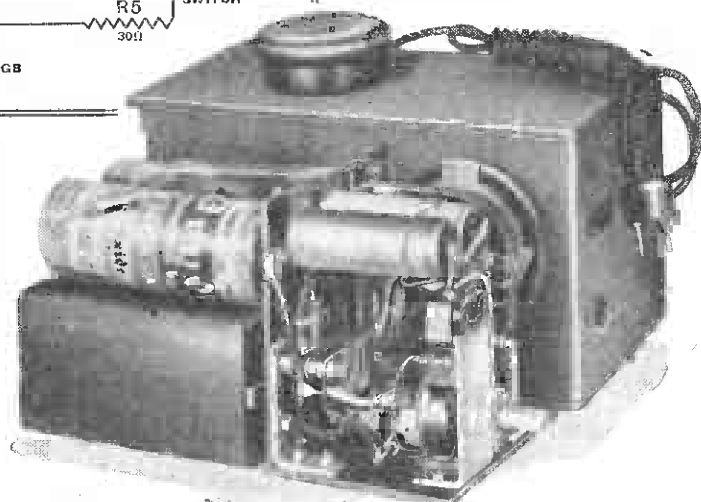


Fig. 1.—Theoretical circuit of the two-valve hearing aid. The connections to the microphone are given in Fig. 2. The instrument and the necessary batteries are shown withdrawn from the container.

circuit is to be preferred to the centre-tapped transformer.

The valve circuits is a straightforward resistance-capacity coupling. With an



¹ "Hearing Aid for the Deaf," *The Wireless World*, April 17th, 1936.

Improved Hearing Aid—

The LT supply consists of the popular type of three-volt cycle battery supplied at most wireless and cycle stores at a cost of eightpence. The filaments of the specified valves are rated at 2.0 volts, and measurements show that there is no appreciable loss in amplification when only 1.5

volts are applied to the filaments. A series resistance of 5 ohms (R4, Fig. 1) in the positive LT lead limits the voltage on the valves to 2.5 when the battery is new. This means the dry battery is effective without loss in efficiency until the voltage drops from the original 3 volts to about 2 volts. With the consumption of filament plus microphone currents of about one-sixth of an ampere this results in a battery life of about 12 hours. It is possible alternatively to use a 2-volt accumulator as the source of LT if desired, but the author has found that, in general, dry batteries are preferable to midget accumulators. For the HT supply one of the Drydex batteries of the same dimensions as that previously specified is used,

except that it has strip contacts for HT and GB connections. With a consumption of about 2.0 milliamperes the high-tension battery will last for about 120 hours (about 0.25 AH at this rate). Although the assembly of the components can be made in different ways, the one preferred in the present article is that in which all the components are housed together in a single box of dimensions $6\frac{3}{8} \times 3\frac{1}{4} \times 3\frac{1}{4}$ in. The microphone and amplifier are assembled in a single unit which can be withdrawn easily at will, should examination or repairs be necessary. Metal contacts are made on the back plate of the unit for connection to the battery supplies.

It is not essential that the deaf aid be constructed in the form shown here, as for certain requirements it might be more convenient if constructed as an attaché-case model, with the amplifier and batteries in separate compartments. The important thing is the circuit, and this should be adhered to without modification. For example, the amplifier and battery units could be carried in the pocket or in a handbag, while the microphone can have a long lead, and can be fitted in any convenient position. However, this particular form of construction is not so

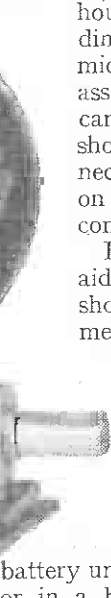
microphone. This can be made of Paxolin or of ebonite, and it has a $\frac{1}{16}$ -inch diameter hole cut in it and through which the back boss of the microphone passes. The holder is secured to the vertical panel by a brass bracket.

The volume control is mounted on a brass bracket, which in this case is fixed to the horizontal panel, and on top is the telephone socket, held in position by a clamp made of a strip of brass bent to the required shape. A 6BA screw passes through a hole in this clamp, then through a hole in the centre of the telephone socket, and through another hole in the bent over top of the bracket, and is secured by a nut. This bracket and the microphone holder should not be placed in position until after the valve-holders have been assembled. These are mounted on the horizontal panel immediately above two large holes for passing the wiring. They are fixed in position by means of brass screws with locking nuts, and their height is such that the tips of the sockets are on about the same level as the upper surface of the panel. The large holes previously mentioned enable the leads to be soldered to the valve-holders after they are assembled, since access is obtained from the back of this panel.

Mounting the Microphone

When all the valve-holder connections have been completed, the height can be adjusted, if necessary, by loosening the locking nuts. The microphone transformer can now be placed in position and secured by two countersunk screws and nuts to the horizontal panel. Immediately above this is mounted the holder for the microphone, which in this case is fixed to the vertical panel.

We now require two small resistances, one of 5 ohms, and the other of 30 ohms, these being shown at R4 and R5 respectively in the circuit diagram. The former consists of $4\frac{1}{2}$ in. of No. 40 Eureka resistance wire wound in the form of a loose



Components are mounted on two Paxolin panels joined together by brass angle-pieces.

volts are applied to the filaments. A series resistance of 5 ohms (R4, Fig. 1) in the positive LT lead limits the voltage on the valves to 2.5 when the battery is new. This means the dry battery is effective without loss in efficiency until the voltage drops from the original 3 volts to about 2 volts. With the consumption of filament plus microphone currents of about one-sixth of an ampere this results in a battery life of about 12 hours. It is possible alternatively to use a 2-volt accumulator as the source of LT if desired, but the author has found that, in general, dry batteries are preferable to midget accumulators. For the HT supply one of the Drydex batteries of the same dimensions as that previously specified is used,

The List of Parts

- 1 Microphone (Siemens Type 500 Differential Transmitter) Peto-Scott
- 1 Microphone Transformer (T) Savage H75/1
- 2 Electrolytic Condensers, 50 mfd., 12-volt working (C1, C2) T.C.C. Type F.T.
- 2 Midget Valveholders Hivac
- 1 1-megohm Volume Control with switch (R3) Centralab Midget with on-off switch
- 1 2-megohm $\frac{1}{2}$ -watt Resistance (R1) Erie insulated
- 1 $\frac{1}{2}$ -megohm $\frac{1}{2}$ -watt Resistance (R2) Erie insulated
- 2 0.002 mfd. Mica Condensers (C3, C4) T.C.C.
- 1 Small Bakelite Knob Bulgin
- 1 Headphone with band Peto-Scott
- 1 Telephone Socket
- Brass brackets, Paxolin sheet, brass strip, 6 BA screws and nuts, small quantity No. 40 Eureka DSC wire.
- Valves: 1 Hivac XSG, 1 Hivac XP
- Batteries: 1 Drydex type C 60 dry battery; 1 Drydex type X 554 45-volt dry battery, tapped -1 $\frac{1}{2}$ GB.

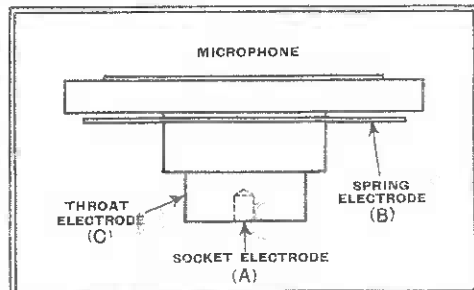


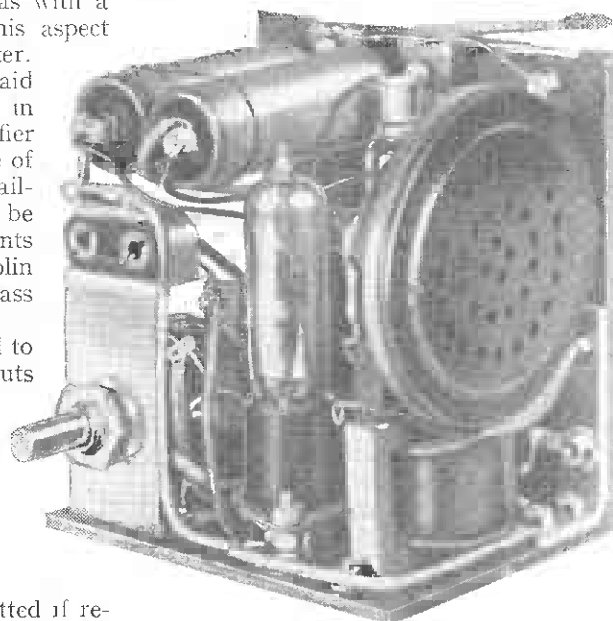
Fig. 2.—The connecting points A, B and C on the microphone relate to those shown diagrammatically in Fig. 1.

easily arranged with a carbon as with a non-carbon microphone, and this aspect will, it is hoped, be dealt with later.

The construction of the deaf aid is not unduly difficult, though, in order to accommodate the amplifier as well as the batteries in a case of the size already given, every available inch of space has had to be utilised. The various components are assembled on two thin Paxolin panels joined together by brass angle brackets.

The vertical panel has secured to it by countersunk screws and nuts six strips of springy brass that serve as contacts for the HT and LT batteries. Five contacts would suffice, three for the HT battery, i.e., HT +, HT -, and GB -, and two for the LT, but the sixth is included so that a small LT accumulator can be fitted if required in place of the dry LT battery.

A special holder is required for the



Another view of the framework, as seen from the microphone side.

Improved Hearing Aid—

solenoid. The same gauge wire is used for the 30-ohm resistance, but in this case it is wound on a thin strip of Paxolin $\frac{5}{16}$ in. wide and $\frac{1}{4}$ in. long, and it requires 30 in. of wire. Insulated wire should be employed.

When assembling the microphone it should be remembered that there are three connections to it. These are marked A, B, and C, and relate to the



Arrangement of contact strips for connecting the batteries.

actual parts of the microphone as shown in Fig. 2.

The amplifier is now completed and can be slipped into the cabinet. A locking nut on the volume control is used to clamp it into position, and finally the volume control knob is mounted on its spindle, which may have to be cut, as some of these midget volume controls have rather long spindles. The batteries can now be inserted, taking care that they are the correct way round, and pieces of wood can be used as packing.

As a test for sensitivity of the instrument, the telephone should howl when it is two or three feet away from the micro-

phone if the volume control is turned to the full position. When the telephone of a sensitive hearing aid such as the present one is removed from the ear while in use, this howling trouble can be a nuisance

both to the user and to others. It is therefore a good practice for a deaf user to develop the habit of either placing a finger or thumb over the hole in the telephone cap immediately it is taken from the ear or turning down the volume control.

In a later article it is hoped to describe a hearing aid using a crystal microphone resulting in less inherent background noise, although three valve stages are needed in the amplifier. It is also hoped to discuss the question of incorporating tone control in a hearing aid, including the present one, and to what extent it is desirable.

“Electrostatic” Scanning

A SUBSTITUTE FOR CATHODE-RAY APPARATUS?

AN electron stream seems to offer the almost perfect medium for scanning. It has no appreciable inertia and is very easily controlled, so that it can be swept over the picture at very high speeds. On the other hand, it necessitates the use of a cathode-ray tube, which is an expensive piece of apparatus with peculiar limitations of its own.

This raises the question as to whether there is any alternative medium which, whilst possessing the same flexibility as the electron stream, can be more conveniently produced and handled. A possible solution of this problem has recently been suggested in Patent No. 476714.

Two electrodes, A and B, in the figure (a), are charged to different potentials, so that an electrostatic field of force is set up between them, and a third electrode, C, charged to an intermediate voltage, is placed across the field, as shown. There will then be some point, such as x, on the transverse electrode at which the field intensity will be zero. On one side of x the field will be positive, and on the other side negative. If, now, the voltage on one of the electrodes A, B is varied, the position

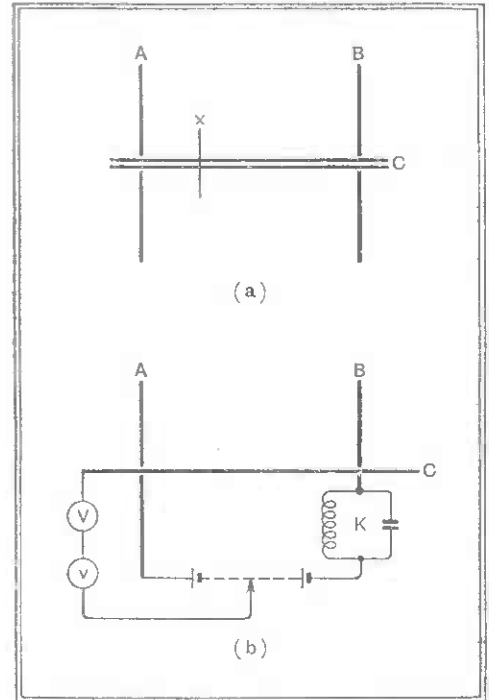
of the point x will shift accordingly. It can, in fact, be made to sweep along the electrode C from one end to the other.

Imagine this electrode C to be replaced by a photo-electric strip on which is focused one line of the picture to be transmitted. The point x now represents the boundary between that portion of the sensitive strip which will emit electrons along the positive field (say, towards the plate A, which will then be the anode) and that other part of the electrode which, because it is subject to a negative field, does not emit electrons. In other words, as the point x moves from left to right it will “scan” the line and send to the anode A a current representative of the varying light values existing along the line.

This current will be an integrated one, but signal “derivatives” can be obtained from it in various ways, such as by passing it through a transformer. Or one can superpose on the saw-toothed voltage V (figure (b)), which is used to “drive” the scanning point, an auxiliary high-frequency voltage, ν , which causes the point x to make rapid fluctuations about its mean position. The resulting HF oscil-

lations, which build up in the circuit K, will then contain a signal component proportional to the illumination from point to point along the line.

The picture to be transmitted is projected, line by line, on to the photo-sensitive electrode C in any suitable way. For instance, one can use a rotating scanning disc in which the usual spiral holes are replaced by narrow slits of sufficient length to pass one complete line at a time. In practice the three essential electrodes A, B, and C are mounted in an evacuated glass bulb to which screening and secondary-emission electrodes are added to control and reinforce the derived signal currents.



Illustrating the principle of a television transmission system in which the image is scanned by the movement of an electrostatic field.

Cathode-Ray Oscillograms

PAPERS AND FILMS FOR PHOTOGRAPHIC RECORDING

A SPECIAL study of the problems associated with the recording of cathode-ray oscillograms photographically has been made by Kodak, Ltd., and their range of papers includes a type (P.25) specially prepared for use with blue fluorescent screens. A film material known as R20 is also available for the same purpose.

Both film and paper are supplied in various widths and standard lengths of 25, 50 and 100ft., and may be obtained with or without perforations along the edges. The perforations fit standard cinematograph sprockets and the 35 mm. and 59 mm. widths are supplied.

The emulsion used is of wide latitude to give a uniform trace with a varying “spot speed,” and technical advice on development, etc., is available from the Service Dept., Kodak, Ltd., Wealdstone, Middlesex.

New Local-Distance Circuit

COMBINING THE SUPERHETERODYNE AND THE STRAIGHT SET

By JAMES WHITE, A.I.L., M.Inst.E.

A METHOD of combining in one receiver the advantages of the superheterodyne for distant reception and the straight set for local listening is described in this article. For local work the author recommends the use of the infinite input impedance detector.

ONE of the most prolific sources of argument among radio engineers, professional and amateur alike, has been the TRF-superheterodyne controversy.

From the general standpoint of economy and, in all-wave sets, from necessity, the superheterodyne circuit is the best for reception from other than a local or relatively near transmitter. When, however, the programme required comes from a nearby transmitter, the TRF set usually gives better results as regards quality with economy. Less tone-correction is required to restore the full frequency response, and rarely is more than one stage of RF amplification necessary to feed an adequate signal to the detector or demodulator.

It would, therefore, seem desirable that, where two separate tuner chassis cannot be used, some method of incorporating both types of circuit with a simple

system for changing over from one to the other should be used. Several arrangements have been used in commercial receivers, but all had some drawback. It

was while considering this problem that the writer originated a circuit which achieves the desired result with simplicity. Before describing this actual circuit it may be interesting to review the stages by which it was arrived at, and the attendant disadvantages of other schemes.

The first idea was to switch the detector of a superheterodyne receiver so that it received its signal either from the last IF

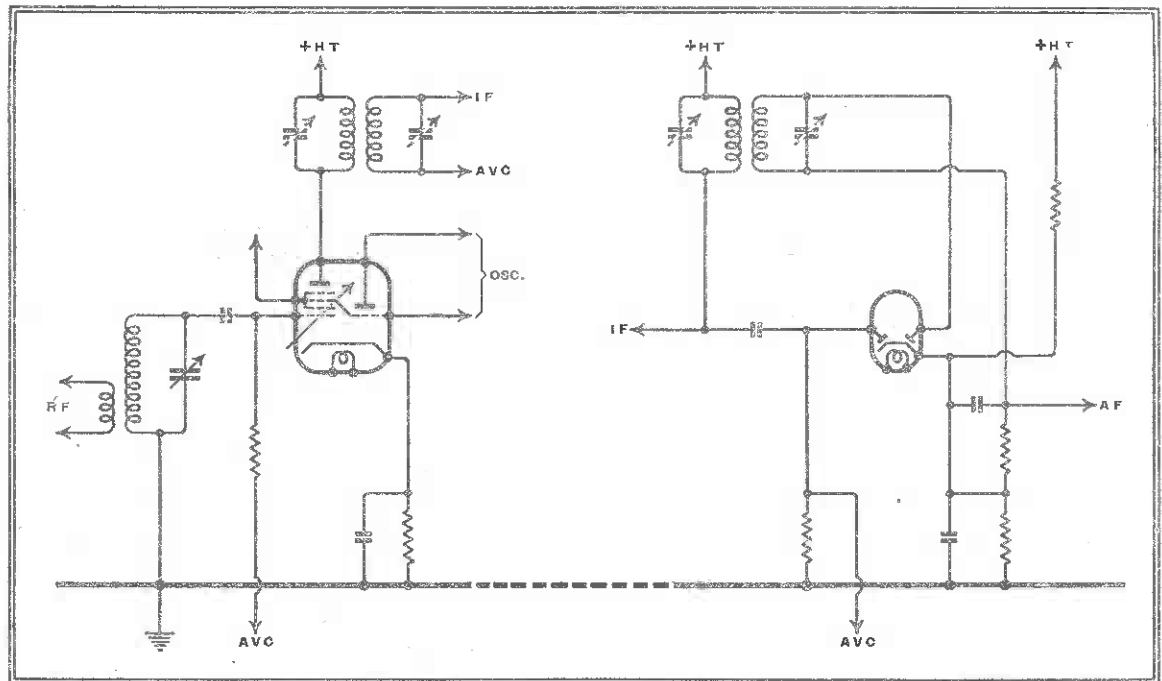
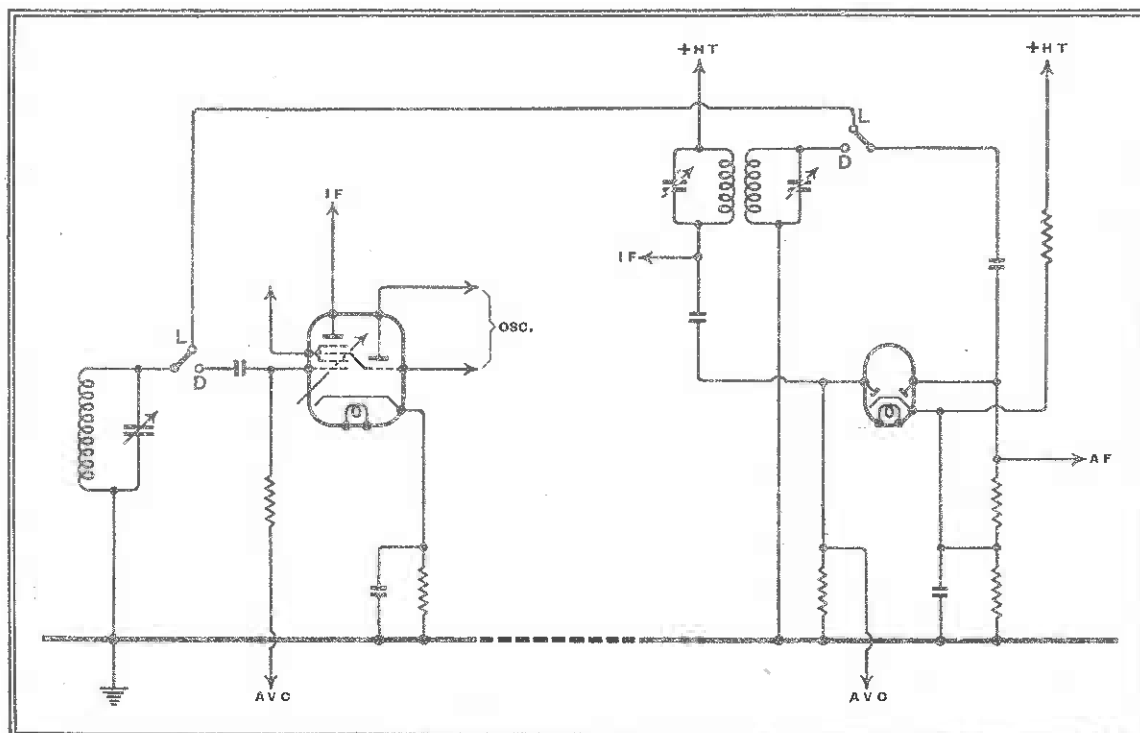


Fig. 1.—The basic frequency-changer and detector circuits of a conventional superheterodyne are shown here.



circuit for distant reception, or from the last signal-frequency circuit for local high quality listening. Let us consider the possibilities in a normal receiver.

In Fig. 1 will be seen the skeleton circuits of the frequency changer and the double-diode detector of a normal superheterodyne. The detector and AVC diodes impose comparatively heavy loads on the tuned circuits to which they are connected. Where the IF amplifier includes a series of such tuned circuits, however, the loss in selectivity is not very serious.

Fig. 2.—One method of changing a superheterodyne to a straight set is illustrated in this diagram. It has the disadvantage of needing switching in RF leads and of damping the signal frequency circuit.

New Local-Distance Circuit—

However, such loading imposed upon a signal-frequency circuit would cause a comparatively large drop in the available selectivity. In addition, the actual arrangement of such a circuit in a practical chassis design would have to be extremely carefully carried out, otherwise feedback with unpleasant results might

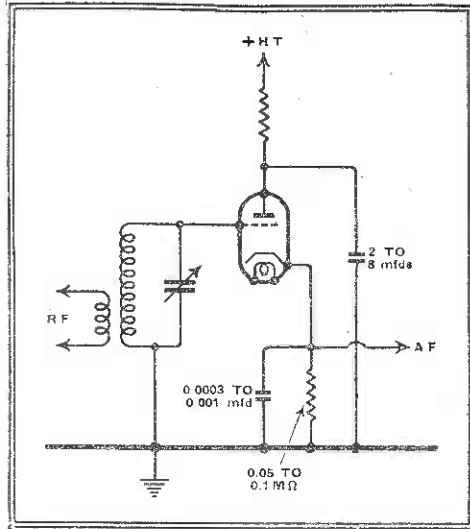


Fig. 3.—The infinite impedance detector is shown here, a better name for it is probably the negative-feedback anode bend detector.

occur when using the set as a superheterodyne. Fig. 2 illustrates the manner of switching such a circuit.

The next possibility examined was a separate valve to operate as detector when receiving a local transmission. The diode was again considered unsuitable for the reason already given, that of loading the preceding tuned circuit too heavily. The most useful of the usual circuits seemed the power grid detector, although this also has a low input impedance. But again switching would bring in difficulties, as a change-over switch would be needed at a point of high RF potential.

The Latest Detector Circuit

Finally, a new detector circuit was considered—the negative-feedback anode bend detector. Another name by which it is called gives the clue to the ultimate circuit—the infinite input impedance detector. Readers of *The Wireless World* will remember an article on this circuit in which two important claims were put forward.¹ The first was that as good, if not better, quality could be attained with such a detector as with a diode, and the second, that the load imposed on the preceding circuit was negligible. The basic circuit of such a detector is given in Fig. 3. Previous experiments by the writer bore out the truth of these claims, and it was decided to try out the circuit in an actual chassis. There still remained, however, the problem of the switch at the high potential end of the driving circuit.

The second of the claims mentioned above suggested a possible solution—that of leaving a separate detector for local

listening permanently connected across the final signal-frequency circuit. In such a case the switching necessary to change from "superhet" to "straight" reception would only be a matter of taking the audio-frequency output from the appropriate detector valve. The circuit in Fig. 4 illustrates the switching.

This circuit was tried out in a superheterodyne consisting of a 6K7G RF amplifier, a Tungram 6TH8G triode-hexode mixer, a 6K7G IF amplifier and a 6C5G arranged as an infinite input impedance second detector. Results justified the confidence placed in the original idea, but certain points came up for revision.

When the set was correctly aligned for superheterodyne reception it was found that retuning was necessary when the change-over was made to the local position. Fortunately, the first remedy tried effected a cure. Another switch was incorporated to cut off the HT supply to the oscillator section of the triode-hexode, and it was then found that the same tuning position was correct for both methods of reception. In the final circuit a DPDT switch was incorporated as in Fig. 5, to break the HT and SG feed circuits of the inoperative valves in the "local" position. Where RF pentode valves are used which require a SG voltage less than the anode voltage, it will be necessary to feed the screen grid of the RF stage from a separate

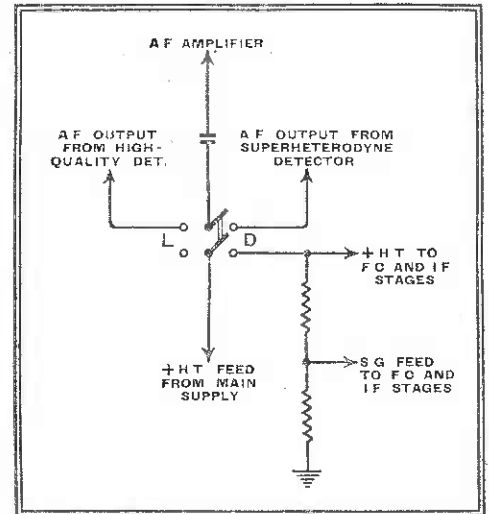


Fig. 5.—It is advisable to insert a switch to remove the HT supply from the frequency-changer as shown here.

potentiometer so that the voltage fed to the mixer and IF amplifier screen-grids may be cut off at the same time as their anode voltages. It is undesirable for the screen potential to be applied to a pentode when no HT voltage is fed to the anode.

This also has the advantage that the valves not in use are drawing no current except in the heater circuits, so that their life is not being uselessly expended.

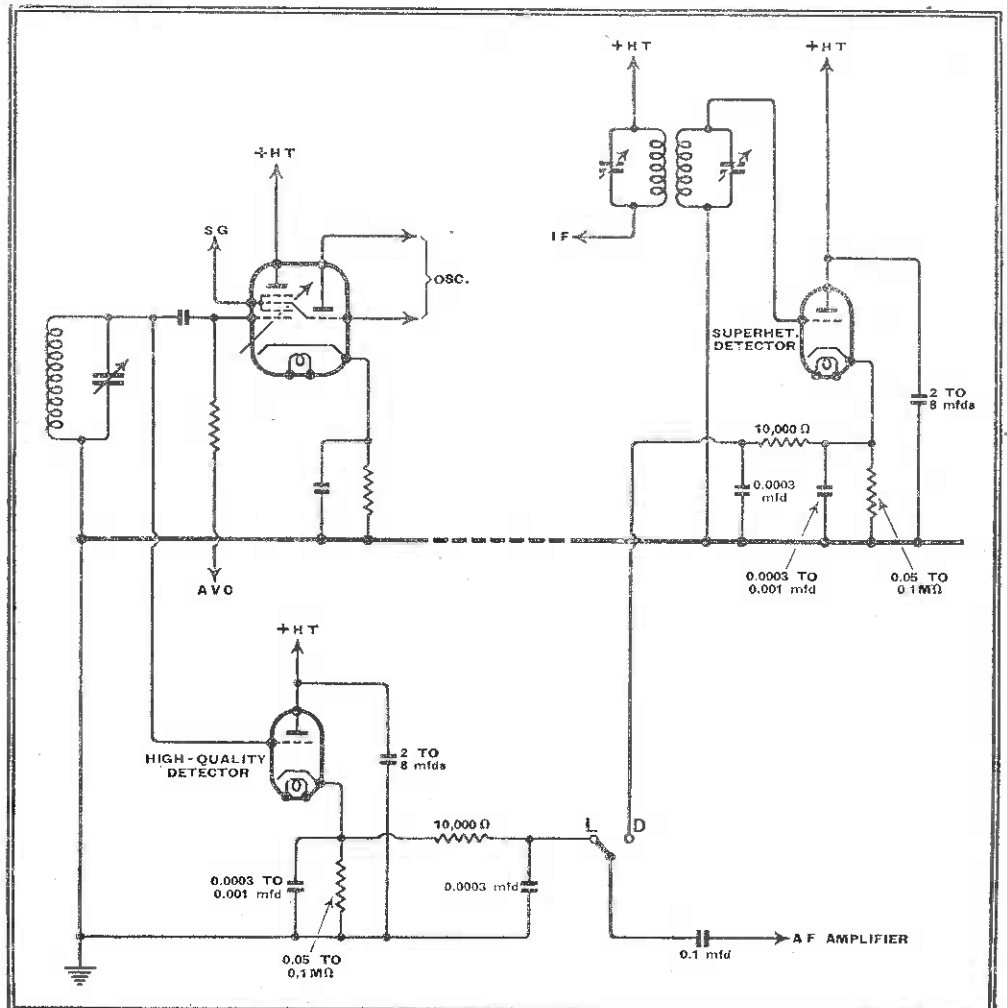


Fig. 4.—This diagram shows the recommended circuit and it will be seen that both frequency-changer and straight set detector are connected to the signal circuit. The switching is in the AF circuits.

¹ *The Wireless World*, January 1st, 1937.

New Local-Distance Circuit —

Another point arises in the AVC feed to the triode-hexode. Any AVC voltage is best parallel-fed as in Fig. 4, that is, through a high resistance connected directly to the control grid so that the "earthy" end of the preceding tuned circuit may be directly connected to the chassis line. Otherwise, if AVC is fed as in Fig. 6, the AVC decoupling and load resistors will all be in the grid-cathode circuit of the detector.

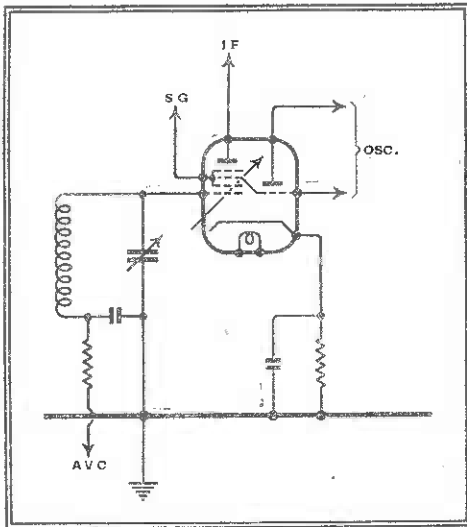


Fig. 6.—The conventional AVC feed is applied at the earthy end of the tuned circuit and is not recommended.

Where a similar detector is used following the IF amplifier AVC may be obtained from a separate IF chain and diode rectifier, or from a "square law" anode bend rectifier fed from the last IF transformer. The latter method was incorporated in the writer's experimental chassis, the potential of about 100 volts below chassis, which such a circuit needs, being supplied by a separate rectifying system, as in the QA Super.⁴

Using a Plain Diode

If desired, the superheterodyne detector may be a normal diode, thus simplifying the AVC circuit, as the change-over switch merely selects the AF output from the detector required. As a filter to separate the residual RF component from the audio-frequency output is connected directly to each detector, the only precautions necessary are such as might be required in AF amplifier input switching circuits, e.g., screened leads to avoid hum pick-up, etc.

In conclusion, it may be mentioned that the shunt effect of the high-quality detector when the set is used for distant reception seems to have no deleterious results. Selectivity is not impaired to any measurable extent, and sensitivity is affected, if at all, to only a negligible degree. When first setting up the circuit, however, there are two points to be watched. The first is that the input capacity of the detector comes across the input tuned circuit of the frequency-changer, so that the setting of

the trimmer must be reduced to maintain correct gauging. The second is that the infinite input impedance detector normally has a negative input resistance³ and so will sharpen the tuning of the signal-frequency circuit. In an extreme case, where the signal circuit is unusually good, it may cause instability, which can be cured by increasing the cathode-to-earth condenser of the detector.

³ *The Wireless World*, October 15th, 1937, and December 15th, 1938.

Kinva Whistle Rejector

A NEW whistle rejector is being produced by Postlethwaite Bros., of Church Hill, Kinver, Staffs, for which an outstanding performance is claimed. It comprises an assembly of two coils, a fixed condenser, a fixed resistance, and a variable potentiometer, and there is a separate air-dielectric variable condenser.

There are two types—the V5 for use in the anode circuit of an AF valve, and the V6 for use in the grid circuit. With the V5 there is an anode current limitation of 12 mA. The tuning range of the V5 is 8,000-11,000 c/s, and of the V6 7,500-11,500 c/s.

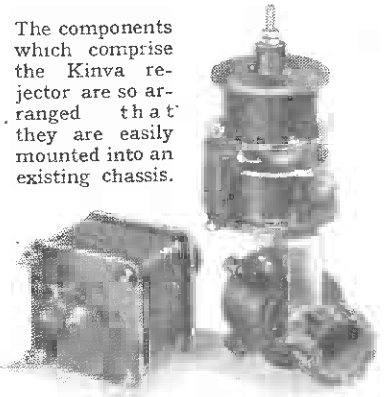
The component acts as a rejector of very narrow band-width, and must be mounted so that both the condenser and potentiometer have their controls accessible. The frequency of rejection is controlled by the condenser which is tuned for minimum whistle, and the amount of rejection can be varied by the potentiometer.

This control actually balances the effects of the coil resistance, and theoretically allows infinite rejection to be obtained. The makers claim that the response can be made less than -65 db, and it is, of course, difficult to measure such large attenuation. The band-width is extremely narrow, and the inclusion of the filter in a receiver con-

sequently has a negligible audible effect on the reproduction.

Owing to this narrow band-width, careful

The components which comprise the Kinva rejector are so arranged that they are easily mounted into an existing chassis.



adjustment is needed to bring the trough in the response to the whistle frequency, but this is by no means difficult, and the filter is capable of an outstandingly good performance. The model V5 is priced at 25s. 6d. and the V6 at 24s. 6d.

PROBLEM CORNER—3**Test Your Powers of Deduction**

THE correspondence of Henry Farad shows that he is looked to by his friends to help them out of their radio troubles. Here is another problem that was put to him. What do you think is the most likely solution?

Rose Cottage,
Nitting Sockbury,
Worcs.

My dear Henry,

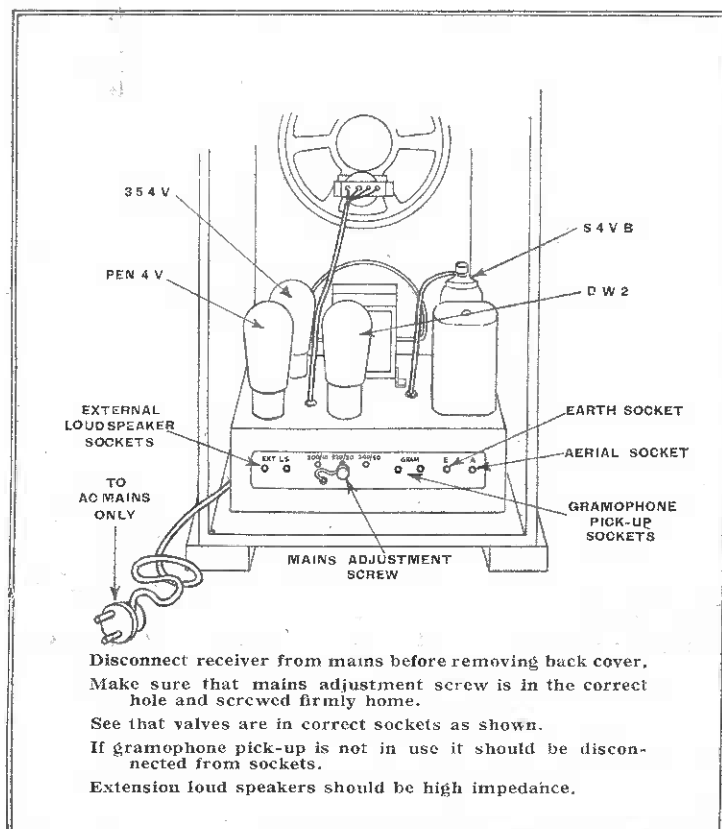
I wonder if you can tell me if anything serious has happened to my wireless. This evening when I switched it on for the

News there was a sort of steady droning noise. The voice was there all right, but not so easy to listen to for the buzz. It was all right this morning when I had it on for the morning service. I did a bit of dusting round afterwards and the plug came out of the wall, but I put it in again directly. It is rather an old wireless, so in case you have forgotten what sort it is I am sending the leaflet. [Reproduced on left—Ed.]

How mild it has turned all of a sudden after the hard frost.

Yours very sincerely,
Jane Stoughton.

Somewhat meagre material on which to base any logical deductions, but to Henry Farad every word was significant. His diagnosis is on page 68.



Disconnect receiver from mains before removing back cover. Make sure that mains adjustment screw is in the correct hole and screwed firmly home. See that valves are in correct sockets as shown. If gramophone pick-up is not in use it should be disconnected from sockets. Extension loud speakers should be high impedance.

⁴ *The Wireless World*, February 28th and March 6th, 1936.

Broadcasting in Iceland

IN a country like Iceland, where a total population of barely 118,000 is scattered over an area of 39,709 square miles, broadcasting is bound to become of greater importance as a factor of national life than in most other countries. The importance of the work of the Iceland State Broadcasting Company (Ríkisutvarpid) is thus summed up by Mr. Jonas Thorbergsson, the Director-General and creator of the organisation: "No nation is more in need of a broadcast service than Iceland. The country is large and the inhabited parts are scattered around the coast and cut off from one another by mountain ridges. Winter communications are rare and difficult. The broadcasting of weather reports in three languages has been a most efficient means to safeguard life around the coasts of Iceland."

It was not until 1930, when most European countries had already gained several years' practical experience in broadcasting, that the Iceland State Broadcasting Company was formed. Having realised from the beginning that broadcasting should be a national affair, the authorities decided to furnish the broadcasting organisation with the greatest possible power in all matters pertaining to broadcast transmission and reception.

The organisation is conducted entirely by the State as an independent Government Department. Culturally, commercially and technically, it is under the control of the Ministry of Education. The charter issued in 1930 gives the company a monopoly not only on the construction and operation of broadcasting stations, the collection of licence fees, and the preparation of programmes, but of the manufacture, importation, and sale of receiving sets and the servicing of receivers.

There are at present two transmitters in use, the recently inaugurated 100-kW station at Reykjavik working on 1,442 metres (208 kc/s) and the 7-kW short-wave station TFJ at Reykjavik, which works on 24.52 metres (12 235 Mc/s). All offices and studios are in the post office building.

An interesting arrangement has been made

situated about half a mile from Eidar, and conveyed by cable to the new station for re-radiation.

There are at present over 15,000 licence holders, which is equal to approximately 127 receivers per thousand inhabitants, which places Iceland ninth in this respect in the countries of the world. The annual licence

fee is 30 Icelandic kroner, or approximately 27s. This is, of course, rather high compared with other European countries, but the

Icelandic listeners are receiving an outstanding service for their money.

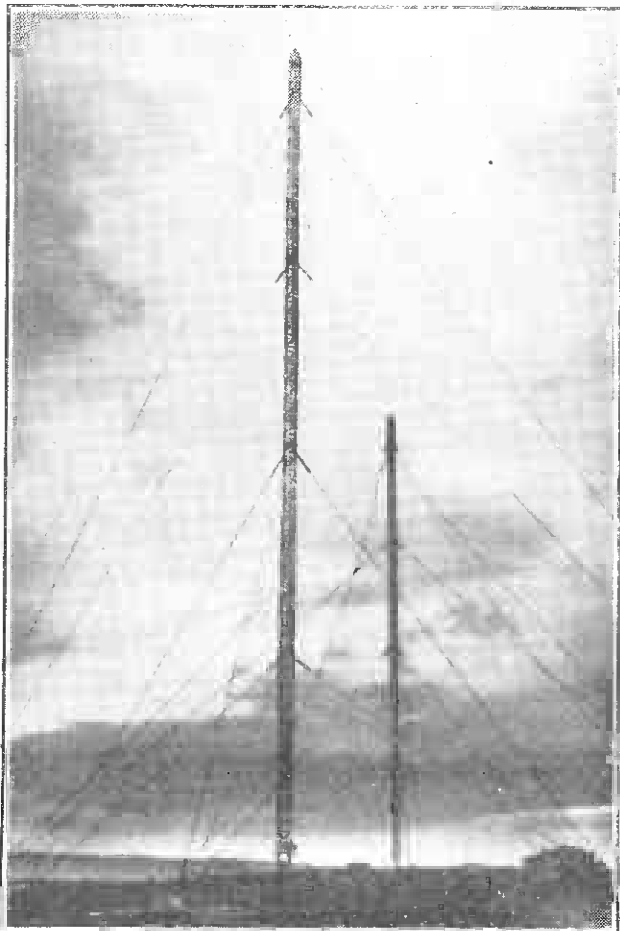
The company does not stop at providing suitable transmitters and a programme service in return for the licence fee, but it is also concerned with the task of ensuring that listeners get first-class receiving equipment and free technical assistance regarding the installation and maintenance of the receivers. A number of leading European high quality sets are tested by the engineers, and those passing the tests are imported by the Sales Department and sold to the listeners at a price leaving the company an extremely modest profit on the transaction.

Owing to the scattered population, the electrification of Iceland has not progressed to any large extent outside the main towns, and battery receivers are therefore the backbone of the radio trade. This has given the company yet another problem to solve, viz., the provision of accumulator-charging facilities. A considerable sum is being spent each year in the con-

The 500ft. masts of the new Marconi-built 100-kW. long-wave station about 5½ miles outside Reykjavik, the capital, a general view of which is also shown

There is a central servicing department at Reykjavik which has a permanent staff of ten service engineers, who carry out all overhauls and repairs on listeners' receivers in the South, with a similar centre in the North. The transport expenses on receivers for overhaul are defrayed by the Ríkisutvarpid. In addition to the servicing department there are a number of private individuals who have been given free technical instruction at the capital so that they may help listeners in their own locality. A service expert from Reykjavik makes a complete tour of the country each year, and any listener who desires to have his set examined is entitled to seek the aid of this travelling serviceman.

Special emphasis is laid on the educational side of broadcasting, and five languages—Icelandic, Danish, English, German and



with regard to the programmes to be radiated by a new 1-kW relay station now under construction at Eidar, on the East Coast of the Island. As a cable would be much too costly, the programmes from the long-wave transmitter at Reykjavik are to be picked up on a high quality receiver

construction of wind- and water-driven generators for this purpose in the remoter districts. So far, over one hundred charging stations have been provided with private individuals in charge of the stations, for which they receive a small fee of from 5 to 10 kroner per accumulator annually.

Esperanto—are taught. The news bulletins and weather reports have a unique significance in this thinly populated country, where newspapers may be days or even weeks on their way to subscribers in lonely outposts, and a greater number of political talks and election campaigns are broadcast in Iceland than in any other European country.

Although a medium-sized radio orchestra and choir are maintained, it is significant that approximately 83 per cent. of all musical programmes is provided by gramophone records. Programmes are supervised by a council of seven elected for four years. Three members are appointed by the Alting (parliament), three by licence holders, and the chairman by the Minister of Education.

UNBIASED

By
FREE GRID

How to Learn Morse

A READER who has aspirations to become an amateur transmitter evidently thinks that I am some kind of oriental djinn, able to build castles overnight, for he has asked me to give him some method whereby he can learn the morse code without the tedious grind of daily practice. I wish really that all questions which are put to me were as simple as this one, for the answer is that there is no such method.

I know what I am talking about, for many years ago I myself tried to find a royal road to morse proficiency, and if I had spent half the energy in daily practice that I did in searching for an easy way out of it, I should have learned it in half the time that I did. There are several methods which claim to make the learning of morse absurdly easy, but to my mind many of them only succeed in making the way of the beginner harder than it need be.

It is my firmly held opinion that the best way to learn morse is similar to the best way to learn languages, that is, not to learn them at all in the sense of studying from books. I know what I am talking about here, also, for I have had a shot at a few languages, and I can truthfully say that the only one I can speak fluently is the one which I imbibed by



Lessons from an expert.

word of mouth from native teachers, not a single word of printed matter being put before me until I had had some half-dozen years' oral practice. Other languages which I tackled in the more orthodox fashion still leave me floundering after spending much greater time and effort on them.

My morse experience also leads me to

the conclusion that to learn that A is dot dash and so on is not only unnecessary but undesirable. The best plan is to get some native teacher—or, in other words, some morse graduate—to sit down with key and buzzer and send a dot and a dash and tell you that that combination of sounds represents A; in other words, learn the morse representation of the various letters of the alphabet as each having a sort of musical rhythm of its own. You will learn much more quickly this way and, what is more, will eventually gain far greater speed and accuracy than by any other method of which I have knowledge.

I well recollect that when I finally arrived at the above conclusion and set out seriously to learn the code I went in for the thing thoroughly and issued a ukase forbidding all conversation in my household, communication being allowed only by means of the morse code. Each member of the family and each servant was supplied with a small portable key and buzzer set, and we got along famously. Mrs. Free Grid's buzzer, I remember, was in such constant operation that three pairs of platinum contacts were worn out in as many days, and as for the dry cells she used, I can only point to the fact that as a direct result of the trade done the local electrical dealer was able to carry out extensive alterations to his premises.

This Radio Realism Business

I SEE that the hoary old question has cropped up again as to whether it can be truly claimed that a receiver reproduces the programme without alteration—or, in other words, *really* reproduces it—unless it bellows it out with the same volume as the original. In one sense, of course, it can certainly be said that no receiver reproduces the efforts of, for instance, a brass band properly unless it preserves the original volume, but who on earth wants a brass band crashing out in a corner of the room?

In my opinion, the proper way to look at the problem is to take an analogy from some other field of art, photography, for instance. Now it would be a perfectly easy matter to construct a camera or an enlarger to produce a full-sized picture of Aunt Maria, but who in their right senses really wants a full-sized picture of her hanging on the wall? It is bad enough having an ordinary-sized one on the piano. A full-sized photograph would be quite in place in a public gallery, of course, where there would be ample space for it, and so, also, would a brass band. For our homes we are perfectly content



Aunt Maria.

with a photograph which reproduces Aunt Maria a fraction of her real size, the exact size depending on how near we want to get to the full-sized original without making the whole thing look incongruous. Similarly with music. It would be ridiculous, to have the full volume of a brass band in the room, and the exact degree of volume which we can and should have depends on the nearness to reality which the size of the room will permit.

Now I know perfectly well that I shall be told that when volume is reduced the softest passages of a musical spasm will be so soft that they will be inaudible or, at any rate, drowned out by the inevitable background of valve hiss and other internal noises. Certainly they will, but we must be content to lose them, just as we are content to lose sight of the gold fillings in Aunt Maria's teeth in a small-sized photograph, for just as the soft passages of music are swamped by the internal background noises of the set, the gold fillings are swamped by the background of the printing paper, commonly known as the grain.

I am perfectly well aware, of course, that what I have suggested is a compromise, but isn't everything in life a compromise? For those purists who must have a full-sized photograph and a full-throated brass band there is nothing to prevent their having them by the simple expedient of building houses of sufficient size to cope with them. At any rate, them's my sentiments.

Confidential

I WAS interested to learn from "Dialist's" notes that a power meter does not register such a relatively low drain as 50 watts, but I very strongly disapprove of facts of this nature being made public. Although the standard of ethics maintained by readers of *The Wireless World* is, I feel sure, as high as my own, it must not be forgotten that, in common with other less worthy journals, its pages are sometimes put to base uses such as that of wrapping up fish and chips, with the result that information of this type is apt to fall into undesirable hands.

It would be perfectly possible for some unscrupulous person to install a battery of accumulators having the same voltage as the mains and to trickle charge them for eighteen hours or so every day and use them at a high discharge rate during the evening. I, of all people, hold no brief for the electric power supply companies, but I should not like to stand idly by and see them *lawfully* cheated out of their just dues.

Designing a Filament Transformer

By H. B. DENT

STEPPING UP FROM 4 TO 6.3 VOLTS

RECENTLY some 6.3 volt valves were required to be used in place of the standard 4-volt variety in an amplifier, and it was decided to make up a small transformer to step up the voltage from 4 to 6.3. This could be made somewhat smaller than a filament transformer with 230 volts input, and it would also maintain approximately the same load on the existing filament supply. Possibly others faced with a like problem might be interested in the design details of this component.

In a case of this kind a double-wound transformer is not necessary, and a single winding with suitable tapplings will serve the purpose. It is merely an auto-transformer arranged as shown in Fig. 1.

It might be asked why two tapplings for the 4-volt input; why not just tap the winding a suitable distance from one end? Well, of course, this would serve the purpose were it not for the fact that it was desired to retain the earthed centre tap to prevent hum. With a single tapping and one end of the winding common to both input and output circuits this could not be done. As will be seen from Fig. 2 that with the existing filament winding centre-tapped and earthed, the earth point would not be the centre of the 6.3-volt section.

The correct procedure would be to calculate the size of wire, volume of iron and number of turns wanted and then find a standard size of stampings to fit this design; but, having a quantity of Stalloy No. 5 stampings available, a short cut was adopted and a design prepared based on this size of core. It must be admitted that the choice was not made without due consideration, and previous experience in the construction of small mains transformers was called upon in deciding on their suitability. Actually, this core is about the optimum size for the transformer, which on full load will be handling about 14 watts. If the design is prepared on the basis of 5 watts per cu. in. of iron it always proves quite satisfactory, though possibly a little more generous in iron content than is sometimes adopted.

The centre limb of these stampings measures $\frac{3}{8}$ in., and bobbins to fit them are readily obtainable from Sound Sales, Ltd.

As the centre hole measures $\frac{3}{8}$ in. \times $\frac{3}{8}$ in., the volume of iron in the core works out at 3.7 cu. ins., which is only 0.67 cu. in. more than the optimum size for this transformer.

A little departure from correct practice was made in calculating the turns per volt required, and the cross sectional area of the side limbs was used instead of the area of the centre limb. Usually the tail of the "T" piece is twice the width of the outside limbs, in which case using either dimensions gives the same number of turns per volt. In this case, however, the centre limb is narrower than usual, and if this dimension is used the winding will have to be based on 15 turns to the volt. On the other hand, taking the dimensions of the outer limbs, 10 turns to the volt only would be needed.

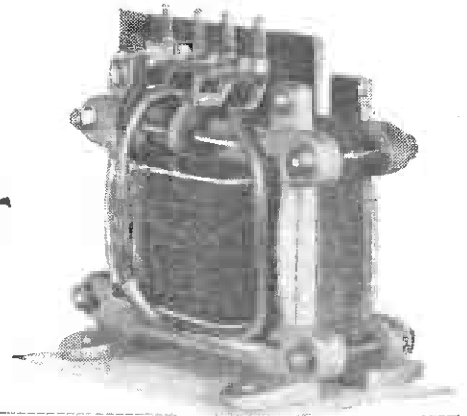
Winding Data

As the centre limb forms only a small portion of the total iron path, and, furthermore, there is more iron than is really needed, a justifiable compromise was made and 12 turns to the volt chosen. Having a shorter total length of wire and a correspondingly lower DC resistance, the regulation of the transformer will be improved.

The transformer was required to give 6.3 volts at 2 amps. or 12.6 watts, and, if we assume an efficiency of 90 per cent. (this figure can actually be checked later when the design is finished), the primary watts work out at 14.

Now, 14 watts at 4 volts means a primary current of 3.5 amps., which, at a current density of 1,200 amps. per square inch, gives the optimum gauge of wire as No. 16 SWG. Enamelled wire is used. Actually, a smaller gauge would suffice, but there is ample space on the bobbin to accommodate the larger.

We therefore require 48 turns for the primary and 76 turns for the secondary. Before starting to make the transformer we must find by calculation the probable volt-



THE design and construction of a small transformer for obtaining a 6.3 volt supply from an existing 4-volt winding on the mains transformer are explained in this article.

age drop due to the resistance of the wire.

In the primary section there will be 7.4 yards, which figure is obtained by measuring the mean length of the turns and multiplying by the number of turns. Similarly, the total length of the secondary works out at 11.6 yards. Now, the resistance of 7.4 yards of No. 16 SWG is 0.55 ohm, and with 3.5 amps. flowing there will be 0.19 volt dropped. To compensate for this, two turns will be added to the primary, making 50 in all.

We now have left on the coil 26 turns to provide the extra 2.3 volts, but at 12 turns to the volt it gives only 2.17 volts. Two turns must, therefore, be added. These 28 turns have a length of 4.2 yards with a DC resistance of 0.0315 ohm, and at 2 amps. 0.06 volt will be dropped. This is too small to justify compensation.

Of the 78 turns now required, 50 become the primary and the remaining 28 are disposed equally on each side of it. We will, therefore, decide to divide the winding into three sections of 14, 50 and 14 turns respectively. At this stage it is possible to check our assumption of an efficiency of 90 per cent., for if it is lower a readjustment may have to be made. From the Abacs in *The Wireless World* Radio Data Charts, and using the curve for

Stalloy 0.014 in., the watts lost in 3.47 cu. ins. of core is 0.53.

The copper loss, i.e., that due to the resistance of the wire or the I²R loss, and before any correction or compensation is made is: Primary section 0.55 watt,

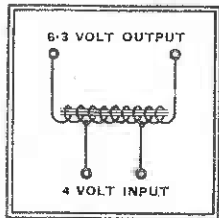


Fig. 1.—Auto-transformer with tapping, arranged for 6.3 volts output with a 4-volt input.

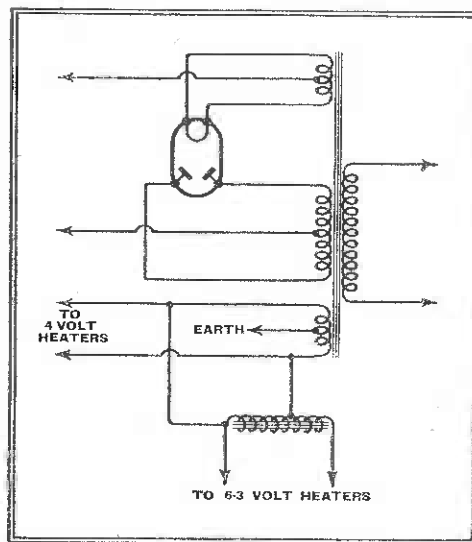


Fig. 2.—If an auto-transformer has a single tapping only the earth connection on the existing 4-volt supply will not be in the centre of the 6.3 volt section.

Designing a Filament Transformer—

secondary section 0.126 watt, which together amount to 0.676 watt. Added to the iron loss this becomes 1.206 watts. Now add 1.206 watts to the secondary output of 12.6 watts, and we get a total primary wattage of 13.806, giving an efficiency of 91 per cent., which is actually better than the assumed figure.

Constructing the transformer hardly needs a detailed description, as it entails nothing more than winding on the turns stated and bringing tappings out where indicated. Owing to the thickness of the wire the turns should be wound on evenly. The 14 turns before the first tap occupy less than the width of the bobbin, but at the end of this section the wire is cut and its end threaded through a hole in the opposite check to that through which the beginning of the wire was passed. The space left can be filled in with four pieces of cardboard having the same thickness as the wire, and over the whole is put on a few turns of good-quality insulation tape. This leaves a smooth surface for the next section of 50 turns, which can easily be accommodated in three layers of wire. This brings the second tap out through the same check as the beginning of the first

section and just under $\frac{1}{2}$ in. up from the bottom of the former. The last 14 turns then finish at the opposite check. Thus, through one end check there is the beginning or one end of the 6.3-volt winding and the second tapping or end of the 4-volt section, while through the opposite check pass the beginning of the 4-volt section and the other end of the 6.3-volt portion.

These ends can be taken to a terminal plate and arranged in the same order as the theoretical diagram, Fig. 1, so that the two outers give 6.3 volts and the two inners are the 4-volt input. Of course, the transformer can be used the opposite way round, and when joined to a 6.3-volt supply will give across the two inner terminals 4 volts.

Before the winding is started a "T" stamping should be inserted in the centre hole in the bobbin to make sure it fits correctly, as it is best to do any smoothing out with a file before rather than after the bobbin is wound. During the winding process the bobbin should be clamped between wooden or metal end plates with holes drilled in them to pass the ends and tappings. This prevents the bobbin becoming distorted when winding on the heavy gauge wire.

Short-wave Therapy

A NEW APPLICATION

FOR several years past increasing use has been made of short waves in treating various ailments of the body, and they are now being applied to deal with certain eye troubles, apparatus for this purpose, using a 6-metre wavelength, having been installed at the Royal Westminster Ophthalmic Hospital.

The use of short-waves for curative purposes was developed as a means of simulating the methods used by Nature for combating certain diseases by creating a fever in the body. It was thought that a whole

host of other diseases might be cured, or at any rate alleviated, if an artificial rise of bodily temperature could be produced, similar to that brought about by a fever. This trend of medical thought particularly applied to diseases of the central nervous system, and many years ago some remarkable cures were reported by deliberately infecting the patient with malaria germs, these producing the necessary fever.

Naturally such a curative measure has brought its own dangers, in some cases the cure being worse than the original

disease, and it was not long before other and safer means of inducing a fever were sought. The subsequent research work led to the development of short-wave therapy as we know it today. One of the main advantages of the method is that a temperature rise is localised in certain organs of the body only without causing any undue effects on the skin and the fatty tissues in which the body is encased.

The wavelength employed in short-wave therapy usually ranges between 6-20 metres, the power being somewhat under 1

kilowatt. In some types of apparatus the radiation is applied vertically through the body by means of two electrodes, whereas in other types use is made of closed loops resting above and below the body of a recumbent patient. It is said that this latter method possesses many advantages over the first-mentioned and older system.

Television Programmes

Sound 41.5 Mc/s.

Vision 45 Mc/s.

An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. till 12 noon each weekday. The National or Regional programme will be radiated on 41.5 Mc/s from approximately 7.45 to 9 p.m. every day.

THURSDAY, JANUARY 19th.

3, Jack Jackson and his Band. 3.30, Gaumont-British News. 3.40, 209th edition of Picture Page.

9, "O Mistress Mine," an anthology of love scenes 9.30, British Movietonews. 9.40, 210th edition of Picture Page. 10.15, News.

FRIDAY, JANUARY 20th.

3-4, "Hansel and Gretel," a masque to the music of Humperdinck; choreography by Andrée Howard.

9, Eric Wild and his Band 9.20, Gaumont-British News 9.30, Cartoonist's Corner—Bruce Bairnsfather 9.40, Film. 9.50, "La Chauve-Souris," in selections from their repertoire. 10.20, News.

SATURDAY, JANUARY 21st.

2.25, Rugger O.B. from Twickenham; England v. Wales. 3.10, Cartoon Film 3.15, "Edna's Fruit Hat," a comedy by John Pudney

9, Cabaret. 9.40, British Movietonews 9.50, "Quotation Marks." Well-known men and women will compete in a new kind of memory-twister. 10.20, News.

SUNDAY, JANUARY 22nd.

3, Cartoon Film. 3.5, "Three-Four," the romantic story of the waltz. 3.35, British Movietonews.

8.50, News 9.5-10.35, Basil Sydney and Margaretta Scott in "Traitor's Gate," from the Duke of York's Theatre.

MONDAY, JANUARY 23rd.

3, Fashion Parade. 3.15, Gaumont-British News. 3.25, "Rehearsal for a Drama," a play for television by Roy Carter and Emanuel Wax.

9, Fashion Parade. 9.15, The Law To-day. 9.35, Henry Hall and his Orchestra. 10.5, British Movietonews. 10.15, Pas Seul. 10.25, News.

TUESDAY, JANUARY 24th.

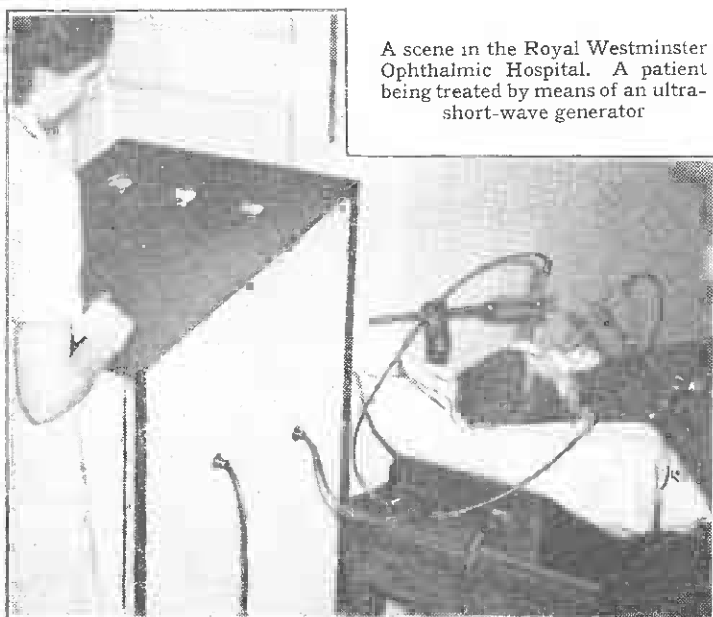
3, Friends from the Zoo. 3.15, British Movietonews. 3.25, Ronald Frankau with Monte Crick. 3.35, Cartoon Film. 3.40, Demonstration of Catch-as-Catch-Can Wrestling.

9, "Footwork"—A demonstration of American dances for English ballrooms. 9.30, Friends from the Zoo. 9.45, Gaumont-British News. 9.55, Reginald Arkell and Harry Rutherford. 10.5, Cartoon Film. 10.10, Music Makers—Susan Slivko, pianoforte. 10.20, News.

WEDNESDAY, JANUARY 25th.

3, "Behind the Beyond," a problem play by Stephen Leacock, with Frank Birch and Nadine March. 3.35, Cartoon Film. 3.40, "Six Gentlemen in a Row," a comedy by Jules Romains; English version by Harley Granville-Barker.

9, "Square Pegs," a play by Lionel Brown with Jack Livesey, Marjorie Mars and A. Bromley-Davenport. 10.30, News.



A scene in the Royal Westminster Ophthalmic Hospital. A patient being treated by means of an ultra-short-wave generator

Magnetic Tuning and Single-span

OBTAINING SELECTIVITY AND FREEDOM FROM WHISTLES

By L. de KRAMOLIN

THE principles of magnetic tuning have been described in previous issues of *The Wireless World*¹ and it will be clear that although it is quite possible to control several tuned circuits simultaneously the position is very much easier if only one variably tuned circuit need be used. This can be achieved by using a superheterodyne operating on the single-span principle, for then it is only necessary to control the inductance or capacity of the oscillator circuit for tuning.

The use of single-span tuning brings two difficulties in its train—at the high intermediate frequency necessary it is difficult to obtain sufficient adjacent channel selectivity for modern conditions, and it is difficult to avoid the production of whistles caused by the absence of

signal-frequency tuning and the usual non-linearity of the first valve. It is possible, however, to solve these problems and to adopt the single-span principle.

It is well known that the single-span receiver has no preselecting circuit, so that all signals which arrive with sufficient amplitude must simultaneously act on the

and these will combine with a third set of oscillations on the input grid to form further sum and difference frequencies of a higher order. As all of these are capable of producing whistles and distortion, the prospects of undisturbed reception are poor.

The process of rectification is not an essential to frequency-changing, however, and it can be avoided by adopting multiplicative mixing of the signal and oscillator frequencies. This enables the rectifying

action at the input grid of a mixing valve to be done away with, with a consequent avoidance of the difficulties mentioned above.

Multiplicative mixing is today employed with most commercial mixing valves and in most superheterodynes, but the linearity of the

characteristics of these valves is only sufficient, in a single-span receiver, to provide a severely limited output. Apart from the fact that it is difficult to obtain a truly linear characteristic, it is the practice to give a commercial mixing valve a certain exponential tendency in its curve in order to make it work in well with automatic volume control. This non-linearity is sufficient to produce quite serious interference when a receiver is used at a high overall amplification.

If a mixing valve with a sufficiently linear characteristic cannot be constructed, the omission of the usual condenser across the cathode bias resistance is very helpful. Negative feedback then occurs and tends to straighten the valve characteristic at the expense of amplification.

On the other hand, a loss in amplification may be avoided by the use of a linear valve. Such a valve has been put on the market by Telefunken under the type title AH700. This is a hexode possessing, in addition to its two screen grids, an input grid next to the cathode and a further control grid between the two screen grids, to which the oscillator voltage is led. The extensive linearity of the control-voltage anode-current characteristic of this valve is attained by what is known as the "damming effect" ("Staueffekte"). The linearising action of this effect may be explained somewhat as follows:—

If, in a hexode, care is taken by suitable design and suitable working conditions to

prevent any appreciable space-charge effect at the third grid, the anode current must to all intents and purposes be proportional to the emission current coming from the cathode. Since this emission current increases according to the non-linear space-charge law, the anode current must rise

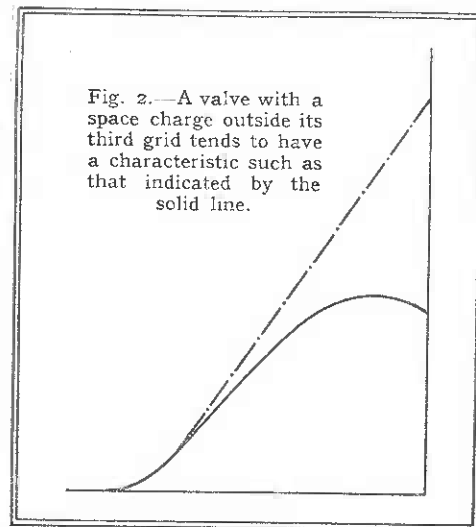


Fig. 2.—A valve with a space charge outside its third grid tends to have a characteristic such as that indicated by the solid line.

approximately exponentially, as in a normal triode. If, on the other hand, the hexode is worked in conditions such that a strong space-charge effect occurs at the third grid, the anode current curve may take a shape in which the initial upward course is more and more flattened out and finally enters into a downward bend. Such a characteristic is seen in Fig. 2, while Fig. 1 shows the curve produced under the previously described set of conditions

Linear Characteristics

Suitable valve design and working conditions enable the space-charge effect, which in its unrestricted condition would produce the full-line curve of Fig. 2, to be so reduced as to compensate the curve of Fig. 1, yielding a linear characteristic as shown in the dotted curve of Fig. 2. Valves constructed on these lines will give measured distortion factors of less than one per cent.; in this connection it must be mentioned that exact measurement of such small amounts of distortion is difficult.

By the use of this kind of input valve the writer has succeeded in eliminating heterodyne-whistle points and similar interference almost completely, provided that the voltage at the input grid is kept within the range 1-1½ volts, which is not difficult to arrange in a single-span receiver with aperiodic input circuits. If the immediate proximity of a local station threatens the fulfilment of this condition, the danger can easily be overcome by a wave-trap in the aerial circuit.

The second main weakness of the single-span receiver which calls for improvement is its low selectivity. In recent years it

THE single-span receiver lends itself admirably to magnetic tuning as there is only one tuning circuit involved and ganging problems are consequently avoided. In this article, the difficulties of obtaining sufficient selectivity and freedom from whistles are described and a suitable circuit is given.

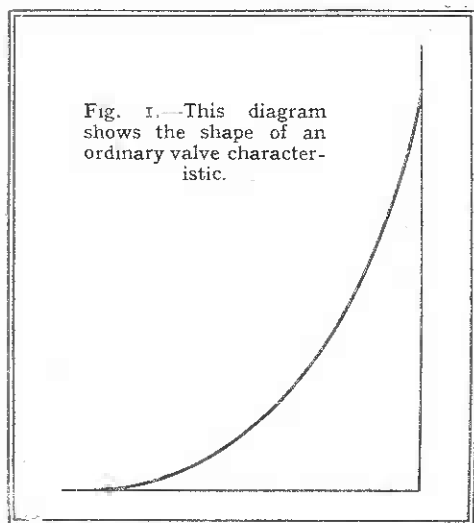


Fig. 1.—This diagram shows the shape of an ordinary valve characteristic.

input grid of the frequency-changer. Now if this valve has a rectifying action on the input voltages, every pair of oscillators will produce sum and difference frequencies.

¹ *The Wireless World*, February 24th, March 3rd, July 7th, 1938.

Magnetic Tuning and Single-span

has, it is true, been possible to raise the intermediate frequency in ordinary super-hets to as much as about 465 kc/s without losing the necessary selectivity by the employment of high-quality iron-cored coils. It is unlikely, however, that similar methods would lead to useful results at 1,600 kc/s. It must be remembered that the "Q" value at such a frequency would have to be at least four times that at 465 kc/s, which would be very difficult to attain.

Tuned Cathode Circuit

The difficulty was overcome in another way. The connection of a series resonant circuit in the cathode lead of an IF valve gives rise to negative feedback which varies with frequency and is a minimum at resonance. The selectivity is consequently increased.

Now an analysis of the conditions occurring with such a circuit shows that, on the simplifying assumption that the dissipative impedance of the series resonance circuit remains unchanged at a definite value (say, about 20 ohms), its selectivity curve is at its best when the capacity of the circuit is made very small and its inductance very large. This is shown in Fig. 3. Thus, for an effective capacity of about 1.5 $\mu\mu\text{F}$., and for the

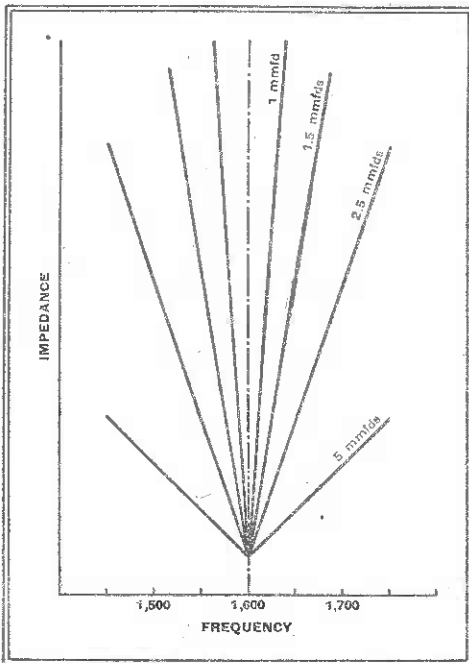


Fig. 3.—These curves show the increase in selectivity obtained by reducing the capacity of a tuned circuit, the series resistance remaining constant.

above-mentioned working frequency of 1,600 kc/s, at a deviation of 10 kc/s, a negative feedback resistance of about 700 ohms will be obtained, as compared with only 20 ohms for resonance.

Two difficulties, however, arise in attempting to fulfil these conditions. In the first place it is difficult to obtain, with the high inductance values necessary in the above-mentioned circuits, ohmic resistances as low as 20 ohms. This diffi-

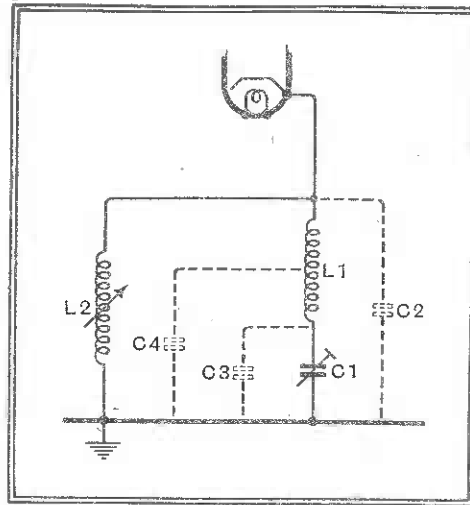


Fig. 4.—This diagram illustrates the basic arrangement of a cathode-connected circuit.

culty can be surmounted in a simple manner by back-coupling the anode circuit inductance of the valve concerned to the coil (in the cathode circuit) of the series-resonance circuit. It may be thought that if recourse is thus had to back-coupling it would be just as good to employ the usual form of such coupling, such as by a parallel-resonance tuned grid circuit of an HF amplifier. It is found, however, that the arrangement just described gives considerably more stable conditions. It has been pointed out earlier in this article that to obtain the necessary 10 kc/s selectivity in the amplification of a 1,600 kc/s frequency, the Q-value of the circuit must be about quadrupled in comparison with that of a normal 465 kc/s circuit; so that the ohmic resistance must be roughly quartered. But this means the obtaining of extraordinarily small values of ohmic resistance, such as can only be produced by retroaction, and the smallest fluctuation in the temperature of the coils or in some component connected to the oscillatory circuit may easily cause the small residual resistance to fall to zero (so that self-oscillation sets in) or else to rise by a very considerable percentage of its value, with the result that the circuit loses its original selectivity.



An experimental single-span receiver is shown here together with the remote control unit for magnetic tuning.

On the other hand, if—as in the series-resonance arrangement described above—it is possible to leave a residual resistance of 10 or 20 ohms and yet to obtain sufficient selectivity, then any unavoidable fluctuations due to warming-up or other causes will alter this resistance by so small a percentage only that the properties of the amplifier will not be influenced to any appreciable extent. This explains why it is possible, with this type of circuit, to obtain quite high selectivity combined with complete stability, even at high intermediate frequencies. For example, a single amplifying stage, under conditions which cannot be called at all critical, will give a 10 kc/s selectivity of from 1:12 to 1:15; which means that with merely a 2-stage IF amplifier of this type it is possible to have a selectivity completely satisfactory for an average receiver.

A further difficulty in the construction of the series-resonance circuit remains, however. This will be discussed with

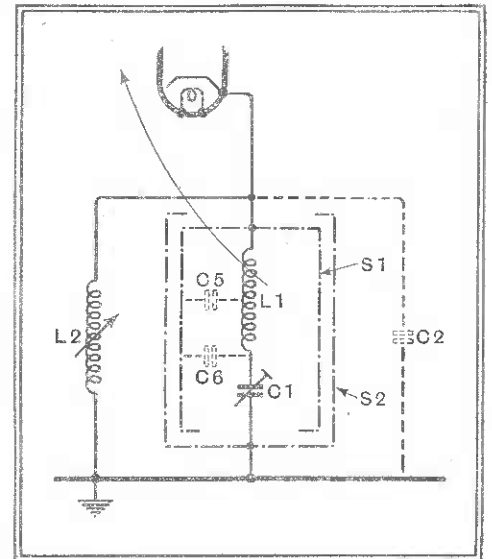


Fig. 5.—The unwanted capacities can be rendered harmless by adopting the screening shown at S1 and S2.

the help of Fig. 4. From the coil L1, representing the inductance of the series-resonance circuit L1-C1 connected between cathode and earth, there are a number of stray capacitances, represented by C2, C3, C4. The capacity C2 can easily be rendered harmless by the addition of a coil L2, such that this coil, together with the capacity C2, forms an oscillatory circuit tuned to about 1,600 kc/s. This circuit, being fairly highly damped owing to the use of a simple solid-wire coil for L2, possesses a high resistance not only for the 1,600 kc/s frequency, but also for all frequencies in its neighbourhood, so that for all those oscillations which the tuned anode circuit allows to be amplified, the amplification is reduced only by a quite small amount. By this "removal" of the capacity C2, the harmful effects of the

Magnetic Tuning and Single-span

self-capacity of the cathode (included in C₂) are also eliminated.

There still remain the stray capacities C₃ and C₄, which are practically in parallel with the tuning capacity C₁ and tend to prevent this from being reduced below a certain minimum value, which in a practically tested example was about 5 μμF. From the curve of Fig. 2 it was seen, however, that the attaining of satisfactory values of selectivity involved a tuning capacity as low as 1.5 μμF. Fig. 5 shows how this difficulty can be overcome. L₁-C₁ is again the series-resonance circuit in the cathode lead. C₂ is the sum of all the stray capacities from cathode to earth; L₂ is a variometer for "tuning-out" these stray capacities, and may consist of two cheap solid-wire coils, random-wound, and mounted on a rod of insulating material so that their relative position can be varied by displacement in an axial direction.

In order that the coil L₂ may not have too high a damping owing to too large a number of turns, it may be advisable to connect a small auxiliary capacity in parallel with the stray capacity C₂. In this case L₂ can consist of a single (random-wound) coil and the added capacity (max. value about 50 mmfds.) can be made variable.

S₁ represents a cylindrical screen covering the coil L₁ and condenser C₁ of the series-resonance circuit. This takes up all the stray capacities proceeding from the coil L₁, so that only stray capacities between L₁ and the screen S₁ remain: these are represented in the diagram by C₅ and C₆. These capacities, however, are no longer in parallel with the tuning condenser C₁, but lie (as seen from the cathode) in series with C₁. Now it is well known that a series connection of capacities always gives a resultant capacity smaller than the smallest of the com-

ponent capacities; so that it is now possible, in the oscillatory circuit L₁-C₁, to obtain an effective capacity of almost any value, however small, by adjusting C₁.

The stray capacities C₅ and C₆ simply act as an apparent increase in the coil L₁, and can be allowed for by a suitable reduction of the number of turns in this coil

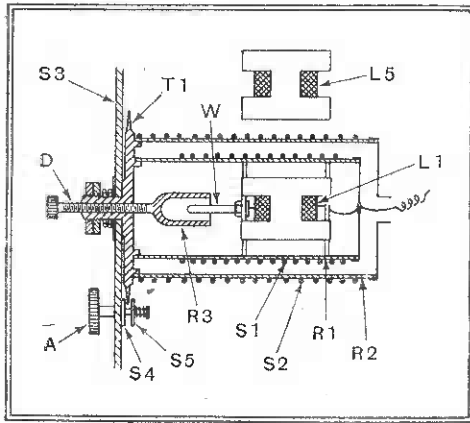


Fig. 6.—This diagram illustrates the construction of a cathode tuned circuit on the lines shown in Fig. 5.

Since, as mentioned earlier, it is desirable to reduce the ohmic resistance of L₁ by back-coupling this to the anode-circuit coil, the screen S₁ must not be solid; it must only act capacitively and permit an inductive coupling to be obtained. Since, on the other hand, this screen S₁ is at cathode potential (which in this case is a high-frequency potential), a second cylinder S₂ is provided outside it; this is at earth potential and, like S₁, must allow an inductive coupling to be made. In practice, S₁ and S₂ takes the form of bakelite tubes covered with a single-layer winding of thin wire of fairly wide spacing.

The construction of such a tuning unit

is shown in Fig. 6. An H-shaped high-frequency iron core of standard type is used to carry the winding L₁, which, as in Fig. 5, represents the inductance of the series-resonance circuit; L₅ is the inductance of the anode-tuning circuit. R₁ and R₂ are the two bakelite tubes carrying the two screening windings S₁ and S₂. The wire pm W, which in the practical form has a diameter of only half a millimetre, acts as one plate of the tuning condenser C₁, the other plate being formed by the tubular rotating part R₃; the air gap is about 1.5 mm. The screw drive D enables the capacity of the condenser C₁ to be adjusted.

By means of the friction drive A, S₄, S₅, the metal plate T₁ can be turned about a horizontal axis in the plane of the drawing so as to alter the position of the iron core of coil L₁ in relation to the iron core of L₅, thus effecting an adjustment of back-coupling. S₃ is the chassis, or a screen at earth potential.

Since, in a radio-frequency stage containing a series-resonance circuit such as that of Figs. 5 and 6, the cathode is no longer at earth potential but possesses an RF potential, the danger exists of unwanted coupling between the oscillatory circuit connected to the control grid of the valve and the cathode circuit, by way of the grid-cathode capacity.

For this reason, if two similar stages are to be employed, either special valves must be used having a screening electrode between the control grid and the cathode, or else an aperiodic stage must be interposed between the two similar stages for decoupling purposes.

In amplifiers in which no very high overall amplification is necessary, the intermediate valve can be dispensed with by providing the anode circuit of the first stage with very high capacity and comparatively small inductance so that the

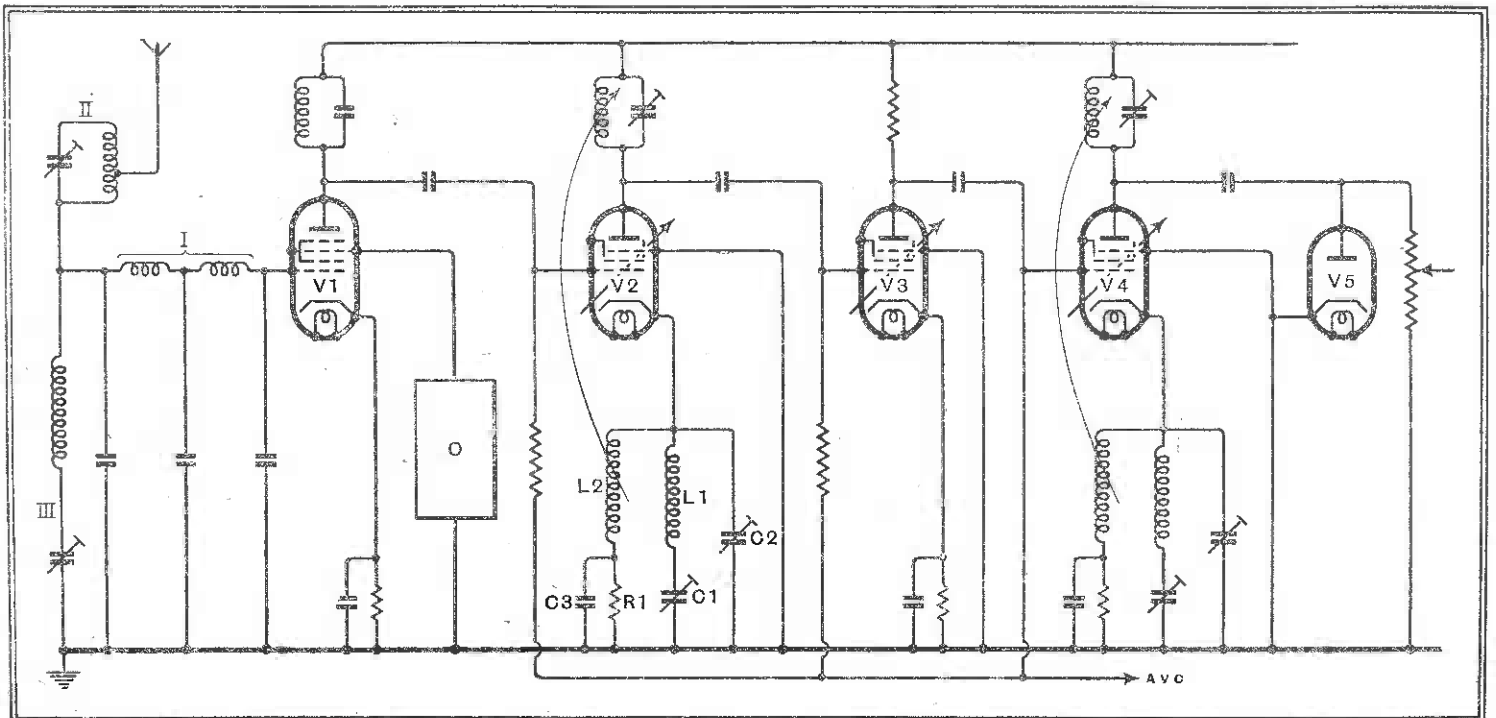


Fig. 7.—This diagram shows the skeleton circuit of a single-span receiver utilising two IF stages with cathode circuits and one aperiodic IF stage.

Magnetic Tuning and Single-span

coupling due to the relatively small grid-cathode capacity becomes negligible. If the Telefunken valve AH100, referred to earlier in this article, is employed, such an arrangement is in any case necessary, since this valve requires low external resistances of the order of 10,000 ohms.

An example of the circuit diagram of a receiver on the above lines is shown in Fig. 7. Here everything which is not essential for the comprehension of the scheme, and everything which does not differ from a normal receiver (such as the decoupling resistances in the anode circuit, the AF stages and the AVC arrangements), has been omitted.

I represents an input filter, usual in a single-span receiver. The necessary damping resistances are omitted.

II is a wave-trap circuit tuned so as to prevent overloading by the local station when the receiver is used in the immediate neighbourhood of such a station.

III is a series-resonance circuit with comparatively small capacity and high inductance, tuned to the intermediate frequency of 1,600 kc/s, and eliminating the

ordinary intermediate-circuit interference.

A Telefunken AH100 mixing valve has been adopted for the circuit as being by far the most suitable for a single-span receiver. If such a valve is not available an ordinary valve may—as mentioned earlier—be employed, but in this case it may be necessary to introduce negative feedback for the sake of linearity.

Since a direct connection of the anode circuit of V₂ with the control grid of V₄ might produce the danger of a troublesome coupling (liable to cause instability) between the series-resonance circuit of V₄ and the anode circuit of V₂, by way of the control-grid cathode capacity of V₄, an aperiodic stage V₃ is introduced.

The oscillator O is represented merely as a box, since the magnetic tuning of the oscillator, as well as its tuning indication, has been dealt with in detail in previous articles.

A receiver on the lines of Fig. 7 is fully equal to an ordinary type of receiver as regards freedom from interference and the attainable selectivity, with the added advantage of the single-span design which eliminates all problems of alignment.

Later in the evening the fading consisted mainly of a continual rise and fall of 0.5 volt above the normal. The range of this rise and fall and the periodicity of it is remarkably regular at times. It will persist seemingly without any alteration for half an hour at the time.

These variations would not be noticeable aurally on a good receiver with AVC and a large aerial, but they are likely to cause trouble in other circumstances.

The comparative effect of this fading is accentuated by the use of a short or indoor aerial. This has invariably been the reason for the trouble making itself felt in cases I have investigated. A full hundred feet of aerial erected as high as possible will nullify its effect.

This fading does not appear to be localised, as one of your correspondents suggests, but can be observed in all localities with suitable instruments. Satisfactory tests cannot be made aurally. What will probably be noticed if co-operative tests are carried out is that while the National carrier is fading in one locality, it is simultaneously increasing elsewhere and vice versa, much the same as all other types of fading.

There is nothing new in night fading at short distances on this particular wavelength. It was noticeable twenty-five years ago with spark transmitters.

B. S. T. WALLACE,
Overseer, G.P.O. Telegraphs.
London, S.W. 16.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

First Transatlantic Television

WIDESPREAD publicity has been given to the recent transmission of television across the Atlantic. This has been claimed to be the first time that television has been sent between London and New York. This is not the case. Television was transmitted from London to New York in 1928 by Mr. Baird. The widest publicity was given to this demonstration at the time and its importance fully recognised. In this connection I would quote from the leader of the *New York Times* of February 11th, 1928:—

"Baird was the first to achieve television at all over any distance. Now he must be credited with having been the first to disembodied the human form optically and electrically, flash it piecemeal at incredible speed across the ocean, and then reassemble it for American eyes.

"His success deserves to rank with Marconi's sending of the letter 's' across the Atlantic"

May I ask that in the interests of truth and in justice to British pioneer enterprise you will be good enough to give this letter or the facts it contains the publicity necessary to correct the false impression created?

CLARENCE TIERNEY, D.Sc.,

Chairman of the Council of the Television Society.

London, S.W. 11.

[* But not in *The Wireless World*.—ED.]

Trade Service

ARRANGEMENTS are going forward for the formation of an association of firms engaged solely in trade service, and, in case any of your readers who might be interested may have missed this announcement in the trade Press, I should be obliged if you would allow me to offer them, through the medium of your journal, an

invitation to communicate with me at their earliest convenience. H. C. RYLATT,
Specialised Radio Service Co., Ltd.
Tanners Lane, High St., Lincoln.

Fading at 25 Miles

WAVELENGTHS between 200 and 300 metres are subject to night fading at and beyond distances of 20 miles or so. I have taken periodical observations here at a distance of 25 miles from the National and Regional transmitters for the past seven years, and have never known the National carrier wave to remain constant after sunset. The Regional carrier is only on rare occasions affected very slightly by fading at short distances.

Observations are taken on a straight circuit embodying a form of valve voltmeter with a seven-inch scale giving a pointer movement of 2 inches per volt, so that carrier variations and modulation can be checked against each other.

A typical test for the present discussion was made on January 5th between 4 p.m. and 6.30 p.m., and again after 9 p.m.

The normal carrier voltage received here during daylight from the National transmitter is about 1 volt. This value was steady until 4.30, when, after a few preliminary flutters, rhythmic fading commenced to the extent of 0.25 volt around the normal reading.

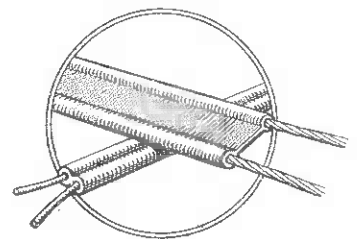
It soon became erratic, as fading usually does at the period of transition from daylight to darkness, the extreme variations extending from 0.5 to 1.5 volts. There would be a gradual increase to a higher reading, where it would remain for a time, not always steady but sometimes fluctuating rhythmically, the complete oscillation taking a few seconds. Then suddenly there would be a sharp drop of as much as 0.5 volt.

Aerial Feeders

HAMRAD WHOLESALE, 259, Ladbroke Grove, Kensington, London, W 10, have introduced some high- and low-impedance feeders for short-wave aerials. The low-impedance kind consists of two insulated conductors each containing 14 strands of No. 36 SWG tinned copper wire which are laid parallel and joined together. The spacing between the centre of the two conductors is 0.0625 in.

The impedance of this cable is stated to be 72 ohms, and it is thus a good match for the centre of a half-wave aerial.

In the high-impedance feeder, which is stated to have a surge impedance of 350 ohms, stranded conductors are also used, and in this case the spacing is 0.375 in.



High- and low-impedance parallel-wire feeders with insulated conductors.

Very tough insulating material is used, and it is claimed that it will withstand all weather conditions. The 350-ohm feeder must, of course, be correctly matched to the aerial, and if a half-wave aerial be employed this can easily be done by means of "Q Bars," or any other form of matching section.

The 72-ohm feeder costs 5½d. per yard, and the 350-ohm kind 6d. per yard.

We understand that a concentric feeder of 150 ohms impedance is also available, and this costs 1s. 4d. per yard.

NEWS OF THE WEEK

TELEVISION PROPAGANDA

Mr. Ogilvie Before the Emitrons

WHEN Mr. F. W. Ogilvie, Director-General of the B.B.C., speaks for a few minutes on television prospects before the emitron cameras at Alexandra Palace on January 26th at 10.30 a.m., it will mark the beginning of the 1939 television drive planned by the Television Development Committee of the Radio Manufacturers' Association in collaboration with the B.B.C. Mr. C. O. Stanley, Chairman of the Television Development Sub-Committee of the R.M.A., will speak directly after Mr. Ogilvie.

This transmission cannot be regarded as the forerunner of a series of propaganda-for-television talks from Alexandra Palace as no arrangements have been made for any further transmissions such as this

WATCHDOGS OF THE WAVE-LENGTHS

SIR NOEL ASHBRIDGE, B.B.C. Controller of Engineering, travels to Switzerland at the end of next month to represent British listeners in the Conference of Governments to discuss adjustments to the Lucerne wavelength plan. Listeners may depend upon Sir Noel to defend to the utmost all those concessions for which Admiral Sir Charles Cypendale worked during his long tenure of office as President of the International Broadcasting Union.

Also holding a watching brief will be Mr. L. W. Hayes, of the B.B.C.'s Engineering Intelligence Department.

REPORTS WANTED

IN celebration of the tenth anniversary of the International Short Wave Club, a special programme is to be radiated from W2XAD, 15.33 Mc/s (19.57 metres), and W2XAF, on 9.53 Mc/s (31.48 metres), from 21.00 to 21.30 G.M.T., on Friday, January 27th. This transmission, which will include recorded items from England, should have been given on December 11th, but the records arrived a day late.

Reception reports for the purpose of compiling data on the propagation of short waves will be appreciated by Mr. A. E. Bear, European and Colonial Representative of the International Short Wave Club, at 100, Adams Gardens Estate, London, S.E.16, who will forward them to America.

CANADIAN BROADCASTING

No Facsimile or Television Transmissions Yet

THE annual report of the Canadian Broadcasting Corporation reveals that Canada will have no television or facsimile transmissions for some time. The Board of Governors has recommended to the Government that no facsimile licences be issued to private broadcasting stations and that applications for research and experimental television should only be considered from financially sound parties. It is actually known that CKAC, Montreal pioneer broadcasting station, recently applied for a television licence and was ready to spend £17,000 on the installation, but the licence was refused.

Veto on Short-wave Projects

It is also stated in the annual report of the C.B.C. that no new short-wave broadcasting licences will be issued to privately owned

transmitters in Canada, but that the Government will be asked to subsidise a C.B.C. short-wave station for National advertisement and International programme exchange.

That broadcasting in Canada is now functioning on the basis recommended in 1929 by the Royal Commission on Radio Broadcasting, with powerful stations owned by the Government and lesser powered privately owned stations, is stressed in the report, the second since the C.B.C. came into existence under the direction of Mr. Gladstone Murray.

During the year under review the C.B.C. operated on £450,000, which was made up of money received from the collection of the annual wireless licence fee of ten shillings and from commercial programmes over C.B.C. stations and leased lines.

R.M.A. ANNUAL REPORT

Suppressing Interference: Specification for School Receivers

AT the annual general meeting of the Radio Manufacturers' Association, held at the Savoy Hotel last Thursday, January 12th, Mr. J. H. Thomas, general manager of A. C. Cossor, was elected chairman, and Col. G. D. Ozanne, of Wingrove and Rogers, vice-chairman. In the absence, through indisposition, of Lord Hirst, who was again elected president, Mr. S. R. Mullard took the chair.

The hope of many that a solution to the problem of interference with television caused by motor cars would be found in the rumoured conference between the R.M.A. and the Society of Motor Manufacturers will be dashed by the announcement in the annual report that the suggested conference has been refused by the S.M.M. on the ground that the matter is still the subject of consideration by a committee of the British Standards Institution.

Regarding the performance specification for school receivers, the report states that it is generally felt that an objective fidelity test would be highly desirable. With a view to making this possible, members submitting receivers to the Central Council for School Broadcasting for approval have been asked to send to the R.M.A. details of the sets in question. It is hoped that the data thus obtained may be sufficient to formulate an objective fidelity test.

SUNDAY TELEVISION

Interest Features for Viewers

OUTSIDE events will be the principal constituents of the new regular Sunday afternoon programmes. On January 29th the cameras will pass along the bays of the International Telephone Exchange at Faraday House. On February 5th "courtesy cops" will be televised at work. Also during the month visits will be paid to the Exhibition of Inventions at the Horticultural Hall, Westminster, and to Hanworth Air Park.

THE AMATEUR IN AMERICA

New Transmitting Regulations

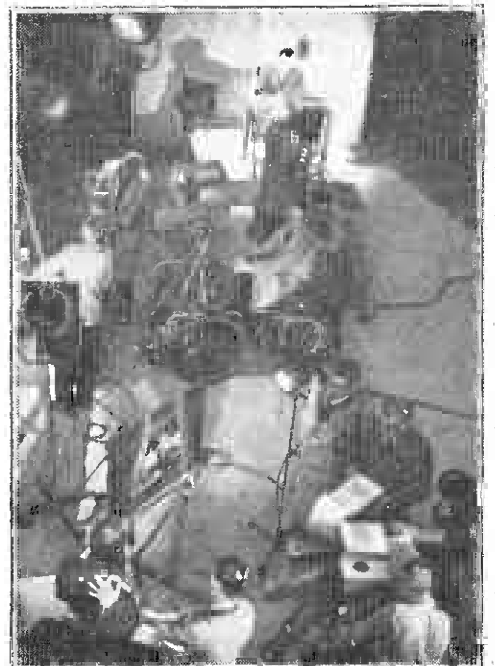
NEW regulations governing amateur radio activity in the U.S.A. are reported by Q.S.T. The 1.7-Mc/s band has been shifted upwards by 50 kc/s, presumably to permit the broadcasting band below it to expand, and it now covers 1.75 to 2.05 Mc/s. Channels 25 kc/s wide in this and the 80-metre bands are reserved for emergency calls where amateurs rendering emergency services to the community can put out distress calls. The 2.5- and 1.25-metre bands are now formally allocated to amateurs.

Two regulations which have long been observed in British amateur circles have just been imposed upon the American "ham". They are the possession of adequate frequency measuring devices, and facilities for the accurate measurement of input power. This latter stipulation only applies if the input exceeds 900 watts, and it is intended to prevent operators from exceeding the 1-kW limit placed upon all U.S. amateurs. In this country even the lowest power, 10 watt, amateur station operator must have instruments for measuring his input exactly.

WHEN IS DISTURBANCE NOT DISTURBANCE?

THE German National Chamber of Broadcasting has drawn an interesting distinction between what does and what

CAMERAS IN ACTION during the televising of an illustrated talk in the "News Map" series from Alexandra Palace. The picture gives a vivid impression of ordered chaos. The large staff required in a studio even during a talk transmission is evident. Professor W. J. Rose is seen speaking before No. 1 camera on a raised dais at the top of the picture, while J. F. Horrabin illustrates his words with rapidly drawn maps on the easel in front of No. 2 camera in the centre. The third camera in the foreground is being used for effects and continuity shots.



News of the Week—

does not constitute disturbance.

In ordinary cases loud speakers in dwelling houses are to be kept at the degree of loudness suitable for a room whenever there is a risk of disturbance to neighbours, and after 11.0 p.m. in all cases whatsoever.

But, says the National Chamber, the operation of a loud speaker on the occasion of a "common reception" is to be regarded as different from all other cases. This includes all broadcasts of a State and cultural character. On such occasions all citizens should participate by means of broadcasting, and every citizen must have an opportunity of hearing the words of the Führer.

RADIO AIDS EXPLORERS**A.W.A. Teleradio Sets**

THE extent to which the Archbold expedition in the wilds of New Guinea is relying on wireless was recently stressed by Captain R. R. Rogers, pilot of the Archbold Expedition's flying boat, before leaving Melbourne on the return trip to Port Moresby. The expedition, which is collecting insects, mammals, plants and geological specimens, is at present based at Humboldt Bay in Dutch New Guinea.

The advance base, which is at Lake Habbema, 11,000ft. above sea level, and the land parties are equipped with small wireless transmitting and receiving sets enabling them to keep in touch with each other and with the main base. Much of this equipment has been supplied by Amalgamated Wireless of Australasia and includes five teleradio sets. The main base keeps in constant touch with the A.W.A. stations at Port Moresby and other New Guinea centres.

INDIAN BROADCASTING**The Views of an Indian Listener**

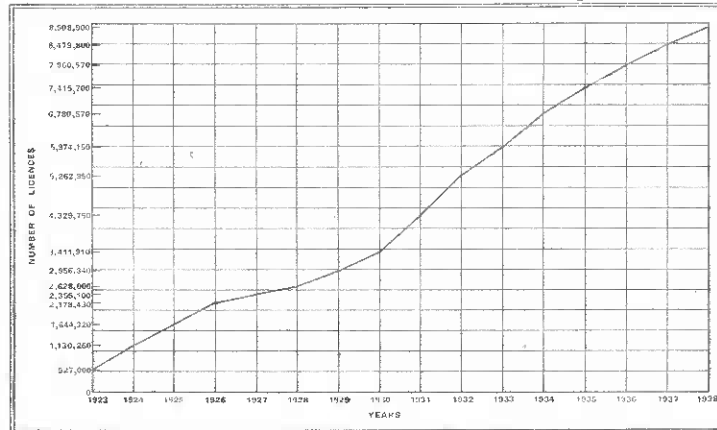
THE apathy of the Indian towards broadcasting, and the struggle of All-India Radio to make a place for itself in the life of the country is stressed in a letter from Mr. S. B. Banerjee, of Calcutta.

As a regular listener, he criticises the service for a lack of sufficiently wide programme appeal, especially in the selection of musical items, and emphasises the necessity of adapting educational broadcasts to the needs of listeners who are mainly illiterate. The language must be simple, and he suggests that agriculture, industry and health should be the main programme constituents.

Incidentally, it may be of interest to English listeners to know that the 10-kW short-wave stations at Calcutta and Bombay were heard strongly on 61.98 and 61.48 metres respectively during the afternoons in London last week.

RECEIVING LICENCES**Saturation Point Still Far Away**

THE hope of some that Great Britain's nine-millionth wireless receiving licence would have been issued by the end of 1938 was not realised, for the ally steepened until 1932, when began a gradual flattening-out. It will be seen, too, that last year's increase is the smallest in the past ten years.



The wireless receiving licence curve from 1923 to 1938.

G.P.O. announces that the approximate total was 8,908,900. This shows an increase during the year of over 429,000.

It is interesting to see from the graph how the curve gradu-

ally steepened until 1932, when began a gradual flattening-out. It will be seen, too, that last year's increase is the smallest in the past ten years.

STANDARD SPECIFICATIONS FOR P.A. EQUIPMENT

A MEETING has been arranged by the Institute of Public Address Engineers, to be held at the West Central Hotel, Southampton Row, London, W.C.1, at 2.30 p.m., on January 30th, to discuss the fixing of standards for the rating and performance of micro-

phones, amplifiers and loud speakers. To this meeting have been invited representatives of bodies and firms associated with PA work. Any manufacturer who would like to take part in the discussion is asked to communicate with the Secretary of the Technical Sub-committee of the Institute at 213, Mortlake Road, Kew.

FROM ALL QUARTERS**For the Quality Enthusiast**

FOR the benefit of high fidelity enthusiasts in New York a local broadcasting station, WQXR, is radiating high-quality transmissions. For the reception of these transmissions a special receiver has been made available to listeners at £27, which includes installation and a year's service. The set is known as the "WQXR High-fidelity Radio," and is designed for use on the medium waveband only.

Pedal Radio for Lighthouses

TRANSMITTER-RECEIVERS worked from power supplied by pedal-driven generators are to be installed in lonely lighthouses on the Eastern Australian coast as a result of a decision made by the Australian Federal Ministry of Commerce.

Norway's 100-kW Station

THE R.C.A. equipment for Norway's new 100-kW regional station at Vigra is now being installed and test transmissions on 476 metres will be conducted during the last week of this month. The official inauguration will take place in February.

Sixty-five Years in the Service of Science

SIR AMBROSE FLEMING, who read the first paper at the inaugural meeting of the Physical Society on March 21st, 1874, addressed the Society on "Science in the 'Seventies'" in London last Friday.

Tribute to Scientific Educationist

THE Gold Medal of the International Faculty of Sciences, which is awarded annually in recognition of outstanding contributions to scientific progress, is to be awarded for 1938 to Mr. J. J. Denton, Secretary of the Television Society and Vice-President of the Institution of Electronics. The award, which is in recognition of nearly fifty years' continuous devotion to scientific and technical education, will be presented by Dr. J. A. Darbyshire at the annual dinner and dance of the International Faculty of Sciences and associated institutions on January 27th.

Hivac's Managing Director

FOLLOWING the death of Mr. S. P. de Laszlo, it is announced that his position of managing director of the High Vacuum Valve Company will be taken by his brother Mr. P. D. de Laszlo.

Radio-telephone Link with Newfoundland

FOLLOWING immediately after the opening of a radio-telephone link between Newfoundland and Canada, the Assistant Postmaster-General, Sir Walter Womersley, speaking from Grimsby last week, inaugurated the radio-telephone service between this country and Newfoundland. This will be effected by the interconnection of the new Newfoundland-Montreal and the existing Montreal-London radio-telephone links.

More Power for Sweden

THE Director-General of the Swedish Department of Telegraphs informs us that the Ostersund station, which at present works with a power of only 0.6 kW on 413.5 kc/s (725.5 metres), will from February 1st have its power increased to 10 kW. Sweden's radio power will be still further increased later in the year, for Falun, the 2-kW transmitter working on 1,086 kc/s (276.2 metres), will have its power increased to 100 kW at the beginning of July.

American Radio Drive

PROPOSALS for a nation-wide publicity drive to popularise radio in America are to be put into practice this spring. A committee of ten leading members of the National Association of Broadcasters and of the Radio Manufacturers' Association (America) has been formed to consider ways and means. Each of these organisations has agreed to defray half the costs of the campaign.

G4 Call Signs

IF a station should be heard working under a call sign commencing with G4, it does not signify that it is a pirate transmitter. So many applications have been received for experimental transmitting licences that all the allocations under the prefix G3 have been exhausted and a start is now being made with G4.

Irish Short-Wave Station on Vatican Wavelength

ALTHOUGH the new Irish short-wave transmitter will work on the same wavelength as Vatican City, viz., 49.75 metres, it is hoped to avoid jamming by careful arrangement of transmitting schedule. The new transmitter should be in operation by the end of February.



Mr. J. H. Thomas, M.C., M.I.E.E., General Manager of A. C. Cossor, the new R.M.A. Chairman.

Television Topics

WITH the increase in the number of television receivers it is becoming a common experience to meet with ghost images. Such an image is a copy of the main image, either positive or negative, and displaced from it. A ghost image is usually much weaker than the picture proper and is caused by the interaction of waves from the transmitter which have travelled over different paths to the receiver. An article dealing with some aspects of the matter appeared in *The Wireless World* for September 15th, 1938, and it has been raised recently in correspondence by Mr. West, October 13th, 1938, and Mr. Dawes, November 3rd, 1938.

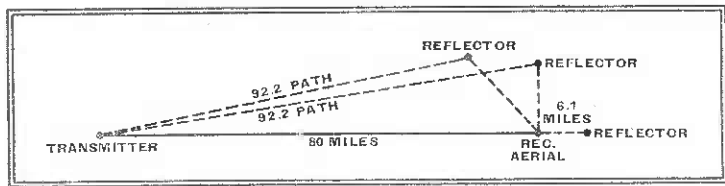


Fig. 1.—This diagram illustrates how waves can reach the receiver from the transmitter by several different paths.

Most ghost images are permanent, but Mr. West has experienced one on some occasions and not on others, the image always appearing two-thirds of the way across the screen.

The time taken for each line is approximately 100 microseconds, so that if the image is two-thirds of a line delayed, the waves causing it are about 66 microseconds late in arriving. Radio waves travel at a speed of 186,000 miles per second or 0.186 miles per microsecond; therefore, the wave causing the ghost image has travelled $0.186 \times 66 = 12.2$ miles farther than the direct wave.

The Reflector Position

There is consequently a reflecting surface 6.1 miles behind the receiving aerial, 8 or 9 miles away to left or right, or, say, 10 miles away to left or right but on the Alexandra Palace side of the receiving aerial, as shown in Fig. 1.

To reflect a strong wave from so great a distance indicates that the reflecting surface is itself situated in a very strong field; and as the field becomes stronger the higher one goes, it points to a cloud as being a possible cause.

Much information has recently been gathered on long-distance reception, and nights of extra strong reception have coincided with an inverse temperature gradient of the atmosphere. Another possibility, therefore, is that the reflected wave is actually a "bent" wave due to this cause, the weaker wave being received direct.

If the image is always in the same posi-

tion on the screen it would rather indicate a fixed reflecting point at the distances mentioned previously, and the occasional reflection may be due to abnormal strength. The most efficient reflectors are gasometers and hills.

The direction of the reflected wave could be ascertained by orientating an aerial with reflector; the reflected wave comes from the direction in which the reflector points when the image is weakest.

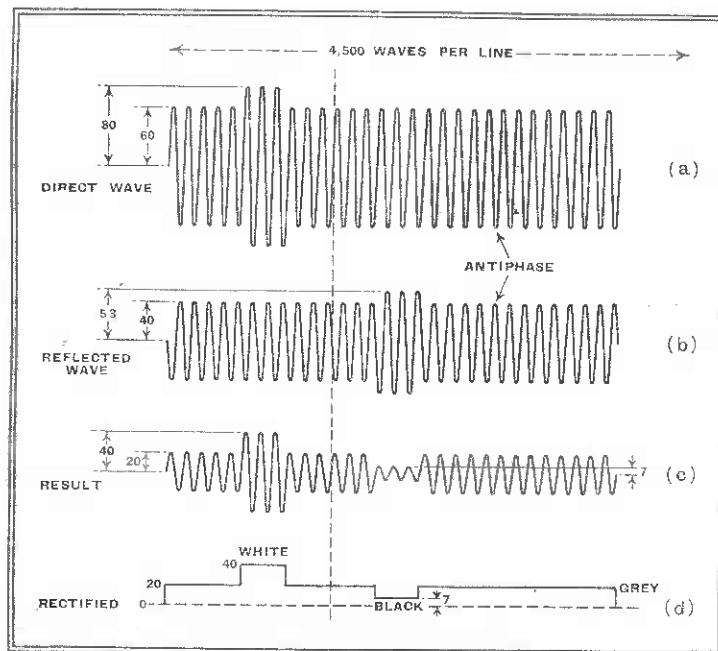
A negative image is almost as common as a positive one and is due to the reflected wave arriving out of phase with direct wave. The action is best explained by considering the waves themselves and not the rectified envelope.

For simplicity, consider the transmission to consist of a small white square on a grey background and we will examine a single line. The negative image will be a black square.

If the energy of the direct waves producing grey is 60 in arbitrary units, and the waves producing white 80, the strength of the reflected waves might be 40 for grey and 53 for white. As these waves are in anti-phase the resultant strength is 20 for grey (i.e., $60 - 40$) and 40 for white, as the white direct wave (80) is opposed by grey (40) of the reflected wave at that instant. This is shown in Fig. 2 to the left of the dotted line.

A fraction of a second later the re-

Fig. 2.—The direct wave for a white dot on a grey background is shown at (a) and the reflected wave at (b). These two combine as shown at (c) because they are in opposite phase, and give the detector output of (d).



lected "white" waves arrive, and their strength (53) opposes the direct "grey" waves (60) to give a resultant strength of 7. The resultant received wave strength, therefore, drops from grey (20) to 7 and produces black. This action is shown to the right of the dotted line in Fig. 2.

It is now a relatively simple matter to

NEGATIVE GHOST IMAGES

see how a transmitted black square on a grey background produces a white square as an image.

Using the same strengths as previously mentioned—direct wave 60, reflected wave 40, resultant 20—the transmission of a black square might drop the direct wave strength to 30, and as this is opposed by a reflected wave for grey (40) the resultant wave strength is 10. The grey background (20) has dropped to black (10). This is shown on the left-hand side of the dotted line in Fig. 3.

Types of Reflecting Surface

Later the reflected waves for black arrive, and these will have a strength of 20, but as they are opposing the direct grey wave (60) the resultant strength of the waves received is 40. This will produce a white square as shown to the right of the dotted line in Fig. 3.

It is interesting to note that a reflected wave of greater strength than the direct wave and in anti-phase could produce a negative picture with a positive image.

A ghost image can be changed from negative to positive by moving the aerial a quarter wavelength in the direction of the direct or reflected wave if the reflector surface is directly behind the aerial, or

up to half a wave if the reflector surface is at right angles to the receiving aerial. This movement will bring the direct and reflected waves into phase.

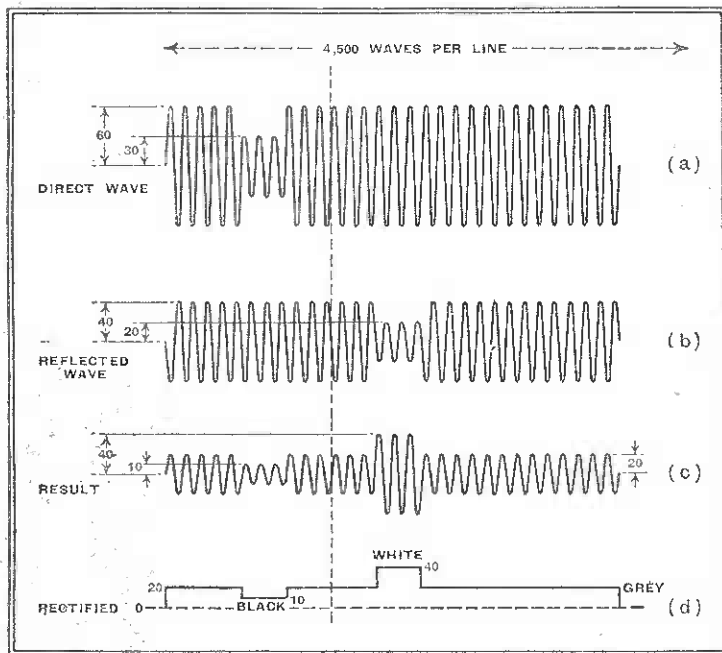
It could also be done by moving the reflecting surface, and a good example is when an aeroplane is the reflector. The picture, in addition, changes in brightness

Television Topics—

as the waves come into and out of phase, and from the rate at which these changes occur the direction of flight with respect to the wave front can be deduced. When flying parallel to the wavefront the changes are slow—one or two per second—but the changes become very rapid as the aeroplane flies on the line connecting transmitting and receiving aeri-als.

Most of the ghost images met by the writer have been removed either by directive aeri-als or by careful placing of the receiving aerial so that it is shielded from the reflected wave. In one case several

Fig. 3.—This diagram illustrates the same conditions as those of Fig. 2 but for a black dot on a grey background. The ghost image is white.



images were received, due to reflections from various sections of the lead roof of a large building, and these were eliminated by carefully placing the aerial so that it was shielded from the reflected waves.

Cases are reported of very weak reception in particular installations. This is often due entirely to a very strong reflected wave in anti-phase to the direct wave, the reflecting surface being sufficiently close to prevent the appearance of a noticeable ghost image. For example, if the reflected wave in Figs. 2 and 3 were only two waves late, a fairly good picture would result, but the received waves would have about one-third of the normal strength.

HENRY FARRAD'S SOLUTION

(See page 56)

THE letter from the lady was not very technically expressed, but presumably the trouble was mains hum. If it had been microphony it would almost certainly have appeared before, and would probably have drowned speech entirely.

A thing that strikes one is that the gramophone sockets are on the same panel as the mains tap adjustment sockets; and, as the instructions state that a pick-up must be disconnected when not in use, the gramophone socket presumably connects straight to the grid of the detector valve without any switching for cutting it out on radio. If the mains tap sockets are on the live side of the mains, a very small amount of leakage would be sufficient to introduce serious hum. For example, supposing the detector grid leak is 2 megohms and the mains voltage is 230, a leak of 2,000 megohms from mains to the grid socket would introduce 0.23 volts AC, which in the

type of receiver concerned would be more than enough to account for the trouble.

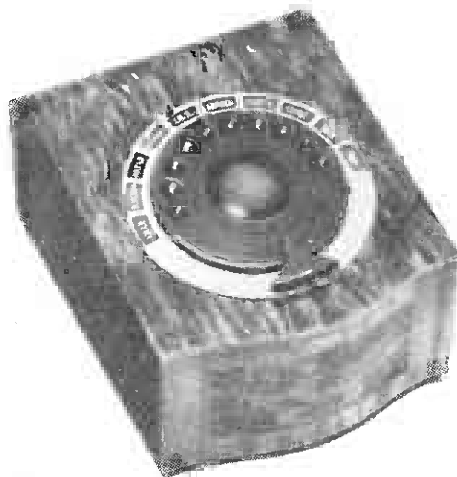
The weather had turned mild very suddenly after a cold spell, and in such conditions it is common for a film of moisture to condense on everything; this would account for the leakage.

The fact that earlier in the same day the

hum had not been noticeable can be explained by the accidental withdrawal and replacement of the mains plug, which might easily have been put back in the alternative way so that the mains taps that were previously on the earthed side became live.

Philco Mystery Control

Station Selection and Volume Control Without Intermediate Wires



The Philco control unit with self-contained batteries weighs 5½ lbs. and measures approximately 5½ × 7 × 9 inches.

IN the latest remote control system developed by Philco and demonstrated in this country for the first time a few days ago, there is no cable connection between the main receiver and the control unit.

The range of the control unit is up to approximately 100 yards and it is equally effective when used on floors above or below the main receiver. A rotary dial carries finger

holes for selecting six medium-wave and two long-wave stations and additional positions for increasing or decreasing volume, the latter if held down long enough resulting in the main receiver being switched off.

Inside the control unit is a single triode oscillator working at a frequency somewhere between 350 and 400 kc/s or just below the bottom of the long-wave band. An oscillatory magnetic field is established by a horizontal frame which is screened to suppress any local electrostatic field which might be picked up by vertical receiving aeri-als within the working range of the control unit. The oscillator sends an impulse the duration of which depends upon the dialling position. The valve takes current only for the duration of the dialling operation and the self-contained batteries will last for the best part of a year.

The controlling impulse is picked up on another horizontal frame in the base of the receiver cabinet and passed to an auxiliary circuit comprising two RF stages with five tuned circuits, a detector, noise filter and a thyatron valve operating a selector-type relay. Separate tuned aerial and oscillator circuits are associated with each of the relay contacts with the exception of the two which actuate the reversible motor driving the volume control.

A sensitivity control is provided to reduce to a minimum the chances of the relay being triggered by external interference and the high selectivity of the control circuits enables sets in adjoining houses to be worked without interaction by setting the control frequencies 10 kc/s or more apart.

The main receiver used in association with the "Mystery Control" is a three-waveband superheterodyne with a total of fourteen valves and an output of 10 watts. The price of the whole equipment is 70 guineas.

News from the Clubs

Croydon Radio Society

Headquarters: St. Peter's Hall, Ledbury Road, South Croydon.

Meetings: Tuesdays at 8 p.m.

Hon. Pub. Sec.: Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

On January 24th a talk will be given by Mr. L. F. Marshall on "Electric Waves and Currents," and on January 31st, Mr. P. A. G. H. Voigt will give a lecture and demonstration, his subject being "High Fidelity Reproduction and Ultra-Short-Waves."

Radio Physical and Television Society

Headquarters: 72a, North End Road, London, W.14.

Meetings: Fridays at 8.15 p.m.

Hon. Sec.: Mr. C. W. Edmans, 15, Cambridge Road, North Harrow.

A committee meeting was held on January 6th to discuss the programme for the second half of the session. Forthcoming events include a lecture on January 20th by Mr. Walters, of Belling and Lee, on "The Suppression of Electrical Interference." At a later date a lecture on "Surface Tension" will be given by Dr. C. G. Lemon, and a lecture, the subject of which is not yet announced, will be given by a representative of the Automatic Coil Winder and Electrical Equipment Co.

Dollis Hill Radio Communication Society

Headquarters: Braintreoft Schools, Warren Road, London, N.W.2.

Meetings: Alternate Tuesdays at 8 p.m.

Hon. Sec.: Mr. E. Eldridge, 79, Oxgate Gardens, London, N.W.2.

The annual general meeting was held on January 3rd, and a new committee was elected. On January 17th Mr. Bayliss lectured on "Cathode-Ray Tubes." The next meeting will be held on January 31st.

Maidstone Amateur Radio Society

Headquarters: 244, Upper Paul Road, Maidstone.

Meetings: Tuesdays at 7.45 p.m.

Hon. Sec.: Mr. P. M. S. Hedgeland, 8, Hayle Road, Maidstone.

The second annual general meeting was held on January 10th when the new committee was elected. The club has now two fully licensed amateurs and six A.A. licences among its members. It is hoped that the club's transmitter, G3WM, will soon be on the air. The programme for the next month is as follows:—

January 31st.—Junk sale.

February 7th.—Demonstration of the products of the Premier Supply Store.

February 14th.—Lecture by Mr. W. H. Allen on "56-Megacycle Operation in General."

February 21st.—Lecture by a representative of the Mullard Co. on "Cathode-Ray Tubes."

Graphs

CHOOSING THE SCALES :

DANGERS OF INTERPOLATION

By "CATHODE RAY"

AN issue of *The Wireless World* without a single graph is almost unthinkable. But I wonder if everybody understands graphs. True, even stockbrokers and share-pushers use them, so it is hardly conceivable that on so much higher a stratum of intelligence as that represented by *The Wireless World* readers there should be found an appreciable number who have not yet caught on to the basic idea. Still, "for the sake of completeness" (as high-brow writers say when shoving in a bit that they are afraid may insult the intelligence of their readers), I start off with a quick explanation of what a graph is and does.

I suppose most of us when we were in the growing stage used to stand as bolt upright as possible against the edge of a door to have our latest height marked up. The succession of marks did not convey very much when reviewed afterwards unless the dates were marked, too. Even then one has to look closely to read the dates, and the progress of growth is difficult to visualise. But, disregarding certain technical difficulties, imagine that the growing boy stands still on a conveyor belt that moves him alongside a wall at the rate of, say, one foot per year. Every now and then a mark is made on the wall exactly at the top of his head, perhaps by a pencil fixed there. If he were not growing, all these marks would be at the same height, and if close enough together would form a horizontal line. Growth would be registered by a rising line, sloping steeply upwards to indicate a rapid rate of growth, and gradually when growth was gradual.

In this way the progress over a period of years could be visualised by a glance at the wall.

and the usual custom is to put it along the foot. The advantage of making the conveyor belt move at exactly uniform speed is that times intermediate between those actually labelled can be identified by measuring off a proportionate distance. As in the present example one foot represents a year, the growth at the end of January could be traced by noting the height of the line—the graph—one inch beyond the start of the year in question. In the same way a scale of height could be marked anywhere in a vertical direction. It happens in this case that height would be represented by height to full scale, so would be identical. But if the graph were being recorded in a book, although height would still represent height, it would necessarily do so on a reduced scale, say half an inch to a foot.

Any point on the line represents the height of the boy at a certain definite time. It could be marked, say, "4ft. 9in.; Aug., 1936." It is thus a quick way of saying "when the time was Aug., 1936, the height was 4ft. 9in." It connects two quantities, in this case time and height. To find the exact height on any date, or the date at the attainment of any height, without having to mark on the line an infinite number of figures, it is necessary to drop a vertical line to read off time along the horizontal scale, and a horizontal line to read height up the vertical scale. To avoid the trouble of actually having to draw these lines, it is usual to plot graphs on paper printed with horizontal and vertical lines so close together that a pair of them is sure to come near enough to the selected point for the eye to judge any little less or more. Again, this is

easiest to do if distance is directly proportional to the quantity being measured. A correct choice of scale is important so that on the one hand the graph is not crowded into a corner of the paper, or, on the other, the printed lines are not at awkward fractional spacings. As I have just said, the position of the scales is not a vital matter, but unless there is a good reason for doing otherwise they are marked along the line where the other quantity is zero. For instance, the time scale would be at the level where height is nil, i.e., along the foot of the wall. If the zero of the time scale is taken as the

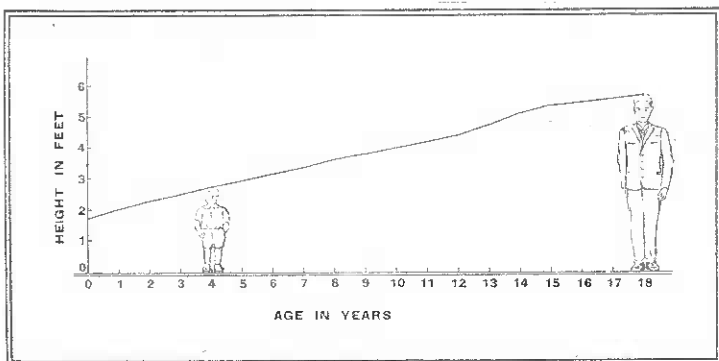


Fig. 1.—Simple (but highly inconvenient) system for automatic graph plotting. The equipment consists of a growing boy, a conveyor belt moving at the rate of one foot per year, a pencil and a white wall.

To make the information quite definite, a mark could be made along a horizontal line each New Year's Day and the number of the year written against it. In more technical terms this would be a time scale,

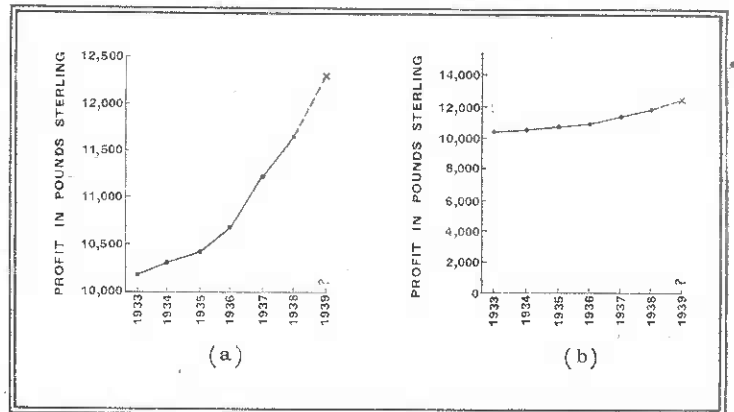


Fig. 2.—(a) Typical financial graph arranged to make the maximum impression consistent with strict truthfulness. (b) The same information presented in a slightly different manner.

year O.A.D. there would be nearly half a mile of blank wall before coming to the graph. To avoid this use might be made of a "false zero," making the scale start at or slightly below the first figure in which one is interested. A sensible way of doing it in the present example would be to reckon from the time the boy was born. That is his natural zero hour.

Misleading Impressions

On the whole, a false zero should be avoided if the object is to convey a true picture of the situation at a glance. On the other hand, it is sometimes useful for enabling a closer scrutiny to be made more accurately. Fig. 2 (a) shows the sort of graph that might appear in a company-promoting prospectus. The word "Profit" would, of course, be in big type, and at first glance the increase in recent years is sensational. But this effect is produced by employing a false zero. If plotted from a true zero as at (b) the results look much less impressive. To the careful student of the situation, who would not be misled by the apparently steep gradient of (a), the false zero is helpful because it enables a far bigger scale

Graphs—

to be employed so that the figures can be estimated with reasonable accuracy. By the way, this example is not a true graph of the sort a mathematician would have anything to do with. Profits are declared to the public annually in lumps, and the lines joining the dots that mark each

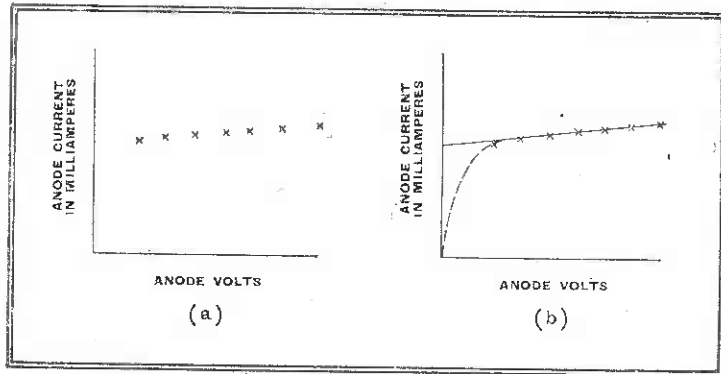


Fig. 3.—(a) Points corresponding to actual readings. (b) The danger of drawing curves beyond the limits of known facts.

year's result have no meaning whatever but are there merely to guide the eye from one to another. In a true graph a continuous variation is shown, and the dots are so close together as to form a line. The line, incidentally, is technically a "curve," whether it is what is commonly understood as a curve or is as straight as the proverbial bee-line.

Taking Risks

Another thing about graphs that can be learnt from financial practices—or malpractices—is the danger of *extrapolation*. At the moment of writing the year 1939 lies ahead. Nobody knows what the profits of a company will be. But the directors look at the graph showing the results for 1933-1938, see that they trend increasingly upwards, and they just extend the line a bit farther to arrive at the next year's profits. This has often been done, and often in a year's time it has been necessary to mark the actual point not up near the optimistic position but down so low that Fig. 2 (b) would have to be used to get it on the paper at all. Although this is less likely to occur in scientific relationships, which operate on regular and reliable principles, and where graphs find their natural use, it is still dangerous to draw bits of curve in freehand, especially when those bits lie outside the observed region. As an example of this, Fig. 3 (a) shows the result of taking a number of readings of anode current in a pentode against anode voltage. They lie together in a delightfully regular straight line. Anybody who knew nothing about pentodes might be tempted to arrive at the values he had not been given by drawing the line a little farther to the left as in (b). But we know that it would swoop right down as shown dotted. It is not even perfectly safe to fill in the spaces *between* the points—the process known as *interpolation*. If they are reasonably close together and there is good reason not to expect any funny business, one is justifi-

fied in drawing the curve smoothly through the points. Fig. 4 shows a similar series of valve readings for an ordinary screen grid valve. Only a "fresher" would risk joining up such sparse points, thereby missing the dynatron kink, shown dotted.

Sometimes, on the other hand, it is possible to be more sure of the line than of any one point. It may be known that there is a definite scientific law connecting two quantities which cannot be measured with great accuracy. In many cases (not all) the errors tend to cancel out when a number of readings are taken. Fig. 5 is an example of this. Suppose

you have a coil of unknown inductance and a variable condenser with a scale of capacity. It is known that the square of the wavelength to which a tuned circuit resonates is proportional to the capacity (the inductance being kept constant). The graph of two quantities that are proportional to one another is a straight line. So that much is known before we start. The slope of the line is proportional to the inductance, which is not known. And its position is not exactly known either, because although the condenser is calibrated its zero is not the true zero. That depends on how much stray capacity happens to be in parallel in the circuit. One reading of wavelength for a certain capacity is not enough because it does not show the slope of the line. So a number of readings of wavelengths are taken at different settings of the tuning condenser, and when they are plotted it may be found that they don't lie exactly on any straight line. As it is known definitely that a true graph of them is a straight line, the irregularities must be

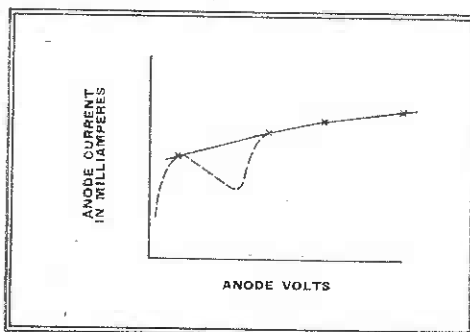


Fig. 4.—Another case of a little knowledge being a dangerous thing.

inaccuracies in the data—capacity and wavelength readings—and, assuming that they are distributed at random, a more accurate result can be gained by drawing a line running as evenly as possible among them (Fig. 5). A point that lies right off such a line will almost certainly

be found to be an error due perhaps to careless scale reading or to a slip in the squaring.

This example gives some idea of how valuable graphs are in laboratory work, not only for showing results in a convenient form but for minimising errors in the experiment or for aiding calculation of the desired quantities. From Fig. 5 it is quite easy to arrive at the amount of stray capacity in the circuit, as well as the inductance.

It also illustrates the importance of choosing the right sorts of scales. If the graph had been plotted as *wavelength* against capacity, it would have been a curved line, which could not have been easily drawn in so as to reveal the extent of the inaccuracy of the readings.

Non-Uniform Scales

A short while ago¹ I explained that for some purposes it is much better to use non-uniform scales in spite of their awkwardness for judging intermediate values, because they give a clearer picture

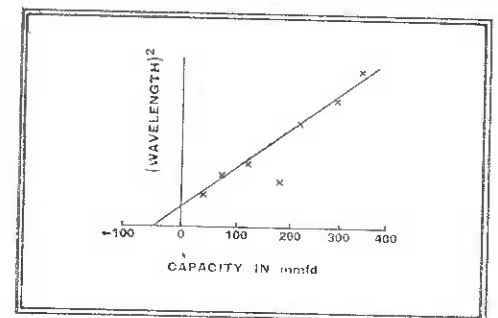


Fig. 5.—How a graph can be used to get results probably more accurate than individual data, and (in the case of the odd point) to eliminate obviously erroneous data.

of what the curve is intended to show. And the mathematical side of the subject has been enormously developed so that there is no end to the things that can be learnt about graphs. But what I have included here should be enough to enable anybody to understand their uses in *The Wireless World*, and to demonstrate that while keeping strictly within the truth it is possible to convey very different first-glance impressions according to how the graphs are drawn.

¹ "How to Understand Frequency Curves," *The Wireless World*, November 3rd, 1938.

Amateur Call Book

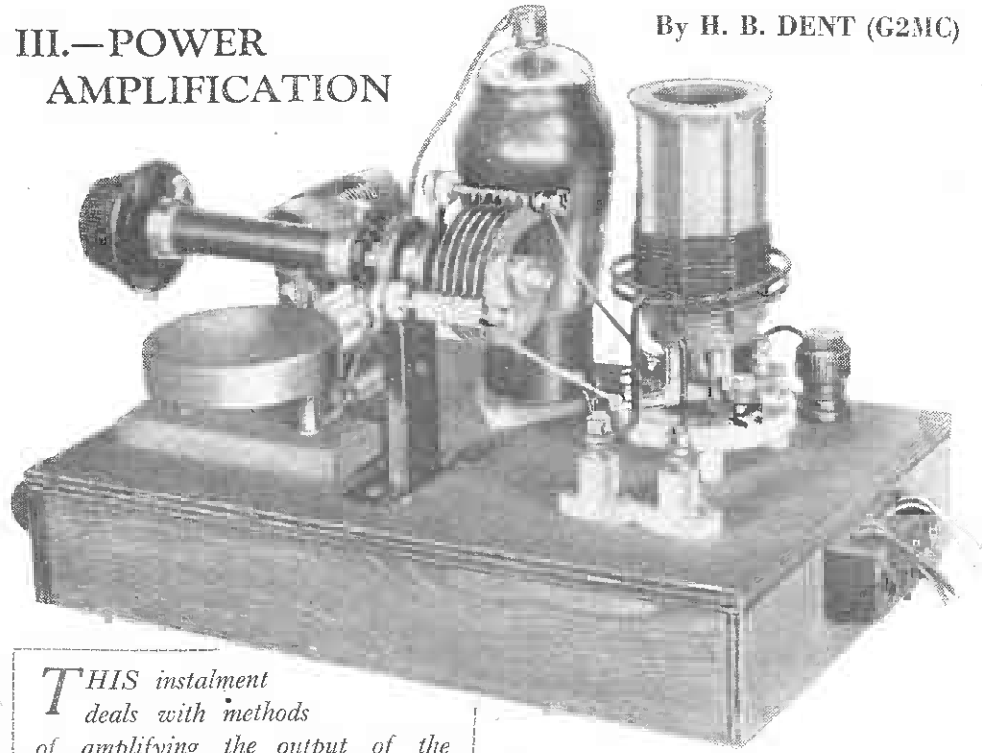
THE latest edition of the Radio Amateur Call Book Magazine containing the call signs and addresses of over 60,000 amateur transmitting stations is now available. Other valuable information included comprises a list of the international prefixes and a map of the world showing to which parts of the different countries they relate, a time-conversion chart and a list of commercial short-wave stations that regularly transmit news and weather reports.

Copies are obtainable from F. L. Postlethwaite, 41, Kinfauns Road, Goodmayes, Ilford, Essex, at 6s. post free.

The Amateur Transmitting Station

Part III.—POWER AMPLIFICATION

By H. B. DENT (G2MC)



THIS instalment deals with methods of amplifying the output of the crystal controlled oscillator described in last week's issue. As amplification of power—and not merely of voltage—is involved, the technique is somewhat different from that applicable in a receiver.

IN previous articles we have dealt with the design of the crystal oscillator, which, it has been shown, can also be employed to double the frequency. In order to bring our thoughts in tune with transmitting terms we will refer to this unit as the exciter. An exciter constitutes that portion of a transmitter which supplies the power for energising the main amplifier (which feeds the aerial) and may contain several stages. In the unit illustrated, however, only one valve is used.

As the exciter is a driving stage it is in some respects the equivalent of the driver valve preceding a Class B audio-amplifier in which grid current flows.

Such a stage has to provide power to overcome the losses in the grid circuit of the amplifier, and if any list of transmitting valves is examined there will be found the power (as well as voltage) needed for full loading of the valve.

If the exciter unit has been built as described it will give an RF output of just over three watts at 42 metres, and only slightly less on 21 metres. The almost equal output on fundamental and second harmonic frequencies is one of the most useful features of the Tritet circuit.

As an exciter for a power amplifier it enables transmissions to be effected on two wavebands merely by plugging in the appropriate coils, and there is no need to switch in an additional stage to make good any loss of output at the higher frequency. With some forms of oscillator this has to be done, or alternatively a separate frequency doubling stage must be included.

Of course, there are other kinds of RF generators in use by amateurs, but as the one described is so easy to get to work

efficiently, the beginner might defer a study of them until a little experience has been had with the Tritet circuit. Better results are usually obtained by concentrating on one circuit rather than devoting a little time to all the known arrangements. The alternative circuits should not be ignored, however, and it may be possible to deal with them in this series at a later date.

Having obtained a useful amount of RF energy with a single valve, it might be thought that an amplifier could be dispensed with and the output from the oscillator fed straight to the aerial. Where it is necessary to conserve power, such as with portable equipment, this course would probably be adopted, as the RF oscillator is consuming about 9 watts of HT. But

the overall efficiency, i.e., the HT consumption of the valve divided by the RF power taken from its anode circuit is only about 33 per cent.

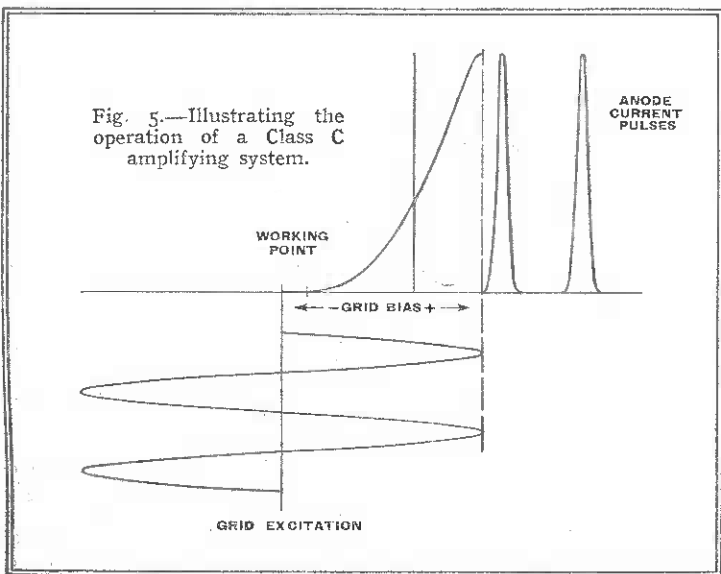
If it were possible to improve on this an amplifier would be redundant in a low-power transmitter of, say, 10 watts rating, but it is possible to obtain a much better performance with a power amplifier in which, under certain conditions of operation the efficiency can be raised to 70 per cent. or higher. That is to say, we can double the aerial power without exceeding the terms of the licence. It has to be remembered that amateur licences stipulate the power delivered to the valve connected to the aerial and not the actual power in the aerial, which is the usual basis for the rating of broadcast stations, for example.

Methods of Amplification

Thus the aim of all amateurs is to obtain the maximum RF output for a given HT input to the final valve. We know from our experience with receiving valves that Class A amplification yields an efficiency of between 20 and 25 per cent., so that system is useless following a 10-watt exciter, and we should be better off without it.

Class B amplification will raise the efficiency figure to between 30 and 40 per cent.; again no advantage ensues. There is, however, a system known as Class C amplification, but as it badly distorts the waveform it is not used for sound amplification.

In Class B working we can bias the valves—for a pair in push-pull is used in



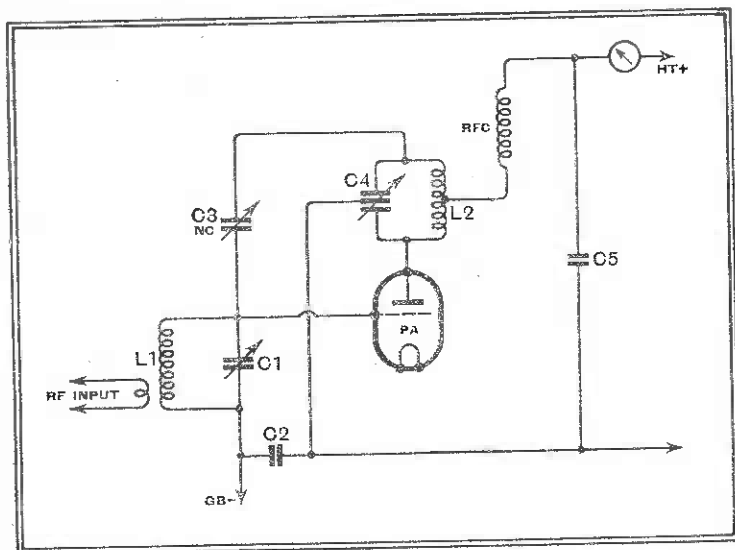
The Amateur Transmitting Station—

audio amplifiers—so that the working point is at the foot of the characteristic curve. If we were to go beyond this point only a portion of each half-cycle of the input would be amplified, consequently the waveform would be distorted.

The Class C System

With RF amplification preservation of the waveform does not matter, provided of course it is an unmodulated wave. In this case we can apply as much negative bias to the amplifier as we like and increase the RF input to the grid until the valve is driven into a region where it becomes conductive and allows anode current to flow. Actually this can be carried still further and the drive increased until grid current flows, the only limitation being the amount of grid current the valve will safely stand. This method of amplification is known as Class C, and it yields the high-efficiency figure previously mentioned. As a result anode current flows only during a portion of one half-cycle of the input wave as shown in Fig. 5. Though a very attenuated version of the original input waves, these pulses will excite a tuned circuit in the anode of the valve in the same way as a weight suspended by a cord can be made to swing to and fro like a pendulum by giving it a succession of correctly timed taps.

In an amplifying stage the taps or pulses of energy have the same frequency

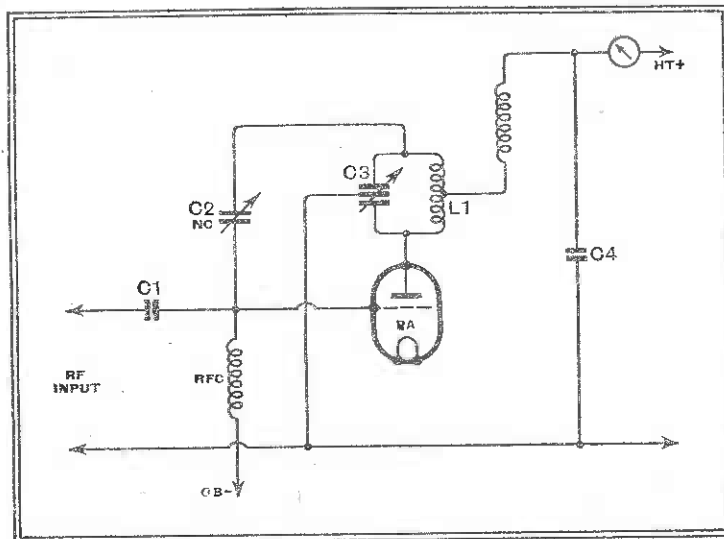


as the input oscillations, and tuning in this case is achieved by correctly tuning the anode circuit. Thus in an RF amplifier it is not essential for energy to be imparted to the anode circuit throughout the full cycle, and provided there is sufficient power in the pulses to overcome the losses in the anode circuit they can be of quite short duration.

Losses in the anode circuit include the power wasted in heat, both in the valve and in the tuned circuit, dielectric losses, energy radiated from the tuned circuit, and the power fed into the aerial. Of these only the last mentioned is useful energy, the others represent so much waste. As a valve operated as a Class C

amplifier gives only a comparatively low voltage gain the input to its grid must be relatively large, but the power amplification can be very high indeed. Thus with a driving power of two watts an RF output of twelve watts can be obtained from quite a small triode valve. The total anode consumption of the valve would be of the order of 17 watts. Valves designed for high operating voltages give a better power gain than the figure men-

Fig. 7.—Another method of coupling the power valve to the exciter.



tioned, and so also do the special RF pentode or tetrode valves.

Grid bias for a Class C amplifier must be derived from a constant voltage source, such as a battery or a small mains unit. Self-biasing arrangements are not applicable, though a combination of battery bias and a grid resistor is often employed. The latter method of obtaining grid bias was explained when we dealt with the crystal oscillator.

The amount of negative bias required for a Class C amplifier is about twice that needed to reduce the anode current to zero. The latter value is known as the "cut-off" bias, and it can be obtained from the valve makers' curves.

Fig. 6.—Power amplifying stage with neutralised triode valve.

With triode valves a close approximation to the exact value is given by dividing the working anode voltage by the amplification factor of the valve. Thus, for a valve operated at 600 volts and having an amplification factor of 25, the "cut off" bias is -24 volts, and the grid bias for Class C operation would be approximately -50 volts.

Since there is a tuned circuit directly or indirectly connected to the grid of the valve with another circuit tuned to the same frequency in its anode, self-oscillation will occur on the peaks of the input if there is a coupling between the two circuits.

Feed-back through the grid-anode

capacity of the valve will also produce self-oscillation, and if the amplitude of these oscillations is large enough to maintain the grid at a potential that permits anode current to flow when the driving

power is removed, the valve will continue to oscillate. We require the valve to oscillate only when an input is applied to its grid, for if signalling is effected in the exciter circuit, the self-oscillation of the amplifying valve will continue to feed power into the aerial even when the key is "open". Therefore, a valve must be used that will not oscillate of its own accord, such as a screen grid RF pentode, with a very low grid-anode capacity, or recourse to neutralisation must be had.

For the sake of gaining more experience we will decide to use a neutralised triode amplifier, of which an example is given in Fig. 6. It is sometimes found that instability troubles arise with RF pentodes unless considerable attention is given to screening, and if it is decided that neutralising must in the end be adopted, it is rendered more difficult owing to the very small grid-anode capacity. When neutralising is adopted, the larger capacity of the triode is more easily dealt with.

An understanding of the procedure and some practical experience is well worth acquiring at the outset, as it will be found very useful if later transmission is attempted on the higher frequencies, such as 28 and 56 Mc/s, for neutralising may have to be employed in the power amplifier on these frequencies, no matter what type of power amplifier valve is used.

It might be advisable to retrace our steps a little and refer again to the statement that in a power amplifier there is a tuned circuit in both the grid and the anode of the valve. It will be recalled that in the exciter unit already described the anode circuit of the valve is always tuned to the output frequency. This circuit is coupled to the grid of the power amplifier either by a link (to be discussed later: see Fig. 6) or by means of a small condenser (C₁ in Fig. 7). Now from the point of view of RF this circuit is just as much a part of the grid circuit of the valve as is C₁L₁ of Fig. 6, the only difference being that the RF path is through C₁ and

The Amateur Transmitting Station—

then back to the earth line *via* the RF bypass condenser in the exciter unit. Without neutralising the arrangement in Fig. 7 would oscillate just as readily as that of Fig. 6; hence the need for neutralising in both cases.

Neutralising only takes account of capacity coupling in the valve and external to it, but magnetic coupling will also produce self-oscillation, and C₁,L₁ and C₃,L₂ in Fig. 7 and the equivalent circuits of Fig. 6 must be arranged so that the minimum of coupling exists. Possibly the best way of ensuring adequate isolation is to erect a vertical screen between the two circuits.

Random Radiations

By "DIALLIST"

Aerial Problems

A SUSSEX reader suggests that, however good anti-interference aerials may be as preventers of nasty noises, it is often quite impossible for those who would like to do so to put them up. The kind of listener that he has in mind is the dweller in "digs," in an hotel, or in an old house converted into flats. Now I should have thought that these were just the people who could derive the greatest benefit from anti-interference aerials. Naturally, if you live in rooms or in an hotel or in a flat you can't just go and stick up one of these aerials of your very own. But there is a great deal to be said for the communal aerial serving a number of different listeners. In blocks of flats tenants might get together and try one of two possible schemes. The first is to persuade the landlord to install an aerial system for the block with points in all flats, the tenants making a small quarterly or annual payment in return for the privilege of better listening. A useful lever here is that the landlord will undoubtedly improve the value of his property if he takes this course. The second possibility, if the landlord won't play, is for the tenants to club together, dividing the cost of installation between them.

In Digs and Hotels

Something similar might be done by those who live in lodgings, especially if the landlord has a wireless set himself and suffers from interference. Here I think it would be fair for tenants who have occupied the same rooms for a considerable time, and are likely to continue to do so, to share the cost of installation with the landlord. In other cases the landlord might be persuaded to install the anti-interference aerial, with a point in each sitting-room, as an amenity, and to make a charge of, perhaps, sixpence a week for its use. Hotels which cater for guests of the resident type rather than of the day-to-day kind might well consider the advisability of installing anti-interference aerials, especially in localities where unwanted noises are severe.

Householders Too

I have often wondered why, as one travels into any large town, one sees every house amongst those built semi-detached or in rows equipped with its own individual aerial—and that usually a pretty poor affair.

In most districts owners or tenants of private houses could get far better listening if they would combine to put up a common aerial of the best kind to serve two or more homes. How often does one see rows of small and rickety aerials in little back gardens, which have no room for anything better when each householder insists upon having his own collector. If, say, half a dozen householders agreed to put up a common anti-interference aerial they could have something pretty good. With the total cost divided by six, each person's share would be small, and the improvement in reception would make it very well worth while.

Legislation Wouldn't Do It

There are some who maintain that it's all wrong that we should have to put up anti-interference aerials at all. Interference, they claim, should be stifled at birth, so to speak; in other words, it should be a punishable offence to radiate interference of any kind with broadcast-reception. I agree that it should; and some day no doubt it will be. But even were the radiation of interference entirely prevented, the aerial problem wouldn't be automatically solved. Even if effective anti-interference legislation came into force to-morrow, good aerials would still be worth while.

Ignition Interference

DURING the very cold spell some magnificent samples of car-ignition interference came my way. I live on a hill whose gradient is about one in eight, and when it was covered with about a foot of snow even those cars provided with the most effective of chains had to make terrific efforts to get up it. Some of them didn't; in fact, for some time two were stuck side by side just outside my gate. But those which did achieve the ascent, with spinning rear wheels and racing engines, caused such deafening interference on the short waves that the only thing to do was to switch off whilst one of them was struggling past. That experience made me welcome the action of that enterprising firm, Belling & Lee, which has issued an ordinance that every one of its employees who makes use of the factory car park must fit suppressors to his ignition system. If other radio manufacturing and retail concerns would follow suit we should, at any rate, have made a start in combating the most serious menace to short-wave and ultra-short-wave reception

and to television. It's a very inexpensive business to "suppress" a car, and every wireless man who is also a motorist should have his ignition system treated unless he is completely satisfied, after making practical tests, that it does not radiate interference.

Wangling

A FRIEND who was recently in the United States tells me of a dodge that he came across over there for inveigling the potential purchaser of a radio set into thinking that he is getting something for nothing. He went into a wireless shop one day to buy some small component and the salesman's eagle eye noticed that he gave more than a passing glance to a very fine set of good make which was prominently displayed. "Wonderful job that," said the salesman, and proceeded to demonstrate. My friend looked on interestedly, and casually inquired the price. It was a pretty stiff one, as shown in the maker's catalogue which the salesman produced. "Can't take less," he said, "but see here." He dived under the counter and fished out an ancient and battered midget: "Give me a dollar for that," said he, "and I'll allow you thirty for it in part exchange." I wonder how often that worn-out veteran emerged from its retreat under the counter to be sold for a dollar and taken back a moment later in "part exchange"?

Who's Going to Pay?

AMERICAN manufacturers, I see, are still puzzled over the problem of who's going to pay for the television programmes that are due to start before so very long in the U.S.A. The "sound" programmes broadcast from the medium-wave stations are, of course, very largely sponsored for advertising purposes by commercial firms of all kinds. But the sponsored programme can't pay those who provide it unless the potential audience runs into millions. There's no such ready-made public for television, and in the nature of things there can't be for a good many years to come. So far as can be seen, the big radio manufacturing concerns interested in developing television will have to find the money for the programmes. This being so, I hardly expect that they'll be quite up to the standard of our own, though a great effort will undoubtedly be made to produce something worthy of the New York World's Fair.



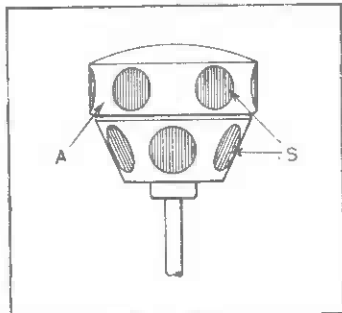
WHAT NEXT! To avoid the many fatal accidents that are caused by collisions at level crossings between cars and trains, an American engineer has devised a signalling system, actuated by rail contacts, whereby the driver of a car fitted with a receiver embodying the necessary device is given warning of the approach of a train. The transmitter giving the warning signal is stated to have a range of ¼ mile.

Recent Inventions

PUBLIC ADDRESS SYSTEMS

THE Figure shows a sound-radiating "post," particularly suitable for public address systems, in which a number of speaker units S are arranged in ring formation. Flat diaphragms about 8 inches in diameter are used instead of horns, which are liable to produce undesirable interference on account of their directional properties, both with other "posts" and with any reflecting surfaces in the neighbourhood.

The power supplied to each unit is limited to two watts, this being found to give a more uniform distribution of the sound than similar arrangements in which speakers fitted with horns are driven at a higher level of power. In the latter case the low notes are over-emphasised and so pro-



Loud speaker "cluster" for all-round radiation.

duce distortion at points outside the range of the corresponding high notes. The casing A serves as a common baffle for all the speakers.

Telefunken Ges. für drahtlose Telegraphie m.b.H. Convention date (Germany), March 10th, 1936. No. 492098.

TELEVISION TRANSMITTERS

IN the Iconoscope tube the picture to be televised is focused on to a mosaic-cell electrode, which is then scanned to develop signal currents. In this type of transmitter, difficulty is sometimes experienced in securing a sharply focused image with good light-and-shade contrast, particularly with "brilliant" pictures when conditions might naturally be expected to be most favourable.

The difficulty is apparently due to part of the light being reflected from the metal parts of the electrodes on to the glass of the tube, and from there back on to the sensitive mosaic. As this reflected light is diffused, it tends to blur the definition of the original picture.

According to the invention, the translucent base of the sensitised

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

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

screen is provided on the side backing the mosaic cells with a coating of carbon which protects the sensitive surface from diffused light, and so improves the focusing and definition of the transmitted picture.

Marconi's Wireless Telegraph Co., Ltd. (assignments of W. H. Hickok). Convention date (U.S.A.), December 31st, 1936. No. 491113.

TUNING WITH AVC

WITH "delayed" AVC, weak signals are received when the set is operating at maximum gain, but it is then necessary to tune by ear alone, since the ordinary visual tuning-indicator will only work properly when the normal AVC voltage is available. The invention provides a visual indicator which can be used for tuning signals received at a strength below that at which the full volume control automatically comes into operation.

The diagram shows a superhet receiver in which V is the combined RF amplifier and mixer, V1 the intermediate-frequency stage, and V2 a double-diode-triode rectifier and amplifier. The visual tuning indicator I is connected in the anode circuit of the IF stage.

With weak signals the voltage developed by the diode D over the resistance R is not sufficient to render that diode conductive, so that the "delayed" AVC voltage is not brought into action; nor is

any control applied through the lead L to the grid of the amplifier V. The same signals are also applied through a condenser C to the diode D1, and here they cause current to flow through the load resistance R1, so that an AVC voltage is applied to the grid of the IF amplifier V1 through the lead L1. This control is comparatively slight, owing to the nature of the incoming signals, but it is sufficient to cause the visual indicator I to operate effectively.

Telefunken Ges. für drahtlose Telegraphie m.b.H. Convention date (Germany), March 12th, 1936. No. 492263.

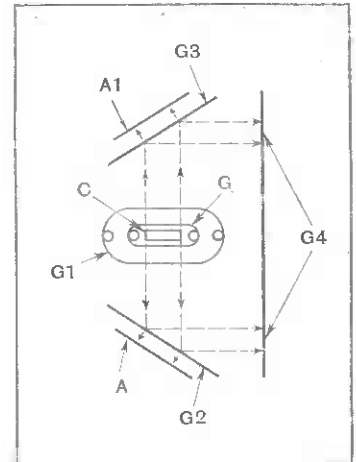
MULTI-GRID VALVES

RELATES to multi-grid valves, such as the hexodes and heptodes used for frequency-changing, in which the electron stream passes first through an accelerating grid, and then through a retarding grid, on to the anode. As they reach the retarding grid, some of the electrons pass through, whilst others are reversed in direction back towards the accelerating grid.

When the valve is handling very high frequencies, an out-of-step condition may arise in which the reversed electrons will pass through the accelerating grid and reach the more-negative control grid, where they are likely to clamp the input circuit and create other undesirable effects. The object of the invention is to prevent

this from happening by using the electrode arrangement shown in section in the Figure.

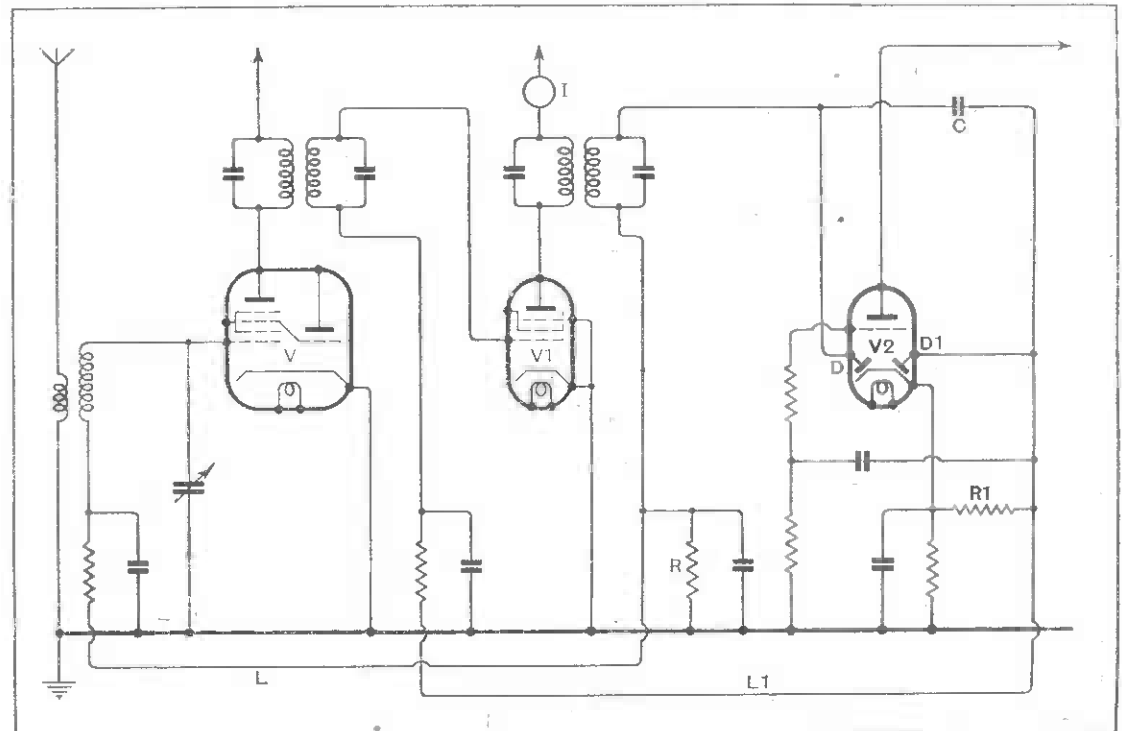
The cathode C is associated with a control grid G and a coaxial accelerating grid G1. The retarding grids G2, G3 are



Sectional drawing showing electrode positions in a multi-grid valve designed for high input resistance.

arranged at an angle, as shown, parallel with the corresponding anodes A, A1; both these grids and their anodes may be connected together. An auxiliary grid G4 then collects that part of the electron stream which is diverted away from the anode by the retarding grids, as indicated by the arrows.

The M-O Valve Co., Ltd., W. H. Aldous and G. W. Warren. Application dates, July 2nd, 1937, and May 5th, 1938. No. 491991.



Visual tuning indicator operating on signals below AVC level.

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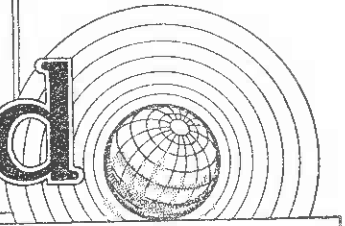
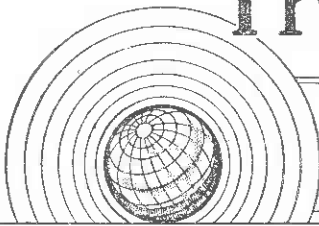
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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

	Page
Editorial Comment	75
Automatic Navigator	76
Television Programmes	78
The Modern Aerial	79
Problem Corner—IV	80
Frequency-changing Problems ..	81
News of the Week	83
The Amateur Transmitting Station IV—Design of the Power Amplifier Stage	85
Unbiased	88
Start Point—the New South Coast Regional	89
Philips 753A Receiver Reviewed..	90
Power Consumption Meters	93
Random Radiations	94
Letters to the Editor	96
Recent Inventions	97
Short Wave Stations of the World	98

EDITORIAL COMMENT

National Wireless Register

Organising Our Radio Resources

IN the event of an emergency which would require everyone to put himself at the service of the Country, the moment will arise when every individual will ask where he can offer his services so that such qualifications as he may possess will be of the greatest value.

Readers of "THE WIRELESS WORLD" have nearly all of them technical qualifications, which in many cases have been acquired from years of training or practical experience.

It is our desire to serve as a medium for introducing such readers to the particular jobs in National Service to which they will be best suited, so that the risk may be avoided that they will be assimilated into all sorts of occupations where their special qualifications would be wasted.

The Register

With this object in view, we are including in this issue a form inviting readers to fill it up and post it, as already addressed, to the Secretary, The Wireless Telegraphy Board, so that those who do so may be classified into appropriate groups and form the basis of a National Wireless Register. The filling up of the form involves, of course, no liability whatsoever, but will serve a useful purpose to the authorities and will avoid the very real risk that the qualifications of wireless men may be lost through individuals being drafted hastily into non-wireless categories.

It is important that the information asked for in the form should be given

as accurately as possible, especially as regards the present position or employment in which the reader may be engaged.

It is hoped that every reader, whatever his qualifications may be, will complete the form and so make this Register of real value.

Foreign Language Broadcasts

Wireless and Peace

THERE is apparently no foundation for the rumour that the Government intends to conduct its own service of broadcasts in foreign languages. Although it is arguable that this service is not strictly within the proper province of the B.B.C., most readers will share our satisfaction at learning that our Government is not to enter into immediate competition with the direct propaganda from other governments which may now be heard on most wavebands at almost any time of the day or night.

Propaganda as at present disseminated is a sorry and discredited thing, ineffectual even in making converts to the causes propagated, and it is a matter for keen regret that the vast potentialities of broadcasting have been put to such base uses. No wonder the B.B.C. has ceased to use, or at any rate to emphasise, its motto "Nation shall speak Peace unto Nation." But we would like to think that, profiting by the mistakes of others, the Corporation can yet find a way of making the motto live again. If means can be found to do so effectively, all the other services that wireless has already rendered to humanity, great as they are, will fade into insignificance.

Automatic Navigator

By J. A. MCGILLIVRAY

BLIND flying is a most unpleasant form of travel, which is, unfortunately, sometimes necessary. If the airlines are to compete with surface travel, they must operate in all sorts of weather. By flying over the top of the clouds, the actual bad weather can frequently be avoided, but navigation under these conditions is apt to be a matter of guesswork, unless full use is made of wireless direction finding.

In order to reduce congestion of the DF service and to assist in blind navigation, there has been built an instrument which is almost entirely automatic in operation and which shows the pilot his position on the chart at a glance.

The indication given is in the form shown in the photograph, that is, by means of intersecting pointers on a chart. The point of intersection of the pointers on the map is, within very close limits, the position of the receiving instrument, and the receiving instrument is small enough and light enough to be carried in any craft used on regular air-line work.

Up to the present, if an air pilot wanted to know his position, he had two courses open to him. The first, and most generally used, is to ask a group of ground stations to take his bearings, and, after

collaborating, to plot his position. The result is signalled to the pilot, and it speaks very well for the efficiency of the service that the whole operation takes a matter of only two minutes to perform. Another, and less used method, is for the radio officer of the aircraft to take two or more consecutive bearings of different stations and pass these to the navigator of the craft for plotting.

The second method has advantages over the first, in that no calling nor answering is required, and the position of the craft is not disclosed to the ground station. Under bad weather conditions, however, the radio officer is usually busily employed, and the fullest use is not made of the aircraft direction finder.

The apparatus described below is, essentially, two automatic direction finders which operate continuously and simultaneously. They do not interfere with the wireless service of the craft, and they cause no crowding of a wave band which is already full up. The apparatus is equally suitable for aircraft or ship use. Bearings are taken of any kind of wireless transmitter, and broadcasting stations are specially suitable, as they are easy to identify and they operate for long periods

DESCRIBING an arrangement of two linked direction-finders by means of which the position of an aircraft is shown by the intersection of a pair of pointers pivoted on a chart.

DIRECT-READING POSITION INDICATOR FOR AIRCRAFT

without interruption. It is, of course, necessary that the exact geographical position of the transmitters selected is known.

The complete position finder is automatic in action when tuned, and each unit has its associated apparatus for plotting on the map the result of its operation. Each direction finder is worked from its own loop aerial, and uses a small fixed aerial for the determination of sense. In the original model, commercial receivers were used, and they required only slight modification. They were built originally as light weight "homing" receivers for use with visual indicators. The essential parts of the circuits are shown in Fig. 1.

Directional Properties

It is well known that when a receiver is operated from a loop aerial the signal strength depends on the angle between the plane of the loop and the direction from which the signal is coming. The signal strength is maximum when the loop is pointing directly at the transmitter, and should be zero when the plane of the

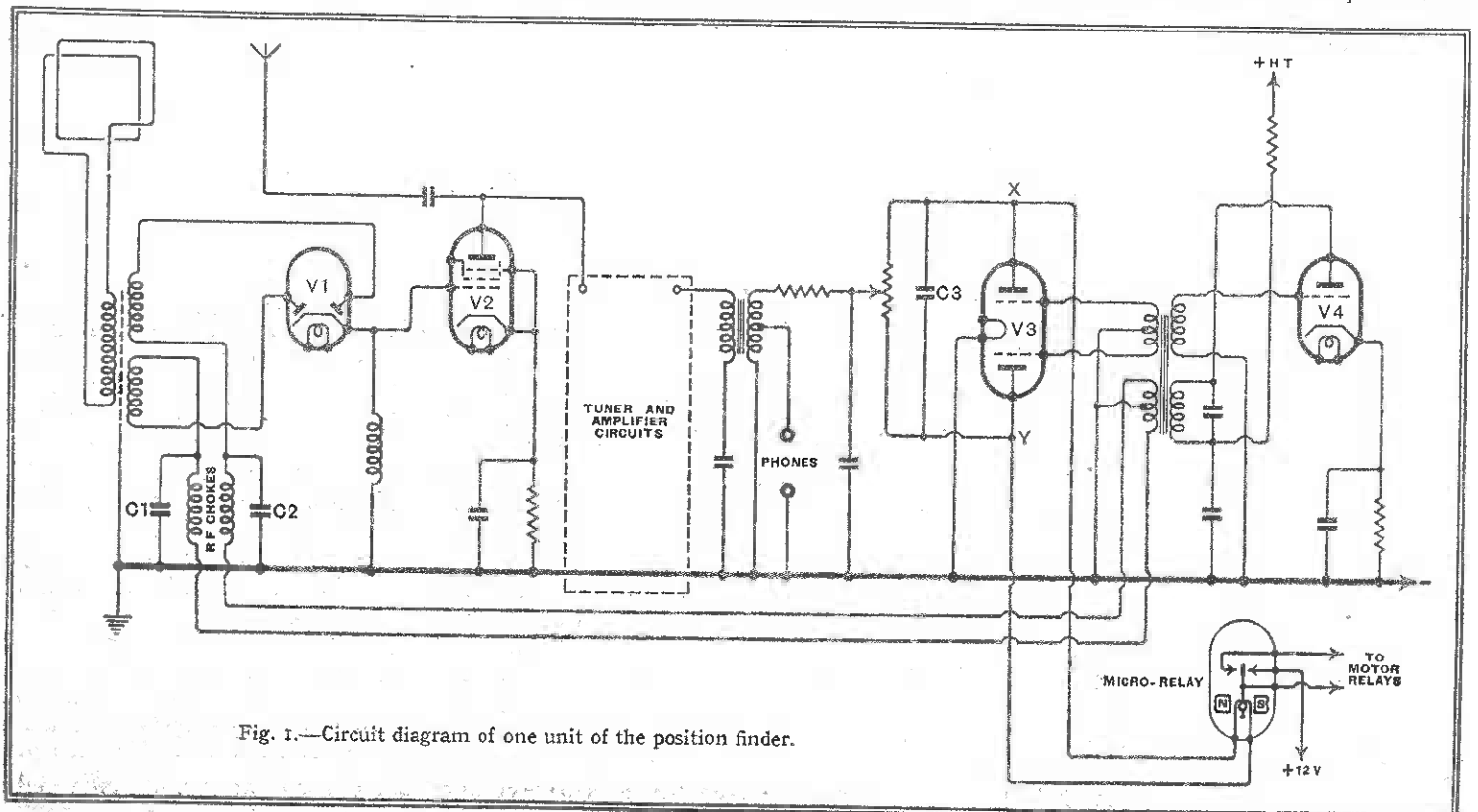


Fig. 1.—Circuit diagram of one unit of the position finder.

Automatic Navigator—

loop is at right angles to a line joining the transmitter and the receiver.

When the loop is in this position the signal strength will be at its lowest level, if it is not absolutely zero, and a slight rotation of the loop, of as little as two degrees, is enough to produce a distinct

a louder signal will be delivered in one position of the switch than in the other; but if the loop aerial is in the minimum pick-up position, then the output on each side of the switch will be the same, and the signal is then said to be balanced.

In the receiver used here the switching and mixing of the two signal voltages

direction finder. An equivalent simplified switching circuit is shown in Fig. 2.

The receiver and amplifier circuits are not shown; they comprise a mixer, IF amplifier, detector and amplifier, terminating in the class B valve, V₃, which has no direct HT connection, but is conductive first on one side then on the other, being controlled, or switched, by the same LF oscillator as before, V₄. A balanced input to the receiver will produce a balanced output from V₃, but an unbalanced input, due to loop aerial pick-up, will produce out-of-balance currents through V₃ and consequent charging up of the large capacity condenser C₃, which will produce directional movement of the micro-relay needle.

“Sense-governed” Relay

The direction in which the needle will move will depend on which component of the V₃ current is the greater, which again depends on the phasing of the inputs to V₁, so that the micro-relay movement is “sense-governed.” If the loop aerial is in the position of zero or minimum signal pick-up, the micro-relay will receive no directional impulse, and the needle will remain central.

When the needle of the micro-relay is fully deflected, on either side, it makes contact with a stop, and allows current to flow from a local 12-volt battery. In order to effect this full deflection of the micro-relay, 15 micro amps. are required, and the input current to the relay is completely separated from all local battery connections.

The current which is released by the micro-relay from the local battery is used to drive a 12-volt shunt-wound reversible motor. The circuit is that of Fig. 3, from which it will be seen that the switching into circuit of the motor is indirectly performed. The contacts of the micro-relay are not heavy enough to carry the current required by the motors, so the micro-relay is used to cut-in a second relay, requiring

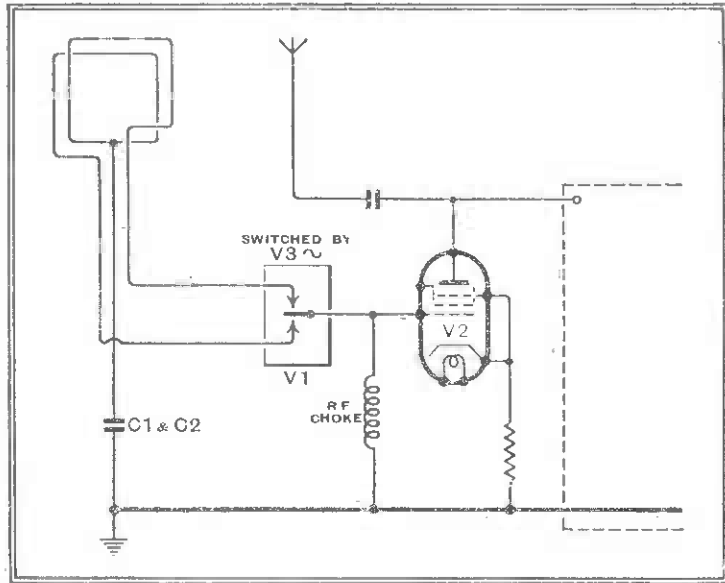
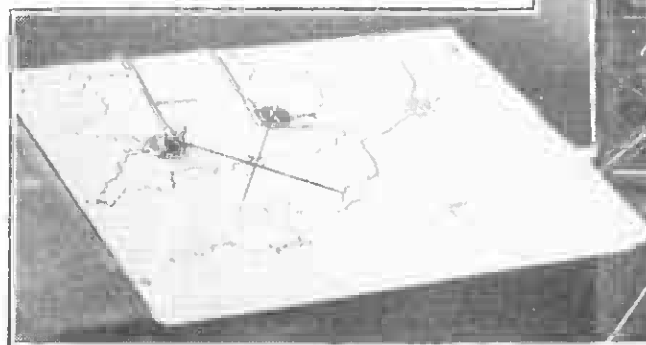


Fig. 2.—Explanatory equivalent circuit of the “electronic” switching system. The loop aerial and its coupling transformer (Fig. 1) may be regarded as equivalent to the centre tapped loop of this diagram, as the secondary of the transformer is earthed to RF through the condensers C₁ and C₂. The action of the oscillator is to make half of V₁ conductive from cathode to anode, which has the effect of joining one end of the loop aerial to the control grid of V₂, and, as each end is joined alternately, the phase of the control grid voltage is reversed at oscillator frequency. This means that the phase of the V₂ anode voltage is reversed at the same frequency, and will therefore be alternately in phase and out of phase with the fixed aerial signal voltage, causing the signal delivered by the receiver to vary in intensity at the oscillator frequency.

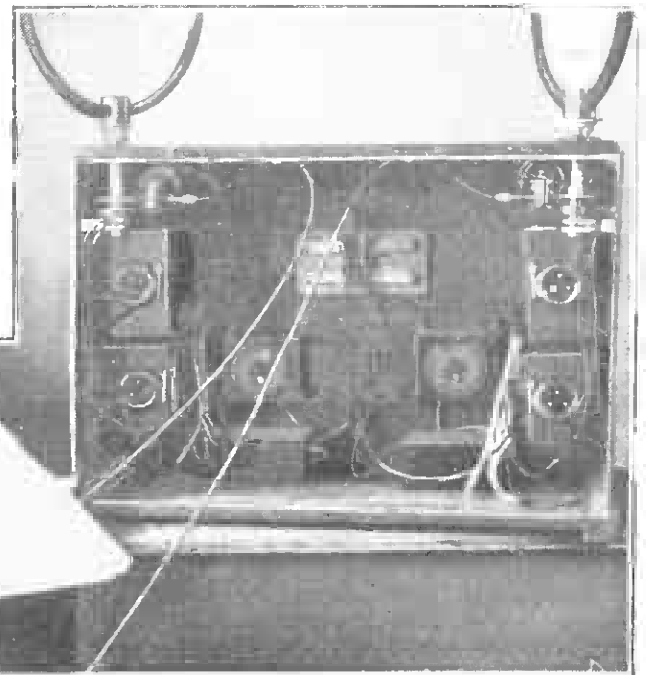
increase in the received signal strength.

If a small fixed aerial is coupled to the receiver at the same time as the loop aerial, then a signal will be produced by the receiver, even if the loop is in the minimum signal position, due to the fixed aerial. As the loop is moved from the minimum position the signal voltage induced in it will mix with the signal voltage induced in the fixed aerial in affecting the receiver, and the signal delivered by the receiver will depend on whether these two signal voltages are in phase or out of phase. In the first case the level will be high and in the second case low. The phase relationship can be reversed by turning the loop through the minimum position, or alternatively, by earthing the electrical centre of the loop aerial and connecting each end alternately to the receiver. If the fixed aerial output and the loop aerial output are fed simultaneously to the receiver, and the loop aerial output is reversed in phase by means of a switch, then

frequencies by the condensers C₁ and C₂, this is the same, in effect, as earthing the centre of the loop aerial and connecting its ends in alternate order to the receiver, i.e., the phase of the loop aerial voltage with respect to the fixed aerial voltage is reversed, or switched, continuously at the frequency of the LF oscillator V₄ (about 400 c/s). The fact that V₂ amplifies the loop voltages before mixing them with the fixed aerial voltages does not affect the explanation, as this has only the effect of making the receiver more responsive to small loop voltages, and therefore more accurate as a



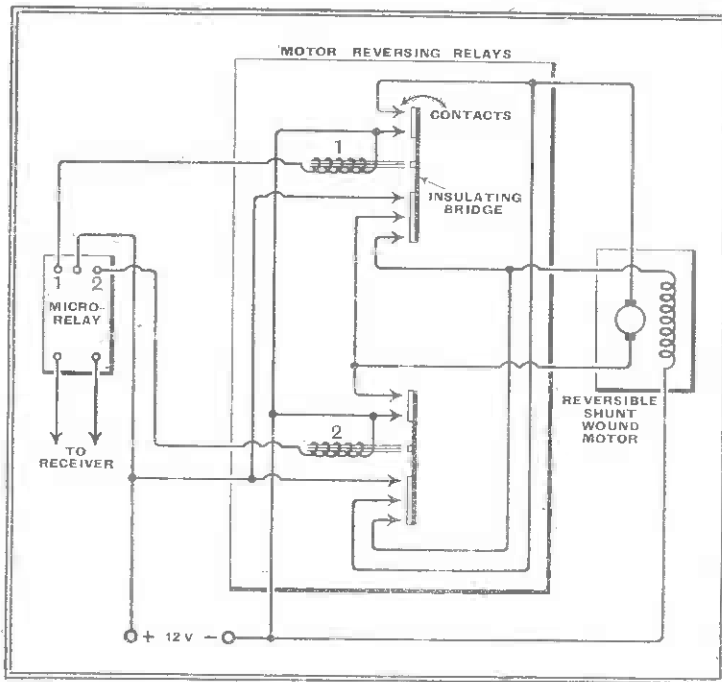
A demonstration model of the “automatic navigator.” The position-indicating pointers are rotated by flexible shafts.



Automatic Navigator— only 12 mA., and this second-stage relay actually switches the motor into circuit. By using two second-stage relays the motor can be reversed. Movement to the right of the micro-relay causes the motor to run clockwise, and vice versa, by reversing the armature current. Fig. 3 makes the explanation more readily understandable.

We have now reached the stage of causing the loop input to control the direction of rotation of an electric motor, and this electric motor is

Fig. 3.—Control system of the motor by which the loop aerial of one unit is rotated to the "zero" position by the effect of the incoming signal. The motor is reversed by altering the direction of current through the armature; only one relay can be energised at a time.



tersection of these two bearings is the geographical position of the receiver. Best results are obtained when one receiver is tuned to a medium-wave station and the other to a long-wave station, but remarkably little interaction has been observed even if both are operating on the same band. As the craft moves steadily along

the appropriate receiver tuned-in. Then the pointer is rotated automatically by the motor until the appropriate bearing is given.

Phones are used for station identification, and these can be disconnected after the station has been tuned. A modification which immediately suggests itself is to fit push-button tuning in order to make the operation even more nearly entirely automatic.

At the point of intersection of the pointers a stylus can be attached so as to trace the track followed by the craft, and the possibility of coupling the apparatus to an automatic pilot has also been considered. The idea behind this is to make the craft follow a desired track instead of a desired course as at present.

The apparatus is susceptible to the same errors as other direction finders and to the same degree. The most serious of these are quadrantal error and night error; while no means has been used successfully to overcome night error on a mobile receiver, quadrantal error should present no insuperable difficulties.

On test the apparatus has repeatedly given very accurate results, showing the position of the receiver to within two miles of where it was known to be, and it is considered that such a degree of accuracy is sufficiently high. It is at least accurate enough to bring an aircraft within the range of a blind approach beacon after making a long journey and without a sight of land *en route*. Doubtless, more accurate results could be obtained by a skilled operator, taking and laying off his own bearings, but it is felt by many that there is wide scope for the robot.

geared so as to rotate the vertical shaft which supports the loop aerial. Any unbalanced signal will, therefore, cut-in the motor, which will rotate the loop aerial as long as the signal is unbalanced, and which will stop turning when the signal becomes balanced. The signal is balanced when the loop aerial is picking up nothing, i.e., when its plane is at right angles to a line joining the transmitter and the receiver. As the receiver moves over the earth, the loop begins to pick up a signal, and again the loop is rotated, and shows, on a circular scale attached to it, the bearing of the transmitter from the receiving station.

As well as driving the loop aerial the motor drives, through a gear train of identical ratio, an indicating arm. The indicator must, therefore, move through the same arc of rotation as the loop every time that the loop is turned. The indicator is driven through a flexible shaft, and is so constructed as to be fixed easily on a map, and by a suitable initial adjustment of the indicator arm to indicate the bearing of the receiver from the transmitter. Then if the loop is turned clockwise by the motor, the indicator is also turned clockwise by an equal amount, and so on. The initial adjustment of the pointer of the indicator is necessary in order to compensate for alterations in course of the craft. The pointer is pivoted on the map, with its pivot over the geographical position of the transmitter to which the receiver is tuned, and the pointer indicates the bearing of the receiver from that transmitter.

By using two complete units as described and tuning them to different transmitters the bearings of the receiver from two points can be laid off simultaneously, and the in-

her course, within the usual tolerances, so the pointers move equally steadily over the surface of the map, showing the pilot his position at all times. When passing out of range of one station the pointer is moved to the next most suitable transmitter, and

Television Programmes

Sound 41.5 Mc/s.

An hour's special film transmission, intended for demonstration purposes, will be given from 11 a.m. till 12 noon each week-day. The National or Regional programme will be radiated on 41.5 Mc/s from approximately 7.45 to 9 p.m. every day.

THURSDAY, JANUARY 26th.

10.30-10.40 a.m., Mr. F. W. Ogilvie, Director-General of the B.B.C., and Mr. C. O. Stanley, Chairman of the Television Development Subcommittee of the R.M.A., will speak on "Television Prospects."

3, Charles Heslop in "More Fun and Games" 3.30, 211th edition of Picture Page.

9, Renée Houston and Donald Stewart in Cabaret. 9.35, Gaumont-British News. 9.45, 212th edition of Picture Page. 10.15, News.

FRIDAY, JANUARY 27th.

3-4.30, "Traitor's Gate," the play by Morna Stuart, with Margaretta Scott and Basil Sydney.

9, "More Three-Four," another essay into the history of the waltz. 9.30, British Movietone. 9.40, "Edna's Fruit Hat," a romance by John Pudney. 10.25, News.

SATURDAY, JANUARY 28th.

3, The Hogarth Puppet Circus. 3.10, Cartoon Film. 3.15, Cabaret (as on Thursday at 9 p.m.). 3.50, Film. "Sky High."

9, "More Fun and Games" (as on Thursday at 3 p.m.). 9.30, O.B. from Wembley of the National Table Tennis Championship Finals. 10, "Rehearsal for a Drama," a play for television by Roy Carter and Emanuel Wax. 10.35, News.

Vision 45 Mc/s.

SUNDAY, JANUARY 29th

3, General Knowledge Bee. 3.20, O.B. from the International Telephone Exchange, Faraday House. 3.40, Punch and Judy, by Bruce McLeod. 3.50, Cartoonists' Corner—Oscar Berger.

8.50, News. 9.5-10.30, The Birmingham Repertory Company presents "The Swiss Family Robinson."

MONDAY, JANUARY 30th.

3-4, "Money for Jam"—a farce by Bernauer Osterreicher, translated by M. and A. Bolton.

9, Guest Night. 9.30, "Behind the Beyond," a problem play by Stephen Leacock. 10.5, Gaumont-British News. 10.15, "Six Gentlemen in a Row," a comedy by Jules Romains; English version by Harley Granville-Barker. 10.35, News.

TUESDAY, JANUARY 31st.

3-4, "1066 and All That," an adaptation of the famous "history" by Sellar and Yeatman. Cast includes Charles Heslop, Hugh E. Wright and Cyril Ritchard.

9, Cabaret. 9.25, Cartoon Film. 9.30, British Movietone. 9.40, Poushnoff. 10, "A Marriage has been Arranged," a duologue by Alfred Sutro. 10.15, News.

WEDNESDAY, FEBRUARY 1st

3, Farm O.B. illustrating life on a farm. 3.20, British Movietone. 3.30, Intimate Cabaret, including Trudi Binar.

9, Speaking Personally. 9.10, Marcella Salzer. 9.30, O.B. from Harringay Arena of the Police Open Boxing Championships. 10.15, News.

The Modern Aerial

WHY IT IS IN THE LIMELIGHT

By R. W. HALLOWS, M.A.

THE story of the development of the broadcast receiving aerial in this country is curious and interesting, for it shows the strangest changes in the attitude of listeners towards one of the most important parts of the whole receiving equipment. When it begins, in the early 1920's, the value of the good aerial was fully recognised; but as time went on there followed a period of neglect. Less and less trouble was taken over the aerial until it became rare to see one that was well erected and well cared for amongst the welter of ramshackle contraptions of poles and wire attached to houses of every kind. The revival set in a year or two ago. The good aerial is coming back, but there are still far too many of the other kind to be seen.

Whatever the sets we made or bought in the early days of broadcasting they cost us dear; we were determined to get the best possible results from them and, since they relied upon crystals, or upon valves whose mutual conductance figures we should now regard as microscopic, the only way of doing this was to provide them with aerials that were long, high and effective. We vied with one another in erecting "inverted-L's," "T's" or "sausages," supported by lofty masts and provided with imposing arrays of spreaders, insulators, pulleys and halliards.

So few stations were at work on the long waves and the medium waves, and so small was their power that there was no need to bother much about selectivity. The single problem was to feed the set with the strongest impulses that could be obtained from the collector system.

As time went on receiving conditions underwent a radical change. Almost every European country began to develop some kind of national broadcasting service. New transmitters made their appearance here, there and everywhere. And there was something more: neither listeners nor radio engineers were content with a service that was unreliable at distances beyond a few miles from the transmitter. Engineers set themselves the ideal of a service area with a radius of from fifty to 100 miles in which good reception could be

guaranteed at all times of the day and at all seasons of the year.

There was only one way of achieving the ideal, and that was to increase the output power of broadcasting stations. The 1-kilowatt or 2-kilowatt transmitters were replaced by others rated at 5, 10, 15 kilowatts. Results were better, though yet far from perfect; still greater power was called for. On the long waves transmitters rated up to 500 kilowatts came into action; on the medium, 120 kilowatts was agreed upon as the maximum permissible, and the majority of individual channels came to be occupied by stations whose output power was 25, 50, 75, 100 or 120 kilowatts.

Trend Towards Small Aerials

The effects of the power increases of transmitters upon receptions were enormous. So far as receiving aerials were concerned there were two of great importance. The first was that it was very difficult to obtain the necessary selectivity to hear foreign stations when the home "local" was working from the average three-valve "straight" receiver (then by far the most commonly used type) connected to a large aerial of the inverted-L, the T, or the sausage type. The second, that owing to the great field strength of

AFTER a long period of neglect, aerial efficiency is again a subject to which attention is being paid. The reasons for this revival of interest are discussed in the present article, which also deals with the advantages of the up-to-date "all-wave" anti-interference aerial.

the local stations and, after dark, of many of those in foreign countries, some kind of reception of a large number of stations could be obtained with almost any kind of aerial. Some manufacturers were, unfortunately, quick to see a "selling point" here. They announced that their sets needed no elaborate or expensive outdoor aerial; they would work quite well from a wire stapled round the picture rail or some similar makeshift.

Hence the need for apparent selectivity, and the ample field strength available drove the large, efficient aerial out of fashion. It failed to return to fashion even when the popularisation of the super-heterodyne set had provided true selectivity or when improvements in receiver design produced instruments that could give of their best only if they were worked from first-rate aerials. It is no exaggera-



Photo by courtesy Belling and Lee, Ltd.

tion to say that until quite recently at least eight out of every ten receiving aerials in this country were hopelessly inefficient and were badly handicapping the sets used with them. We might well question the sanity of the man who, having acquired a car capable of fine performance, insisted on always driving with his brakes partly on, using a low gear all the time in order to overcome their effects. But the purchaser of a high-grade wireless receiver who operates it from some travesty of an aerial and must therefore run it nearly "all-out" in order to obtain results of a kind is doing much the same thing.

The coming of the modern aerial dates from the introduction of the "all-wave" receiver. It was soon realised that though the bad aerial might enable a sensitive set to give some account of itself on the medium and the long waves, it was of little avail for short-wave reception. And there was another factor whose importance was rapidly increasing; this was man-made interference. Even well built and well cared for aerials of the old types gave no help here; the higher, in fact, their efficiency as collectors, the greater might be the amount of interference that they brought in.

The broadcast receiving aerial of to-day aims at killing two birds with one stone:

The Modern Aerial—

it is both "all-wave" and "anti-static." With it a set is enabled to put up a good performance on all the bands of wavelengths that it covers, its sensitivity being given full play; and, if properly erected, such an aerial will in the vast majority of instances greatly reduce the effects of local interference—if, indeed, it does not altogether eliminate them.

The principle behind most modern aerials is to place a highly efficient collector above the zone of interference and to connect it to the receiving set by means of a low-impedance transmission line. The transmission line may be of several different kinds. Where interference is not severe, simple twisted flex will often suffice; in bad cases a line with an earthed metal sheath may be needed.

Besides its good qualities as an averter of interference the transmission-line aerial has other advantages. It can serve a large number of receiving sets, all of

which can be used simultaneously and tuned to different stations without interfering with one another. It is therefore eminently suitable for blocks of flats, as well as for houses or other buildings in which several aerial points are required. A single aerial can also be used to supply a number of houses situated close to one another. The "semi-detached" and those who live in rows of houses might have far better reception if they clubbed together for the provision of one first-rate common aerial to replace individual low-efficiency collectors.

Again, the low-impedance transmission line can be of considerable length without any great effect upon results. It can be treated very much as if it were a bell wire, being run along skirting boards, under floors, or round door and window mouldings. The modern aerial thus offers the simplest of solutions to those whose

problem is how to install a receiving set in a front room when the only possible

site for the aerial is at the back of the house.

The new aerials are of many kinds and of many makes. Most have a horizontal collector, slung between masts and with a transformer at one end, in the middle, or dividing the "root" into two unequal parts. From this runs the transmission line, a second transformer being needed at the receiving set to match the line to the high-impedance receiver circuits. Some have a vertical rod as collector, with a transformer at its lower end.

So far I have spoken only of aerials intended for general reception; reception, that is, of broadcasting stations on the long, medium and short waves. Ideally one should have not one aerial but several, each being specially designed for a particular band of wavelengths. The "all-wave" aerial

Imposing aerial system at Mr. G. W. Bagshaw's experimental station near Sheffield, at which A. P. television has been received.

is a compromise—and no bad compromise at that—giving performance good enough to satisfy most listeners on wavelengths between 10 and 2,000 metres. But those who want to make the very utmost of the short-wave stations will find aerials designed to meet their requirements exactly. For television and for ultra-short wave reception in general special aerials are, of course, essential.

Efficient and Good-looking

In the past many have objected to the outdoor aerial on the grounds of its unsightliness. There is no reason why the up-to-date aerial should be an eyesore. Some kinds are hardly noticeable, and one great advantage of the transmission line is that, if need be, the aerial can be put up a considerable distance away from the house.

The saying that a good set demands a good aerial is as true to-day as ever it was. Good sets have not always met with their deserts in years gone by; but now that excellent aerials are to be bought and erected for a very moderate outlay there is every inducement to provide the receiver with a collector that will ensure its doing itself full justice.

PROBLEM CORNER—4**Test Your Powers of Deduction**

REGULAR readers will need no introduction to Henry Farrad, whose solutions of his friends' problems are being published week by week. Here is another sample from his correspondence. Try working it out yourself.

All Hallows School,
Berkhamsted.

Dear Henry,

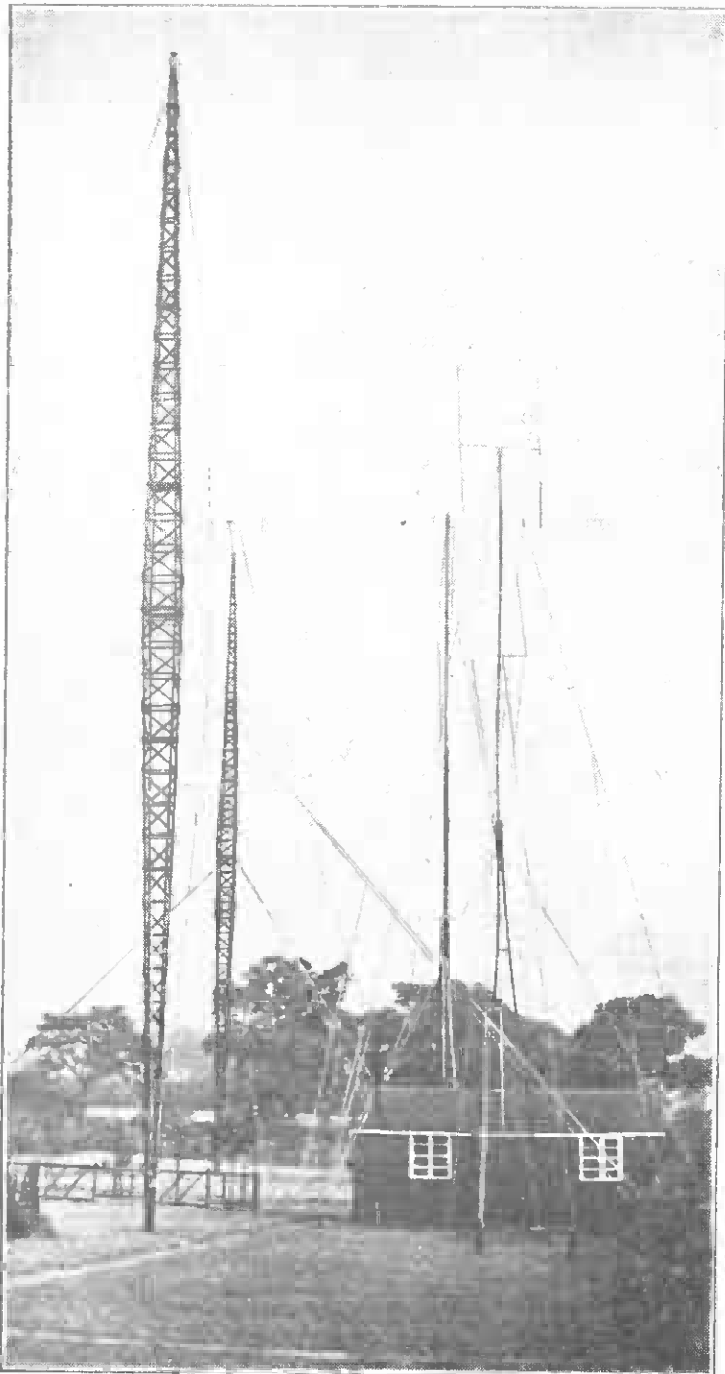
The other day I bought some stuff at one of those places that clear off surplus junk, and among it what appears to be a potentiometer, only instead of the usual three terminals it has four. As it is all sealed up I cannot see the connection, but as I have a test meter with a resistance scale I measured the resistances between all terminals, with the knob in two positions, (1) at the left-hand limit, and (2) at the right-hand limit. From the metal case there is no measurable contact with any of the terminals. I have marked the terminals A, B, C and D.

	(1)	(2)
	Ohms	Ohms
Resistance between A and B	0	48,000
Resistance between A and C	23,000	25,000
Resistance between A and D	48,000	0
Resistance between B and C	23,000	23,000
Resistance between B and D	48,000	48,000
Resistance between C and D	25,000	25,000

I am not quite sure what all this indicates; I should be awfully obliged if you would let me know exactly how it is connected.

Yours sincerely,
Tony.

How did Henry Farrad work out the connections? See page 95 for the solution.



Frequency-Changing Problems

FURTHER DEVELOPMENT IN MIXER VALVES

By E. LUKACS and J. A. SARGROVE (Tungsram Research Laboratory)

THE requirements of modern frequency changing have been enumerated previously,¹ and it was shown that multiplicative mixing offers one of the most satisfactory ways of achieving this end. Since that date the various effects occurring within the frequency-changer valve have been subjected to exhaustive analysis, mainly in connection with the difficulties experienced on the shorter wavelengths. An attempt is made in this article to review briefly the factors that effect recent development in order to satisfy the demand for higher efficiency frequency changers for short-wave wireless receivers and in the field of television.

THE action of modern frequency-changing valves is quite complicated, and an incomplete understanding of their action often leads to difficulty in their use. In this article some of the interaction efforts are explained and the importance of correct valve design and its correct use for the avoidance of frequency drift is emphasised.

main direction of the electron flow from cathode to anode.

With triode-hexodes and triode-heptodes, which we shall briefly term hexode valves, the modulator or signal grid is nearest to the cathode. Frequency drift in valves of this type is caused by variation of the injector grid capacity.

A virtual cathode exists just before the injector grid, in the form of a considerable negative space-charge, with the result that the actual input capacity of the grid is greater than that due purely to its geometrical position. An increase in the signal grid-bias voltage causes the current density to be reduced, and

hence the density of the space-charge in front of the injector grid. The grid input capacity is consequently reduced.

As the injector grid is internally linked to the oscillator grid it is obvious that the operation of AVC will cause changes in the oscillator frequency. However, this frequency drift can be considerably mitigated

by using a tuned-anode oscillator circuit for the triode, for only a fraction of the change in grid capacity will then be reflected on to the oscillator circuit. This fraction is, in fact, exactly proportional to the ratio of the mutual inductance of the reaction and oscillator coils to the self-inductance of the oscillator coil (M/L ratios).

At this juncture it is well to note that the rather open-mesh injector grid of the older type triode-hexode type TX4 has only a small retarding action on the electron stream, and so produces only a low density space charge. Consequently the change in its injector grid capacity due to AVC is but slight, the frequency drift caused by it being merely a fraction of one kc/s.

Owing to its open-mesh injector grid, for maximum efficiency, the TX4 requires about 20 V. peak oscillation. To satisfy a general demand on the part of set manufacturers the TH4A was designed in such a way that 10 volts oscillator peak voltage is sufficient for its full control. This was achieved by making the injector grid of closer mesh, but this brought about an increase in the capacity variation as a result of the greatly increased space-charge density. However, if the oscillator circuit is of the tuned-anode type, the frequency drift with the TH4A at 15 metres is still only 2 kc/s, and thus barely perceptible.

Some frequency drift caused by changes in the capacity of the oscillator grid also occurs in octode-type valves. In octodes such as the VO4 and EK2, a virtual

It is a well-known fact that the natural losses of the oscillator circuits are considerably greater on the short-wave bands than on the broadcast and long wave bands, and thus in order to obtain a suitable heterodyne voltage a considerable increase in reaction turns ratio must be used on the oscillator coil. However, this is accompanied by various drawbacks; the shortest wavelength obtainable at minimum tuning condenser capacity becomes longer; owing to the larger number of turns on the reaction coil the phase of the feed-back voltage is shifted, and this is detrimental to the frequency stability of the local oscillator. A modern oscillator triode consequently has a mutual conductance of 4.5 to 5 mA/volt instead of 1.2 to 2 mA/volt as in earlier valves. A triode having such a slope is embodied in the triode-heptode type TH4A and in the beam octode, EK3.

Frequency drift of the local oscillator may be caused by a fluctuation of the applied potentials as follows:—

- (1) Alteration in the value of the signal grid bias due to AVC.
- (2) Inconstancy of the supply mains voltage.

In dealing with these problems it is necessary to separate triode-hexodes and triode-heptodes into one group, and the octode types into a separate group. While all these are frequency changers of the multiplicative type, the essential difference between them lies in the sequence of the two control grids with reference to the

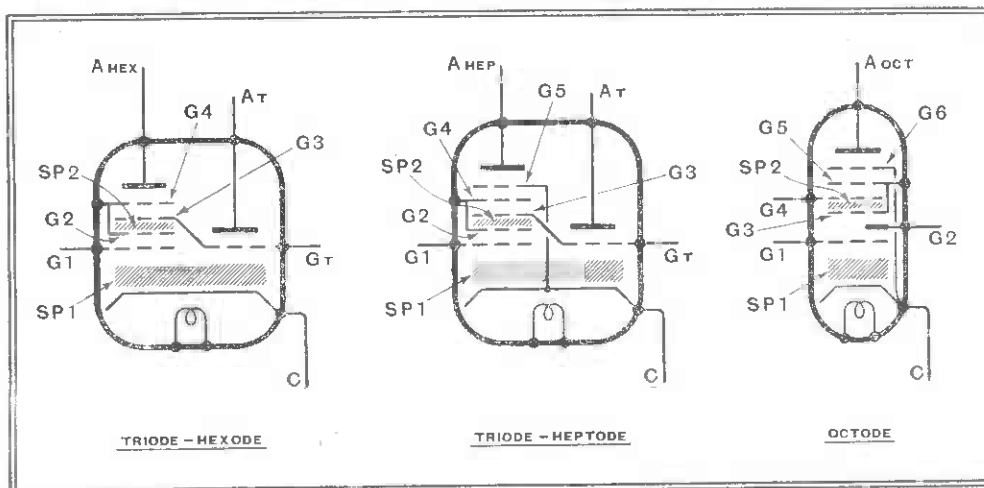


Fig. 1.—The symbolic arrangement of electrodes and space-charges in the triode-hexode, triode-heptode and octode is shown above, and the meaning of the lettering is given below.

Term.	Cathode.	Cathode Space-charge.	First Control-grid.	First Accelerator.	Virtual Cathode.	Second Accelerator.	Suppressor.	Output Anode.	Osc. Anode.	Osc. Grid.
Triode-hexode	C	SP1 (1st space-charge)	G1 Signal grid	G2	SP2 (2nd space-charge)	G4	—	A hex.	A trio.	G trio.
Triode-heptode	C	SP1	G1 Signal grid	G2	SP2	G4	G5	A hep.	A trio.	G trio.
Octode	C	SP1	G1 Osc. grid	G3	SP2	G5	G6	A oct.	G2	G1
Potential	O	Slightly negative	—ve	+ve	Slightly negative	+ve	O	+++	++	—ve

¹ The Wireless World, April 7th and 14th, 1937.

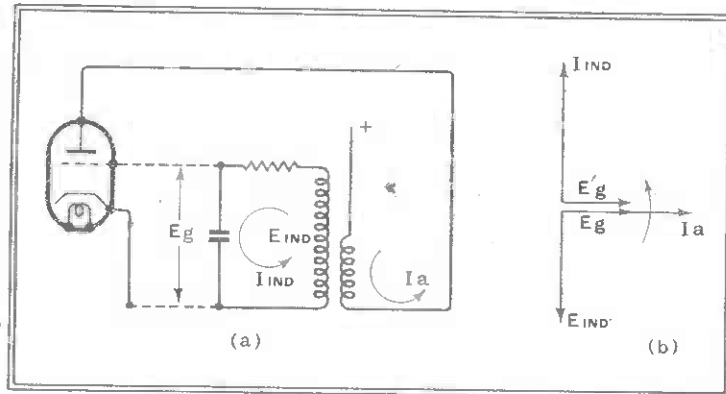
Frequency-Changing Problems—

cathode is formed before the signal grid (G₄). Some of the electrons will return from this virtual cathode, their quantity depending on the bias voltage of the signal grid. (As the signal grid does not influence the magnitude of the cathode current a decrease in anode current is accompanied by an increase in the currents of the accelerator electrodes.) Of the electrons

in direction to the potential in order that equilibrium may be re-established between the induced potential and the voltage drop across the resultant resistance of the oscillator circuit. This current produces a potential $E'g$ across the capacity of the oscillator circuit, lagging by 90 deg. with reference to itself, and this, as shown in the vector diagram, is in phase with the grid voltage Eg .

fourth grid to become more negative, then the current of the second grid increases, thus diminishing the impedance of the oscillator triode (formed by the cathode, the first and the second grids), the phase deviation increases, and the oscillator frequency changes.

The change in the impedance of the triode is not the only cause of the phase lag of the anode current. Fig. 3 shows that in types VO₄ and EK₂ a large number of the electrons can reach the second grid only by a roundabout route (namely, they first fly into the space between the third and fourth grids and then fly back to the second grid). The transit time is consequently comparable to the period of oscillation of the higher frequencies (short waves below 10-15 metres), and this results in the anode current of the oscillator lagging considerably behind the grid potential. This in itself would not matter and would merely mean that the oscillator circuit would oscillate at a lower frequency than its natural frequency. Owing to AVC, however, the signal-grid bias changes, and influences not only the density but also the position of the virtual cathode, and thus causes the transit time, the phase lag of the anode current and the oscillator frequency to change.



However, conditions will change if the phase of the anode current is delayed relative to the grid voltage, for then the system will oscillate at a lower frequency than the

Fig. 2.—The fundamental oscillator circuit is shown at (a) and the vector diagram of the voltage and currents at (b).

returning from the virtual cathode, only a part fall on the first positive accelerator grid, the rest flying through and falling on the second electrode (oscillator anode). These electrodes enhance the first space charge which is in the proximity of the first control grid, thereby increasing the input capacity of the oscillator grid. It follows, therefore, that an increase in signal grid bias causes a change in oscillator-grid capacity.

Phase Error

This, however, is but one of the causes of frequency drift in the mixer valves of the octode type. A further cause lies in the phase difference between the oscillator anode current and the instantaneous oscillator grid potential. This phase error also varies with the degree of AVC. In all regenerative systems continuous oscillation will be maintained only if the voltage applied to the input terminals by amplification and feed-back is equal in frequency, phase and magnitude to the original input voltage. Let us now examine in detail the conditions prevailing in a triode oscillator with inductively coupled regeneration. Let us suppose that the grid circuit be tuned while the reaction coil is in the anode circuit, and that the frequency of the alternating voltage applied to the oscillator grid corresponds to the resonant frequency of the oscillator circuit. If the phase of the anode current coincides with the phase of the EMF induced by the reaction coil upon the oscillator grid, this EMF will also coincide with the alternating EMF originally on the grid—that is to say, the phase condition for self-oscillation is fulfilled.

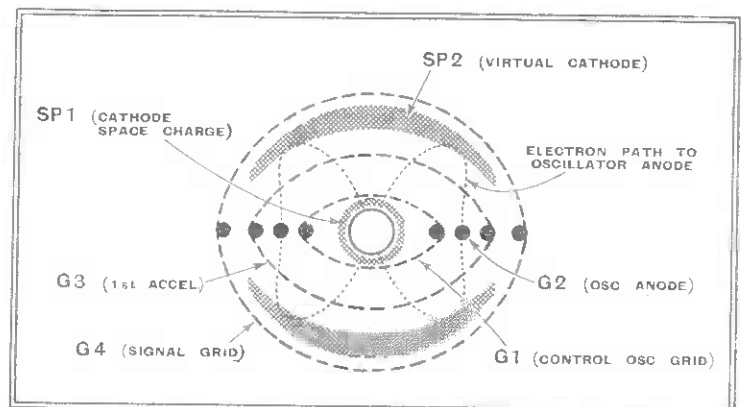
Assume that in an ideal case (Figs. 2a and 2b) the current Ia in the reaction coil will induce in the grid coil a potential $EIND$ lagging by 90 deg. with reference to itself. This potential will produce a current $IIND$ in the oscillator circuit. The circuit impedance of the oscillator circuit is resistive in the resonant case, and the current flowing in the oscillator circuit will be contrary

natural frequency of the oscillator-tuned circuit in order that phase equilibrium may be re-established.

If the current flowing in the oscillator circuit is lower in frequency than the natural frequency of the oscillator circuit, the reactance of the oscillator circuit is capacitive, and its current will lead the induced voltage. In consequence, it will be able to balance the phase lag of the anode current. If, however, owing to the phase error of the anode current, the oscillator circuit oscillates at a frequency deviating from its natural frequency, then a change in that phase error will cause a change in the oscillator frequency. It should be noted, however, that in hexode-type valves the anode current also lags, but in these a change in the signal grid cannot influence the oscillator frequency by this means, for such a change in bias has no effect upon the oscillator anode current.

The phase lag in the oscillator anode current in VO₄ and EK₂ valves is caused by two factors, namely, the type of external anode circuit used

Fig. 3.—This diagram shows the electrode arrangement of one of the older octodes; the space-changes are shown by the hatched areas.



and the *finite transit time* of the electrons.

The anode alternating current causes a voltage drop across the reaction coil, which drop then reacts on the anode current; the tangent of the phase lag angle is equal to the ratio between the impedance of the reaction coil and the impedance of the valve. As mentioned above, the magnitude of the electron current which returns from the virtual cathode depends on the bias of the fourth grid; if AVC causes the

Inconstant Regeneration

The anode current phase lag causes other disagreeable effects as well, for the phase shift reduces the degree of regeneration, for the magnitude of the regeneration is proportional to the cosine of the phase angle. This is obvious, for if the oscillator anode current has a phase lag with reference to the instantaneous oscillator grid potential, then energy is fed back solely by the in-phase component of the oscillator anode current. Naturally, the oscillator voltage decreases at the same rate as the regeneration.

(To be continued.)

BOOKS RECEIVED

Practical Mechanics' Handbook. By F. J. Camm. Pp. 400. 365 diagrams and illustrations. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 6s.

Workshop Calculations, Tables and Formulae. By F. J. Camm. Pp. 144. 120 diagrams and illustrations. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 3s.

NEWS OF THE WEEK

TELEVISION AERIALS

Vertical or Horizontal Polarisation?

DURING the reading of his paper on "Recent Progress in Television" to the Royal Society of Arts on January 18th, Mr. H. L. Kirke, head of the Research Department of the B.B.C., said that considerable attention has been paid to the question of whether the waves of the Alexandra Palace television transmitter should be vertically or horizontally polarised. In this country, of course, vertical polarisation has so far been used, but in America horizontal polarisation is favoured largely because interference from car ignition is thereby considerably reduced. Referring to this fact, Mr. Kirke said, "It is probably a simpler matter to design an aerial system with symmetrical radiation in the horizontal plane using vertical polarisation. Recent experiments have shown, however, that, at any rate in certain circumstances, a considerable improvement in signal strength has been obtained by the use of horizontal polarisation."

The use of a horizontal aerial array at Alexandra Palace would, of course, necessitate the adoption of horizontal dipoles for reception. The design of a virtually non-direction horizontal array for the transmitter would prove a formidable task.

"Experiments have shown," said Mr. Kirke, "that for the O.B. radio link, horizontal polarisation is considerably the better, and with a suitable design of transmitting and receiving array a gain of six to twelve decibels in signal strength over the present arrangement is expected, in addition to the improvement obtained by the reduction of general interference from motor cars." Mr. Kirke announced that new aerial arrays for both transmitter and receiver are now being designed.

HIS MAJESTY'S CANADIAN BROADCASTS

IT was announced last week by Mr. Mackenzie King, Premier of Canada, that H.M. The King would broadcast on six occasions during his tour of the Dominion in May and June. H.M. The Queen will also be heard.

The King's broadcasts, which will be from Winnipeg, Quebec, Vancouver, Ottawa, Victoria and Halifax, will all be relayed by the B.B.C. That on Empire Day from Winnipeg will, as was officially announced from Buckingham Palace at Christmas, be relayed throughout the Empire.

HIGH-FIDELITY BROADCASTS FOR U.S.A.

Frequency Modulation to Exclude Interference

THE method of transmitting speech and music by wireless is universally effected by varying the amplitude of the radio waves by the waves of sound which strike the microphone. By means of another and hitherto neglected method, the frequency of radio waves is made to vary while the amplitude remains constant. This is known as frequency modulation, and a station employing this system of transmission has been constructed at Alpine, New Jersey, under the direction of Major Edwin H. Armstrong.

An illustrated description of this station during the early stages of its construction appeared in *The Wireless World* of February 10th, 1938, and now it is announced that permission for it to broadcast with frequency

modulation on 75 metres has been granted.

Most interfering noises are amplitude modulated, and so receivers designed to receive amplitude-modulated signals also receive interference. Frequency-modulated signals received on sets designed exclusively for such reception would give greater freedom from interference. This is the most vital point of the system.

Already transmissions on 2.5-metres with a power of 500 watts have given satisfactory reception over a distance of fifty miles and the 50-kW Alpine station, W2XMN, is expected to provide all Metropolitan New York, as well as certain parts of New Jersey, with high-fidelity broadcast free from all kinds of interference.

RADIO-NORMANDIE'S FIELD STRENGTH

Analysing the Louvetot Service Area

THE International Broadcasting Company, which operates Radio-Normandie station, has put on the roads of South and South-East England a field strength measuring van. The van, a Morris Ten, is equipped with a Marconi-Elco field strength measuring set which was designed for interference measurement by the G.P.O. It is interesting to note that the difference between the signal received in the van and that received when the set was in the open was less than 1 db. down. A four-foot rod aerial and a directional loop aerial, which are stowed away when travelling, are used in conjunction with this receiver.

A standard commercial receiver, which has been chosen as

Capt. Sir Ian Fraser, a vice-president of the R.M.A., presented, on behalf of members, a bag of golf clubs and a pair of cuff links to Mr. D. Grant Strachan, the 72-year-old director of the R.M.A., who retired at the end of last year. He had been with the Association since its formation in 1926, first as secretary and later as director.



NOISY LOUD SPEAKERS

Is Legislation in Sight?

THE news, as announced by Lord Horder at a meeting of the Noise Abatement League last week, that a Bill is being prepared by the League against noisy loud speakers will be welcomed by the thousands who suffer from this growing menace.

It is, of course, useless to put a Bill before Parliament unless it is practicable to bring it into force, and the problem is "How can a case be proved?"

Mr. A. P. Herbert, the well-known author-M.P., is to introduce the Bill when it is completed. The difficulties, however, of drawing up such a Bill are legion, and, moreover, what exactly is a really "loud" speaker. It is proposed that the Bill should empower magistrates to suspend a listener's licence similarly to that of an offending motorist. At present, many town and borough councils have by-laws to limit the nuisance, but the scope and effectiveness of these are limited.

"AUSTRIAN" STATIONS

The End of a Broadcasting Service

RAVAG, the former Austrian broadcasting company, which has been in liquidation for some time, will cease to exist from February 1st, when the German Post Office takes over the control of the transmitters.

Reichs Rundfunk Gesellschaft will take over the programme side of Austrian broadcasting, so that there will no longer be a sub-centralisation in Vienna. The Vienna station (506.8 metres) will be a Reichssender, and its programmes will be relayed by Linz (338.6 metres), Innsbruck (578 m.) and Salzburg (222.6 m.) will become relays of Munich. Bregenz (231.8 m.) will relay Stuttgart and Graz (338.6 m.) will become a separate independent Reichssender. The reason for the latter is that this station is important as a direct means of broadcasting to the German minority of 700,000 in near-by Hungary and Yugoslavia. Graz will shortly have a new 120-kW transmitter.

typical of the average listener's set, is also carried for comparative listening. A telescopic aerial fitted to the side of the van is connected to this receiver. All the apparatus is battery-driven; the batteries being charged from the car dynamo.

The objects of these tests are two-fold, first to examine the performance of the new Louvetot transmitter and, secondly, to obtain data of the service area of the station.

POPULARISING TELEVISION Plans for the R.M.A. Campaign Continue

"TELEVISION is here—you can't shut your eyes to it," the slogan of the combined R.M.A.-B.B.C. campaign to popularise television, will be displayed extensively in the London television service area during next month.

In addition to the advertising drive, the R.M.A. has organised a series of six sales and technical talks for dealers and service engineers to be held in London,

News of the Week—

and the B.B.C. is arranging a series of lecture-demonstrations to be given by Mr. D. K. Woolf-Murray, the B.B.C. television public relations officer, in public halls in the service area.

RADIOLYMPIA

THE R.M.A. Council appointed at the annual general meeting held its first meeting last week and, contrary to rumours which were then current, decided that this year's Radiolympia exhibition will be held. An exhibitions committee has been appointed to make all necessary preparations for the show, which will be held at the end of August.

BRITISH EXPORTS

IT is interesting to note that the exports of wireless apparatus for 1938 surpassed those of the previous year by nearly £150,000. The actual figures are: 1937, £1,653,419, and 1938, £1,794,792. In commenting on this welcome increase, *The Financial News* says: "As the standard of living rises in overseas countries, markets of considerable importance will be opened up and, though competition will be keen, these markets should, in the long term, add appreciably to the outlet for British radio apparatus."

A large percentage of the increase is accounted for by transmitting apparatus and receivers, which show an increase of approximately forty and twelve per cent. respectively.

ANOTHER PIONEER RETIRES

MR. H. M. DOWSETT, Principal of the Marconi School of Wireless Communication at Chelmsford, and one of the early English pioneers in wireless communication, retired last week at the age of sixty after forty years' service with the Marconi Company. Mr. Dowsett, who will be well known to *Wireless World* readers as the author of the "Handbook of Technical Instruction for Wireless Telegraphists" (of which the sixth edition has just been published from these offices), joined the engineering staff of the Wireless Telegraph and Signal Company, now Marconi's Wireless Telegraph Company, in April, 1899.

After taking part in the installation of many of the early marine and land stations, he has successively held the posts of Head of the Marconi Testing Department, Personal Assistant to the Technical General Manager, Research Manager, Technical Editor and Editor of the *Marconi Review*, and since 1935 has held his present post.

We join with his many friends in the world of wireless in wishing him every happiness in his retirement.

RECORDED AND LIVE TALENT BROADCASTS

THE International Labour Bureau in Geneva is dealing with the question of protecting artistes' radio rights. Statistics drawn up in fourteen different countries show that, in three months, 8,000 hours of recorded music were broadcast at a cost of £9,250. If the broadcasting organisations had used live talent for the same programmes the cost would have been £200,000. Many stations rely almost completely on recordings for their programmes and the solution of the artiste problem does not promise to be easy.

Sir Thomas Beecham, presiding at the conference of the Incorporated Society of Musi-

cians recently, deplored the increasing use by the B.B.C. of mechanical reproduction by gramophone records.



A WIRELESS SET figures for the first time on a postage stamp. This 90 centimes stamp issued by the French Post Office carries a super tax of 25 centimes, which amount goes to the French Wireless for the Blind Fund.

**FROM ALL
QUARTERS****Extensions at Alexandra Palace**

By the end of this month the B.B.C. will have equipped two more sections of Alexandra Palace for television purposes. The whole of the "Art Gallery," adjoining the Concert Hall and measuring some 250ft by 30ft., has been fitted up as a carpenter's shop with the most modern tools, including lathes for turning out scenery at short notice. New office accommodation has been found for producers and administrative staff to the left of the East Entrance.

S O S Broadcasts

A TOTAL of 1,248 SOS messages were broadcast by the B.B.C. during last year, an increase of 35 on 1937. While the number of broadcasts increased, the percentage of successes, however, declined from 50.79 to 49.03. The largest number of broadcasts were for relatives of sick people—836, the remainder being police messages.

Exhibition in London

At the forthcoming Exhibition of Aerodrome Equipment to be held at the Central Hall, London, from February 1st to 3rd, will be a display by Standard Telephones and Cables, which is to include an entirely automatic omnidirectional radio beacon, a highly sensitive seven-valve receiver with a frequency range of 12,000 to 75 kc/s, a high quality short-wave receiver, and a Standard-Adcock direction finder.

Newspaper Enterprise

PERMISSION to transmit television programmes has been applied for by a newspaper in Milwaukee, U.S.A. The newspaper plans to distribute locally at its own expense fifty television receivers which will be used mainly for the purpose of making field tests.

Bush Radio Capital Increase

BUSH RADIO, LTD., an associate of the Gaumont-British Picture Corporation, has increased its capital from £2,500 to £80,000 by the creation of 310,000 new ordinary 5s. shares.

World's Longest HF Cable?

BETWEEN Moscow and Khabarovsk, the industrial centre of East Siberia, a new communication link has been provided which is claimed to be the longest HF telephony cable in the world—over 5,600 miles long. The construction of this cable permits the simultaneous transmission of three telephone calls, thirty-eight telegraphic messages, a broadcast programme and picture transmission impulses. The contract for this work was given to Standard Telephones and Cables, of London.

German Licences

THE increase in the number of listeners in "old" Germany has been remarkable in 1938. This may be attributed to the desire of listeners for news from other countries. The increase was 4.3 per cent., and the total on January 1st for "old" Germany only was 10,821,858; of these 671,000 are free.

Broadcasting Houses of the World

DR. ARNO HUTH, who has contributed articles on broadcasting organisation to our pages on more than one occasion, is to give a talk at 6 p.m. on January 28th from the French-speaking station of the I.N.R. at Brussels, on "The Headquarters of the World's Broadcasting Organisations."

B.I. Cables

BRITISH INSULATED CABLES announce that Mr. G. H. Nisbett has been elected Deputy Chairman of the Board of Directors, in addition to retaining his position as Managing Director. Mr. T. A. Eades, Managing Director of the Automatic Telephone and Electric Company, has been appointed a Director.

"A Cornerstone"

"WE recognise as the cornerstones of our American democracy the institutions of free religion, free speech, free press and free radio."—Mr. David Sarnoff, president of the R.C.A., when addressing the American Association for the Advancement of Science at Richmond, Virginia, U.S.A.

The Carpathian Ukraine

M. SVOBODA, Director-General of Czechoslovakian broadcasting, has visited Chust, the newly constituted capital of the Carpathian Ukraine, where he is arranging technical preliminaries for broadcasting from this new European capital. A broadcasting house is to be built, and until the completion of a new station a provisional low-power transmitter is to be established.

Turkish People's Set

FIFTY thousand People's Sets, which will be available to villagers at a nominal cost, are to be distributed throughout Turkey; purchasers will be exempt from paying the annual wireless licence fee. A Bill, which is now awaiting the approval of the National Assembly, will give the Department of Posts and Telegraphs the monopoly of the supply and maintenance of the receivers.

Grossdeutsche Rundfunk

THE German Minister of Propaganda has granted German broadcasting stations permission to announce themselves as "Hier ist der Grossdeutsche Rundfunk," in recognition of the work they did in preparation for the unions with Austria and Sudetenland.

Applications for Patents

NEARLY two thousand more inventions were filed for patents during last year than during 1937. Although the international crisis was responsible for a percentage of this increase, television accounted for a large portion of it.

Ship-to-Shore Radio

A NEW commercial radio-telephone transmitter operating on 111 metres has been opened on the outskirts of Malmo, Sweden. It will be used for ship-to-shore communication.

Fishing Craft Radio

AT a recent meeting of a Swedish maritime insurance association, a resolution was passed that the companies concerned refused to indemnify damage to radio equipment in fishing craft which was caused during rough weather at sea. It has since been pointed out at a public meeting that this measure could not but discourage the increased use of radio in fishing vessels.

February Meetings

- Wednesday, 1st, 6 p.m. I.E.E. Wireless Section, Savoy Place, London, W.C.2. "Electrolytic Condensers" (illustrated by a cinematograph film and demonstrations). P. R. Coursey and S. N. Ray.
- Thursday, 2nd, 6 p.m. I.E.E. Ordinary Meeting. "The Empire Service Broadcasting Station at Davenport," L. W. Hayes and B. N. MacLarty.
- Tuesday, 21st, 7.30 p.m. Institution of Electronics (Telecommunications Section), 75, Gloucester Place, London, W.1. "Production Aspects of Press-Button Tuning," J. N. Adams.
- Friday, 24th, 6.45 p.m. R.S.G.B., monthly meeting at the I.E.E. "Insulating Materials for the Higher Frequencies," Dr. George Bloomfield.

The Amateur Transmitting Station

Part IV.—DESIGN OF THE PA STAGE

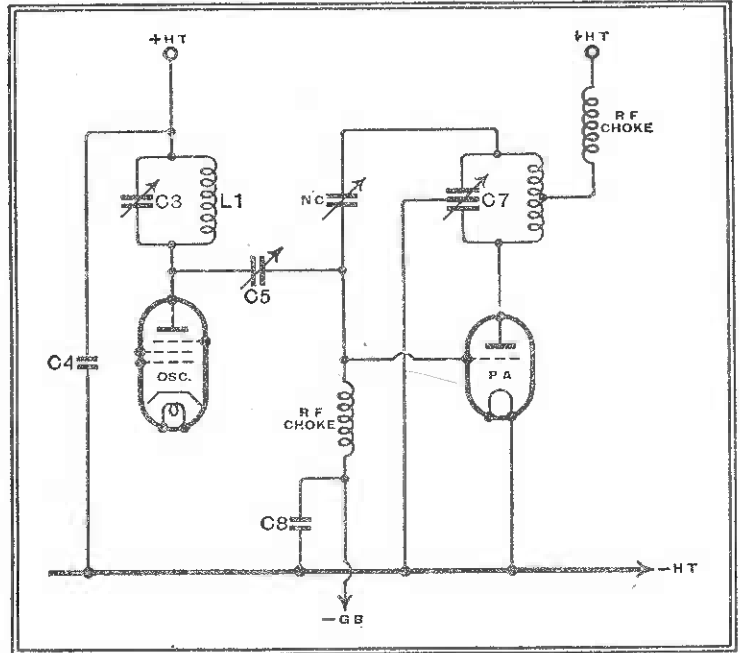
IN the preceding instalment the purpose and functioning of the PA stage was described. The author now goes on to treat the design of this stage from the practical point of view of the amateur who is building his first transmitter.

BEFORE thinking about the design of the power amplifier, usually referred to in amateur circles as the PA, we must come to a decision regarding the method of coupling the exciter and the PA units. Two alternative methods were indicated in outline in Figs. 6 and 7, and are repeated here with more detail in Figs. 8 and 9. It has already been explained that the PA will have to be neutralised with either arrangement when a triode valve is used.

As the grid circuit of the PA has to be tuned with the link coupling of Fig. 9 it is not so economical in components as that of Fig. 8. On the other hand, with the condenser coupling of Fig. 8 the exciter and PA units must be arranged to allow for a short connection between the anode and grid of the two valves. However,

By H. B. DENT
(G2MC)

Fig. 8.—A simple and economical method of linking the crystal-controlled oscillator to the power amplifier.



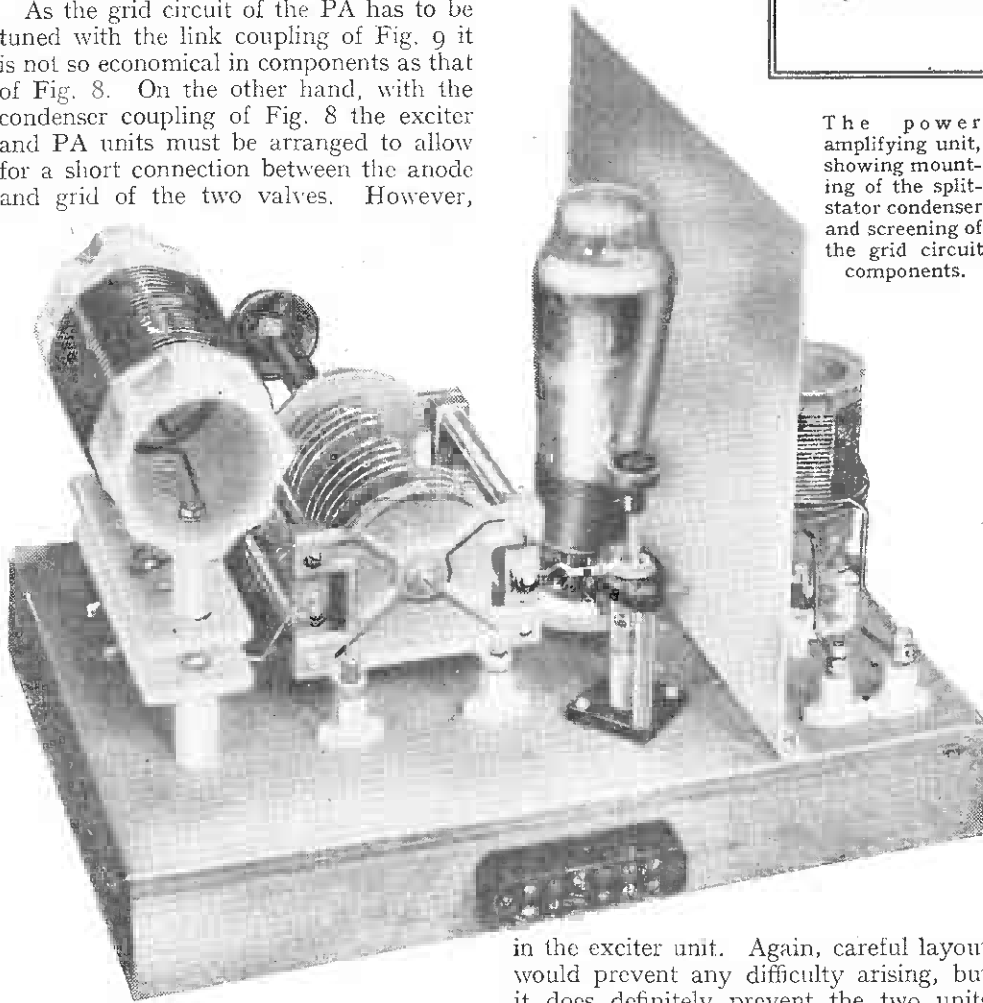
The power amplifying unit, showing mounting of the split-stator condenser and screening of the grid circuit components.

contained, and they can be separated by several feet without any loss in efficiency, and for the beginner this has obvious advantages. When the transmitter is completed it can be assembled in rack form, should it be necessary to conserve bench space. A three-tier rack with the power unit at the bottom, the exciter on the first shelf, and the PA at the top, makes a very compact assembly requiring the minimum of floor space. It may be said that we are now looking too far ahead, but it is necessary to give a little thought to the future housing of the transmitter, and plan its design accordingly.

Experience has shown that with a link coupling neutralising is appreciably easier than with capacity coupling, also it avoids adding to the stray capacities across the anode circuit of the oscillator valve. As on several points the link coupling scores, we will decide to adopt it in the present case.

On several occasions mention has been made of neutralisation, but as it is many years since this expedient for stabilising an RF amplifier was employed in receivers a brief description of what it means might not be out of place here.

An amplifier in which the anode and grid circuits are tuned to the same frequency will oscillate if there is a sufficient coupling between the circuits. This coupling can be either magnetic or capacitive, and, though we can eliminate magnetic coupling by suitably screening the circuits, capacity coupling cannot be treated in the same way. Not only can it arise by the juxtaposition of components in the two circuits, but the high-potential ends of each circuit are coupled together by a capacity



this is not a difficult matter to arrange.

If we examine the grid circuit of the PA in Fig. 8 we find that the RF path is somewhat extensive, for it includes the tuned anode circuit of the oscillator valve, and only terminates at the earth line via C4

in the exciter unit. Again, careful layout would prevent any difficulty arising, but it does definitely prevent the two units being entirely self-contained so far as their RF circuits are concerned. This coupling arrangement is more applicable to a transmitter in which all the stages are assembled on a common chassis.

Now, with link coupling, as shown in Fig. 9, the exciter and PA units are self-

The Amateur Transmitting Station—

formed by the grid and anode electrodes in the valve. In screen-grid valves this has been reduced to such a small value that insufficient energy is transferred from one to the other to maintain self-oscillation with ordinary circuits, but in triodes this capacity is, relatively speaking, quite large. It may be as much as 10 or 15 m-mfds., but can be as small as 3 or 4 m-mfds.

Neutralisation, as its name implies, is nothing more than arranging the circuit of the amplifier so that the grid-anode capacity is balanced by an external condenser which applies to the grid circuit an RF voltage equal to but opposite in phase to that fed back *via* the grid-anode path in the valve.

From the various circuits of the PA it will be seen that its anode circuit is tuned by a split-stator condenser, this having been adopted because it leads to a more symmetrical arrangement of the stage. This will, perhaps, be better appreciated if the circuit is drawn in the form of a bridge, taking into account all the valve capacities. If an amplifying stage in which a single section condenser tunes the coil is treated in the same way, the better symmetry afforded by the split-stator condenser will be apparent.

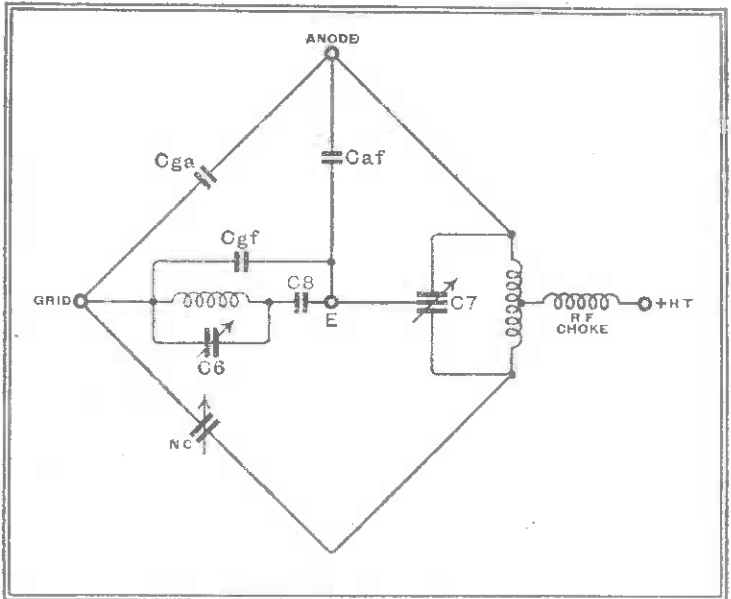
Though it is possible to stabilise both circuits, the one incorporating a split-

example, quite strong signals can be heard in the 21- and 10-metre bands up to several miles away.

If only even harmonics were radiated, the worst offence committed would be unnecessary interference in the other amateur bands, but some of the odd harmonics will be present also, and it is more than likely that they will cause bad interference with commercial and other important services.

A decision now has to be made regarding the capacity for the anode condenser. If it is

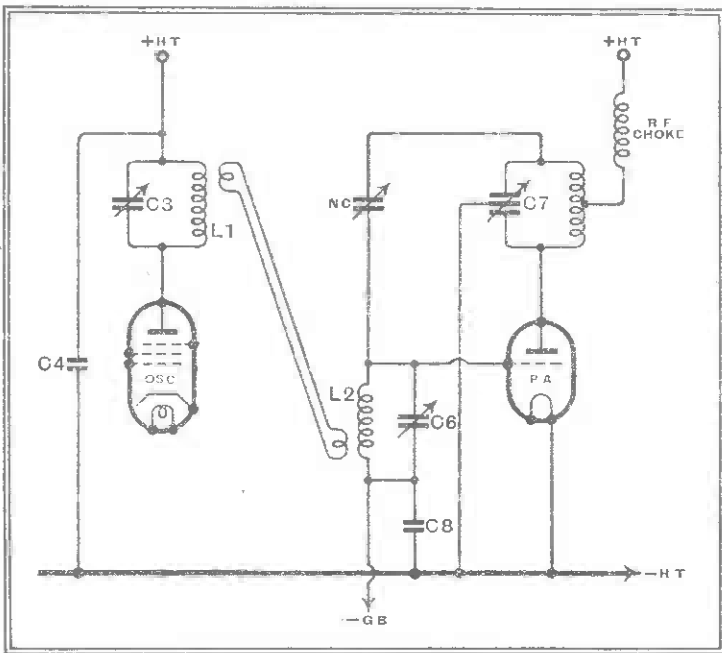
Fig. 10.—The PA circuits drawn bridge fashion to show how neutralising is effected.



too large the dynamic impedance of the anode circuit will be lower than desirable. It has to be remembered this circuit is nothing more than a transformer between the valve and the aerial, therefore the higher its dynamic resistance the better the efficiency will be.

On the other hand, sufficient capacity must be included in the circuit to store energy during the non-operating periods of the valve, it being remembered that the valve delivers power during a small portion only of a cycle. This might be termed the fly-wheel action of the circuit.

Fig. 9.—The link coupling between oscillator and power amplifier allows considerable latitude in the relative positions of the units.



stator condenser will be easier to neutralise, and, in addition, there will be less loss of driving power in unbalanced capacities, resulting in a correspondingly larger RF output. Also, the neutralisation holds better over a wide range of frequencies, which is an essential feature when wave-changing is effected by plug-in coils.

Another advantage of the split-stator condenser is that it provides a low-impedance path for harmonics in the anode, or tank, circuit of the valve. With Class C amplification strong harmonics are produced, and unless suitable precautions are taken it will be found that when the transmitter is working on 42 metres, for

With the arrangement shown in Fig. 9, a capacity of about 1.5 m-mfds. per metre of wavelength is a satisfactory amount, so that for 42 metres the condenser should have 60 m-mfds. per section, while 30 m-mfds. would suffice for 21 metres. We will compromise, and choose a condenser of 50 m-mfds. per section.

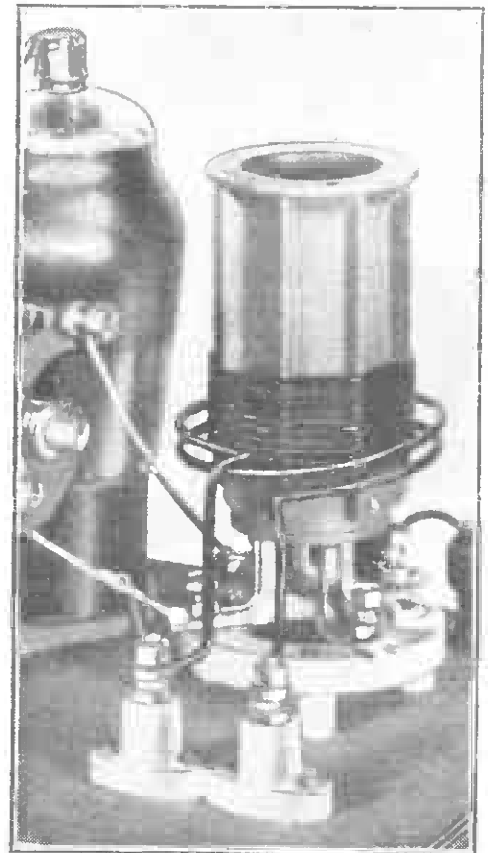
Having decided upon the size of the condenser we can now calculate the inductances for the tank coils for 21 and 42 metres, not forgetting that the total effective capacity across them is half of that of each section in the condenser, viz., 25 m-mfds., plus the stray capacities and self-capacity of the coil.

The total stray capacities in the anode circuit will usually be fairly small, and total about 15 m-mfds. only.

Now with regard to the grid circuit.

Here we will find the stray capacities much higher, for, not only is the input capacity of the valve across the whole coil, but so also is the capacity of the neutralising condenser. In the anode circuit most of the stray capacities appear across each section of the split-stator condenser, so that only half of them actually appear in shunt with the coil.

Fig. 10 shows the PA stage arranged in the form of a bridge with C_{ga} the grid-



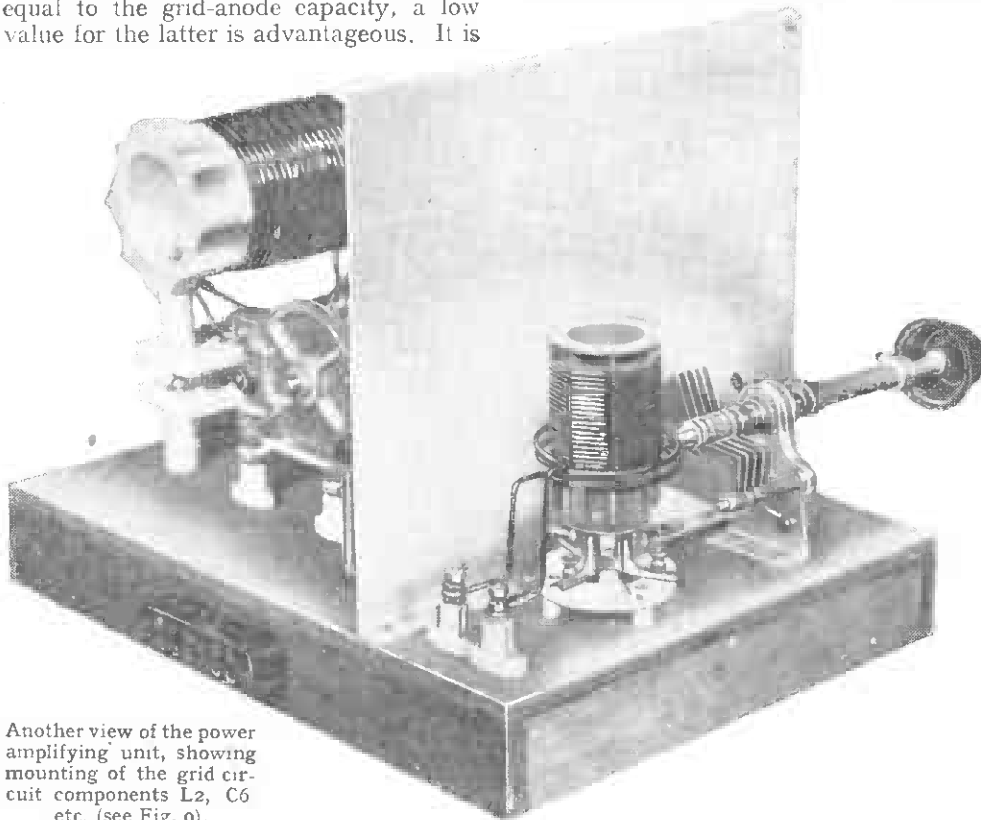
How the 2-turn link coupling coil is mounted in the oscillator unit.

The Amateur Transmitting Station—
anode capacity, C_{gf} the grid-filament, and C_{af} the anode-filament capacity of the valve.

As the neutralising condenser has to be equal to the grid-anode capacity, a low value for the latter is advantageous. It is

in the design of the power supply unit at very little extra cost at the outset.

The valve was operated as a Class C amplifier, and given -48 volts grid bias with 350 volts on the anode. A grid-bias



Another view of the power amplifying unit, showing mounting of the grid circuit components L2, C6 etc. (see Fig. 9).

in this respect that tetrodes and pentodes score heavily, added to which, if the grid-anode capacity is small enough, neutralising can be dispensed with, but special precautions have to be taken to avoid coupling between grid and anode circuits, or instability troubles will be encountered.

For 21- and 42-metre working triodes with grid-anode capacities not exceeding 10 mmfd. can be used, but if it is proposed to transmit on shorter wavelengths such as 10 and 5 metres, a valve with the lowest possible grid-anode capacity should be chosen.

The Power Valve

In the PA which was built for use with the exciter unit already described, initial tests were made with a Mullard TZ05-20 triode transmitting valve. Actually, this valve is rated for 50 watts input at maximum, and it is suitable for use on all amateur wavelengths down to 10 metres.

Though a larger valve than actually needed for a small transmitter, it gives a very good RF output on low power, for with 10 watts input just over six watts of RF can easily be obtained on both 21 and 42 metres.

It is economical to purchase valves of greater power handling abilities than the immediate requirements warrant, for the exciter unit described is capable of driving a much larger PA stage than a 10-watt one. Moreover, valve life will be longer, and if permission is obtained to use more power, say, 25 watts, increasing the HT to 400 or 500 volts is all that is necessary. Even this eventuality can be allowed for

resistance of 5,000 ohms was also included, and the grid current was of the order of 10 mA on both wavebands.

News from the Clubs

Mersey-side Transmitting Society

Headquarters: 368, Stanley Road, Bootle, Liverpool, 20.
Meetings: Tuesday evenings.
Hon. Sec.: Mr. C. E. Cunliffe, 368, Stanley Road, Bootle, Liverpool, 20.

The following programme has been arranged:—
January 31st.—Theory and Design of Crystal Oscillators.

February 7th.—Practical demonstration of crystal oscillators.

February 14th.—Discussion night.

February 21st.—Theory and Design of Power Amplifiers and Coupling Systems.

February 28th.—Practical demonstration of power amplifiers and coupling systems.

March 7th.—Discussion night.

Edgware Short-wave Society

Headquarters: Constitutional Club, Edgware.
Meetings: Wednesdays at 8 p.m.
Hon. Sec.: Mr. F. Bell, 118, Colin Crescent, London, N.W.9.

At the annual general meeting held recently, Mr. P. A. Thorogood presided, and gave a resumé of the past year's activities. The committee was re-elected.

Eastbourne and District Radio Society

Headquarters: The Science Room, Cavendish Senior School, Eastbourne.
Hon. Sec.: Mr. T. G. R. Dowsett, 48, Grove Road, Eastbourne.

The annual general meeting of the Society, which was held recently, resulted in a good attendance. The secretary presented his report for the year, and the treasurer then dealt with the financial status of the Society, which was satisfactory.

Exeter and District Wireless Society

Headquarters: Y.W.C.A., 3, Dix's Field, Southernhay, Exeter.
Meetings: Mondays at 8 p.m.
Hon. Sec.: Mr. W. J. Chung, 9, Sivell Place, Heavitree, Exeter.

The second half of the session commences on January 30th with a film showing the activities of the Radio Society of Great Britain. Some of the outstanding events of the future, of which the dates will be announced later, are a visit to the local telephone exchange, a lecture by Dr. Wroth, the radiologist, a lecture by Mr. D. R. Barber on "Atmospheric Electricity," and a lecture by Mr. G. S. Bradley on "Ultra-Short-Wave Links of the Post Office."

Croydon Radio Society

Headquarters: St. Peter's Hall, Ledbury Road, South Croydon.

Meetings: Tuesdays at 8 p.m.
Hon. Pub. Sec.: Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

The following programme has been arranged for the second half of the session:—

January 31st.—Lecture and demonstration by Mr. P. G. A. H. Voigt on "Reproduction." His demonstration will include the B.B.C. high-fidelity USW transmissions.

February 7th. "Radio Reminiscences," by Mr. H. Bevan Swift, past President of the R.S.G.B.

February 14th.—Push-pull balancing problems will be discussed by Mr. A. W. Graham, who will then demonstrate with his amplifier and his cathode-ray oscillograph.

February 21st.—Lecture by Mr. H. L. Bowen, of the Mullard Wireless Service Co., on "The Latest Valve and Television Developments."

February 28th.—A representative of Everett Edgembe, Ltd., will lecture on "Radio Servicing Instruments."

March 7th.—The chairman will discuss the latest improvements incorporated in his new high-quality apparatus.

March 14th.—To be announced later.

March 21st.—Lecture by Mr. G. Parr, of the Edison Swan Electric Co., on "Electro-encephalography."

March 28th.—Annual General Meeting.

April 4th.—Mr. H. G. Salter will conclude the session with a musical programme on gramophone records.

Surrey Radio Contact Club

Headquarters: The Alhambra, Wellesley Road, Croydon.

Meetings: First Tuesday in the month at 8 p.m.
Hon. Sec.: Mr. A. R. Willsler, 14, Lytton Gardens, Wallington.

At the last meeting Mr. Barnes, who had with him several Mareconi instruments of pre-war vintage lent by the British School of Telegraphy, dealt with his marine experiences before and after the War.

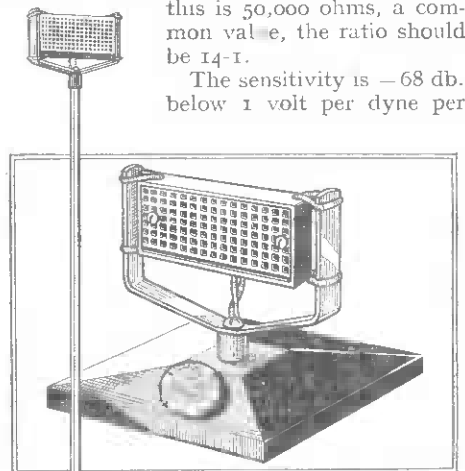
B.T.H. STRAIGHTLINE MICROPHONE

THE Straightline Carbon Microphone is made by the British Thomson-Houston Co., Ltd., of Rugby, and an exceedingly good characteristic is claimed. The maker's rating is ± 4 db. between 50 c/s and 10,000 c/s.

The impedance is 250 ohms, and a transformer is required to match this figure to the input impedance of the amplifier. If

this is 50,000 ohms, a common value, the ratio should be 14-1.

The sensitivity is -68 db. below 1 volt per dyne per



The microphone is shown on the left with its stand, and above, in greater detail, with the small base for table use.

sq. cm. corresponding to an open circuit microphone voltage of 0.4 mV. On load the voltage will be about 0.2 mV. Conversation at about 3ft. corresponds to about 0.1 dyne per sq. cm., so that the output to be expected is of the order of 20 μ V.

Using a 14-1 transformer a pre-amplifier gain of about 3,500 times will be needed for 1 volt output to feed to the main amplifier. This will usually mean a 3-stage pre-amplifier. The polarising voltage needed must not exceed 6 volts.

The microphone measures only 2 3/8 in. x 1 1/8 in. x 7/8 in., and is priced at £2 5s. with stand, and £1 17s. 6d. without stand.

Unbiased

By
FREE
GRID

Embarrassing
moments.



The Week's Good Cause

I SEE that the B.B.C., like most of us at this time of the year, finds itself in a state of financial embarrassment. In the case of the B.B.C., however, it is not a seasonal phenomenon but is a chronic condition. It is this state of perpetual penury which is responsible for the irritating habit of diagonalising the programmes whereby the same old stuff is churned out on different nights by different Regional stations.

In order to get over these embarrassing pecuniary problems, I can't see why on earth the B.B.C. don't adopt the same principle as the theatres and cinemas. In the latter places of so-called entertainment if you are hard up, like myself, you have to sit in the gallery or pit but if you are a wireless manufacturer, or somebody like that to whom money is dross, you sit in the stalls or even in a box. It is just a matter of paying what you can afford or are willing to spend.

My suggestion is that a somewhat similar scheme should be adopted in the case of broadcasting. One of the two wavelengths of a Regional station should be reserved for the pit-and-galleryites, represented by the ordinary 10s. licence of to-day, who would get the same programme to which we are all accustomed. Those who were willing to pay an *extra* 10s. or so would, under my scheme, be provided with a super-programme on the other wavelength, but how would it be possible to prevent people tuning in to it when they hadn't paid the extra 10s.?

Actually, it would be perfectly easy, but I am not going to put forward such a silly and hoary old suggestion as the fixing of a coin-slot-meter to the set, which could be as easily short-circuited as the ordinary shilling-in-the-slot electric light meter; nor am I going to suggest that listeners should be provided with fixed wavelength receivers, for even if a listener had to produce his licence before he could buy a receiver to tune in to the wavelength of the de luxe programme station, the handiness of the home constructor must be taken into account.

No, my idea is that the de luxe programme should be deliberately "scrambled" as are private transatlantic wireless telephone conversations so as to render them unintelligible to anybody not possessing a de-scrambler. The de-

scrambling unit, for attachment to any receiver, could be rented for an extra 10s. to listeners who wanted it. If any of you are so foolish as to suggest that the average home constructor could easily knock up a de-scrambling unit, or that the pirate wireless dealer could make and sell them on the sly, I would only ask you to examine the extreme complexity of one of these devices. Apart from the great technical difficulties of constructing them, the cost of doing so would be such as to make it far cheaper and simpler to pay the extra 10s. to rent one from the B.B.C.

Single Sideband Stereophony

RECENTLY I received remarkable confirmation of my stereophonic broadcasting prediction from a technical correspondent on the sun-kissed beaches of far-off Malaya.

As you will observe from his letter, which I reproduce below, he has had special opportunities of listening to it. Unfortunately, I have not his permission to publish his name and qualifications, although I will undertake to

I have long waited an opportunity to use this photo from my album of my correspondent's home town.
—F. G.



forward any letters you may write asking him for further details.

DEAR FREE GRID,—

I was extremely interested in your description, in *The Wireless World* of November 24th, of your friend's stereophonic reproduction. I recently had an opportunity of listening to the same type of reproduction in the Bell Laboratories, New York, and was as much impressed as you appear to have been.

In the New York set a dummy called "Oscar" is fitted with a *microphone* in each ear, and the outputs are taken to two extremely good amplifiers, which, I understand, are linear up to about 15 kc/s. The phase relationship is kept the same right through and taken to earphones in another room, and the listener is treated to a demonstration which is rather amazing. When the demonstrator whispers into the ear of the dummy, you have the feeling that he is just behind you, but there are one or two queer things which are noticeable.

In the first place, all the sound appears to originate from behind the listener. As the demonstrator was not in sight, I presumed the original source to be behind the dummy; I discovered later this was not so, and, on ask-

ing why, was informed that this was a phenomena not yet understood. The demonstrator informed me that if the demonstration is performed with loud speakers which the listener can see or of which he knows the position, then the sound appears from the front. I suggested that possibly the ears of the dummy threw the sound into the microphones from a backward angle, and was informed that experiments were being made of inserting the microphone into the dummy's ears at the end of a tube as in a human being.

Another remarkable feature of this demonstration was the difference in quality when using the binaural method, as they call it, against the single microphone. First, it must be remembered that both amplifiers and microphones were of similar characteristics. They had a switch by means of which the earphones could be connected either to one amplifier or the two at will, and the difference in favour of the two amplifiers was amazing.

Your idea of using the Alexandra Palace transmitters for this would certainly wake up most people amazingly if it could be carried out, but the combination I am hoping to see eventually is this: frequency modulation on ultra-short-waves using binaural or stereophonic transmission on single sidebands of same carrier. I was also fortunate in New York in being treated to a demonstration by Major E. H. Armstrong of his frequency modulation system. The transmission was made from a house in Yonkers, New York, on a transmitter having an output of 500 watts on a frequency of 150 Mc/s, and we listened at Major Armstrong's house in Bayport, Long

Island, which is 50 miles away. The quality and volume were astounding and considerably superior to transmissions from 50 kW stations which were much nearer. It may interest you to know that Major Armstrong is now completing a 50 kW frequency modulated broadcasting station for 41 Mc/s at Alpine, New Jersey, and that another company, the Yankee Network of Boston, are planning a further 50 kW station using the same type of modulation on 43 Mc/s, to be erected at Mount Wachusett, about 45 miles out of Boston. The programmes to this latter station will be sent from Boston to the station on 135 Mc/s. The band width to be used at 43 Mc/s is 200 kc/s, and at 135 Mc/s 300 kc/s.—Yours sincerely,

Kuala Lumpur, WIRELESS ENGINEER.

[An experimental broadcasting service, using the system developed by Major Armstrong and described above, is to be inaugurated in the New York area. This is dealt with more fully in the News of the Week pages in this issue. With regard to "Oscar," he was, of course, described in an article which appeared in *The Wireless World* of September 1st, 1933.—ED.]

Start Point

THE NEW SOUTH COAST REGIONAL

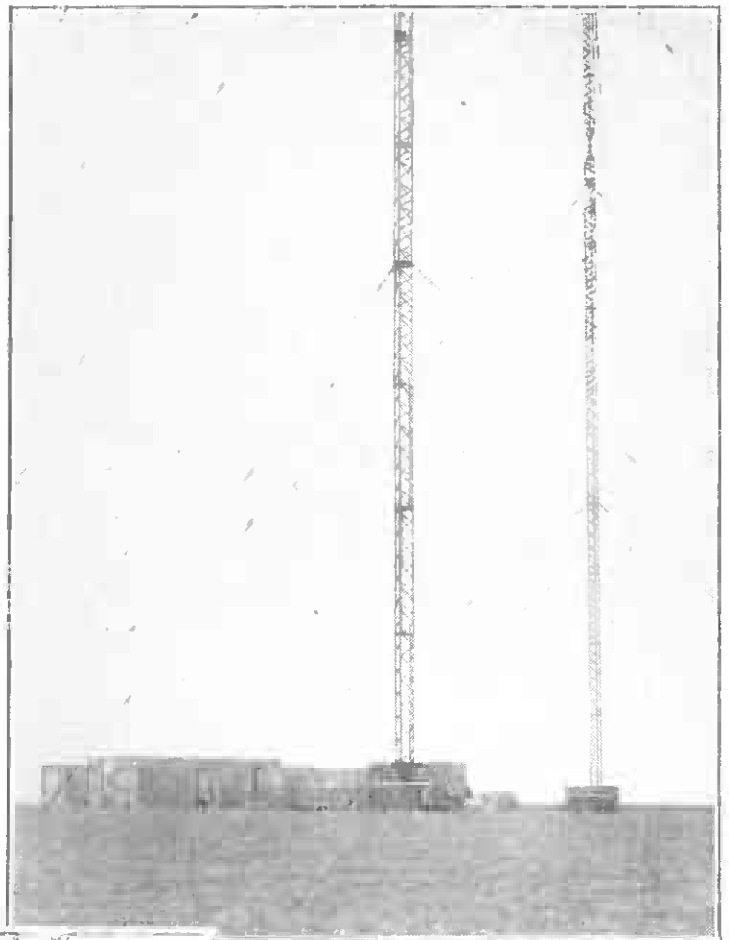
CLOSE to the winding coast road along Start Bay, bleak and isolated, stand the completed buildings of the Start Point transmitter, the station which is to bring a B.B.C. Regional service into the homes of people along the South Coast from Cornwall to Sussex as well as to Dorset and the southern parts of Cornwall, Devonshire, Hampshire and Wiltshire.

Engineers are working on the installation of the 100-kW transmitting apparatus, and the two 470-ft. masts are almost ready for use. The construction of these masts is unusual. One will be used as an aerial and the other as a reflector to reduce the strength of radiation over the sea to the south and to give a corresponding increase in other directions. The aerial is divided two-thirds of the distance from the ground, and this gap, which can be seen in the picture, is bridged by an inductance coil. This scheme is expected to be an improvement on the capacity-top aerial employed at certain other B.B.C. stations.

The transmitter was intended to replace the 1-kW relay stations at Plymouth and Bournemouth, but some time ago local authorities made application to the B.B.C. for the retention of the Bournemouth transmitter. They questioned the assurance given by the B.B.C. Engineering Division that they would receive Start Point free of interference.

Following a short period of indecision on the matter, the B.B.C. have agreed to retain the transmitter during the Start Point test period until the doubt is settled by practical experience.

In the construction of Start Point, the B.B.C. took into consideration the problem of broadcasting arrangements during periods of National emergency. It has been suggested that two or perhaps three 100-kW stations could cover the British Isles effectively in the event of war, and it is obvious that such stations would have to be in more or less



The Start Point building is similar in design to Stagshaw, near Newcastle. The cut in the aerial can be seen clearly in this picture of the new station.

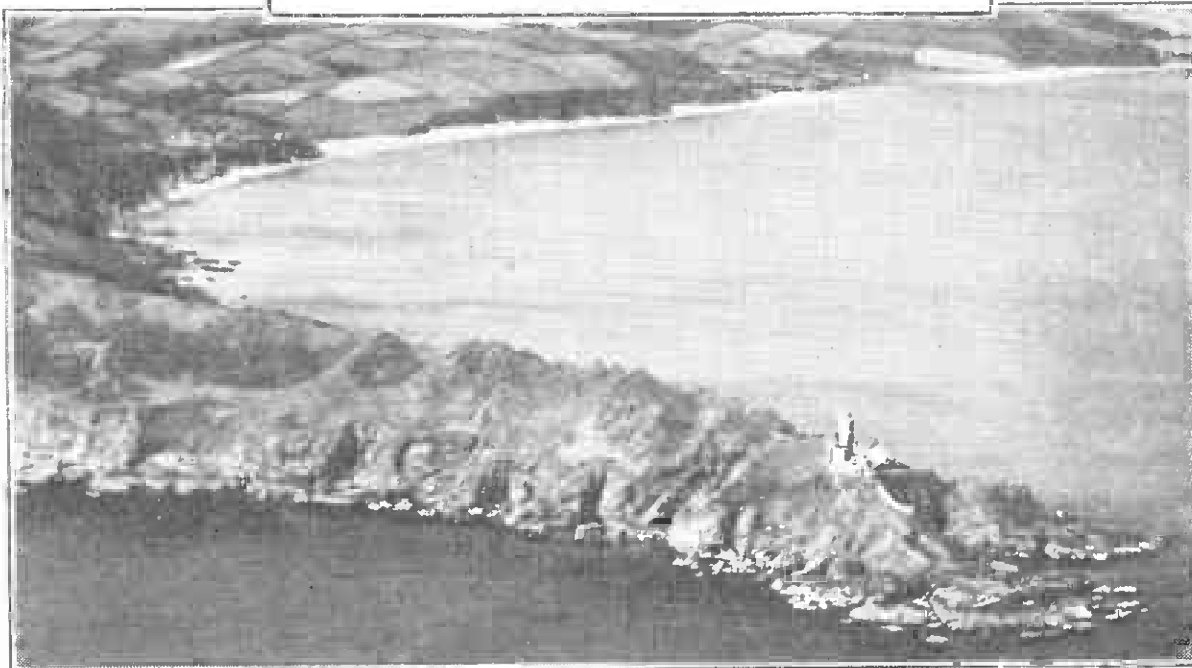
3,000,000 people will come within the service area of Start Point. Its isolation can be gauged from reference to the map and the reproduction of the headland, below.



isolated positions, as far away as possible from the scenes of bombing activity. Start Point, together with Burghead and Droitwich, are well suited to this purpose and could, it is estimated, serve the whole of Britain.

The new station will work on a wavelength of 285.7 metres, now temporarily in use by the transmitter at Washford, which will in due course be relieved of its duties towards the West of England and confine its radiations to Wales. Areas around Bristol and the northern and western parts of Somerset which cannot be covered by Start Point will be served by a low-powered station at Clevedon, Somerset, which is in approximately the same stage of construction as Start Point. The two stations will radiate the same programme and tests will probably begin in the early summer.

Incidentally, Clevedon is to use Bournemouth's present wavelength of 203.5 metres, so it is clear that, unless the reception of Start Point in the Bournemouth area is unsatisfactory, it will be impracticable to keep the local transmitter in operation after the two new stations have taken up their duties.





Philips TYPE 753A

A WELL-BALANCED PERFORMANCE
SUPPLEMENTED BY AUTOMATIC TUNING

FEATURES. *Waveranges.*—(1) 16.8 - 51 metres. (2) 195 - 585 metres. (3) 708 - 2,000 metres. *Circuit.*—RF ampl.—frequency-changer—IF ampl. (and 1st AF on gramo.)—2nd det and AVC rect.—AF ampl.—output valve. Full-wave power rectifier. Cathode ray tuning indicator. *Controls.*—(1) Tuning. (2) Waverange. (3) Volume. (4) Tone. (5) Selectivity, gramo and on-off switch. (6) Bass control (speech-music) switch. (7) Internal loud speaker switch. *Price.*—17½ guineas. *Makers.*—Philips Lamps Ltd., 145, Charing Cross Road, London, W.C.2.

WHEN we took delivery of this receiver for test we assumed that the motor-driven automatic tuning mechanism would provide the central topic for discussion in our report. The performance of the receiver itself is, however, so good that we propose to deal with this aspect first and to treat the tuning mechanism as the finishing touch to a thoroughly efficient and well-balanced design.

The quality of reproduction is outstandingly good and something of a mystery

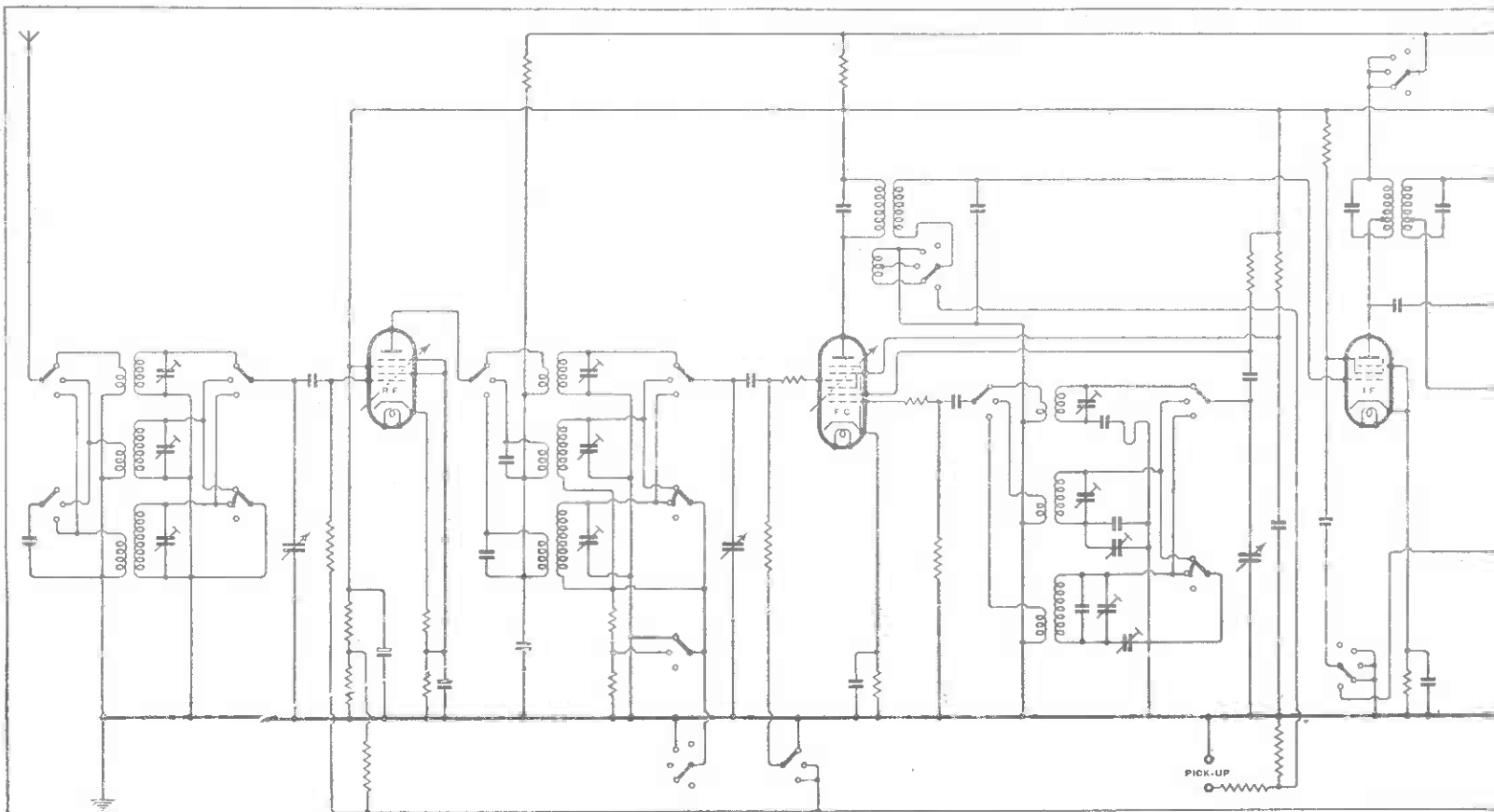
when the small size of the permanent magnet used in the loud speaker is taken into account. The diaphragm is, however, 8in. in diameter and the frontal area of the cabinet is greater than in the average table model, so that every advan-

tage is given to the full and clean bass response from the audio-frequency stages of the set. Working at an average level equivalent to about 2 watts there is complete freedom from overloading and negligible harmonic distortion. This, no doubt, accounts for the very natural pianoforte tone which is characteristic of this particular set.

A switch is provided at the back of the set to reduce the bass response if desired, but we preferred the quality with the full bass response, even on speech. It is only when the volume is turned up above the level of the natural speaking voice that a bass cut is called for.

The loud speaker is fitted with a high-frequency diffusing cone in front of the diaphragm, and the balance of tone is well maintained up to wide angles on either side of the axis.

On the radio side the performance is unblemished by self-generated whistles on any of the three wavebands, and second



Complete circuit diagram. Special features include negative feed-back with tone correction, variable selectivity in both RF and IF circuits and the use of a valve with low intrinsic background noise in the RF stage

channel break-through on the lowest wavelengths is absent. The signal-to-noise ratio is excellent and enables full advantage to be taken of the high overall sensitivity. There is no appreciable difference between the background noise on short waves and that on the medium and long-wave ranges. In the position of maximum selectivity it is possible to approach well within one channel on each side of London Regional at a distance of fifteen miles, and on long waves the Deutschlandsender is received at full volume with only slight help from the tone control to reduce sideband interference from Droitwich to the accepted minimum.

Effective AVC

Excellent reception of American broadcasting was obtained on the 16- and 19-metre bands. Fading was clearly shown by the sensitive cathode-ray tuning indicator, yet the volume level was held constant. Incidentally, on the short-wave range AVC is applied only to the RF stage.

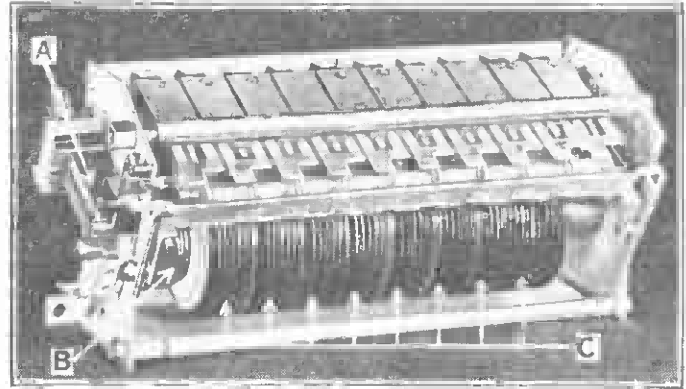
The valves throughout are chosen from the recently introduced "E" series. The RF amplifier stage makes use of the EF8, which is a pentode specially designed to combine high efficiency with a low level of inherent valve noise. The frequency changer is an octode, and the IF amplifier a pentode operating at 470 kc/s. The

input IF transformer has variable coupling, and there are three degrees of selectivity and quality. In the "minimum" (quality) position the primary and secondary are loosely coupled to give the highest selectivity, and the coupling circuits between the RF amplifier and the frequency-changer are also sharply tuned. In the "medium" position resistance is added to damp the RF coupling circuit, and a section of the third winding on the IF transformer is introduced to increase the coupling and broaden tuning. In the "maximum" position the coupling is still further increased by including the whole of the tertiary winding. Compensation for changes in overall sensitivity are made for each position of the switch in other parts of the circuit, and to balance the loss of high frequencies in the position of maximum selectivity the negative feed-back in the output stage is increased in the bass to reduce the output at low frequencies.

AVC and signal rectification is carried out by a triple diode, the function of the third diode being to prevent the applica-

tion of volts to the AVC diode on weak signals. Normally the auxiliary diode is positive, but when a sufficiently strong signal arrives it becomes negative and the by-pass effect of its anode-cathode resistance is removed.

The IF stage operates at maximum



Details of the station selector mechanism. A, motor reversing switch; B, clamping spring; C, selector drums.

sensitivity under all conditions, and AVC bias is applied to the frequency-changer only on the medium- and long-wave ranges.

The audio-frequency voltage resulting from rectification is developed across the volume control potentiometer, with which is associated a tone compensating network. The change of low frequency response associated with the "speech-music" switch at the back of the set is effected by alteration of the value of the coupling condenser to the grid of the first AF amplifier, which is a pentode valve connected as a triode. The variable tone control is also associated with the input circuit to this valve.

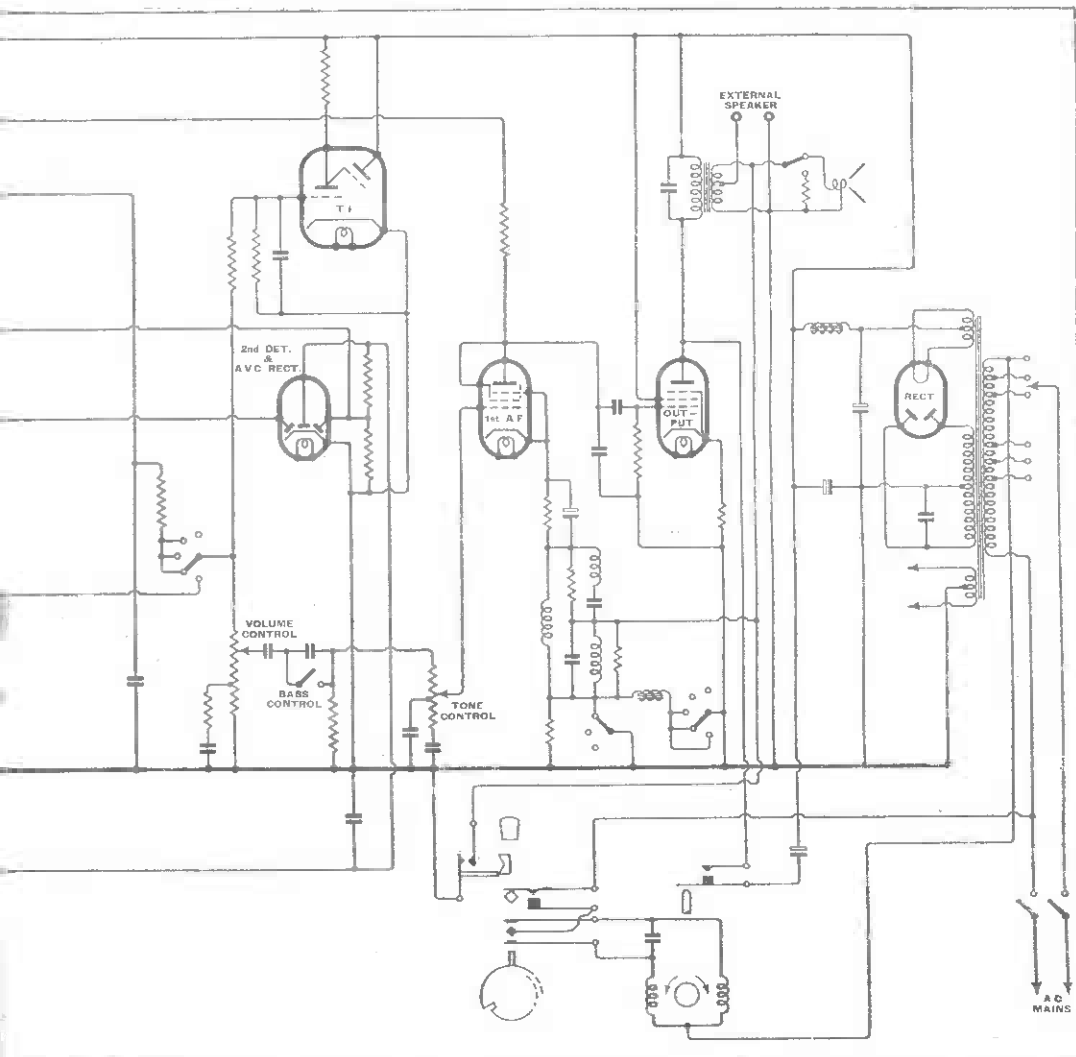
For the reproduction of gramophone records the IF amplifier is brought in as an additional AF stage. The anode is disconnected from the HT supply, and the valve functions as a triode using the screen as its anode.

Negative Feed-back

The output valve is a resistance-capacity coupled pentode. Negative feed-back is applied in two ways: (1) by omitting the by-pass condenser on the cathode by-pass resistance; (2) by returning a portion of the volts developed in the secondary of the loud speaker output transformer to the grid-cathode circuit of the preceding stage through a frequency discriminating potentiometer.

There is provision for an external loud speaker of 5 ohms impedance, and the output sockets are connected to a tapping on the loud-speaker transformer secondary. A switch is provided for disconnecting the internal loud speaker, and this automatically substitutes a suitable load resistance.

This is a very easy set to handle. All the controls are smooth mechanically and the tuning scale, complete with pilot lamps, tuning indicator, etc., can be tilted to any convenient angle. The scales are horizontal and arrows at the



Philips Type 753A—

right-hand edge show the waveband in use. A sharply focused vertical line of light projected on to the underside of the scale by a cylindrical lens serves as the tuning "pointer" and is absolutely free from parallax errors. The wavelength and station calibration is accurate and on the crowded 16- and 19-metre bands numbered markings are conveniently provided for noting the positions of stations.

The automatic tuning system makes use of the existing variable condenser, and in addition to the pre-set keys for eight stations there are press buttons at the ends of the keyboard for traversing the tuning scale in either direction. It is necessary to operate the waverange switch when changing from medium- to long-wave pre-set stations, but against this disadvantage may be set the fact that one is not re-

The tuning scale hinges down into a recess in the top of the cabinet. When the back is removed from the set, the mains are automatically disconnected.

stricted as to the proportion of stations allocated to each range.

The principle of operation is as follows: A spindle geared to the tuning condenser carries a number of drums held in position by friction and capable of being set independently in any desired position. On the circumference of each drum a spiral groove is cut with a locating hole in the centre of the track so formed. The depth of the groove is greater on one side of the hole than the other, and when the push-button is depressed and the locking pin descends into the groove the direction in which the driving motor rotates will depend on whether the pin falls on the high or low level of the spiral. Thus the direction of rotation is always towards the central locking hole, and when this is reached the current to the motor is switched off.

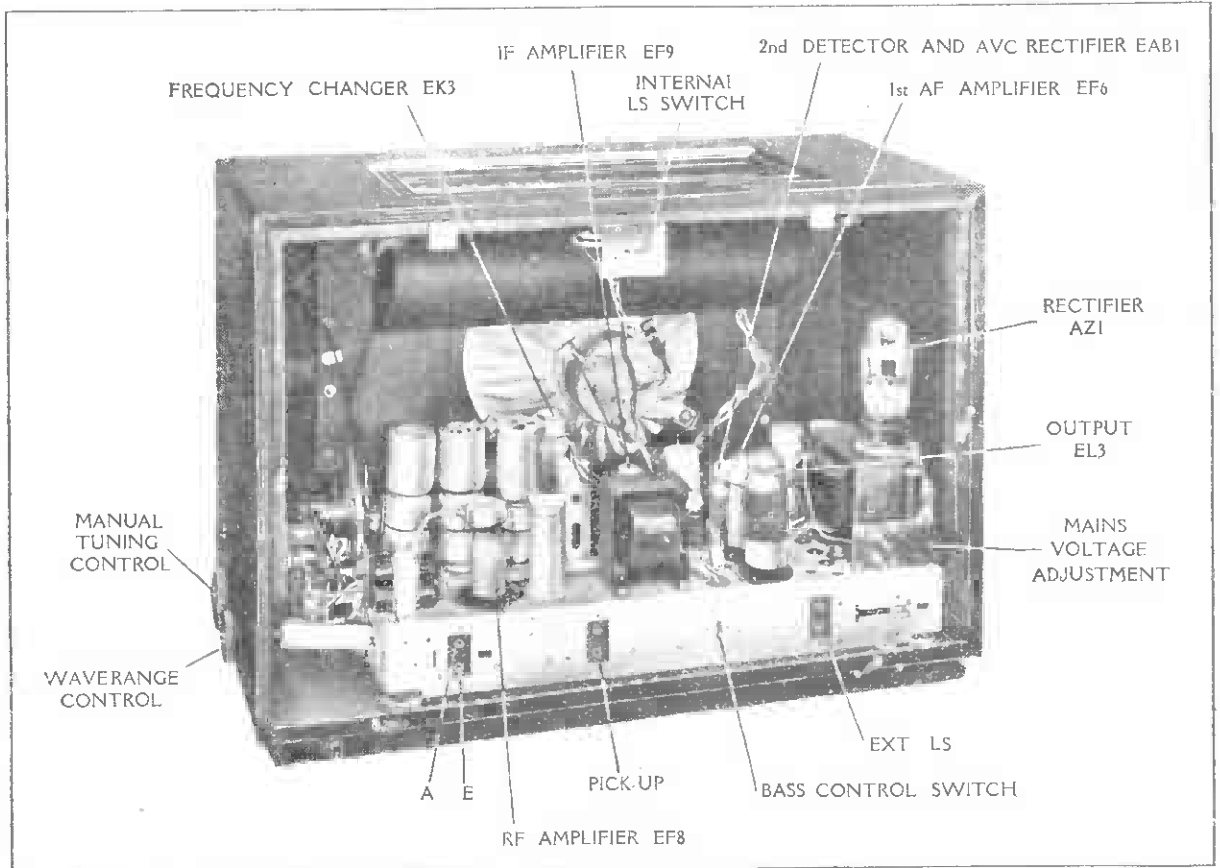
An important advantage of this system is that press buttons can be set up or station wavelengths changed by the user without special tools. All he does is to press the button in question, wait for the mechanism to come to rest with the locking pin in the locating hole and then tune in the desired station on the tuning indicator with the manual control knob pressed inwards from its normal position. This has the effect of rotating the selector drums with the exception of the one held by its locking pin. Since the selector

drums make several revolutions for the 180-degree movement of the tuning condenser the length of the spiral track is about 12 inches and the accuracy of setting is therefore high.

The mechanism is coupled to the electric motor through a friction drive which auto-

the conductor, and because of the conical shape, the act of screwing it on compresses the end of the cable.

These connectors are produced mainly in large sizes for heavy electrical purposes, but the small types are eminently suitable for the termination of the heavier leads used for wireless. The smallest size is made



matically disengages when the current is cut off. The same movement also actuates a silencing switch across the loud speaker.

It is impossible to damage the mechanism through mishandling, and if the manual tuning knob is inadvertently pressed in and turned while a station key is depressed, it is but the work of a moment to recover the correct setting for that station. Coloured pilot lights at each end of the keyboard indicate which waverange is in use, and the station name tabs supplied with the set are coloured to correspond.

The automatic tuning operates silently and without vibration and appears to us to be a thoroughly reliable job. It adds the finishing touch to a really first-rate design from the point of view of quality of reproduction, sensitivity, selectivity and general good manners in performance.

Hamman's Cable Sockets

A NEW type of cable socket or lug has been produced by Hamman's Industries, Ltd., of Abford House, Wilton Road, London, S.W.1, with which a reliable and mechanically strong connection can be made without soldering.

The shank of the lug is slightly conical, and is internally threaded, and it is fixed merely by screwing it on the bared end of the cable. The lug cuts its own thread in

for 23/36 flexible cable, and others are available for 40/36, 70/36, 90/36 and 110/36, while types can be supplied to take No. 18 and No. 16 SWG solid wire.

The Wireless Industry

THE Rider Chanalyst, an interesting and novel service instrument, is described in literature available from Holiday and Hemminger, 71-78, Hardman Street, Deansgate, Manchester, 3.

Reliance Manufacturing Co., Ltd., of Sutherland Road, Higham Hill, Walthamstow, London, E.17, has issued a new series of leaflets describing standard potentiometers and rheostats; full technical data is given.

A new edition of the Bulgin catalogue is now available. Details of over 1,300 components and accessories are given in this extremely useful 120-page publication, and a number of price alterations (almost all reductions) are shown. New introductions include television aerials and feeders, "magic eye" holders, suppressors, etc. Copies (price 3d.) are obtainable from A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex.

A series of transformers for use with home cinematographs are described in a leaflet just issued by F. C. Heavberd and Co., 10, Finsbury Street, London, E.C.2.

In referring to the **Philco Mystery Control**, in last week's issue, the range of control should have been given as 100 feet and not as 100 yards.

Power Consumption Meters

WHAT THEY REALLY MEASURE

By "CATHODE RAY"

THE method of measuring the consumption of receivers—or anything else connected to the mains—by means of the domestic electricity supply meter, described recently by M. G. Scroggie in his *Radio Laboratory Handbook*, and by "Diallist" in this journal, raises some questions in the minds of readers who are not quite clear about such things as *power factor*.

Only last week I picked up a book of the type that sets out to make electricity simple for the novice, and read that the *watt* is a particular sort of unit of electric current, and on the same page that the *ampere* is another sort of unit of electric current. Now that way of making things "easy" is not only confusing at the time but is pretty certain to make things much harder if later on the reader really wants to know something about how electricity is measured. It seems to me that electricity is very definitely something that one ought to know about correctly or not at all.

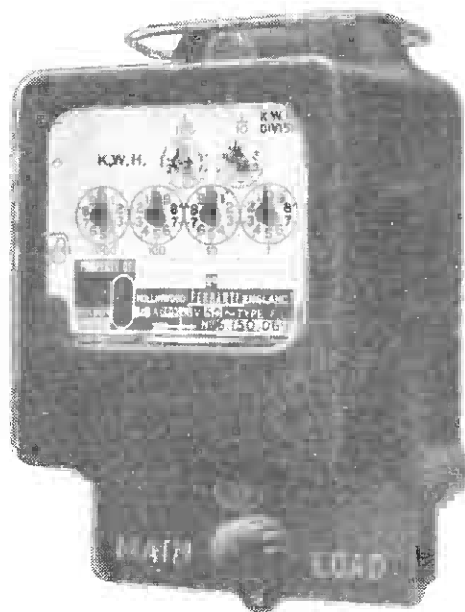
To be clear about what the supply meter actually measures it is necessary to begin at the beginning and run over things, if only very briefly. Newspapers, reporting a fatality from electric shock, invariably state that a current of so many thousand volts passed through the deceased. If only the little word "of" were changed to "at" it would be correct, but as it is it cannot help giving the impression that the current is measured in volts, which pass through the unfortunate person (or whatever else happens to be in circuit). Actually, of course, volts are used to indicate the electrical *pressure*, which may exist without any current at all. To adopt the favourite analogy, water is supplied to our houses under pressure, measured in pounds per square inch. It is nonsense to talk of this pressure flowing through the pipe; it is there whether water is flowing or not. When the tap is turned on the pressure causes water to flow; and the rate at which it flows (in gallons per minute) depends on the pressure and on the resistance in the pipes, tap, etc. The electrical equivalent is that when a circuit path is provided the voltage causes a current to flow, and the rate of flow (in amperes, or amps for short) depends on the pressure and also on the resistance (in ohms) of the circuit.

What is Power ?

Having distinguished between the flow of current and the pressure that is necessary to cause it, the next idea to grasp is *power*. Pressure alone is not power. Power can be obtained from water, but not if the tap is turned off. So a high voltage does not necessarily mean a large amount

of power, or even any power at all. The resistance may be so high as to allow only a mere trickle of current to flow, or perhaps cut it off altogether. On the other hand, a large flow of current does not mean a large amount of power if there is little pressure behind it. That is the difficulty about schemes for harnessing the tides. The volume of water moved is enormous, but the pressure, or "head," is relatively small.

The amount of power is reckoned by multiplying the pressure by the rate of current. The result of multiplying volts by amps. is the power in *watts*. Put another way, power is the *rate* at which work is done. But generally that is not what people get paid for. If a man has to do a certain job of work in a day, it is only when it is very urgent that an employer will agree to pay him extra for working twice as quickly and then going home at lunch-time to have the afternoon off. So far as electricity is concerned it is the total work-performing capacity (known technically as *energy*) that is paid for, and it



A typical kilowatt-hour meter of the type under discussion in this article.

is up to the consumer to decide whether he prefers to run a 1,000-watt heater for 12 hours or a 3,000-watt heater for 4 hours—it costs the same either way, because he has used 12,000 watt-hours of energy. To save a lot of noughts, energy is practically always specified in kilowatt-hours (kWh), which are also called Board of Trade Units because they form the legal basis for the sale of electric energy: 12,000 watt-hours equals 12 kWh.

So far so good. The way Units are

reckoned is too obvious for me to have to emphasise it. If a 60-watt lamp is run for 100 hours the consumption is 6 kWh. When the supply is DC the foregoing exceedingly simple knowledge is all one needs. It is with AC that confusion begins. I am hoping that you read my article "The Great Ohms Muddle (and the Way Out)" (June 23rd last) because there is no room here to explain in detail the difference between resistance and reactance. If the circuit contains only resistance, the whole of what I have said about power and energy applies to AC as well as to DC. The only difference is that the rate at which it is supplied is not steady, but keeps on rising from nothing to a peak, then dying down and reversing to a peak in the opposite direction; but as it does all this fifty times every second the variations are too rapid to matter much, and it is reasonable to consider only the average.

Complications

But when the circuit includes coils and condensers the whole process from the point of view of supplying power is quite different. It is true that either a coil or a condenser allows a certain current to flow, and its limiting effect (reactance) is measured in ohms, the same as resistance. But whereas a resistance converts all the electrical energy that is supplied to it into heat so that it is entirely withdrawn from the circuit, a coil or condenser without resistance returns to the circuit all the energy that is supplied. In practice there is bound to be *some* resistance, so part is consumed and part returned. But supposing for the sake of simplicity that we have got a *pure* (i.e. resistanceless) condenser, the current does not actually pass *through* it at all, but just charges it up, in the same way that a rubber balloon connected to a water or gas tap would allow a current to flow into it until the back-pressure of the balloon balanced the forward pressure from the supply. If the supply pressure was caused to cease, the balloon would blow its charge back where it came from, so the situation would be precisely as it was originally. Apart from frictional losses, the net power supplied would have been nil, for what was supplied to the balloon in the first half of the cycle was given back to the supply in the second. The same argument applies to a condenser on alternating current. Alternately, the pressure of the supply and the charging current constitute energy delivered, and the pressure of the condenser and the discharging current constitute an equal amount of energy returned. Although there is current it ought not to be paid for.

The current that flows in an inductive coil stores the energy in magnetic form. During the declining part of the AC cycle, this magnetic energy generates an electric

Power Consumption Meters—

current in the reverse direction, so again the energy is shuttlecocked to and fro, and is never permanently delivered.

The meter should take no account of any current of this nature, but only of that which represents energy permanently removed from the circuit. The proportion of the whole that is so removed is called the *power factor*. So to get the only amount of power that is of practical interest it is necessary to multiply amps by volts by *power factor* to get watts. Power factor is, of course, always less than 1. The remaining watts, that circulate to and fro, are ignored; or rather that is not invariably true, because if large users of power operate their systems in such a way as to have a bad (low) power factor, it is clear that to supply them with a given amount of power the current must be far larger than at unity power factor (power factor = 1); and the supply company has to provide larger mains to carry it and larger machines to generate it. Contrary to popular supposition, the cost of generating the electricity itself is negligible; most of what you pay is required for capital cost and maintenance of the plant and cables. So if people use a large amount of energy at a needlessly low power factor it is only fair that they should be discouraged from this policy by a heavier bill. However, so far as domestic consumers are concerned my original statement—that the proportion of energy not permanently delivered is ignored by the meter—may be taken to apply, because the great majority of current supplied is for heating, cooking and lighting, which being a pure resistance load is at unity power factor.

Wattless Current

A transformer connected to the mains but with its secondary windings disconnected is an example of a low-power factor load. The majority of the volt-amps goes to magnetise the core, and the only part that counts on the meter is what is unavoidably lost in heating up the transformer. I have a large transformer for testing sets at various voltages and other jobs, and by putting an AC ammeter in circuit found that the current on no load was 0.6 amp. As the mains voltage is 240 that represents 144 volt-amps. But *not* 144 watts! I made up a real 144-watt circuit from some lamps and a regulating resistor, adjusting the current to 0.6 amp again. The meter then made one revolution in 27 seconds. Supplying the same current to the transformer it took 180 seconds. So the actual power supplied to the transformer and lost in it as heat was only $\frac{144 \times 27}{180}$, or 21.6 watts.

$\frac{27}{180}$, or 0.15, is the power factor of the unloaded transformer. The remaining 85 per cent. of the volt-amps is what is often described as *wattless*.

In a sphere of work with such ill-chosen terms as ours, one must always be on the

look out for confusion. I can already see some readers puckering their brows and hear them saying, "You said a little while ago that the meter ignores all but the true watts; yet you used a meter to measure the current, which was the same for the two very different power factors." The trouble there is that in orthodox electrical engineering a "meter," without prefix, has come by long custom to be understood to mean an energy meter; and this is even officially recognised in the British Standards Institution list of technical terms. But up crop we radio people with no traditions or old school ties, having very little indeed to say about the electrical engineer's "meter" (until "Diallist" started a sort of weekly running commentary on that hitherto unknown curiosity), and begin using the term for our commonly used pointer instruments of all kinds. Of course, when the electrical engineer protests we can come back at him by asking him to suggest a name that he could approve, and that we could use, for the modern service-engineer's instrument. After all, even an orthodox electrical en-

gineer is human at the core and can't expect us to call the thing a volt-amp-milliamp-ohm-microfarad-meter every time we ask the boy to sling it in our kit.

Various people have shed doubts on the accuracy of the domestic meter as a measuring instrument. Apparently, in certain cases it is possible to take quite an appreciable amount of power before the meter starts to move. When this is so one would not expect the reading to be very accurate even when it does move. The lucky owners of such meters are unlikely to complain to the suppliers and are doubtless content to forgo the use of these instruments for accurate measurements. But if such gross errors exist it is no fault of the legislators, for the law requires that at any load between 5 per cent. and 125 per cent. of full load the error should not exceed $+2\frac{1}{2}$ per cent. or $-3\frac{1}{2}$ per cent. And the British Standards Institution specifies ± 2 per cent., and a starting current not exceeding one-hundredth of full rated current. My meter starts at one-thousandth, so my opportunities for free juice are very restricted!

Random Radiations

By "DIALLIST"

Dry Battery Receivers

THE new battery valves with low-voltage filaments are beginning to be used in radio receivers as well as in deaf aids. Their great advantage is that they can derive their filament current if need be from single dry cells of no great size, which, of course, makes them exceedingly useful both for portable sets and for receivers of other kinds operated in places where there are difficulties about charging accumulators. A recently launched portable containing four of these valves is stated to require only 0.25 ampere of LT current at 1.5 volts. The HT current is also small, being of the order of 9 milliamperes. As the total voltage required from the HT battery for the plate circuits and for automatic grid bias is only 90, the load on this battery works out at 0.81 watt. That on the filament battery is 0.375 watt. The set thus requires but 1.185 watts from both its batteries together, an astonishingly low figure for a 4-valve receiver. The figure is, as a matter of fact, almost exactly the same as that for a pocket flash lamp worked by a three-cell battery. We seem to have progressed a little since the old bright-emitter days, when each valve needed about 3 watts for filament heating alone.

Electricity!

THE other day I was thrilled by an account in my morning paper of a demonstration, given, as you might expect, in America, of the use of electric eels as generators. Wires were attached by means of metal clips (that must have taken a bit of doing!) to various squirming inhabitants of a tank of salt water, the other ends—ends of the wires, of course—being connected to small

motors, lamp bulbs, and so on. Switching on was done by the simple process of tickling an eel; the apparatus connected to it then lit up or revolved as the case might be. In my mind's eye I couldn't help picturing an eel-power wireless receiver for use in outposts of Empire where eels of the right kind abound, though mains supplies and accumulator-charging facilities are non-existent. His day's work done, the exile from home reclines in his camp chair, whilst with one hand immersed in the eel tank he gently tickles-in the Empire programme. Perhaps even that process could be eliminated by mounting the loud speaker on the tank, its vibrations supplying the necessary filtration. The only snag that I can see lies in the well-known tendency of eels to wind themselves into coils. I have no data of the inductance and self-capacity of a coiled electric eel. Would it upset the tuning or merely serve a useful purpose by providing a smoothing choke in the power supply?

Demonstrations

A FRIEND who is keenly interested in short-wave reception decided recently that the time had come for him to invest in a communication receiver. He lives at some distance from London and it wasn't possible for him to see any sets of this kind in his own small town. But after perusing many catalogues he discovered two sets of different makes which on paper seemed to meet his requirements and whose prices suited his pocket. Both firms announced that daily demonstrations were given in their London showrooms. He therefore decided to make a special trip—something over a hundred miles there and back—to see and hear the receivers put through their paces. On reaching showroom No. 1 he was

enthusiastically received and was duly shown the set. Could he hear it at work? Most certainly! The demonstrator applied himself to the controls and in a moment produced the London Regional. My friend explained that he didn't need a communication receiver to hear the London Regional; might they please go farther afield amongst the short-wave stations? Sadly it was explained to him that local interference was too severe for anything but the London Regional to be tuned in satisfactorily. The demonstrator was sorry, but that was just that.

Foiled Again

At showroom No. 2 a further surprise was in store. Again he received an enthusiastic welcome; but this time he wasn't even shown the set that he had come so far to see. The demonstrator was exceedingly sorry, but that was just the one model that they hadn't in stock. Production had been delayed; if my friend would return in a week or so he would be delighted to let him examine one and even to operate it himself. At the moment nothing could be done about it beyond showing him pictures and enlarging upon the description contained in the catalogue. A sadder but a wiser man, my friend journeyed home with his money still in his pocket; and there, as they say, the matter rests for the present.

Mains-Battery Sets

THE other week I mentioned that I'd been using a communication receiver whose internal arrangements were such that you could run it either from AC mains through a power unit or direct from a 6-volt LT battery and a large-capacity HTB of 270 volts. By one and the same post I received letters from two readers, each of whom tells me that he has just completed the design of a receiver which works either off 230-volt mains or off a 6-volt car accumulator. One of them is kind enough to send me a circuit diagram of his set, which is an interesting piece of work. To change over from mains to battery operation, all that you need do is to turn a knob which operates a five-pole double-throw switch. In one position this connects the mains to a conventional transformer supplying a rectifier with one secondary winding, and the heaters with the other. In the battery position the heaters go straight on to the 6-volt supply, which is also taken to a vibrator. The secondary of the transformer to which the latter is connected is now fed to the aforesaid rectifier. There is one peculiarity about the circuit on which its author makes the pencilled comment: "Rectifier cathode 250 volts positive to heater! But [mentioning a well-known manufacturing firm] do it, so here's hoping."

Should be Useful

Both these sets are intended to be semi-portables for use either in the car or in the home. The idea strikes me as an excellent one. It's not new, of course, but in the past snags of various kinds seem to have cropped up. Let's hope that this time there won't be any snags and that the mains-battery set will be a great success. Perhaps someone will go a step farther and give us a still more flexible set that will work off either a 12-volt car battery or AC or DC mains with a voltage between 200 and 250. That would be something really worth having on a holiday, for you could use it almost anywhere.

Some Queer Survivals

I say almost anywhere because there are still some rather queer kinds of mains current supply in this country of ours. Looking through the latest list available showing the supplies in different parts of the country, I find that two London areas have DC at 100 volts, and no fewer than four AC at the same voltage. In the provinces there are quite a lot of places with DC at 100, 110 or 115 volts, whilst among those that have AC I find voltages of 100, 105, 110, 170 and frequencies of 25, 30, 40 and 100.

An Adventure

DID I ever tell you of an adventure that befell me in the little East Anglian town of Southwold? I was going there for a short holiday, and my family, of course, urged that a suitable wireless set should be taken as part of the equipment. Turning up the mains supply tables, I found that the current there was 230 volts AC. I decided to take a largish set, as I'd heard that reception conditions in that part of the world weren't too good. Arrived at our hotel, one of my offspring proceeded to install the set in our rooms, which formed a kind of annexe to the main building. Presently he called to me that, though he'd got everything shipshape, there wasn't a sound to be obtained from the set. There was, however, a distinctly nasty smell, and my first act was to switch off, for something was undoubtedly near frying point inside. Something suggested to me that we'd plugged into DC. I traced out the electric wiring and found that it emerged from a little DC meter tucked away in a corner of the vestibule of the said annexe. Subsequent enquiries showed that the town had originally been on 200 volts DC and that almost all of it had been changed over to 230 volts AC. Here and there, though, small DC circuits had been left, and one of these served just two rooms out of those in the hotel. Luckily, the set stood up to its trying ordeal and proved none the worse when we connected it later on, by means of long flex leads, to an AC point in one of the other rooms. It is a bit disconcerting, though, to find little DC islands like this in an AC area!

MULLARD BEAT-FREQUENCY OSCILLATOR

THIS audio-frequency oscillator is of a particularly useful type for many purposes since the whole range of audible frequencies can be covered in one swing of a control. It is of the beat-frequency type; that is, the output is obtained by the rectification of the mixture of two RF oscillators. One of these operates at a fixed frequency, and the other has its frequency variable by the panel controls. The output is equal to the difference in frequency between the two oscillators.

One control gives a continuous range of output frequencies of 0-1,500 c/s and the other of 0-15,000 c/s. The lower useful limit of output is 15 c/s.

The equipment is entirely mains-operated and calibration is effected by comparing the output at 100 c/s with the mains frequency, the comparison being effected by means of a cathode-ray tuning indicator. The scales are direct reading in frequency, and the calibration is remarkably accurate.

A diode rectifier is used followed by an AF stage and output pentode with negative feed-back. The output is 400 milliwatts for a harmonic content of less than 2 per

cent., and the output voltage is claimed to be constant within 2 db. over the whole frequency range.

There is a continuous control of output voltage, and a 6-way switch enables several different output circuits to be secured. In one position a six-step attenuator is included, but in the other positions only the continuous control of output functions.



The Mullard GM2304 audio-frequency oscillator.

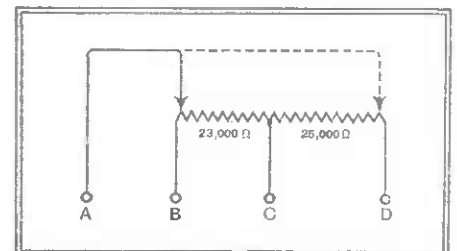
Except on this one output, it is important that the output terminals be connected to the correct value of impedance and the values for the other five switch positions are 2.5, 5, 250, 500, and 1,000 ohms. On the 2.5- and 5-ohm positions both output terminals are isolated; on the other three the output is balanced to earth, the centre of the output transformer winding being earthed.

On test, the oscillator behaved admirably, and it can confidently be recommended for all ordinary test and laboratory requirements. It is made by the Mullard Wireless Service Co., Ltd., of Mullard House, 225, Tottenham Court Road, London, W.1.

HENRY FARRAD'S SOLUTION

(See page 80)

THE only terminal that is involved in resistance readings that change as the knob is turned is A, which can therefore be identified as the slider terminal. With the control at the extreme left, terminals A and B coincide, as shown by the fact that resistance A to B is nil and B to C is the same as A to C, also B to D the same as A to D. Similarly, A and D coincide when the knob is turned fully to the right. B and D are therefore the end terminals of the resistance element. Resistances from C to each end add up to equal the total resistance B to D, regardless of slider position, and



are approximately equal to one another. C is therefore a centre tap in a nominally 50,000-ohm potentiometer, which when so provided is usually described as a *fader*.

Without measurements at intermediate knob settings it is not possible to say whether the element is linear or tapered.

The required diagram of connections, with actual measured values, is shown above.

Letters to the Editor

The Editor does not necessarily endorse the opinions
of his correspondents

Output Transformers

I HAVE read with interest Mr. Partridge's article on output transformers in your issue of January 12th, and while his statement that the efficiency is lowered by the copper losses and iron losses cannot be contradicted, I disagree with his ideas as to the manner in which these losses (or their equivalent resistances) enter into the theory of matching.

In the examples given in the article the loadings arrived at are admittedly those which permit the valve (considered by itself) to operate at its best, *i.e.*, it will give out its maximum permissible power. But as some of this power is being dissipated *wastefully* in the transformer, it does not follow that we thus obtain the maximum possible power dissipated usefully in the output load, and this is really the object to be aimed at.

If a valve could be regarded as an ordinary AC generator, with pure and constant internal resistance, then it would be quite easy to evolve a formula to secure matching with a resistance load through a transformer having resistance.

The true principle is that the useful resistance in the load is to be matched (through the transformer ratio) with the total wasteful resistance.

It would then be found that the transformer resistance would have to be considered as part of the internal resistance of the generator, and the best load resistance would be *higher* than with a transformer of no resistance.

Owing to the peculiarities of a valve, however, the matter is not so simple, and the problem would seem to call for a re-determination of the optimum load, using a new family of curves taken with an appropriate external resistance in circuit, with due allowance for HT voltage loss.

A somewhat superficial consideration of the matter inclines me to the opinion that the result would be a load certainly higher than that given by Mr. Partridge, and probably slightly higher than that at present published in valve lists.

Further, the efficiencies with the new loads would be rather better than those indicated by Mr. Partridge's figures.

Stratford-on-Avon. P. G. DAVIDSON.

The Author's Reply

MR. DAVIDSON'S letter puts forward a very interesting line of reasoning, which is, indeed, based upon sound engineering principles. But it is a pity that so much thought should have been wasted upon so trivial a cause. Why encourage the birth of a new family of curves for the sole purpose of being able to use a third-rate output transformer?

When designing a power stage, the object is to feed into the load (speaker, recording head, etc.) as much undistorted power as is possible with the particular valves selected. The first step is to see that the valves operate in the manner recommended by the manufacturers. This involves regulating the HT

supply so that the full permissible voltage is applied to the plates. One allows for the voltage dropped through the smoothing chokes, the primary of the output transformer, bias resistor, etc., and therefore a "due allowance for HT voltage loss" does not arise. Having got the valves working under the optimum conditions, the only means of transferring the maximum power to the load is by using an efficient transformer. The mental effort of considering the transformer resistance as a part of the internal resistance of the generator will not produce more watts. The unavoidable fact remains that transformer resistance means loss, and the correct procedure is to reduce the resistance and not to undertake research to make the best of a bad job.

In order not to appear too harsh, let me add that I am in complete agreement with Mr. Davidson. A transformer can be matched to a speaker by adjusting the valve. But, please remember, my article dealt with the problems of matching a speaker to a valve by adjusting the transformer.

N. PARTRIDGE.

London, S.W.1.

Ignition Interference

AS the last paragraph of Mr. Dundas Bryce's letter and your own comment in your issue of January 12th seem to point my way, I append some of my own observations on the practical side of this subject.

I have been experimenting continuously with motor car interference for the past eighteen months, first on a 1933 Morris Ten, and latterly on a 10 h.p. Ford "Prefect."

Dealing first with the question of easy starting on cars fitted with suppressors, an experience I had in Aberdeen last winter may interest your readers. My hotel was situated some distance from public garages, and it was customary to leave cars out all night in single file at the side of the building, the radiators being drained to avoid freezing.

My car never once failed to burst into life at the first touch of the starter in the morning, and was the envy of others with more modern cars who were forced to use their starting handles. The secret of success in this connection lies in keeping the outside of plugs and suppressors clean and free from dust and oil, particularly in damp or frosty weather. With dirty suppressors and plugs the current will tend to travel over the outer surface of the body of the plug rather than force its way through the wet and cold plug points.

Regarding the effect of suppressors at high speeds, I usually travel at 50 m.p.h. on my longer journeys where road conditions permit, and have occasionally touched 60 for many miles, which is the maximum top speed of the car, with or without suppressors.

I have had misfiring troubles due to the suppressors, but have invariably found this to be due to rough handling by garage mechanics when working at the engine. A

sharp knock with hand or tool loosens the base of the suppressor, and engine vibration does the rest.

The effect of ignition suppressors can easily be demonstrated by detaching the centre HT lead from the distributor cap and holding the wire close to any part of the cylinder block. If the make and break is then slipped open with the finger nail, the ignition switch being on, a spark should result. With no suppressor fitted a large fat spark should appear, and the addition of the suppressor will make the spark much smaller, but snappier, and more intense.

It should be pointed out that although a simple choke fitted in the LT lead of a well-screened car set will prevent the interference breaking through into the receiver, it is still radiating from the ignition system, and will affect any other receiver in the vicinity working on short waves. A. D. MILNE.

Coatbridge

Interference: Voluntary Suppression

I ONLY wish some of the suggestions contained in the letter from Mr. Dundas Bryce, relating to the suppression of ignition interference with television on the ultra-short waves, could be put into practice to help the listener to ordinary sound broadcasting to obtain interference-free reception! Why should not the B.B.C. every now and then issue an appeal to owners of every kind of electrical appliance to have them fitted with suppressors wherever possible?

There is one particular piece of electrical apparatus in use close to this address. When it is actually in operation *all* reception on the medium waves becomes utterly impossible. Local listeners know who is the culprit, but the latter is impervious alike to threats and pleas. I do wish *The Wireless World* would hammer home this question of interference on all the wavebands in every single issue!

As for the "difficulties" of carrying out the necessary legislation to compel owners of static-broadcasting appliances to have them fitted with suppressors, let the legislation be passed first, then ways will be found for applying it! In any case, other countries have done so.

T. J. E. WARBURTON.

St. Leonards-on-Sea.

Indented Sound Track

AS the contributor of the item describing the Filmograph "Home-Talkie" unit, *The Wireless World*, December 8th, 1938, I would like to reply briefly to the points raised by Mr. Appleby in his letter (December 29th issue) referring to this instrument.

First, I must state that I have no information regarding the sound quality obtainable with this device. However, I can answer his query regarding the problem of eliminating the intermittent film motion through the picture-gate of the projector. In this instance (see photographs accompanying the item) the film motion is not intermittent because, contrary to standard professional practice, the recorded and reproduced sound comes before the picture and from a loop *above* the continuous or steady speed sprocket.

For the benefit of the many persons who have written to me requesting the source of supply of these Filmograph units I append the required name and address: The International Film Recording Company, 812, Broadway, New York, N.Y., U.S.A.

D. W. A.

Recent Inventions

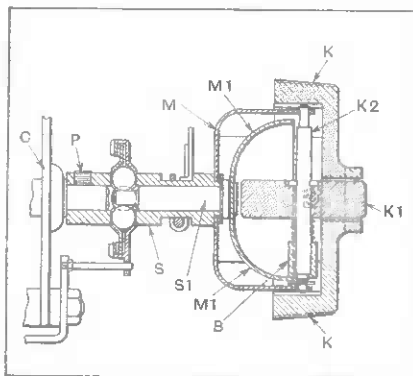
The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

"FINE" TUNING

THE control knob of a wireless receiver consists of an ordinary disc or knob for making the first rough adjustment, across the face of which is inset a "thumb-wheel" used for fine tuning.

As shown in the figure, the rough-tuning knob K is fixed to a hollow cup-shaped member M, and drives the condenser C through a hollow shaft S keyed to the condenser spindle at P. The fine-tuning thumbwheel K₁ protrudes slightly through an opening in the knob K so that it can conveniently be turned by a finger or thumb of one hand.

It is mounted on a transverse spindle K₂ which applies a frictional drive to the edge of a second cup-shaped member M₁, and so rotates the condenser spindle through a shaft S₁. The slow-motion drive is applied through a spring-pressed slider B



Two-speed tuning condenser drive mechanism with finger-tip control for fine adjustment.

which forces the edge of the member M₁ against a nut on the end of the spindle K₂.

The Plessey Co., Ltd.; P. H. Morrison and P. J. Pachman. Application date, June 25th, 1937. No. 492548

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AVC "ON THE ROAD"

THE inventor points out that the agreeable level of sound when receiving programmes on the road, particularly in an open car, depends to some extent upon the prevailing wind-speed, since this produces a definite background of noise. He accordingly proposes to regulate the output volume automatically, not by the actual speed of the car, but by the speed of the air-stream flowing past it.

He does so by using the well-known Pitot tube. One limb of the U-tube faces the front, and the other the rear of the car. The difference of pressure so set up regulates the level of a column of mercury inside the tube. The inside of the latter is coated with carbon, the effective resistance of which therefore depends on the length not short-circuited by the mercury. This variable resistance is then made part of the ordinary or "manual" volume control, applied to the A₁ amplifier, and so introduces the desired automatic regulation.

E. J. C. S. St. J. Chesney. Application date, February 13th, 1937. No. 490598.

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

SEPARATING SOUND AND VISION SIGNALS

TWO closely adjacent wavelengths, such as the sound and vision signals in a television receiver, are fed to the control grid of a pentode valve and are heterodyned by the same local frequency, the sound signals being taken off from the screening grid and the picture signals from the anode of the same valve.

As shown in the figure, both sets of incoming signals are applied across the terminals T, T₁ to the control grid of the pentode V, together with local oscillations from a source S. If the picture signals are transmitted on a carrier of 45 megacycles and sound on 41.5 megacycles, a local frequency of 32 megacycles is used. In the anode circuit A, of which the tuning is broadened by a shunt resistance R, a difference frequency of 13 megacycles (45-32) is produced and transferred to the IF stage A₁ of the picture channel.

A second tuned circuit B is connected to the screening grid, and is decoupled by a resistance R₁ and condenser C. Here the second difference frequency of 9.5 megacycles (41.5-32) appears and is passed through a separate amplifier B₁ to the sound channel. The

arrangement avoids cross-modulation and prevents undue attenuation of either set of frequencies.

Ferranti, Ltd., and G. M. Tomlin. Application date April 24th, 1937. No. 492398.

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TELEVISION TRANSMITTERS

TWO or more electron-multipliers are built into the glass tube of a cathode-ray tube of the Iconoscope type so as to form a unitary structure. They are arranged symmetrically about the mosaic-cell screen, as well as about the window or aperture through which the picture to be televised is projected.

The electrons released from the sensitive electrode by the action of the scanning stream are attracted directly to the multipliers, and are amplified by them before passing to the signalling circuit. Provision is made to allow the outputs from the various multipliers to be suitably "mixed" in order to give control of shading and background.

Marconi's Wireless Telegraph Co., Ltd. (assignees of L. E. Flory and G. A. Norton). Convention date (U.S.A.), January 28th, 1937. No. 491425.

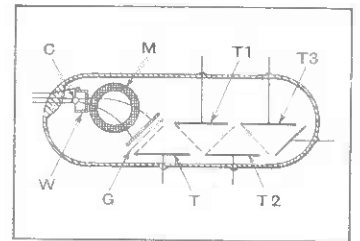
o o o o

ELECTRON MULTIPLIERS

IT is possible to obtain practically any desired degree of amplification from an electron multiplier, particularly when the primary current is small, as is the case with a photo-electric cell. But it is not so easy to apply the secondary emission effect to the comparatively large currents emitted from a heated cathode, or

to control or modulate these currents by the feeble signalling currents available in television.

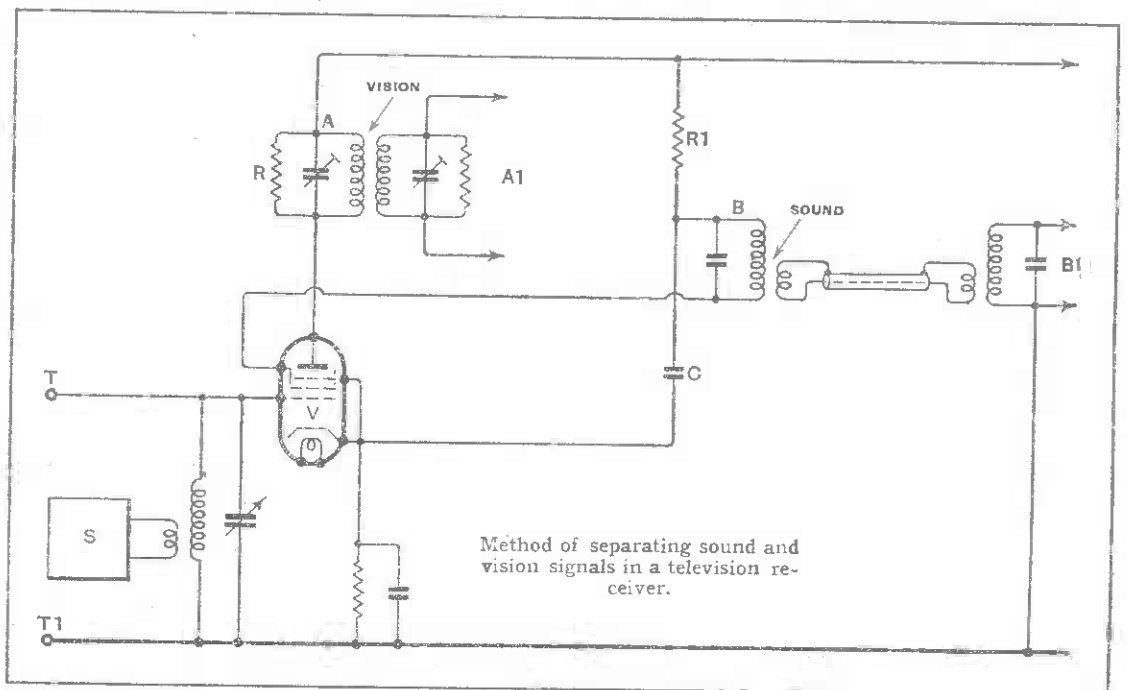
Part of the difficulty lies in the fact that electrons emitted from an incandescent cathode follow the Maxwell law of distribution, and show "emergence" velocities varying from 0 to 4 volts; these cannot effectively be controlled or modulated by signals of the order of microvolts.



Electron multiplier tube designed for modulation by weak impulses.

According to the invention, the primary current is produced by a special form of incandescent cathode C covered with a very thin "monocrystal" coating of copper. Alternatively a photo-electric cathode energised by monochromatic light may be used. Either type yields an electron stream having an average velocity of between 2 and 2,000 volts. The stream is focused by a Wehnelt cylinder W, and the magnetic field from a coil M, on to a series of target electrodes T, T₁, T₂, T₃. Signals of the order of millivolts will then give "deep" modulation when applied to the control grid G. The slope of the multiplier can be given any desired value, the amplification being free from distortion.

G. Weiss. Convention date (Germany), March 31st, 1936. No. 492698.



Method of separating sound and vision signals in a television receiver.

SHORT - WAVE STATIONS OF THE WORLD

Arranged in Order of Frequency and Wavelength (Stations with an Aerial Power of 20 kW and above in heavy type)

Station.	Call Sign.	mc/s.	Tuning Positions.	Metres.	kW.	Station.	Call Sign.	mc/s.	Tuning Positions.	Metres.	kW.
Amateurs		1.71		174.43	—	Warsaw (Poland)	SPD	11.53		26.01	20
		to		to		Motala (Sweden)	SBP	11.70		25.63	0.7-12
		2.00		150.00		Moscow (U.S.S.R.)	R1A	11.71		25.62	15
Amateurs		3.50		85.71	—	Paris (Radio-Mondial) (France)	TPA4	11.72		25.60	12
		to		to		Paris (Radio-Mondial) (France)	TPA6	11.72		25.60	25
		4.00		75.00		Huizen (Holland)	PHI	11.73		25.57	25
Calcutta (India)	VUC2	4.88		61.48	10	Boston (U.S.A.)	W1XAL	11.73		25.57	20
Bombay (India)	VUB2	4.90		61.00	10	Vatican City (Vatican State)	HVJ	11.74		25.55	25
Madras (India)	VUM2	4.95		60.61	10	Daventry (Gt. Britain)	GSD	11.75		25.53	10-50
Delhi (No. 2) (India)	VUD2	4.99		60.06	10	Poděbrady (Prague) (Czechoslovakia)	OLR4B	11.76		25.51	30
Moscow (U.S.S.R.)	R1A	5.85		51.24	15	Zeesen (Germany)	DJZ	11.77		25.49	5-40
Moscow (U.S.S.R.)	RNE	6.00		50.90	20	Boston (U.S.A.)	W1XAL	11.79		25.45	20
Montevideo (Uruguay)	CXA2	6.00		49.96	5	Tokio (Japan)	JZJ	11.80		25.42	50
Pretoria (South Africa)	ZR11	6.01		49.94	7	Zeesen (Germany)	DJO	11.80		25.42	5-40
Rangoon (Burma)	XYO	6.01		49.94	10	Vienna (Germany)	DJZ	11.80		25.42	50
Poděbrady (Prague) (Czechoslovakia)	OLR2A	6.01		49.94	30	Rome (Italy)	12R04	11.81		25.40	25
Zeesen (Germany)	DJC	6.02		49.83	5-40	Daventry (Gt. Britain)	GSN	11.82		25.38	10-50
Moscow (U.S.S.R.)	RW96	6.03		49.75	100	Wayne (U.S.A.)	W2XNE	11.83		25.36	10
Poděbrady (Prague) (Czechoslovakia)	OLR2B	6.03		49.75	30	Lisbon (Portugal)	CWS5	11.84		25.34	10
Vatican City (Vatican State)	HVJ	6.03		49.75	25	Poděbrady (Prague) (Czechoslovakia)	OLR4A	11.84		25.34	30
Boston (U.S.A.)	W1XAL	6.04		49.67	20	Zeesen (Germany)	DJP	11.85		25.31	5-40
Tandjong Priok (Java)	YDA	6.04		49.67	10	Daventry (Gt. Britain)	GSE	11.86		25.29	10-50
Miami (U.S.A.)	W4NB	6.04		49.67	5	Pittsburgh (U.S.A.)	W8XK	11.87		25.26	24
Daventry (Gt. Britain)	GSA	6.05		49.59	10-50	Paris (Radio-Mondial) (France)	TPB7	11.88		25.24	25
Cincinnati (U.S.A.)	W8XAL	6.06		49.50	10	Paris (Radio-Mondial) (France)	TPA3	11.88		25.24	12
Philadelphia (U.S.A.)	W3XAU	6.06		49.50	10	Moscow (U.S.S.R.)	RNE	12.00		25.00	20
Motala (Sweden)	SBO	6.06		49.46	0.7-12	Reykjavik (Iceland)	TFJ	12.23		24.52	7.5
Vienna (Germany)	DJY	6.07		49.40	50	Warsaw (Poland)	SPW	13.63		22.00	10
Zeesen (Germany)	DJM	6.08		49.35	5 40	Amateurs		14.00		21.42	—
Lima (Peru)	OAX4Z	6.09		49.24	15			to		to	
Capetown (South Africa)	ZRK	6.10		49.20	5			14.40		20.83	
Bound Brook (U.S.A.)	W3XAL	6.10		49.18	15-35	Radio-Nations (Switzerland)	HBJ	14.53		20.64	20
Chicago (U.S.A.)	W9XF	6.10		49.18	10	Moscow (U.S.S.R.)	RK1	15.08		19.89	25
Daventry (Gt. Britain)	G3L	6.11		49.10	10-50	Lisbon (Portugal)	CSW4	15.10		19.87	10
Mexico City (Mexico)	XEUZ	6.12		49.98	20	Zeesen (Germany)	DJL	15.11		19.85	5-40
Montevideo (Uruguay)	CXA4	6.12		48.98	5	Vatican City (Vatican State)	HVJ	15.12		19.84	25
Pittsburgh (U.S.A.)	W8XK	6.14		48.83	28	Paris (Radio-Mondial) (France)	TPB6	15.13		19.83	25
Wayne (U.S.A.)	W2XNE	6.17		48.62	10	Boston (U.S.A.)	W1XAL	15.13		19.83	20
Vatican City (Vatican State)	HVJ	6.19		48.47	25	Daventry (Gt. Britain)	GSF	15.14		19.82	10-50
Radio-Nations (Switzerland)	HBQ	6.67		44.94	20	Delhi (India)	VUD3	15.15		19.80	10
Amateurs		7.00		42.85	—	Guatemala City (Guatemala)	TGWA	15.17		19.78	10
		to		to		Skarnieback (Denmark)	OZH	15.17		19.78	6
		7.30		41.09		Daventry (Gt. Britain)	GSO	15.18		19.76	10-50
Mexico City (Mexico)	XECR	7.38		40.65	20	Moscow (U.S.S.R.)	RW96	15.18		19.76	100
Radio-Nations (Switzerland)	HBP	7.80		38.48	20	Ankara (Turkey)	TA9	15.20		19.74	20
Budapest (Hungary)	HAT4	9.12		32.88	6	Zeesen (Germany)	DJB	15.20		19.74	5 40
Radio-Nations (Switzerland)	HBL	9.34		32.1	20	Pittsburgh (U.S.A.)	W8XK	15.21		19.72	18
Ankara (Turkey)	TAP	9.46		31.70	20	Huizen (Holland)	PCJ2	15.22		19.71	60
Madrid (Spain)	EAP	9.49		31.62	10	Poděbrady (Prague) (Czechoslovakia)	OLR5A	15.23		19.70	30
Rio de Janeiro (Brazil)	PRF5	9.50		31.58	12	Paris (Radio-Mondial) (France)	TPA2	15.24		19.68	12
Melbourne (Australia)	VK3ME	9.50		31.58	5	Boston (U.S.A.)	W1XAL	15.25		19.67	20
Bangkok (Siam)	H88PJ	9.50		31.58	5	Daventry (Gt. Britain)	GS1	15.26		19.66	10-50
Mexico City (Mexico)	XEWV	9.50		31.58	10	Wayne (U.S.A.)	W2XNE	15.27		19.65	10
Daventry (Gt. Britain)	GSB	9.51		31.55	10 50	Zeesen (Germany)	DJQ	15.28		19.63	5-40
Moscow (U.S.S.R.)	RW96	9.52		31.51	100	Buenos Aires (Argentine Republic)	LRU	15.29		19.62	7
Skarnieback (Denmark)	OZF	9.52		31.51	6	Daventry (Gt. Britain)	GSP	15.31		19.60	10-50
Pretoria (South Africa)	ZRH	9.52		31.50	7	Schenectady (U.S.A.)	W2XAD	15.33		19.57	18
Calcutta (India)	VUC2	9.53		31.48	10	Zeesen (Germany)	DJR	15.34		19.56	5-40
Schenectady (U.S.A.)	W2XAF	9.53		31.48	25	Budapest (Szekesfehervar) (Hungary)	HAS3	15.37		19.52	6
Tokio (Japan)	JZI	9.54		31.46	50	Djibouti (Somaliland)	FZES	17.28		17.38	5
Zeesen (Germany)	DJN	9.54		31.45	5-40	Hicksville (U.S.A.)	W2XGB	17.31		17.33	10
Poděbrady (Prague) (Czechoslovakia)	OLR3A	9.55		31.41	30	Zeesen (Germany)	DJE	17.76		16.89	5-40
Paris (Radio-Mondial) (France)	TPB11	9.55		31.41	25	Wayne (U.S.A.)	W2XNE	17.76		16.89	10
Vatican City (Vatican State)	HVJ	9.55		31.41	25	Huizen (Holland)	PHI	17.77		16.88	25
Bombay (India)	VUB2	9.55		31.40	10	Bound Brook (U.S.A.)	W3XL	17.78		16.87	15 35
Schenectady (U.S.A.)	W2XAD	9.55		31.40	20 25	Daventry (Gt. Britain)	GSG	17.79		16.86	10-50
Zeesen (Germany)	DJA	9.56		31.38	5-40	Daventry (Gt. Britain)	GSV	17.81		16.84	10 50
Lima (Peru)	OAX4T	9.56		31.37	10	Rome (Italy)	12R08	17.81		16.84	25
Millis (U.S.A.)	W1XK	9.57		31.35	10	Paris (Radio-Mondial) (France)	TPB3	17.81		16.84	25
Daventry (Gt. Britain)	GSC	9.58		31.32	10-50	Buenos Aires (Argentine Republic)	LSY3	18.11		16.56	5
Delhi No. 2 (India)	VUD2	9.59		31.28	10	Ankara (Turkey)	TAR	18.30		16.38	60
Philadelphia (U.S.A.)	W3XAU	9.59		31.28	10	Radio-Nations (Switzerland)	HBH	18.48		16.23	20
Sydney (Australia)	VK2ME	9.59		31.28	20	Bangkok (Siam)	H88PJ	19.02		15.77	5
Huizen (Holland)	PCJ	9.59		31.28	60	Zeesen (Germany)	DJS	21.45		13.99	5-40
Moscow (U.S.S.R.)	RW96	9.60		31.25	20	Boston (U.S.A.)	W1XAL	21.46		14.00	20
Capetown (South Africa)	ZRK	9.60		31.25	7	Daventry (Gt. Britain)	GSH	21.47		13.97	10-50
Rome (Italy)	12R03	9.63		31.13	25	Schenectady (U.S.A.)	W2XAD	21.50		13.95	18
Vatican City (Vatican State)	HVJ	9.66		31.06	25	Wayne (U.S.A.)	W2XNE	21.52		13.94	10
Buenos Aires (Argentine Republic)	LRX	9.66		31.06	7	Daventry (Gt. Britain)	GSJ	21.53		13.93	10-50
Bound Brook (U.S.A.)	W3XAL	9.67		31.02	15-35	Pittsburgh (U.S.A.)	W8XK	21.54		13.93	6
Zeesen (Germany)	DJX	9.67		31.02	5-40	Daventry (Gt. Britain)	GST	21.55		13.92	10-50
Guatemala City (Guatemala)	TGWA	9.83		30.98	10	Amateurs		28.00		10.71	—
Madrid (Spain)	EAQ	9.86		30.43	20			to		to	
Dairen (China)	JDY	9.92		30.24	10			30.00		10.00	
Lisbon (Portugal)	CSW3	9.94		30.18	5	London Television (Sound)		41.50		7.22	3
Marapicú (Brazil)	PSH	10.22		29.35	12	London Television (Vision)		45.00		6.66	17
Ruysselde (Belgium)	ORK	10.33		29.04	9	Amateurs		56.00		5.35	—
Buenos Aires (Argentine Republic)	LSX	10.35		28.99	12			to		to	
Kootwijk (Holland)	PDK	10.42		28.79	80			60.00		5.00	
Taihoku (Japan)	JIB	10.53		28.48	10	Amateurs		112.00		2.67	—
Lisbon (Portugal)	CSW6	11.04		27.17	10			to		to	
Radio-Nations (Switzerland)	HBO	11.40		26.31	20			120.00		2.50	

NATIONAL WIRELESS REGISTER

THE MINISTRY OF LABOUR is issuing a booklet giving the details of various services which are essential for the defence of our country, and is asking members of the public to volunteer their services so that the whole efforts of the country may be rightly directed. Every individual can then be put to that task for which he is most fitted by previous training. A large percentage of readers of "THE WIRELESS WORLD" possess technical qualifications which in many cases have been acquired from years of training and practical experience. In the event of a state of emergency arising, the defence services of the country will have a great need of wireless operators, teleprinter operators, and technical personnel capable of caring for and repairing wireless and light electrical apparatus. During the Great War the needs of the Services for operators were largely met, especially during the early stages by the voluntary enlistment of trained Post Office operators, but as Morse is no longer used in the Post Office, this possible source of supply is rapidly dwindling. It is therefore imperative that all our readers who have at least a good working knowledge of Morse or have other qualifications such as ability to service and repair wireless and electrical apparatus, should apply to help fill the vacancies which now exist in the R.N.V.(W.)R., the Royal Corps of Signals, T.A., and the R.A.F.C.W.R.

Such applications will enable much valuable time to be saved and will facilitate volunteers being in their right position at the right moment if the necessity arises.

Readers who are not at present in a position to volunteer in the above-mentioned Services are asked to complete the Questionnaire which is reproduced below, and post it without delay. From the answers to this Questionnaire a register of wireless experts who are willing to serve their country should an emergency arise will be compiled in conjunction with the Wireless Telegraphy Board. This Register will be regarded as confidential and the information contained therein will only be made available to the Defence Services.

1. Name in full (in capitals)
2. Permanent address
3. Age
4. State whether British by
 - (1) Birth
 - (2) Naturalised
 - (If naturalised, state former nationality and date of naturalisation.)
5. Give particulars of any technical degrees or other recognised qualifications
6. In which of the following categories would you place your qualifications :—
 - (1) Research and design of wireless apparatus
 - (2) Servicing and tracing faults
 - (3) Construction of apparatus from blueprints and designs
 - (4) Wireless operating. State number of words per minute
 - (5) Teleprinter operating
7. Have you a sound knowledge of wireless theory and the ability to read circuit diagrams?
8. Have you had war experience, if so, give brief details
9. Are you already liable for service with any Force or Organisation? (If so, state particulars)
10. Have you any preference for service in either the Navy, Army or Air Force?
11. Are you physically fit?
12. Present occupation

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On His Majesty's Service

SECRETARY,

WIRELESS TELEGRAPHY BOARD,

c/o ADMIRALTY,

WHITEHALL,

S.W.1.

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