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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.

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EDITORIAL COMMENT

High-Fidelity Broadcasting

New Control Technique Needed?

TO criticise the quality of the B.B.C. ultra-short-wave broadcasts, for which we have so long pleaded in this journal, may seem ungracious, especially at this early stage. But we feel bound to express mild disappointment at the opening transmissions of the present experimental service; if, as we hope, this feature is to become permanent, its potentialities will be largely wasted unless it is conducted on the soundest possible basis.

It was not a little disconcerting during the first concert to find faults in the balance of the transmission of so serious a nature as almost to obscure the improved transient and high-frequency response of which ultra-short-wave broadcasting is capable. The balance may have been suitable enough for the long-distance land-line relays to those countries who were taking the Toscanini concert on that particular occasion, but the local listener had the impression that the overpowering bass was more than the violins could support—let alone penetrate.

At the second concert balance was very much better but there were one or two irritating lapses on the part of the control room which were quite unmistakable on account of the sensitivity of "high-fidelity" equipment to changes in microphone noise level.

Unworthy of USW

The point that emerges is that the routine balance and control methods, while good enough for medium- and long-wave broadcasting as received on ordinary standard sets, hardly suffice for transmissions of the quality obtainable in the television sound channel. A revision of control technique and perhaps a little more care generally will be needed if the new service becomes permanent.

But, if the potentialities of the ultra-short-wave service are to be realised to the full, is a mere revision of the normal broadcasting technique enough? We consider that it is not, and suggest that the service should be planned from the start to do the fullest justice to the most highly developed reproducing equipment. In particular, the volume range might be extended considerably, as there would be no need to bear in mind the users of standard 10-guinea sets with strictly limited outputs; in fact, the activities of the control section might be heavily curtailed on most kinds of transmission. Volume expansion (of which the complete success is at least problematical unless a complementary automatic compression system is in operation at the transmitter) would then become unnecessary even in receivers designed for the highest quality.

Independent Balance and Control

If this suggestion were adopted, it would, of course, no longer be possible to "tap off" modulation for the ultra-short-wave channel from the National switchboard. An entirely independent balance and control system would be necessary, but, in our view, the relatively slight extra cost would be well justified.

Be this as it may, it is unfortunate that some satisfactory solution was not found for the major problems of balance and control before the start of the experimental service, over which many critical musicians were sitting in judgment.

Stage Amplification

TO preserve the illusion of naturalness is perhaps the greatest difficulty in the use of amplifying equipment in the theatre; this and other problems peculiar to this specialised branch of sound reinforcement are discussed in the present article by a contributor who has had wide experience of the subject.

By ALEXANDER BLACK (*Alexander Black Ltd.*)

IN a recent Editorial in *The Wireless World*, the question of sound reinforcement in the theatre was discussed, and the prejudice of some theatre managements against the use of microphones in the footlights to help artists' voices was criticised.

There is no doubt that the early type of installation in theatres was unsatisfactory, due to the poor frequency response of the microphones then used, and the unsuitable, and in many cases unsightly, positions of the loud speakers. The result was that the dialogue was distorted and the audience was in many cases disconcerted by hearing the sound apparently coming from various parts of the auditorium instead of only from the direction of the stage. The unfortunate result is that some managers still cannot believe that there has been a great improvement in stage amplification in the last year or two. Further, many theatrical people are very conservative and staunchly maintain an attitude summed up in the words "We were able to do without microphones in the old days; why should we want them now?"

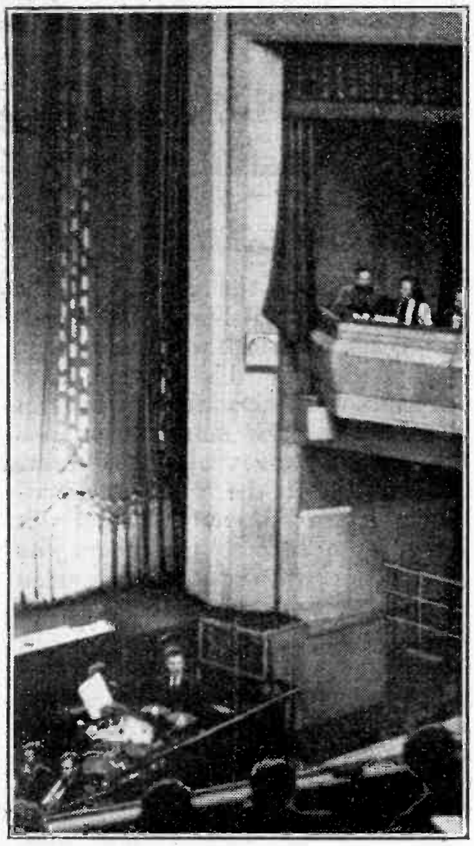
Since the coming of Talkies the public have found out that it is possible to hear easily in the cinema, even in the back seats, which certainly cannot be said of a number of theatres, and to make matters worse some actors and actresses, after a spell of film work, find that on returning to the theatre stage they are apt to forget to speak up, and so cannot be heard with any ease by the audience unless assisted by microphones in the footlights.

C. B. Cochran's Views

The writer was fortunate in being able to have a talk on the subject with Mr. C. B. Cochran during the rehearsals of his new show "Happy Returns" at the Adelphi Theatre, where extensive use is being made of microphones. Mr. Cochran considers that stage amplification should only be used where the lights and shades of the unassisted human voice cannot be heard distinctly in every part of the building.

He regards it as essential that the audience should be unaware that amplification is being used; such knowledge would tend to destroy the illusion of naturalness and put the stage on a level with the cinema as regards artificiality.

It is sometimes maintained that present-day actors and actresses are not training their voices to carry over the footlights, but Mr. Cochran thinks the need for amplification is largely due to the public becoming accustomed to the high level of sound intensity in cinemas. He holds that we in this country have something to learn from America, and cites the large Radio City Theatre, where "a whisper from the stage carries to any part of the house without any suggestion that amplification has been used."



One of the loud speakers at the Adelphi Theatre. A little retouching has been done on the photograph to make clearer the position of the instrument.

There are, of course, a number of smaller theatres with reasonably good acoustics in which stage amplification is quite unnecessary and one or two of medium size have excellent acoustics and really do not want any help from microphones to get a play across the footlights satisfactorily. In many of the larger theatres there seems to be a definite need for microphone assistance; some "dead spots" are almost certain to exist in the auditorium, though sometimes this trouble only affects a few isolated seats.

It is usually difficult to hear in back rows of the stalls under the circle; in some theatres the cut-off by the circle is very pronounced; similarly, the back rows of the dress circle are affected, especially if the headroom to the upper circle is low. The gallery in most cases hears quite well, the sound being reflected from the auditorium ceiling.

In eliminating these "dead spots" each theatre has its own problems. First, it is essential that the reinforced sound should only appear to come from the direction of the stage; secondly, the audience should not be conscious of the existence of loud speakers in the auditorium; thirdly, there must be no distortion of artists' voices.

Illusion of Naturalness

In order to satisfy the first condition, it is usually necessary to have a loud speaker on either side of the proscenium, and it is desirable to have further loud speakers working at a lower volume to cover the sides of the back stalls and circle. The volume has to be carefully adjusted to avoid them becoming obvious by being too loud.

To satisfy the second condition, the loud speakers must be concealed as much as possible, and this, of course, depends on the scheme of decoration in the auditorium; where there is ornate carving, etc., round the proscenium arch it is often possible to fix the speakers on baffles covered with gauze material the same colour as the paintwork, and it is quite surprising how the speakers seem to disappear into their surroundings. In others it is sometimes possible to let the loud speakers into the wood panelling surrounding the proscenium, This method as applied at the Adelphi Theatre in London is illustrated in an accompanying photograph.

To satisfy the third condition, it is essential that the microphones should be very sensitive, as they must be able to pick up artists' voices up to 25ft. away. The microphones should be small, so that they are unnoticed by both audience and artists.

The writer is in complete agreement with "Cathode Ray" in his interesting article on distortion, especially with regard to his remarks on straight-line frequency response. An amplifier for microphone work in the theatre having a frequency characteristic level from 20-10,000 cycles is often unsatisfactory; it must be remembered that in an average theatre full of people the upper frequencies are absorbed tunately, this has two objections; first, the difficulty of finding a suitable position where he is unnoticed by the audience, and, secondly, if there are off-stage effects to be worked as well during the show, the

—SOUND REINFORCEMENT IN THE THEATRE

far more than the lower and middle ones, and it is therefore up to the amplifier to level things out by emphasising the higher frequencies. Each theatre must have its overall characteristic curve of its amplifying and reproducing equipment adjusted to suit the auditorium acoustics. The type and positioning of loud speakers has also to be taken into consideration when planning an installation.

Usually it is necessary to arrange for a rising curve at the higher frequencies, starting at about 5 to 7,000 cycles; at times it is even advisable to attenuate the bass. Peaks in the characteristic curve must be avoided at all costs, as their presence causes stage amplifying equipment to howl back before any useful amplification can take place. In the opinion of the writer small ribbon velocity microphones are by far the best type for this purpose. Although their response is not absolutely linear, this can easily be corrected in the amplifier. If properly designed, they are devoid of peaks and can be made very sensitive. The amplifier should also be absolutely free from hum, which in the case of most London theatres is a problem as the electric supply is D.C., and thus the use of a rotary converter is involved.

The Prompt Corner at the Adelphi. One of the stage microphones can be seen near the footlights. The volume level of any of the loud speakers used in the theatre can be regulated from this point.

In the Brasserie at the Coventry Street Corner House. One of the ceiling speakers with a deflector to facilitate the downward diffusion of sound is seen.

As can be seen from the picture of the Prompt Corner at the Adelphi Theatre there are a great many cables for the lighting system and wires galore for cue lights and buzzers; the majority of these are not metal-sheathed and, in consequence, great care has to be taken in running microphone lines. Insulated shielded cable has to be installed, especially if ribbon velocity microphones are being used, in order to avoid DC ripple being picked up by induction from the mains. The DC-AC converter for the amplifier has to be put out of the way, usually under the stage, as there is often a considerable external field from these machines. When the theatre supply is AC, conditions are much easier, thanks to the absence of a converter and other DC motors, although insulated shielded microphone cable is still advisable for ribbon microphones. Footlight microphones have to be mounted on a very flexible, shock-absorbing suspension in order to avoid picking up the vibrations on the stage caused by walking and dancing. The picture shows a special type of horizontal ribbon microphone and its suspension used at the Adelphi Theatre.

To get the best results from stage amplification, it must be controlled intelligently; the correct volume for each turn or scene must be found during rehearsal. It is probably not realised that quite wide variations of volume setting are required for the same artist but with different stage sets; as an instance, in the new Adelphi show there are approximately 60 cues for change of volume on the footlight microphones. The best position for the operator is obviously in the auditorium, either at the back of the stalls or dress circle, so that he can have a direct indication of results. Unfortunately, this has two objections; first, the difficulty of finding a suitable position where he is unnoticed by the audience, and, secondly, if there are off-stage effects to be worked as well during the show, the operator is out of touch with the stage manager, and so difficulties in working may arise. In a few theatres the operator is stationed with the orchestra; this, in the opinion of the writer, is definitely wrong, as he is too near the stage to hear if his speakers are working. In any case, he is deafened by the orchestra, and is still out of touch with the stage manager for off-stage effects. The best place on the whole is in the Prompt Corner, as then he can check stage amplification with headphones, and he is in immediate touch with the stage manager for off-stage effects. (The writer hopes to deal with amplifying equipment for stage effects in a further article.)

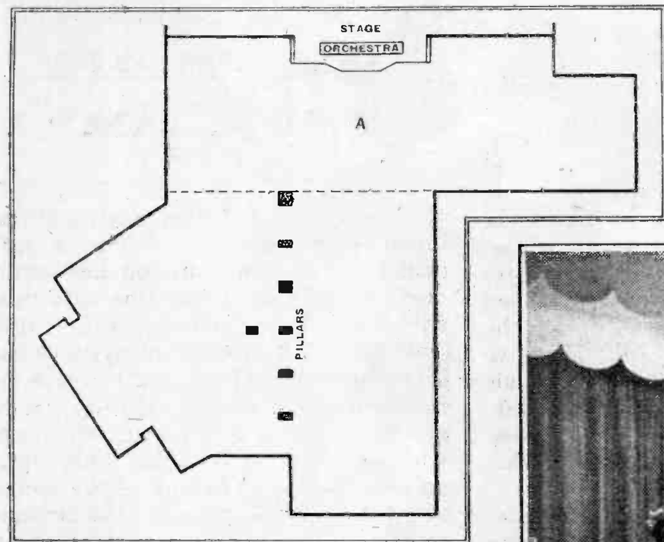
Downward Diffusion

An interesting installation of stage amplification has recently been carried out at a theatre in Blackpool, where, in addition to the usual two proscenium speakers, thirteen smaller speakers have been distributed throughout the auditorium. Some of these speakers are mounted vertically in mushroom-shaped baffles, which are fitted below the speakers and above the audience; it was found that this plan gave very good diffusion of sound, which apparently came from the stage. This type of installation may also be seen at Lyons' Coventry Street Brasserie.

The advantages of downward diffusion of sound, as shown in the photo of the Brasserie, is that, providing there is some form of deflector between a speaker in the ceiling and someone standing beneath it, it is not possible for him to detect the origin of the sound, as it appears to come

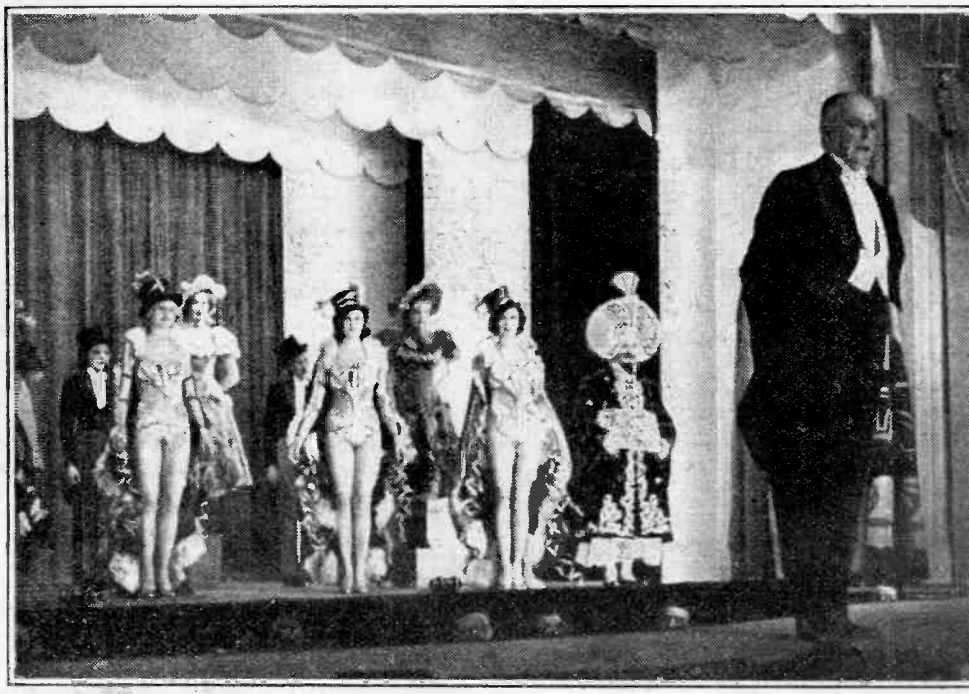
Stage Amplification—

from all directions. In the above cases the illusion of direction is given by the original sound waves coming from the stage, and in the case of the theatre this is helped by the proscenium speakers.



The layout of the Trocadero Grill Room can be gathered from the sketch, the position of the stage, seen below, is also indicated.

The Trocadero Grill Room, in which Mr. Cochran presents an elaborate suppertime cabaret every night, is a place which presented many unusual problems. The sketch plan indicates its awkward shape; the section A is quite lofty, but the rest of the room has a fairly low ceiling. Without amplification, only the audience in the centre of section A could hear comfortably; the rest could only see the show. It was necessary that all the loud speakers should be concealed, but unfortunately, the most suitable positions artistically were not necessarily the best positions acoustically. However, of the thirteen loud speakers installed, only one is in any way noticeable. A further difficulty was the orchestra pit, which in a sense is in the middle of the stage; to pick up songs and dialogues five microphones are used, only one of which is really noticeable, being suspended over the centre of the runway.



The microphones on the stage in the Grill Room are concealed as far as possible, one suspended microphone can be seen just in front of Mr. C. B. Cochran, who is standing on the runaway in front of the orchestra pit. Two footlight microphones are also just visible. The violinists and 'cellist are seen to the left wearing lapel microphones.

Another problem was that the orchestra was rather trapped in the pit, and the string instruments were hardly heard, so the expedient was tried of giving two violins and the 'cellist small lapel microphones for picking up their instruments, and a microphone in the piano for helping the rhythm. This made a big improvement in getting the melody over satisfactorily. Each group of microphones is controlled separately, so that a good balance is obtainable. This idea was first used in America, and certainly offers scope for further experiments in large halls or even in small ones which happen to have bad acoustics.

In conclusion, the writer wishes to express his thanks to Mr. C. B. Cochran and Messrs. J. Lyons and Company for help given to him in the preparation and illustration of this article.

Emergency Broadcast Calls

In a national emergency the broadcast service offers a direct and convenient channel for the distribution of authoritative news and for issuing official instructions to the nation at large. In addition, it might prove useful, on occasions, for sending out special warnings to any particular locality.

This presents no difficulty, provided listeners were "on the alert," so to speak, for special announcements of the sort, though it would not be so easy to ensure that an emergency call would be heard by all those concerned if it came suddenly and unexpectedly. Some sets would be out of use at the time, whilst others might be tuned to different stations, and so would miss any broadcast appeal.

The situation could, of course, be met if each house was fitted with a separate "stand-by" receiver—which might be a simple crystal set—coupled to its own aerial and arranged to sound an automatic buzzer alarm in response to a special "call" signal sent out on a fixed frequency. Something of the sort is, in fact, used to allow Headquarters to attract the attention of police patrol cars wherever they may be.

Apart altogether from emergency requirements, the idea of fitting up a separate and inexpensive "calling device" has recently been put forward in America as a means of attracting listeners' attention to the fact that some specially "red-hot" news is about to be transmitted.

The "news call" is given by a single-valve unit which is fed by a separate aerial and tuned to a fixed frequency outside the normal broadcast range. On receipt of a special call signal it sounds a buzzer alarm to attract the listener's attention. It can be left on "stand-by" duty alone, or coupled in parallel with the receiver proper so that it can make its "call" and interrupt any programme that is being received, or it can be switched right out of action if the programme is too good to be interrupted, even for red-hot news.

The Acoustic Labyrinth

HOW IT IMPROVES LOUD-SPEAKER PERFORMANCE

By LAWRENCE G. SNELL

THE author shows the advantages of the acoustic labyrinth over the conventional baffle or cabinet as a mounting for a loud speaker. He also describes the construction of a labyrinth that is well within the capabilities of the amateur handyman.

ONE of the most formidable problems to be overcome in the quest of high-quality reproduction has always been that of providing the loud speaker with a satisfactory baffle. The principal shortcomings of the average receiver cabinet as a baffle may be classified under three headings:— First, excessive "box resonance"; secondly, poor baffle effect; and thirdly, insufficient loading of the speaker diaphragm.

All these shortcomings particularly affect the low-frequency response. The first is due to the major resonance of the air column contained within the cabinet, and gives rise to the only too familiar "booming" effect, especially noticeable in the large deep cabinets in which most radiograms are housed. This resonance is usually of the order of 50-100 cycles, and is often supplemented by the natural resonance of the speaker diaphragm. The second fault particularly applies to small cabinets, and results in a pronounced falling-off of the bass response due to interference effects from the rear surface of the diaphragm. Thirdly, the question of loading and damping. It is quite obvious that the effective load on a diaphragm vibrating in free air must be small, and it is therefore necessary for it to vibrate with considerable amplitude to radiate the requisite amount of acoustic energy. This introduces difficulties. It is by no means simple or inexpensive to design a diaphragm suspension which presents a substantially constant restoring force at large amplitudes. The same may usually be said of the field system, which is likewise only uniform over a limited displacement. Therefore, large, undamped vibrations of the system will give rise to amplitude distortion, again particularly noticeable at low frequencies.

From the foregoing observations it should be clear that adequate loading of the diaphragm is of primary importance. Another result of insufficient damping is that at the natural resonance of the diaphragm itself the coil impedance is subject to wide variations—another source of distortion, especially with pentode-type output valves. The ideal "infinite" baffle would, of course, answer objections one and two, but would do nothing to improve the third. I need hardly enlarge on the effect of damping on transients.

In considering how the "acoustic labyrinth" helps to solve the foregoing problems it will be helpful to examine the effect of coupling a loud speaker to the end of a long tube, open at its other end and having non-absorbent walls. This is really analogous to a transmission line terminated in a fixed resistance, the latter being equivalent to the free end of the tube. The theoretical variation of resistance presented to the diaphragm with wavelength is shown plotted in Fig. 1, from which it will be seen that a pronounced peak occurs whenever the length of the tube equals an odd quarter-wavelength of the applied sound, i.e., at $\frac{1}{4}\lambda$, $\frac{3}{4}\lambda$, etc. At the minimum points, which occur every half-wavelength, the resistance presented to the diaphragm is merely that of the open end of the tube. Furthermore, at every odd half-wavelength the phase at the open end is opposite to that of the diaphragm, and reinforces that from the front surfaces of it. Reference to Fig. 2 should make this clear.

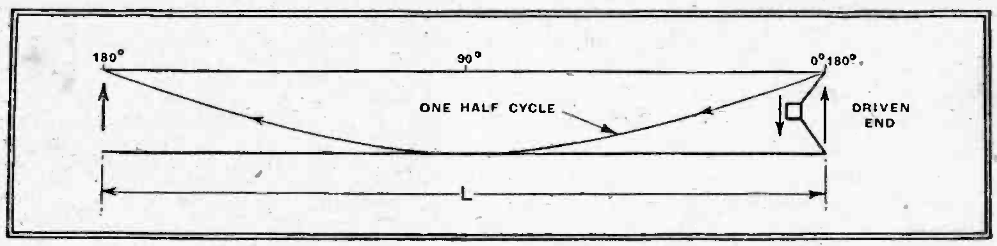


Fig. 2.—Diagram showing phase displacement of transverse wave in a tube when the length L equals half a wavelength. Vertical arrows show relative direction of motion of air particles. Wavelength (in feet) $= \frac{1{,}100 \text{ (velocity of sound)}}{\text{frequency in c/s}}$.

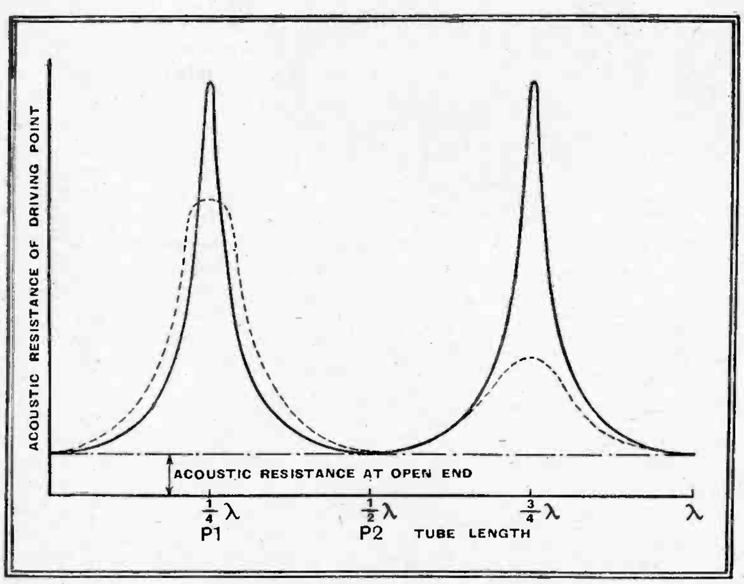


Fig. 1.—Variation of acoustic resistance of a tube, open at one end and with a loud speaker coupled to the other end. The full curve relates to an unlined tube and the dotted curve to a lined tube. λ = wavelength of applied sound.

If matters could be arranged so that the resistance peak at $\frac{1}{4}\lambda$ (P1), would fall at the natural resonance of the speaker, thereby damping it; and so that the phase-reversal point P2 builds up the bass response at that point, we should have partly overcome the defects of the orthodox baffle. This arrangement would, however, be subject to one serious defect in that these effects repeat and at higher frequencies pronounced irregularities in the response would result. It is well known that the effect of most sound-absorbent materials increases rapidly with frequency, so that by lining our tube with such material we can suppress the unwanted higher frequency resonances, and also reduce the sharpness of the peak at P1, a very desirable feature. Thus at higher frequencies the reproducer behaves as a single sound source—in effect, an infinite baffle. To sum up, the lined tube gives adequate loading at low frequencies, especially in the region of the diaphragm resonance; bass boost by phase reversal; and "infinite baffle" effect in the upper registers.

A practical labyrinth constructed by the

The Acoustic Labyrinth—

author employed a B.T.-H. 10in. speaker of early pattern, and measured approximately 2ft. 6in. by 2ft. 6in. by 1ft. overall. The natural resonance of this speaker was found to be in the neighbourhood of 40 cycles, and a simple calculation gave the wavelength equivalent to this frequency as approximately 28ft. The length of tube required was therefore 7ft. The tube was formed within the cabinet by inserting three "baffle" plates horizontally across it as shown in Fig. 3. These were held in position by fillets of inch square-section wood. Both cabinet and divisions were constructed of $\frac{3}{8}$in. plywood, a material which possesses a remarkable degree of mechanical rigidity and can, moreover, be obtained with several sorts of surface veneers. The speaker was mounted in the upper left-hand corner of the cabinet on a sub-baffle slightly spaced from the end face, in which is a 10in. square aperture concealed by an ornamental fret. The sound-absorbent material, consisting of hair felt about $\frac{3}{8}$in. thick, was loosely tacked to the inside surfaces with short wire nails, three thicknesses being employed in each section except the lowermost. The hair felt is in the form of large rectangular sheets, and it was found most economical to cut strips exactly the width of the inside of the cabinet, and to fold these around divisions and the top, sides and bottom, tacking it down as loosely as possible. After this operation all that remain are the detachable back and three small rectangles. The back of the box, fitted last, was similarly covered with three layers of the felt; and, when screwed on, produced a completely lined conduit, with the loud speaker at its upper end, and terminating in a small aperture in the bottom left-hand corner.

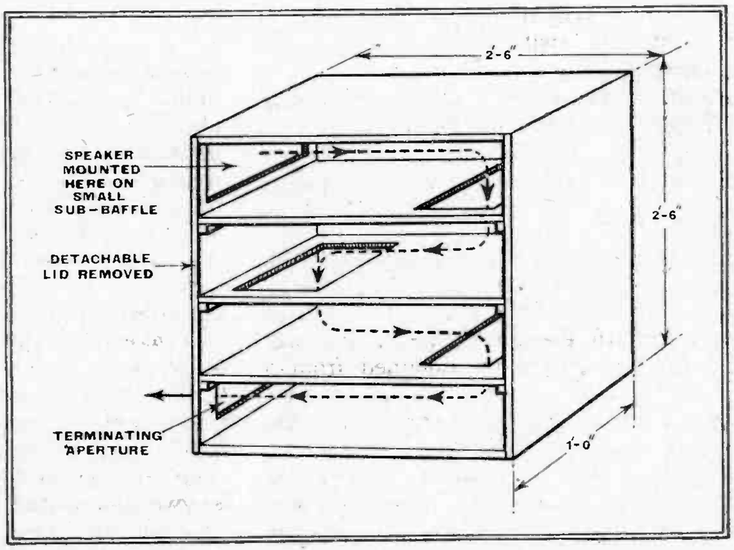


Fig. 3.—Constructional details of the labyrinth described in the text, with one side removed to show interior. All interior surfaces are lined.

Permissible Modifications

Many variations of this construction will, no doubt, suggest themselves, it being of small consequence what form the tube takes, provided that the correct length be employed and the loud speaker closely coupled to it. With smaller speakers, the natural diaphragm resonance will in all probability be higher, thus necessitating a shorter labyrinth, though naturally with a diminished bass range.

When considering the inclusion of a labyrinth in a complete receiver it should be remembered that the shape of the cabinet is not of first importance from the acoustic point of view, provided that it will contain the labyrinth, and also that the arrangement is unaffected by the proximity of a wall as are most cabinet speakers.

In the case of the writer's labyrinth, a high-quality amplifier was available for driving it. This amplifier had an undistorted output of well over 8 watts, and had an excellent transient response, being resistance-coupled throughout. Field excitation for the speaker was provided from the amplifier power unit. One of the first things to be noticed on test was a decidedly unpleasant 50-cycle hum, which was obviously due to the very considerable response in that region. This was certainly an anticipation of what to expect in the way of bass response, and was only removed by the addition of another stage of smoothing to the early stages of the amplifier, a measure not previously necessary.

Listening tests soon showed a very marked improvement. The absence of the usual "boom" from cavity resonance gave rise to a vastly more natural reproduction, especially on speech, and it was obvious that the degree of coloration due to spurious peaks and harmonics was of a very low order. It was also noticed that even with very considerable power the amplitude of the speaker diaphragm was quite small, demonstrating the adequacy of the loading, and, no doubt, accounting for the entire absence of any "cross-modulation" between the treble and bass registers. The extent of the bass response was highly satisfactory, the string tone of the orchestral basses being very realistic and the smooth, even reproduction of organ pedal registers was quite exceptional. The upper frequency response, that is, over 4,000 cycles, was, as might be expected, limited by the characteristics of the speaker, but the expected improvement in transient response was amply borne out in practice. The outfit handled up to 6 watts without showing signs of distress, somewhere about double its output with an ordinary baffle.

PYE ALL-WAVE AERIAL

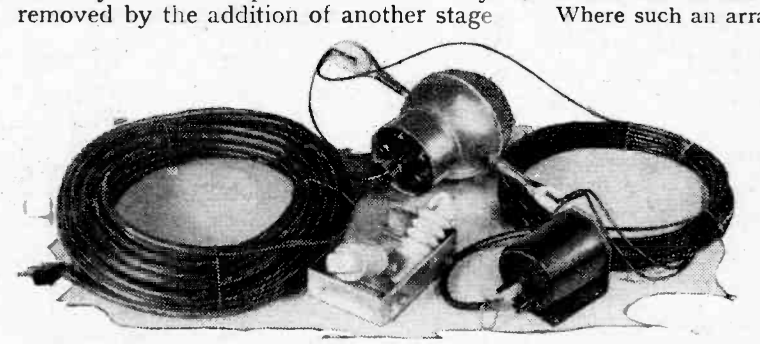
THE Pye "Double-3" All-Wave Anti-Static Aerial kit comprises 60ft. of screened transmission cable, aerial and receiver transformers, and aerial wire in addition to insulators and fixing brackets.

The transformers are of the iron-core type and the receiver transformer has a centre-tapped primary and an electrostatic screen between primary and secondary. This not only prevents the transference of interference to the receiver by capacity in the transformer, but makes it possible to operate the cable in a properly balanced condition so that its effective pick-up of interference is at a minimum. The transformers cover the wide range of 7-2,000 metres without switching.

The aerial wire is insulated and has seven copper and two steel strands, the latter being included to give greater strength and reduce stretching. The wire may be erected in various ways according to individual circumstances.

If a suitable tree or pole is available an inverted-L aerial should be used with the down-lead at the end remote from the house. The total length of the horizontal span and the down-lead should be 60 feet, and the aerial transformer fitted just above ground level. The cable connection to the receiver can be buried if desired.

Where such an arrangement is inconvenient, a T-Dipole can be used. This consists of two horizontal stretches of 20-30ft. each, with the aerial transformer mounted between them. The down-lead from the transformer then consists of the screened transmission cable.



The Pye All-Wave Anti-Static Aerial Kit.

A similar arrangement known as the "All-Dipole" can be adopted when interference is very bad. The difference, however, is that the aerial must no longer be horizontal, but inclined at an angle. The connections to the aerial transformer are also different.

With the inverted-L and the All-Dipole arrangements, these systems are operative on all wavebands, but with the T-Dipole the system functions as a T-aerial on medium and long wavebands and as a dipole on short.

The aerial is available from Pye, Ltd., Radio Works, Cambridge, and is priced at £2 2s. 6d.

The Home Laboratory

A PRACTICAL design is given in this instalment for a dynatron test oscillator with AOC and provision for modulation at various frequencies ranging from 50 to 10,000 c/s. Some of the uses of the oscillator in conjunction with cathode-ray gear are discussed.

Part VI.—DESIGN OF SIGNAL SOURCES

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

IN the last article it was explained why a valve oscillator in its simplest form is unsuitable as the basis of a laboratory signal source—the waveform, amplitude, and frequency calibration are at the mercy of circuit conditions that are liable to vary, particularly if the apparatus is to provide more than one frequency. On the other hand, the dynatron oscillator with automatic oscillation control offers a number of important advantages, including constant amplitude and good waveform without any special adjustment during use.

Four years ago* the present writer gave information for making a dynatron oscillator giving a selection of separate frequencies between 50 and 10,000 c/s. Since then he has had occasion to construct another similar oscillator, improving on the old design by incorporating AOC. Fig. 1 shows the complete circuit. Details are given of the components in case it is desired to follow this design exactly; but there is no special significance in the specified values of smoothing condensers—they happened to be available in a standard block.

It may be as well to repeat the warning that a high-resistance potential-divider for supplying the anode is useless, owing to the negative resistance characteristics of the dynatron.

Safety Precautions

As there is no transformer winding for supplying anode volts the circuit is in direct connection with the mains, and the precautions that usually apply to DC mains apparatus should be adopted to prevent contact with any part of the circuit other than the secondary of the output transformer. The design can easily be modified by using a mains transformer with HT winding, and perhaps a larger output stage. The output of the oscillator as specified is about 150 milliwatts; and the output transformer should be selected to suit the work in view—a multi-ratio type is very useful. If particular frequencies are required with any exactitude it may be necessary to play about with a number of condensers of the same nominal capacities, or to supplement them with padding condensers.

The approximate frequencies given in the different switch positions with the components specified are:—

Switch Position	Frequency C/S	Switch Position	Frequency C/S
1	50	6	1,000
2	70	7	3,000
3	115	8	4,500
4	250	9	7,000
5	450	10	10,000

As the switches are ganged it is possible to mark the frequencies on the scale traversed by the control knob. In order to avoid an excessive number of coils, several frequencies are obtained from a single tapping, and the L/C ratio changes very considerably from one position of the switch to another.

Without AOC it would be necessary to adjust by hand in order to avoid excessive harmonics and variations in output.

The circuit is arranged so that a voltage of 100 is applied to the screen of the AC/S2 (dynatron) valve, and 50 to the anode. Without AOC the tendency would be for oscillation, once started, to reach a peak amplitude of at least 40. The initial grid bias supplied to the AC/S2 is about −2 volts; little enough to allow oscillation with the LC circuit of lowest dynamic resistance, and too little to avoid over-oscillation and consequent distortion at most of the frequency-switch positions. A greater bias, totalling 17 volts, is applied to the V914 diode, delaying rectification until the peak oscillation voltage exceeds that amount. Any extra is rectified and applied as additional bias to the AC/S2, until equilibrium is established, which is generally when the oscillation is about 19 volts peak. There is, therefore, no probability of it reaching anywhere near the bends of the dynatron characteristic slope, and distortion is very slight, what there is being due almost entirely to the V914 control valve (and, at the lowest frequencies, to the iron-cored coil). The coils, incidentally, are

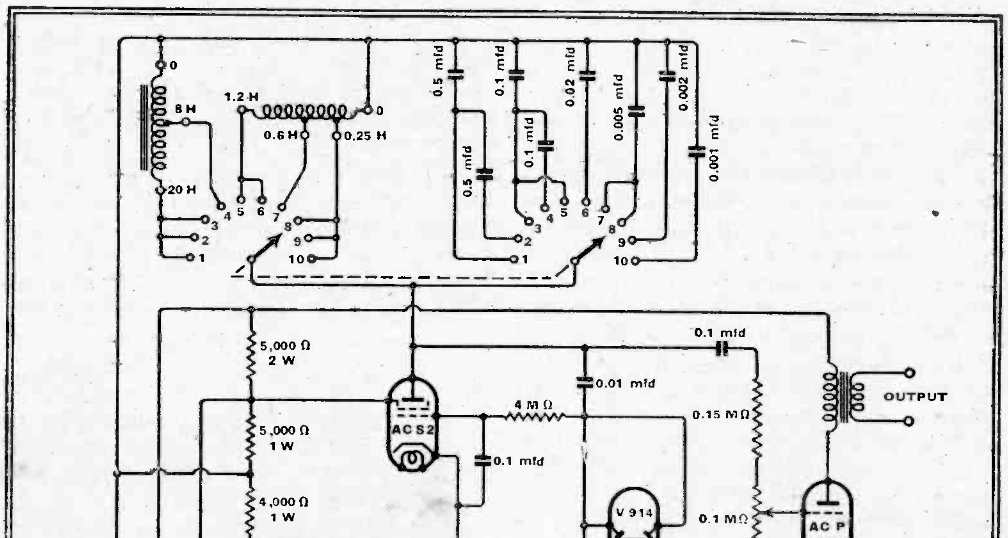


Fig. 1.—Complete circuit diagram of one form of controlled dynatron audio-frequency oscillator. The rectifier is a Westinghouse Type HT15.

With AOC and no manual adjustment the waveform is very good, and the maximum variations in amplitude are within 0.5 db.

* The Wireless World, July 20th, 1934.

The Home Laboratory—

the same as those used in the earlier oscillator, and are made by Wright and Weaire, from whom the smoothing choke also can be obtained. To minimise rectifier distortion, the leak and filter resistances are as high as 4 megohms.

As it is undesirable to draw power radio-frequency oscillators, of course; and, as explained last time, another valuable advantage is the ability to modulate it up to 100 per cent. with negligible distortion and negligible power from the modulating source, which may itself conveniently be another AOC dynatron.

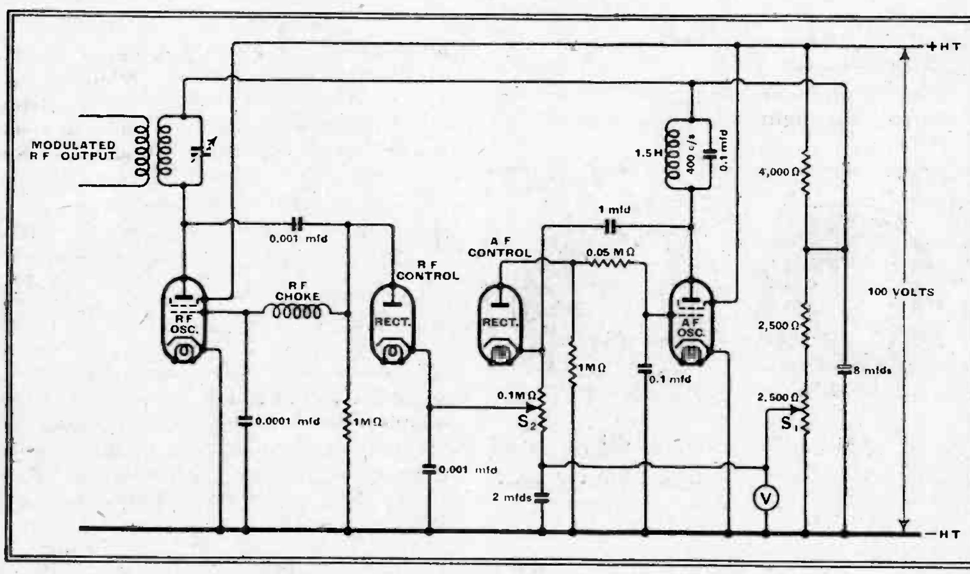


Fig. 2.—Circuit of two controlled dynatron oscillators, one modulating the other. Amplitude and modulation depth can be conveniently adjusted.

direct from the oscillatory circuit, a buffer or output valve is used. An AC/P valve with 175 volts on the anode would be overloaded by the full signal of 19 volts or so, and is tapped down as shown. It is useful if the potentiometer controlling the output is calibrated in decibels, as this enables measurements of amplification to be carried out very quickly and easily, using merely some sort of indicator to keep at constant level the output from the amplifier being tested.

An oscillator of this sort can be used for taking frequency characteristic curves of transformers, amplifiers, tone control circuits, etc.; for cathode-ray tests; for bridge measurements; and other purposes. It is a straightforward and stable piece of equipment, and the only serious disadvantage is that it cannot easily be made to cover the whole band of frequencies continuously. To do this conveniently it is necessary to adopt the heterodyne (or beat-frequency) principle.

Shortcomings

Now although the beat-frequency oscillator is very simple in principle (being employed unwittingly by owners of the cheapest sorts of receiving sets when they make them oscillate on a station), it is a very difficult job of design when required as a signal source. The Sullivan beat-frequency oscillator, for example, costs £250. The defects of the cheap sorts are chiefly a drifting frequency calibration; poor waveform, especially at low frequencies; output varying with frequency; radio-frequency leakage; and spurious whistles. It is too big a subject to be dealt with in part of one article.

The AOC dynatron can be used for

There are all sorts of possible arrangements, according to what is required. Fig. 2 is a suggestion. It shows two dynatron oscillators, one for radio-frequency and the other for the modulation frequency; both are amplitude-controlled. The slider S1 adjusts RF and AF amplitudes simultaneously by biasing the cathodes of both control rectifiers. The percentage modulation is, therefore, unaffected by this adjustment, and either its knob, or the DC voltmeter V, may be calibrated to read amplitude.

With the slider S2 in its lowest position the bias applied to the RF control valve is steady, and so the RF amplitude is also steady. But if the slider is moved up, an audio-frequency alternating voltage is superimposed on the steady bias, and the RF amplitude similarly alternates, or in other words is modulated. When S2 reaches the top position the alternating bias equals the steady bias, and the modulation is 100 per cent. The control S2 can, therefore, be calibrated in modulation depth.

Actually the voltages do not work out quite so simply as this, and some allowance, found by trial, is necessary for the initial biases required by the dynatrons before control becomes effective, and for the imperfection of the rectifier; but the principle holds good. By making the normal amplitude fairly large, the initial bias variations are relatively small, and the system conforms approximately to the simplified description just given.

Component values are marked, to give some idea of suitable magnitudes; but they depend to some extent on the frequencies to be covered. And to prevent the external circuit from affecting the radio frequency, an output valve (not shown) is needed, as in Fig. 1; unless, of course, the oscillation is picked up by radiation or *very* loose coupling.

A system along the above lines can be made the nucleus of a signal source for testing receivers, RF stages, and detector stages, particularly where substantially distortionless modulation of variable depth is required. In conjunction with a cathode-ray tube some very searching tests can be carried out. With regard to that, it may be of interest at this point to refer to the most generally useful of several cathode-ray tube methods of testing modulation depth and distortion. It is very simple. The modulating signal is connected across one pair of plates, and the modulated signal across the other.

Testing Power Handling Capacity

For example, suppose one wants to test a final IF amplifier stage for its ability to handle a large output without distorting the modulation. The stage is represented in Fig. 3 by the valve V and IF transformer T. The resistance shown connected across the secondary is the detector load. With the usual arrangement, in which the transformer coil and diode detector are in series, the circuit shown is obtained by earthing the anode of the detector. The deflector plate R is shown connected across part of the resistance, as it may be necessary to do so to prevent the deflection from running beyond the screen.

But first the oscillator should be tested, if that has not already been done. The horizontal deflector plates, being connected to the modulating signal (e.g., across S2 in Fig. 2), draw a horizontal line across the screen when no signal is

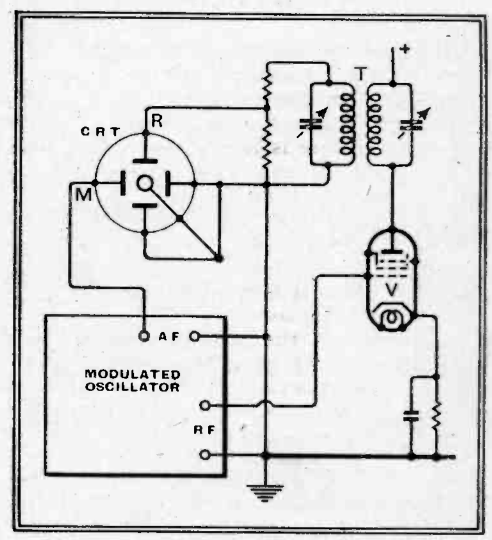


Fig. 3.—Use of cathode-ray tube in testing modulation depth and freedom from distortion of the modulated signal. It is shown connected for testing a stage of IF or RF amplification.

applied to the vertical plates. But if the plate R is connected to the modulated output, a parallel-sided figure appears, such as those shown in Fig. 4. When the sloping sides are straight lines, as in Fig. 4 (*a*), modulation is undistorted.

The Home Laboratory—

It is important to understand that "undistorted modulation" is not intended to imply that the modulating signal is a pure sine wave, but only that the modulation process does not distort the modulating signal, whatever waveform it may have.

The percentage depth of modulation is given by $\frac{100\ (A-B)}{(A+B)}$. Fig. 4 (b) is an example of distorted modulation; and an appearance such as (c) indicates over-modulation. With perfect 100 per cent. modulation the figure is an isosceles triangle. A phase shift is shown by the sloping sides opening out into double lines.

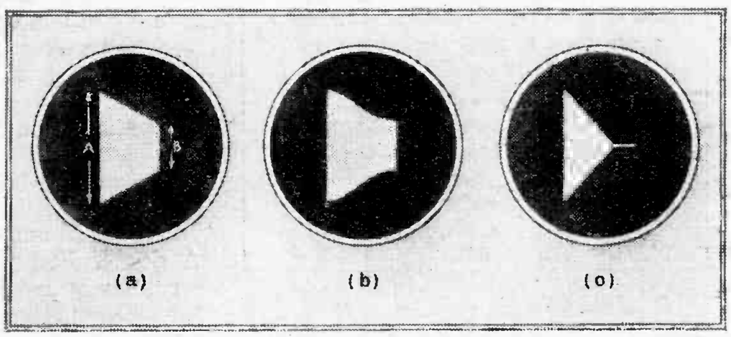


Fig. 4.—Typical example of modulation figures on the cathode-ray screen. (a) is modulation without distortion; (b) with distortion; and (c) shows over-modulation.

Having made sure that the modulation of the oscillator is satisfactory over the full range of adjustment, one can transfer the plate R to the output of the amplifier under test, the output of the oscillator being suitably reduced. If the signal across the primary of the IF transformer were required to be examined, the plate R would be connected to the anode of the valve V through a condenser of about 0.0001 mfd., and also to the anode of the cathode-ray tube through a leak of about 2 megohms. The amplitude of output at which distortion sets in, and any change in the depth of modulation, can be detected by means of the methods under discussion.

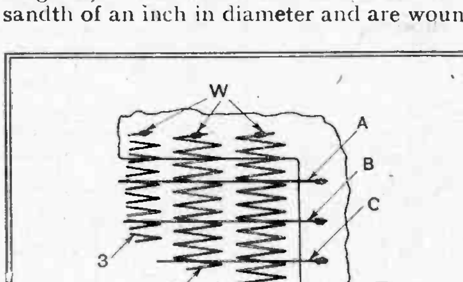
Further tests can be made with the signal- and/or AVC-diodes in operation, the cathode-ray plates being connected across the corresponding load resistances. The effects of delay voltage, distortion due to AC load being materially lower than DC load, and leakage of IF into AF circuits, can all be traced. When the deflector plates are across the AF volume control, the figure disappears except for one of the sloping sides, if IF has been all filtered away. If not, a figure of appreciable area remains. Absence of distortion at this or any subsequent point is, of course, indicated by straightness of the line. But the most favourable condition for showing up distortion is when, by adjustment of signal amplitudes at the deflector plates, the line is at an angle of 45°. A great disparity between vertical and horizontal amplitudes is useless for distortion testing.

Television Images for Projection

SPECIAL screens have been used to reproduce a televised picture by incandescent instead of fluorescent light. In the so-called projection tube, for instance, an intensely brilliant picture is formed by bombarding a small metal screen only a few microns thick, the incandescent image then being projected through a magnifying lens on to a large viewing screen. By contrast any fluorescent material has a definite limit of brightness beyond which it is impossible to go without risk of burning out the screen.

In practice the incandescent screen is usually made of very thin tantalum, tungsten or molybdenum, and is initially heated to a temperature just below the glow point by current from a local battery. The bombardment of the screen by the electron stream from the gun of a cathode-ray tube is then sufficient to create the details of the picture in varying degrees of incandescence, ranging from red to white heat. The thinness of the metal ensures rapid cooling and prevents undue persistence of the glowing points. Trial has also been made of a screen of very thin wire, 0.001in. in diameter, woven into a mesh of, say, 200 to the inch. This is found to improve the cooling effect without sacrificing any detail of the picture formed on the mesh as a whole.

As a further advance (Patent No. 479318) a screen capable of reproducing an incandescent picture of high light-intensity is built up of a number of coils 1, 2, 3 of thin tungsten wire, each separately spot-welded at W to a supporting frame (see accompanying diagram). The wires are less than a thousandth of an inch in diameter and are wound



Coiled wire elements are employed to reduce thermal lag in the incandescent screen described in Patent No. 479318.

1,200 turns to the inch. They are supported and kept in one plane by a series of cross-wires A, B, C, also spot-welded to the frame.

This screen construction permits of a certain amount of expansion and contraction under the heat of bombardment, without creating any noticeable distortion of the picture. In order to reduce the scanning voltages required, the screen is initially raised to a temperature just below the glow-point, either by feeding current to it from a local battery, or by heating its surface with infra-red rays. Or the screen may be sprayed uniformly, for the same purpose, by electrons coming from a separate gun to that which supplies the modulated scanning stream.

Photoelectric Cell Applications. Third edition. By R. C. Walker, B.Sc. (Lond.), and T. M. C. Lance, Assoc. I.R.E. Pp. 336+x., and 200 illustrations. Sir Isaac Pitman and Sons, Ltd., 39, Parker Street, London, W.C.2. Price 12s. 6d.

IN this third edition of a very acceptable book the rapid expansion of the subject is reflected in an increase by about 40 per cent. in the number of pages and illustrations (and price) compared with the previous edition reviewed in 1935.

Although the applications and even the existence of photoelectric cells are still almost unknown to the general public, it is not too much to say that nobody with a practical interest in any branch of industry or science can any longer afford such ignorance. The variety and ingenuity of photocell applications is quite astonishing, and so is the simplicity of some of the arrangements by which such a refined product of research is made to serve under unskilled supervision.

The volume under review gives only such theory as is necessary for understanding the use of cells. The applications described are interesting not only for their own sake but for suggesting how readers' own problems may possibly be solved. Enough information on circuit values and on practical limitations and difficulties is given to enable the reader to devise many sorts of apparatus for himself or to get the best results from any in his charge.

After an extensive chapter on general methods of use, the authors deal separately with counting, timing and mechanical handling devices; alarms, indicators and safety devices; advertising; sound reproduction; phototelegraphy; television; scientific instruments; and miscellaneous applications. Photo-cells are made to serve even such purposes as ensuring that cigarettes are all packed in boxes with their trade-marks facing upwards.

The briefest chapter but one is on television, and most of that is devoted to Baird systems, Marconi-E.M.I. not being specifically mentioned. The iconoscope is dismissed in a page and a half, and the super-iconoscope omitted entirely. The latter should certainly be brought into the next edition, but it is no doubt wise to devote most attention to those applications on which little information is available rather than television, which is comparatively well known.

The treatment is on the whole very clear, but the term "sparking voltage" at the foot of page 14 does not appear to be defined, and the authors should note that "preventative" is not recognised by any dictionary. The practice of dividing decibel scales in steps of 3, described as general, is one that the reviewer has not met hitherto, nor does he see why plotting response curves on a logarithmic base of frequency should necessarily make the performance of the apparatus appear very much worse than an aural test (page 187). M. G. S.

Peto Scott

DP COMMUNICATION RECEIVER

A Dual-Purpose Superheterodyne for Broadcast and Morse Reception

FEATURES. ***Waveranges.***—*(1) 10-25 metres. (2) 22-65 metres. (3) 200-550 metres. (4) 800-2,000 metres.* ***Circuit.***—*Var.-mu pentode RF amplifier—triode-hexode frequency changer—var.-mu pentode IF amplifier—triode beat oscillator—double diode pentode 2nd det., AVC and output valve. Full-wave valve rectifier.* ***Controls.***—*(1) Tuning. (2) Waverange. (3) AF volume control and on-off switch. (4) RF gain and HT switch. (5) Tone. (6) AVC and beat oscillator switch.* ***Price.***—*11½ guineas.* ***Makers.***—*Peto Scott Co., Ltd., 77, City Road, London, E.C.1.*

THERE are many technical features in this receiver which will appeal to the short-wave receiving and transmitting amateur, but scope of the set is not confined strictly to his rather special requirements. Long waves up to 2,000 metres can be received as well as the usual medium-wave broadcast band, and the quality of reproduction is much better than is necessary for amateur experiments in communication.

The coloured tuning scale is indirectly illuminated and is of the conventional "all-wave" type with a few wavelength calibrations, but plenty of station names. There is no auxiliary band spread dial, and the amateur bands are indicated by short dashes similar to those showing the limits of the broadcast bands on the two short-wave ranges.

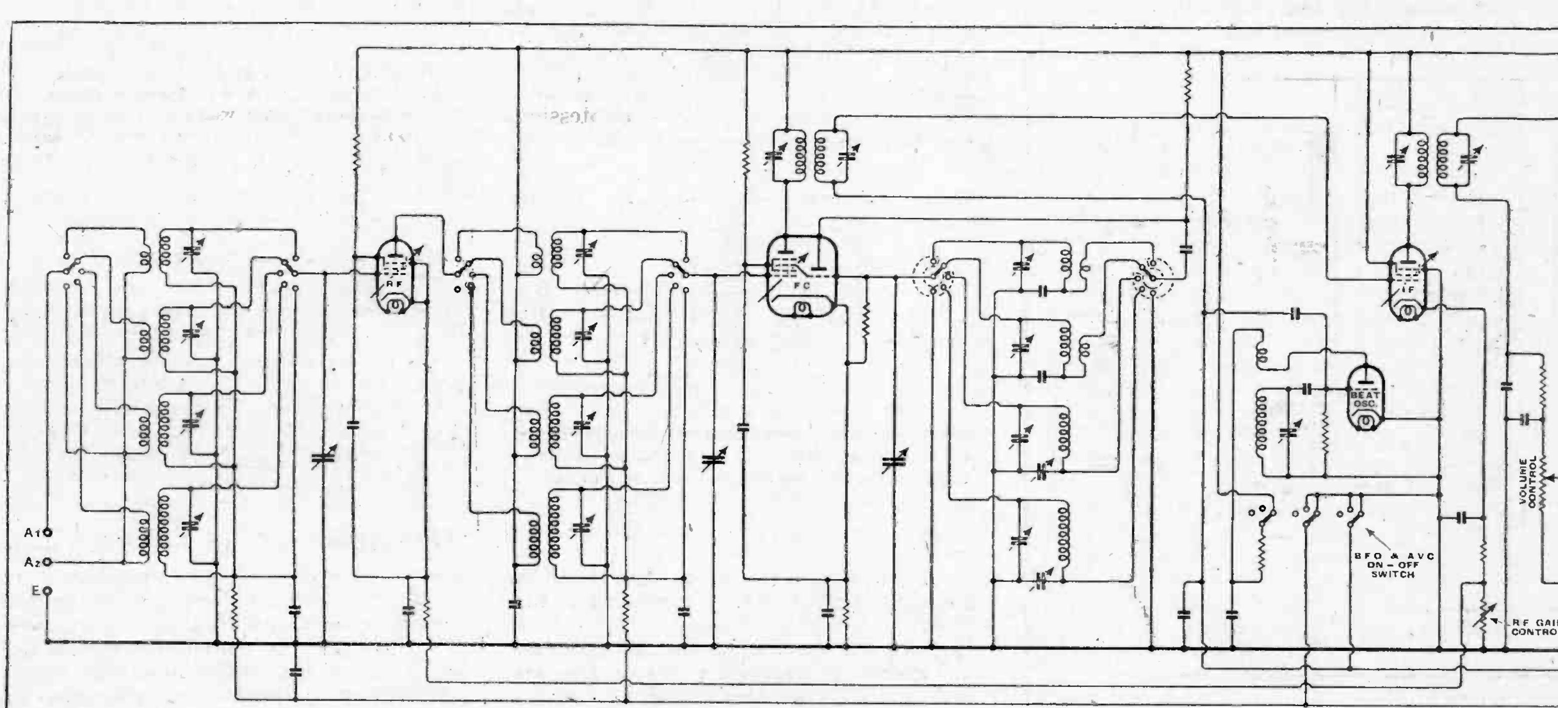
When used as a normal broadcast receiver tuning will therefore present no difficulty to the non-technical members of the household, and in exchange for the few concessions made in their interest the short-wave enthusiast is presented with a number of refinements found usually in communication type receivers of much higher price. AVC is optional, and may be cut out by means of a rotary switch when Morse signals are to be received. A further turn of the switch brings into action a beat frequency oscillator coupled to the IF stage and giving a heterodyne note near the middle of the audio-frequency scale for pure CW reception. The beat frequency may be adjusted by means of a trimmer in the coil can immediately behind the HL4 valve on the chassis.

In addition to the usual AF volume control and mains on-off switch there is an RF gain control incorporating a switch at the minimum position which breaks the main HT supply to the valves but leaves the current on the heaters. This feature will be appreciated by those who propose to use the instrument in close proximity to a transmitter.

Provision is made in the aerial couplings for the use of either a dipole or a conventional single-wire aerial. The RF amplifier functions on all four wavebands and feeds a triode hexode frequency changer which is controlled with the RF valve and IF amplifier from the AVC line. A double-diode pentode combines the functions of second detector, AVC rectifier and output valve. The latter section is rated for an output of 3 watts, and is provided with a variable tone control across the anode circuit. Telephones are resistance capacity fed, and the jack switch automatically substitutes a suitable load resistance for the loud speaker output transformer.

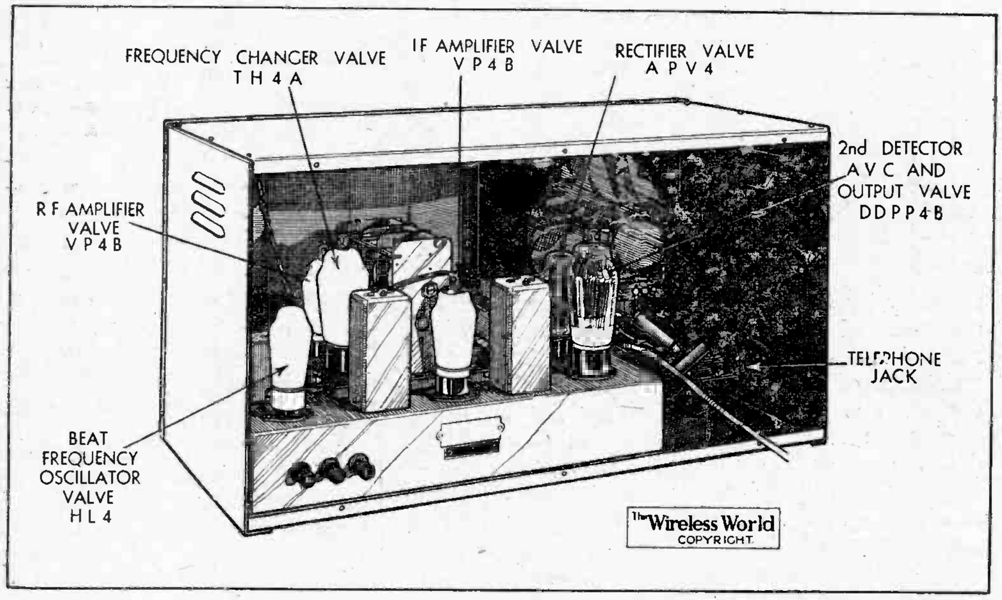
As a broadcast receiver the set performs well on the medium and long waves. The overall magnification is excellent, and the sensivity is well maintained at the ends of scale. About 1½ channels are lost on either side of the London Regional transmitter at a distance of fifteen miles, and on long waves the Deutschlandsender can be received with average sideband interference from Droitwich and Radio

Complete circuit diagram. Most of the amplification is provided by the RF and IF stages. The beat oscillator and AVC are controlled by a three-position ganged switch.



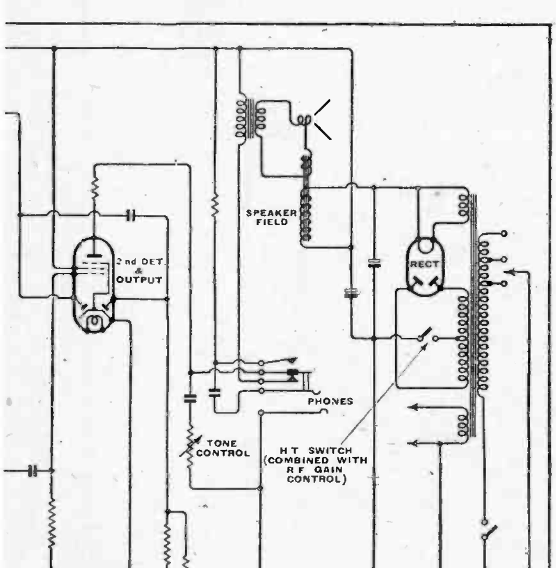
Paris. The few self-generated whistles developed in the circuit are all to be found on the long-wave range, the other wavebands being entirely clear.

Making allowance for the restriction of bass in the interests of low background noise and microphony on short waves the quality of reproduction is well balanced and clear-cut. In this direction a happier compromise between the requirements of the experimenter and the broadcast listener could hardly have been found.



The cabinet is constructed of steel with a crystalline black finish. All RF components including the first two valves in the circuit are contained in a separate rubber-suspended unit.

Of the two short-wave ranges the lower, covering wavelengths from 10 to 25 metres, is the quieter. It does not seem to matter, even on strong signals, whether the AVC is in or out on this range, which rather suggests that the quiet background is related to the general sensitivity rather than to an exceptionally good signal-to-noise ratio. There is a considerable jump in noise level when the second short-wave range is switched on and the stronger carriers are able to provoke microphony with both RF and AF volume controls at maximum. The RF control is the more effective in dealing with this trouble, but when stability is reached the loud speaker volume available with the AF control at maximum is hardly adequate. On short waves the set will undoubtedly give of its best with headphones which are well suited to a receiver with more RF than AF amplification.



Thus the receiver fits well into the arrangements of a family with wide and varied wireless interests. During the earlier part of the evening weight of opinion will be in favour of medium and long waves and the loud speaker, but later the younger members of the family will be able to try their hand at really long-distance reception on short-waves without causing annoyance to anyone else however late the sitting. The pleasure they derive will be enhanced by the knowledge that they have at their command all the auxiliary services of a professional "communication" receiver, and a field for experiment and skill in handling denied by the conventional all-wave receiver.

Television. By J. H. Reyner, B.Sc. Pp. 224+xi. Second edition. Published by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2.

IN the early chapters of this book the author describes a number of the many mechanical systems of television which have been used at one time or another. He then deals with the characteristics of the eye in relation to television, and in this chapter flicker, interlacing and illumination are discussed.

The cathode-ray tube is treated in the following chapter, which also includes some notes on high-voltage supply circuits. Time-bases have a chapter to themselves, which is followed by a discussion of synchronising, including the allied subjects of sync separation, DC restoration and the transmitted waveform.

After this there is a chapter on high-definition mechanical systems, which is followed by one dealing with the television receiver. In this RF and IF tuned circuits are treated in addition to the choice of intermediate frequency and VF couplings. The first part of the book concludes with the subject of aerials.

The second part represents about one-quarter of the book and deals with transmitting technique. It begins with photo-cells, goes on to discuss the optics of mechanical scanning systems and then deals with electronic methods. Film transmission and velocity modulation have chapters to themselves, and are followed by one on colour television. The book concludes with a short appendix on the decibel and an index.

The book covers a wide field and can be confidently recommended to those seeking something more than a superficial knowledge of television. It is not, however, of a highly technical nature and is substantially non-mathematical.

The book is well printed and bound and unusually free from errors. One questionable statement appears on page 79, however. It is said that in a time-base amplifier grid bias is obtained by grid current action. Actually, however, this distorts the saw-tooth waveform in a way which is probably most noticeable as an increase of fly-back time. Consequently, it is the general practice to use cathode bias and to arrange the operating conditions so that grid current does not flow.

W. T. C.

Club News

Stafford and District Short-wave Club

Headquarters: 21a, Sandon Road, Stafford.
Hon. Sec.: Mr. G. L. Wale, "Branksome," Acton Gate Stafford.

This club has been recently formed.

On May 23rd a cine lecture was given by Mr. W. G. J. Nixon of the Osram Valve Technical Department. At the conclusion of the lecture Mr. Nixon carried out some experiments with photo-electric cells.

Exeter and District Wireless Society

Headquarters: 3, Dix's Field, Exeter.
Meetings: Mondays at 8 p.m.
Hon. Sec.: Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

On May 22nd members of the Society were conducted over the Exeter Odeon Theatre. A very interesting time was spent in the operating room. Several records were played in order to demonstrate the quality of the amplifying system.

There are no further meetings until the autumn session commences in September.

Robert Blair Radio Society

Headquarters: Islington Men's Institute, Blundell Street, London, N.7.
Meetings: Wednesdays at 8 p.m.; Thursdays at 8 p.m.
Hon. Sec.: Mr. A. R. Richardson, 24, Mercers Road, London, N.19.

When the weather improves, the Society hopes to arrange some field days.

Wednesdays are usually given up to theoretical talks of interest to beginners while the advanced group is improving its morse. On Thursdays practical work is undertaken.

Belling-Lee Transmission Line

IN describing this non-hygroscopic twin feeder cable on page 430 of the May 12th issue, figures were given for an earlier type of cable. The specification of the twin feeder now being supplied is as follows:—characteristic impedance is 80 ohms and loss per 100 ft. 3 db, both at 45 Mc/s. The price per standard reel of 65 ft. is 10s. 6d.

Self-Ranging Milliammeter

By "CATHODE RAY"

Using a Selenium Rectifier Shunt

MULTI-RANGE milliammeters of the ordinary sort are very useful for general testing, but they all have a number of disadvantages. Although the work in hand may demand all one's thought, a certain amount of mental energy must be side-tracked for deciding on the appropriate range and switching the meter accordingly. A moment's inattention or thoughtlessness, or a pure accident, and flick! — the pointer is wrapped round the stop, and a more or less costly meter repair becomes necessary. Or, if a fuse is thoughtfully provided, "bang goes saxpence" on a new one, and even then the instrument may not be any better for the nasty jolt it has had. Lastly, a multi-range meter is usually a good deal more expensive than a corresponding single-range type.

The ideal thing is a meter that automatically adjusts itself to the current it gets, so that one does not have to give any thought to range switching; and even if an accidental short does occur the pointer is still somewhere on the scale. As I explained several years ago,[1] such a miracle exists, and is actually cheaper and simpler than the common range-switching system. It is nothing else than the well-known metal rectifier. The resistance of a rectifier diminishes as the current through it increases, which is just what we want for an automatic or safety shunt for a meter.

Choosing the Shunt

In selecting a rectifier shunt these are the requirements:—

(1) Near the zero end of the meter scale the resistance of the rectifier to be so high in relation to the resistance of the meter that practically the full sensitivity of the latter for small currents is preserved.

(2) The resistance of the rectifier to be so much lower than that of the meter when the latter is passing its full-deflection current as to bring the total current to a suitably high value.

(3) With the rectifier shunt in place, no part of the meter scale to be unduly crowded.

(4) The shunt current when the meter is fully deflected to be within the safe rating for the rectifier.

To make these stipulations clearer, let us consider a particular example, making use of a meter reading up to 5 milliamps. And suppose that in order to provide a good margin of safety, and to include all readings likely to be wanted, we aim at a full-scale reading, when shunted, of 1 amp. (1,000 milliamps.). Therefore, making sure of requirement (4) first, the rectifier should be rated to carry 1 amp. (to be very exact, of course, the rectifier current is 0.995 amp. at full-scale deflection). The voltage drop across a single rectifier disc at its maximum current rating is in the region of ¾ volt, so the meter resistance to pass 5 milliamps. must be about 150 ohms. The resistance of most 0-5 moving-coil milliammeters is less than this and must therefore be increased. This can be done experimentally by connecting the rectifier, supplying and keeping adjusted a total current of 1 amp., and adjusting the extra resistance of the milliammeter until full deflection is just obtained (Fig. 1).

Now see how much the shunt affects the deflection near the minimum, say, at 1 milliamp. If there is no perceptible effect at all, it would seem to follow that the upper parts of the scale will be very crowded in order to cover the whole range up to 1,000 milliamps., and the resistance of the shunt should be lowered by using a larger rectifier disc. On the other hand, if the shunt reduces the deflection almost to zero the instrument loses most of its effectiveness for reading such small currents; but if the size of the rectifier is reduced it can no longer carry 1 amp., and we must be less ambitious about the full-scale current. Fortunately, the deflection with 1 mA falls to about 0.8 mA on the original scale, which seems quite reasonable, and the rest of the scale up to 1,000 mA is then calibrated by means of a multi-range meter, borrowed for the occasion if necessary.

The scale having been adjusted at the top and near the foot, its exact distribution in between depends on the characteristics

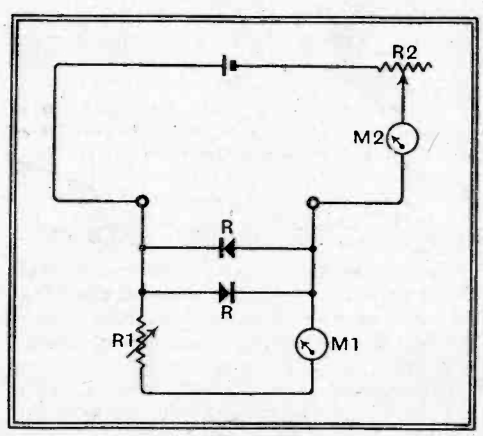


Fig. 1.—Method of adjusting the full-scale reading of the rectifier-shunted meter M1. The rheostat R2 is used to adjust the current to the required amount, shown by M2, and R1 is then adjusted so that full deflection of M1 is obtained. RR are the rectifiers.

of available rectifiers. Assuming that equal prominence is desired for all parts of the scale, rather than open readings here and crowded ones there, the ideal is a logarithmic scale. In such a scale the distance between, say, 1 and 2 milliamps. is the same as the distance between 2 and 4 or 100 and 200. In the arrangement I described previously, using a Westinghouse copper-oxide rectifier, more than half the scale was occupied by the relatively uninteresting readings above 100 mA. If anything, this part of the scale ought to be more crowded than the rest; an effect which, however, does not seem to be obtainable. A considerable improvement could be made, using the Westinghouse rectifier specified by lowering the full-scale current and reducing the meter resistance accordingly. But if a wide range of logarithmic scale is wanted, some tests I have been carrying out show that the selenium rectifier sold by Standard Telephones and Cables possesses special advantages.

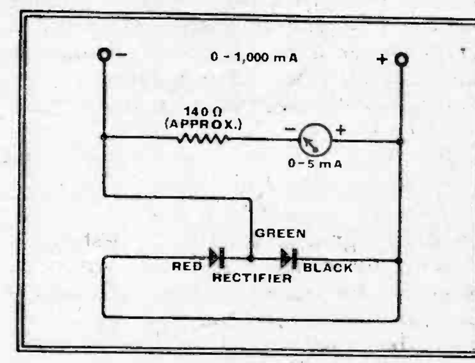


Fig. 2.—Circuit of suggested arrangement for increasing the full-scale reading of a milliammeter from 5 to 1,000 while leaving the sensitivity to small currents practically unimpaired. The rectifier is Type D84-1-1 (Standard Telephones and Cables) and the meter is a Ferranti.

Protection Against Reverse Currents

For 1 amp. full scale, the most suitable standard selenium rectifier is the D84-1-1, which consists of two discs in series, tapped at the junction. This is just what is wanted, for if only one disc were used there would be no protection against accidental reverse currents. So they are connected as shown in Fig. 2, with one disc each way. The resulting scale is shown in Fig. 3, in which it can be seen that nearly equal room is given to the ranges 1-10, 10-100, and 100-1,000, with actually slightly more for the much-used 1-10 mA range than for the others.

In writing about rectifier shunts previously I pointed out their two disadvan-

[1] Jan. 11th, 1935.

Self-Ranging Milliammeter—

tages. One—the more serious—is the influence of temperature on their characteristics and consequently on the accuracy of instruments of which they form a part. I tested samples of both selenium and copper-oxide (Westinghouse) rectifiers in

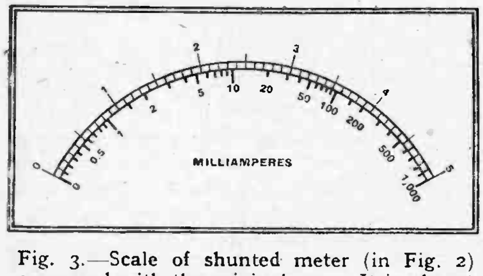


Fig. 3.—Scale of shunted meter (in Fig. 2) compared with the original one. It is almost perfectly logarithmic from 0.5 to 1,000 mA.

an extemporised oven—consisting of a cardboard box fitted with a small electric heater and a thermometer—and found that over the range of atmospheric temperature, 41 deg.-100 deg. F., there was nothing to choose between them. A rectifier-shunted meter is suitable only for comparatively rough tests, with possible errors up to 15 per cent. at extreme temperatures, assuming the meter to be calibrated at the probable mean temperature, usually about 65 deg. F.

The other disadvantage is that even when the irreducible minimum of one rectifier disc is used as a shunt, the voltage drop is greater than in the best types of multi-range meter. This is rather a nuisance, for example, when measuring filament current, the total voltage of the circuit being only 2. Using the Westinghouse LT4 rectifier previously suggested (as that was the most suitable type listed at the time, in spite of its two discs in series in each path) the voltage drop at full scale is 1.4, which for the purpose just mentioned is absurd. But a Westinghouse rectifier with one disc per path, the LT7A, is now available, and halves the voltage drop. It is, in fact, a shade better in this respect than the selenium rectifier.

The advantages of the rectifier-shunted meter are most realised in fault-locating and other uses where the current may be very different from what is expected, and high accuracy is generally unnecessary. The commonest of all faults—intermittent contact—is the most liable to damage instruments not provided with rectifier shunts.

There is an application where the rectifier shunt has *no* disadvantages—for protecting bridge galvanometers. Anybody who has used a Wheatstone bridge knows how much care is needed to prevent the galvanometer from damage due to excessive unbalance. What is wanted is an indicator that is extremely sensitive close to zero, but will take almost unlimited current without bad effects; a sort of AVC, in fact. That is just what the rectifier shunt provides, and as the measurements do not depend on the scale readings the effects of temperature are entirely unimportant.

Television Programmes

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

Sound 41.5 Mc/s — Vision 45 Mc/s

THURSDAY, JUNE 2nd.

3, "A Night in June," musical play including Queenie Leonard and Charles Hickman. **3.20**, Gaumont-British News. **3.30**, 151st edition of Picture Page.

9, Repetition of 3 p.m. programme. **9.25**, British Movietonews. **9.35**, 152nd edition of Picture Page. **10**, News Bulletin.

FRIDAY, JUNE 3rd.

3, Suggestions for a Picnic by Marcel Boulestin. **3.15**, British Movietonews. **3.25 - 4.15**, "Derby Day," a comic opera by A. P. Herbert, with music by Alfred Reynolds.

9, West End Cabaret. **9.30**, Gaumont-British News. **9.40**, Repetition of 3 p.m. programme. **9.55**, Cartoon Film. **10**, Clothes Through the Centuries. **10.25**, News Bulletin.

SATURDAY, JUNE 4th.

3, "In Our Garden," by C. H. Middleton. **3.15**, Gaumont-British News. **3.25**, "Eastern Cabaret"; a development of the popular feature, "Cabaret Cruise."

9, Victoria Hopper in "The Constant Nymph," the famous play by Margaret Kennedy and Basil Dean. Cast also includes Margaretta Scott and Dorothy Hyson. **10.30**, News Bulletin.

SUNDAY, JUNE 5th.

3-3.45, Polo O.B. from Hurlingham.

8.50, News Bulletin. **9.5**, The Birmingham Repertory Company in "Seven for a Secret." **10.5**, Gaumont-British News. **10.15-10.40**, The Ballets Jooss in "The Big City" and "A Ball in Old Vienna."

MONDAY, JUNE 6th.

3, Polo O.B. from Hurlingham—The Empire Cup. **3.40**, "The River," a film depicting the story of the Mississippi Valley.

9, "With Your Permission," a play including Richard Haydn and Arthur Marshall. **9.35**, British Movietonews. **9.45**, The Vic-Wells Ballet. **10.15**, News Bulletin.

TUESDAY, JUNE 7th.

3, Starlight. **3.10**, Friends from the Zoo. **3.25**, British Movietonews. **3.35**, "Rory Aforesaid," a West Highland comedy by John Brandane.

9, "Speaking Personally." **9.10**, Friends from the Zoo. **9.25**, Gaumont-British News. **9.35**, Ray Ventura and his Band. **10**, News Bulletin.

WEDNESDAY, JUNE 8th.

3, "The Old and Young," a comedy by Louis Goodrich. **3.15**, Cartoon Film. **3.20**, Starlight. **3.30**, Gaumont-British News. **3.40**, The Vic-Wells Ballet.

9, Starlight. **9.10**, British Movietonews. **9.20**, Exploration Talk. **9.35**, Cartoon Film. **9.45**, The Vic-Wells Ballet. **10.5**, News Bulletin.

SHORT-WAVE AERIAL FEEDERS

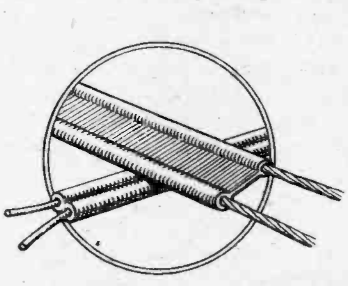
SOME examples of feeders for short-wave aerials that are being made in this country have been sent in for examination.

One is a low impedance cable, for which, however, no values are given, and this consists of two parallel insulated wires. If these wires were air-spaced the characteristic impedance of the cable would be of the order of 170 ohms. In the production cable the size of the wire is to be increased from No. 22 to No. 19 SWG, i.e., 1 mm. diameter, which, in conjunction with the higher capacity of an insulated line, will bring the impedance down to a value that is a reasonably good match to the centre of a half-wave aerial.

The high impedance feeder consists of two 7/0.014in. stranded-wire conductors spaced approximately $\frac{3}{8}$in., the surge impedance of this line being given as 350 ohms. Calculation based on the wire size and spacing produced a figure of 380 ohms. The small difference could quite well be accounted for in the measurements of the wire and the spacing, as an ordinary ruler was employed.

The high impedance feeder is light, compact and flexible, and, unlike most open-wire lines, the spacing throughout cannot change.

Very tough insulating material is used, this being described as "chlorinated vinyl," for which is claimed a very low power factor.

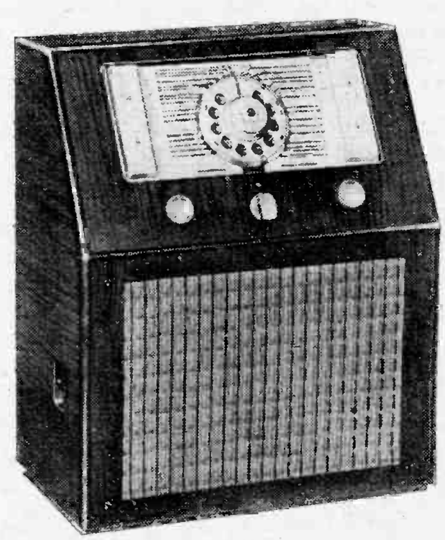


High- and low-impedance feeders with insulated and spaced conductors.

Both these feeders are, of course, equally suitable for transmitting as well as for receiving aerials.

Supplies are obtainable from the Electrical and Physical Research Laboratory, 72a, North End Road, West Kensington, London, W. 14, the price being 5s. 6d. per 12 yards for the low impedance feeder and 6s. for the high impedance line.

Cossor Model 397



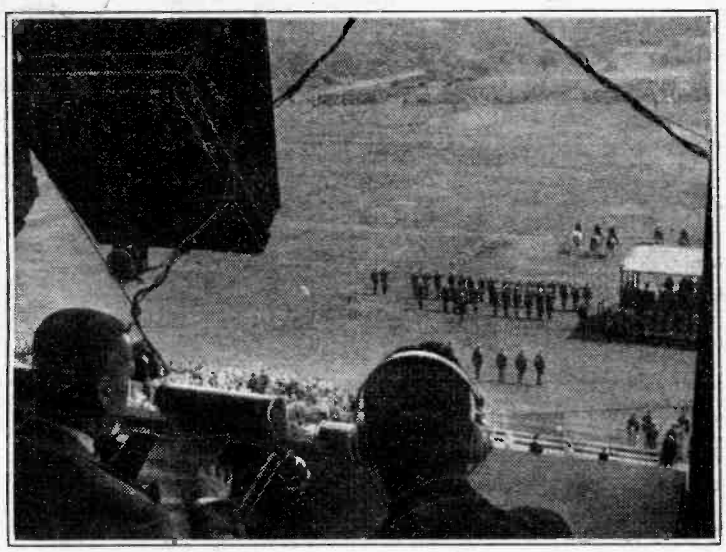
TEN stations may be selected automatically by the "Teledial" control in this new table model AC superheterodyne. Normal tuning is by means of a two-speed drive, and 44 station names are marked on the flood-lit dial. The circuit includes an RF stage, and two degrees of selectivity are provided in the IF circuits. A large triode in the output stage feeds a 10in. moving-coil loud speaker, and the cabinet presents a large frontal baffle area with a comparatively shallow depth from back to front. The price of the Model 397 is $11\frac{1}{2}$ guineas.

THEN AND NOW: B.B.C. Takes Stock

IN seven years the B.B.C. has doubled the hours devoted to gramophone record broadcasts, according to statistics just prepared showing the amount of time given to thirteen different types of programme from 1931 to 1937. In 1931 records were transmitted for 616 hours 41 minutes, whereas in 1937 they were allotted 1,246 hours 3 minutes. Drama broadcasts were more than doubled; variety and revue were nearly doubled; running commentaries were exactly doubled, the time given to these in 1937 being 268 hours as compared with 134 hours in 1931.

Interesting decreases are recorded. Dance music showed a considerable drop over the period; in 1931 the B.B.C. stations gave us 1,089 hours of jazz, but in 1937 only 734 hours. A still bigger drop is shown in Children's Hour transmissions, which fell from 1,552 hours in 1931 to 897 hours last year.

The total hours of British broadcasting increased by relatively little in the seven years under review. In 1931 the figure was 12,718 hours 23 minutes; in 1937 it was 13,737 hours 59 minutes. These statistics do not include Empire and television programmes.



B.B.C. COMMENTATORS, looking down from this observation box into the vastness of Rushmoor Arena, will endeavour to convey to listeners some of the glittering pageantry of the 1938 Aldershot Tattoo. A preliminary broadcast will be radiated at 3.20 p.m. on Tuesday (Reg.) and three transmissions on Wednesday, beginning at 10.15 p.m., will be relayed in the National programme.

HIGH FREQUENCIES IN NATURE

THE B.B.C. mobile recording unit is trying to find feathered songsters or talkers who can be induced to face the microphone and, incidentally, to provide owners of high-quality receivers with a chance to test their instruments on nature's own audio frequency generators.

Last week Mr. H. L. Fletcher, chief of the mobile "flying squad," went to Woodford, Essex, to test the claims of "Joey," a budgerigar with a vocabulary of fifty words and a frequency scale ranging between 256 and 12,000 cycles, and as a result it is expected that a recording of Joey's voice will shortly be broadcast.

DELHI METEOROLOGICAL CENTRE

A FORECASTING meteorological centre is expected to be established at Delhi, and a short-wave wireless station to meet meteorological requirements will be erected at Poona. Synoptic weather information will be exchanged between the forecasting centres at Karachi, Delhi, Calcutta and Poona in India and Rangoon in Burma. It is hoped to arrange for the Poona station to exchange the information collected from the other Indian and Burmese stations with synoptic reports from countries to the east and west.

NEWS O

ACOUSTIC RESEARCH

Tests with Reverberation Rooms

THE B.B.C. Acoustic Section at Nightingale Square, Balham, under Mr. John McLaren, is making a close study of resonant absorption of sound. There are two reverberation rooms of different sizes and two experimental studios, also of different sizes. The reverberation rooms are used for carrying out routine measurements on the sound-absorbing properties of various materials and for laboratory types of measurements, and the test studios are erected to try out various types of acoustical treatments in practice. The two reverberation rooms are lined with tiles. This is not a new method of changing the reverberation period rapidly, but of obtaining as long a reverberation period for the room as is possible so that comparatively large samples of material can be measured. The tiles are not moveable (as was recently stated in these columns), but are cemented to the walls of the room in the usual manner.

On the completion of any new studios, and also when time permits during their construction, investigation and measurements are made in order to gain information for future design.

IMPRISONMENT FOR UNLICENSED CANADIAN LISTENERS

A REVISION of the Canadian Radio Act now before the Parliament at Ottawa carries with it fines up to $500, a year's imprisonment and the seizure of the radio set for unlicensed possession of a receiver. The revised law also calls for the use of a search-warrant being issued to police officers or radio inspectors if there is any suspicion that there is an unlicensed receiver in a house. Our correspondent says that the radio tax is the most disliked in Canada.

SUPERIMPOSED IMAGES IN TELEVISION

COMPOSITE television is the subject of a patent recently issued to J. C. Batchelor, of New York. He claims that by means of his invention one subject can be superimposed upon another without causing the ghost effect, familiar to many viewers in this country.

The apparatus, which is known as a distortion amplifier, interrupts the scanning spot from that part of the background covered by the image of the main subject.

CHECKMATE?

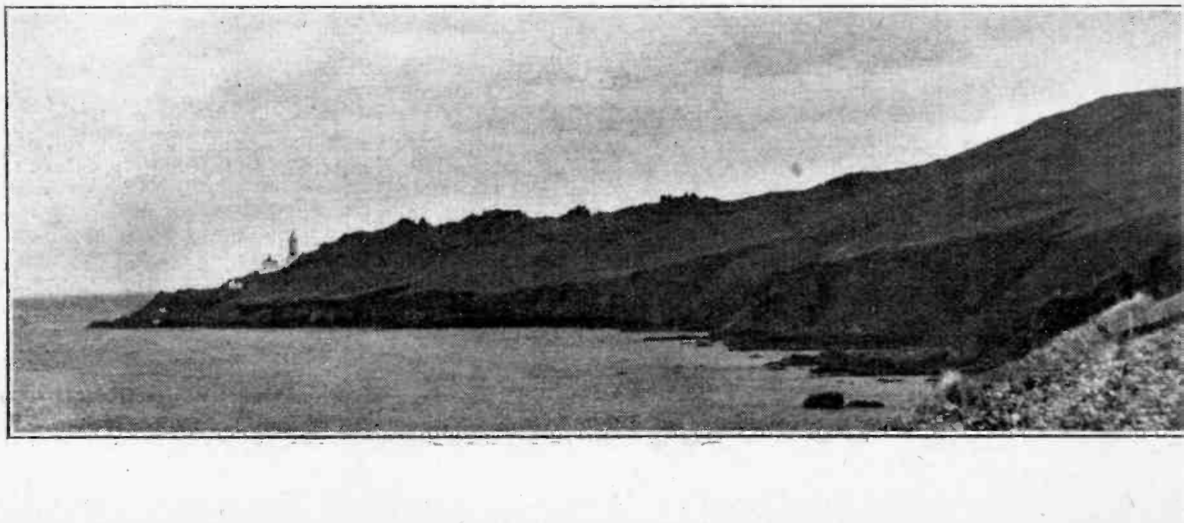
THE opening move in a game of chess between the B.B.C. and listeners will be broadcast after the 7 o'clock news on Friday, July 1st. By the following Monday morning it is hoped that chess players all over the country will have sent in their suggested move to Broadcasting House, and the most favoured one will be announced at the same time as before on Monday evening.

These short broadcasts on the progress of the game will continue each Monday, Wednesday and Friday.

SAILORS OPERATE TO BROADCAST INSTRUCTIONS

FOR thirty-six hours last week wireless messages passed between two ships in the Indian Ocean. On one, the Greek cargo boat *Shelatros*, a member of the crew was in agony with an abscess in the back. On the other, the *Port Wellington*, the doctor (a brother of Clyde Fenton, Australia's well-known flying doctor) was answering the SOS for medical help.

Messages were sent telling the officers of the *Shelatros* how to go about the required operation. "I don't quite know even now



THE WEEK

what happened," Dr. Fenton said. "Possibly the only equipment was what the chef could supply, but the last message was that the patient was recovering from the operation and was doing well. I left them with instructions as to his diet."

FROM ALL QUARTERS

Thirty-one Million of Us

OMITTING pirates, the B.B.C. now estimates that the potential listener audience is approximately 31,000,000. The figure is based on the total number of wireless licences (8,609,800) multiplied by the size of the average household, i.e., 3.6 persons.

Television Home Constructor

A YOUNG radio engineering student, Pat Hansford, of Portsmouth Municipal College, has constructed a television receiver with which he reports the reception of excellent pictures from Alexandra Palace at Bognor Regis. The receiver has also been used with an 80ft. aerial at the College, where, although screened by Portsdown Hill (400ft.) which runs along the north boundary of Portsmouth, and with electric trains and trolley buses in close proximity, pictures of good contrast have been received.

In Exchange

DURING 1937 the Italian broadcasting organisation, E.I.A.R., provided 128 programmes for foreign countries, and itself received 79 programmes from abroad. A large percentage of the former were undoubtedly operas.

Fifty Years Ahead

THE most enthusiastic radio subscriber in the world must surely be C. M., of Belgrade, Yugoslavia. A few days ago he sent a cheque for 12,000 dinars (about £54) to the radio authorities to pay for his wireless licence until January 1st, 1988.

New York Television Sound

HIGH - FIDELITY transmissions, such as those of the Toscanini concerts which Londoners have been enjoying, are looked forward to by New Yorkers, for, according to a correspondent, the Vice-President of Communicating Systems Inc., New York, has announced the marketing of a small three-valve receiver to cost "as little as $15" (£3) for the reception of the sound channel of the New York television transmissions.

Electric Fans and Radio Reception

THE curse of summer reception in India is not so much atmospherics as the interference caused by electric fans. According to the Civil and Military Gazette of Lahore, the best way to counteract this would be to relay through the local transmitter the Empire programmes from the receiving station at Delhi. The journal contends that, although this elaborate receiving plant cost a lot of money, it is rarely used.

Records Library

ALL historical recordings will be preserved in a *Phonethèque Nationale* which was recently instituted by the President of the French Republic.

Regulating School Sets

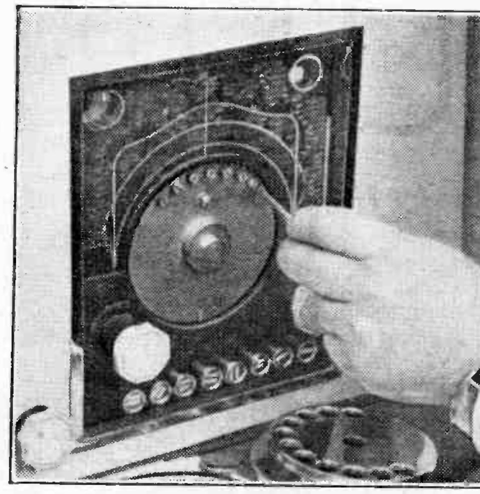
THE use of wireless sets in schools in Czechoslovakia is limited to strictly educational broadcasts. It is forbidden to use the receivers for political purposes, and listening to any foreign programme is prohibited.

Siam Calling

HS8PJ, BANGKOK, transmits a programme for European listeners every Thursday on 31.58 metres. The identification signal consists of three chimes of an ascending scale.

Paris Broadcasting House

THE site has been secured for the erection of a broadcasting house on the Boulevard des Invalides, Paris. The building is expected to be completed in the spring of 1941.



AT THE FOIRE DE PARIS, which closes on June 6th, many receivers have automatic tuning. In the "Melody" receiver the setting of the preselection teledial tuning arrangement is easily accomplished by removing the dial, thereby exposing the setting screws.

New Tripoli Station

THE new Tripoli station which the Italian Government is erecting on the Oasis of Zanzur is to commence experimental transmissions in August and will be officially opened on October 28th. Its aerial arrays will be directional to the east and to the west.

Battle Sounds from Loud Speakers

THE Paris correspondent of *The Times* states that M. Maxime Baze, a Frenchman, is reported to be at work on a PA system designed to produce most of the sounds of battle. The apparatus could be set up in a field, and timid troops might be frightened into immobility by nothing more lethal than a series of gramophone records played behind the enemy's lines.

High-power Dutchman

A NEW 125-kW transmitter near Jaarsveld, in Holland, is expected to be ready in about eighteen months' time. It will make use of the wavelength of 301.5 metres, which at present is allotted to Hilversum II.

Sottens Radio Orchestra

RIVALRY between the Geneva and Lausanne studios for the services of the Sottens radio orchestra has now been ended by the decision to contract the famous Orchestre Romand, conducted by Ansermet, for broadcasting and to station it at Geneva. It is pointed out that Lausanne's big studio will probably fall into disuse.

Woman Announcer at Addis Ababa

IT is interesting to note that the chief announcer at the temporary 1 kW short-wave station at Addis Ababa is a woman, Signorina Luisa Gasparini. The new transmitter which is under construction, and will be ready in about twelve months, will have an aerial power of 5 kW, which it will be possible to increase to 25 kW. The station is at present using a wavelength of 31.25 metres, transmitting at 14.40 and 21.00 local time.

Swiss Licence Increase ?

THE board of the Swiss Broadcasting Company has decided to ask the telegraph administration to increase the Swiss radio licence from 15 to 18 francs per annum to meet the added cost of "the spiritual defence of the nation," namely, to provide programmes for the Swiss overseas and to extend the hours of transmissions to counteract the effect of broadcasting from neighbouring countries.

Station Moving

THE transmitter of Florence II (238.5 metres) is shortly to be moved from Via Bolognese to Trespiano, and its power increased from 1 to 5 kW. Trespiano, where the 20-kW Florence I station is situated, is found to be a more favourable site for the propagation of wireless waves. The station will be equipped with a new aerial system.

P.T.T. Headquarters

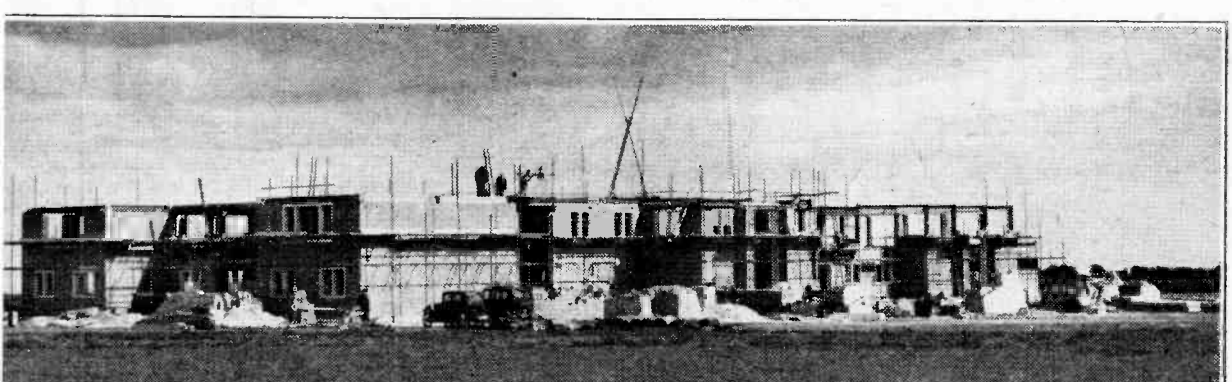
THE French P.T.T. will shortly be moving to new headquarters in the Avenues de Saxe and de Ségur, Paris.

Marconi Patents

THE total number of patents filed by the Marconi Company during 1937 was 1,351. 252 were filed in Great Britain, and of these 44 related to sound and vision reception. There are now approximately 6,000 of the Company's patents in force in various parts of the world.

Miscellaneous Advertisements and Whitsun

WITH the approach of the Whitsun holiday slight alterations are necessary in our printing arrangements. Miscellaneous advertisements intended for the issue of June 9th must be received not later than first post to-morrow, Friday, June 3rd.



THE NEW SOUTH REGIONAL station buildings shown above, which are being erected about a mile from Start Point, are rapidly taking shape although the transmitter is not expected to be in use before July next year. It will probably radiate, on 285·7 metres, the West Regional programme from Washford Cross, with which station it would then be synchronised. Its service area, with a population of at least 3,000,000, will be increased by the use of a second 500-ft. mast which will serve as a reflector reducing the radiation over the Channel. The masts will be visible over the slope of the headland shown on the left.

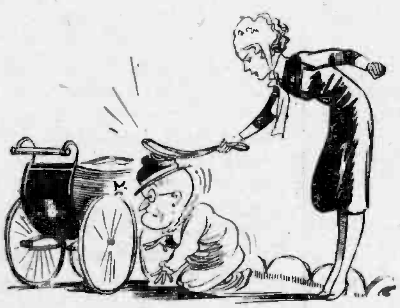
UNBIASED

By

FREE GRID

Pity the Poor Component Makers

I DAREESAY that there are quite a large number of you who, in your innocence, imagine that the manufacturer of a wireless set makes every component of it in his own factory, and even grows the wood for the cabinet. I well recollect that more years ago than I care to remember I was of the same opinion concerning my perambulator, but a tyre happened to come off one day and when the nursemaid lifted me out of the pram to adjust it I noticed that it was branded with a different name to that on the chassis. Even then the fact might not have impressed itself so forcibly



Hit me over the head with the tyre.

on my memory had not the nurse hit me over the head with the tyre in a fit of rage, due to my fumble-fistedness and slowness in effecting the repair which caused her to miss an appointment which she had made with a soldier.

Please do not think that I am in any way chiding you if you *do* think all the components of your wireless receiver are made by the set's manufacturer, for if you open it up and examine the variable condenser, for instance, you will quite frequently find no indication on it concerning the firm who made it. What more natural, then, than to think that the maker of the set is responsible for this component also.

Now, I am perfectly well aware that on reading this the first thought which will occur to you is that if some other firm makes certain of these components, why on earth doesn't it stick its name on them as a sort of free advertisement, if for no other reason. Lest you should jump to the conclusion that they are turned out by some obscure cheapjack firms who are ashamed of their reputations, let me tell you that so far from this being the case the components in a wireless set are more often than not made by some very well-known firms indeed, who are afraid of risking their reputations by sticking their trademarks on some of the shoddy stuff you find in certain sets which I could name were it not for the archaic condition of our libel laws.

The next question which naturally arises is why do reputable makers of components turn out shoddy stuff which they are ashamed to brand with their names? Are they making hay while the sun shines and feathering their nests by battening on the unfortunate set makers, charging fabulous prices for indifferent products? The answer is very definitely in the negative.

The fault, I fear, lies with certain set makers who won't pay a decent price for a decent article. The prices which the particular set makers I have in mind are willing to pay the component manufacturers are so low that they leave no hope of a legitimate profit for them unless they turn out junk which, of course, they do, but, as we have just seen, through no fault of their own. It is small wonder, therefore, that they do not wish to risk their good name by sticking it on the shoddy components. It is little wonder also that certain makes of set are subject to as many breakdowns as they are. The next time your set breaks down, therefore, and you have to foot the bill for a new condenser, or whatever it is, pity the poor component maker.

Servicemen, Beware !

WE hear a lot of talk from time to time concerning the alleged inefficiency of servicemen, many of whom, it is said, do not seem to have advanced much further in their knowledge than swinging-coil reaction technique. Many wireless dealers, when asked why they do not take the trouble to employ efficient and knowledgeable servicemen, reply that they would willingly do so but that they are as scarce as good health in a doctor's household.

On the other hand, it is alleged that there are plenty of good servicemen available if the dealers would only pay them the money they are worth. Now I do not propose to enter into an argument concerning this matter as, like a policeman, I do not believe in intervening in other people's quarrels, but there is one very shocking aspect of the problem which has been forced on my attention recently, and I can do no other than relate the bare facts.

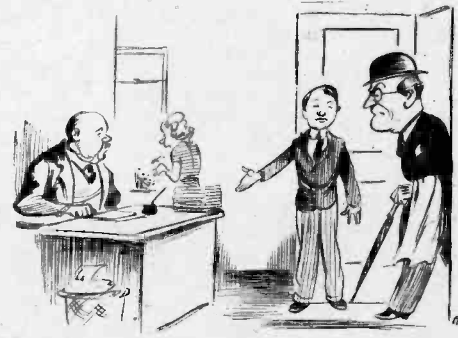
A serviceman of my acquaintance, whose knowledge and skill are, as I am aware from personal experience, all that could be desired, recently approached me with a request that I give him a technical overhaul as he rather feared that he must be getting too old-fashioned in his methods to get a decent job. He recently had an enforced holiday owing to his firm unfortunately going on the rocks, and, although he had applied for one or two jobs, he had failed to get them, although, as far as he knew, he had succeeded in the practical test of his abilities which they asked him to give.

When he told me the names of the firms I must confess that I was not reassured. They were definitely not firms of unimpeachable integrity or anything like it. Nevertheless, it appeared to me that the fact that they had the reputation of being a trifle shifty in their dealings would tend to cause them to employ any old servicemen rather than for them to be sticklers for efficiency.

In the end I decided that, since one of the vacancies was still advertised, I would apply for the post myself. Consequently, I duly presented myself at the establishment in question and was eventually ushered by a greasy-looking youth into an inner sanctum where I discovered a typist in company with a paunchy gentleman wearing spats and a dirty collar and with a large cigar stuck in the corner of his mouth.

Having made known my errand I was taken to a very ill-equipped and badly lighted workshop and bidden to exercise my talents on a well-known make of receiver which had ceased to function. The job was by no means an easy one, but I flatter myself that I carried it out creditably, and fully expected to receive the appointment forthwith. I was very surprised, however, when I was told they would write to me, and still more surprised when, after a lapse of many days, I had heard nothing, more especially as the job was still advertised.

It was some time before the true artfulness of this scheme dawned on me, but when it had done so I lost no time in instituting the necessary enquiries, from which it appears that a very old dodge is



" Ushered by a greasy-looking youth into an inner sanctum."

being practised, not only by this firm but by others of a similar shady nature. A serviceman's job is advertised and, since the pay offered is high, the very best type of man is attracted and the number of applicants is large. Each is given a test, as in my own case, and, of course, the shady firm who are running this racket get all their service jobs done for nothing. The worst part of the whole affair is that, so far as I am aware, it is perfectly legal.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Sunset and Fading

I AM very grateful to the three correspondents who have supplemented my article "Sunset and Fading." My reference to weather, which "L. H." quotes, was not meant to imply that I expected reception to fit in with weather conditions, but rather to point out to the weather-influence school (with whom in general I disagree) that it did not.

I attach much more importance to the solar phenomena pointed out by "L. H." and W. H. Jarvis, even though I am not aware of any comprehensive explanation having so far been published of what exactly happens in daylight propagation of medium wavelength signals. The old story was that during daytime one received the ground wave, which at distances outside the service area of the station was weak but consistent; then as darkness supervened the sky wave became available, which at its best was much stronger, but unreliable owing to varying reflections and interferences between different waves, including the ground wave, fading generally being worst in places where the ground and sky waves are approximately equal and therefore likely to cancel out completely.

My experience is that it is the daytime reception that is entirely irregular and unreliable, while reception after dark reaches a comparatively constant level, broken only by downward fades. Not having kept closely in touch with this branch of the work I may have missed a newer theory than that just mentioned, accounting for the actual facts, and I would be very glad to be referred to it.

Mr. D. A. Bell's deduction seems to be entirely justifiable. I was a little alarmed by his suggestion of conducting a set of observations at and before sunrise, but seem to have a good excuse in the absence of regular transmissions at that hour. On the other hand, I may take advantage of the Autumnal Equinox to make some tests on Athlone, although, of course, the distance, angle and wavelength do not agree so satisfactorily. A comparison between Athlone and Stuttgart might be instructive.

"CATHODE RAY."

The Fadeout of April 15th

Observation at G2XC, Portsmouth

LISTENING on the 28-30 Mc/s band of frequencies commenced at 08.15 G.M.T. On the previous day conditions on these frequencies had been very poor indeed, no signals at all being heard. This morning, however, there were a number of commercial harmonics audible at good strength (R7) and one amateur signal, believed to be J2CE. The commercial signals appeared to be mainly of Russian origin. All these were still audible at 08.41, but at that time a hissing sound, which gradually increased in strength, was heard. It was realised that this was probably the hiss which G6DH and others have reported on various occasions since late 1935. The tuning range of the coil in the set was 22 to 32 Mc/s, and it was observed that the hissing was strongest at the high-frequency end. The peak strength was reached at approx. 08.43: there was a smaller peak about 30 seconds later, after which the hiss faded away, leaving the 27-Mc/s band void of signals.

A search was immediately made on other frequencies (10 to 16, 5 to 8, and 33 to 49 Mc/s) but no signals at all could be heard. Every station operating on the high frequencies from 5 Mc/s upwards had disappeared. Repeated searches were made. The first signals heard were two commercials, PDQ on 10 Mc/s and one unidentified on 13 Mc/s (time 08.48). At 08.52 GMX was heard sending (on 15 Mc/s) "JNC de GMX ZAN ZFO 844 ZMR ZHC?" This was repeated continuously for at least thirty minutes. At 09.00 approx. G8QW in Southampton was heard calling "Test" on 14 Mc/s, and was the only amateur signal audible at that time. The 7 Mc/s amateur band was "dead." Other commercial signals were by now reappearing, among the first being DAN 12Mc/s, DGR 13 Mc/s, DFC, FYQ and others from the nearer European countries. At 09.20 listening had to cease, and except for about two minutes at 09.40 no more listening could be done at all until 11.20. At 09.40 it was observed that the commercials had returned on 28 Mc/s. At 11.20 a contact was made with G8WC, of Portsmouth, who reported 14 Mc/s conditions as "very dud."

During the remainder of the day other signals heard on 28 Mc/s (approx.) were (times approx. only): 11.40 G.M.T., RKA, HAS2. 12.05, HI7G, VU2CO, OK3TM. 15.10, ZELJJ, G6NZ. 17.30, ZELJA, F8RR, G5TP (flutter fade), VP6MR, G2JU (flutter), K4??.

On 56 Mc/s, at 21.00, conditions were above normal. G2PF was R8 instead of usual R6/7, and signals from G2XC were R6 instead of usual R4 at G2PF, Chichester.

On 11 Mc/s W1XAL was inaudible at 21.55 during its URSIgram broadcast of cosmic data. Its usual strength at that time is R6/7. E. J. WILLIAMS.

Portsmouth.

EDITORIAL NOTE.—It is pointed out by Greenwich Observatory that the magnetic storm type of fadeout, such as that in question, may very likely be due to the ejection of a jet of corpuscles from the sun, occurring at the time and in the region of a bright eruption in the sun's chromosphere, some 24 to 36 hours earlier. It is realised, of course, that the actual particles travel much slower than the speed of light, and, therefore, the magnetic or ionosphere storm, which results in the very poor propagation conditions on all frequencies, does not occur until later. By observation of sunspot activity it would seem possible to forecast such fadeouts some 30 hours ahead.

The fadeout mentioned in the report on April 15th by G2XC relates, of course, to the direct effect of ultra-violet light from the eruption, an effect which is, naturally, more or less instantaneous, but is of short duration and mostly affects the lower frequencies. In other words, the so-called Dellinger effect may be the forerunner of a much more violent ionosphere storm when the sunspot in question is near the meridian.

"Debunking Harmonic Distortion"

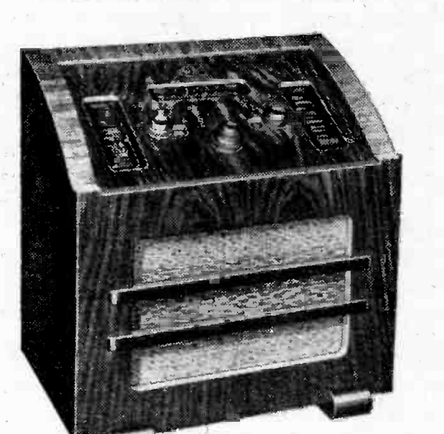
"CATHODE RAY" rather gives the impression in his article that the subject of intermodulation in valves is a new one, starting with Harries' February, 1937, *Wireless Engineer* paper, whereas it is nearly five years old (see references in Harries' paper).

Apart from the fact that undesirable distortion due to this cause has long been realised, not only in connection with valves, but with non-linear devices generally (iron cores, for example), it is probably true to say that the apparent absence of interest signifies mute assent. Had the subject been in contravention of fundamentals there would probably have been no shortage of letters to the Editor. In the case of intermodulation, however, no fundamental principles are attached, and anyone attempting an article on "Debunking Intermodulation" would, I think, particularly after "Cathode Ray's" lucid exposition, find it difficult to make out a case.

As a less serious challenge to "Cathode Ray's" claims to "heresy," and by way of reassurance to the effect that Harries' convincing experimental results met with a measure of response at the time, I may, perhaps, be permitted to quote a paper of mine despatched to the Institute of Radio Engineers on May 22nd, 1937. This paper, being somewhat comprehensive and mathematical, has not yet appeared in print, but will, I gather, be issued shortly. Section 4 of this paper is devoted to harmonic distortion, Section 5 to intermodulation. Whereas the results for harmonics confirm that it is an easy matter to arrange that the total harmonic distortion is well below 5 per cent. of the fundamental, it is found that tones of small amplitude can, by intermodulation with louder tones, and in virtue of curved characteristic, be distorted over 50 per cent. This result would refer to a pentode obeying a 3/2 power law. In the case of a triode, obeying a 3/2 power law, the effect of the load resistance in straightening the characteristic brings the figure down to some 25 per cent. In all cases the valves are supposed to be fully driven to the zero grid axis and any effect of grid current is neglected. Generally speaking, the experimental curves of Harries accord well with theory, but some of them appear to contain anomalies.

Ilford. W. E. BENHAM.

McMichael Model 380



THREE separate tuning scales for long, medium and short waves are a feature of this 9½-guinea AC superhet.—the first of the 1938 series. The circuit consists of triode-hexode frequency changer, pentode IF, double diode second detector, and AVC rectifier and pentode output valve with a rated output of 2½ watts. A two-speed drive actuates the three tuning scales simultaneously, and a visual indicator is used for both the volume control and the waverange switch.

New Range of Valves

SPECIAL DIODE TYPES FOR AVC PURPOSES

Concluded from page 475 of last week's issue

ALTHOUGH the low-noise RF pentode in the "E" series is of especial interest its advantages are largely confined to the first stage of amplification, and its low noise properties confer little benefit in later stages. Here other factors may be more important, particularly the variable-mu characteristics. As a result the range includes other types of RF pentode.

A variable-mu valve should have as low an anode current and as high a mutual conductance as possible at minimum bias,

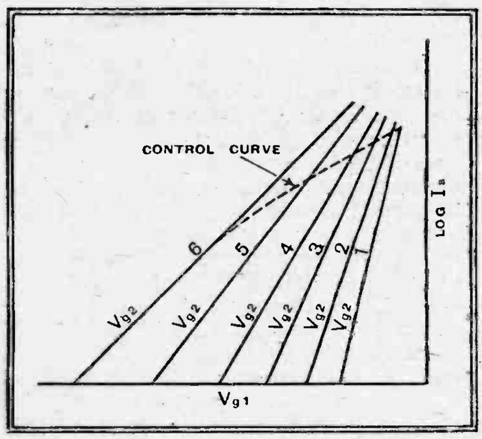


Fig. 4.—When a screen voltage-dropping resistance is used with a variable-mu valve, the effective control curve takes the form shown by the dash line.

and the maximum bias needed for control should be as small as possible. Since the characteristics of a variable-mu valve are necessarily curved, there are several possibilities of trouble; there may be distortion of the modulated waveform, cross-modulation, modulation hum, and the introduction of harmonics of the carrier. This last is important in the IF stages of a superheterodyne.

These troubles are minimised by the adoption of a valve characteristic of exponential form, having a flat slope when plotted on a logarithmic scale. Such a curve, however, leads to a low maximum value of mutual conductance or else a high anode current. For instance, for a mutual conductance of 2.0 mA/V. and a maximum grid bias of −60 volts, the anode current would be of the order of 14 mA.

In the case of the EF9, therefore, the desired characteristic is not a property of the valve alone, but of the valve in conjunction with the circuit. The desired result is secured by feeding the screen-grid through a voltage-dropping resistance instead of from the more usual potentiometer. The result is that as the grid bias is increased, the screen voltage rises. Referring to Fig. 4, the solid line curves show the variation of anode current with bias for a series of values of screen-voltage. With a constant-screen voltage the working point would be on the curve corresponding to the voltage selected. The dotted curve shows the effect of using a series resistance in the screen circuit. As the bias is changed the anode current alters according to this curve, but the characteristic for AC voltages is the solid line curve which intersects the working point.

The EF9 has input and output capacities of $5\mu\mu F$. and $7\mu\mu F$. with a grid-anode capacity of less than $0.003\mu\mu F$. With 250 volts HT supply, the screen should be fed through a 90,000-ohm resistance, and the anode and screen currents respectively are 6.0 mA. and 1.7 mA. The mutual conductance is 2.2 mA/V. at −2.5 volts grid bias, and the AC resistance is 1.25 megohm. The maximum grid bias is about 40 volts.

The Duo-Diode

The range includes a duo-diode triode, the EBC3, but perhaps the EB4 duo-diode with separate cathodes is of greater interest in view of the wide variety of uses to which it may be put. Apart from AFC circuits, it finds application in noise suppression arrangements, and one circuit is shown in Fig. 5. This is an extremely simple arrangement, and to clarify the diagram the diodes are shown separately. One diode is used as a detector and fed from the IF amplifier in the usual way, the load resistance and by-pass condenser being R1 and C2. The AF volts across this resistance are fed through the RC circuit C4 and R3 to the AF amplifier.

The cathodes of the controlled values are returned to the earth line and the grid circuits are returned through the usual filter C2 R2 to the diode load. The second diode, however, has its anode connected to the AVC line and its cathode taken to a point about 2 volts negative with respect to earth.

In the absence of a signal D2 conducts and there is a current through R1 and R2 and this diode. The voltage drop across the diode is small compared with that

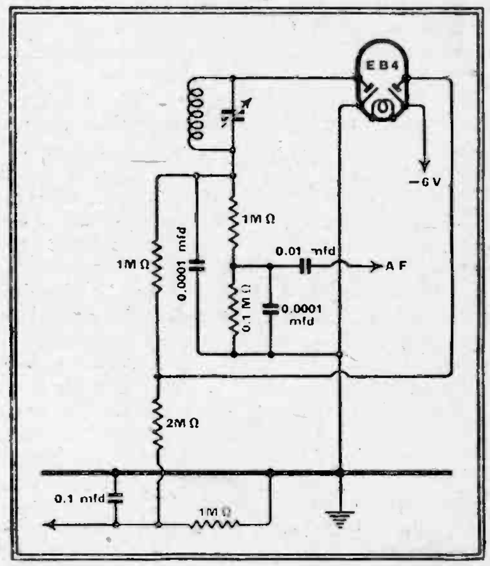


Fig. 6.—The recommended detector and AVC circuit for the EB4 is shown here.

across R1 and R2, and nearly the full 2 volts is applied through the diode to the grids of the controlled valves for their initial negative grid bias. A fraction of this voltage equal to $R_1/(R_1+R_2)$ is applied to the anode of the detector diode D1. This diode is consequently non-conductive and inoperative, so that it does not respond to weak signals and gives

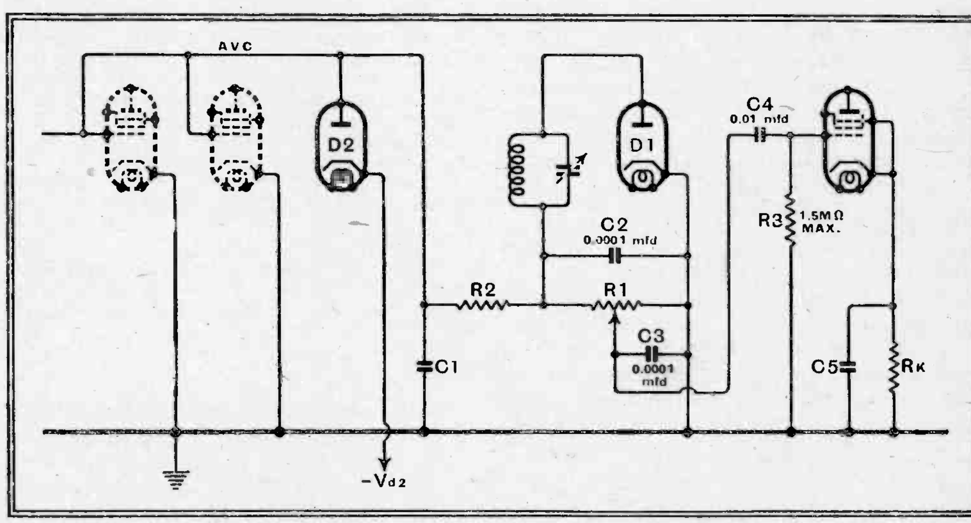


Fig. 5.—This circuit shows how delayed AVC, detection, and noise suppression can be obtained with a duo-diode.

New Range of Valves—

noise suppression. When a strong enough signal is tuned in, however, D1 begins to operate as a detector in spite of the small negative bias on its anode; a current consequently flows through R1 and a potential is developed across this resistance, making the diode anode negative with respect to the cathode. When this potential exceeds 2 volts the anode of D2 becomes negative with respect to its own cathode, and hence this diode becomes

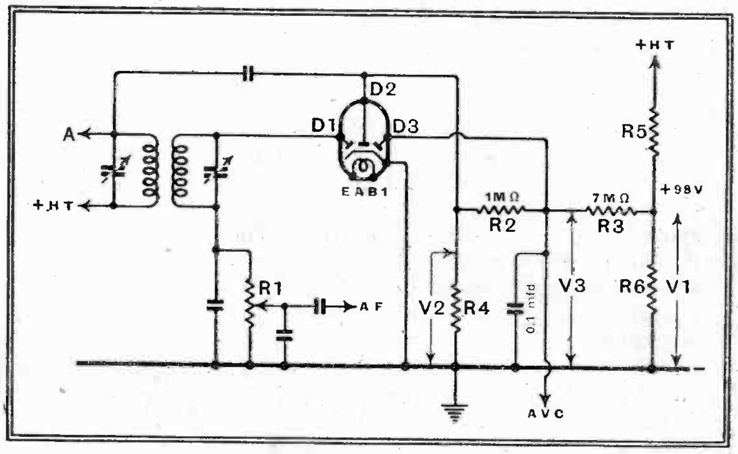


Fig. 7.—The use of a triple-diode for detection and distortionless delayed AVC can be seen from this diagram.

non-conductive. The initial bias is then removed from the controlled stages and the detector diode, for it has been overcome by the AVC voltage. For signal strengths great enough to produce more than about 2 volts AVC bias, the operation of the circuit is identical with that of the ordinary simple AVC system, for D2 then plays no part. For weaker signals D2 introduces muting and a small delay on AVC.

The Triple-diode

This circuit has the practical disadvantage that the delay voltage is equal to the initial bias of the controlled valves. Consequently, if a large delay is needed, the sensitivity is greatly reduced. This can be overcome by applying only a portion of the voltage across C1 to the controlled valves. If this is done, however, the AVC voltage is divided in the same ratio and the AVC characteristics suffer. Some compromise in design is thus needed. The recommended arrangement is shown in Fig. 6.

Another of the new valves is also designed for use in AVC circuits; it is a triple-diode and is used in the circuit of Fig. 7. One section D1 functions as a detector in the usual way and has the load resistance R1. The second section D2 is fed from the primary of the IF transformer; it has the load resistance R4, and also functions as a detector without delay. Its output is used for AVC purposes, and delay is subsequently introduced by the third diode D3. This is done in order to avoid the distortion which would be caused by using a delay voltage on D2.

The resistances R5 and R6 form a potentiometer across the HT supply, and a voltage V1, which is positive with respect to the earth line, is applied to the delay circuit through R3. This makes the anode of D3 positive, and it then has a very low internal resistance. The AVC line is then very close to the potential of the earth line. When signal strength increases a voltage V2 appears across R4, making the anode of D2 negative with respect to earth. When V2 is great enough it overcomes the positive voltage on D3 and this diode becomes non-conductive and negative with respect to earth. The potential of the AVC line then follows it.

The voltage V3 on the AVC line is given by $V_3 = \frac{V_1R_2 + V_2R_3}{R_1 + R_2}$. In design V3 is taken as the voltage at which the delay action is just overcome and is about −0.8 volt. V2 is then approximately equal to the peak RF carrier volts at which it is desired that AVC should begin to work. If this is 15 volts peak, then we have $-0.8 = \frac{V_1R_2 - 15R_3}{R_2 + R_3}$, and the values assigned to the parts must satisfy this relationship. Suitable values in this case are $V_1 = 98$ volts, $R_2 = 1$ MΩ, and $R_3 = 7$MΩ. Then after the start of AVC, $V_3 = 12.3 - 0.875\,V_2$.

In addition to these special valves, the "E" series includes two output pentodes —the EL3 and EL6—and a duo-diode-output pentode, type EBL1. This last is substantially the same as the EL3 with the additional diode elements.

The EL3 consumes 1.2 A. heater current and takes 36 mA. anode and 4.5 mA. screen currents at 250 volts. The normal bias is −6 volts and the mutual conductance 9 mA/V. The rated output is 4.5 watts into a 7,000-ohms load. The EL6 is a larger valve, taking 72 mA. anode and 8.5 mA. screen currents and rated for 8.2 watts output into 3,500 ohms. A pair in push-pull will deliver 16 watts for a no-signal anode current of 90 mA.; at full output this rises to 108 mA.

A cathode-ray type tuning indicator, EM3, is included in the range, and there are two rectifiers—the AZ2 and AZ3—taking 2 amperes at 4 volts. The AZ2 is directly heated and rated for 500-0-500 volts at 120 mA. or 300-0-300 volts at 160 mA., while the AZ3 is indirectly heated with a rating of 350-0-350 volts at 120 mA.

Direct Recording Blanks

The price of the M.E. recording discs is 2s. each, and not as given on page 450 of our issue for May 19th.

Random Radiations

By "DIALLIST"

The Drought and Earths

AS I write real rain still hasn't come, though heavy clouds and occasional fat drops have threatened (or should one say promised?) it for some days. I expect that a good many of those who live in those places with gravel soil, whose virtues are so much extolled by house agents, are suffering from the effects of absence of rain on their wireless reception, though possibly not all of them have realised it. During the great drought of 1934 one enthusiast of my acquaintance found that his receiving set was becoming poorer and poorer in its performance as the soil grew more parched. His conscience wouldn't allow him to break the existing regulations against watering gardens by pouring cool and refreshing draughts from the tap over the spot beneath which his earth-plate was buried. But he was a man of infinite resource. Why, he argued, should used bath water go to waste down the drains? To his earth-plate all water, clean or dirty, would be equally wet. Therefore he contrived an arrangement of piping which allowed the family's used bath water to be discharged at will in the place where it was most needed. The scheme worked like a charm, and I commend it to you should you be similarly situated and the drought continue.

Curious

Talking about earths brings to mind one rather queer fact. Nearly all set makers urge you in the book of the words which accompany their products to provide them not only with the best of aerials, but also with earths that are beyond reproach. Most mains sets are inclined to be noisy if the earth is not good, and there are many both of the mains and the battery varieties whose all-round performance is much below the mark unless they are well and truly earthed. But, on the other hand, I have come across not a few which seemed to be completely indifferent to the quality of the earth, and some which didn't appear to be handicapped by the entire absence of an earth connection. I have often wondered why this should be, and though I have devised various explanations I am not quite satisfied with any of them. I suppose that the metal chassis itself and any external wiring that may be connected to it—battery leads, for example—form the equivalent of a counterpoise; but one doesn't quite see why, in that case, of two sets each with metal chassis of about the same size and each with a similar amount of external wiring, one should be perfectly at home without an earth whilst the other is all at sea.

Our Queer Words

WHAT queer terms we do invent and collect in this hobby of ours! I notice just now quite a number of advertisements announcing receiving sets of the "communication" type. Offhand, one would have said that any wireless receiver might merit that adjective; it seems, however, that the word is now becoming crystallised as a term for a special kind of set. Designed originally on the lines of those used for the reception of messages rather than entertainment, the communication receiver is not intended to appeal to the mere "wetnose" listener who wants a receiver with the fewest possible number of knobs on its cabinet and the biggest possible number of station names on its dial. The communication receiver doesn't try to sacrifice efficiency to simplicity; if an extra knob is going to improve performance it will have an extra knob—or half a dozen for that matter. You won't find any station names on its dial as a rule, but you will find either good, open scales of kilocycles and megacycles or a degree scale of the kind which lends itself readily to calibration. Many of the communication receivers take in television sound frequencies, and most of them are provided with that most useful adjunct for short-wave and ultra-short-wave listening, the beat-frequency oscillator. I am all in favour of this kind of set—but I do wish that they had chosen a better name for it.

The Future of the "All-wave" Set

LATELY I have been wondering whether the alleged "all-wave" set will shortly be as widely seen in wireless shops and in the home as it is nowadays. Somehow I feel that there will be a tendency before long to return to the two-band receiver, at any rate in the cheaper models. To some extent the public was led up the garden by last year's Exhibition slogan, "The world is yours with modern radio," or words to that effect. And it didn't find that everything in the garden was quite so lovely as it had expected. It was given, though not perhaps in so many words, to believe that it had but to buy any three-band set at any price in order to be able to tune in America or Australia or Siam or Timbuctoo just whenever it felt so minded. As some of the cheap sets had short-wave departments of rather elementary design with the roughest and readiest of tuning arrangements, those who purchased them found that though they'd got the modern radio the world still appeared to consist mainly of

Broadcast Programmes

THURSDAY, JUNE 2nd.

Nat., 1.15 and 5.45, Cricket Commentaries: England *v.* The Rest. 6.20, "Forgotten Anniversaries"—An attempt on Queen Victoria's Life. 8. A Formby Do (with George Formby). 9.40, "Tosca," Acts 2 and 3 of the opera by Puccini from Covent Garden.

Reg., 6, Billy Cotton and his Band. 6.40, From the London Theatre—"People of our Class." 8.40, Hail, Variety! 9.20, A Record of the attempts to master Everest.

Abroad.

Milan Group, 9, "No, No, Nanette," operetta (Youmans).

FRIDAY, JUNE 3rd.

Nat., 7.15, Ray Noble and his Orchestra. 8.15 and 9.35, The fifth concert of the London Music Festival, 1938, conducted by Toscanini.

Reg., 7.30, "Under the Cheviots"—a story of life in Northumberland. 8, Stanelli's Bachelor Party—Ladies' Night. 9, Northern Music Hall.

Abroad.

Stuttgart, 7.15, "From 'Rose Marie' to 'Senorita'"—a Friml potpourri.

SATURDAY, JUNE 4th.

Nat., 1.30 and 4.50, The Walker Cup: Great Britain *v.* America. 3.45, Massed Pipers of the Scottish Regiments from the Royal Tournament. 8, Music Hall, including Ann Penn, Will Fyffe and Stainless Stephen. 9.20, American Commentary. 9.35, Experimental Hour—"Matrimonial News," specially written by Tyrone Guthrie.

Reg., 7.30, "Behind the Lace Curtains," a play by Esther McCracken. 8, The Birmingham Philharmonic String Orchestra. 9, Ray Noble and his Orchestra. 9.45, Tug-of-War at the Royal Tournament.

Abroad.

Deutschlandsender, 8, Dances of Grandfather's Day.

SUNDAY, JUNE 5th.

Nat., 10 a.m., Troise and his Mandoliers. 6.30, B.B.C. Theatre Organ with Alfredo Campoli, violin. 7, Mantovani and his Tipica Orchestra. 9.5, "The World of the Spirit," a programme devised for Whitsun, with the B.B.C. Singers (B) and Orchestra (C).

FEATURES OF THE WEEK

Reg., 5, Shanties and Sailor Songs. 6.50, "Forgotten Successes"—a comedy in three acts by T. W. Robertson. 9.5, Songs of the British Isles.

Abroad.

Königsberg, 8, "The Gipsy Baron," operetta (Johann Strauss).

MONDAY, JUNE 6th.

Nat., 3, The Locke-King Trophy; commentary from Brooklands. 3.45, Hurlingham Polo Commentary—The Empire Cup. 7, "Monday at Seven." 8.40, Final Instalment of "The Gang Smasher." 9.35, "Crush Hour," a tubular revue for straphangers.

Reg., 6, Brian Lawrence and his Orchestra. 7.45, "Dunmow Flitch," the rural trial for happily married couples. 8.25, "Rigoletto," Act 1 of the opera from Covent Garden.

Abroad.

Leipzig, 7.30, "Faust," opera (Gounod).

TUESDAY, JUNE 7th.

Nat., 7, The International Staff Band of the Salvation Army. 8, "The Silent Melody," a new musical comedy, including Bebe Daniels and Ben Lyon. 9.20, "My Best News Story," by J. L. Hodson—The First Aeroplane Across the Atlantic.

Reg., 8, "The Quiet House at Haworth," a microphone visit to the Parsonage where the strange genius of the Brontë family lives on. 8.25, "Gotterdammerung," Act 3 of the opera from Covent Garden. 9.35, B.B.C. Theatre Organ and three grand pianos.

Abroad.

Paris (Eiffel Tower), 8.30, Symphony Concert of music by famous composers.

WEDNESDAY, JUNE 8th.

Nat., 7, Ray Ventura and his Band. 8, Sir Adrian Boult conducts the B.B.C. Symphony Orchestra in Norwich Cathedral. 9.20, The Way of Peace. 10.15, 11.15 and 11.40, Relays from the Aldershot Tattoo.

Reg., 8, Dave Frost and his Band. 8.30, The World Goes By. 9, "The Silent Melody."

Abroad.

Warsaw, 9.10, Chopin Recital by Zofia Zabcewicz.

Random Radiations—

Europe so far as their radio reception was concerned. Many have, unfortunately, come to regard the short waves as not much fun on this account, and I shall be surprised if in the future "all-wave" sets of the kind of which I am talking continue to have any strong appeal. If the man in the street but knew it, he would get a much better bargain in the low-priced set if all the money that he spent on it went to making it the best possible performer on the medium and the long waves.

A Luxury Receiver

All of us who go in for short-wave reception know that it does demand a really good set if it is to be worth while. That's why I think that the "all-wave" receiver may be in the future what it should have been in the past, a luxury, or at any rate a semi-luxury set. You have only to look at a list of stations with their frequencies to appreciate one reason why this should be so. A 300-metre medium-wave station has a frequency of 1,000 kilocycles; a 30-metre short-wave station, a frequency of 10 megacycles. The short-wave station is at least ten times as difficult to tune in properly. That naturally means that if the tuning arrangements are such as are just about good enough for medium-wave stations, you are not going to have a very large bag on the short waves. For satisfactory short-wave work you must have band-spreading, you must have tuning arrangements with real slow-motion and smooth-motion as well, and you must have an oscillator that doesn't creep, let alone *gallop*, as those in some of the cheaper sets that I have tried are prone to do. These things and other refinements that make reception really worth while you can't expect (or if you do you certainly won't get them) in a receiving set, the price of which in pounds can be expressed by a single modest figure.

A Hot Weather Change

AS I rather thought might be the case, AIR, the Indian Broadcasting Authority, has had to drop for the time being the use of the 90.8-metre wavelength for the evening transmissions from Bombay No. 2. When this wavelength was adopted it was predicted that it wouldn't work during the hot weather on account of the prevalence of violent atmospheric interference. Listeners of long experience foretold that reception would be impossible on any wavelength much over 60 metres, and this has turned out to be true. Bombay is now using 61 metres (4.905 megacycles) for its evening transmissions. The output rating of the station, whose call-sign is VUB2, is 10 kilowatts, and reception in this country should be possible when conditions are favourable. The short-wave transmitter is at work from 1 p.m. until 6.30 p.m. BST.

Nearing Saturation ?

THE increase in the number of wireless licences during April was the smallest for the last three years, the total being only 18,679. This compares with nearly 50,000 for last year, just under 26,000 for 1936 and between 43,000 and 44,000 for 1935. It looks as if the upward curve were now really beginning to flatten out, and we can't be surprised, for the total is now, in round figures, 8,600,000 for England, Scotland, Wales and Northern Ireland. The number of homes in the whole country is round about 13,000,000, so that there cannot now be such a very great number of people able to afford a wireless set who haven't got one. That doesn't mean that there's going to be no increase in the number of licences in the future. There will be for a very long time to come, though naturally we can't expect it to go on at the previous rate. After all, it was predicted long ago that we should never get much beyond the 5,000,000 mark. Forecasts have been revised again and again since we passed it, but most people seem to agree nowadays that 9,000,000 is about as far as we can expect to go in the next year or two.

Inconstant Reduction Gear

Automatic Change-speed Drive

A TWO-SPEED reduction drive between a tuning condenser and its actuating knob is common enough, but the speed of either drive is (ignoring possible accidental effects of slip) constant throughout its working range in the conventional arrangement.

The suggestion is now made that in certain cases it would be desirable to arrange for equal increments of angular movement of the control-knob spindle to impart unequal increments of movements to the moving vanes of the associated condenser. For example, it might be desirable to provide automatically for extremely accurate and critical tuning over a section of the tuning scale, adjustments over the remainder being relatively rapid and coarse.

This might be accomplished by means of a reduction drive which rotates the condenser shaft through the medium of a rack and pinion, the rack being formed against the surface of a cam mounted on the control spindle or on a spindle geared to it. The cam may be so shaped that the movement imparted to the shaft of the condenser obeys any desired law; the cam would preferably be arranged in the form of a disc provided with a suitably shaped slot which would form a guide for the projection associated with the rack.

THE WIRELESS INDUSTRY

THE Park Royal factory and offices of the British Rola Company, Ltd., will be closed from Friday evening, July 22nd, to Monday morning, August 8th. The Company's customers are asked to anticipate their requirements over this period.

A leaflet describing the new Pilot Model B43 all-wave battery superheterodyne has been issued by Pilot Radio, Ltd., 87, Park Royal Road, London, N.W.10.

Mr. L. B. Felton, lately Radio and Electrical Sales Manager and Director of British Mechanical Products, Ltd., Westminster, S.W.1, has resigned his directorship and severed active connection with the Company.

The Furzehill Laboratories, Boreham Wood, Herts, have issued an illustrated catalogue of laboratory equipment. Cathode-ray gear, oscillators, signal generators (including a simplified model for service work) and other apparatus are included.

Dolmetsch Recording, Jesses, Haslemere, Surrey, notify us that they are producing cutters for direct recording on cellulose acetate discs. Samples and prices will be sent on request.

Sound Amplifiers, Ltd., 21, Queen Square, Leeds, 2, have issued a leaflet describing the various kinds of gramophone recording that they are prepared to undertake.

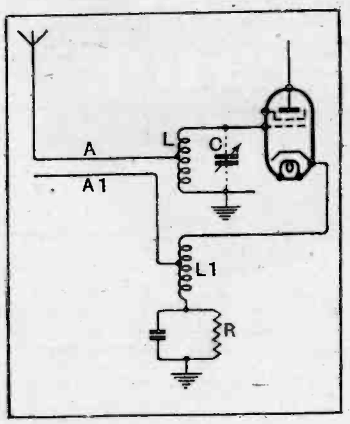
Recent Inventions

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. A selection of patents issued in U.S.A. is also included.

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

ELIMINATING "STATIC"

STATIC or other local disturbance, picked up by the aerial lead-in, is automatically balanced out against similar voltages picked up on a "dummy" lead. As shown in the drawing, the aerial down-lead A is taken to the centre of the grid or input coil L, whilst the



Circuit arrangement for suppressing electrical interference.

"dummy" lead A1 is tapped to a similar coil L1, which is included in the cathode circuit of the amplifier, in series with the usual biasing resistance R.

Any fluctuations of grid voltage produced by static interference will now be offset by similar fluctuations of voltage applied through the "dummy" lead to the cathode. The amplifier will, therefore, respond only to those grid variations which are due to the desired signal. A condenser C is shunted across the grid coil to compensate for the extra capacity effects of the cathode coil L1.

E. K. Cole, Ltd., and G. Bradfield. Application date, September 18th, 1936. No. 481806.

o o o o

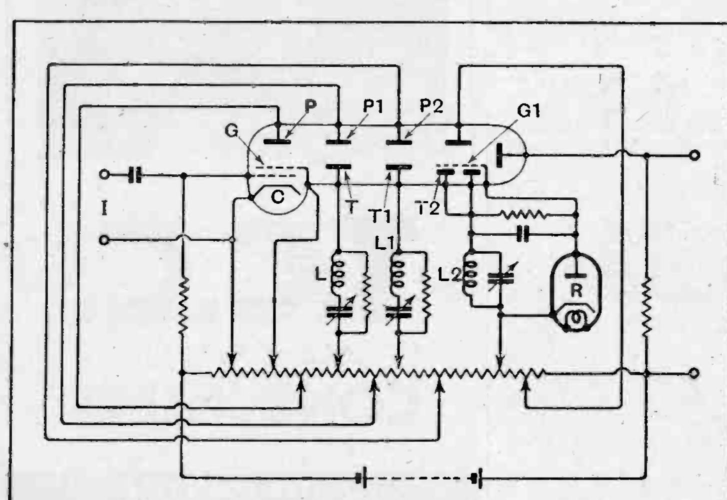
SECONDARY-EMISSION AMPLIFIERS

THE modern electron-multiplier is capable of giving enormous magnification, but has not yet succeeded in competing with the ordinary valve amplifier for work which requires some degree of selectivity. In practice the multiplier treats all frequencies alike, and even if unwanted frequencies are removed, subsequent to amplification, this does not prevent the production of cross-modulation effects.

According to the invention, the overall gain of a secondary-emission amplifier is made dependent on frequency by connecting one or more of the "target" electrodes to the voltage supply through tuned circuits. The Figure shows a wireless receiver in which electrons coming from the cathode C are deflected by a plate P and a transverse magnetic field (not shown) on to a target electrode T, where secondary emission takes place, the amplified stream being similarly directed, in turn, against other targets T1, T2 by the charged plates P1, P2 and the transverse magnetic field. Incoming signals are applied to the input grid G, and the targets T, T1 are connected to the supply potentiometer through circuits L, L1 tuned to the carrier-wave frequency. A parallel-tuned circuit L2 in the last stage helps to build up voltages at the signal frequency, which are rectified at R and applied to a detector grid G1.

The General Electric Co., Ltd., and N. R. Bligh. Application date, September 21st, 1936. No. 481750.

o o o o

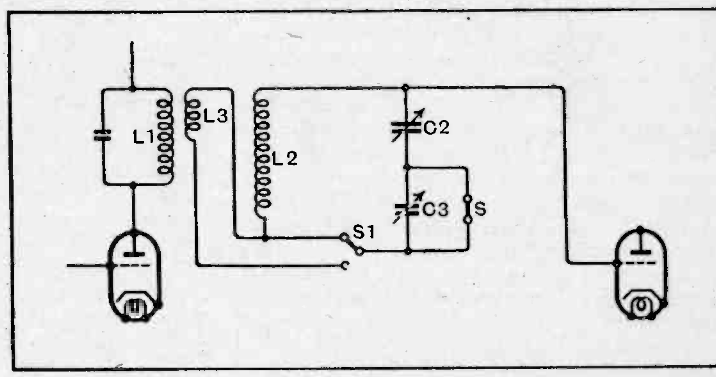


Electron multiplier valve and circuit designed for radio reception.

SELECTIVITY AND QUALITY

WHEN a set is switched over from a highly selective setting to receive a less-distant station at better quality, it is usual to damp the tuned circuits either by inserting resistance (which naturally introduces losses) or else by tightening the coupling. The latter expedient similarly reduces efficiency and may also introduce distortion due to the change of resonance.

The Figure shows an arrangement which is said to be free from both defects. For the selective reception of a distant station, the switches S and S1 are in the position shown, so that the primary coil L1 is coupled only to the secondary coil L2, which is tuned by the condenser C2. For higher-quality reception, the switch S is opened and the switch S1 changed-over to the lower contact. This inserts a coil L3, which is closely coupled to the coil L1, in series with the coil L2, and introduces a condenser C3 in series with C2. The condenser C3 is pre-set to a value which makes the new circuit resonate at the same frequency as the current used in the first or highly selective position.



Circuit giving high or low selectivity and constant gain.

E. K. Cole, Ltd.; A. W. Martin; and H. Hunt. Application date, November 30th, 1936. No. 481310.

o o o o

A TELEVISION-BROADCAST RECEIVER

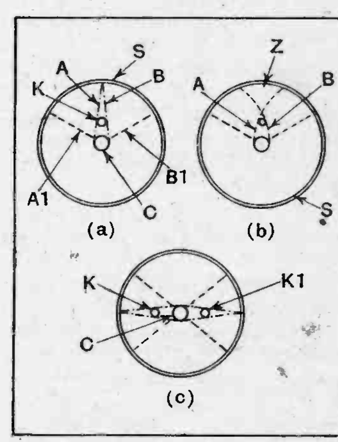
SHORT-WAVE television signals, as well as the associated sound programme, which are usually transmitted on wavelengths of 6.6 and 7.2 metres respectively, are separately heterodyned in the same set, the video signals being fed to a cathode ray tube, and the audio signals to a loud speaker. Provision is also made for receiving ordinary broadcast programmes on the same set. Long or medium wave signals are picked up on a separate aerial, and are heterodyned by a local oscillation which is obtained by combining the two oscillations used in the short-wave circuits. The two oscillations in question are applied to two separate grids of the long-wave "mixing" valve, the incoming broadcast signals being applied to the third grid of the same valve. The resulting intermediate frequencies are then rectified and fed to the loud speakers used to reproduce the short-wave programme.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of A. A. Linsell). Application date September 18th, 1936. No. 481893.

LUMINOUS INDICATORS

IN a visual tuning indicator of the miniature cathode-ray type, a rod-like electrode K, shown in plan in the figure (a) controls the stream of electrons from a cathode C, and is so biased that, in the absence of any signal, only a very narrow zone AB (where the lines converge) of the cylindrical fluorescent screen S is illuminated. When a signal is tuned in, the control voltage on the electrode K becomes practically equal to that on the fluorescent screen, so that the illuminated zone spreads out, as indicated by the lines A1, B1.

If the biasing voltage is increased, the two lines A and B can be made to overlap, as shown in (b), to form a more-intensely illuminated zone Z which can be used to indicate the tuning over a second range of wavelengths. By placing control electrodes K, K1 on each side of the cathode C, as shown in (c), double zones of



Diagrams illustrating illuminated zones on screen of tuning indicator described in the text.

illumination are formed, as indicated by the dotted lines, to give "pattern" tuning.

Instead of depending upon luminous zones, the "dark" space between them can be used to show, even more precisely, when the circuits of the receiver are correctly in tune with the signal.

Marconi's Wireless Telegraph Co., Ltd. (assignees of H. C. Thompson). Convention date (U.S.A.), June 27th, 1935. No. 481791.

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.

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EDITORIAL COMMENT

Television Triumphs

But Public Response Disappoints

THE excellence of the television transmission of the Derby was a matter for congratulation to all those members of the B.B.C. staff who had a hand in the arrangements, and also to the E.M.I. engineers responsible for the apparatus employed for the transmissions from Epsom.

The very fact that this transmission was such an outstanding success and that the standard of television transmissions in general has improved so greatly during the past few months, seems to us to intensify the seriousness of the present position in this country in regard to television progress.

Here we have at our disposal a scientific achievement, probably more remarkable than anything which science has produced for us during the past fifty years. Very large sums of money are being expended on the television service, and yet we are still practically in the dark as to whether or not television is going to make an appeal to the public sufficient to justify this outlay and provide a commercial return for those who have incurred the cost of developing the apparatus which has made television possible.

The Radio Manufacturers' Association has decided to give television a great " boost " at the Radio Show in August, and there seems little doubt that the Exhibition will make visitors to it television-conscious and receptive to the idea of acquiring a set for the home. But we must remember that television was a prominent feature of the Ideal Home Exhibition recently, and we believe that there has so far been little evidence that that publicity produced any appreciable increase in actual sales of television receivers.

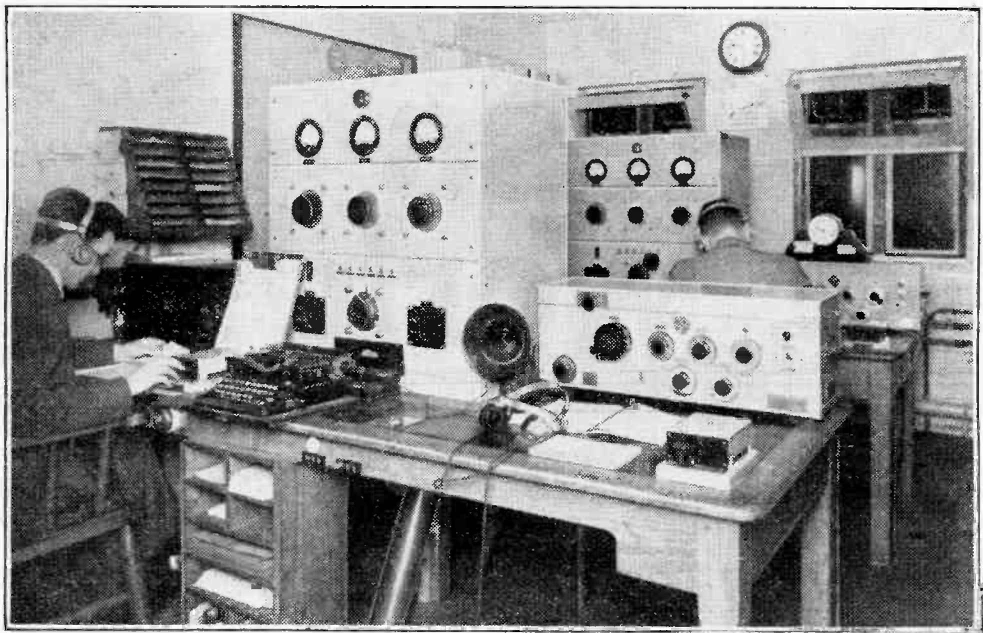
We would suggest that the time has come when it is imperative to ascertain what is the real reaction of the public to television, with a view to discovering why there is not greater enthusiasm to acquire receivers.

The Television Committee might well consider the possibility of a carefully compiled questionnaire to be distributed to the public, perhaps, on the occasion of the Radio Exhibition, the object of the questionnaire being to obtain a series of answers which would provide an explanation of why public response is disappointing.

Finding the Weak Spot

Reasons which one hears put forward to explain why television sets are not in greater demand are very varied and none of them convincing. They can, we think, be grouped under three or four heads, as follows:—(1) Receivers are thought to be still experimental and likely to become out of date if purchased now; (2) The cost is considered prohibitive and the public is waiting for price reductions; (3) The bulk of the programme material is unsuitable; (4) Television is not wanted by any large section of the public and never will be, because it is compared with the cinema but lacks many of its advantages.

If a representative cross-section of the public could be induced to provide answers to a questionnaire, then it might well be that we could put a finger on the weak spots of television development, but at present we feel that there is nobody in a position to explain why this amazing technical achievement, providing a novel form of entertainment and interest, on which very large sums have been expended, has failed, so far, to catch on with more than a very small percentage of those who are well able to afford receivers at their present price.

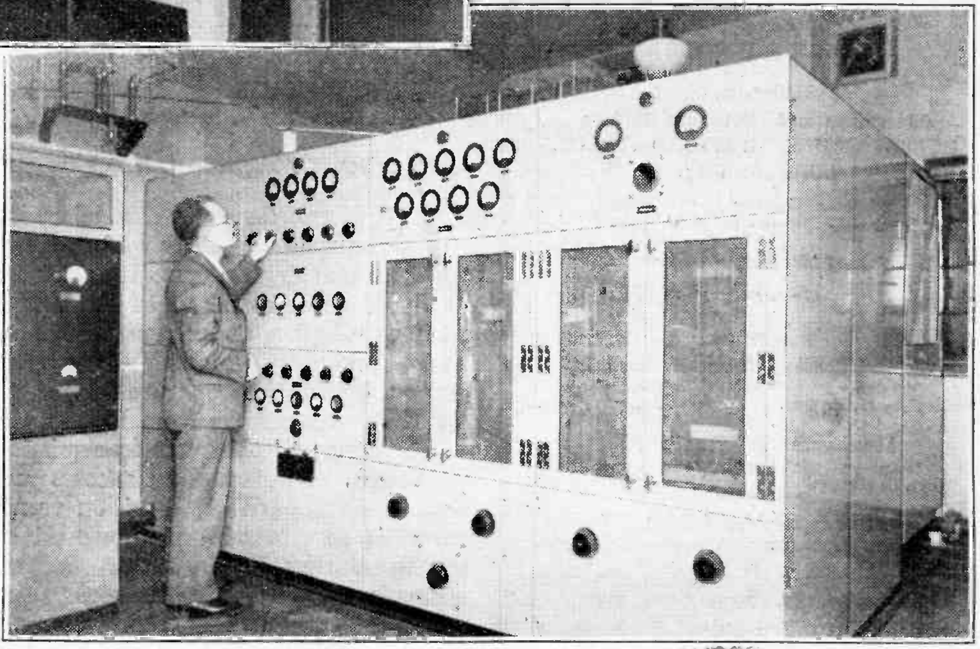


Serving th

MULTIPLE-CHANNEL WORKING AT WICK RADIO

By J. AINSLIE

Operating Room at Wick Radio. No. 1 transmitter is controlled from the panel on the front bench, at which there are two operating positions. Control of No. 2 transmitter is similarly effected from the bench in the background.



No. 1 transmitter at GKR, operating on 435, 500 and 1528 kc/s ICW or CW, 1837 kc/s RT, 2505 kc/s ICW or CW, and 2605 kc/s RT. The emergency transmitter is on the left.

THE advance of wireless communications depends to a great extent upon improvement in technique and organisation, and the great strides forward which have been made are largely due to the invention of methods of isolating the ever-increasing number of radio stations from the influence of their neighbours; this is equally true in the case of ship-shore radio services as it is for broadcast and telegraph and telephone point-to-point ones.

In 1927 there were some 200 British small craft fitted with radio transmitters and receivers; to-day there are over 1,300, one-third of the total number of British vessels that are equipped for wireless communication. A decade ago these two hundred trawlers and a few tugs were served by our coast radio stations on spark, using frequencies of 1,360, 500 and 375 kc/s; to-day over six times that number of trawlers, coasters, yachts, drifters, cross-Channel ships, tankers, tugs, tenders and lifeboats employ either ICW or RT, and are catered for on a multiplicity of frequencies.

British coast stations are concerned with the safety of life at sea, direction finding, medical advice and the emission of weather bulletins, gale and navigation warnings, as well as with the acceptance and delivery of radiotelegrams. Wick is the busiest of the coast stations, for it handles the greater part of the small-craft traffic load, and here the problem was how to operate Morse and radiotelephony services simultaneously on a number of frequencies on the same site. It was undesirable on economic grounds to provide separate transmitting and operating stations, particularly as arrangements for simultaneous working might have to be provided at other points at some future date.

Now, the theory concerning transmission over concentric conductors dates back some twenty years, but it was only within the last year or two that this arrangement came into prominence for high-frequency transmission purposes. The freedom of a coaxial cable from the effects of external disturbances is due to the electrostatic and electromagnetic screening effects of the outer conductor; also, a cable of this type allows of the transmission of a band of high radio frequencies, with negligible attenuation and distortion, and therefore appeared to offer a solution of the Wick Radio problem of providing a suitable "lead in" from an aerial system about a mile from the station. A screened operating room was, of course, necessary, together with transmitters and receivers of a high standard of performance.

Multiple Aerial System

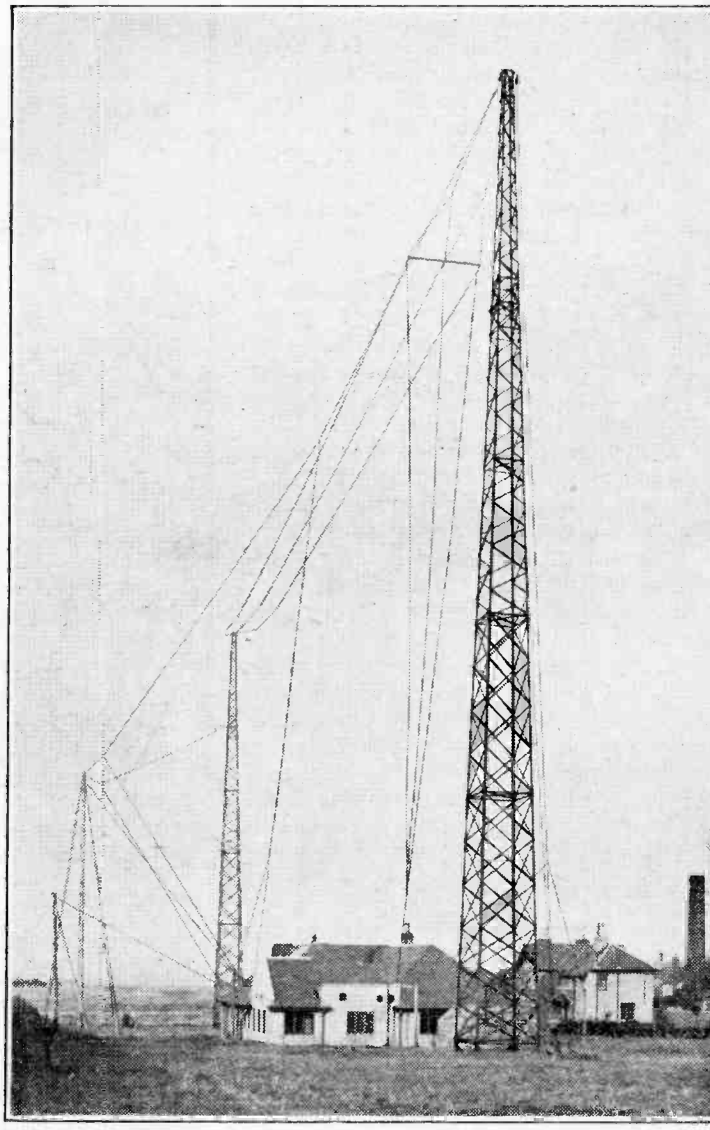
The Wick Radio building, in which both the transmitting and receiving equipment are housed, lies directly under the main transmitting aerial, which is suspended between two 140ft. steel lattice towers. In addition to this aerial, which serves for frequencies of 435 and 500 kc/s, three single-wire vertical aerials are available for emissions on 1,528, 1,650, 1,837, 2,505 and 2,605 kc/s.

The problem of effectively screening the wireless operating room was made more difficult by the immediate proximity of the machine, transmitter and telegraph rooms, each of which was a potential source of interference in one form or another, particularly where high-sensitivity receivers were to be employed. The difficulty was overcome by converting the operating room into what is virtually a tin can; the walls and ceilings were metalised, the floor, door and cable chases copper-lined, and the windows glazed with wired glass. The whole screening was thoroughly bonded and earthed, and each lead, whether in the supply or control circuits for the transmitting and receiving equipment, or in the power or lighting circuits, filtered on entering and leaving the room.

The remote receiving antenna system consists of three inverted "L" aerials for use on the 1,500/3,000 kc/s waveband, and connection between the coaxial cable

Fishing Fleets

IN order to cope with the large and ever-increasing volume of radio traffic with the fishing fleets in Northern waters, as well as with its other coast-station duties, Wick Radio (GKR) has recently been modernised, provision having been made for simultaneous working on several channels



Aerials at GKR, with station building between the lattice masts and official residence to the right.

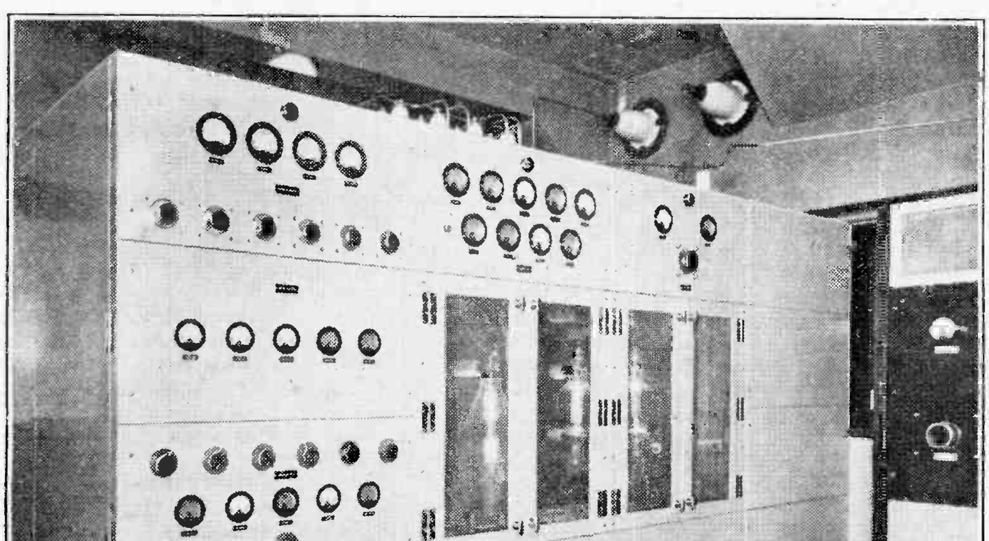
leading-in points and the receivers is made by means of flexible screened cable. A remote "Adcock" direction-finding aerial system has also been provided.

In the operating room four manipulative positions are disposed, one on each side of the two transmitter control panels, and at each of these receiving points is fitted a superheterodyne receiver, a microphone, a morse key and a send/receive switch. Other simple switches at the operators' hands provide for the automatic sending of the "Alarm Signal" and for simultaneous speech or WT transmissions on two frequencies.

Receiver Details

The type of receiver used comprises an RF stage, triode-pentode frequency changer, high-frequency pentode IF amplifier, duo-diode triode, output pentode and a separate beat oscillator for CW reception. The duo-diode triode functions as second detector, AF amplifier and source of delayed AVC voltage. The signal-frequency range is from 183 to 2,750 kc/s in three separate ranges. The circuit design follows normal practice; the IF used is 110 kc/s —a frequency suggested some years ago by Mr. W. T. Cocking, of *The Wireless World*—and provision is made whereby the adjacent channel selectivity may be continuously varied from eight to one kc/s. Each receiver is fitted with a simple switch for remote receiving aerial selection purposes.

The receivers are designed for AC, and as the local power supply is DC they are normally run from rotary converters. They may, however, be readily changed to DC operation; in this case HT is supplied from the mains and LT from large-capacity accumulators. Battery-driven converters are also installed so that reception can be maintained in the event of a failure of the power supply.



No. 2 transmitter works on 435, 500 and 1528 kc/s ICW or CW, 1650 and 1837 kc/s RT, and 2605 kc/s ICW or CW.

The transmitters are remotely controlled from the operating room, the control panels being provided with press-button switches for starting and stopping the high-tension and filament-heating alternators and associated voltage regulators, and also a switch for the selection of transmitter frequencies and systems.

The two main transmitters—there is a third, a battery-driven, low-power one for emergency purposes—are capable of operation on any one of six frequencies, and are so arranged that either may work independently of the other, provided that identical frequencies, or frequencies of insufficient separation, are not required. Interlocking of the control wiring has been arranged to prevent the second transmitter coming into operation on, or near, the frequency being used by the other. Pilot lamps are provided on the control panels of each transmitter to indicate which frequency is occupied by the other.

Two telephony and four telegraphy frequencies are available on each transmitter; these are given in the inscriptions to the accompanying photographs of the apparatus.

Each transmitter is crystal-controlled

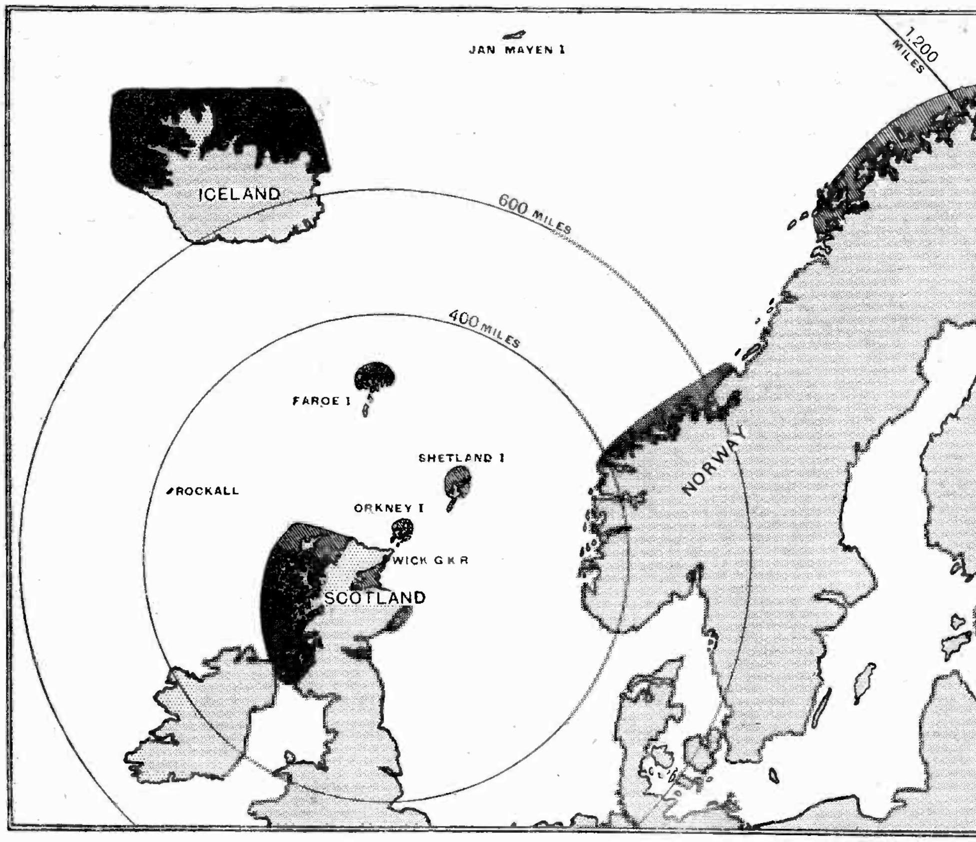
Serving the Fishing Fleets—

on all frequencies, and comprises three stages—oscillator, buffer and amplifier. The input power to the amplifying valves in the carrier condition is 1.7 kW and 2.4 kW on ICW. The carrier aerial power is about 600 watts.

The note frequency for ICW working—900 cycles—is obtained by means of a modulator stage, and CW can be used on any frequency by switching at the control panel.

The power supply is from a three-wire DC system at 460/230 volts, which can be taken from either of two cables. This arrangement allows the radio station to be fed from alternative sections of the power company's distribution system. The 460-volt supply is used for the motor alternators and the battery-charging equipment; the 230-volt supply serves lighting, teleprinter, receiver and control circuits.

In general, the transmitters present no unusual features other than their flexibility from manipulative and control viewpoints. It is their operation in conjunction with the receiving arrangements described which enables Wick Radio to maintain continuous simultaneous services on the lines and at the ranges indicated on the map. The ship-to-shore channels utilised are 375, 425, 500, 1,520, 1,650, 2,012 and 2,500 kc/s.

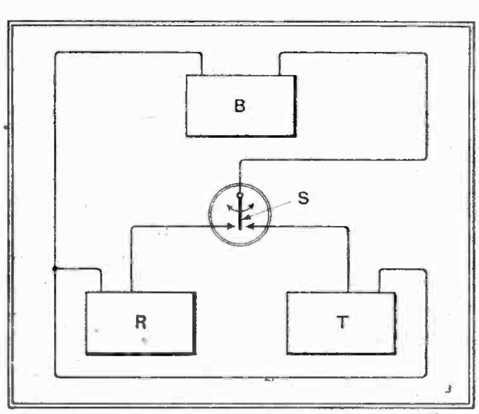


GKR's "sphere of influence" embraces most of the Northern fishing grounds. Under average conditions the more distant White Sea and Bear Island grounds are worked on 120-metre morse after darkness has fallen at Wick, while during daylight signals on 197 metres morse are exchanged with vessels within a 600-mile radius. The 400-mile circle represents the average maximum daylight range for 163-metre radio-telephony. In the black areas severe screening is experienced, while in the shaded areas this trouble is present in a less acute form.

Wireless on the Road

THE idea of fitting motor cars with wireless equipment for traffic signalling—as distinct from receiving the broadcast programmes — presents certain advantages. Radio signals could be used, for instance, in foggy weather, and as a substitute for the noisy horn at sharp turns or when approaching cross-roads in daylight. There is also the possibility of supervising road traffic from a fixed radio beacon when the use of coloured lamps might be either inadequate or undesirable.

The equipment would consist of a combined transmitter and a receiver, in order to allow each car both to give and receive signals. In practice it would also be necessary to use a common fixed wavelength for all cars. The problem, then, is to prevent the transmitter on any given car from affecting its own receiver, because this would shut out from the latter any warning signal that may be "on the ether" from another car.



Signalling system for cars: the vibrating switch ensures that transmitter and receiver will not be operative at the same time.

The figure shows one method of overcoming this difficulty (Patent 465129). The transmitter T and receiver R on each car are alternately connected to a source of energising current through a vibrating switch S which allows either one or the other to become effective, but not both together. An interesting feature is that the two-way switch S is operated in some definitely irregular fashion, such as by road shocks, or by a fluctuating movement derived from the engine, the object being to avoid the possibility of the switches on any two cars being identically "timed." In other words, it prevents the receiver on one car from being switched off at the exact moment when the transmitter of an approaching car is switched on—in which case, of course, the former would not receive the warning signal. Meanwhile each switch cuts out the receiver when its own transmitter is in action, so that it is not swamped by the local radiation.

The arrangement ensures that a radio warning signal transmitted by one car must energise the receiver of any other car in the vicinity, and vice versa. The incoming signals may be used to flash a light on the dashboard, and simultaneously to light up red lamps in the front or rear of the vehicle; or they may sound a buzzer or bell to give an audible warning to the driver.

Economy or Quality

A Change-over Switch for Battery Sets

IN the interests of HT battery economy many users of battery sets would be willing on occasion to tolerate reproduction of a lower standard than the best that the receiver can give. With this idea in view the proposal has been made that a "quality-economy" two-way switch might be provided.

Such a switch may be arranged to insert (in the "economy" position) a resistance in the HT lead in order to limit HT consumption when listening to local stations. The resistance may be placed so as to cut down the supply to the voltage amplifying stages only so as to reduce the sensitivity while maintaining the normal undistorted output from the last stage, or, alternatively, the resistance may be arranged to cut down the supply to all the valves, including the output stage, in which case a somewhat lower and distorted output is obtainable.

It has been found possible by this means to halve the HT consumption; for example, a reduction from 8 mA to 4 mA has been obtained while still providing reasonable quality and volume of reproduction on the local stations. It is expected that the life of the battery will be extended from 300 hrs. to 600 hrs.

The arrangement is applicable to both TRF and superhet battery receivers, but in the case of the latter care must be taken to see that the oscillator anode voltage is not too greatly reduced. On the other hand, if exceptionally good reproduction of local station programmes is desired and provision is made to cut down the current of the voltage amplifying stages only, then assuming that the output stage is biased by the total receiver current, a larger DC feed to the output stage is simultaneously obtained.

In the case of receivers with AVC, it may be simpler to arrange for an increase in the standing negative grid bias voltage on the AVC line. In this connection it may be pointed out that, on account of the relatively poor regulation given by AVC in most battery receivers, the controlled stages are not sufficiently biased back on local stations, and so HT current to these valves is wasted.

Five-metre DF

ADAPTING AN EXISTING RECEIVER

By H. B. DENT (G2MC)

A SUGGESTION for improving the sensitivity and performance of an ultra-short-wave set when adapted for direction-finding experiments. The loop aerial and detector valve, with its associated components, are mounted at the top of an elevated pole; in this way the "vertical aerial" effect of the necessary connecting leads is avoided.

THIS summer's programme of field days has by now been published by most Radio Societies, and in the majority of cases some of the events will be concerned with five-metres.

The attraction of the ultra-high-frequency band is that it is still very much an unknown quantity, though certain valuable facts have come to light as the result of work carried out by many experimenters during the past year or so.

Perhaps it might be of some interest to recapitulate what so far is known about this band. In the first case it has been proved that five-metre signals are not confined to a visual path and generally they are audible well beyond the horizon. It is important that the waves get a good start, that is to say, a good transmitting site is essential. Better signals are heard even in a comparatively poor receiving position if this condition obtains, while a good receiving position will not be very beneficial if the transmitter is poorly situated.

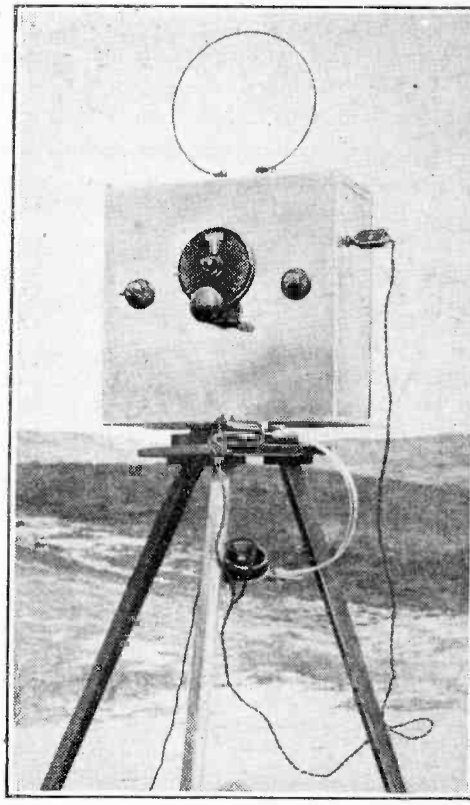
Again, evidence is available showing that a horizontal aerial is in general better for long-distance transmission than a vertical aerial, but the horizontal kind is, of course, more directional.

The type of aerial will thus be governed by the nature of the tests to be carried out. If point-to-point working is to be attempted a horizontal aerial will usually give the best results; on the other hand, if direction-finding experiments are in view the transmitting aerial must not be directional, so that for this purpose the vertical aerial will have to be used.

There is not a great deal of time now in which to construct entirely new sets, so it is worth while to consider the possibilities of adapting an existing five-metre receiver for DF work.

The super-regenerative type of set is used extensively for portable work, as it is compact, quite sensitive and economical so far as HT and LT consumption is concerned, few sets of this kind having more than three valves. A typical circuit is shown in Fig. 1.

Adaptation for direction-finding is quite a simple matter, as it only requires that the coils L1, L2 be replaced by a single-turn loop. A high order of accuracy can hardly be expected with a simple set of this kind, but it will answer the purpose for initial experiments, and, if one has a reasonable amount of luck, will enable the transmitter to be located, if not entirely by DF, then at least by a combination of wireless and scout-craft.



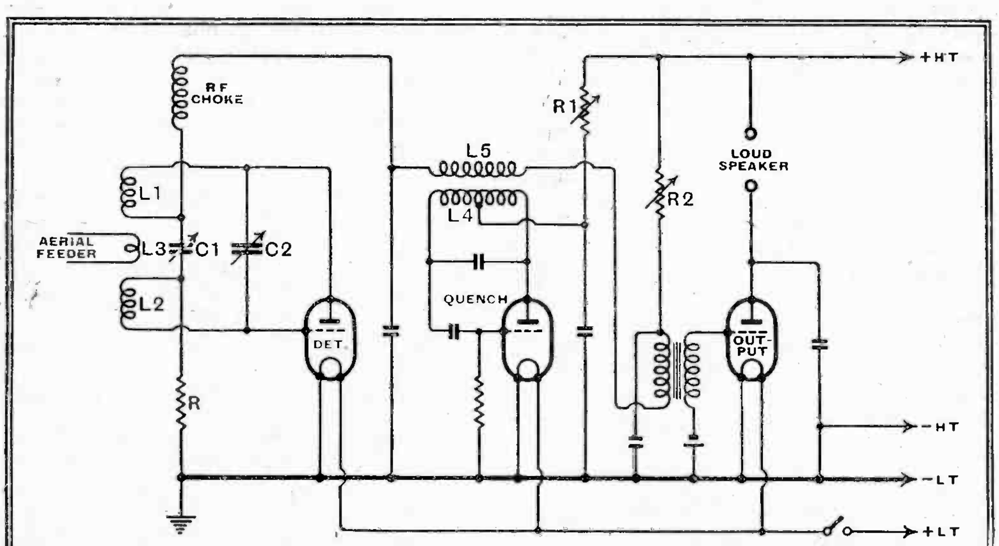


Fig. 1.—A typical ultra-short-wave super-regenerative receiver of a type suitable for adaptation to direction-finding work in the manner suggested in this article.

When altered as suggested, the performance of the receiver will fall much below that of the original set with an elevated aerial owing to the low height of the loop, and unless one happens to be reasonably near the transmitter probably no signals will be heard.

This is, of course, a serious drawback because on starting out the participants in the event have only the vaguest idea of the location of the transmitter. It is obviously essential that signals must be heard before any attempt can be made at DF.

One solution to this problem is to arrange for the loop aerial to be fixed at the top of a sectional pole consisting of two four- or five-feet wooden rods socketed together. The difficulty of feeding the incoming signals to the first valve then arises, for if an ordinary feeder is employed it might itself act as a vertical aerial, admittedly untuned but with quite enough pick-up to upset the directional indications of the loop.

Elevated Loop-detector Unit

However, as the loop *must* be raised as high as convenient the best thing to do is to hoist the detector valve up with it and feed only HT, quench voltage and audio signals by means of the cable.

This can be done by making up a small unit to the circuit shown in Fig. 2. Only a two-wire cable will be required, as the filament of a battery valve can quite well be lit from a 3-volt dry battery with some resistance in series.

RF chokes joined at the top of the cable, one in each lead as shown, will effectively isolate the detector stage from the quench and AF portion of the set, and moderately

Five-metre DF—

good directional effects will be obtained.

Tuning of the loop will call for a little mechanical ingenuity, but only C2 of the two condensers C1 and C2 needs tuning;

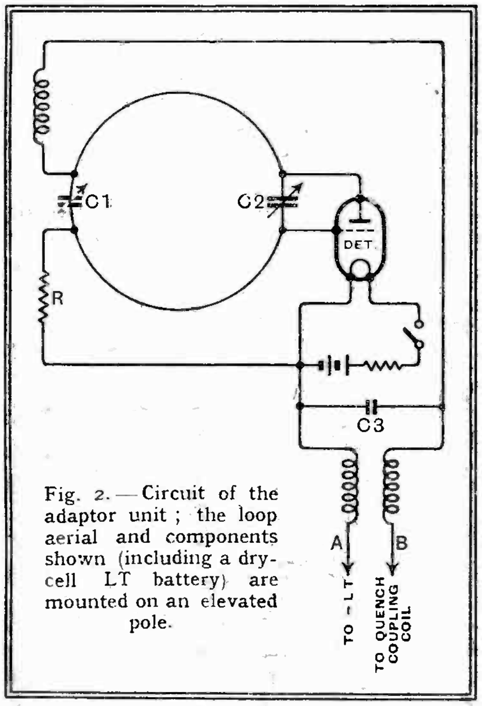


Fig. 2.—Circuit of the adaptor unit; the loop aerial and components shown (including a dry-cell LT battery) are mounted on an elevated pole.

the other can be pre-set at a capacity sufficient to maintain oscillation over the waveband to be covered. Condensers C1 and C2 must be as small as possible, electrically, as the size of the loop will be governed by their capacities. It should be quite possible so to reduce the capacity of C1 and C2 that the loop can be made 10in. or more in diameter.

In altering the set arrangements could be made for the loop and detector valve to be mounted on top of the set when signals are strong enough to dispense with the elevated arrangement.

Reverting to the question of tuning, if a wooden disc with a groove in it is secured to the spindle of C2 the condenser can be operated by means of a cord. Super-regeneration has the advantage in a case like this that tuning is not very critical. If it were, the remote control mechanism would need to be very good indeed.

The receiver would be operated in exactly the same way as any ordinary super-regenerative set. Resistance R2 in Fig. 1, or its equivalent in the reader's set, controls the RF oscillation of the detector valve, while R1 is the quench control.

Too much capacity in the wrong place will make a big difference in the size of the loop, so it might be advisable to experiment with and without condenser C2. If it is omitted tuning will have to be carried out by C1. However, this idea is quite practicable though any change in the capacity of C1 will also affect regeneration in the detector stage. Omitting C2 will enable a much larger loop to be employed.

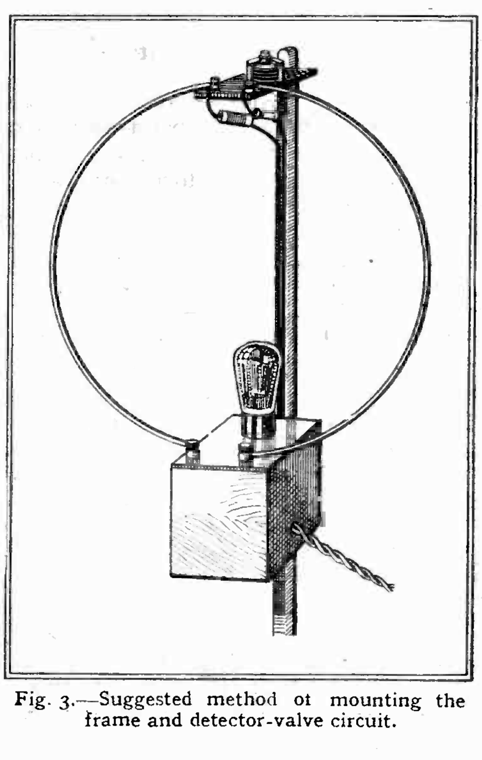


Fig. 3.—Suggested method of mounting the frame and detector-valve circuit.

On the Short Waves

ONE really makes no excuses for returning to the subject of 56 Mc/s again, since during the past fortnight a further opportunity has been afforded to study the general conditions in Surrey and surrounding counties. For example, when in contact with G2MV, of Old Coulsdon, on Sunday morning last, I learnt that he had been in contact with no fewer than 50 stations in the Home Counties on 5 metres during the past three months.

About 70 per cent. or more of these stations are crystal-controlled, and some of those that are not (such as G3CU at present) are stable enough to be read on a superhet when on 'phone.

Over 90 per cent. appear to be using horizontal polarisation and quite a fair percentage have steerable aerials or, alternatively, have available several different aerials with dissimilar radiation patterns.

My own aerial, now a horizontal half-wave mounted on a piece of 1in. square batten, 8ft. 6in. long, and fed with a 3in. spaced open wire feeder three waves long, is rotatable through 90 deg.—which is sufficient—by means of two guy ropes attached to ends of the batten.

I would not like to inflict on readers details of the transmitter in use at present, but suffice to say that it contains 14 valves in all, the final modulated amplifier on 5 metres being a carbon anode DET12, which neutralises as easily in a classical circuit as if the working wave were 40 and not 5 metres.

Several receivers have been tried, including a two-valve self-quenched superregen without RF stage, but the best results to date have been given by the H.M.V. 650, to which an acorn (R.C.A. 954) has been added in place of the normal RF stage in the set. The output anode circuit of the acorn feeds directly in the top grid cap of the X64 (6L7G) mixer—the receiver otherwise being standard.

The acorn stage is pretuned to the 5-metre band and the receiver is operated normally.

On this arrangement 'phone signals from G2oD in Ascot, Berks, are received in Epsom at QSA5 R8/9.

To mention all the stations heard would be an invidious task.

The provision of a rotatable array being somewhat of a necessity, considerable thought has been devoted to the matter, and a number of helpful suggestions received from G5MA, a pastmaster in this particular art.

My brightest idea to date involves an adaptation of the "commutator" used in motorised tuning. This, the steerable dipole, or array, should be motor driven through a reduction gear, the motor being controlled by the "commutator," which would rotate with the aerial (i.e., the equivalent of the condenser shaft).

A multicore cable running from the motor and switching "commutator" would, as usual, terminate at the press buttons—each marked with the call sign of a regular contact. On pressing GIAA's button the aerial would automatically rotate to the preselected direction, exactly as does the tuning condenser of a motorised receiver.

Before passing on to some brief remarks regarding short-wave conditions, there is just a point about push-pull grid-parallel-plate 10 to 5 metre doublers; it is that the L/C ratio of the 10-metre grid circuit should not be too high, and, although the inductance may be some distance from the tuning condenser, the leads from the tuning condenser to the grids of the 6N7 (or equivalent) should be as short as possible.

If these precautions are not taken the impedance of the grid circuit will be high at 56 Mc/s and a tuned grid-tuned plate 56 Mc/s oscillator will result, and the doubler will be very unstable or will self-oscillate. That is, the grid circuit should be tied down to 10 metres as close to the grids of the valves as possible, and, since both valves are acting independently as Class C amplifiers, this doubler may be plate-modulated without distortion.

So far as I know, no other doubler can be successfully plate-modulated, but even in this case, for successful operation as a modulated amplifier, the grid drive must be approximately twice that required to produce "carrier output." In order to check this operating condition in all plate-modulated stages, the drive may be progressively reduced until the carrier output just begins to fall off; the grid drive would then be re-adjusted to twice the value (i.e., twice grid current) thus found.

The necessity for this overdriving in a *plate*-modulated stage arises from the fact that when the plate voltage is doubled at the moment of peak positive modulation, the RF voltage across the tank circuit should also double—but since the magnification of the valve remains constant it cannot do so if the input RF voltage times the magnification is only sufficient to produce the carrier value of RF voltage in the plate circuit.

This grid overdrive has no effect on the carrier condition—since, in any case, the RF in the plate circuit cannot exceed 80 per cent. of the effective DC plate volts.

Since the ionosphere storm of May 11th short-wave conditions have been stable, but not too good, although an improvement has been noticed during the past few days.

These conditions are typical of the summer months, and a feature has been the number of Russian and Western European signals in the region of 26-24 Mc/s.

ETHACOMBER.

Television Topics

APERTURE-EFFECT AND THE TELEVISION RECEIVER—II

IN the last article, dealing with aperture-effect, it was shown that as the light spot tracing the picture is comparable in size with the finest elements of picture detail and also has an undesirable luminosity contour, the receiver must have a frequency characteristic which compensates for this limiting resolution of the CR tube, the correction being increased gain at high frequencies. As it is possible to introduce multiple outline and other "ringing" effects when applying aperture correction it is necessary to arrange circuit constants so that the correction is applied more as a property of the complete receiver than of one particular amplifying stage, and an arrangement will be described by which the experimenter can investigate the process of characteristic shaping and attain suitable correction.

The study of aperture effect soon gives the experimenter a useful knowledge of the practical aspects of wide-band amplification and the behaviour of circuits under transient conditions. Before dealing with a concrete case it will be useful to consider the behaviour of various parts of the receiver when dealing with the transient type of signal.

The requirement of sufficient band-width has to be supplemented by sufficient extra gain at high vision frequencies to correct the overall characteristic of receiver and CR tube.

It was shown that, when dealing with a vision-frequency amplifier, the effect of a cut-off frequency which is too low, together with a high $\frac{L}{R}$ ratio in the coupling circuit to give a rising characteristic, leads to free oscillation in the inductance which dies away after a transient and so falsifies the output waveform. This is especially objectionable if the oscillation frequency is low enough for the light spot to render it on the screen.

Before the detector stage the same transition is represented by a sudden change in carrier level, and similarly at the end of the transition the IF circuits can "ring" at the frequency to which they are tuned, though not quite in the same manner as if they had been "hit" by a sudden change in DC. However, the same requirement as to damping or $\frac{L}{R}$ is found whether the amplifier deals with a modulated carrier or any other form of the vision signal. It will be realised that, for the modulated carrier condition, the tuned circuits can be in the form of band-pass couplings, or single tuned circuits which are staggered in their tuning, or any other arrangement which results in a characteristic similar to Fig. 1 (a) which shows a typical IF amplifier response suitable for a receiver in which any post-detector amplification is by circuits having a normal amount (2-3 db) of HF boost.

There is one further method of response shaping which is interesting to study; it is shown in Fig. 1(b). Here the IF carrier is placed on the sloping portion at one end of the characteristic so that carrier and low frequencies are amplified less than the higher frequencies, thus the band-width is reduced, and the shape of the curve can be made smoother for results equivalent to those of 1 (a).

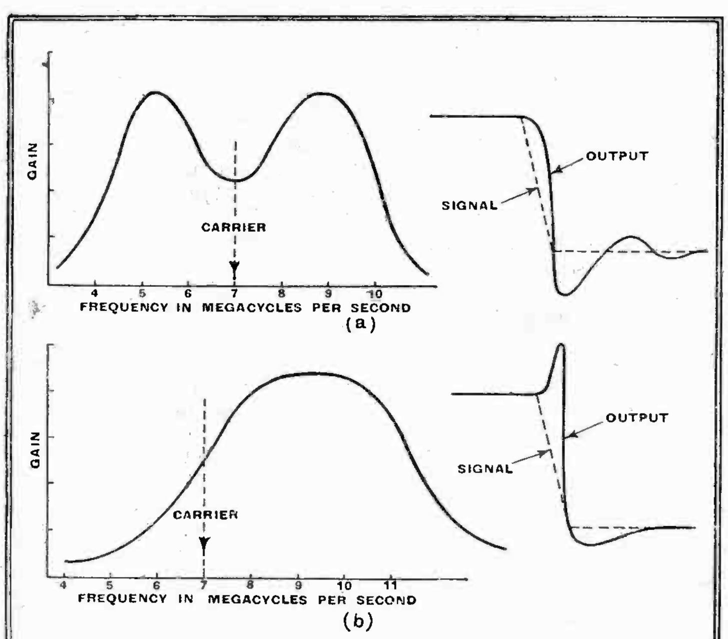


Fig. 1.—When a double-humped resonance curve is used and the carrier falls in the trough, the output waveform is distorted in the manner depicted at (a). With single-sideband reception and a single-peaked resonance curve the distortion is different and of the form shown at (b).

As only one sideband is completely passed the behaviour of this system, on exaggerating HF boost, is different from that of the symmetrical arrangement, in fact, the case may be compared with the troubles experienced during selective fading on a telephony circuit.

Recognition of the effects in a picture may help the experimenter in manipulating the receiver, if at any time the oscillator of a superheterodyne receiver is varied so that the IF carrier moves along the characteristic. Beside each curve of Fig. 1 is shown the wave form of a transient on using over-compensation. It will be seen that the chief effect of the single sideband condition is "white before black," which, in a picture, gives the impression of prophecy in the receiver.

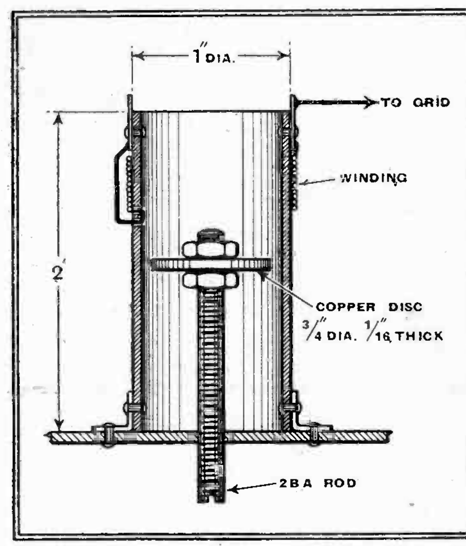


Fig. 2.—Details of a typical IF coil with spade tuning are shown here.

IF Tuned Circuits

In order to construct a receiver which can be easily varied in its band-width and shape of characteristic the stagger-tune method has a great deal to recommend it when there are four or more stages. Here each coupling unit is a single-tuned circuit which can be varied in tuning over a range equal to the width of the received signal. If all the circuits are tuned to the same frequency the response is that of a tuned circuit so many times as sharp as one of the couplings. On the other hand, if some couplings are tuned higher and some tuned lower than the nominal frequency the response is broader and takes on the double-humped appearance of the band-pass circuit. By supplementing such adjustments with damping of the tuned circuits any shape of characteristic can be obtained, the gain at any particular frequency being proportional to the total gain of all stages at that frequency.

In building an IF amplifier on these lines it is best to dispense with trimming

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condensers, adjusting the coils to resonate with the valve and wiring capacity, as inductance values will then be at their highest, and consequently excessive damping will not be required. Variation of tuning is obtained by the "short circuited turn" effect of a copper disc, mounted on a rod and moved in or out of the field of the coil.

Fig. 2 shows a section of such a unit mounting a paxolin former on a metal chassis, the latter being drilled and tapped to carry a screw holding the tuning disc. Coil and valve screening will be necessary, and one suggestion which may ease this requirement is the use of a mixture of "top grid" and "top anode" valves to simplify the interstage wiring.

Considering a 4-stage IF amplifier. The IF anode of the mixer is below chassis. Thus a coupling coil is mounted under the chassis with screwed tuning adjustment above chassis and feeding a valve such as the Cossor 42 MPT, with grid under chassis, as 1st IF. The 2nd IF is an Osram KTZ41 with grid at top of bulb to match the anode at the top of the 42 MPT, and the coupling unit is mounted above chassis, the tuning adjustment being underneath. The 2nd IF to 3rd IF coupling now repeats the mixer to 1st IF coupling arrangement, etc., the amplifier terminating in a KTZ41 feeding a DDL4 as second detector. DC reception is obtained by connecting the detector load direct to any vision-frequency amplifier which may be used, while the anode circuit of this may be again directly connected to the modulation electrode of the CR tube if scanning and gun voltage arrangements will allow this, otherwise a DC restoring diode arrangement must be adopted.

It must be pointed out that the arrangement here is intended to be used for experimental studies of HF response, and so whether or not the DC component of the signal is retained may become a minor consideration.

The circuit of Fig. 3 is, therefore, given with suitable values for manipulation into

Coupling Stage.	Capacity $\mu\mu$F.	L μH for 5 Mc/s.	Turns 36 DSC.
(1) 41 STH to 42 MPT	Anode–E 10.0 Grid –E 14.0	43.0	37
(2) 42 MPT to KTZ 41	Anode–E 5.0 Grid –E 14.0	52.0	40
(3) KTZ 41 to 42 MPT	Anode–E 11.5 Grid –E 14.0	40.0	35
(4) As for 2	—	—	—
(5) KTZ 41 to DDL 4	Anode–E 11.5 Heater-Cath., etc. ... 7.5	52.0	40

similar conditions to those of Fig. 1, the IF being chosen with reasonable regard to IF harmonics around 45 Mc/s. The shunt coupling uses the anode feed resistance as coil damping, the screen feed arrangement allowing a fair range of variation.

The table gives tentative figures for the tuned circuit constants, and the damping used will depend on the amount of shaping required. For example, if a really exaggerated double-hump characteristic is required the final stage may be tuned to 7 Mc/s and well damped—it is always fairly damped on account of the diode load. The other circuits are divided equally between, say, 8.5 Mc/s and 5.5 Mc/s tuning, with damping resistances of some 10,000 ohms. The damping values given in the circuit are suitable for working with the circuits more evenly distributed in their tune frequencies, though with all circuits at 7 Mc/s the characteristic will be much too sharp for normal reception as the response will be about five times down at 6 and 8 Mc/s.

The Detector Circuit

The filtering of the DDL4 output will depend for its effectiveness on how well the output wiring is screened from the early stages of the amplifier. This subject has been dealt with already in Television Topics. A quarter-wave choke will assist in minimising IF harmonics; it consists of about 6ft. of fine gauge wire wound on to a small former (about ⅜in. diameter). Filtering the diode heater leads is also useful, the condenser on each heater pin to earth being important. Similar treatment may be necessary for the other stages, particularly the mixer.

The oscillator, at 38 Mc/s, can be calibrated with the aid of an existing short-wave oscillator (15-17 metres), using the first harmonic, exciting the hexode grid through a loosely coupled loop and inserting a pair of phones in the IF anode lead, then checking with the signal from the vision transmitter and all coil tuning discs at the same setting. Subsequently the oscillator dial can be calibrated in terms of intermediate frequencies, and then any characteristic measurements are performed by swinging the oscillator tuning through its range while receiving a tuning signal or any other steady output from the vision transmitter, noting the diode current at each frequency. Owing to the fact that any vision transmission will contain a band of frequencies this method is not highly accurate, but is quite sufficiently so for comparative measurements if the same form of steady signal is always used.

As the staggering of the circuits is altered a considerable variation of gain is experienced at carrier frequency. Each change should be accompanied by a check at carrier frequency so that the gain can be set to give a standard reading on the diode meter.

For the oscillator and RF coils the fol-

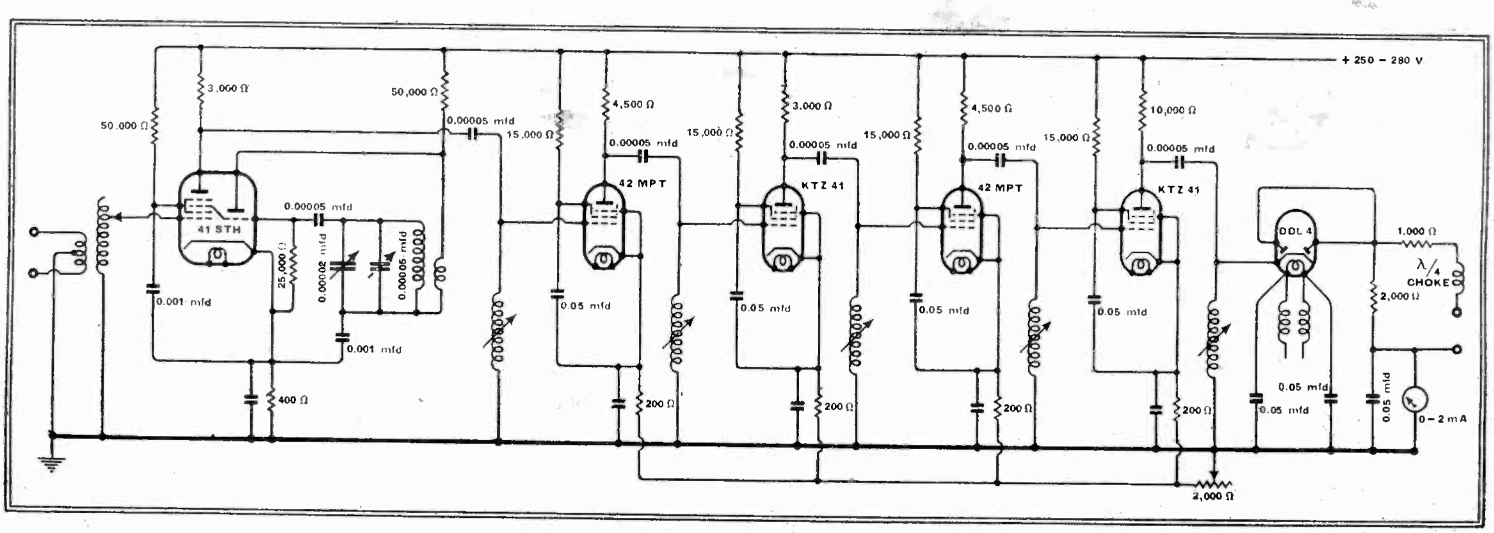


Fig. 3.—The circuit diagram of an experimental superheterodyne is given in this diagram together with the more important values of components.

Television Topics—

lowing brief specification is appended:—

Oscillator.

Former: $\frac{1}{2}$in. dia.

Grid Coil: 3 turns, 22 SWG. Bare in 0.25in.

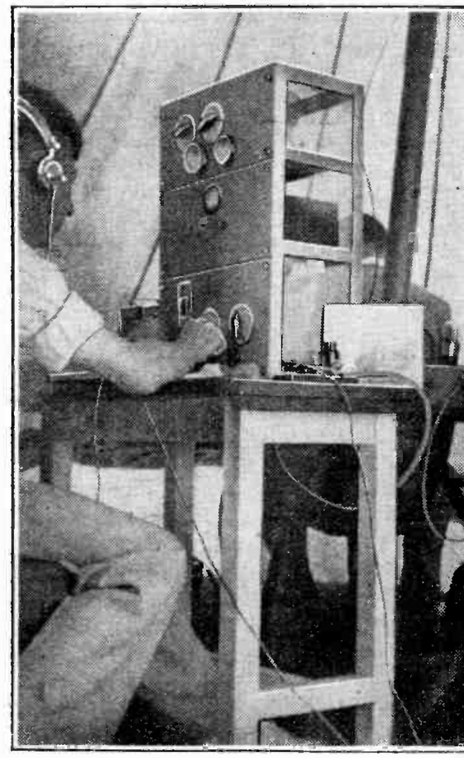
Anode Coil: 3 turns, 26 SWG. DSC interwound with the grid coil.

Input Grid.

Former: $\frac{1}{2}$in. dia.

Grid Coil: 11 turns, 22 SWG. Bare in 0.75in. Probable grid tap at 10. Wind over 2 turns of tape at earthy end and spring on 2 turns of 18 SWG bare, to couple to the dipole.

If preferred a similar tuning arrangement to the IF coils can be used. In this case the 1 inch former will require 6 turns in 0.5 inch with a 1 turn feeder coupling. There is very little sharpness about such a circuit, as the input damping of the mixer is considerable, and so it cannot be looked upon as much use, compared with the IF tuning, in characteristic shaping.



National Field Day

A POPULAR ANNUAL EVENT

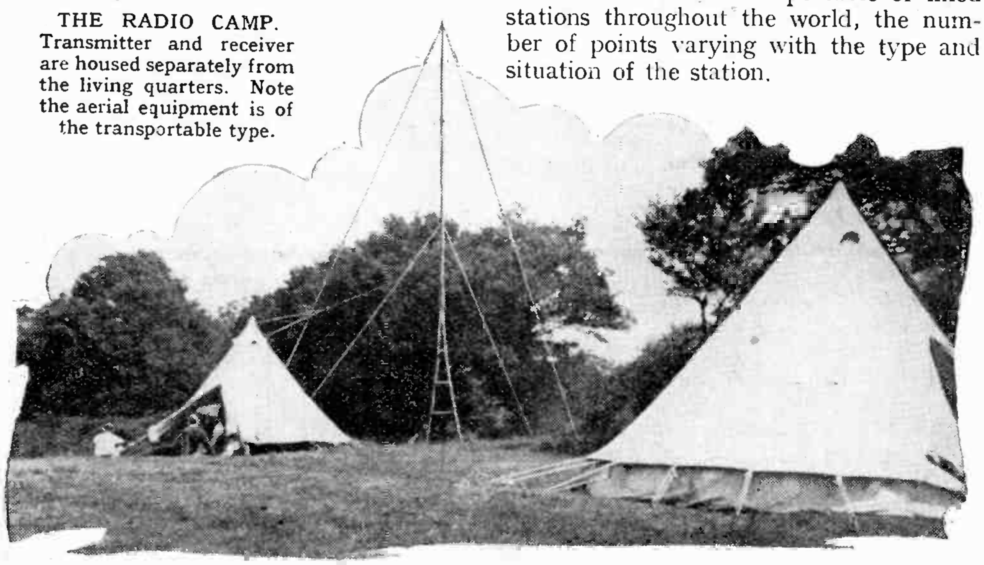
By ARTHUR C. GEE

THE coming week-end will see the majority of the radio amateurs of this country out in the "field" operating portable radio gear. National Field Day is probably the most popular and best supported of any of the contests organised by the Radio Society of Great Britain. Whilst "N.F.D."—as it is colloquially called—takes the form of a contest, its real purpose is not so much to provide a week-end's amusement as to give members an opportunity of getting some really practical experience in the erection and operation of portable transmitting and receiving gear.

In this country national emergencies necessitating the use of portable radio gear seldom arise, although during last winter's heavy snowstorms and flooding one or two instances of amateur radio stepping into the breach did occur. In other countries where storms and floods are more disastrous than they are in this country many instances are on record where the ability of amateur radio operators to get portable gear efficiently set up and working has been the means of saving many lives and much property. One of the most outstanding examples of this was in the recent American floods.

Though we may be immune from catastrophes of this nature, there is no reason why we should not be prepared, and it was to provide an opportunity of getting experience in field work that N.F.D. was started. The competitive aspect was included to stimulate interest, and there is now keen competition between the various districts to secure the maximum number of points.

The contest begins at 1900 B.S.T. on Saturday and ends on Sunday at 1900. Each district puts up one or more stations and transmissions take place on either 1.7 Mc/s, 3.5 Mc/s, 7 Mc/s or 14 Mc/s, CW only being used. Points are awarded for contacts with other portable or fixed stations throughout the world, the number of points varying with the type and situation of the station.



THE RADIO CAMP. Transmitter and receiver are housed separately from the living quarters. Note the aerial equipment is of the transportable type.

For some weeks prior to the contest there is great activity among those responsible for organising the erection of stations. Sites have to be chosen and permission to use them obtained from their owners. Gear must be got together and arrangements for erecting a good aerial system made. Some form of power supply which shall be quite independent of the mains must be obtained. This usually consists of accumulators driving generators, although hand-driven generators and small petrol motor generators are occasionally used.

The R.S.G.B. encourages the use of gear which is truly portable, and in a number of instances compact rigs having both transmitter and receiver built into one cabinet are used. Operation goes on throughout the whole twenty-four hours, different operators taking it in turn to do duty at the key. Those not on duty usually make the occasion a social one, and Sunday afternoon is characterised by visits from the ladies and other friends. Given good conditions and fine weather, the event invariably proves a most enjoyable one for both the operators and the visitors, and when 1900 hours B.S.T. on Sunday evening comes and N.F.D. is over for another year, all and sundry vow that "they will certainly be along next year" and they'll see that the mistakes made this year will be rectified by the time N.F.D. next comes along.

McCarthy Dual Unit Assembly

THE basic idea of this new equipment made by McCarthy Radio, Ltd., 44a, Westbourne Grove, Bayswater, London, W.2, is to provide an efficient superheterodyne receiver (Unit "A") suitable for use with any good audio-frequency amplifier, or with the Unit "B" which has been designed specially for it.

The receiver consists of a six-waveband 4-valve unit with RF stage, frequency changer, IF amplifier and second detector. Wavelengths from 4.5 to 550 metres are covered in five overlapping bands, and the two remaining positions on the selector switch give long waves (900-2,000 metres) and provision for gramophone reproduction.

Unit "B" consists of a 5-valve 10-watt "phase-reversed" amplifier with an overall gain of 80 db and faders for mixing microphone, gramophone or radio inputs. There is a tone control, and the mains equipment is independent of external smoothing, though the HT current available is sufficient to energise a loud speaker field if required.

Complete with valves, Unit "A" costs £7 10s., and Unit "B" £11 10s.

How a Receiver is Designed—XIV.

Developing a High-Quality Communication Receiver

SPECIAL REQUIREMENTS TO BE CONSIDERED

THE requirements for a high-quality communication receiver are dealt with in this article and the design of the apparatus is begun. By the term "high-quality communication receiver" is meant a set having the performance of a communication receiver on short waves combined with the ability to give really high quality of reproduction in broadcast reception.

IN this series of articles, which has been running for some considerable period in *The Wireless World*, the design of various types of receiver has been considered in detail, and in choosing a receiver to form the conclusion of the articles it has been felt better to consider the design of a large receiver of possibly somewhat specialised type rather than to deal with two or three small sets of more orthodox arrangement. The latter would involve a considerable amount of repetition, since there are many factors which are common to all sets, and the description of a large set will bring out many points which become of importance in such equipment.

Although the receiver as a whole will be of an elaborate nature, and in common with all communication sets will have a large number of controls, there is no reason why those parts of it which an individual constructor does not require should not be omitted. As the term is generally understood, a communication receiver is one which is primarily adapted to the needs of the amateur transmitter. His requirements are extreme sensitivity and selectivity combined with great ease of tuning on the short wavebands. The equipment must include a beat frequency oscillator for CW morse reception, and arrangements must also be made for cutting AVC out of circuit at will. This, in turn, necessitates the inclusion of a pre-detector gain control, and a useful refinement is the provision of some form of signal strength indicator.

Broadcast Characteristics

From his point of view quality of reproduction is usually of secondary importance, as is also the ability to cover the wavelengths used in broadcasting. Many of the attributes of the true communication receiver, however, could, with advantage, be incorporated in a broadcast set, and it is felt that the usual specification of a communication receiver is rather too narrow for most people. It is felt, therefore, that a receiver of this general type, which must in any case employ quite a large number of valves, could well have its specification extended so that it will form a first-class broadcast receiver as well as suiting the more specialised needs of the amateur.

This means primarily that the tuning range must include all broadcast wavelengths, that a really high standard of quality must be obtainable, and that the output must be reasonably large. Before we can consider the design of the equipment we must draw up a provisional specification in more accurate terms. It is clear that to cover all requirements the tuning range should be continuous from about 5 to 2,000 metres, except for a small gap around the intermediate frequency. This frequency is probably best of the order of 465 kc/s, partly because this fits in well with the conflicting requirements of adjacent-channel selectivity and a low degree of image interference, and partly because it falls in a portion of the wavelength scale at which a gap can be best tolerated, since it comes in a portion of the 600-metre shipping band.

The second requirement is that on all wavelengths tuning should be easily carried out. This is a really difficult problem and will be discussed in detail later. The adjacent-channel selectivity should be extremely high, and for amateur purposes we need not worry unduly about the presence of a considerable degree of sideband cutting, since the aim is to receive intelligible signals with a low interference and noise level rather than obtain high-quality reproduction.

From the point of view of the broadcast requirements of the set, however, the latter is extremely important, hence it will be necessary to include some form of variable selectivity, and this control must permit the selectivity being varied between two extreme limits, one the maximum of which the set is capable and the other a minimum which will permit nearly full retention of modulation frequencies up to 10,000 c/s. Experience shows, however, that the selectivity need not be continuously variable between these limits unless it is mechanically easier to arrange such a control. In practice it is sufficient to be able to adjust the selectivity in a suitable number of steps.

For high-quality reproduction an output of some 6 watts or so is desirable, with a very low degree of amplitude distortion,

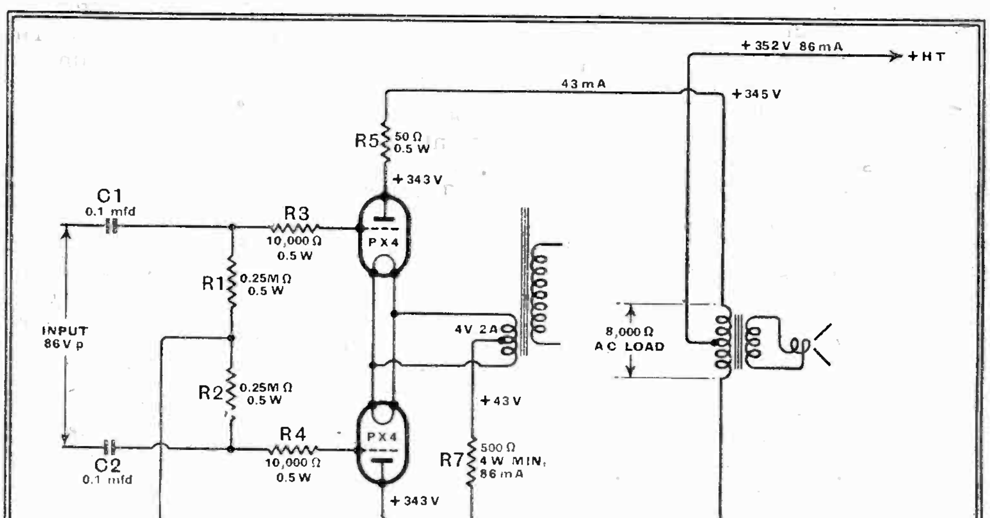
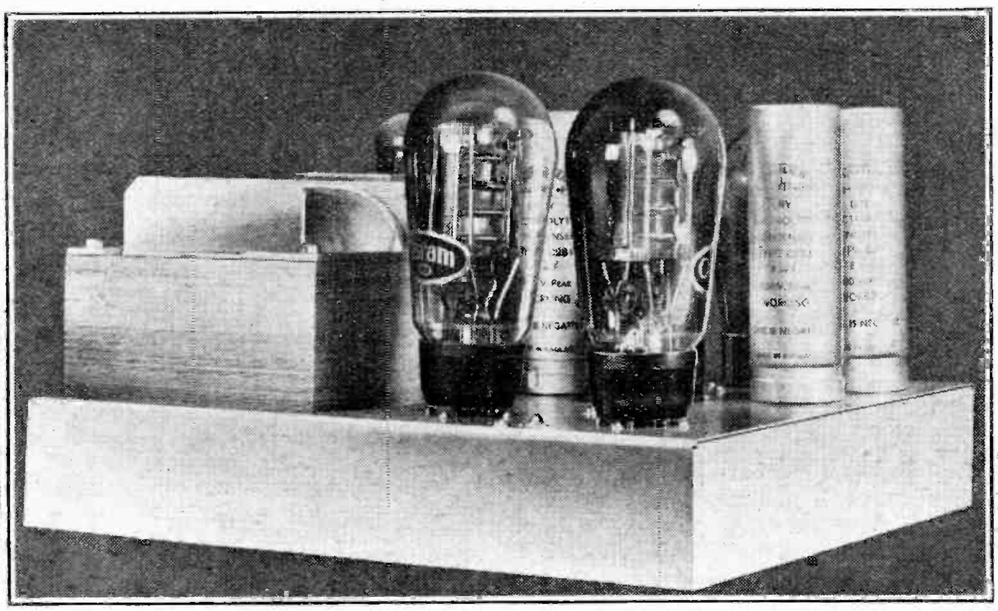


Fig. 1.—The circuit diagram of the output stage is shown here in the way it is prepared by the designer. It shows values of components, currents and voltages.

Developing a High-Quality Receiver—

and it is very useful, also, to have tone controls which enable the bass and treble response to be independently varied. The detector must be designed for distortionless rectification and the AVC system incorporated must also introduce negligible distortion. A beat-frequency oscillator must be included to permit CW morse



A view of the completed power unit showing the output valves.

reception and must be provided with an on-off switch. An on-off switch for AVC will also be necessary, but these two switches can be combined, if desired, since it is hardly ever necessary to dispense with AVC when the beat-frequency oscillator is not employed. There will, of course, be an AF gain control and a pre-detector gain control will also be needed, if only for the case when the equipment is used without the AVC control. We thus find that we shall have six controls, apart from the tuning and waveband switching. To meet the requirements of those who will use the receiver for entertainment purposes, a radio-gramophone switch must be added, and to meet the needs of amateur transmitters a muting switch must be included so that the receiver can be rendered inoperative without being switched off at the mains while the transmitter is in use. This brings the controls up to eight in number without the tuning.

Preliminary Valve Arrangement

Before considering the design of the receiver in detail it is necessary to sketch out a tentative arrangement which can form a basis for design and which we may find we shall have to modify as we go along. At first sight it would appear that the requirements would best be met by a receiver including a push-pull triode output stage fed from a push-pull resistance-coupled penultimate triode stage on the lines of the Push-Pull Quality Amplifier. This will be preceded by a phase-splitting valve, and this, in turn, would have before it a tone-control stage giving a moderate gain. Before this would come a diode detector and at least two IF stages. There would also be a valve for the beat-frequency oscillator feeding into the detector. A triode-hexode or similar frequency-changer and one RF stage would complete the active chain. A rectifier valve for the HT supply would, of course, be necessary, and an additional valve might prove desirable for operating a signal strength meter, and it is even possible that an extra one in the frequency-changer might be found desirable on ultra-short waves. The total number of valves is thus likely to be about twelve or thirteen.

The Output Stage

The first step in design is to work out the details of the audio-frequency equipment, then to deal with the detector, the AVC system and the last IF amplifier. The attainment of the necessary IF gain and selectivity then follows, and after this comes the turn of the general tuning equipment, followed by the details of the RF and frequency changer.

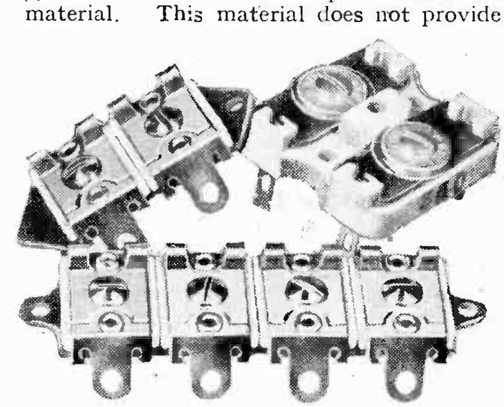
Turning now to the output stage, a single PX4 valve is rated for an output of 3.5 watts, so that a pair of these in push-pull will enable about 7 watts to be obtained quite easily. Such an output stage should easily meet our requirements.

The valves require 300 volts for the anode supply and take 50 mA. apiece. A pair of valves in push-pull would require the same operating voltages but the total current will be double. If the valves are run from a single filament winding on the mains transformer, so that a common bias resistance is used, following the usual practice, the value of this resistance should be 475 ohms—a non-standard value. In practice, therefore, it is convenient to use a resistance of 500 ohms. This results in a slightly lower anode current for each valve and a slightly higher grid bias. Actually, the bias becomes 43 volts and the anode current 43 mA. per valve. The output power obtainable is slightly affected, it is true, but in practice to a negligible extent. As will be shown later, it is easily possible to obtain 7 watts from a pair of PX4 valves under these conditions.

We can now draw out the circuit of the output stage, as shown in Fig. 1, and start to assign values to the various components. The bias resistance, R7, we have already decided shall be 500 ohms, and as the current through it is 86 mA. it must be capable of dissipating not less than 4 watts. Anti-parasitic oscillation resistances, R5 and R6, of 50 ohms, are advisable in the anode circuits, and similar resistances, R3 and R4, of 10,000 ohms, in the grid circuits. The grid leaks, R1 and R2, should be of as high a value as possible, but if they are too high there is a danger of damage to the output valves should grid emission occur. It is, therefore, advisable to compromise somewhat at this point, and a suitable value has been found to be 0.25 megohm. With these values of resistance, input coupling condensers, C1, C2, of 0.1 mfd., enable an adequate bass response to be secured. The output stage will require a total load of about 8,000 ohms, and if we allow that the transformer will have a total DC resistance for the primary of 300 ohms, the voltages and currents in the various parts of the circuit will come out at the figures marked in Fig. 1.

WEBB TRIMMING CONDENSERS

A WIDE range of trimming condensers is now marketed by the Webb Condenser Co., Ltd., of 32, Hatton Garden, London, E.C.1. Among specimens which have been sent to us are multiple trimmers of the postage-stamp type with ceramic insulation. These consist actually of single trimmers with a ceramic base and a capacity range of 2-30 $\mu\mu$F, mounted on a strip of bakelised material. This material does not provide insulation, for it contacts only with the ceramic bases of the condensers. This type is available at the price of 9d. per condenser in the bank, and with a capacity of 100-200 $\mu\mu$F at 1s. 3d.



Webb multiple trimmer units.

A range of larger double-trimmers with ceramic bases is also available. The types in this range have insulated adjusting screws and can be mounted with a single fixing screw. The maximum capacities available are from 70 $\mu\mu$F to 0.001 μF at prices from 1s. 6d. to 2s. 6d.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

56 Mc/s Amateur Band

IT may be of interest that at 13.35 G.M.T. on May 23rd I received signals from SM5SN, Sweden, on 56.7 megacycles. The transmission was automatic, calling "TEST DE SM5SN LUMA SWEDEN," tone-modulated morse on a steady carrier which peaked at R7. Unfortunately, the signals faded out in ten minutes approximately, and I did not have a chance of calling SM5SN to establish contact. The above has been confirmed by SM5SN, who states that the transmitter runs automatically every day from 0700-1600 and is situated at the Luma Lamp Works.

The period from the evening of May 22nd onwards gave exceptionally good "intense E layer" conditions, making it possible to hear UHF broadcast, television, and commercial harmonics from many parts of Europe between 500 and 1,000 miles. On the 22nd, signals were heard up to 48 Mc/s; on the 23rd, 56 Mc/s; and 24th, 57 Mc/s. It is unfortunate that there were no European amateurs active during the period, as it is quite certain that several inter-European contacts could have taken place on the 56 Mc/s amateur band.

I cannot say what conditions were like after the 24th, as my station is now closed down for six weeks (except for automatic transmission on 56 Mc/s each Sunday), while I am on a trip to Canada and U.S.A.

Gt. Clacton. D. W. HEIGHTMAN. (G6DH.)

Overseas Trade

AS a regular reader of your excellent journal and as a wireless engineer, may I add to your remarks in your recent editorial concerning overseas trade? The failure of the British manufacturer to improve his trade in this country is entirely his own fault. May I quote you just one example of the lack of business efficiency of British radio traders?

Recently I was asked to recommend to some friends a reliable radio receiver. I selected a receiver by a well-known British firm. Three receivers were ordered from England, the total cost being in the region of fifty pounds. After much delay the invoices arrived here and eventually the receivers. To our dismay, the receivers ordered, the receivers quoted on the invoice, and the receivers which actually arrived were of three different types. Those which arrived were entirely unsuitable for the purpose intended, and all were damaged, due to bad packing. The firm in question has not even replied to the subsequent letter. Needless to say, their terms were cash in advance for overseas orders.

The local agents for British firms are very badly informed concerning their firm's products, and bear no comparison with agents for other countries.

J. MORTON, A.F.R.Ae.S.

Baghdad, Iraq.

Television Reception

WITH reference to the letter in your issue of May 26th from Mr. W. MacLanachan entitled "Television Responsibilities," may I be permitted to take up arms on behalf of the B.B.C.?

Mr. MacLanachan's report that the transmission from Hurlingham was, on the whole, better than previous outside broadcasts is a complete mystery to me. My own conclusions coincided exactly with those of my viewing colleagues and apparently with the B.B.C. monitors, and were to the effect that the transmission was a complete technical failure. The receivers on which this conclusion was based were of a normal commercial type giving a picture somewhat, but not greatly, less perfect than the transmission. If Mr. MacLanachan has a receiver which can actually convert a bad transmission into a good one I should be interested to see it.

It is unfortunate for Mr. MacLanachan that his condemnation of the B.B.C. television organisation occurs on a page which also contains one of the finest week's programmes that have ever been offered, including, as high lights, "Pride and Prejudice," "Friends from the Zoo," "Broadway," "Toscanini," "The Constant Nymph," "Derby Day," and (Oh, Triumph of Incompetence!) "The Derby."

London, N.W.11. L. H. BEDFORD.

Muffled Broadcasting

I HOPE *The Wireless World* will print this letter, since whenever I write to the B.B.C. on the subject about to be discussed, they invariably make some ambiguous or evasive reply, if not a flat denial of my allegations.

It is the B.B.C. "blanket effect" which bothers me, and a good many other listeners, I suspect, even though they may not all know what is wrong. This effect manifests itself in the form of "backwardness" in speech and music, so that everything sounds muffled and *uninteresting*. It is due to the following possible causes, and I will leave it to those concerned to decide which cause:—

1. Insufficient modulation of the carrier wave.

2. Unsatisfactory placing of the microphone(s).

3. Studios which are acoustically *too* perfect.

Of course, there are several other possible sources of defective transmission of programmes, such as unsuitable landlines in outside broadcasts, etc., but the above suggest themselves as being more likely, and of the three enumerated, No. 1 seems to me the most feasible possibility. I have noticed that when, for instance, London Regional fades (which in this part of the world it does quite often, especially at night), speech or music become clearer and more "forward" up to a point, that is, to the point of distortion, when the fade is becoming definitely marked. This would seem to be due to the fact of the modulation attaining, during the process of fading of the carrier wave, a better proportion in relation to it, with a consequent improvement in tone and quality of the programme being transmitted, up to the point mentioned above, where distortion sets in.

The cause of the insufficient modulation of which I complain is, I think, inherent in British psychology. The engineers responsible are so anxious to send out broadcasts in good taste (in every sense of that expression) that, rather than run the "risk" of distortion they under-modulate the carrier.

It is a curious fact, but one which cannot truthfully be disputed, that "special" (royal, for example) broadcasts *always* come out well! My set was new this year, and cost 15 guineas.

T. J. E. WARBURTON.

St. Leonards, Sussex.

Fadeout of April 15th

IN connection with the letter from Mr. D. W. Heightman (G6DH) in *The Wireless World* of May 19th, the following cosmic data received from the International Scientific Radio Union (URSI) may be of interest. All times are G.M.T. The MAG (terrestrial magnetism) report from Cheltenham, Maryland, shows that a disturbance of moderate intensity began at 08.35 hours on the 13th and lasted until 24.00 hours on the 15th. A fresh, violent disturbance began at 05.47 hours on the 16th, lasting until 16.00 hours. The SOL (sunspots) report for the period from the Mount Wilson Observatory is: 13th, no observation possible; 14th, eight groups, 135 spots; 15th, ten groups, 170 spots; 16th, nine groups, 125 spots; 17th, eight groups, 200 spots.

Reports on fadeouts are supplied by Japan. They show that fade-outs were observed on the 15th at 03.32 hours and at 08.30 hours. The latter time coincides closely with Mr. Heightman's observations. It is interesting to note that on April 16th the Japanese Ursigram, which is transmitted on at least three different frequencies at 13.00 hours, could not be received in San Francisco. "DIALLIST."

A.R.P. and Amateurs

IF space can be found for this letter it may be the means of preventing patriotic amateurs from:—

1. Wasting valuable operating time.

2. Jeopardising their position as holders of *experimental* licences by attempting to organise communication services, and

3. Offering their stations to A.R.P. authorities who obviously have no control whatsoever, directly or indirectly, over radio communication.

Condition No. 14 of the Amateur licence can only be interpreted as meaning that the station will be, as in the last war, closed down immediately an emergency arises.

The fact that the Postmaster-General does not contemplate any other step is borne out by the Home Secretary's reply to a scheme, worked out over a year ago, in which responsible amateurs were to have co-operated with the police in forming an emergency radio link for A.R.P. communications.

Sir Samuel Hoare states that "he is advised on technical grounds that, owing to traffic-carrying capacity and mutual interference difficulties, the use of wireless for A.R.P. communications is not considered practicable. A.R.P. authorities are being circularised that the telephone must be regarded as the normal means of communication and relied upon so far as possible, with a messenger service as a stand-by. Volunteers for A.R.P. service should mention, at the time of enrolling, any operating qualifications." N. P. SPOONER, G2NS.

Bournemouth.

NEWS OF THE WEEK

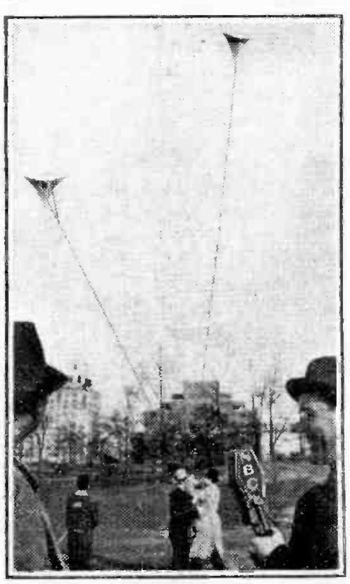
INTERFERENCE SUPPRESSION

How the Authorities Became Interested

AN interesting method of attack against the annoyance of electrical interference has been adopted by a large organisation of 38,000 listeners in Finland.

They pointed out to the power authorities that their annual consumption of electricity amounted to approximately 2 million kWh, which means a yearly income of more than £17,000 for the company. If interference from electrical appliances could be eliminated, or at least reduced, power suppliers would benefit from the many hundreds of listeners who would promptly change their present battery sets (which are not so prone to mains-borne interference) for new all-mains receivers.

The power authorities were impressed by the argument, and immediately responded by making a thorough investigation. It was found that about 50 per cent. of electrical interference in Helsingfors originated from lifts, and as a result of this discovery an order has been issued to the effect that all lifts are to be equipped with interference suppressors before March 1st, 1939. The necessary installations, which will apply to some 2,000 lifts, are to be paid for by the landlords.



THE KITE AERIAL, famous for its application in the pioneer days of wireless, has come back in America, where it is being used by N.B.C. commentators for the short-wave transmission of outside events to the parent station.

SIR JOHN REITH

Rumours Denied

THE Wireless World understands that, despite suggestions to the contrary, Sir John Reith has no intention of leaving the B.B.C. The organisation of broadcasting can never be regarded as complete; it will always be in a fluid state and therefore in need of a strong guiding hand.

The only possibility of a change in the Director-Generalship might arise in the case of a national emergency, when the Government might need the services of such an experienced organiser elsewhere. Even so, the feeling in official quarters seems to be that broadcasting would be one of the essential services and that Sir John would be of greater assistance in his present sphere than, perhaps, in any other.

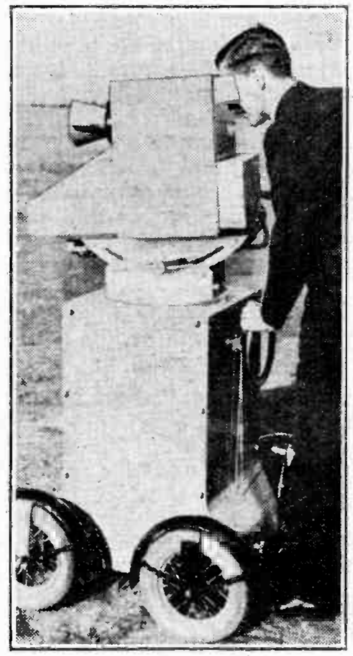
"NATION SHALL SPEAK PEACE . . ."

A COMMITTEE will meet in Geneva on June 17th and 18th, under the auspices of the League of Nations, to discuss and report on the means of using broadcasting in the cause of peace. This committee will submit its findings to the International Committee on Intellectual Co-operation, which will take this as a basis for a report to the next League Assembly.

A number of broadcasting companies will be represented, among them being the B.B.C., those of Yugoslavia, Belgium, Hungary, Czechoslovakia and Sweden, as well as the European representatives of the American companies. Mr. A. R. Burrows, of the U.I.R., will, for the first time since taking over duties in Geneva, speak in public for the Union.

FIRE ESCAPE AERIAL FOR TELEVISION

WHEN the tennis tournaments are televised from Wimbledon a new aerial will be used by the B.B.C. mobile unit. It is understood that this will be adapted from a fire escape, some 80ft. in height, to which will be attached a short mast giving an effective height of about 100ft. It is estimated that at least one day will be saved in installing the mobile unit when this aerial is employed, for hitherto the task of finding a suitable site for the aerial has absorbed more time than the actual transmission tests.



EASE OF MANIPULATION is one of the main features of this camera used by Philips with their mobile television station designed for demonstration purposes.

GROSSE DEUTSCHLAND RADIO INDUSTRY

Internal Trade Concession

AN agreement has been signed by representatives of the German and former Austrian radio industries that no receivers will be supplied to, or advertised in, Austria by the German industry before June next year. The Austrian firms Eltz, Eumig, Ingelen, Kapsch and Minerva will, however, be allowed to supply up to 30,000 receivers to Germany during the period from July 22nd, 1938, to June 30th, 1939.

The two remaining Viennese firms, Siemens and Philips, have decided to forgo this privilege to give others a greater opportunity. It is, however, believed in German industrial circles that the German radio industry would not consent to an increase in the number of sets to be sold in the Reich by Philips, who are already allowed to manufacture and sell an established number of receivers in Germany.

From August, 1938, onwards People's Receivers will be available in Austria as well as in Germany. The Austrian radio industry will co-operate in the manufacture of these and the same prices and conditions of sale will prevail throughout greater Germany.

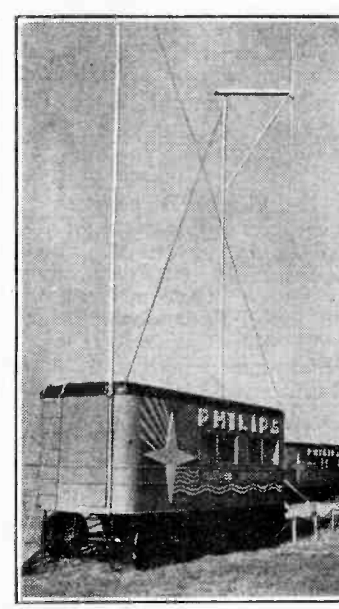
CLEVEDON DIFFICULTIES

AN unexpected altercation has arisen over the building of the new B.B.C. station at Clevedon, Somerset. A large site, contiguous to that selected by the B.B.C., has been reserved for an aeroplane landing centre, and the 375-ft. mast of the broadcasting station would be an obvious danger to landing aircraft. Discussions have taken place between the B.B.C., the Post Office and the Air Ministry, but no decision has yet been arrived at.

DEMONSTRATION TELEVISION TRANSMITTER

FOR the purpose of demonstrating the possibilities of television, the Philips Laboratories at Eindhoven have produced a mobile low-powered television transmitter, which is housed in two large trailers. In one is the scanning apparatus, whilst in the second are two transmitters, one for sound and the other for vision. Two detachable aerials, about 10 metres high, are mounted on the transmitting van. Pictures are transmitted on 405 or 567 lines at 25 per second with interlaced scanning.

No generators are installed, as power is obtained from the supply mains. A small studio



THE TRANSMITTING VAN of the Philips mobile station showing one of the two aerials.

set-up is carried, which consists of an easily dismantled steel framework. This is fitted with five 1-kilowatt high-pressure mercury lamps.

When demonstrating, several

News of the Week—

receivers are set up in the vicinity on which the transmissions are received. Should conditions be unfavourable, a cable is provided for direct link with the demonstration receivers.

SOS FROM EMPIRE STATIONS

AN appeal for information relating to the position of the 5,000-ton cargo boat, *Anglo Australian*, was broadcast from the B.B.C.'s Empire station on behalf of the Mercantile Marine Dept. of the Board of Trade. This is the first occasion on which the B.B.C. has broadcast a world-wide S O S. Since the vessel wirelessed that she was passing Fayal, in the Azores, on March 14th, on her way from Cardiff to Vancouver, nothing has been heard of her, and considerable anxiety is felt for the safety of her crew of thirty-eight.

"OUT OF TOWN TO-NIGHT"?

ALTHOUGH the ever-popular B.B.C. feature "In Town To-night" ceases, temporarily at least, on July 3rd, the authorities are already flirting with the idea of shifting the centre of gravity to the provincial centres. There is no reason why Manchester, or Birmingham, or even Wigan, should not be able to produce at least one batch each of interesting personalities within their frontiers on any night in the year.

The idea will find an outlet, to some extent, in the seaside concert party relays arranged for the summer months, which will include mobile microphone work among the crowds on the seashore. This radio beachcombing may bring as many colourful folk to the microphone as can be had on Saturday nights in London.

ANOTHER LUXEMBOURG?

A CONCESSION has been granted to an English advertising company to operate a sponsored broadcasting station in the State of Liechtenstein, as was foreshadowed in *The Wireless World* some months ago.

Vaduz, the capital of Liechtenstein, which is situated between the German and Swiss frontiers, is about 550 miles from London. According to *World's Press News*, it is likely that a temporary station for testing will be erected as a preliminary to the larger transmitter.

Repairs by Broadcast Instruction

Two pilots of the Western Air Express flying over Salt Lake City were in imminent danger of making a crash landing when their machine's landing gear jammed. Wireless instructions from Lockheed factory engineers enabled them to effect repairs in the air, and the plane landed without mishap.

£30,000 Test Broadcasts

IT is reported that the Australian Broadcasting Commission is arranging, at a cost of £30,000, to broadcast to listeners in the Commonwealth ball-by-ball commentaries of all the five test matches.

New SW Schedule

A NEW Danish 6-kW short-wave station, Skamlebaek, is now directing special transmissions to South America and East Asia on 31.51 metres from 1 to 2.30 a.m. (G.M.T.), and to North America and Greenland from 2.30 to 4 a.m. (G.M.T.).

Valuable Amateur Aid

A.R.P. authorities at St. Austell are benefiting considerably by the co-operation of the St. Austell Radio Club, whose members have provided a short-wave transmitter for headquarters and two portable short-wave receivers.

Police Wireless

THE proposal to equip Blackpool police with a comprehensive wireless system has received approval from the Watch Committee.

It has been found necessary to equip the Essex Police Courtesy Squad with short-wave transmitter-receivers.

New Radio Normandie

RADIO NORMANDIE has for some time been waiting to leave Fécamp and occupy the new station at Louvetot. M. Fernand Le Grand, famous as the founder of Radio Normandie, says that the new station is not quite ready for work as revised wavelength allocations have necessitated certain modifications of existing settings. In addition he stated that official permission for the working of Louvetot has not yet been granted.

Uniform Aerials

THE Polish Minister of the Interior has issued an order which compels town dwellers to replace their old aerials with those of a uniform variety in cases where ungainly aerials are æsthetically offensive. A similar measure has been adopted in Amsterdam.

Diagnosis by Television

TELEVISION serves a novel purpose in the Moscow Clinical Institute for Infectious Diseases, according to the official Soviet news agency. Visitors to the hospital, who would not normally be allowed to see infectious cases, are permitted to look at, and converse with, patients over a closed television circuit. The device may also be used by visiting specialists who, by direct contact with patients, might tend to spread disease.

FROM ALL QUARTERS

N.P.L. Director

THE Lord President of the Council has appointed Professor R. H. Fowler, O.B.E., M.A., F.R.S., at present Plummer Professor of Applied Mathematics in the University of Cambridge, to be Director of the National Physical Laboratory with effect as from October 1st, 1938. Professor Fowler will succeed Dr. W. H. Bragg, who has been elected to the Cavendish Professorship of Experimental Physics in the University of Cambridge.

New Scottish Transmitter

THE 5-kW transmitter at Nigg, Aberdeen, will start testing in the next few weeks, and is due to open in the autumn. It will use the wavelength of 233.5 metres at present employed by the 1-kW Aberdeen transmitter.

West of England Studios

B.B.C. SCOUTS are now searching for sites for new Bristol offices to become the headquarters of West Region. In Plymouth at least three possible sites have been found for new studios, the intention being to provide a goodly percentage of Plymouth programmes for the new Start Point transmitter.

Radio Luxembourg

IT is understood that the Luxembourg Chamber has passed a Bill ratifying Luxembourg's agreement to the International Broadcasting Convention's wavelength plan. This will mean Luxembourg relinquishing the wavelength of 1,293 metres.

Is it Carried Too Far?

DURING the recent talks in the series, "My Best News Story," all references to the names of newspapers were cut out by the B.B.C. Is this carrying the rule prohibiting advertising to the extreme.

PACIFIC COAST HEADQUARTERS of the C.B.S. in Columbia Square, Hollywood, which, having cost $1,750,000, was inaugurated a few weeks ago. Inclined walls and windows, to overcome sound reflection, with the floor, walls and ceiling, "floating" on special material which acoustically separates them from the main structure, thus preventing vibration, are features of the eight studios of the station KNX, which the building houses.

Broadcasting House Extension

THE enlarged Broadcasting House is not likely to be complete for two years. We understand that the frequently announced demolition of the buildings adjoining Broadcasting House in Portland Place will now begin in October.

Cinema Television

PROVISION for Baird television will be made in the new super-cinema which is to be erected in the centre of Wigan.

PA for Travellers

EXPERIMENTS have been carried out at Folkestone Harbour, using PA speakers as a medium for conveying directions to passengers arriving at and leaving the port.

Mobile Recording in India

RECORDS of talent in Indian villages may shortly be included in the programmes of All-India Radio. According to the *Times of India*, the Bombay station is acquiring a mobile recording unit.

Ceylon Wants More Worlds to Conquer

Is the world too small for the radio amateur? The keen worker will strenuously deny this defeatist attitude, which finds expression in the decision of the Ceylon Radio Club to discontinue its weekly short-wave bulletin. As reported in the *Ceylon Radio Times*, the Club considers that, with the wonderful progress made in receiving sets, reports on reception conditions are not now so necessary.

Wireless Treatment for Eyes

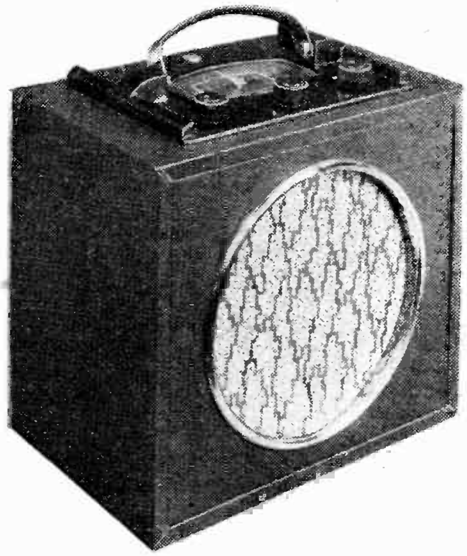
HIGH-FREQUENCY oscillations are used for treating acute inflammatory eye conditions in the Royal Westminster Ophthalmic Hospital, London.

Radio in Trains

BY order of the Ministry of Public Works all trains of the Turkish State Railways are to be equipped with wireless.

I.E.E. Council

THE following have been nominated by the Council of the I.E.E. for the vacancies which will occur on September 30th, 1938:—President, Mr. A. P. M. Fleming, C.B.E., D.Eng., M.Sc. (Metropolitan - Vickers); Vice-President, Professor C. L. Fortescue, O.B.E., M.A. (City and Guilds College); Hon. Treasurer, Mr. W. McClelland, C.B., O.B.E. (Henley's Telegraph Works); ordinary members of Council, Mr. P. Dunsheath, O.B.E., M.A., D.Sc. (Henley's Telegraph Works), Professor R. O. Kapp, B.Sc. (University College), Mr. A. P. Young, O.B.E. (British Thomson-Houston), Mr. L. G. Brazier, Ph.D., B.Sc. (Callender's Cable and Construction Co.).



Philips PORTABLE MODEL 225B

Battery Superheterodyne Circuit with AVC

FEATURES. ***Waveranges.***—*(1) 200-550 metres. (2) 900-2,000 metres.* ***Circuit.***—*Octode frequency-changer—pentode IF amplifier—double-diode-triode second detector, AVC and 1st AF amplifier—pentode output valve. Automatic bias.* ***Controls.***—*(1) Tuning. (2) Volume and on-off switch. (3) Waverange.* ***Weight.***—*16 lb.* ***Dimensions.***—*11½in. × 10½in. × 7¾in.* ***Price.***—*8½ guineas.* ***Makers.***—*Philips Lamps Ltd., 145, Charing Cross Rd., London, W.C.2.*

THE announcement of this portable was an event of interest alike to the buying public and the trade, for it is the first self-contained receiver to be included in the Philips range of broadcast sets. It can be said at once that it is a typical Philips design both mechanically and electrically. The tuning condenser, for instance, is a compact and rigidly constructed unit with close vane spacing and porcelain insulation. Screening and "earthing" problems—so essential in any portable designed to operate without the stabilising influence of an external aerial and earth—have been carefully studied in the audio as well as the radio and intermediate frequency stages. As a result a high overall magnification has been achieved without the slightest suggestion of feed-back or instability.

An octode frequency-changer occupies the first stage in the superheterodyne circuit. It is followed by an IF amplifier with iron-cored couplings in which the secondary of the output transformer is tapped down to reduce the load of the signal-rectifying diode. The AVC diode is fed from the primary and the control voltage, which is delayed, is passed to both IF and frequency-changer stages. The auto-transformer coupling the triode portion of the second detector stage to the output pentode is filter-fed.

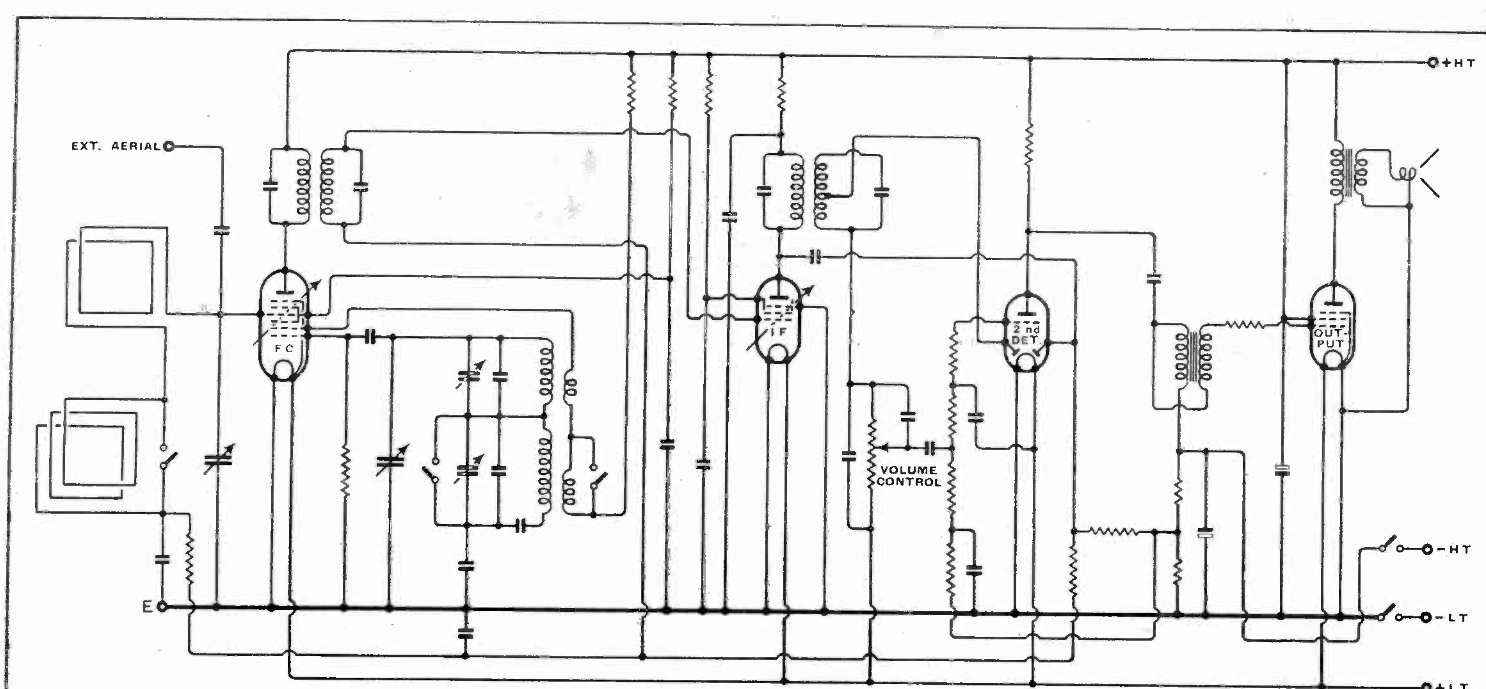
The control spindles project vertically through a black moulded escutcheon plate in the top of the case and the waverange switch has coloured dots corresponding to the colours of the printed station names on each of the two wavebands. The tuning scale and pointer are protected by a domed cover of transparent flexible moulded material.

Among the many good points in the performance of this receiver we would put first the high overall magnification up to the grid of the output valve. Few portables have given such a convincing demonstration of long-range reception inside the steel-framed building where initial adjustments and tests are usually carried out. When used out of doors or in a normal brick-built house the Philips portable can be relied upon to give as wide a choice of alternative programmes as the average table model broadcast receiver, and that without the trouble of putting up an exterior aerial.

Selectivity, too, is of a very high order, and on long waves the Deutschlandsender was easily separated from Droitwich and Radio Paris without invoking the aid of the directional properties of the frame. In this connection it is worth noting that in spite of the inclusion of AVC a well-defined minimum is obtained on most stations.

The set is commendably free from self-generated whistles. None could be traced on the medium-wave band, and on the long-wave range a clash between a harmonic of the oscillator and London Regional was noticeable only when an external aerial loaded the input tuned circuit.

Measurements of current consumption gave 0.5 amp. for the LT and an average of 8.5 mA from the 90-volt HT battery. There is very little change of HT current under the action of AVC even on strong signals unless an external aerial is attached, when the reduction is of the



With transformer coupling following the triode 1st AF amplifier the superheterodyne circuit has a high effective overall gain. The IF transformers have iron cores which are adjustable for final tuning to the intermediate frequency of 470 kc/s.

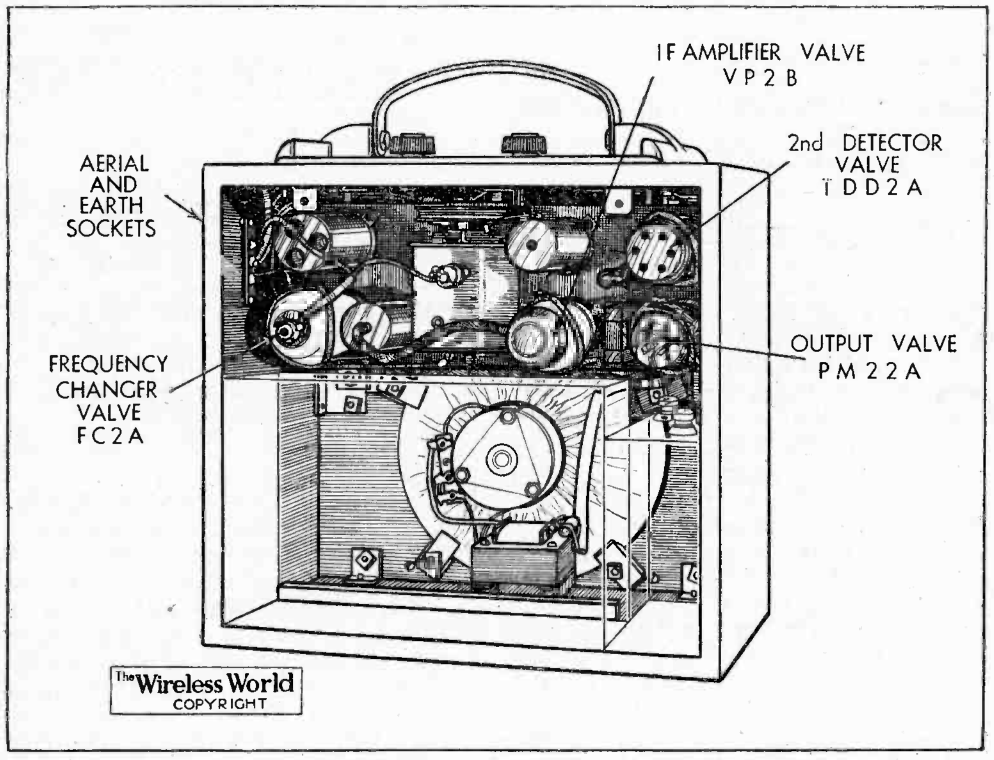
Philips Portable Model 225B—

order of 1 to 2 mA. An increase of a similar amount results from overloading the output stage—a frequent occurrence until one becomes accustomed to the controls. It is only on weak stations that the set can be fully extended, and under normal conditions of use a watchful eye must be kept on the volume control to avoid distortion. The volume then available is adequate for outdoor conditions provided that there is not too much wind about; indoors the maximum undistorted output gives precisely the level one would normally choose for general reception in a room of, say, 1,250 cubic feet with normal absorption.

Making allowance for the lack of extreme bass inherent in any receiver of this size there is no fault to find with the quality. On the contrary, it is ideally suited to speech and the lighter musical programmes. The piano in particular comes through extremely well provided one does not strive for too much volume.

The performance is so much above the average in the matter of range and selectivity that the attention which must be given to the volume control is a small price to pay. One does not have to pay for it in maintenance, for the average HT current is well within the capacity of the battery and fluctuations from the average are small.

The appearance of the receiver is attractive and the silver-grey loud speaker fret and polished chromium surround look well against the blue leatherette finish. There is a firmness and promise of permanence in the shaped metal carrying handle which is lacking in some of the straps fitted to cheaper models. In spite of, or perhaps because of, its rigidity it seems to be more comfortable than a flexible grip, and when hinged down is quite unobtrusive. Incidentally, if it is hinged down the "wrong" way, some additional protection is afforded to the control knobs in the event of heavy parcels being placed on top of the set in the back of a car.



Layout of interior of cabinet showing positions occupied by the HT and LT batteries. The valves which are mounted horizontally are secured by moulded rubber bands.

Club News

Wirral Amateur Transmitting and Short-wave Club

Headquarters: Beechroft Settlement, Whetstone Lane, Birkenhead.
Meetings: Last Wednesday in the month at 7.30 p.m.
Hon. Sec.: Mr. J. R. Williamson, 13, Harrow Grove, Bromborough, Birkenhead.

A successful junk sale was held on May 25th. There is now a great deal of activity in preparing the first issue of the club magazine.

The members of the Society will pay a visit to Speke Airport to view the radio equipment on Saturday, June 11th. Members and friends are asked to meet at the corner of Water Street, by the Cunard Buildings, Liverpool, in time to catch the 3.30 p.m. bus.

North Manchester Radio Society

Headquarters: 14, Fairfax Road, Prestwich, near Manchester.
Meetings: Alternate Sundays at 3.30 p.m.
Hon. Sec.: Mr. R. Lawton, 10, Dalton Avenue, Thatch Leach Lane, Whitefield, near Manchester.

It has been decided that the membership fee shall be 5s. a year, payable in two half-yearly instalments of 2s. 6d. Arrangements have been made for more instruction to be given at the meetings, and it has been decided that the Society shall have its own receiving equipment, and, later on, will apply for a transmitting licence. It is also intended that commercial types of short- or all-wave receivers shall be available at the clubroom. The next meeting is on June 12th.

London Transmitting Society

Headquarters: 40, Raeburn Road, Edgware.
Meetings: Thursdays at 8 p.m.
Hon. Sec.: Mr. G. Yale, 40, Raeburn Road, Edgware.

The Society has decided to purchase a Lissen Hi-Q4 SW receiver for the use of members. Agreement has now been reached on the apparatus to be built for the new laboratory.

Morse lessons are given every Thursday by 2DWS. A junk sale is arranged for to-night.

Eastbourne and District Radio Society

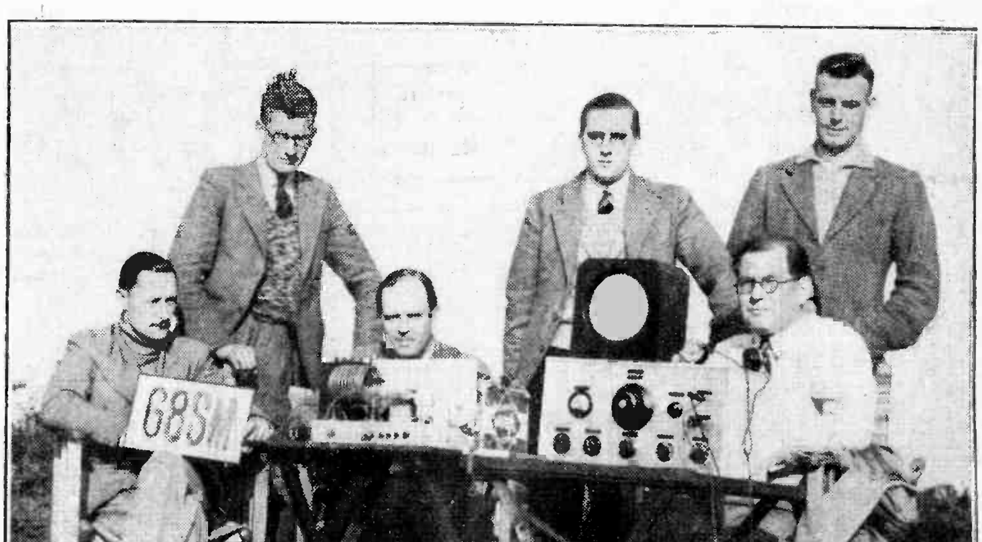
Headquarters: The Science Room, Cavendish Senior School, Eastbourne.
Hon. Sec.: Mr. T. G. R. Dowsett, 48, Grove Road, Eastbourne.

Recently Mr. E. Morey, of Belling and Lee, Ltd., gave a lecture entitled "General Interference Suppression Work." He demonstrated the "Eliminoise" anti-static aerial, and various types of suppressors.

Beethoven Model P.555

DESIGNED for use either as a home transportable or an outdoor picnic portable, this recent addition to the range of receivers made by Beethoven Electric Equipment, Ltd., Chase Road, North Acton, London, N.W.10, is housed in a blue leathercloth case 9½in. × 9¼in. × 5in. The controls are concealed under a hinged lid, and the carrying handle is detachable.

A four-valve straight circuit with pentode RF stage is employed, and the 80-volt HT battery is provided with quick-fitting contacts. The price complete with batteries is £6 15s., and the weight approximately 12½ lb.



AMATEUR FIELD DAY. One of the portable 40-metre transmitters which took part in a direction-finding contest organised recently by the Thames Valley Radio Society. The transmitter employed a straight crystal oscillator using an RK23 coupled to a 132ft. Hertz aerial. The receiver was of the TRF type. Included in the photograph is G8SMP, the owner of the station, together with G5LC, G2NN and other amateurs, who took part in the contest.

The Home Laboratory

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

Part VII.—BRIDGES

A GENERAL discussion of the properties and design of bridges, to be followed by constructional details of a general-purpose instrument in which an inexpensive cathode-ray indicator is used.

BROADLY speaking, there are two sorts of ways in which a thing can be measured. Meters of various types, so familiar in all radio laboratory and service work, are examples of *indirect* methods. In measuring the voltage of a battery by means of a voltmeter, one does not compare it with a standard *voltage;* actually the instrument responds to the *current* passed through a certain *resistance,* and even the current measurement is an indirect one. On the other hand, in laboratories devoted more particularly to very accurate measurements for the calibrating of meters, an unknown voltage is measured by comparing it directly with the voltage of a standard cell.

The same choice of methods is available for measuring resistance. The ohmmeters commonly incorporated in multi-range servicing instruments adopt an indirect method, indicating the *current* passed through the unknown resistance by a certain *voltage.* But when a resistance is to be measured very accurately it is more usual to compare it with a standard of the same kind, i.e., *resistance.*

Direct and Indirect Methods

In each of the above examples the *direct comparison* method is used for accurate laboratory purposes; the *indirect* method for approximate tests. This is quite typical. It is natural to expect greater accuracy and reliability if the thing being measured is directly compared with a standard of the same sort than if it is deduced indirectly. This is particularly so when the quantity concerned is something *passive,* such as a resistance. It may not be so with an *active* quantity, such as amplification.

The disadvantage of direct comparison, from a practical point of view, is that the quantities quite ordinarily required to be measured in a radio laboratory include such an enormous range. Taking capacity; there is 0.001 micro-microfarad at one extreme (the anode-grid capacity of a RF valve), and 100 microfarads at the other (a by-pass condenser for a valve biasing resistor). They enclose a range of a hundred thousand million to one. Resistance is encountered over a rather wider range; inductance rather less. The prospect of having to provide accurate standards for direct comparison covering all of these enormous ranges is truly alarming to contemplate!

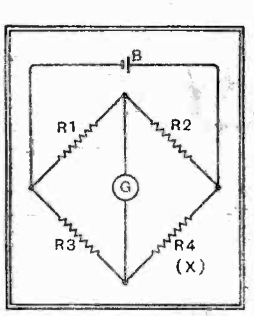


Fig. 1.—A typical DC bridge circuit.

That is where the bridge comes in. It is not practicable to measure the diameter of the sun against a standard yardstick by applying a pair of outside callipers directly to that luminary; but by holding the yardstick a little distance from the eye the sun can be measured if one knows the ratio of the distances from the eye to the stick and to the sun. A bridge is, first, a convenient system for comparing two electrical quantities with great precision, and secondly, a sort of electrical pantograph for introducing a multiplying ratio into the comparison. The simplest bridge, the Wheatstone, is a symmetrical network of six arms, one containing a source of current, such as a battery or oscillator, and another a detector, such as a galvanometer or phones; when the impedances of the remaining four are in proportion, no current flows via the detector arm. In Fig. 1, showing an ordinary Wheatstone bridge circuit for D.C., balance is obtained, and the deflection of the galvanometer G is zero, when $\frac{R1}{R2} = \frac{R3}{R4}$, which, of course, is the same as $R1\ R4 = R2\ R3$. Obviously, if three of these are known, the remaining one can be calculated. It is not even necessary to know the actual values of three; the value of one and the ratio between two is enough. Thus, if it is merely known that R1 and R2 are equal, balance is obtained when R3 = R4.

This illustrates the bridge as a means of comparing two resistances with greater precision than could be done in a more direct fashion. Suppose they are compared directly, by noting the reading given on a meter in series with each in turn; if the meter is a good one and has a very long scale it may be just possible to detect a difference amounting to a thousandth part of the deflection. But to get this it is necessary for the supply voltage to remain constant within still smaller limits, and for the deflection to be somewhere near full-scale. Generally, one part in a hundred would be a more likely accuracy of comparison. There is no advantage in using a very sensitive meter, because it would simply be driven off the scale. But in the bridge circuit it does not matter exactly what the battery voltage is, nor need it be perfectly steady; and the higher the sensitivity of the meter the more precisely can the comparison be made. There is hardly any limit. This is the advantage of the so-called *null method.*

Now suppose that R4, the "unknown," is higher than the standard, R3, can go to. If R2 is made, say, 10 times R1, then R4 at balance is 10 times R3. This illustrates the second object of the bridge circuit; to extend the range of comparison beyond that of the standard. In AC bridges this extension applies not only to quantity but to quality; not only can 1,000 microhenrys be accurately compared with 100 microhenrys, but it can be compared with 100 micro-microfarads or 1,000 ohms. Obviously all this makes it possible to cut down the number and variety of standards enormously. To give an example of this, a commercial make of bridge (the General Radio 650-A), in which everything including DC and AC sources is contained in a box a good deal smaller than a table radio set, covers 0.001 ohm to 1 MΩ, 1 mmfd. to 100 mfd., and 1μH to 100 H. Standards of equal accuracy, continuously variable between those limits would cost a small fortune and require a large part of the laboratory to house.

The DC bridge of Fig. 1 is simple enough, but there are a few practical points to be observed even about it. Maximum sensitiveness of balance is obtained when all four arms are equal. The nearer one can get to this condition the better. If the arms R1 and R2 are in the ratio of 10,000 to 1, the minimum observable deflection requires a much larger percentage unbalance than if a 1 to 1 ratio is adopted. More than that; the ratio itself is not likely to be known to great accuracy when it is large, because extreme values of resistances are not so accurate as medium values. Furthermore, a great advantage of a 1 to 1 ratio is that errors may be largely eliminated by reversing one pair of arms and taking the average of the two readings. If the resistance to be measured is very large, the sensitiveness of adjustment can be improved by increasing the battery voltage, but if R1 and R2 are quite low in resistance the resulting current may overheat them. So it is

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better for R4 and R2 to be the large resistances, in order to limit the current in both paths. A variable resistance in series with the battery is useful.

Although the detector G is not primarily intended as a measuring instrument, but merely to show the presence or absence of current, it is in practice used to make up for the customary absence of a continuously variable resistance standard. Having found, for example, that with R3=527 ohms the galvanometer

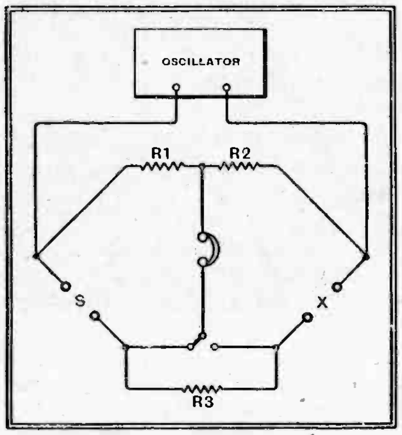

Fig. 2.—A simple type of AC bridge, in which R1 and R2 are the ratio arms.

reads 3 divisions to the left and with 528 it reads 2 to the right, one can see that the resistance for exact balance would be 527.6 ohms.

Until balance is approached it is essential for the well-being of G to shunt it down heavily, or reduce B, or both. If a suitable metal rectifier is used as a shunt it can be left connected all the time, because when the signal is near zero its resistance is so high as not to reduce the sensitivity of G very much, but it prevents disaster if one of the resistances is accidentally open-circuited when G is delicately adjusted to balance.

It is usual to have keys in the B and G circuits, and by tapping the G key in time with the natural swing period of the pointer of G, a smaller current can be detected than if it is kept steady. The B key must be closed before the G key, because if any of the resistances is reactive, as for example when the resistance of a transformer or loud speaker coil is being measured, the different impedance of such an arm to a current that is varying causes a momentary detector current even when the bridge is perfectly balanced for steady currents.

That is the obvious cue to go on to AC bridges; a vastly more complex subject. The most important complication is that besides resistances there are reactances of two sorts—inductive and capacitive—and for an AC bridge to be balanced it is necessary for both resistance and reactance to balance simultaneously. Then in some types of bridge the balance depends on frequency; in others it does not. Unless one particularly wants to distinguish between frequencies, the latter types of bridge have the advantage that the AC source need not be strictly of one frequency—it is not essential to provide a perfectly pure wave, free from harmonics. Another complication with AC is that unless one is very careful there may be unauthorised arms to the bridge, such as the capacities between the various components of it. The higher the frequency the worse the trouble is. And there are difficulties in making sure that what is meant to be a resistance arm really is a resistance and not a mixture of resistance and reactance. The difficulties in keeping reactances free from resistance are even greater still.

Looking at Fig. 1 again, if the arms R1 – R4 are all pure resistances it is quite possible to run it on AC instead of DC. In fact, if the frequency is about 1,000 c/s the detector can be a pair of phones, which is cheaper, more sensitive and robust than a galvanometer. The AC source may be a buzzer or valve oscillator. Headphones are very suitable for middle frequencies, but not for much lower or higher frequencies (e.g., 50 c/s). The resistance measured is, of course, the resistance to AC at the frequency of the source, which is not necessarily the same as the DC resistance.

Next, suppose the arms are all occupied by condensers or inductors. The same law for balance applies to their reactances; but it is necessary for them all either to be pure reactances or to have the same power factors (ratios of resistance to impedance); otherwise the unbalanced resistances obscure the reactance balance. In practice it is highly unlikely that four reactive arms would balance for reactance and resistance simultaneously, unless special provision is made for adjusting the quantities independently. In certain types of bridge, more especially those including self-inductance, these adjustments are not independent, and one may work away at them, first one and then the other, for a considerable time before finding a balance. Capacity arms are generally better, because a good condenser is a fair approximation to a pure reactance.

Ratio Arms

It is inviting unnecessary difficulties to make all four arms reactive, and in most practical AC bridges two of them (known as the ratio arms) are pure resistances and the other two—one of them including the unknown—are reactances with or without resistance. For example, Fig. 2 shows the circuit of a very simple but adaptable type of bridge. R1 and R2 are the ratio arms, either fixed at some one ratio or variable. The advantages of using a 1 to 1 ratio, mentioned for DC, are much more marked with AC, because it is much easier to prevent stray capacities from affecting the accuracy, but, of course, the range of measurement is much restricted. The component to be measured is connected at X and a standard of the same sort at S, and the switch is set to the position that puts R3 in the arm with least resistance, to enable the resistances to be balanced. If X is a resistance, the S terminals are shorted and R3 switched into that arm, giving the simple Fig. 1 circuit. If X is a condenser, S is a standard condenser, which is generally sufficiently good to be almost a pure reactance, so for balancing the resistance of X it is likely that R3 will have to be on the S side. Unless the condenser to be measured has a bad power factor (e.g., one of the electrolytic type) a reasonably good balance may be possible without R3. Finally, if X is a coil, a standard coil must be connected at S. As a matter of fact, this type of bridge, for the reason already given, is not very suitable for inductance measurements, except possibly for detecting differences between coils that are supposed to be the same. One common type of inductance bridge balances X against a capacity in the arm marked here as R1. Probably the best bridge of all for inductances employs a mutual inductometer as the standard.

Other Types

But it is not possible in a single article like this to go into details about the many sorts of AC bridges, especially those for accurate laboratory work. Some of them are dealt with in the forthcoming book of which these articles are a foretaste. Considering, then, the requirements for measuring a wide range of components with moderate accuracy, such as in service work, it is better to dodge the difficulties than to overcome them by sheer weight of finance and precise design and workmanship.

Stray capacities, for instance. The results obtained with a bridge of the Fig. 2 type are liable to differ considerably according to which point (if any) is earthed. If one side of the oscillator is earthed, any capacity from headphones to the wearer

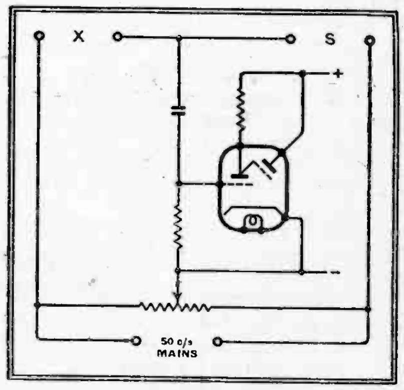

Fig. 3—A "universal" bridge with a tuning indicator as a detector.

and hence to earth comes across either the unknown or the standard. On the other hand, if the phones are earthed, the oscillator capacity may cause trouble, though at least it is less likely to be a variable quantity than is the capacity of headphones. In precise bridges all sorts of devices, such as screened and balanced input and output transformers, "Wagner earths," and so forth, are adopted with varying degrees of success. By taking suitable precautions it is possible to run bridges at high or even ultra-high fre-

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quencies. But the range of measurement is very limited. For covering a wide range, for general component checking, even 1,000 c/s is high enough to land one in difficulties.

Using the Mains Supply

But how about 50 c/s? Assuming standard electricity supply, there is no trouble or expense in providing an oscillator; just plug in to as much as is wanted. And at such a low frequency, stray capacities are correspondingly small in their effects, and a very moderate degree of care in this respect is sufficient for general purposes. But of course that very fact is awkward when measuring very small capacities. And another drawback of 50 c/s is that phones are practically useless, as they respond almost exclusively to the upper harmonics of the supply, and hence to the strays and errors more than to the real thing.

Fortunately it is possible to escape these drawbacks very easily by using as detector one of the familiar cathode-ray tuning indicator tubes. Not only is there no falling off in sensitivity at low frequencies, but the input impedance is so high—megohms, if necessary—that it lends itself favourably to measurement of the high impedances corresponding to small capacity and low frequency. And another advantage is that the inconvenience of headphones with their enslaving leads and varying stray capacities is avoided, and response is visual. As we are requiring the AC mains anyway as our "oscillator," it is easy to provide the feeds for the valve. As everybody knows, this tube includes a stage of amplification, so is sensitive enough without having to provide an external amplifier. The Mullard TV4 is again selected because although its form of indication is not ideal for instrument purposes, it has a greater sensitivity than any other, not being of the "variable-mu" type.

Fig. 3 is a schematic diagram of a simple bridge according to these suggestions. The item to be measured ("X") is balanced against a fixed standard of the same sort ("S"), the variable ratio arms consisting of an ordinary rotary potentiometer. To cover a wide range of measurement without extreme ratios, the S arm can consist of a group of standards selected by a switch. There is no great difficulty about condensers and resistors, but this type of bridge is not suitable for general measurements of coils, though as mentioned before it is quite good for matching similar coils against either one another or a standard. But at 50 c/s the reactance of coils below about a henry is too small compared with the resistance for accurate comparison.

In the next (and final) article details will be given of the construction of a simple and inexpensive bridge of this sort, measuring resistances over a range of 10 ohms to 10 megohms and capacities of 25 m-mfds. to 10 mfds., and, with somewhat lower accuracy, over considerably greater ranges. The power factor of large condensers—more especially electrolytics—is indicated; and a separate device shows condenser leakage. The whole is very compact and direct-reading resistance and capacity scales are provided.

Television Programmes

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

THURSDAY, JUNE 9th.

11 a.m.-12, Trooping the Colour. O.B. from the Horse Guards Parade, Whitehall, of H.M. The King's Birthday parade.

3, Ray Ventura and his Band. **3.25,** British Movietonews. **3.35,** 153rd edition of Picture Page.

9, Cabaret. **9.30,** Gaumont-British News. **9.40,** 154th edition of Picture Page. **10.10,** News Bulletin.

FRIDAY, JUNE 10th.

3, The Vic-Wells Ballet in "Façade"—music by William Walton, choreography by Frederick Ashton. **3.15,** Gaumont-British News. **3.25,** Cartoon Film. **3.30,** "The Cardinals' Collation," adapted from the Portuguese of Julio Dantes, by H. A. Saintsbury.

8.15, (sound only) Relay of last Toscanini Concert. **9.10,** Sheila Barrett in Starlight. **9.20,** British Movietonews. **9.30,** Artists and their Work. **9.45,** "Geological work of Ice"—Film. **9.55,** The Vic-Wells Ballet in "The Gods Go A-begging." Music by Handel, arranged by Sir Thomas Beecham. **10.20,** News Bulletin.

SATURDAY, JUNE 11th.

3, In Our Garden, C. H. Middleton. **3.10,** "The Happy Family"—a Hans Andersen story, told by Paul Leyssac. **3.20,** British Movietonews. **3.30,** Cabaret.

9, "Cabaret Cartoons": Cartoons by Harry Rutherford. **9.40,** Gaumont-British News. **9.50,** As on Friday at 3 p.m. **10.15,** News Bulletin.

SUNDAY, JUNE 12th.

8.50, News Bulletin. **9.5,** Music-Makers—Frances Day. **9.15,** Cartoon film. **9.25,** "Miracle at Chester," a play by Reginald Beckwith and Andrew Cruickshank.

MONDAY, JUNE 13th.

3, Forecast of Fashion. **3.15,** British Movietonews. **3.25-4.20,** The Northolt Derby. Three cameras will give views of the complete race, and Miss Jasmine Bligh will introduce personalities among the crowd.

9, Hildegarde. **9.10,** Forecast of Fashion. **9.25,** Cartoon Film. **9.30,** Gaumont-British News. **9.40,** "Charles and Mary," the play by Joan Temple. **10.40,** News Bulletin.

TUESDAY, JUNE 14th.

3, Catch-as-catch-can wrestling. **3.20,** Gaumont-British News. **3.30,** "Tele-ho," revue.

8.40, "The Cardinals' Collation" (as on Friday at 3.30 p.m.). **9.10,** British Movietonews. **9.20,** Foord v. Phillips, boxing. O.B. from Harringay Arena of the eliminating contest for the Empire Heavyweight Championship. **10.30,** News Bulletin.

WEDNESDAY, JUNE 15th.

3-4.10, "Lady Precious Stream," the play by S. I. Hsiung. Cast includes Esmé Percy and Josephine Middleton.

9, "100% Broadway," an all-American show. **9.40,** Gaumont-British News. **9.50,** Bridge Demonstration, organised by Hubert Phillips. **10.5,** News Bulletin.

RANDOM RADIATIONS

By "Diallist"

A New System?

DID you, I wonder, listen to the relay of Mr. Raymond Gram Swing's weekly talk on Saturday, May 28th? If you did, and if your critical faculties were at work, you must have noticed how different it was from the Transatlantic relays to which we have become accustomed. What struck me most was the perfectly silent background. There was none of that hissing which has come to be regarded as a necessary concomitant of long-distance relays using the radio link and none of the "sad sea waves" noise which some of the uninitiated still believe to be produced by the rollers of the Atlantic. As a rule, when there is fading about, AVC makes background noises more and more prominent as the signal wanes; but as there were not any background noises, this effect was completely absent. That there was a certain amount of fading was obvious, but the speaker's voice did not blast at the peaks or become badly distorted at the troughs. The whole thing was, in fact, so good and so free from the kind of blemishes that one associates with relays from great distances, that I felt at the time that some new system of reception must be in use.

News Awaited

A day or two later I rang up the B.B.C. to give them my impressions of this relay, and to ask whether I was right in thinking that some big improvement had been introduced in the receiving equipment. I learnt that the transmission came, not through the B.B.C.'s Tatsfield Station, but through the G.P.O.'s Transatlantic system. My friend at the B.B.C. had not heard of any special alterations in the receiving gear, but, like me, he had been vastly impressed by the relay. Its quality could not, I think, have been due to anything special in the way of conditions. Directly it was over I tried the 19-metre, the 25-metre, and the 31-metre bands, and found that nothing seemed to be coming through very strongly on any of them from the other side of the Atlantic, but that there was a good deal of quite deep fading. I wish I could discover the secret of suppressing superhet. background when I am engaged in short-wave listening. The set that I am using at present is pretty quiet for a superhet., but hiss is certainly annoying on the weaker far-away stations or when the strong ones are fading.

Another Misnomer

OFTEN I've had occasion to lament over the sadly misleading terms that we have chosen for so many things in wireless. When AVC was first introduced, *The Wireless World*, unless my memory plays me false, rightly made a strong bid to call it AGC, or Automatic Gain Control. Would that it had succeeded! And here's the reason. True automatic *volume* control should, of course, be a device concerned with the audio-frequency side of the set for keeping the output at any pre-selected level, no matter what station within the powers of the receiving set is tuned in. Such an arrangement has always been desirable; it has become still more desirable since the introduction of press-button tuning, and it has made its appearance on the other side of the Atlantic in the newest Scott receiver. Without something of the kind the press-button set loses half its charm, for you've got to work the manual volume control, as a rule, after touching the button that brings in the station you want.

Really Automatic

The trouble is that in most localities the local National and Regional are by far the most strongly received stations. If you live in their service area their volume doesn't vary much by day or night; but that of more distant stations most certainly does. For most people there is a particular level of sound which gives the most pleasing reception. A device which can be permanently set to ensure that all stations worth hearing come in at this level would be worth its weight in gold. The new Scott set goes a long way further than that in its array of automatic fitments. You can arrange it beforehand to bring in all the programmes that you select for the coming twenty-four hours. In place of a dial there's nothing to be seen but an ordinary electric clock. This has an outer rim driven by a two-to-one gearing, so that it makes one revolution in twenty-four hours. By pushing little pegs into sockets you can take your choice from the items provided by twelve stations during broadcasting hours. That doesn't mean that the set is working all the time! It comes into action only at the right moment and switches itself off automatically if you have "pegged" no immediately following item. But if you have previously selected an item to follow immediately from another station, a squelch valve comes into play whilst the receiver is retuning itself; then when all is ready you hear what you wanted to hear. I shall buy one of these receivers when ASP is introduced. ASP? Oh, just Automatic Self Purchase.

Americans and Television

THERE is still, I notice, a distinct tendency in the States to belittle our achievements in television. In a recent issue of *Radio News* there is an interview

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, JUNE 9th.

Nat., 6.20, An examination of post-War best sellers, talk by Philemon. 7.40, The Old Music Halls. 8.40, Seaports—a transport talk by Sir David Owen. 9.20, Band Boomerang between Max Schonherr and his Band in Vienna and Peter Yorke and his Orchestra in London.

Reg., 6.40, Under London, talk by F. L. Stevens. 9.10, "Safe Deposit," a radio play by James Eaton and Norman Hillas. 10.30, Tunes of the Town—intimate revue.

Abroad.

Strasbourg, 7.30, Wagner Concert, conducted by de Villers.

Budapest, 8, "Othello," opera (Verdi) from the Royal Hungarian Opera.

FRIDAY, JUNE 10th.

Nat., 7.30, "Rhythm Express." 8.15 and 9.30, Last Concert of the 1938 London Music Festival, conducted by Toscanini.

Reg., 6, Alfredo Campoli and his Orchestra. 8.15, "Crooners Corner," compèred by Eddie Pola. 9, Solos and Novelty Numbers by the B.B.C. Variety Orchestra. 9.30, Variety from Plymouth.

Abroad.

Belgrade, 8.30, European Concert of Yugoslav Music.

Brussels I, 8.30, Excerpts, "Tannhäuser," opera (Wagner)—I.N.R. Choir and Symphony Orchestra conducted by Dejoncker.

SATURDAY, JUNE 11th.

Nat., 3.15 and 4.35, An account of the day's play for the Wightman Cup. 8, Palace of Varieties, with the Ridgeway Parade. 9.20, American Commentary. 9.45, Music for Ballet and Chorus.

Reg., 6.30, Music by Mozart. 8.30, "A Bride for the Unicorn," a modern morality by Denis Johnston. 9.30, Reg Pursglove and his Orchestra.

Abroad.

Warsaw, 8, Gala Concert from the Cracow Music Festival.

Stuttgart, 8, "The School for Laughter," variety.

Budapest, 9.30, Budapest Concert Orchestra, conducted by Rajter.

SUNDAY, JUNE 12th.

Nat., 12.30, Spelling Bee, 6: London *v.* Dublin. 1.15, Coventry Hippodrome Orchestra. 4.20, Mario de Pietro and his Estudiantina. 9.35, Theatre Organ.

Reg., 5, Eugene Pini and his Tango Orchestra. 5.45, Round the Courts. 9.5, Fred Hartley and his Sextet.

Abroad.

Vienna, 7.10, "Der Rosenkavalier," opera (Richard Strauss).

Stuttgart, 8, "The Gipsy Baron," operetta (Johann Strauss).

MONDAY, JUNE 13th.

Nat., 7, "The Bungalow Club," variety, introduced by Anona Winn. 8.50, Gillie Potter. 9.20, World Affairs. 9.35, Recital of Spanish Music by Irene Kohler, pianoforte.

Reg., 7.30, "Gibraltar," the story, in sound, of our smallest dependency. 8, The B.B.C. Symphony Orchestra, conducted by Sir Adrian Boult. 9, "Songs of the River" by the Northumbrian Singers.

Abroad.

Alpes-Grenoble, 8.30, Mozart Festival.

TUESDAY, JUNE 14th.

Nat., 7.40, The Poet Laureateship, talk by Humphrey Jennings. 9.20, My Best News Story—Front Page Fight, by Trevor Wignall.

Reg., 7.30, Swift Serenade. 8, Arthur Catterall and the B.B.C. Northern Orchestra, conducted by Arnold Perry. 9, Joe Loss and his Band.

Abroad.

Strasbourg, 8.30, Sacred Concert from the Cathedral. Marcel Dupré, organist of Notre Dame, at the organ, with Cathedral Choir and Radio Orchestra.

Brussels II, 9, Alex de Vries, pianoforte, and the Belgian National Orchestra conducted by Jan Kumps.

WEDNESDAY, JUNE 15th.

Nat., 8, Milestones of Melody—Geraldo and his Concert Orchestra. 9.20, "Hail, Variety." 10, "La Bohème," Act 3 from Covent Garden.

Reg., 7.30, The World Goes By. 8, Recital by Douglas Cameron, 'cello. 8.25 and 9.25, "La Bohème," Acts I and 2, from Covent Garden.

Abroad.

Brussels I, 8, "The Tsarevitch," operetta (Lehár).

Lille, 8.30, "William Tell," opera (Rossini) relayed from Rouen.

with Mr. Gilbert Seldes, Director of Television Programmes of the Columbia Broadcasting System. "We haven't," Mr. Seldes is reported as saying, "been premature here in America as they have been in England. . . . They have the sets and they still have the 'bugs.' When America starts buying television sets for its homes it will be able to do so with the knowledge that the 'bugs' which give our cousins across the Big Pond headaches have been ironed out as far as we are concerned." I don't quite know how you iron out a bug, but I take it Mr. Seldes intends to convey that viewers in this country suffer from a variety of defects and difficulties in their reception of the A.P. programmes. If he really does believe that, one wishes that he could come over here and look-in for himself. The only serious fly in our ointment is man-made interference, particularly from motor cars, and I imagine that that is at least as bad in the States as it is here.

Not So Easy

However many bugs may be ironed out in the course of the long-drawn-out preliminary research work that is being done in America, they're going to have one big difficulty in starting television which, happily, did not come our way. Those who are developing it over there have always made it plain that, to begin with, television will be confined to the big cities, such as New York and Chicago. Mr. Seldes estimates that, if these two are chosen, only about 5 per cent. of the population of America will be within the first service area. His figure is on the low side, for by my reckoning Chicago and New York between them contain about 7½ per cent. of America's population. Still, even 7½ per cent. is a very small proportion. Our single station at the Alexandra Palace covers an area which contains at least 25 per cent. of our people, and three more transmitters, one at Birmingham and others in the neighbourhoods of Manchester and Leeds, would mean that more than half of the population of Great Britain was within range of a television transmitter. To achieve anything like the same result in the United States a vastly greater number of stations, separated from one another by enormous distances in some cases, would be required. Our existing co-axial cables would probably enable British stations serving half the population to transmit programmes originating from a single centre in London. Tens of thousands of miles of co-axial cable would be needed for anything on similar lines to be done in the United States.

Sunspots and Magnetic Storms

REFERRING to the recent note in which I suggested that the appearance of large numbers of spots on the sun's disc was not necessarily accompanied or followed immediately by terrestrial magnetic disturbances, a Portsmouth reader expresses the view that it isn't so much the number or size of the spots that matters as their position. He suspects that when a large group crosses the sun's central meridian magnetic disturbances on the earth usually follow within a matter of hours. I agree with him up to a point, though not entirely. As the average time for a complete solar rotation with respect to the earth is just over twenty-seven days, any group which is visible for seven days or more must surely cross the central meridian. Also, it's interesting to remember that the aurora of January 25th and the very severe magnetic storm which took place then both occurred long after a group of spots, so big that it was visible to the naked eye, had passed the central meridian. On January 25th this group was actually very close to the edge of the sun's disc. However, I am with this reader in feeling that it would be a very great advantage if the cosmic data sheets gave some idea of the position of the sunspots which they report.

Business Methods

AS I have quoted in these notes several instances of slackness on the part of British manufacturers in fulfilling orders, chiefly from abroad, I was very interested in a recent letter in *The Wireless World*, whose writer took up the cudgels in defence of makers of radio sets and radio components. I grant him willingly that many —perhaps most—of our firms are pretty good. But one comes across far too many instances of slackness and of carelessness in dealing both with orders and with enquiries about products. Let me give an instance of what happened to me recently. I wanted to use in a piece of apparatus that I am making up an appliance made by a firm of some standing. I knew that it was by no means a cheap item, but the price had not been stated though it had received a certain amount of publicity. I wrote to the makers asking the price and the current produced under certain conditions. After some days I had a reply from the technical department giving a figure for the current, but omitting any mention of the price of the appliance. A leaflet was sent which gave certain particulars and also mentioned that the appliance was available in two other forms. I wrote again, asking once more for the price and the current produced by the appliance in its other forms. The reply, though giving me the prices, mentioned no figures for the current from the second and third forms of the appliance, and, without any comment or explanation, gave me a figure for the current of the first appliance that was entirely different from that originally stated. I therefore had to write yet a third time to ask for confirmation of the figures given for the first form of the appliance and to ask once more for those for the second and third. The whole business resulted in about a fortnight's waste of time. It's just that sort of thing that makes people so irate and so critical of business methods.

The Wireless Industry

LARGE-SCREEN reception of the Derby television broadcast was successfully demonstrated to large audiences by the Baird system at the Tatler Theatre, London, and by the Scophony mechanical method at a Kensington store.

Anglo-American Radio (& Motors), Ltd., are the appointed distributing agents in England, Wales and Ireland, for the Meissner Manufacturing Company, whose products include the Meissner Communications Receiver.

The Sturdy Electrical Company, of 1, Wesley Terrace, Newcastle-on-Tyne, announces reductions in the prices of transformer rewinding.

The price of 12in. Phono-Disc recording blanks is 20s. per dozen, and not as given in our issue of May 19th.

Recent Inventions

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

ELECTRON MULTIPLIERS

AN amplifier, operating by secondary emission, is made with a series of "target" electrodes, alternately plane and cylindrical in shape, and carrying progressively increasing voltages. As shown in the Figure, primary electrons from the cathode C are accelerated by a grid G towards the first cylindrical anode A. Here they produce secondary electrons, the stream so augmented being attracted on to a disc anode A1 from which it passes to a second cylindrical anode A2.

The process is repeated at the next stage, as shown by the zig-zag "arrowed" lines, the final output being collected at O and passing through an external load resistance R. The advantage is that the cross-section of the path available to the electrons becomes larger as the multiplication increases, thus keeping the concentration of the stream within desirable limits.

Farnsworth Television Inc. Convention date (U.S.A.), June 1st, 1936. No. 482026.

o o o o

ONE of the defects of secondary-emission amplifiers lies in the difficulty of stabilising the "gain" (or the ratio of secondary to primary electrons) produced at each of the target electrodes.

According to the invention, the output current from the tube is used to apply negative reaction to the control grid of the multiplier, so that if the output increases the grid is made more negative, to cut down the supply of primary electrons. Similarly, if the output current falls off, the control grid automatically becomes more positive, and the primary emission is increased.

The General Electric Co., Ltd., L. I. Farren and E. P. George. Application date November 30th, 1936. No. 481996.

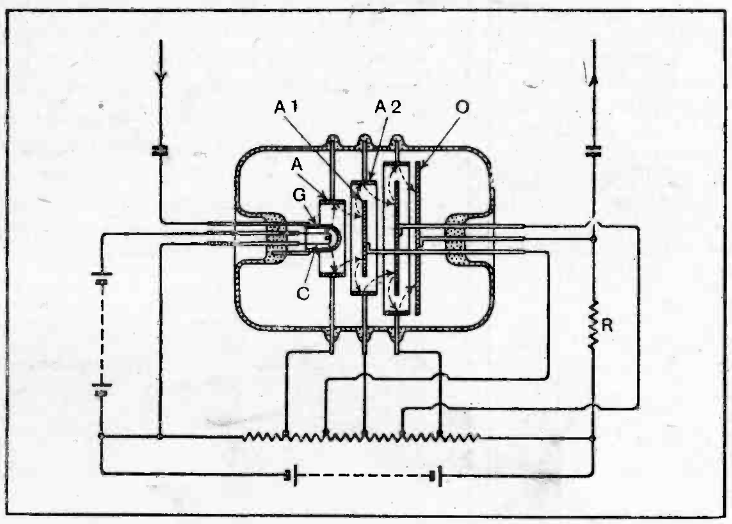
o o o o

BROADCASTING SYSTEMS

IN common-wave broadcasting the programme is usually distributed from a central station by line-wire to a number of outlying stations, which radiate it simultaneously on a common carrier-wave. To prevent interference in places which may "overlap" the service-area of two or more of the relaying stations, it is essential to keep the radiated carrier-wave constant, and this can be done by sending periodical impulses from the central station, over the line-wire connection, to synchronise the local carrier-wave generators.

Another alternative is to modulate the carrier-wave, once and for all, at the central station, and to transmit it in this form over the line-wire to the outlying stations, where it is simply amplified up and radiated. The snag here is the severe attenuation of the carrier-wave currents along the wire link. This is overcome, according to the invention, by first stepping-down the modulated carrier-wave at the central station before feeding it into the wire, and then stepping it up by a frequency-converter at each of the outlying stations before it is radiated.

Standard Telephones and Cables, Ltd. (Assignees of H. A. Affel). Convention date (U.S.A.) July 10th, 1936. No. 481841.



Arrangement of elements in electron multiplier described in the text.

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.

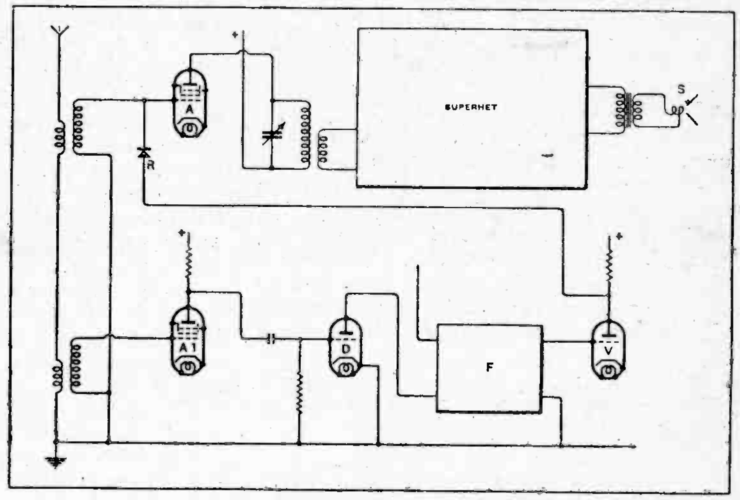
ELIMINATING STATIC

THE invention is based on the fact that static interference consists of highly damped impulses of relatively short duration. Such impulses can accordingly be cut out from the desired signals by interrupting the operation of the receiver at intervals which are so rapid that they do not affect the apparent continuity of speech or music.

The arrangement is shown in the Figure, the upper part of which consists of a semi-aperiodic HF amplifier A, followed by the usual stages of a standard superhet receiver, and a loud speaker S.

The lower branch of the circuit consists of a high-frequency stage A1 which is made aperiodic so that the static impulses which, together with the signals, are fed to it from the aerial keep their original highly damped form. After rectification at D, the currents are passed through a high-pass filter F, which cuts-off all frequencies below, say, 6,000 cycles. The rectified static impulses, being higher than this, pass through the filter F to a low-frequency amplifier V, though the rectified signal frequencies are blocked. The resulting pulses of static are then applied through a rectifier R to "paralyse" the grid of the amplifier A, for short periods during which neither signal nor static can reach the loud speaker. The periods of interruption are so rapid, however, that the reception of the desired signals appears to be continuous.

L. Gabrilovitch. Convention date (France). April 28th, 1936. No. 482074.



Circuit for suppressing electric interference of the "pulse" or short period kind.

o o o o

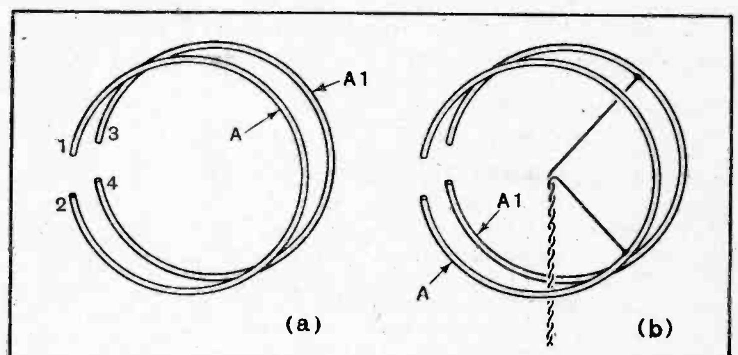
SHORT-WAVE AERIALS

AS shown the aerial consists of a pair of parallel wires A, A1, Fig. (a) bent into almost a complete circle, the free ends 1, 2, 3, 4 forming the four corners of an imaginary square. The length of each wire is between 0.4 and 0.5 of a wavelength, and the wires are spaced apart by approximately one-hundredth of a wavelength.

The feed-line may be connected across the two opposite open ends marked 1 and 4, or across the two wires midway along their length. Or the two points of connection of the line to the aerial may subtend an angle of approximately 42 deg. at the centre of the circle, as shown in the Figure (b).

The arrangement, which is particularly suitable for transmitting wavelengths of between 5 and 20 metres, gives a highly concentrated field in the plane containing the two wires and in the direction pointing away from the open ends. This is said to be due to the fact that the electrostatic field created across the open ends opposes the magnetic field which would otherwise be radiated in that direction from the centre of the system.

Marconi's Wireless Telegraph Co., Ltd. (assignees of J. L. Reinartz). Convention date (U.S.A.), October 8th, 1936. No. 482114.



Compact beam aerial particularly suitable for the ultra-high frequencies.

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.

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EDITORIAL COMMENT

Broadcast Distribution

"Group Allocation" Possibilities

THE organisation of broadcasting in Europe has developed so rapidly in the past few years, with a succession of "plans" for wavelength allocation amongst the various countries, that it seems perhaps absurd even to consider that proposals for wavelength allocation made as far back as 1928 could offer any useful lessons to-day. Yet we have on this page on more than one occasion harked back to proposals for wavelength distribution in Europe put forward by Mr. Siffer Lemoine, of the Swedish Telegraph Administration, in a contribution to *The Wireless Engineer* in July, 1928. There is much of Mr. Lemoine's scheme which to-day would probably be regarded as inapplicable to modern conditions, but one aspect of his proposals, described by him as "group allocation" of frequencies, seems to us to be particularly worthy of consideration to-day if there is any possibility that it could be put into force.

Briefly the idea was that instead of frequencies being allotted in Europe so that the stations of different countries jostled one another, bands of frequencies should be allotted to the same countries as far as possible, so that each country could please itself as to how it utilised these allotted wavebands and could crowd into them a number of stations of narrow band width or fewer stations giving better quality, or again, could have one or more stations of high quality and others with restricted frequency bands. If mutual interference took place it would be a matter for one authority to contend with and would not involve representations to Governments of other countries.

Naturally, the "service value" of different wavelengths would have to be taken into consideration ; it would not be fair, for instance, to allocate wide bands of the best frequencies to one country and less useful bands to others, but it should surely be possible to apportion the wavebands fairly. Countries of small area might well be content with wavelengths unsuitable for covering great distances, whilst large territories should be given a proportionately larger share of the longer wavelengths suited to their peculiar requirements.

High-quality Stations

In these days when frequency control has reached so high a standard that there is far less inter-station interference, perhaps the most attractive feature of these proposals in the light of present-day requirements would be the ability for stations of very high quality to be established in each country by sacrificing quality in the case of other stations of the same nationality. At present if it were desired, for instance, to increase the frequency band of one of our own stations for the purpose of improving quality, we should at once find that we were encroaching upon the frequencies allotted to other countries whose stations were located on either side of our own.

Whether or not the present organisation has been so firmly established that it must remain unalterable is not a matter on which we feel we can express an opinion, but we believe, that if it were possible to start afresh with wavelength allocation in Europe the idea of "group allocation" would merit the closest consideration, in spite of the fact that the idea was launched so long ago.

Automatic Tuning

A SURVEY OF AMERICAN METHODS

THE author shows how the various systems of automatic tuning now in use in America can be divided into three main categories; the essential differences between the various methods are described.

DURING a recent visit to the United States the writer had an excellent opportunity of studying recent trends in automatic tuning devices. The purpose of the following article is to give a short survey of the situation encountered at the time, without going very far into technical details.

Readers of *The Wireless World* will be aware of the fact that automatic tuning devices are by no means a novel invention, nor did they, it is believed, originate in the United States. I remember having seen the first push-button tuning set as far back as 1924 at the first Berlin Wireless Exhibition. It was designed by the well-known inventor, de Kramolin, and based, if I remember correctly, on the purely mechanical principle of connecting buttons and condenser by levers with a variable leverage.

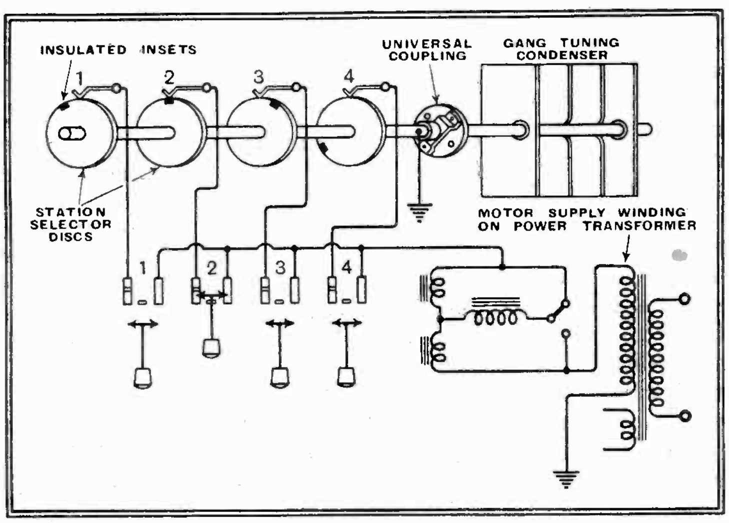


Fig. 1.—Diagram of motor tuning system with separate contact discs for each button and reversing switch on motor winding, the latter being thrown over automatically at each end-position of the tuning condenser. The two symmetrical windings determine the direction of rotation.

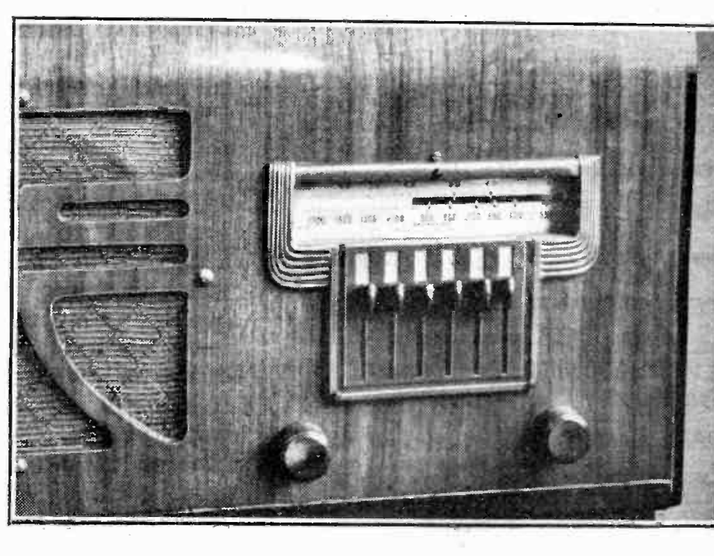
In those days, however, none of the conditions had been fulfilled that make automatic tuning a really practicable proposition. Most of the tuning had to be done by way of correction by hand, and the buttons had only a more or less symbolic significance. Various attempts at remote tuning were made in the United States and elsewhere, but apparently without success. Most systems were not truly automatic; the general plan was to segregate parts of the tuning mechanism, e.g., high-frequency or oscillator circuits complete with tuning condenser, from the rest of the set and connect it to the latter by means of a cable. These arrangements proved to be both expensive and unreliable, and they soon sank into oblivion. In 1933 a German firm started the idea of telephone dial tuning. The dial operated one of the usual automatic telephone relays, which, in turn, connected various combinations of fixed capacities to the tuning coils. The dial was numbered in the usual way, and there was a table on the set giving the "call numbers" for the various stations which corresponded to different combinations of fixed condensers. Most readers will probably remember the early automatically tuned British set that was marketed several years ago by the Aerodyne Company. This set had many of the features which are to-day considered necessary and expedient.

I believe that this set did a lot towards starting the present fashion of automatic tuning. A somewhat elaborated set, brought out in 1935 by a Viennese firm (Eltz), can be said to be in every way characteristic of the best modern motorised automatic tuning. Its immediate sales success was not considerable, chiefly owing to the comparatively high price. There is no doubt, however, that it set the minds of radio engineers working furiously.

At this point I may remind my readers that one great difficulty had so far prevented general acceptance of automatic tuning devices. I am speaking of the lack of mechanical and electrical stability in circuits and the great influence of very minute changes on the precision of tuning. Pre-set tuning devices can only retain their original setting if condensers, coils, and wiring retain their capacities and inductances with the utmost accuracy. The fact that they do not do so without special measures being taken has prevented radio engineers from seriously contemplating the introduction of automatic tuning before the advent of some form of automatic correction. This is where the important American contribution comes in. American engineers developed efficient and comparatively simple circuits for automatic frequency control, and it was very soon recognised that the realisation of AFC was the first stepping stone to a really perfect form of automatic tuning device. With AFC absolute accuracy of the mechanical parts of the tuning system was no longer required, because the automatic correction would correct any possible errors due to mechanical imperfection.

Cost of AFC

It was only after the advent of the first automatically tuned radios with AFC that people in America began to delve into the possibilities of automatic tuning systems without AFC, the idea being to go one better than the other man and bring out sets with the same sales appeal at very much lower prices. There is, of course, no denying the fact that AFC is both expensive and tricky; it is probably responsible for at least half the costs of the entire automatic tuning device. The question as to whether AFC can be dispensed with or not has yet to be answered, but I believe that some American firms are satisfied if their sets tune correctly when they are first installed, and they



The control panel of a receiver operated by mechanical means. The depression of levers tunes in selected stations. This Belmont receiver can also be manipulated by the usual manual control.

Systems

By
WOLF E. FELIX

leave it to the dealer and his customers to readjust irregularities which may occur in course of time. There is, of course, always the regular tuning knob to fall back upon in case one or other of the pre-tuned stations should go out of tune.

There are quite a number of systems of automatic tuning in actual commercial use in the United States. They can all be summarised, however, under the following headings:—

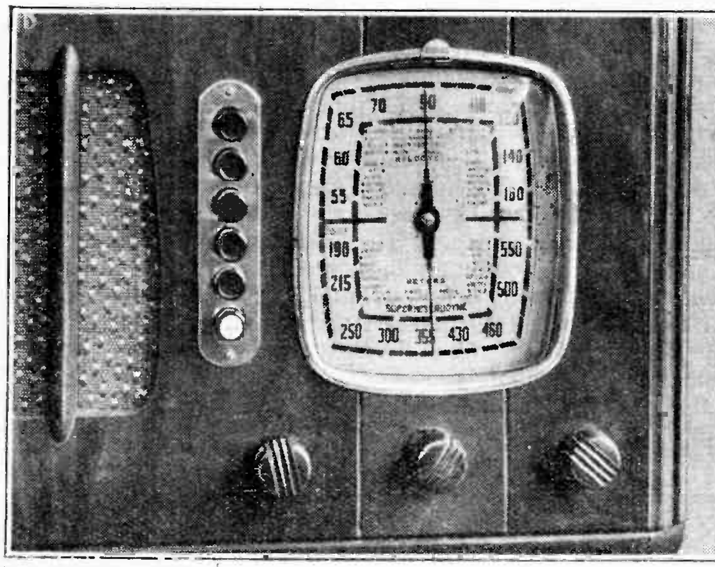
Mechanical Systems.
Motorised Systems.
Capacity Substitution Systems.

Any of these three systems can be actuated by different devices, such as levers, telephone dials, or push buttons. All these methods have been put into practice, but there is no longer a shadow of doubt that the push-button has carried the field. Its appeal to the public as a simple and straightforward arrangement is not to be beaten.

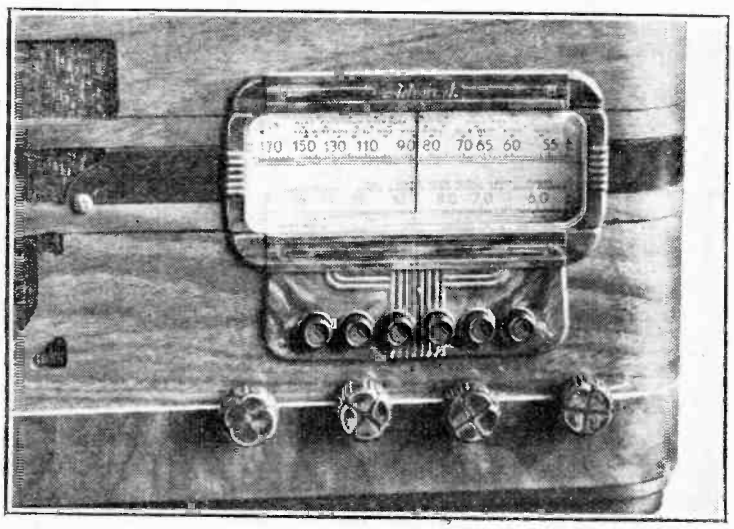
Let us add a few words to explain the three systems.

The Mechanical System consists of coupling the normal variable condenser with a set of levers or more generally with a sort of telephone dial. The dial is so arranged that if you insert your finger into one of the dial holes you depress a pin which eventually strikes a stop when you twist the dial. Unlike a telephone dial, this radio dial does not return to its original position after you have let go, for this would mean a severing of the connection between the condenser and dial. There are various devices for assuring the greatest possible accuracy and for combining with the dial motion the other desirable functions, such as automatic muting devices and the switching on and off of the AFC, if any.

This type of set, which has been manufactured in larger numbers than any other during the last season, has only one serious drawback: the public does not take to it as much as to the push-button sets. A technical deficiency that can be mentioned in its disfavour is the fact that it cannot be used to tune stations on neighbouring channels automatically, the distance between two adjacent dial-holes being determined by the size of the human finger and the possible diameter of the dial, and not by the width of the broadcast channel. This difficulty could, of course, be overcome by using several rows of holes in a staggered position. But this would only accentuate the drawback of the entire system, which consists in the circular arrangement with its inherent lack of legibility, as compared with the linear arrangement in use with the push-button system.



Capacity substitution is the system employed for the automatic tuning of this De Walde model, which also caters for normal control.



An Admiral receiver in which motorised tuning is available for six different stations.

Another theoretical disadvantage of telephone dial tuning is the impossibility of making the drive mechanism serve as a remote control, a feature which is an additional attraction with motor tuning. This point has not been of very great importance so far, however, as remote control presents other difficulties which have not yet been completely overcome. The most important of these is the absence of a practical solution of remote volume and tone control.

Motor Tuning in its simplest form consists in the addition of a reversible motor to the ordinary tuning condenser and the provision of a two-way switch. In the centre or vertical position this switch cuts off the current from the motor winding, while it starts the motor revolving clockwise or anti-clockwise when the switch lever is pressed to the right or to the left. As long as the motor is revolving, the pointer will travel over the dial in one or the other direction, and the switch has to be turned to the centre position as soon as the pointer reaches the desired station mark. It goes without saying that the

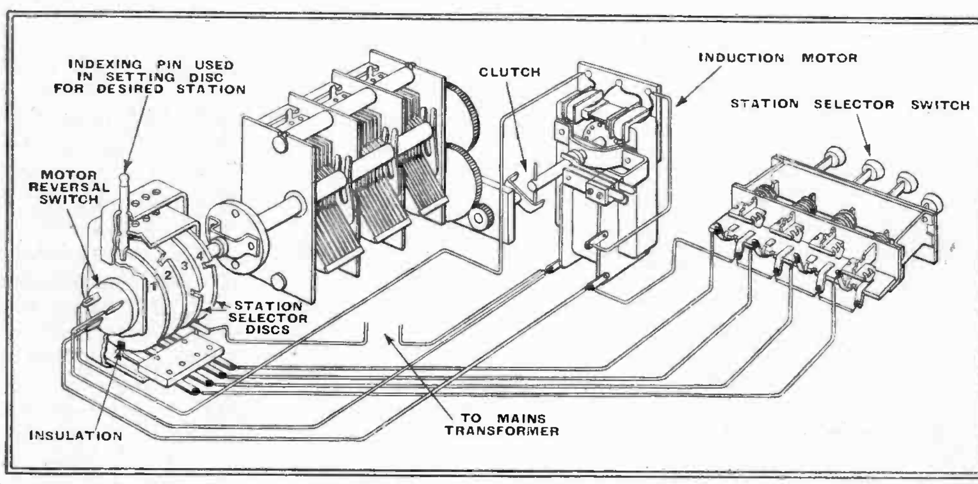


Fig. 2.—Schematic drawing of motor tuning system as represented in Fig. 1, showing push-buttons, motor with clutch and contact-springs and the group of contact-discs with the motor-reversing switch. These contact-discs are held on their shaft by friction and are easily adjustable by locking them with a special pin and turning the condenser by hand to the desired station.

Automatic Tuning Systems—

method is only possible in combination with AFC, as accurate tuning is almost impossible. Most motorised tuning systems work in connection with push-buttons, which is hardly more complicated, and appeals to the public to a far higher degree. The push-buttons are connected to contacts which close circuits, including the motor winding. The motor is therefore started automatically as soon as one of the buttons is depressed, and goes on running until the contact is broken. The breaking of the contact disengages a clutch on the motor, thus ensuring immediate stoppage, irrespective of the inertia of the motor armature. In a very practical design of one of the small tuning motors on the American market the entire armature performs a movement in axial direction as soon as the winding is energised. This movement can be utilised not only to actuate the clutch, but also to make or break auxiliary contacts for the purpose of muting during the tuning operation, and closing the AFC circuit as soon as the motor tuning action is completed. A fuse is provided for the protection of the motor winding.

Different systems on the general principle indicated have been put into practice. The simplest and cheapest method appears to be the design introduced by firms such as Detrola and Midwest and recently brought out in England by Ekco. A reversible motor of the shaded pole type is used, and there is a disc of insulating material on the end of the condenser shaft. The insulating disc carries two metal half-discs, separated by a narrow insulating gap, their rims being of the same diameter as the rim of the insulating material. A semi-circular rail surrounds the disc and contains one or more slots in which the contact springs are fastened. These springs can be displaced along the slots and arranged in a staggered disposition so as to touch the periphery of the disc at any desired points—if necessary closely adjacent. Each of the two metal half-discs is connected with one of the shading windings, causing the motor to turn clockwise or anti-clockwise according to which of the two discs is contacted. When the button is pressed the current flows by way of the corresponding contact on the rail to the metal half-disc with which this contact is in touch and on to the motor, making it turn in the direction of the station whose button is depressed. The position of the contact on the rail is so arranged that the contact spring touches the gap between the two metal half-discs when the condenser is at the correct tuning position for the station in question. The contact spring comes to rest on the insulating material, and the contact is broken, thus disengaging the clutch and stopping the motor. In case the clutch action is not swift enough, the disc will continue to turn until the contact spring reaches the other metal half-disc. In this case the motor is energised in the opposite direction and turns backward, without, however, gaining sufficient momentum to over-jump the gap a second time. A very simple contrivance facilitates the correct adjustment of the contact springs on their brackets for the purpose of tuning the various push-button circuits. A special small lamp is provided which can be connected to the disc circuit. The push-button for the desired station is depressed and the set tuned by hand with the ordinary tuning knob. The contact spring is now displaced in its slot until the lamp is extinguished. This is the case when the spring touches the gap between the two metal half-discs. The tuning of stations for the push-button circuits is thus rendered extremely simple.

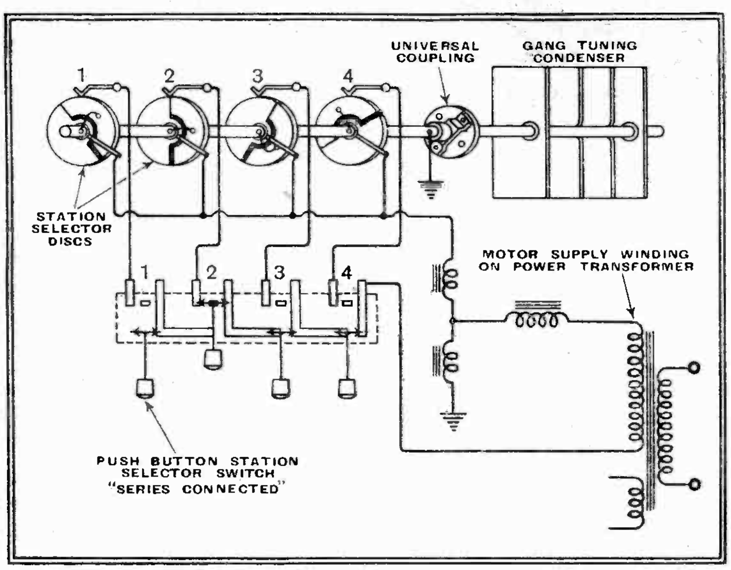


Fig. 3.—Tuning system of the "direct homing" type, but with one contact-disc for every button. The smaller half-disc is connected to the shaft and thence to earth. The larger half-disc is permanently connected to the motor winding by means of the lower sliding contact. Both half-discs are insulated. In position 1 the smaller, in position 3 and 4 the larger, half-disc is in circuit, causing corresponding direction of rotation. Position 2 shows interruption of current and a station ready tuned.

The arrangement described was by no means the first solution on the American market. As a matter of fact, it was one of the last to appear. The most successful models, especially the RCA 150-dollar set, is far more complicated and expensive to manufacture, as it uses a separate contact-disc for every push-button. I believe, however, that it has been universally recognised that the arrangement described is so far the most practical solution. Not all sets employ motors which will turn in the direction required to reach the desired station directly. Some of the motors move in one direction only, with the result that the pointer, wherever it stands, always has to move in the same direction. If the station happens to be placed on the other side of the pointer, the latter has to move to the end of the dial, where it actuates a switch reversing the direction of rotation of the motor. It then travels backwards across the dial to the point required. This takes quite a time and is certainly less effective than the other method.

Remote Control Possibilities

It is obvious that with motor-tuned systems there is no difficulty in separating the push-button mechanism from the set itself and using it as a remote control unit connected to the set by a cable carrying DC of comparatively low tension. The push-buttons are generally so arranged that the depressed button is locked and released again upon pressing another button. Other methods are, however, also used; for instance, buttons which have to be depressed during the entire tuning operation. A separate button is usually provided to change over to manual tuning.

As the appeal of push-button motorised tuning is universally recognised, efforts are at present being directed towards its simplification. Once the American component industry has made up its mind about what to manufacture, there is no doubt that all the accessories necessary, such as push-button strips, complete contact units, and tuning motors will be produced at prices even lower than heretofore. Tuning motors are at present available at prices ranging between 65 cents and a dollar, which shows that motorisation in itself is not an expensive proposition. The main question seems to be the inclusion of AFC. It is perhaps interesting to note that motorised push-button sets *without* AFC are already available at prices below 30 dollars for a six-valve table model.

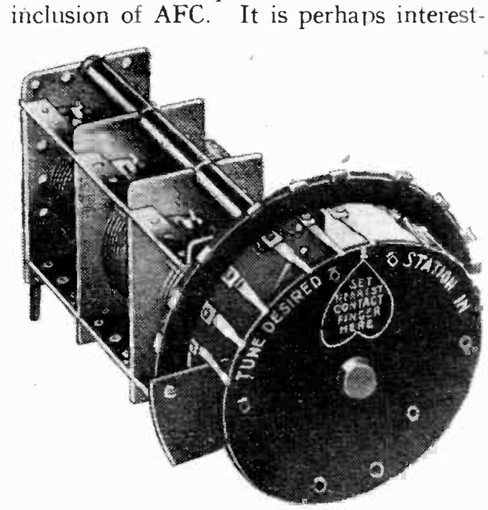
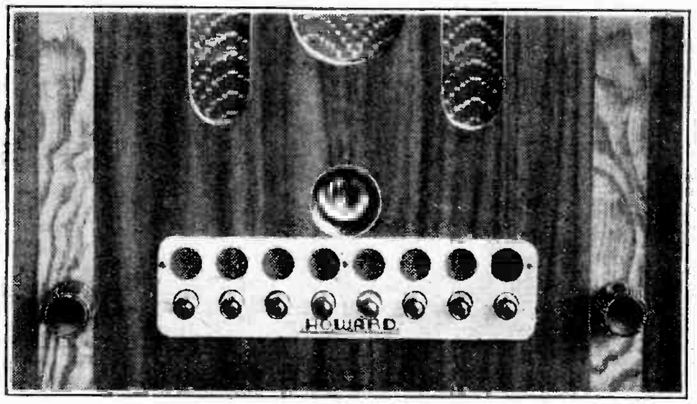


Fig. 4.—Variable condenser with contact-disc for "direct homing" system. The point of the heart-shaped mark indicates the gap between the metal half-discs, which are on the rear of the insulating disc.

Automatic Tuning Systems—

Capacity Substitution Systems constitute a simple solution of the problem to provide push-button tuning without encountering any of the mechanical problems inherent in the two other systems mentioned. As a general rule, trimmer-type condensers are substituted for the variable condenser of the set. They may be connected to the existing tuning coils, or separate tuning coils may be provided so that entire circuits are substituted. The latter, however, is not the rule. It goes without saying that one condenser per station has to be provided and adjusted for every tuned circuit—that is to say, for the oscillator and at least one RF circuit. This is the reason why substitution systems are rarely used for more than six or eight automatically tuned stations. Six stations require adjustment of twelve or eighteen condensers, according to whether one or two RF circuits are used. As the capacity of the usual adjustable trimming condenser is but small, additional fixed condensers have to be used in order to cover the whole range of capacities required. The advantages of the substitution system consist in the possibility of adapting existing sets to push-button tuning and in the instantaneous action of the tuning process as opposed to the comparatively slow action of motor tuning. The latter difference is, however, not sufficient to impress the public. Capacity substitution systems are chiefly used on the cheaper kind of sets. Their great drawback consists in the amount of servicing they may require in case of changes in the wavelength of broadcasting stations and the cost of adapting every individual set to the wishes of the buyer in the first instance. Some firms have found it expedient to tune their push-button circuits at the factory according to the average requirements to be expected in certain parts of the country. The tribulations of the dealer may be appreciably lessened by this method of proceeding.



Eight stations, all controlled by push-button, are available on this all-automatic Howard table model receiver.
For this and other photographs of receiver control panels we are indebted to R. A. Rothermel, Ltd.

Preventing Frequency Drift

A question that has been raised by the advent of automatic tuning is the stability of circuits in general. I believe that considerable work is being done in this respect in American laboratories. The first point to be considered is the effect of temperature. The positive temperature coefficient of inductances is being counteracted by capacitors having a negative temperature coefficient. All electrical parts, such as coils and condensers, are being specially protected from the effects of moisture by immersion in wax compounds (chiefly ceresin) of high melting point. Special attention will have to be given to the arrangement of the wiring, which should not alter its position. Exhaustive tests will be necessary with regard to changes of electrical properties due to ageing of components. If a satisfactory solution to all these problems can be found, it will perhaps be possible to dispense with AFC and thus arrive at truly popular prices.

So far American manufacturers have mostly sacrificed a certain amount of selectivity. The band-width of the IF circuits is made large enough to permit a station being heard even if the oscillator is slightly off tune. It is doubtful whether this method would be feasible in Europe, where considerable selectivity is required even from the cheaper kind of set. In adapting American methods to European conditions it should be kept in mind that long-distance reception in the United States generally means short-wave reception, and the push-button feature is not used for this purpose. There is also a tendency in the United States to extend the effective band-width of AFC further than would appear advisable under European conditions. I have been told of sets where this width is ±9 kilocycles, which makes it almost inevitable that the tuning jumps to a powerful neighbouring station instead of the desired station if the manual or push-button tuner is not well adjusted. In the better type of American set the effective area of the AFC has been fixed at about 4.5 kilocycles. Even so, the tuning may swing over to the neighbouring station if there is a deep fading of the tuned station and unless the band-width is narrowed down. Automatic selectivity control would appear to be the only effective remedy.

Mention may also be made of the fact that push-button tuning has been introduced into American auto-radio, about 14 per cent. of this year's models showing this new feature, which offers the obvious advantage of allowing the driver to concentrate on his main task.

In conclusion, grateful acknowledgment is due to *Electronics* for permission to reproduce the drawings which illustrate this article.

The Wireless Industry

A NEW 16-mm. sound film projector, designed for educational and similar uses, is announced by the British Thomson-Houston Company. One of the features of the apparatus is a new spool arm, which accommodates films of lengths varying between 400 and 1,600ft. The amplifier, which is provided with an adjustable tone control, has been specially designed to suit the average sound-track characteristics of sub-standard film.

Blackpool is to be the scene of this year's Exide Convention, which is to be held from June 22nd to 24th; headquarters will be at the Hotel Metropole, where over 600 guests will assemble.

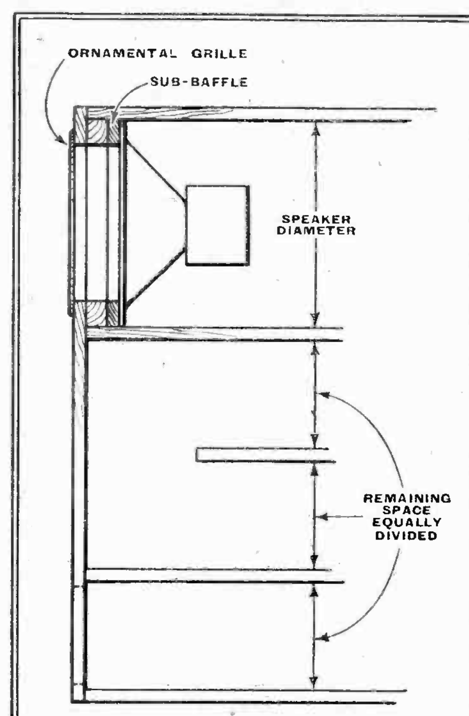
Trix amplifying equipment was installed at Buckingham Palace on the occasion of the Derby Day Ball.

It is regretted that, in the advertisement of Ambassador Radio Works on p.5 of our issue for June 9th, the trade name of the valves included in the Ambassador all-wave chassis was incorrectly printed; actually, Mazda valves are supplied.

The Acoustic Labyrinth

SEVERAL readers have written to point out an apparent discrepancy in the drawing illustrating the article on "The Acoustic Labyrinth." The difficulty is one of simple arithmetic, namely, that it appears to be impossible to get three equally spaced shelves *and* the 10in. loud speaker mentioned by the author into a cabinet with the overall dimensions shown.

Actually, the shelves are not equally spaced, and the form of construction recommended is shown in the accompanying sketch. It may be argued that the change of cross-section is undesirable, and at higher frequencies this would be true, but at the low frequencies considered reflections are less serious, and it is for this reason that the sharp bends essential to a labyrinth can be tolerated.



Distribution of "shelves" in the acoustic labyrinth described in the June 2nd issue.

The Home Laboratory

Part VIII.—A USEFUL CAPACITY AND RESISTANCE BRIDGE

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

IN the previous article the general principles of DC and AC bridges were reviewed, and it was shown that most of the difficulties in designing a convenient form of measuring instrument were avoided by using the 50-cycle AC mains as the "oscillator," and a "magic eye" as a visual detector. Bridges of this sort, offered mainly for service work, are sold by a number of manufacturers, or can be quite easily made for oneself according to the following information.

The capabilities of the design to be described, which has been carried out specially for this series of articles, are shown in the accompanying list, from which it will be seen that it is an exceptionally useful piece of gear. It is not intended for extreme accuracy over a narrow range of measurement (though in fact it can be made to do better than within one per cent.), but rather for moderate accuracy over the greater part of the whole wide range of components that have to be dealt with in radio. Such an instrument is indispensable for service work; and in the experimental laboratory encourages the sound practice of checking all components used. The more strictly laboratory types of bridge being generally more difficult to use quickly, there is the temptation not to bother about checking.

The basic principle is shown by Fig. 1, repeated from the last article. The component to be tested, connected at X, is compared with any one of a number of standards, S, selected by a range switch. To avoid the need for continuously variable standards, the ratio arms are

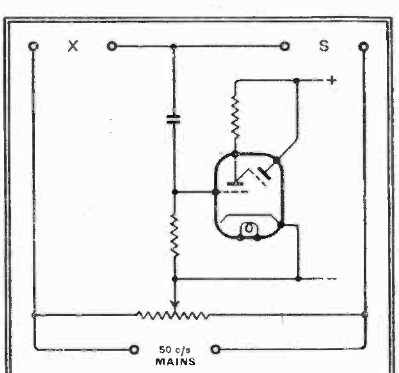


Fig. 1.—Basic principle of the bridge described in this article.

made variable, and are composed of an ordinary potentiometer, which is calibrated to read ratios directly. It is supplied with a 50-cycle voltage, and balance is shown by the cathode-ray tuning indicator. The reading of the potentiometer at balance, multiplied by the value of the standard in circuit, gives the value of X directly; and as in this present example the standards are all multiples of 10 this process demands no appreciable amount of mental arithmetic. For instance, if the potentiometer reading when balance is obtained is 0.65 and the range switch is set to 100 ohms, the required result is of course 65 ohms.

Turning now to the full circuit diagram, Fig. 2, some of the other features can be seen. The special mains transformer supplies 4 volts for the heater of the TV4 indicator, 150 volts through a small metal rectifier and simple smoothing circuits for the anode of the TV4, and 50 volts to the bridge itself. The bridge voltage should be graduated to suit the impedance being measured, and this is done automatically by the 1,000-ohm 3-watt resistor in series with the transformer winding. For high impedances, such as grid leaks and small condensers, which would be difficult to balance sharply without a high signal voltage, practically the full 50 volts is available; but for low impedances which at 50 volts would pass too much current for themselves and for the transformer, the voltage falls to a suitable value. The resistor has been chosen so that even if the test terminals are shorted no harm will follow. And electrolytic condensers rated at low voltages will not be damaged. The 1000-ohm potentiometer should be a reliable one with a smooth and uniform resistance element, for it is the component with which measurements are actually carried out. The input resistance of the TV4 indicator is kept high, otherwise it would not be possible to get results with such high impedances as 10 m-mfds., which at 50 cycles is no less than 300 megohms.

The accuracy of measurement is, of course, no better than that of the standards used. And here there is room for wide differences according to individual

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WHAT THIS BRIDGE DOES

Measures resistance from about 10 ohms to 10 megohms.

Measures capacity from about 10 micro-microfarads to 10 microfarads, including electrolytics.

Gives rough checks over ranges a hundredfold greater than above.

Measures power factor, up to 60 per cent., of "bad" condensers from 0.1 microfarad upwards.

Compares components, including large inductances, with any standard of similar sort.

Detects leakages from about 100 megohms downward.

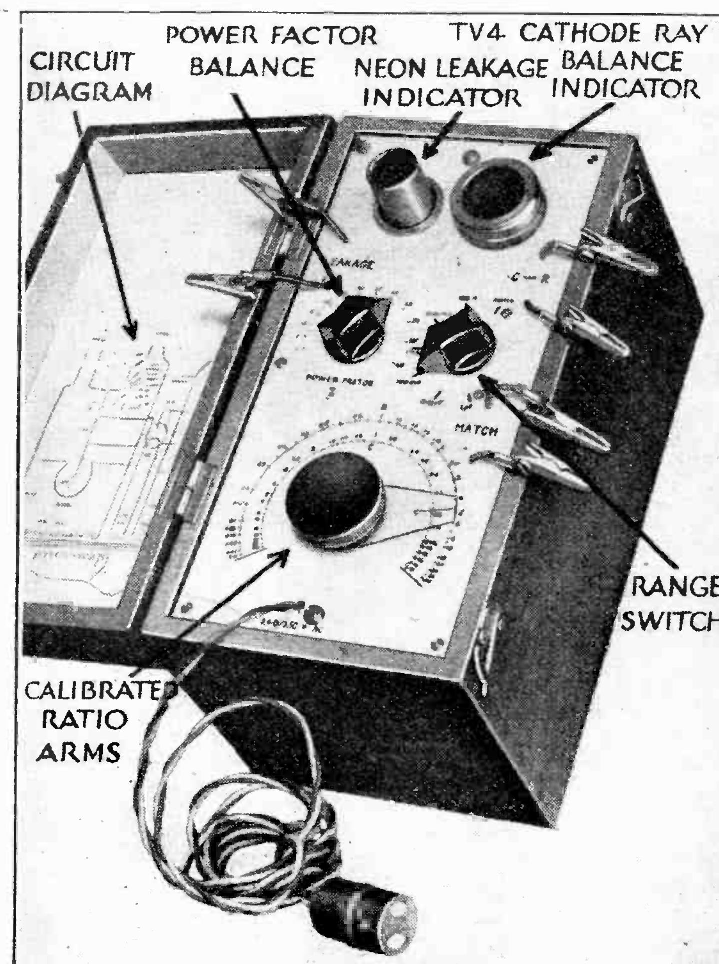
Provides a continuously variable 50-cycle signal up to 50 volts.

Is compact, portable, self-contained (except for mains connection), and direct reading.

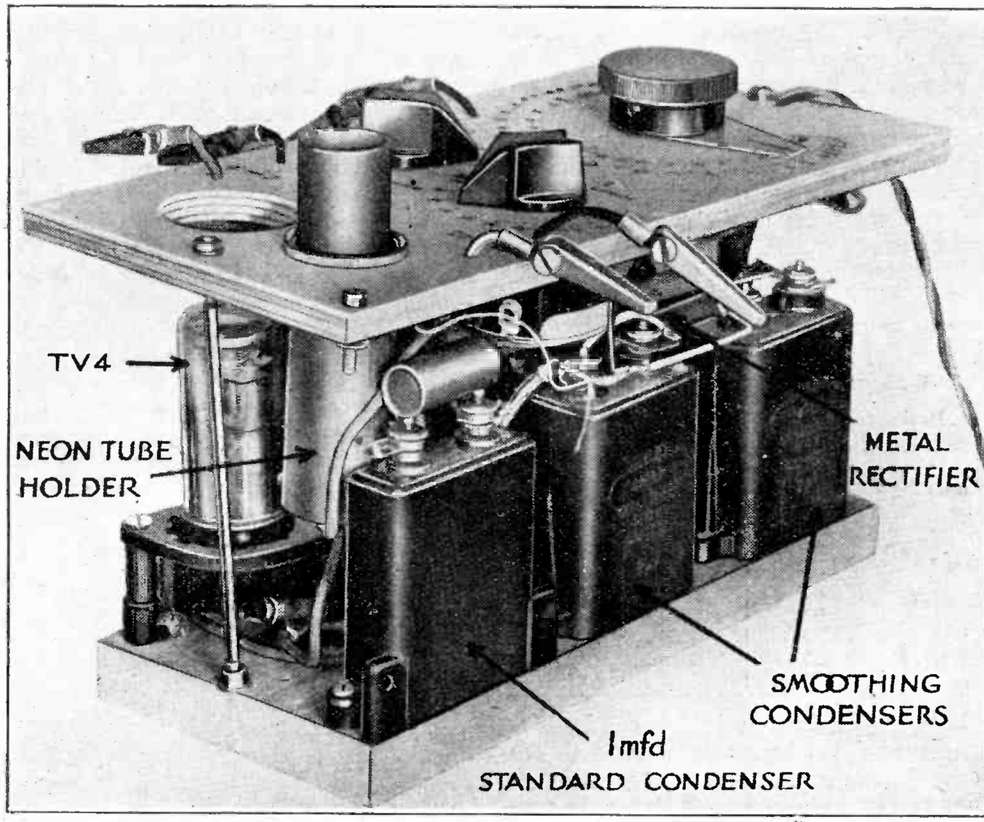
No earth connection needed.

Visual adjustment by "magic eye."

Is not expensive—cost of components, including "magic eye," from four guineas.



The complete resistance-capacity bridge; note the crocodile clips in place of the more usual terminals.



How the components are mounted under the panel.

requirements and opportunities. If one is tied for cost, and has no chance of getting standards checked, condensers and resistors of the ordinary receiver type can be bought within 5 per cent. limits at little, if any, increase in price. That is good enough for rough checking. At somewhat higher prices, resistors are sold by Bulgin correct within 0.5 per cent., which is quite good enough for most purposes, and approaches the maximum closeness of adjustment of the potentiometer. Or, if another bridge is available, resistors can be wound with Eureka wire to the right values, taking care that approximately half the turns are wound in opposite rotation to minimise inductance. Enthusiasm probably falls short of wire-winding the one-megohm resistance; a selected grid-leak type of resistor is more practicable.

Capacity Problems

Standard condensers are more difficult. Apart from the question of measuring their capacities, the sorts commonly used are liable to vary with temperature, age, etc. The smallest should preferably be one of the new ceramic or plated mica types; the middle size a good quality mica; and the largest—well, mica is prohibitive, so a good quality paper specimen is suggested. If facilities for accurate capacity measurements can be begged, borrowed or hired, an attempt should be made to bring up the condensers to their exact ratings by shunting small ones across them. So if those selected are not dead right (an unlikely stroke of luck) it is convenient for them to be slightly low. If one is prepared to spend a pound or two on accuracy some firms such as H. W. Sullivan can supply accurate condensers.

It is very desirable for the standards to be as nearly as possible exactly multiples of 10, for convenience in reading, but, of course, it is not inconsistent with high accuracy for them to be somewhat different *so long as the exact values are known.* For instance, if a condenser is 1.04 mfds., within 0.5 per cent., it can be assumed to be 1.0 mfd. for direct reading within an accuracy of, say, 5 per cent., while on occasions when greater accuracy is wanted the actual value can be worked out. The point is that the cost of a condenser whose capacity is guaranteed to a given accuracy is much greater if it is required to an exact round number rather than to a nominal value.

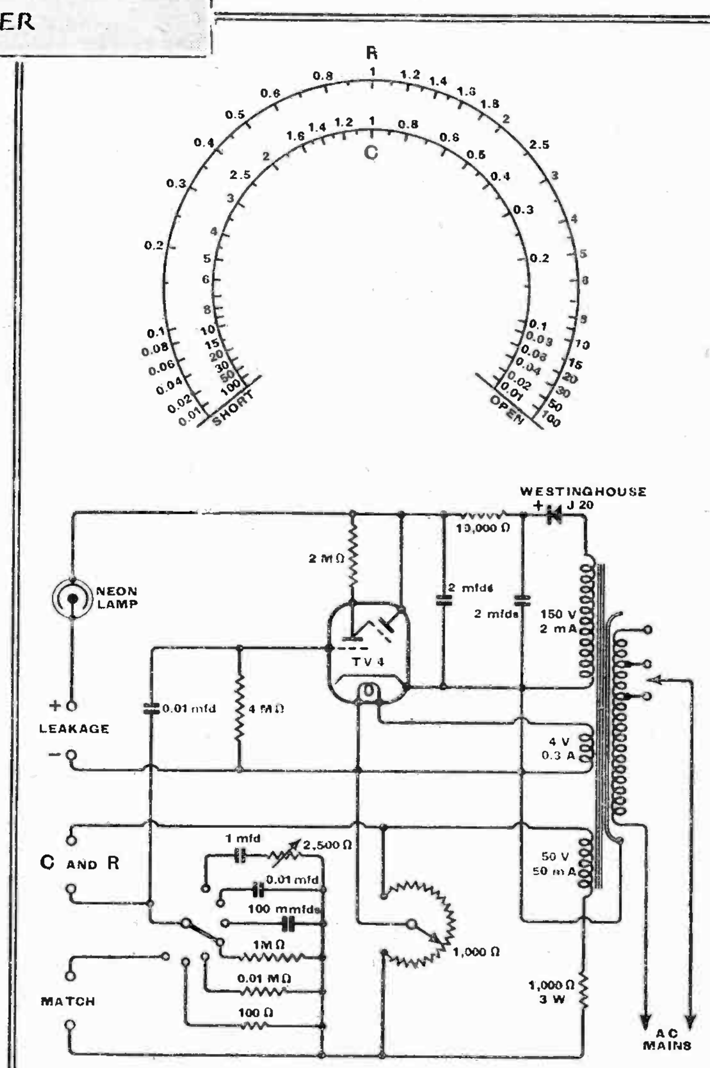


Fig. 2.—Complete circuit diagram and calibration of the ratio arms scale.

No provision is made for balancing the resistance of the smaller condensers. It is generally enough to observe whether the sample under test gives a reasonably sharp balance; if not, it is a bad one. But in the largest sizes most of those now used are of the electrolytic variety, and at low frequencies a relatively large power factor is not necessarily a ground for rejection. At the same time it should not be too large. Some electrolytic condensers show a power factor of less than 5 per cent. and are quite acceptable; others show 30 per cent. or more and are not to be recommended. The adjustment to exact balance when the power factor—or, more appropriately, *loss* factor—is appreciable is done by the 2,500-ohm rheostat, which can be of the same type as the 1,000-ohm potentiometer. Calibration of this control will be described later.

In use, the component to be measured is connected to the "C and R" terminals, and the range switch set to what is believed to be the nearest value. In all probability the screen of the TV4 is nearly covered with illumination. But if the potentiometer is turned, a point should be reached at which the light shrinks into a clearly defined cross. If by careful adjustment the edges of this pattern cannot be made dead sharp, the power factor of the component must be different from that of the standard. On the largest capacity range this can be cleared up by alternate adjustment of the power factor knob.

The Home Laboratory—

If balance falls outside the readings 0.1 to 10 on the ratio scale a better result will be obtained on another range. If balance is obtained only at one extreme limit of the potentiometer adjustment, the component must be open-circuited or short-circuited, or at any rate substantially so in relation to the range in use. A 10-mfd. condenser would appear as a dead short if tested on the 100-m-mfd. range.

When measuring condensers on the 100-m-mfd. range, the same sharpness of balance must not be expected as on the higher capacity ranges. It is not that balance is blurred; assuming that the power factor of the sample is not exceptionally bad, balance is quite good; but a larger movement of the ratio control is required in order to show an appreciable change in the indicator pattern. The best way is to swing the knob to and fro between positions each side of balance until the exact balance point can be judged. With the particular bridge illustrated here, it is possible to observe a capacity as low as 5 m-mfds., and the readings around 100 m-mfds. are surprisingly accurate.

A useful feature is a seventh position on the range switch, whereby an external standard can be connected to the "MATCH" terminals. For example, it might be necessary to adjust a number of components to the same value, or to check their departures from a standard. This is available for inductances of not less than about 1 henry. Push-pull transformers can be tested for balance of windings. And other uses will readily occur.

But how about calibrating the potentiometer? In doing so it is an enormous help if one can use a laboratory resistance box and at least one accurate known resistance. These are connected to "C and R" and "MATCH," and their ratios set to various values. If the fixed resistance connected to "MATCH" is 100 ohms, the other is set to 100, giving the ratio "1" to mark on the scale. Increasing to 110 ohms gives 1.1, and so on. There should be two scales, because the capacity or "C" scale increases in the opposite rotation to the "R" scale. The "1" marks coincide, of course, and each setting on one scale is the reciprocal of the corresponding point on the other. The result is shown in Fig. 2.

Calibrating With Eureka Wire

If no resistance box is available a quantity of Eureka wire can be used for calibrating in ratios on the assumption that its resistance is proportional to length. But, of course, it becomes rather tedious cutting lengths of wire if a large number of scale points are to be found.

To calibrate the power factor adjustment the 1-mfd. condenser is temporarily shorted and the 2,500-ohm rheostat balanced against a fixed or variable standard in the "C and R" arm. A table is given showing the relationship between power factor and resistance in series with 1 mfd. at 50 c/s.

The leakage test is an optional extra, requiring only a neon lamp. The most suitable type is that supplied by Philips for indicator purposes. The lowest available voltage lamp should be chosen, but it may be noted that a 230-volt lamp (which is the only one that appears to be actually stocked at the time of writing) lights up on the 175 volts available. Though it can be used for detecting DC leakage anywhere, its main use is for condensers. When any condenser is connected the lamp flashes momentarily, due to charging, and in a dim light this should be perceptible with capacities down to about 0.005 mfd. If the condenser is a good one it may be necessary to wait quite a long time for the next flash. But a poor condenser flashes like a police road beacon, while a downright bad one shows a continuous light. This judgment must not be applied too literally to electrolytic condensers (which, incidentally, must always be connected the right way round) because they always leak to some extent, but whether that extent is reasonable can be gauged by watching the lamp. A light that remains bright continuously after the condenser has been connected for a minute or two shows excessive leakage. Frequency of flashing depends not on *megohms*, but on *megohm-microfarads*, a quantity that is a truer measure of the condenser's quality. A 1-microfarad condenser with a leakage of 50 megohms is proportionately similar to a 0.25 microfarad condenser with a leakage of 200 megohms.

Power Factor Calibration Table.

Power factor per cent.	Resistance ohms.
5	160
10	320
15	485
20	650
25	820
30	1000
35	1190
40	1400
45	1610
50	1830
55	2080
60	2370

The variable 50-cycle signal, mentioned in the list of advantages, can, of course, be derived from the "LEAKAGE –" terminal and one of either of the other pairs. And, of course, a 50-volt signal with a centre tap (or any other ratio) is available by using three terminals.

With regard to construction there is scope for individuality. The photographs give some idea of how it can be done. It was wanted to get it into a handy ex-Navy wavemeter box, hence the crowded appearance. It would be much easier to make if done on a less compact scale. The disposition of the components is of some importance; the leads connecting the parts of the bridge proper should be short, and the 1-MΩ and 100-m-mfd. standards particularly should be joined close to the switch and have minimum capacity to other parts. The Ferranti switch is recommended because the capacity is low, the contacts good, and the spindle is not live; but the type of knob supplied is finnicky and the contacts are difficult to solder reliably. The 50-volt leads from the transformer need not be particularly short. But all AC leads must be kept as far as possible from the grid of the TV4, the connections to which should be well insulated. The cathode of the TV4 is connected to heater, – HT, transformer screen, and metal lining of box, if any. The last precaution does not seem to be essential, nor does an earth connection, but if there is difficulty in getting balance with very high impedances, one can be tried. "LEAKAGE – " is available for the purpose.

Crocodile clips are quicker to use and generally more convenient than screw terminals, but, of course, one can please oneself about this. Matt ivorine sheet is very convenient for covering the panel as it looks good and takes pencil calibration, which can afterwards be made permanent with Indian ink. But remember it is very inflammable!

To enable the TV4 and the neon lamp to be used in bright light they are shown with tubular shields projecting some way above the panel. But it is necessary to make quite sure that the neon tube is not kept so much in the dark that it cannot start to glow on the voltage supplied to it. The flash voltage is sometimes raised considerably by darkness.

If the box has a lid, a detailed circuit diagram should be gummed inside it—a sound practice with all lab. gear.

For reference a list of suitable components follows, but, as already said, there are alternatives so far as at least the standards are concerned. With approximate (within 5 per cent.) standards, the retail cost of components, including indicators, is about £4 5s.; including the more accurate standards listed here, the cost is nearly 30s. more. The required accuracy must be specified when ordering.

LIST OF PARTS

1 Transformer (special) — **N. Partridge**
1 Rectifier — **Westinghouse J20**
Ratio Arms — **Claude Lyons "Clarostat" M1**
Power-factor control — **Claude Lyons "Clarostat" M2½**
1 Range switch — **Ferranti No. 5**
Fixed condensers:
1 0.01 mfd. (special ±2%) — **Dubilier B.770**
1 0.01 mfd. — **Dubilier 4601/S**
1 1 mfd. (selected) — **Dubilier "BB"**
2 2 mfds. — **Dubilier "BB"**
1 100 mmfds. (special ±1%) — **Dubilier "CTS"**
Resistances:
1 100 ohms (±0.5%) — **Bulgin R20**
1 10,000 ohms (±0.5%) — **Bulgin R26**
1 1 megohm (selected ±5%) — **Claude Lyons**
1 2 megohm ⅓ watt — **Claude Lyons**
1 4 megohm ⅓ watt — **Claude Lyons**
1 10,000 ohms 1 watt — **Claude Lyons**
1 1,000 ohms 3 watts — **Claude Lyons**
6 Crocodile clips — **Bulgin CR6**
Panel surfacing $\frac{1}{16}$in. matt ivorine — **Reliance (Nameplates), Ltd., Twickenham**
2 small knobs — **Bulgin K58 or K92**
1 large knob — **Bulgin K70**
1 Cursor — **Bulgin K72**
Cathode ray indicator — **Mullard TV4**
Cathode ray indicator holder — **Bulgin VH24**
Neon indicator, 17 × 52 mm. — **Philips SES**
Neon indicator holder — **Bulgin D18**

More About Five-Metre DF

In last week's issue the author described the adaptation of an existing receiver for direction-finding experiments with the help of a loop aerial. He now explains how the directional properties of a dipole-reflector combination may be used for the same purpose.

COMPARING THE MERITS OF A LOOP WITH A DIPOLE-REFLECTOR AERIAL

By H. B. DENT (G2MC)

It was explained last week how a super-regenerative receiver can be adapted for direction-finding on five metres by separating the detector stage from the remainder of the set and hoisting it to the top of a pole. The signals are picked up by a loop connected in place of the original tuning coils.

Now a loop is not the only kind of aerial suitable for direction-finding; its use was suggested as it happens to be less cumbersome than some of the alternative types, and so fitted in very well with the requirements of a portable set.

Let us now examine this idea more carefully and compare it with the most attractive of the alternative aerial systems. A loop receives equally well from two directions, signals being strongest when the plane of the loop AB in Fig. 1 is in line with the path taken by the incoming signals, and, in theory though not always in practice, they are reduced to inaudibility when the loop is turned through 90 degrees, as indicated by the line CD.

Minimum Signal

The practical realisation of the inaudible condition is usually only a position giving a minimum strength of signals. This position, however, is reasonably well defined, but the position for maximum signals is always very broad. Thus in DF work one uses the minimum setting for taking a bearing.

If now a loop is positioned for minimum signal strength and slowly rotated, signals will rise to a maximum and then fall to a minimum again at 180 degrees from the original position; thus the loop only gives us the *line* along which the waves are travelling. It does not give any indication of the true direction of the transmitter, for it can be anywhere along this line, ahead or behind the receiving position.

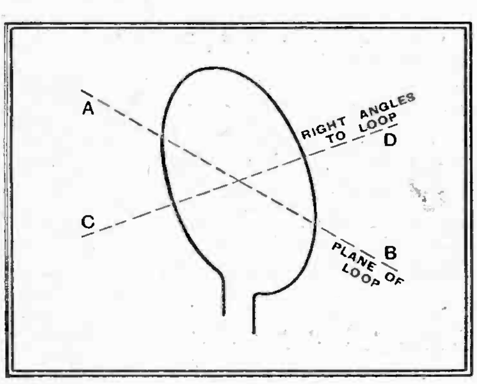


Fig. 1.—Reception by means of a loop (or frame) aerial is at maximum in the plane AB and at minimum in the plane CD.

On the normal amateur wavelengths this is not a serious disadvantage, for signals are receivable at good strength anywhere within the area of operations. Five-metre signals, however, are not quite so accommodating, and many positions, often reasonably close to the transmitter, fail to provide a signal. Thus some time might elapse before a second bearing can be obtained giving a definite indication as to the direction in which the transmitter lies.

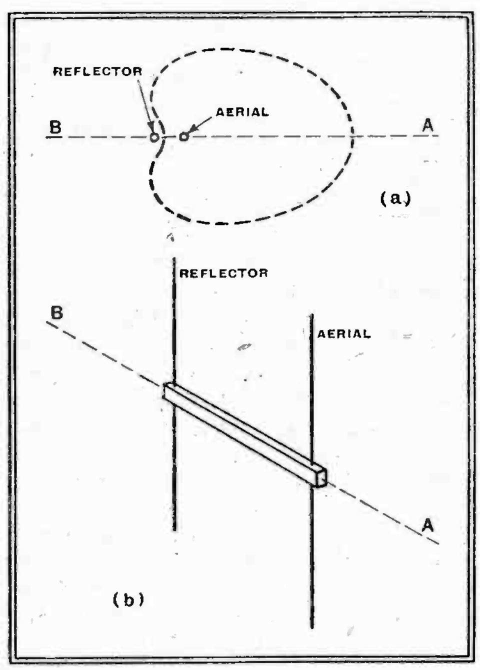


Fig. 2.—The directional properties of a dipole-reflector combination.

Uni-Directional Aerial

The vagaries of ultra-short waves must be borne in mind on every five-metre field day. One or two failures to receive signals must not be taken as an indication that the transmitter has broken down or that the receiver is defective.

Conditions being what they are, it would be much more satisfactory if one could devise an aerial system that did not possess the ambiguity of a loop, but gave a definite indication of direction on the first reception test.

An aerial that will do this does exist, but it is rather cumbersome. It is an ordinary half-wave dipole backed by a reflector. Its size can be gauged by the fact that for 57 Mc/s both aerial and reflector are approximately eight feet long and they have to be spaced by just over four feet. This form of aerial has one position only for maximum signal strength and likewise a single position for minimum signals, these two being at 180 degrees to each other. Whilst a loop aerial need be capable of only 180 degrees rotation the dipole-cum-reflector must be rotatable through a full 360 degrees.

The polar diagram of a dipole backed by a reflector takes the form shown in Fig. 2 Maximum signal strength is obtained when the incoming waves are travelling from A to B, Fig. 2 (a) and (b), and minimum signals from the direction B to A. This arrangement will not give a silent point, but by careful adjustment of the length of the reflector the ratio of forward to backward reception can be made quite high.

An attractive feature of this aerial system is that almost any existing five-metre receiver can be used. No alteration is required to the set, but direct pick-up on the feeder must be avoided or the directional property of the aerial will be affected. A low-impedance feeder joined into the centre of the aerial is generally preferable to any end-fed arrangement as a better electrically balanced system is obtained in this way.

Club News

Cardiff and District Short-wave Club

Headquarters: Globe Hotel, Castle Street, Cardiff.
Hon. Sec.: Mr. H. H. Phillips, 132, Clare Road, Cardiff.

On May 26th Mr. R. T. Mathews gave a lecture entitled "B.C.L. Interference Cures."

Meetings of the Society are being held fortnightly during the summer. The following programme has been arranged:—

June 23rd.—R.S.G.B. Meeting, at which transmitters will be discussed.
July 7th.—"Propagation," by Mr. H. H. Phillips.
July 21st.—R.S.G.B. Meeting, at which transmitters will be discussed.
August 4th.—To be announced later.

Golders Green and Hendon Radio Scientific Society

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

A 5-metre field day will be held on June 19th to which anybody interested is invited. Members will meet at 11 a.m. at the cricket ground on the east side of the King's Langley-Watford road.

UNBIASED

BY FREE GRID

Amateur Telemitters

I HAVE often wondered why it is that amateur transmitters who provide us with such an interesting alternative programme on Sunday mornings and at other times have never tried their hands at television transmissions. After all, they, or at least their progenitors, among whom I include myself, have always been in the vanguard of any movement connected with wireless transmission, from the early spark days onwards. Telephony was heard on the air long before the B.B.C. began to pollute the ether, and it seems a pity that there are no amateur television transmissions to tune in. It is not a case of lack of official permission, for an enquiry has resulted in my being informed that this will be granted if the applicant can show reasonable grounds.

I have been wondering of late whether it is a case of degeneration among the transmitting fraternity or whether, in reality, we old pioneers of more than a quarter of a century ago would have shown similar apathy had we had the glorious opportunities of the modern amateurs. As the result of my musings I became so hot under the collar concerning this apparent evidence of modern degeneracy that I determined to seek the views of a friend who used to do DX with me in the good old Edwardian days.

To my astonishment he told me that I was being very unjust indeed in censuring amateurs for an imagined lack of initiative in this matter, and that if I cared to listen, or, rather, to look round about the 5-metre mark at certain times, I should be able to pick up some amateur telemissions. He, furthermore, told me that some of the curious noises which I had

Getting something on the screen

mentioned as having been picked up by me on 5 metres and which I have unjustly branded as amateur telephony were the sound of the vision signals.

As a proof of his assertions he led me forthwith to his wireless den, and after a certain amount of juggling with the controls of a special 5-metre television receiver we certainly did succeed in getting something on the screen which was rather reminiscent of the cinema pictures we used to see round about the time of Queen Victoria's Diamond Jubilee.

Even now I am in some doubt as to whether what we saw were amateur television transmissions or merely the effects of local interference. If, therefore, there are any amateur telemitters on the air I should be extremely glad to know of it.

Bottled Programmes

I SUPPOSE that a considerable number of you listened to the running commentary on the Derby the other day while as many of you as were able saw the whole thing televised. Unfortunately, I was able to do neither. My laboratory work has become so pressing of late that I really haven't the time to spare for the frivolities of life. Nevertheless, I must confess that as 3 p.m. approached I was sorely tempted to switch on my television set, but my better nature prevailed and I continued with my research work.

Happening to drop round to see an old friend that evening we fell to discussing the Derby, and I found that he, too, had missed the television as he had been out on business at 3 p.m. that afternoon. He somewhat surprised me, however, by saying that it did not matter much as we would both have a look at it now. I was somewhat puzzled by his words but still more so when he crossed over to his television set and switched on. To my amazement the well-known scenes at Epsom leapt into view on the screen and the whole panorama of the race was unfolded before our eyes with the customary running commentary accompanying it.

Quite naturally I immediately demanded to know how it was done, but I found that like most great and outstanding things it was very simple. Both sound and vision programmes had been recorded during the afternoon on steel tape using a home-made instrument of the Blattnerphone type. I was perfectly well aware, of course, that television can be recorded after a fashion on gramophone discs or other form of recorder used for bottling ordinary sound programmes, but I had never actually seen it done before.

The most interesting part of my friend's apparatus, however, was that it was entirely automatic in its action, and he uses it to record any items among either the ordinary broadcasting or the television programmes which may occur during the daytime when he is away from home and which he may particularly desire to see. The apparatus is switched on and off at appropriate times by one of the well-known programme clocks which he sets before leaving the house.

The Maple and the Oak

WE in this old country justly pride ourselves on our ancient traditions and point to the long cavalcade of achievements in the world of science which lie to our credit. There is, however, always a grave risk that if this sort of thing is

Advertising the cup that cheers.

carried too far it will lead to a sense of false complacency inclining us to rest on the laurels of our ancestors rather than to be up and doing in order to wrest still further secrets from nature.

I cannot help thinking that it is something of this sort that has led us in recent years to fall so much behind younger countries in the matter of wireless development. When all is said and done, practically all the pioneering work of wireless was done in this country, and in the matter of television it is well known that we lead the world, leaving even the U.S.A. limping painfully along behind.

It is not good enough, however, for, judging by what I have just been reading, Canadian engineers are far ahead of us in modern wireless technique. It was, as a matter of fact, a reader who brought this serious state of affairs to my notice by sending me along a newspaper cutting in which are reported certain words of wisdom uttered by the general manager of the Canadian Radio Broadcasting Corporation.

As is well known, a certain amount of advertising is permitted in the programmes of the Canadian stations, and among the things advertised is beer. However, in certain of the Provinces of Canada, advertising of the cup that cheers is forbidden by law and it would be a shocking thing if these advertisements were allowed to drift over the border from some Province where this sort of thing is allowed, but does this possibility daunt the great and wise radio engineers of the Dominion? Not a bit of it, for, according to the Press cutting sent to me, we have it on the word of the general manager himself that such advertisements will not be allowed to stray over the border but are to be restricted to the Provinces where they are still legal.

Unfortunately, the general manager preserves a strictly hush-hush policy as to the methods to be employed by the engineers to keep the offending transmissions out. I am, however, told by a technical friend that in all probability special reflector aerials are to be erected around the edges of the forbidden territory, such aerials being designed to resonate to the wavelength of the offending transmissions and to turn them back. It is obvious, however, that whatever method is employed, wireless technique on the other side of the Atlantic is far in advance of anything achieved over here, otherwise the B.B.C. engineers would long ago have tackled the Radio Luxembourg problem.

NEWS OF THE WEEK

TELEVISION FOR CINEMAS

Will the Law Step In ?

THE successful television broadcast of the Derby has made it obvious that this new medium of entertainment and news reporting will shortly be a vital influence on our everyday lives. The problem of equipping cinemas with facilities for television reproduction is under keen consideration, and it is stated that the Baird equipment used at the Tatler Gaumont-British News Theatre in London for the projection of the Derby transmission is to become part of the permanent installation of the house. Plans to bring Baird public tele-viewing sets into a number of cinemas throughout the country are in hand, and the cost of the receivers will probably be no more than that of talkie equipment.

The activities of Scophony in the field of big-screen television have attracted the interest both of the trade and of the public since the inauguration of the B.B.C. television service of 1936, and the installation of this system throughout the entire Odeon Cinema Circuit is foreshadowed in a statement made by the company's managing director. Their first cinema installation is under construction in the new Monseigneur News Theatre, now being built at Baker Street, London.

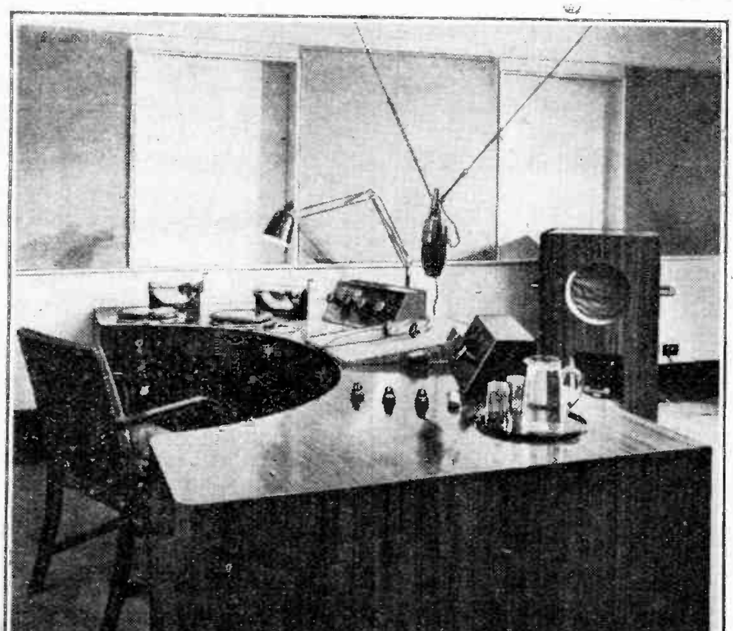
The screen will measure 6ft. × 5ft., and a similar receiver to that which will be installed was seen at work by a *Wireless World* representative last Thursday during the transmission of the Trooping of the Colour Ceremony. At a distance of 30ft. from the screen the picture lacked nothing in brilliance and definition, and it is anticipated that the designers will have overcome the present minor shortcomings within the next six months.

Will Parliament Intervene ?

Curious as it seems the most important side of public tele-viewing development remains to be settled, not in the laboratory but in Westminster. Mr. De La Bere, M.P., has given notice of a motion to be placed before the House of Commons condemning the use of television in places of public entertainment. His objection is based on the monopoly vested in the B.B.C. and the additional expenses incurred.

"Since," he said, "this was not contemplated at the time the charter of the B.B.C. was renewed this House urges on the Government the necessity of a charter revision for the B.B.C. to enable them to deal with this development."

No date for the motion has yet been fixed.



STUDIO 4c, one of the two new Foreign Languages studios in Broadcasting House, embodies the latest developments for talks. The clocks in the studio show both GMT and BST and of the two control boxes mounted on the desk, seen above, one provides for fading in the output of the microphones and two gramophones and the other enables the announcer to make his announcement and then obtain either the National, Regional or Empire programmes, or Big Ben.

TELEVISED DRAMA recently made its debut in America with the presentation of a 25-minute performance from the RCA Building, New York. The transmission was radiated from the Empire State Building, about a mile away from the studio, on the 7m. waveband.

LIFEBOAT WIRELESS

Its Purpose and Limitations

IN the course of the annual report of the Royal National Lifeboat Institution, its chairman stated that nine more cabin lifeboats on the coast are to be fitted with wireless during 1938, and an additional fourteen boats, which are in course of construction, will be similarly equipped.

Of fifty-three cabin boats in the Institution's fleet, twenty-seven are fitted with wireless transmitting and receiving equipment. "The purpose of these installations," said the Chairman, "is solely to keep lifeboats in touch with the shore when they are out of sight of visual signals; it is not their duty to pick up messages from vessels in distress. That duty belongs to the shore stations, which then pass the messages to the lifeboat stations through the Coastguard. It is through the shore stations that lifeboat stations communicate with their vessels at sea."

Two Limitations

For obvious reasons, then, it is only practicable to use wireless in lifeboats which operate within range of shore stations. A second limitation to the use of wireless is that the gear must be protected from the sea, so that at present its installation is confined to cabin lifeboats.

The Institution is endeavouring to overcome this disadvantage, and hopes to find satisfactory water-tight apparatus suitable for use in open boats.

A Case in Point

Early in the year it was mentioned in these columns that considerable difficulties were being experienced in finding suitable wireless equipment for the Plymouth lifeboat owing to screening by the hills along that part of the coastline. It has been found that with Gambrell Type 131 radio telephone equipment the ranges required were efficiently covered, and this equipment has been permanently installed.

PHYSICAL DRILL BROADCASTS

Jerks Night and Morning

NEGOTIATIONS for physical drill broadcasts are now proceeding, but it seems probable that the B.B.C.'s part would be confined to the granting of broadcast facilities, while the National Fitness Council would provide the gramophone records.

Physical jerks by wireless have always been associated with the early morning, but a large proportion of the population probably prefers physical drill just before retiring for the night. It is possible, therefore, that broadcasting will have to compromise by offering physical instruction in the morning between 7 and 8 and at night between 10 and 10.30.

It is safe to assume that when the programmes start they will be on an experimental basis for a period, and that no regular service will be introduced until the autumn.

B.B.C. TELEVISION AT 220 MILES

Long-distance Reception Record

TELEVISION programmes from Alexandra Palace have been received at Ormesby Bank, Middlesbrough, which is more than 220 miles from the transmitter. The pictures were received on a standard set installed in a hut 700ft. above sea level. The receiver was fed from an aerial 80ft. high, and almost uninterrupted reception of good quality was enjoyed for over an hour. The effect of weather and other atmospheric conditions on the signals is to be studied during a prolonged period of test.

The previous long-distance record for sustained reception of B.B.C. television was 110 miles,

News of the Week—
although reports of freak reception have been received from such widely divergent places as South Africa and America.

FLOOD HERO

Signal Honour for Amateur

THE William S. Paley Award, given each year by the president of the C.B.S. to the amateur who has contributed most usefully to the welfare of the American people, was formally bestowed upon R. T. Anderson, of Harrisburg, Illinois, at a luncheon in New York last Thursday.

A report from the American Radio Relay League states that Anderson achieved this honour for his work in saving the people of Shawneetown during the 1937 Ohio River flood. With all other forms of communication broken down he worked his portable transmitter, W9MWC, for sixty hours with hardly a break, and he alone was responsible for summoning aid to the marooned people of the town.

RADIO ENGINEER HONOURED

MR. H. BISHOP, Assistant Chief Engineer of the B.B.C., receives the C.B.E. in this year's Birthday Honours List. Joining the staff of the B.B.C. in 1923, he was appointed to his present post in 1929. He has been closely associated with broadcasts of national importance, and outstanding amongst these are the first broadcast by King George V, which was made from the Wembley Exhibition of 1924, the Jubilee broadcasts of 1935, and the Coronation broadcasts of 1937.

RE-TIMING THE NEWS BULLETINS

SMALL but important changes in the timing of B.B.C. news bulletins come into force in July. While the First News will be at 6 p.m., as usual, the Second News will be delayed half an hour and will be given on Regional wavelengths at 7.30. From July 10th, for one week only, the Third News will be broadcast at 9.40 instead of 9.

SEASIDE BROADCASTS BEGIN

LISTENERS will almost smell the ozone when, on July 5th, the first of the B.B.C.'s series of seaside broadcasts comes from Brighton. During the tour of coastal towns, John Watt and Harry Pepper will escort the microphone not only to concert parties but to many dance halls, and the arrangements will provide strenuous work for the O.B. department, who may be called upon at short notice to cope with microphone interviews on the beach. Lines will be taken to the end of piers, and it is whispered that listeners will learn some of the secrets of fishing from the pierhead. A mobile control room will accompany each expedition.

We understand that Yarmouth will be visited on July 12th, Aberdeen on July 19th, and Bournemouth a week later.

FROM ALL QUARTERS

Lectures by Television

Two hundred students of the New York University recently gathered before fifteen television receivers on the sixty-second floor of the R.C.A. Building, Radio City, to watch a demonstration given by their professor in the television studio fifty-nine floors below them. This marks the first occasion upon which television has been used as a medium of instruction in America.

A South African "Tatsfield"

TATSFIELD technique, already in vogue in America, India and elsewhere, is to be copied in South Africa. We understand that the South African Broadcasting Corporation is seeking sites for an elaborate receiving station from which important programmes from abroad could be relayed to listeners throughout the Union.

Scholarships at Manchester University

A LIMITED number of Scholarships and Exhibitions leading to the degree of Bachelor of Technical Science (B.Sc.Tech.) are offered by the Manchester Education Committee. The Scholarships are tenable at any of the three-year full-time day courses at the Municipal College of Technology. Intending candidates should make immediate application to the Registrar, College of Technology, Manchester, 1.

Loud Speakers for Police Cars

THE familiar sight of a police officer wearing earphones in his patrol car will soon be a thing of the past. Motor vehicles at work in the Metropolitan area are to be equipped with small loud speakers which will render earphones unnecessary.

Muted Strings

FAMOUS seaside orchestras will have an opportunity to broadcast during the summer owing to the holiday absence of the B.B.C. Symphony Orchestra, and listeners will hear concerts from such places as Margate, Torquay and Eastbourne. The B.B.C. Orchestra takes its vacation in two sections. Section C will be away from June 19 to July 16, and Section B from July 3 to July 30. Section A, of course, comprises the whole orchestra.

Clevedon Difficulties Overcome

THE difficult situation which arose when it was found that the site chosen for the new B.B.C. station at Clevedon was adjoining a site chosen for an aerodrome, has been settled in favour of the B.B.C.

Broadcasting Houses

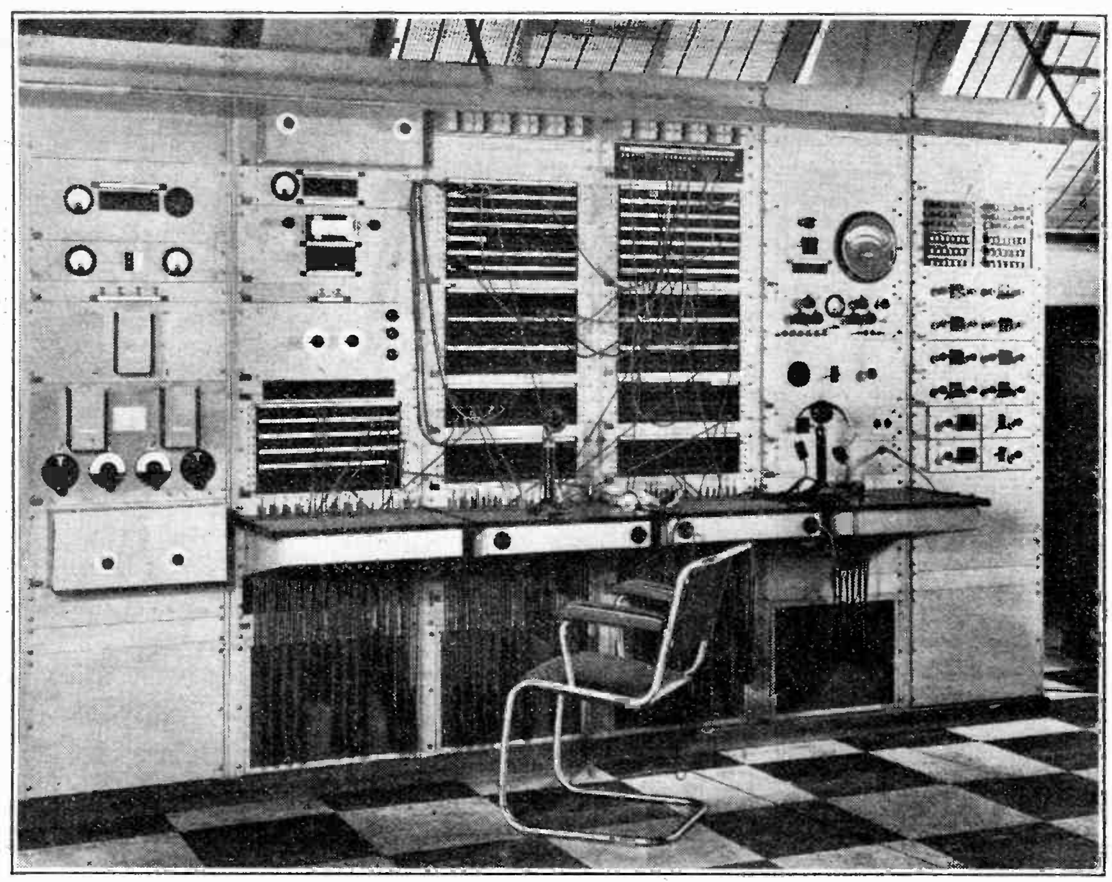
THE annual report of the Building Research Board states: "It is quite evident that the conventional 9in. party wall in semi-detached buildings does not provide sufficient sound insulation." This statement was made as a result of many complaints by householders regarding the nuisance of next-door loud speakers.

Time Marches On

THE B.B.C. has announced that it has been found necessary to postpone from July 1st to July 8th the opening move in the Chess Tournament between listeners and members of the Corporation's staff. It would seem that the first move is giving rise to unexpected mental exertion on the part of the B.B.C. staff. It is not generally known that a broadcast chess contest took place in 1924, from the end of June until August, when the moves were announced each evening during the News Bulletin.

Oh Yeah ?

"To Englishmen, the B.B.C. is something they hold almost in reverence. It is something far more than the N.B.C. is to America; far more than the A.B.C. is to Australia. It is an institution as essentially British as huntin', shootin' and fishin'."—*Radio Call*, Adelaide.



THE NEW LINES termination bay in the London Control Room, Broadcasting House, is the main control centre of the permanent network of lines which is rented by the B.B.C. from the Post Office. From left to right are seen the tone source and transmission measuring set, O.B. and miscellaneous lines termination, DC test panel and variable equaliser panel.

Superhet Alignment

THE COMPLETE PROCESS, STAGE BY STAGE

By "TRIMMER"

THE number of superhet receivers now in common use, coupled with their dependence upon the correctness of their trimming and tracking adjustments, makes the subject of superhet alignment one of the greatest importance to anybody interested in practical radio.

In order that this article may be of some value to all readers, it is proposed to deal with the subject from a practical point of view in some detail and from all the different aspects that must be taken into account owing to the variety of circumstances that can arise. Some receivers will need complete, others only partial, alignment. Again, some readers will have ganging test gear at their disposal, while others will not be so fortunate.

Before we get down to details there are some general observations to be made. If a superhet has to be completely aligned the process falls into several distinct jobs:—

- IF alignment.
- Oscillator trimming.
- Oscillator tracking (although not necessary in all cases).
- Signal frequency circuit trimming.
- IF filter and image rejector adjustments (in some cases).

Ultimate Objectives

It is as well that the ultimate aim of all the work should be kept very much in mind. To say that the aim is to align the receiver is true enough, but not very enlightening. Actually the purpose of all one's efforts is to get the receiver into such a condition that—

(1) The sensitivity is up to standard on all wavebands.
(2) The station tuning is accurate with the scale calibration.
(3) The selectivity is normal.
(4) There are either no image signals, or second-channel whistles, or, alternatively, such as may show up are not abnormal for the particular receiver concerned.
(5) There are no signs of bad "humping" when tuning, and no instability.

Unless the alignment is accurately done it may be taken for granted that the receiver will be below par as regards at least some of the above.

If a testing oscillator is going to be used, then the common incorporation of delayed AVC in superhets raises one very important point. If the output from the speaker is going to be the criterion upon which the correctness of the adjustments are judged, it is obvious that the basic action of AVC is directly antagonistic to requirements during alignment. When aligning on speaker output we want the slightest changes of RF amplitude to produce proportional changes in output, so we must

A FULLY detailed description of all the operations involved in "trimming" the circuits of a superheterodyne receiver. Although largely written for those in possession of a certain amount of test gear, a later instalment will discuss the question of alignment without the help of any apparatus

consider how to prevent AVC from, possibly, masking the indications. One obvious way would be to modify the circuit arrangements temporarily, so that the AVC bias is cut off the controlled valves. But if a modulated test oscillator with a variable output is being used, there is a much simpler way. All that is necessary is to cut down the test signal amplitude so much that the receiver's normal AVC delay voltage keeps the AVC out of action. There is a trap in this connection that must be guarded against, however. A test signal that is not strong enough to "trip off" the AVC while the receiver is badly out of alignment may be more than strong enough to do so when the receiver is closer into alignment. There is thus the danger that, although the AVC may be out of action to commence with, it may come into play as the alignment work proceeds and the signal amplitude builds up. The cure is obvious: keep cutting down the test signal amplitude whenever the improvement of circuit conditions permits. The golden rule is to work at all times with the smallest possible test signal amplitude—just sufficient to give clear peak indications.

We will deal in detail, first, with the case where complete alignment is necessary and also assume that an accurately calibrated modulated test oscillator, and an output meter, are available. Even those readers who have no ganging test gear should derive some benefit by reading the following, even if it is only an appreciation of just where they will need to be exceptionally careful in the absence of test gear. We will later go into the question of aligning without test gear.

Half the battle with complete aligning is to do the various jobs in the right order. The first job must be that of getting the IF stages right. This means more than mere aligning of circuits; it means proper aligning *at the correct intermediate frequency*.

Fig. 1 is a diagrammatic sketch indicating the three definite sections into which the high-frequency part of a superhet receiver falls when considered from the alignment point of view. The signal-frequency section must obviously be tuned with reference to the carrier frequency (F1) of the signal. The intermediate frequency (F3) has a (fixed) value that is chosen by the designer and is in many respects an independent value. Certain features of the receiver design, however, depend upon the choice of IF value. The oscillator section must be tuned to such a frequency (F2) as to bring about the relation F2 − F1 = F3, or F2 = F1 + F3. The oscillator must also be tracked to maintain this relation over the waveband. It must be understood that F3 is the frequency for which the IF circuits are designed and to which they are actually tuned.

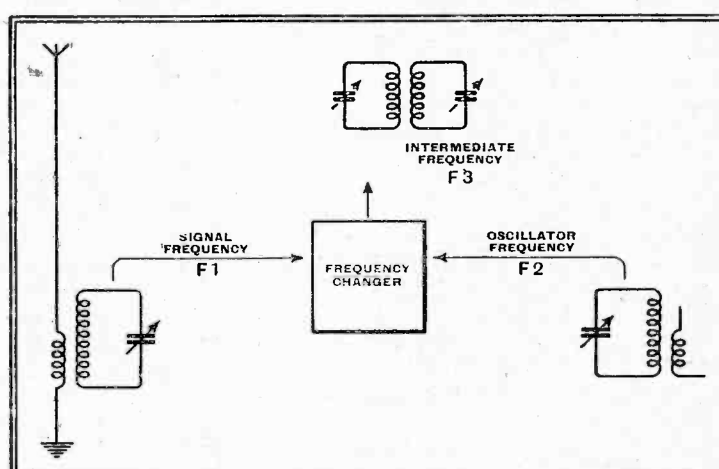


Fig. 1.—The three frequencies involved in alignment adjustment. F2 − F1 = F3.

The importance of aligning the IF amplifier at the correct frequency cannot be

Superhet Alignment—

over-emphasised. We will not go so far as to say that it is a hair-splitting matter and that a kilocycle or so up or down will matter, but the point is that the oscillator and signal circuit inductance ratios, and, in particular, the oscillator tracking system, are definitely arranged with reference to a certain intermediate frequency value. It is, therefore, essential to get as close to this value as possible.

In a case where only partial re-alignment is required, it is usually easy to find out by test what the IF value is, but we are at the moment concerned with the case where complete alignment is required, and the original setting of any trimmer cannot, therefore, be trusted as being correct.

In the great majority of cases the IF will either be a value coming between the normal broadcasting bands, or one below the long band. Typical examples of the first set of values are 450, 455, 456, 464, 465, and 473 kc/s, and of the second 110, 117.5, 123, 128, and 134 kc/s. It is easy enough, by test, to find out the group to which any particular IF transformer belongs, but with our receiver that is awaiting complete alignment it is going to be possibly an awkward question as to what the exactly correct IF value is. As a matter of fact, it is really worth while to make an inquiry upon the point from the manufacturers of the coils or receiver before the work is commenced. If this is not convenient there is only one thing that can be done, and that is to choose some reasonable value and align on this in the hope that it is near enough correct, but with the knowledge that it may become necessary at a later stage in the work to condemn the original choice and to have to start all over again.

Now for practical details. First of all, the receiver should be temporarily modified so that the receiver oscillator keeps out of action. This can be done simply by connecting a 1- or 2-mfd. condenser across the oscillator tuning section of the ganged condenser. Next connect the output meter across the speaker primary. If an AC voltmeter is used and it is found that the DC component in the speaker causes a deflection, it will be advisable to join a condenser in series with one of the meter leads. The two output leads of the modulated test oscillator should be connected, one to chassis and the other to the frequency changer grid, via a 0.1-mfd. condenser. With the standard heptodes, octodes, and triode-hexodes the correct grid connection will be at the top cap.

Determining the Intermediate Frequency

Next switch on the receiver and the test oscillator and tune the latter to the correct intermediate frequency, if known. If the latter is not known it will be necessary, as already stated, to make some tentative decision on this point. One useful suggestion is to set the IF trimmers to half-way between maximum and minimum and to tune the testing oscillator to give the strongest signal.

There is one more thing to do before actually starting the aligning, and that is to cut down the test signal amplitude as far as possible, still leaving a reading on the output meter that will show a peak when the adjustments are being made.

The aligning can now be tackled, although the details of the procedure will vary with the following circumstances: The IF transformers may have coupling which is not above optimum, and they will in this case have been designed for single peaked characteristics; they may, on the other hand, have tight coupling and be designed for band-pass characteristics; there is another possibility, and that is that the receiver incorporates variable selectivity which will certainly mean an IF over-all characteristic of single peaked type at maximum selectivity but of band-pass type at minimum selectivity.

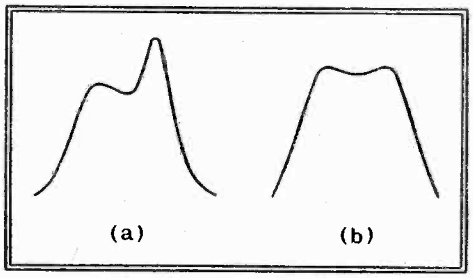


Fig. 2.—Incorrect (a) and correct (b) band-pass IF alignment as it would be shown on the screen of a cathode-ray oscilloscope.

If all the couplings are fixed and single peaked characteristics can be assumed, proceed as follows: Starting with the last IF trimmer (the one associated with the detector input) and working towards the first trimmer (anode circuit of frequency changer), adjust each one in turn to give a maximum peak indication on the output meter. Keep cutting down the amplitude of the test signal as the peak output values tend to increase. Since the tuning of each IF circuit is liable to be affected by the tuning of its companion, it is advisable to run over the adjustments a second time.

As a check test, rock the test oscillator some 10 kc/s or so up and down and carefully watch the behaviour of the output meter indication. Try to judge the shape of the output characteristic curve and do not be satisfied unless it seems to be symmetrical. If it is obviously lopsided, and particularly if two unequal peaks can be observed, it will probably mean that the couplings are of band-pass type after all and a fresh start should be made, following the procedure detailed below for such a case.

If the couplings are fixed and are of band-pass type it is a bad mistake to work towards maximum peak indications without special temporary receiver modifications. To do so will almost certainly mar the selectivity of the receiver and possibly affect the quality of reproduction to a marked extent. For speedy as well as accurate band-pass IF alignment a cathode-ray oscillograph with a frequency modulated test signal is essential. Without this apparatus the job is still possible, but time and patience will be needed. It is going to be necessary when adjusting the trimmer of any one IF circuit to have the other circuit which is coupled to it heavily damped, and this will mean transferring a resistance shunt from circuit to circuit. There is no critical value for the resistance, and 10,000 ohms can be tried. If it is not convenient to get at both ends of a winding the resistance should be joined in series with a condenser of 0.1 mfd., and the two in series connected between the appropriate anode, or grid, and chassis.

The primary of the last IF transformer should be shunted first and the secondary trimmer adjusted for a peak indication. Then transfer the shunt to the secondary and adjust the primary trimmer for a peak. Proceed thus with the other IF transformers, working back towards the frequency changer valve. After all the IF trimmers have been adjusted remove the shunt from the first secondary, rock the test oscillator tuning, and take very careful note of the behaviour of the output meter needle; a symmetrical frequency response is, of course, wanted. Do not be satisfied unless the response curve appears either to be sensibly flat-topped or to have two equal peaks (that are not too exaggerated). Look, too, for sharp cut-off on each side of the band-pass range. If the response characteristic is obviously not as it ought to be, then it will be necessary to work on trial and error lines with *slight* trimmer readjustments. It will be most important to restore a trimmer setting to the original whenever there is no benefit to be gained by a readjustment.

Value of CR Gear

Fig. 2(a) shows a possible response curve with incorrect alignment, while Fig. 2(b) shows the result of correction. The statement that, using a cathode-ray oscillograph and a frequency modulated oscillator, the response curve is rendered visible on the tube screen, and the effects of any adjustments can be clearly seen, is enough to indicate that this apparatus can be of the greatest possible value in alignment work. Apart from time saving, it removes all elements of uncertainty where band-pass adjustments are concerned.

There is now left for consideration the case of the superhet with variable IF selectivity. Since at maximum selectivity the over-all IF characteristic will be single-peaked, the IF aligning should be done with the selectivity control at maximum, and the adjustments can be made for peak indications. It is important, however, that after this initial aligning the selectivity control should be turned to minimum and a check test made on the shape of the frequency response characteristic. If any lack of symmetry shows up it should be corrected by a touch on the trimmer adjustments.

When the IF aligning has been done, if the IF value is known to be correct, a firm resolution should be made not to alter the IF adjustments again. If the IF

Superhet Alignment—

value is a doubtful factor, however, then, as we have stated, it may later prove to be necessary to start all over again.

Before we change the subject there are two odd points to be noted: If reaction is incorporated in the last IF transformer, the reaction control should be kept well back while the aligning is being done.

Some receivers have two different IF values—one for medium and long waves, and a higher value for short waves. Needless to say, the aligning must be done separately for the two values.

Having, at least for the meantime, finished with the IF adjustments, the condenser shunt across the receiver oscillator tuning condenser must be removed and the feed from the test oscillator must be taken off the frequency-changer grid.

Assuming that the IF stages have been aligned at a certain frequency, it is now necessary that the receiver's oscillator circuit shall be adjusted to oscillate at a frequency above that of the test signal by an amount exactly equal to the IF value. It is further necessary that the oscillator shall "track" properly, i.e., that the difference between oscillator and signal frequencies shall remain constant for all settings of the tuning control.

The trimming of the oscillator, the tracking of the oscillator (assuming that it is not a case of fixed tracking), and the trimming of the signal-frequency circuits are jobs that have considerable reference to one another, and it will be necessary to be careful as to procedure. The immediate task is to get the oscillator into trim on a test signal, but in many cases this adjustment will not be the final trimming one, as we shall see presently.

Dealing with Separate Wavebands

Having left the IF stages, we must needs allow for the fact that adjustments now will have to be made on two or more wavebands. Complete alignment should be made on the first waveband chosen before other wavebands are tackled, but at the outset the position must be sized up as to whether the order in which the various wavebands are dealt with is going to matter. In some receivers there are independent coils, trimmers, and trackers for each waveband, and in these cases the wavebands can be taken in any order one pleases. In other cases, however, the wavebands should be taken in some particular order. Such cases arise when any one oscillator or signal-frequency trimmer is in circuit on more than one waveband, but an additional trimmer is associated with it on one particular band. It is usually safe to assume that in such a case the order of work should be: short, medium, long.

As there are one or two special comments to be made about short-wave aligning, we will discuss first the case of a MW/LW receiver and assume that the medium waveband is the first to be tackled.

First of all connect the test oscillator leads, one to the aerial terminal of the receiver and the other to chassis. Strictly speaking, the lead to the aerial terminal should contain a standard "dummy aerial" in series, but generally a 0.0002-mfd. condenser in series will be satisfactory enough.

Before switching on and commencing trimming, it is most important to make certain that the pointer setting of the receiver is correct. Usually there is some obvious mark on the tuning scale to which the pointer should be set when the ganged condenser is at maximum (or minimum). Having made sure on this matter, the adjusting can commence. The oscillator trimmer must be adjusted for peak indication on the output meter from a test signal having a frequency appropriate to a wavelength near the lower end of the waveband. Really the receiver manufacturers' specified trimming frequency should be worked to, but if this is not known there are not likely to be difficulties of any consequence if a frequency of 1,400 kc/s (214 metres) is chosen. The tuning control of the receiver should, of course, be set to this reading on the scale before the oscillator trimmer is adjusted (and the receiver put on MW).

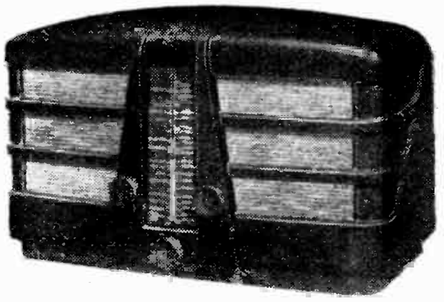
It is possible that two oscillator trimmer settings will be found to give peak indications on the output meter. If these two peak indications are equal it can be assumed that one is correct but that the other is giving an oscillator frequency lower than the correct value by twice the IF value. If this effect is found it is essential to choose the *smaller* of the two trimmer capacity settings. As to whether or not the two equal peaks will be found in any particular case will depend firstly upon the value of the IF and secondly upon the capacity range of the oscillator trimmer condenser. The lower the IF and the larger the maximum capacity of the trimmer the more likely will it be that the effect will be found.

If several trimmer settings are found to give unequal peak indications it will be a sign that harmonic beat effects are occurring. These are more likely to occur with a strong test signal, so we have once again an argument for keeping the amplitude of the test signal well down. The second-channel beat referred to in the previous paragraph may hold a trap for the unwary (assuming that conditions permit it to occur), but it is usually easy to avoid trimming on to a harmonic beat. If in any doubt, trim to the strongest output peak if there is only one of this strength, but if there happen to be two equally strong (and stronger than others), then choose whichever of these two requires the smaller trimmer capacity.

(To be concluded.)

G.E.C. NEW SEASON'S PROGRAMME

THE receivers announced last week as the foundation of the new 1938-39 programme are in many cases improved versions of current types which are fulfilling successfully one or other of the diverse requirements of the broadcast listener. The firm's policy of strict price control and distribution through approved dealers is being maintained.



G.E.C. two-waveband A.C.5.

In all there are nearly twenty models to choose from, and among the completely new designs the following may be selected for special mention.

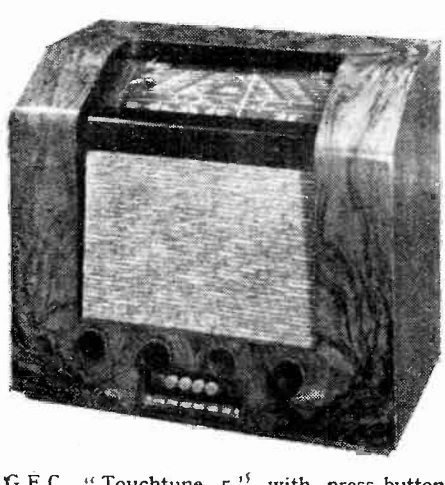
"A.C.5."—Designed for medium and long waves this AC superhet. (four valves and rectifier) is housed in a horizontal moulded bakelite cabinet of striking design with vertical tuning scale and visual switching indicators. Price, £7 19s. 6d.

"Touchtune 5."—Press-button automatic tuning for five stations (four medium-wave and one long-wave) and a "Chromoscopic" dial for general reception are features of this all-wave AC superhet. (four valves and rectifier). The short-wave range is 16.5 to 50 metres, and the price is 12½ guineas.

"Selectalite 6."—Automatic selection of five stations by means of a rotary switch is coupled with an illuminated panel above the main tuning scale showing the name of the station to which the set is tuned. There are five valves and a rectifier, and the set covers short, medium and long waves. Power output is 6 watts, and the price 16½ guineas.

"Fidelity All-Wave Super 10."—The five waveranges in this receiver cover 11-550 metres and 900-2,100 metres. Twin loud speakers are provided and the output from the push-pull stage is 15 watts. The price is 29 guineas.

Battery receivers are represented by four models, including one with the "Touchtune" feature. An AC console with automatic station selection and a full range of radiogramophones round off a comprehensive programme.



G.E.C. "Touchtune 5" with press-button tuning for one long-wave and four medium-wave stations.

Developing a High-Quality Communication Receiver

How a Receiver is Designed—XV.

THE AF EQUIPMENT

CONTINUING in this article the design of a quality communication receiver, the push-pull penultimate AF stage is discussed together with the phase-splitting stage which feeds it. The design of a tone control which enables the bass and treble responses to be independently raised or lowered is treated in considerable detail.

IN the last article of this series details of the output stage were decided, and we now have to consider the penultimate stage. Each of the two output valves requires a maximum input equal to the grid bias for full output, or 43 volts peak; the total input needed by the output stage is thus 86 volts peak. In the writer's opinion this is rather too great to be obtained directly from a phase-splitting stage embodying a valve with anode and cathode coupling resistances, for to obtain linearity the mean voltage drop across the coupling resistances would have to be at least 60-70 volts, and preferably more. This represents an undesirably large voltage between heater and cathode; it is not necessarily too high, but it is better to avoid it if possible.

The alternative phase-splitting circuit is sometimes called the paraphrase connection. One output valve is fed directly from the preceding amplifier and a portion of its input is also applied to a phase-reversing valve which feeds the other output valve. With this circuit careful balancing is usually needed, the penultimate stage does not operate in true push-pull, and a perfect balance at very low and very high frequencies is not secured.

In the writer's experience, the best course is to use two valves in a true push-pull amplifier for the penultimate stage, and phase-splitting can be adopted at the input to this stage.

The Penultimate AF Stage

The first step is obviously to choose the valves, and we know that triodes with an AC resistance of 10,000-30,000 ohms with an amplification factor of 20-40 will be suitable. Before we can select the actual type, however, we must select the general type to be used throughout the set. There are now several distinct ranges available which are not conveniently mixed; there are the standard 4 v.-heater types with British 4-, 7- and 9-pin bases; there are the 4 v.-heater types with the British octal base; there are the 6.3 v.-heater types with the Continental side-contact base; and there are the 6.3 v.-heater types with the American octal base.

All types are readily available in this country. We must remember, however, that a quality communication receiver is one which naturally has a special appeal overseas and there the American or International octal base types are probably the most readily obtainable. The side-contact types are, it is true, available on the Continent and in Australia, but so are the octal-base valves. The American octal-base types are now standard in America, but our choice of this range does not mean that we are forced to use American valves. The more important types are included in the International series and are made in this country by several firms. As far as possible, therefore, we shall choose valves in this range so that the constructor can use British- or American-made valves as he prefers or as he is able to obtain them. We shall not confine ourselves entirely to this range, however, for if we can obtain a better performance or reduce the cost through using a British valve for which there is no American equivalent or an American valve for which there is no British counterpart, we shall do so.

In the British-made types with the octal-base, there are few triodes, but certain tetrodes and pentodes can be used as triodes by strapping the appropriate electrodes. Thus, the Marconi and Osram KTZ63 can be used as a triode with an AC resistance of 10,000 ohms and an amplification factor of 20; in other makes and in American types this valve is the 6J7. Two of these valves can be used in the penultimate stage.

If we look through the list of American valves, however, we find one which has no British counterpart but which is particularly attractive for our purpose. This is the 6N7 double-triode. It consists of two triode assemblies with a common heater and cathode, built into a single glass envelope. Each triode section has an AC resistance of the order of 25,000 ohms with a mutual conductance of about 1.3. Its attractiveness lies in the fact that one 6N7 will do the work of two of the 6J7 type, and we shall consequently decide to use it.

The design of resistance-coupled amplifiers was dealt with in earlier articles in this series and so we need not enter into the exact process for the determination of circuit values here. The circuit takes the form shown in Fig. 2 upon which the values of components are marked. Coupling resistances R3 and R4 of 100,000 ohms are suitable and with an HT supply of 350 volts each half of the valve takes 3.3 mA. For a total output of 86 volts peak calculation gives the total input as 3.42 volts, so that the stage gain is about 25 times.

Before this stage we need one for phase-splitting and experience shows the most satisfactory arrangement to be that of Fig. 3; a suitable valve is the KTZ63 or 6J7 connected as a triode. The coupling resistances should be of as low a value as possible in order to maintain the difference of potential between heater and cathode at a low value. Good results are secured with a value of 10,000 ohms.

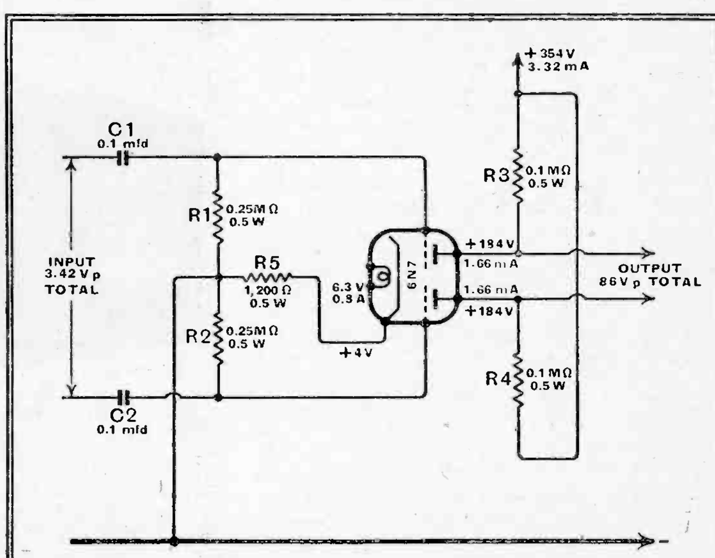


Fig. 2.—The circuit diagram of the push-pull penultimate stage, for which a double-triode is used, is shown here.

It is possible to use anode and cathode resistances of the same value provided that the bias resistance is shunted by a condenser of very large capacity. This condenser, however, can be omitted if the coupling resistance and bias resistance in the cathode circuit are together equal to

High-Quality Communication Receiver—

the coupling resistance in the anode circuit. Referring to Fig 3, it is necessary for R3 to equal R4+R5; as R3 is 10,000 ohms and a bias resistance R4 of 1,000 ohms is needed, correct results are secured

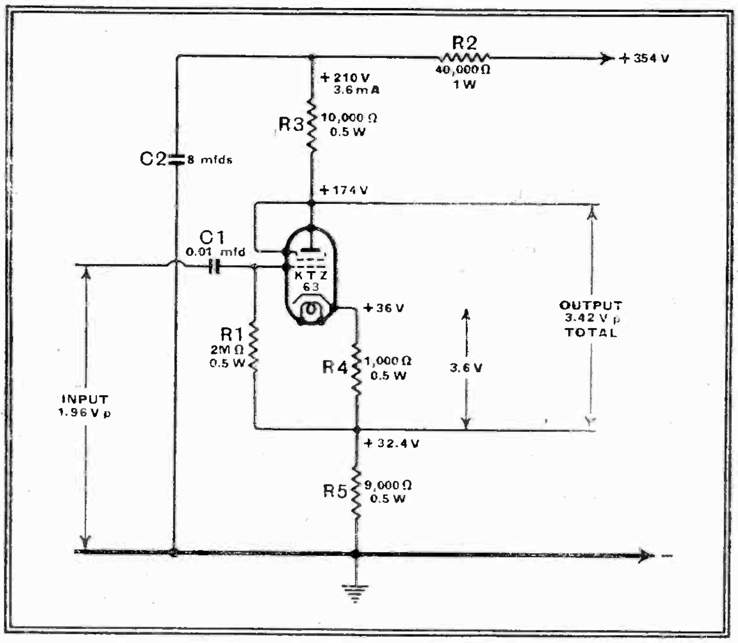


Fig. 3.—The phase-splitter is of simple and reliable type using an RF type tetrode connected as a triode.

by giving a value of 9,000 ohms to R5.

On the input side it is necessary that the grid leak R1 should be as large as possible; in general, it is unwise to exceed 2MΩ for a grid circuit resistance if it can be avoided. We accordingly choose this value, and it is then unnecessary for the coupling condenser C1 to exceed 0.01μF to ensure the full bass response.

As shown the stage will take 3.6 mA, so that the voltage between heater and cathode will be 36 volts—quite a reasonable figure. Owing to the heavy negative feed-back along the cathode resistance, the gain is very low and actually works out at 1.75 times between the input and the *total* output. The maximum input needed is thus 1.96 volts peak.

The First AF Stage

Now the amount of AF gain required additional to that provided by these stages depends upon the output of the AF source. This will normally be the detector and can be made anything we like within quite wide limits; it may, on occasion, be a gramophone pick-up or a microphone, however. The output of a pick-up measured with standard frequency records varies from about 0.25 volt RMS to about 1.5 volts; with some types even higher outputs have been recorded. The peak output on loud passages of music often exceeds these figures, however, and experience shows that an amplifier requiring an input of 0.5 volt RMS can be fully loaded from the less sensitive types of pick-up and easily overloaded with the more sensitive types. We can thus say that if full output can be secured with an input of 0.5 v. RMS or 0.707 v. peak the amplifier will have sufficient gain for all current pick-ups and for the majority of the older patterns. This calls for an extra gain of 1.96/0.707=2.78, or say 3, times.

The best output for the detector depends upon its type and must be discussed later; it will not, however, be less than 0.5 volt RMS. If it is greater, we shall have to throw away some of its output, but we cannot economise by providing less AF gain if the amplifier is to be effective for gramophone work.

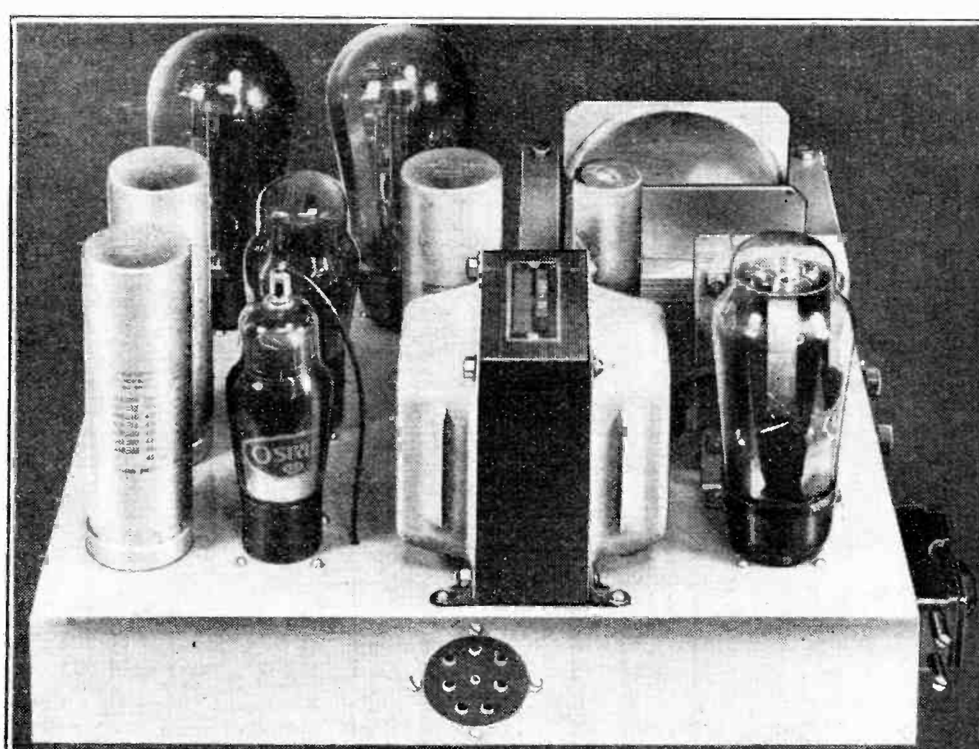
The question of using a microphone should receive attention. For a good carbon microphone, such as the transverse-current type, the amplifier should work with an input of about 0.05 volt only. Many higher quality types give a much smaller output. If we are to cater for a microphone, therefore, we must provide additional AF gain of at least 100 times instead of merely 3 times. This will not be economical, and as a microphone is rarely required we shall not do it. This omission does not prevent the use of a microphone, but entails the use with it of an external pre-amplifier.

We thus see that we need one extra AF stage to give a gain of three times; we also laid down in our initial specification that independent bass and treble tone controls should be included. An AF stage giving very low gain is the right place to obtain tone control when these words are used to denote a control which enables the response to be *increased* as well as lowered.

Experience shows that continuously variable controls are unnecessary and that most requirements are met by two 5-way switches, one acting on the bass and the other on the treble. One position of the switches gives a flat amplifier response curve; the other positions allow two degrees of bass lift and fall and two degrees of treble lift and fall in any combination. Experience also shows that the major audible effect of a tone control should be that of a tone control This may seem too obvious to need mentioning, but it is a fact that many widely used circuits have the main audible effect of changing the volume. The response curve is altered, certainly, but the amplification is changed at the same time.

The Tone-control System

These tone-control troubles usually occur only when it is required to increase the response at low or high frequencies. As far as the response curve is concerned it does not matter whether we increase the amplification at low or high frequencies, leaving it unchanged over the middle range, or whether we keep the gain constant at low or high frequencies and reduce the amplification over the middle range. The "volume control" tone controls do the latter; therefore, we must adopt the former. There is, however, a limit to the possible gain with a



A view of the amplifier and mains equipment. The phase-splitter can be seen at the front, with the double-triode behind it and the two output valves at the rear.

High-Quality Communication Receiver—

valve. This figure cannot be exceeded at maximum boost; consequently, the normal gain of the stage must be less than the maximum possible gain by at least the amount of boost required. Thus if a boost of 20 db. is needed, the normal gain cannot exceed one-tenth of that possible if tone-control were not included. By normal gain is meant the amplification over the middle register and over the whole range of frequencies when the control is set for a flat response.

We have already decided on the normal gain needed; it is about 3 times. Before we can design the control circuit, we also want to know the amount of rise and fall in the characteristic. This must be determined experimentally and experience shows that a rise or fall of 7-10 db. is about right for the first step and 15-20 db. for the second. Whether or not we can obtain a rise of 20 db. with a normal gain of 3 times depends upon the valve characteristics.

At first sight there should be no difficulty, for it is easy to obtain an amplification of 60 times from a resistance-coupled stage. The kind of valve necessary for this, however, has a high AC resistance and must be worked into a high resistance load. Stray circuit capacities then become important and may prevent correct operation of the tone control at high frequencies. In tone-control circuits it is wise to keep all circuit resistances at a moderate value if possible.

Now octal-base triodes have fairly low mutual conductances—a normal figure being about 1-2 mA/V., with amplification factors around 15-25. The 6N7, however, has a resistance of 25,000 ohms with mutual conductance of 1.3 mA/V., the amplification factor being 32.5. If we connect the two halves of the valve in parallel the resistance will become 12,500 ohms and the mutual conductance will be 2.6 mA/V., the amplification factor remaining unchanged. This valve is the most suitable in the octal-base range and we shall accordingly select it.

If the valve is to have a reasonably linear characteristic it should work into a load not much less than twice its own AC resistance. The majority of tone-control circuits are such that the load is less than the valve resistance; with these there is a greater risk of amplitude distortion and this is particularly bad in such a stage since the importance of harmonics is increased by the use of "top-lift." We shall, therefore, adopt the circuit of Fig. 4 because this enables the valve to be worked into a reasonable load. The circuits (a), (b), (c) and (d) show the basic arrangements for bass and treble lift and bass and treble cut respectively, and on the right the equivalent electrical circuits are shown. The condenser C1 is included to prevent the HT being short-circuited through the tone-control network; if it is large enough it has a negligible effect on the performance and is consequently omitted in the equivalent circuits.

The Value Good

The minimum load on the valve is equal to $R_1 (R_2 + R) / (R_1 + R_2 + R)$. In general, R will be a good deal smaller than R2, so that the load is roughly equal to R1 and R2 in parallel. If we make their combined value twice the valve resistance, therefore, we shall have satisfactory operating conditions as regards linearity. It is also convenient, although by no means essential, to make R1 and R2 of the same value. As in our case the valve resistance Ra is 12,500 ohms, this gives us R1 = R2 = 50,000 ohms.

As far as the calculation of the tone-control circuit is concerned, this network of resistances can be replaced by a single resistance R′ equal to R1 and Ra in parallel in series with R2; that is

$$R' = \frac{R_a R_1}{R_a + R_1} + R_2.$$

In this case R′ = 60,000 ohms. The generator representing the input voltage delivers a voltage e′ equal to $e_1 \mu R_1 / (Ra + R1)$ where e_1 is the input to the grid circuit. The ratio $e_2/e_1 = A$ is the amplification of the stage. Here we have the generator voltage e′ equal to 26 e_1.

Now when the response is flat only R′ and R are effective and $e_2 = e'R/(R + R') = 26e_1R/(R + R')$; therefore, $A = 26R/(R + R')$ and $R = AR'/(26 - A)$. As A = 3 and R′ = 60,000 ohms, we find R = 7,820 ohms. This is not a standard value, so we will take R = 7,500 ohms, which will give A = 2.89. This will be satisfactory, for the required gain calculated earlier was 2.78 times and we took 3 times as the nearest round figure.

The minimum gain with the controls set for "boost" will be 2.89 times; the maximum possible will be 26 times. The relative boost will be 26/2.89 = 9 times or some 18 db. Actually, it will be less than this because the gain will never reach the "maximum possible." We cannot, however, obtain greater boost without reduc-

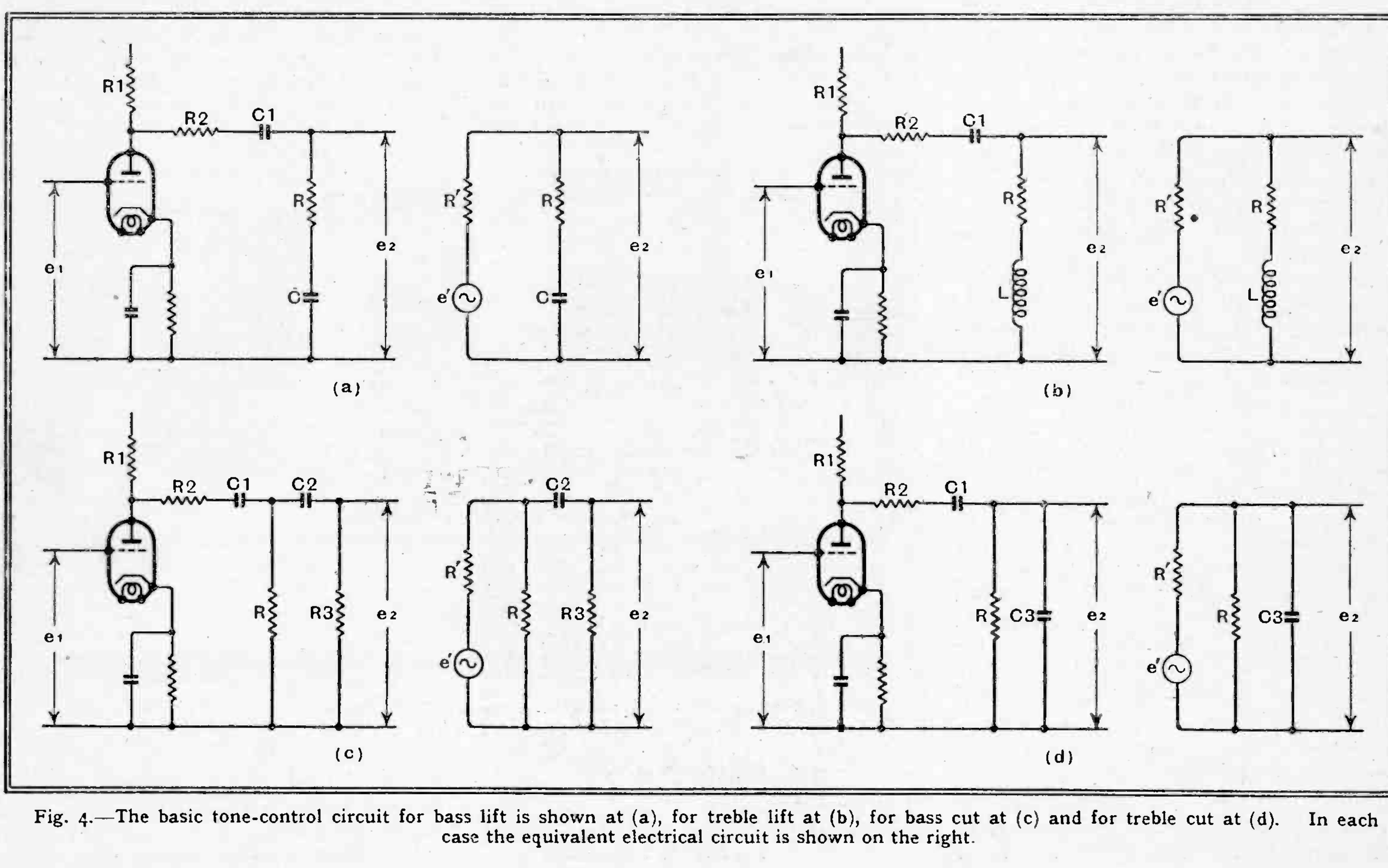


Fig. 4.—The basic tone-control circuit for bass lift is shown at (a), for treble lift at (b), for bass cut at (c) and for treble cut at (d). In each case the equivalent electrical circuit is shown on the right.

High-Quality Communication Receiver—
ing the normal gain or using a valve of higher amplification factor.

Consider now the bass boosting circuit of Fig. 4 (a); at any frequency $e_2/e' = \sqrt{1+\omega^2C^2R^2} / \sqrt{1+{}^2C^2(R+R')^2}$ and for the steps of bass boost we have $S = 6.3$ and 2.5 at 50 c/s so that $C_2R_3 = 5.12 \times 10^{-4}$ and 1.385×10^{-3} respectively. If R3 is 0.25 MΩ, C2 must be 0.00204 μF. and 0.00554 μF.; 0.002 μF. and 0.005 μF. are suitable standard values.

$(R+R')$. From this we have $C_3R'' = \sqrt{S^2-1}/\omega$; in this case R″ is 6,660 ohms and we can take S as 6.9 and 2.28 at 10,000 c/s to give drops equal to the rises. This gives the values of C3 as 0.00163 μF. and 0.00491 μF. The nearest standard values of 0.015 μF. and 0.005 μF. are likely to be satisfactory.

The complete circuit of this stage, including switching, can now be drawn and is shown in Fig. 5. Apart from questions of decoupling and bias components, which can be settled on the usual basis, it only remains to choose C1. The reactance at the lowest frequency must be small compared with the effective circuit resistance which is 67,500 ohms in this case. If we use a 0.5-μF. condenser for C1, choosing the value because it is the largest capacity in the tubular range, its reactance at 50 c/s will be 6,370 ohms, so that its presence will cause a negligible loss at this frequency.

It may be remarked that on measurement certain discrepancies in response may be found, because the circuit has been considerably simplified for calculation purposes. A precise formula, taking into account every possible effect regardless of its magnitude, would be impossibly complicated for the determination of circuit values.

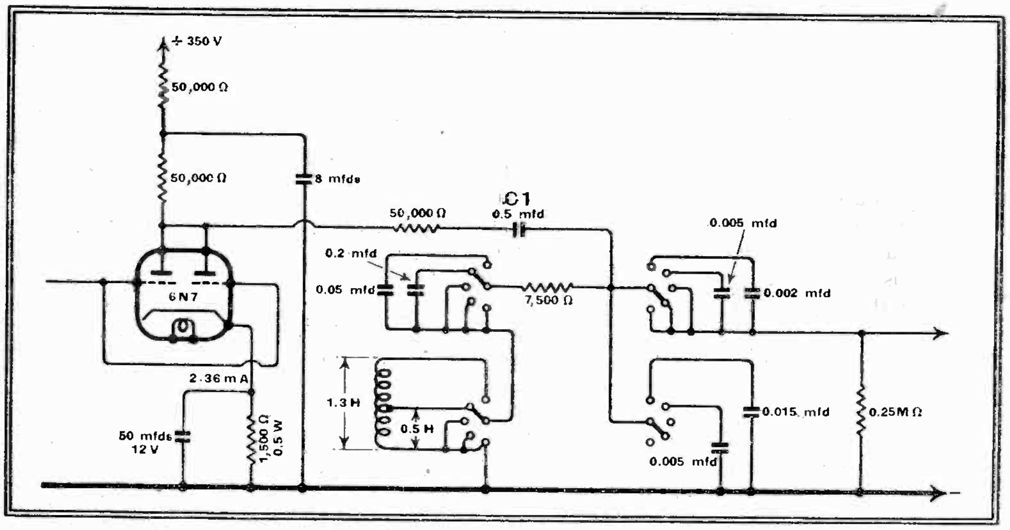


Fig. 5. The various items of the tone-control, which are discussed in the text, are here put together to form a complete whole.

this particular case $A = 26\ e_2/e'$. From this

$$C = \sqrt{1 - \frac{A^2}{670}} \Big/ \omega \sqrt{(R+R')^2A^2/670 - R^2}.$$

This value taken for A must be less than 26, and 20 would seem a reasonable figure; if we take the frequency as 50 c/s we can find C straight away. It is 392×10^{-8}F. $= 0.0392$ μF.

Choosing Circuit Values

The nearest standard value is 0.05μF., so let us try this. We find that $A = 18.2$, giving a bass boost of $18.2/2.89 = 6.3$ times or some 16 db. This is satisfactory, and for the intermediate step we need a boost of 8 db. or 2.5 times; giving a gain at 50 c/s of 7.25 times. Inserting values in the formula we have $C = 0.1775$μF. The nearest standard value is 0.2 μF., and with this $A = 6.6$. The rise in bass is consequently 2.28 times or 7.2 db. This, again, is satisfactory.

We have now to deal with the treble booster of Fig. 4(b). The procedure is exactly the same save that the equations now become

$$e_2/e' = \sqrt{R^2+\omega^2L^2} / \sqrt{(R+R')^2+\omega^2L^2}$$

and

$$L = \sqrt{(R+R')^2A^2/670 - R^2} / \omega\sqrt{1-A^2/670}.$$

For $A = 20$ and 7.25 at 10,000 c/s we have $L = 1.3$ H. and 0.518 H. respectively for the two steps.

Turning now to Fig. 4 (c) for bass cut, the values of R and R′ have a very small effect upon the performance if R3 is very large compared with R and we can reckon the response on C2 and R3 alone; the relative response at different frequencies is $1/\sqrt{1+1/\omega^2C_2^2R_3^2}$. Calling the ratio of response at medium frequencies to that at low frequencies S, we have

$$S^2 = 1 + 1/\omega^2C_2^2R_3^2,$$

whence $C_2R_3 = 1/\omega\sqrt{S^2-1}$. If we make the steps of bass attenuation the same as

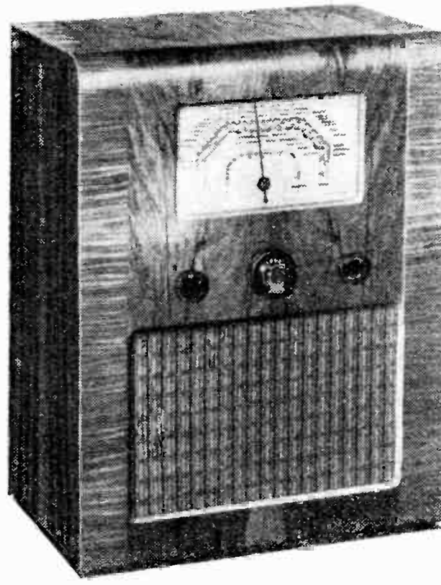
At high frequencies the circuit is that of Fig. 4 (d) and the relative response is $1/\sqrt{1+\omega^2C_3^2R''^2}$ where $R'' = RR'/$

Two New Cossor Receivers

MAINS AND BATTERY SUPERHETERODYNES

BOTH these "all-wave" sets are superheterodynes; one is for AC mains and the other for battery operation. The short-wave range in each case is from 16 to approximately 52 metres.

The battery set (Model 439) has a four-valve circuit with triode-heptode frequency changer, pentode IF amplifier with permeability-tuned couplings, double-diode-triode second detector, AVC and first AF amplifier, and pentode output valve. The chassis is rubber-mounted to reduce microphony and the glass-protected dial carries 43 station names. Without batteries the price is £7 15s.



Cossor Model 439 battery superheterodyne for "all-wave" reception.

A radio-frequency amplifying stage is included in the circuit of the Model 396 AC mains receiver. There are five valves excluding the rectifier, and the final stage is a triode. The cabinet is of the horizontal type and the price is 9½ guineas.

New Hivac Cathode-Ray Tube

HIGH VACUUM TYPE CR3

A NEW cathode-ray tube is announced by the High Vacuum Valve Co., Ltd., of 111-117, Farringdon Road, London, E.C.1. It is a hard tube of the two-anode type. Its cathode is indirectly heated and consumes 2.0 amperes at 2.5 volts. It is rated for 1,200 volts maximum second anode potential and with this the first anode should be about 350 volts. Approximately −50 volts grid bias is needed for current cut-off. The tube can be operated with as little as 600 volts for A2 and 175 volts for A1. At the higher voltage the deflection sensitivities are 0.25 and 0.27 mm/volt DC for the D1, D2 and D3, D4 plates respectively. At the lower voltage the sensitivities are doubled.

The plates D2 and D4 are internally connected to the second anode. Under normal conditions the time-base is connected to D1 and the work voltage to D3. A shield is included between the two sets of plates to eliminate distortion.

The overall length of the tube is 11in. and it has a screen diameter of 3in.; the screen colour is green. The tube has a 7-pin base, and is priced at 2 guineas.

RANDOM RADIATIONS

By "DIALLIST"

Quick Work

THE Indian broadcasting authorities are to be congratulated upon the extraordinarily rapid development of their ingenious broadcasting system. At the beginning of the year four new broadcasting stations, Lucknow, Lahore, Delhi 2 and Bombay 2, were opened, all within fourteen weeks, and three more are expected to be in operation before the end of June. These three are Delhi No. 3 and the medium- and short-wave transmitters at Madras. The problems facing All-India Radio when they worked out their broadcasting scheme were terrific. To put it in a nutshell, A I R's task was to devise, with the comparatively small amount of money at its disposal, a system which would provide a reasonably good service over the whole of a country as large as Europe. Really high-powered stations were ruled out by their cost, and no use could be made of the long waves since atmospherics are so severe. The way in which the system has been worked out is very clever, and it has gone a long way towards achieving its object, though, naturally, it isn't perfect.

How It Works Out

The basis of the scheme was to divide the map of India into nine great service areas. For each of these a central medium-wave station is either projected or already in operation. This is intended to supply broadcasting to an area immediately surrounding the transmitter with a radius of about 50 miles. The area lying more than 50 miles but less than 500 from each transmitting centre is to be served by a short-wave station with a wavelength in the neighbourhood of 30, 60 or 90 metres. But it is also desirable to have one station which can cover, by itself, a very large part of the country for the dissemination of national news bulletins and for relay purposes. This is the object of Delhi No. 3, a 5-kilowatt station, which will use a wavelength of about 19 metres. It probably won't be heard much within 200 or 300 miles of the capital, but that area is served by Delhi No. 2. Outside this area the 19-metre station should, generally speaking, be heard pretty well in most parts of India.

How We Progress

IT is amazing how quickly wireless text-books become out of date nowadays, or perhaps I should say how often those published only a few years ago are found to contain definite statements which have since proved to be complete nonsense. This was brought home to me the other day when I happened to be looking up a point in an authoritative work of some 700 pages published as recently as the autumn in 1932, or just five and a half years ago. It was at the time, and still is in many respects, one of the best text-books going. But how is this for a statement that hasn't quite stood the test of time? It is laid down categorically that radio waves whose length is below a certain limit pass right through the reflecting layers into outer space and are lost. The author states that experience has shown that no waves of shorter length than 8-11 metres can be bent back to earth in the daytime and that by night the shortest that can be so bent back are between 15 and 25 metres. Of shorter wavelengths he remarks, "long-distance communication at these frequencies is hence impossible"! The only safe course for anyone who writes a wireless text-book would seem to be to eschew all such definite words as "is," "are," or "will," and to write in their stead, "appear to be" and "may be," with lavish use of qualifications such as "possibly," "probably" and "apparently." Another statement which "dates" even in so recent a book appears in a discussion of service areas. We are told that the power required to enable any broadcasting station's actual service area to approach the maximum possible dimensions is of the order of 500 kilowatts; "so it is much greater than the most powerful broadcast transmitter in operation." WLW and Moscow No. 1 have been using 500 kilowatts for quite a while now.

Long-range Television

THE reception of the whole of an Alexandra Palace programme at Ormesby, near Middlesbrough, is an astonishing feat. A correspondent writing in the *Sunday Times* stated that he saw the entire 70-minute programme, reception being excellent except for occasional interference. It must be admitted that the reception took place under almost ideal conditions. The aerial was some 700ft. above sea level in a locality well away from houses and tall trees. If you look at a physical map of England you will see that except for the Yorkshire Wolds, which are presumably to the east of a line joining the receiving aerial and the A.P., there's nothing worth calling a hill in the path of the ultra-short waves. But whatever the circumstances, the reception of television and the maintenance of sync. at a distance of 220 miles is an amazing business. There has, by the way, been no revision of the official estimate of A.P.'s service range since the new sync. apparatus was installed last year. The range up to which good reception is likely must be a good deal longer than it was. Wouldn't 50 miles be nearer the mark than the official 25-30?

More O.B.'s Wanted

WHENEVER I discuss the question of the Alexandra Palace programmes with owners of television sets I find, not a bit to my surprise, that they prefer outside

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, JUNE 16th.

Nat., 7, The Band of H.M. The Royal Dragoons. 7.30, "The Skipper's Birthday"—a harbour night's entertainment. 8.15, Discussion on Transport and the State. 9.20, The Western Brothers present "Cads' College."

Reg., 2.20, Commentary on the Ascot Gold Cup. 6.40, From the London Theatre. 8, Commentary on Trout Fisherman at Work. 8.45, Dance Cabaret from Newquay.

Abroad.

Rome, 9, "Der Rosenkavalier," opera (Richard Strauss).

Brussels, 1, 9, English Music played by the I.N.R. Symphony Orchestra.

FRIDAY, JUNE 17th.

Nat., 6.30 and 9.50, "Die Meistersinger," Acts I and II of Wagner's opera from Covent Garden. 7.50, Alec Rowley and Edgar Moy at one piano. 8.15, An excerpt from Cochran's show "Happy Returns" with Beatrice Lillie and Flanagan and Allen.

Reg., 7.30, Eddie Carroll and his Orchestra. 8.15, First Orchestral Concert of International Society for Contemporary Music, 1938.

Abroad.

Hilversum, I, 7.40, Mass in B Minor (Bach).

Beromunster, 7.55, "The Count of Luxembourg," operetta (Lehár).

SATURDAY, JUNE 18th.

Nat., 8, "Music Hall" including the two Leslies and Issy Bonn. 9.20, American Commentary.

Reg., 6.35, "The Organ, the Dance Band and Me." 7.30, The Free Church Choir Union Jubilee Festival Concert from Alexandra Palace. 8.20, "Weep for Polyphemus," the riddle of Jonathan Swift. 9.20, Jay Wilbur and His Band.

Abroad.

Radio Eireann, 7, Dublin Banjo Club Band Concert.

Milan Group, 9, "Der Rosenkavalier," opera (Richard Strauss).

SUNDAY, JUNE 19th.

Nat., 2.20, Medvedeff's Balalaika Orchestra in Russian Sunday Music. 6.40, Theatre Organ. 7.15, Mantovani and his Orchestra. 9.5, Recollections of Lord's Cricket Ground, 1787–1938. 9.35, Flotow's "Martha."

Reg., 6.40, World Theatre—Marlowe's "Doctor Faustus." 10.5, Charles Ernesco and his Quintet with Anne Ziegler.

Abroad.

Rome Group, 9, "Barber of Seville," opera (Rossini).

MONDAY, JUNE 20th.

Nat., 5, Tennis commentary from Wimbledon. 6.20, Chopin Recital, by Nina Milkina, pianoforte. 7, "The Bungalow Club." 7.45, Descriptive Music on the B.B.C. Theatre Organ, assisted by the Effects Department. 8.40, A Ravel Recital. 9.20, World Affairs.

Reg., 6.40, Victorian Reminiscences by Phyllis Scott and John Rorke. 7.30, Trial of Sir Walter Raleigh. 8.20, "Radio Olympus." Cast includes well-known Immortals! 9.30, Peter Yorke and his Orchestra.

Abroad.

Luxembourg, 10.20, The Luxembourg Cathedral Choir.

TUESDAY, JUNE 21st.

Nat., 5, Tennis Commentary. 6.25, Rachmaninoff Recital by Cyril Smith. 7.35, Poetry as a Best Seller—Discussion. 8, "The Silver Spoon." 9.20, My Best News Story—W. L. Andrews tells of the Battle of Neuve Chapelle.

Reg., 7.30, "The Pig and Whistle"—a truly rural episode. 8.20, Constant Lambert conducts B.B.C. Orchestra (F). 9.20, Theatre of Variety.

Abroad.

Strasbourg, 8.30, "The Damnation of Faust," opera (Berlioz).

WEDNESDAY, JUNE 22nd.

Nat., 5, Tennis Commentary. 6.45, "Don Giovanni," Act I from Glyndebourne. 9.20, Jay Wilbur and his Band with Billy Caryll and Hilda Mundy.

Reg., 6.30, Jack Hardy's Little Orchestra. 7.30, "Blackpool, The Pirate," a play by H. Hamilton Earle, with music by Michael Sayer. 8.30, The World Goes By. 9, "Parnell."

Abroad.

Radio Eireann, 7.20, Great Irish Names in Modern Music, talk by Victor Herbert.

Kalundborg, 8.50, Songs from "Snow White."

Random Radiations—

broadcasts of current events to anything else in the bill of fare provided. Cabaret seems to be fairly popular so long as it is well done, and some plays go well, though I don't find any vast enthusiasm for plays as a whole. News reels and other films are, perhaps, the least welcome items. I have always felt that the outside broadcast, whether it comes from the theatre, music-hall, the cricket field, the racecourse, the sports ground, the boxing ring or just the streets of London, was the field which offered by far the best opportunity for the development of television. The Alexandra Palace organisers do us pretty well in this way already, and I am sure that they'll be wise if they concentrate more and more on outside broadcasts. After all, there's always something happening in London, and O.B.'s, difficult though they may be to arrange and carry out, may be less expensive than plays, which can't be presented without a great deal of preliminary rehearsal. The more the O.B. side is developed, the quicker will be television's progress towards wide popularity.

Guarantees

IT seems to me that it's quite time that there was some kind of standardisation of the guarantee that accompanies wireless sets. As matters are, a few makers guarantee a receiver for a year, though most do so for three months. All undertake to make free replacements of defective components, but some charge for the labour entailed, whilst others don't. Some, again, make the owner of the set pay carriage both ways if it has to be returned to the factory during the guarantee period, whilst others are more accommodating. Then there's the wording of the guarantees themselves. I have seen some so loosely worded that they might mean almost anything—or nothing. The whole position needs straightening out, and the sooner this is done the better. If set-makers only realised it, the man in the street who buys their products has an earnest desire to know exactly where he stands, and they would be helping themselves as well as him if they took steps to make everything perfectly plain sailing. A standard form of guarantee, plainly and simply worded, would be very welcome.

Hard Cases

No one, I think, looks upon the present state of affairs as regards the servicing of wireless sets under guarantees as perfectly satisfactory. In many—perhaps most—instances the manufacturer undertakes that the set shall be put right if it goes wrong within the guarantee period, but makes the shop which sells the set responsible for carrying out any necessary work that is within the powers of its assistants; only those repairs which they cannot deal with are to be sent back to the works for attention there. And that is one of the big snags. Too many makers don't choose agents who understand wireless servicing themselves, or employ first-rate service men. The result is that the silliest little breakdowns baffle some local men, and if the owner of the set is under obligation to pay carriage on it both ways, he may be put to a good deal of expense that should have been quite unnecessary. Manufacturers should exercise considerably more care in the choice of their agents, and I do think that it would be a graceful action on their part to pay the carriage when a set is returned to them, purely and simply because the local man is incompetent.

Our South American Broadcasts

SOME cuttings from the *Buenos Aires Herald* which have just reached me seem to show that our Spanish and Portuguese broadcasts to South American countries didn't exactly set the Amazon on fire when they were started. Things may be better now, for these cuttings have been some weeks on their travels. One sincerely hopes that they are. The B.B.C. apparently thought that the way to attract South American listeners was to give them music of the local brand. They get plenty of that, probably better done, from their own stations, and the B.B.C. is roundly accused of sending "coffee to Brazil," which is the local equivalent of sending coals to Newcastle. Another point made by some of the writers is that when they tune in English news from Daventry they hear nothing that they haven't already read in their evening papers. That these foreign broadcasts ever became necessary is one of the saddest aspects of wireless, but if they are necessary then surely it's up to us to see that they are done in the best way; otherwise the B.B.C.'s efforts are worse than wasted.

Television Programmes

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

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

THURSDAY, JUNE 16th.

3, Eric Wild and his Band. **3.25,** Gaumont-British News. **3.35,** 155th Edition of Picture Page.

9, Cabaret, including George Robey. **9.25,** British Movietonews. **9.35,** 156th Edition of Picture Page. **10,** News Bulletin.

FRIDAY, JUNE 17th.

3, Starlight—Hildegarde. **3.10,** British Movietonews. **3.20,** "Le Médecin Malgré Lui," by Molière, adapted from Lady Gregory's version "The Doctor in Spite of Himself."

9, Starlight. **9.10,** Gaumont-British News. **9.20,** "Lady Precious Stream," a Chinese play by S. I. Hsiung. Cast includes Esmé Percy and Josephine Middleton. **10.30,** News Bulletin.

SATURDAY, JUNE 18th.

3, In Our Garden, C. H. Middleton. **3.10,** New Dance Steps demonstrated by Alex Moore and Pat Kilpatrick. **3.25,** Gaumont-British News. **3.35,** Cabaret, including George Robey.

9, "Tally-ho," revue including Nelson Keys and Valerie Hobson. **9.30,** British Movietonews. **9.40,** Spelling Bee. **10,** News Bulletin.

SUNDAY, JUNE 19th.

8.50, News Bulletin. **9.5,** Irène Prador. **9.10,** Film. **9.20-10.30,** "A Hundred Years Old"—a comedy by Serafin and J. Alvarez Quintero.

MONDAY, JUNE 20th.

2.30-4.30, O.B. from the Centre Court at Wimbledon.

9, Cabaret, including Horace Kenny. **9.35,** Film. **9.50,** "The Old and Young," a comedy by Louis Goodrich. **10.5,** British Movietonews. **10.15,** Agnes de Mille, with Henry Bronkhurst at the piano. **10.25,** News Bulletin.

TUESDAY, JUNE 21st.

2.30-4.30, O.B. from the Centre Court at Wimbledon.

9, Hildegarde. **9.10,** Gaumont-British News. **9.20,** "Le Médecin Malgré Lui" (as on Friday at 3.20). **10,** News Bulletin.

WEDNESDAY, JUNE 22nd.

3-4.15, "Badger's Green," a comedy by R. C. Sherriff. Cast includes Louis Goodrich and Richard Fleury.

9, Starlight. **9.10,** British Movietonews. **9.20,** "A Hundred Years Old" (as on Sunday at 9.20). **10.30,** News Bulletin.

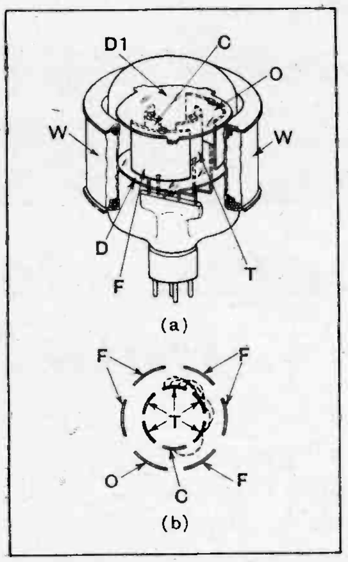
Recent Inventions

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

SECONDARY-EMISSION AMPLIFIERS

THE Figure (a) shows a compact form of electron multiplier in which all the electrodes are arranged around a common centre between upper and lower supporting discs D, D1.

Primary electrons emitted from the cathode C are coerced by the magnetic field from an external winding W, and by the electrostatic field from the field-plate F, so that they follow a curved path on to a target electrode T. Here



Constructional details of electron multiplier described in the text.

they produce secondary electrons, the amplified stream being collected by an output anode O.

A section through a similar tube containing five target electrodes T which, with the cathode C, are arranged on an inner circle is shown in Figure (b). The same number of field-plates F, together with a collector or output plate O, form an outer ring. the curved path of the electron stream from target to target being indicated in dotted lines

Ferranti, Ltd.; M. K. Taylor; and S. Jackson. Application date, October 16th. 1936. No. 482454.

o o o o

QUADRANTAL ERROR

WHEN taking wireless bearings from a ship or aeroplane the presence of fixed metal parts in the vicinity of the receiver introduces what is called quadrantal error, an effect which is due to re-radiation of the incoming signal energy from the fixed conductors. It is a fluctuating factor which varies, more or less sinusoidally, according to the particular direction in which the direction-finding aerial is pointing at the moment.

In practice it is usual to add to, or subtract from, the observed bearings, amounts which are read off from a previously prepared calibration curve, the corrected figure being the true bearings. Or the correction may be applied automatically by means of a cam with a suitably shaped contour.

The invention describes a direction-finding system in which the bearings taken by the aerial are recorded as a "line of light" on the fluorescent screen of a cathode-ray tube. The necessary correction for quadrantal error is made by using a voltage derived from a ray of light which passes to a photo-electric cell through a semi-transparent mask, the latter being shaded to correspond with the calibration curve.

Telefunken Ges. fur drahtlose Telegraphie m.b.h. Convention date (Germany) July 24th, 1936. No. 482101.

o o o o

WIRELESS TRANSMITTERS

DURING periods of 100 per cent. modulation, the amplifiers at a transmitting station are called upon to handle four times the normal carrier-power, so that in order to meet occasional "peaks" the whole of the amplifiers must have a power-rating far in excess of average requirements. The object of the invention is to avoid this unnecessary expense by increasing the efficiency of operation.

Instead of radiating the modulated carrier-wave from the same aerial, three different aerials are used. One is fed with the unmodulated carrier-wave alone, whilst the two others are fed with the upper and lower side-band frequencies respectively. The three aerials are preferably spaced at least a wavelength apart, so as to avoid "radiation coupling." The effect of the outgoing waves on a distant receiver is exactly the same as if the signals were radiated in the usual way, but the power to be handled at the transmitting end is more evenly distributed.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of G. H. Brown). Convention date (U.S.A.) July 16th, 1936. No. 481855.

o o o o

TUNING ARRANGEMENTS

IN one of the modern methods of "easy" tuning, a brake is automatically brought into action when the circuits of the set are set accurately in tune with an incoming signal. The brake "jams" the control shaft and so makes it impossible for a listener to "overshoot" the mark. The brake is controlled by a rectified current which is rapidly built up, at the moment of resonance, in a highly-selective circuit associated either with the high-frequency input, or with one of the intermediate frequency stages of a superhet set.

The rectified control current must, of course, be amplified to enable it to operate the braking device effectively, and this involves the provision of one or more extra valves.

In order to avoid this addition, one of the existing low-frequency amplifiers is made to serve the required purpose. For instance, the output circuit of the last L.F stage is provided with a relay winding, which is insensitive to the normal anode current, but responds to a rectified impulse applied from the selective "control" circuit and immediately applies the tuning brake.

N. V. Philips' Gloeilampenfabrieken. Convention date (Germany) August 14th, 1936. No. 481858.

o o o o

DEFLECTING COILS FOR TELEVISION

IN television it is sometimes necessary to deflect an electron stream, representing in cross-section an electron image of the picture, bodily across a scanning aperture. For this purpose it is essential to keep the magnetic control-field homogeneous over the whole area of deflection. Also for high-definition work, it is desirable to keep the inductance of the coils as small as possible in order to reduce the power required to operate them.

Fig. 1 shows two pairs of coils A, B, one for horizontal and the other for vertical deflection, the direction of the current flow being represented by the conventional signs + and O. The windings L are arranged along the axis of the tube as shown in Fig. 2, the end turns E lying outside the area within which the electron stream is to be controlled. The wires are wound closer together the further away they are located from the

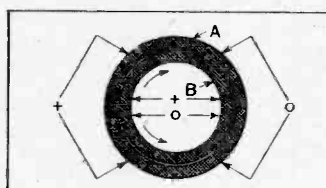


FIG. 1

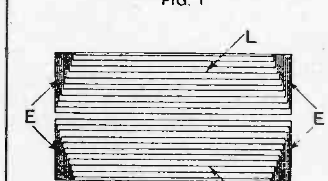


FIG. 2

Fig. 1.—Deflecting coils for "shift" control of CR tube. Fig. 2.—Schematic arrangement of windings on magnetic "shift" coils.

horizontal and vertical sections of the tube, respectively.

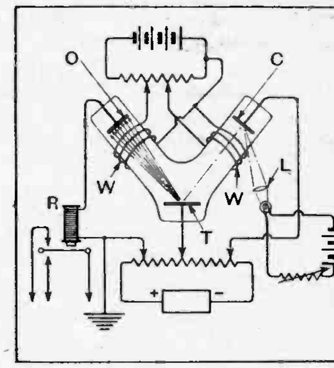
Fernseh Akt. Convention date (Germany), September 30th, 1935. No. 482513.

o o o o

ELECTRON MULTIPLIERS

A TARGET electrode capable of producing a high ratio of secondary electrons from each impact of a primary electron consists of an aluminium surface covered with a thin layer of aluminium oxide, upon which is deposited a monatomic layer of an alkali metal such as caesium.

As shown in the figure, a photo-sensitive cathode C under the action of a ray of light L emits primary electrons, which are focused by an external winding W on to a secondary emission electrode T of the kind described above. The amplified beam produced as the result of the impact is similarly focused on to an output electrode O, from which it



Electron multiplier and circuit arrangement providing a high order of amplification.

may be applied to operate a relay R.

The emission of secondary electrons is not instantaneous, but persists after the primary impacts have ceased, owing, it is said, to the formation on the outer layer of a positive surface-charge, which continues to extract further electrons from the sensitive material. The action of the outer layer is compared with that of the grid of a thermionic valve.

Marconi's Wireless Telegraph Co., Ltd. (assignees of V. K. Zworykin). Convention dates (U.S.A.) September 6th, 1935, and April 30th, 1936. No. 481170.

o o o o

LOW-LOSS COILS

FOR high-frequency currents, the ordinary ohmic resistance of a conductor is increased by the so-called skin-effect, which includes eddy currents, and leakage into the dielectric. To reduce such losses a core of insulating materials is covered with a thin coating of a metal of high conductivity, such as silver, which may either be sprayed on, or deposited from vapour in the same way as valves are metalised.

The thickness of the conductive coating in relation to the diameter of the core is a critical factor. The correct ratio is determined by measuring the ohmic and RF resistances by a resonance method, or on a balanced bridge.

E. Friedlaender. Convention date (Germany), January 8th, 1936. No. 481319.

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

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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.

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EDITORIAL COMMENT

Directorship of the B.B.C.

A Modified System of Control?

THE resignation of Sir John Reith from the Director-Generalship of the B.B.C. has provoked the thought in many minds that the present time is opportune for introducing drastic changes into the internal government of the Corporation. In particular, there seems to be a feeling that a more democratic system than that prevailing under the autocratic powers with which Sir John Reith was popularly invested would be more in keeping with our national institutions and tastes.

In this matter there is surely a danger in regarding the B.B.C. as precisely analogous to other national institutions and organisations with which it is often compared. Actually, there is nothing truly comparable with it, and so any attempt to seek guidance from existing precedent are bound to fail. One can hardly imagine anything more disastrous to the future of British broadcasting than a directorship of which the sole aim and object was to give everyone what they wanted—and which in consequence would fail to please anybody. Programmes produced under such a system would necessarily be scaled down to the lowest level of intelligence and broadcasting as a vital national force would cease to exist.

Much as our natural instincts may incline towards a truly democratic form of control, in the sense in which that expression is generally understood, there is another and very practical objection to the governance of the B.B.C. by a body representative of the almost limitless number of conflicting interests which might plausibly claim a hearing. Such a body would inevitably be unwieldy, and nothing short of a miracle could prevent its time being wasted in fruitless discussion on matters (e.g., those of taste) to which no solution can possibly be found.

Even the most uncompromising opponents of autocracy are usually ready to admit that no other system of control would have given British broadcasting its present pre-eminence. Mistakes there have been, but it is perhaps the greatest tribute to Sir John Reith's work that the broad outline of the system he created has proved entirely workable, needing no major alterations during fifteen years of trial.

It seems to us that the real answer to the basic problem is summed up in the somewhat trite statement that the issue between autocracy and democracy depends entirely on the qualities of the autocrat. If those whose responsibility it is to appoint Sir John's successor are fortunate enough to find a man of equal capabilities for the task, the present system will probably survive for many years.

An eventuality that would, we think, be most damaging to the future of British broadcasting, and which would establish a most dangerous precedent, would be the appointment of a Director-General whose main qualification to the position was the holding of views acceptable to his sponsors in the Government. It may be argued that the efficient machine created by Sir John Reith would go on working satisfactorily without a strong guiding hand, and to those who hold such views the attractions of a "safe" man are obvious. But it is no disparagement of Sir John's work to say that the task he set himself fifteen years ago is not finished ; broadcasting has not reached finality and is never likely to do so.

The Aerial Connection

EXPERIMENTS WITH THE "BIG PRIMARY" COUPLING SYSTEM

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

After discussing the various problems incidental to coupling an aerial to the input tuned circuit of a receiver, the author goes on to describe a method of measuring the effects of this connection. The results of his tests will be given in a concluding instalment

AERIAL coupling is a problem. One can imagine the difficulties of designing a receiver if, for example, the valves to be used with it were unknown, being any that the purchaser of the set might plug in at random! Yet that is something like what the designer is up against in arranging that very vital part of the receiver that leads the signals in. He does not know whether the aerial is to be a bit of wire around the picture rail, a full hundred feet out of doors, or a modern anti - interference system; but he has to arrange things so that no matter what is connected the set makes the best of it.

Even when one particular aerial is given, the thing is not entirely simple. The requirements are:

(1) To get as much as possible of the signal transferred to the tuned circuit, and in so doing:

(2) To reduce the selectivity of the tuned circuit as little as possible, and

(3) When gang tuning is used, to avoid mistuning due to aerial coupling.

Finally (4) to do all the above things over the whole tuning range.

Of course, these requirements are conflicting. If the aerial is very loosely coupled, (2) and (3) are achieved at the expense of (1). As the coupling is increased, up to a point (1) is improved; but beyond that it falls off, quite apart from the losses due to reduced selectivity and tuning accuracy.

In a big set with plenty of valves it is particularly important to consider the effectiveness of signal transfer, for while selectivity can be gained elsewhere, poor signal pick-up cannot be made good by extra amplification because that brings up unavoidable noise as well.

Some of the many possible methods of coupling the aerial are shown in Fig. 1. The first—the series condenser method—at one time used to be much more popular than now. Some years ago[1] I showed that, while it has the merits of simplicity and easy adjustability, in the matter of mistuning for a given signal transfer it compares very unfavourably with the next—the tapped coil. The capacity thrown across the tuning condenser by the latter method of connecting the aerial is reduced approximately in the proportion of the square of the tapping ratio; so if the coil is tapped low, say across one-twentieth of the turns, the aerial capacity is reduced to one four-hundredth, and there is no necessity to take great care to keep it very small. The aerial can even be run around the house in lead-covered wire—a thing that would be quite unworkable with the series condenser method.

If the aerial coil in the third diagram consists of a few turns closely coupled, it is equivalent to the second method; but more often now a coil of comparatively high inductance is used.

The foregoing are the fundamental methods, but there are innumerable combinations and trick circuits—especially for balancing out image interference in superhets. The last of the four shows an arrangement with both top and bottom capacity coupling and possibly inductive coupling as well.

[1] *The Wireless World*, February 2nd, 1934.

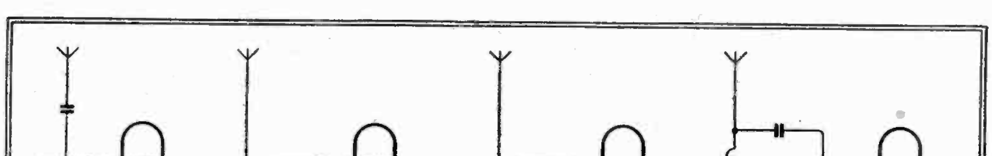


Fig. 1.—Four typical methods of aerial coupling, as described.

The advantages of using a high-inductance primary coil were explained theoretically in an article by W. T. Cocking[2]. The following is an account of some experiments devoted to finding how it works out in practice.

The tests were confined to the medium waveband. Particulars of the tuning coil are given in Fig. 2; it is fairly typical, having an inductance of 160 microhenrys and a Q (inclusive of the condenser, valve and other associated parts) of rather more than 100. The whole measurement system is shown in Fig. 3. In addition to the usual tuning condenser there is a small variable very accurately calibrated from 0-12 mmfds. The method of calibration, by the way, is to use it to control an oscillator of known frequency giving an audible beat note with another oscillator and to calculate the change in capacity required to tune through zero beat frequency to the same beat frequency the other side of zero. The audible frequency is synchronised with a standard audio oscillator. Things can be arranged so that one such movement of the small tuning condenser is equal to 1 mmfd.

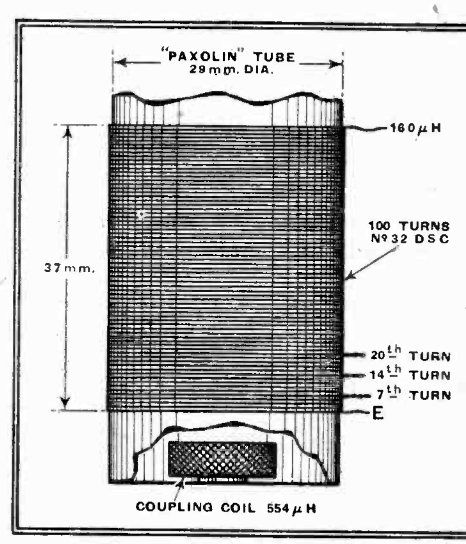


Fig. 2.—Details of the coil used for aerial coupling experiments.

This experimental aerial tuned circuit can be set into oscillation by a dynatron, and the grid bias corresponding to the start of oscillation read on the large voltmeter V. The dynatron[3] was previously calibrated for negative resistance by the

[2] *The Wireless World*, November 4th, 1937.

[3] For a description and photographs of this apparatus see "The Home Laboratory" (First Series), *The Wireless World*, August 7th and 14th, 1936.

The Aerial Connection—

method I described in *The Wireless Engineer* (Oct. 1933, p. 536); so by reading the voltmeter V at the starting point of oscillation, the dynamic resistance R of the tuned circuit can be derived by referring to the calibration curve.

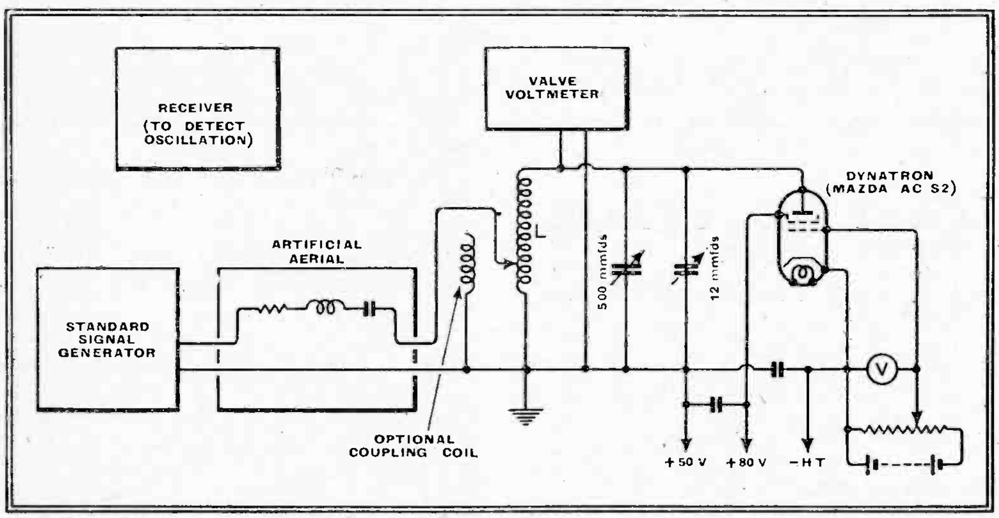


Fig. 3.—Complete set-up of apparatus for the experiments. L is the coil shown in Fig. 2. Coupling is effected either by the tapping as shown, or by connection to the high-inductance coupling coil. Alternatively, also, a typical outdoor aerial is used.

Knowing the inductance of the coil, and its dynamic resistance at any frequency, the Q (or "magnification") can be worked out ($Q = \frac{R}{\omega L}$, where $\omega = 2\pi f$), and the effect thereon of connecting an aerial can be noted. The selectivity of a tuned circuit is proportional to $\frac{Q}{\omega}$, so very easily follows. The mistuning effect is measured by restoring the original frequency of oscillation, observed by the change in beat note in the receiver. Lastly, the efficiency of signal transfer from the aerial is arrived at by measuring by means of a valve voltmeter the signal voltage developed across the tuned circuit at resonance due to a known signal in the aerial. If the same signal were injected directly into the tuned circuit it would be magnified by the amount Q. The valve voltmeter is a special one with an acorn valve probe, imposing very little extra loss on the circuit to which it is connected. A description of this instrument appeared in *The Wireless World* of April 28th. The combined effect of dynatron and valve voltmeter are reasonably similar to that of the first valve in a receiver; so the whole arrangement simulates working conditions quite fairly.

An alternative to the generator and artificial aerial was a typical outdoor aerial, with which all but the signal transfer measurements were made. And the alternative coupling consisted of a small lattice-wound litz coil, inductance 554 microhenrys, near the earthed end of the tuning coil. Two degrees of coupling were tested.

In considering the loss of signal in transfer, it is necessary to distinguish between the reduction in Q due to aerial resistance affecting the tuned circuit, and the loss of signal (and, of course, selectivity) due to the *reactance* of the aerial mistuning the circuit. In the measurements to be specified, the circuit was tuned to the signal in each case, so only the resistance loss is shown; but the mistuning loss is calculated for comparison.

Another important point is that a mistuning effect consisting of a constant capacity at all frequencies—even if rather large—is relatively unobjectionable, because it can be compensated *for any particular aerial* by one adjustment of the condenser trimmer. But a capacity effect varying with frequency causes the ganging to go out of line, however the trimmer is set. Also, when the effect of the aerial consists of a change of inductance that is constant with frequency *and for all aerials* it can be allowed for in the original design of the tuning coil. But an inductance trimmer, adjustable for each aerial, is not common.

In considering the seriousness of a certain mistuning, account must be taken of the frequency at which it occurs; for example, a capacity change is much worse near the minimum of the tuning condenser than near the maximum.

To make the procedure clearer, it will be described in detail for one set of conditions, say 800 kc/s and the tapped coil coupling.

The dynatron is set going; and the signal generator, *not* connected to the coil, tuned to 800 kc/s and picked up by the receiver to serve as a standard for adjusting the dynatron oscillation to that frequency. The dynatron negative grid bias is increased until the division between stop and start of oscillation is reached, and the bias voltmeter read. The calibration curve (not shown) indicates this reading to correspond to an R of 91,000 ohms. Q is therefore 113, and the selectivity $\frac{Q}{\omega}$, or $\frac{R}{\omega^2 L}$ as already defined, is 22.5. $\frac{R}{\omega^2 L}$ is calculated in ohms, henrys, and *kilo*cycles per second, as that gives convenient-sized numbers. Now each aerial is connected in turn to each tapping. With the artificial aerial to tap 2, it is found that the small tuning condenser must be shifted by 2.7 mmfds. to restore the original frequency (as shown by zero beat note against the signal generator in the receiver). The dynatron bias has meanwhile had to be adjusted to re-establish oscillation, and the new R is 83,000 ohms, and the selectivity 20.5. Then, cutting off the power to the dynatron anode, and with the signal generator giving 0.1 volt, the valve voltmeter is turned on and its reading found to be 0.95. The actual signal step-up is, therefore, 9.5. This, of course, is with the aerial circuit right in tune. The loss due to the mistuning already noted can either be measured or calculated. Adopting the latter method, the frequency off-tune corresponding to 2.7 mmfds. in the circumstances named is found to be 1.8 kc/s, from which, knowing the selectivity, the loss in signal strength can be calculated. It is 10 per cent. Measurement would be easier, but it happened in this instance that all the in-tune tests had already been made.

Results of measurements are most conveniently shown in the form of curves. The dynamic resistance R, the "goodness" or "magnification" Q, and the selectivity $\frac{Q}{\omega}$ (which, incidentally, is proportional to $\frac{L}{r}$, where r is the loss resistance of the tuned circuit, regarded as being in series with L) for the tuned circuit alone are given in Fig. 4. This is quite typical of circuits tuned by variable condensers, and shows that when the condenser is at its minimum the tuned circuit at resonance is equivalent to a very high resistance, but the selectivity is relatively poor. And vice versa with the condenser at maximum. The Q, on the other hand, is fairly constant over the whole range.

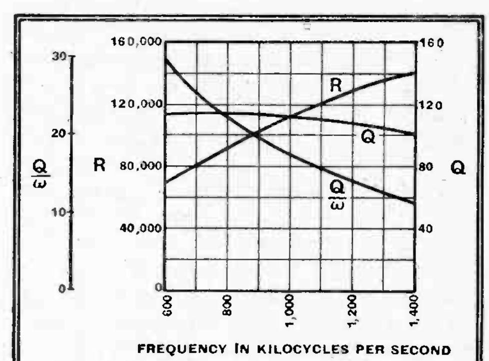


Fig. 4.—Results of measurements on the coil of Fig. 2, without aerial. R is the dynamic resistance, Q the "magnification," and $\frac{Q}{\omega}$ is a measure of the selectivity.

In superhets, where most of the selectivity is obtained at a fixed frequency, the varying selectivity of the preselector circuit or circuits does not matter so very much; but in "straight" sets the performance varies very seriously with the tuning position unless something is done to counteract it. Inductance tuning is for this reason to be preferred to condenser tuning, but is not so easy to contrive.

(To be concluded.)

How a Receiver is Designed—XVI.

Developing a High-Quality Communication Receiver

PROCEEDING with the design of a communication receiver, the problems associated with the attainment of distortionless detection are discussed in this article. The question of AVC and the voltage handling capacity of the last IF valve are also treated.

DETECTOR AND LAST IF STAGE

Obtaining Distortionless Rectification and AVC

IN the last article in this series the AF equipment was dealt with and we saw that the amplifier would need an input of 0.707 volt peak for full output. It is the business of the detector to deliver this output from a modulated intermediate frequency input. There are four possible detectors—the grid, the anode bend, the diode and the so-called infinite input impedance detector. This last is really a form of anode bend detector used with heavy negative feed-back.

The grid detector is, in general, unsuitable for a large receiver which incorporates AVC, for it is much too critical in respect of the signal input at which it operates. The anode bend detector is better from this point of view, but it introduces too much amplitude distortion for our purpose. The diode can be nearly distortionless and can provide the AVC voltage; furthermore, its input voltage is by no means critical. Its disadvantage is that it has quite a low input impedance when it is designed for distortionless reproduction, especially when it provides the AVC voltage. This makes it somewhat difficult to feed from the IF amplifier.

The Real Drawback

The infinite input impedance detector is on a par with the diode from the point of view of quality and the same difficulties in the input circuit do not exist. The input impedance is not infinite, however, but usually contains a negative resistance component for which feed-back through the grid-cathode capacity is responsible. This makes the detector one which is likely to lead to instability. This objection is not insuperable, however, and the real drawback to the detector lies in the difficulty of obtaining AVC. With this detector it is still necessary to use a diode for producing the AVC voltage unless the complication of a DC amplifier is resorted to.

This leads us to another question: Should AVC be amplified or not? In general, amplified AVC demands a voltage source negative with respect to the cathodes of the controlled valve by 50-150 volts. This can be obtained from the main HT supply if there is sufficient surplus voltage available, but in the writer's experience it is difficult to prevent motor-boating effects, and the system is in any case rather complicated. Many of the difficulties can be removed by using a separate HT supply for the AVC amplifier, but the system is still somewhat complicated and more open to trouble than the simple diode arrangements. We conclude, therefore, that even if the AVC characteristics are less perfect it will pay us to use one of the extremely simple diode types.

We now come back to the detector. If we have to use a diode for AVC we may as well do so for the detector, particularly as the same diode will do for both. To use a diode for AVC and an "infinite input impedance" detector would confer little, if any, benefit, for the AVC diode will in any case have a fairly low input impedance.

Most of the difficulties in the diode detector are brought about by the limitation to the maximum resistance in the grid circuit of a valve. This is usually 2 megohms, but if a resistance is common to the grid circuits of more than one valve, its value multiplied by the number of valves must not exceed 2 megohms. We do not, of course, know how many valves will be controlled by the AVC system until the early stages have been designed, but we can tentatively assume that there will be three—the RF, FC and first IF stages. Later on, if we alter the number of controlled stages, we must modify the detector circuit to suit.

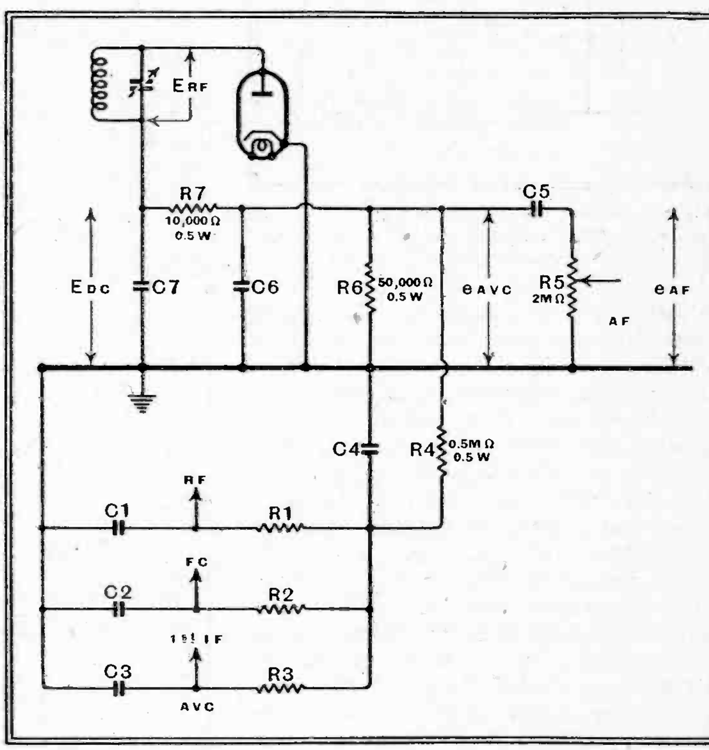


Fig. 6.—The basic diode detector and AVC circuit is shown here.

The circuit is shown in Fig. 6. Here R1 C1, R2 C2 and R3 C3 are the individual filters in the grid return circuits of the controlled valves. In some stages they may not be necessary, in others they may appear in modified form. The total effective grid circuit resistance for any one valve is 3 (R4 + R6) + R1 (or R2 or R3) and should not exceed about 2 megohms. This value of 2 megohms is by no means critical and the fact that it is the maximum recommended value in many cases does not mean that there is any harm in exceeding it slightly. Nothing disastrous will happen, for instance, if it becomes 2.1 MΩ. Consequently, we can for the present ignore R1, R2 and R3, since in most cases there is no need for them to be greater than 50,000-100,000 ohms. Ignoring these resistances R4 + R6 should not be greater than 0.66 MΩ and preferably somewhat less.

For distortionless detection of deep modulation the ratio of the AC diode load resistance R_{AC} to the DC diode load resistance R_{DC} must be as high as possible. Actually, the deepest modulation which the detector can handle without distortion is equal to R_{AC}/R_{DC}. Now $R_{DC} = R_6 + R_7$ and $R_{AC} = R_7 + \dfrac{1}{\dfrac{1}{R_6}+\dfrac{1}{R_4}+\dfrac{1}{R_5}}$. The resistance R5 is the grid leak of the first AF stage and we have already settled its

High-Quality Communication Receiver—

value as 2 MΩ; R7 is the IF filter resistance after the detector. So far as filtering is concerned its value is chiefly important in conjunction with C6; it should, however, be small compared with R4, R5 and R6, all in parallel. It is by no means

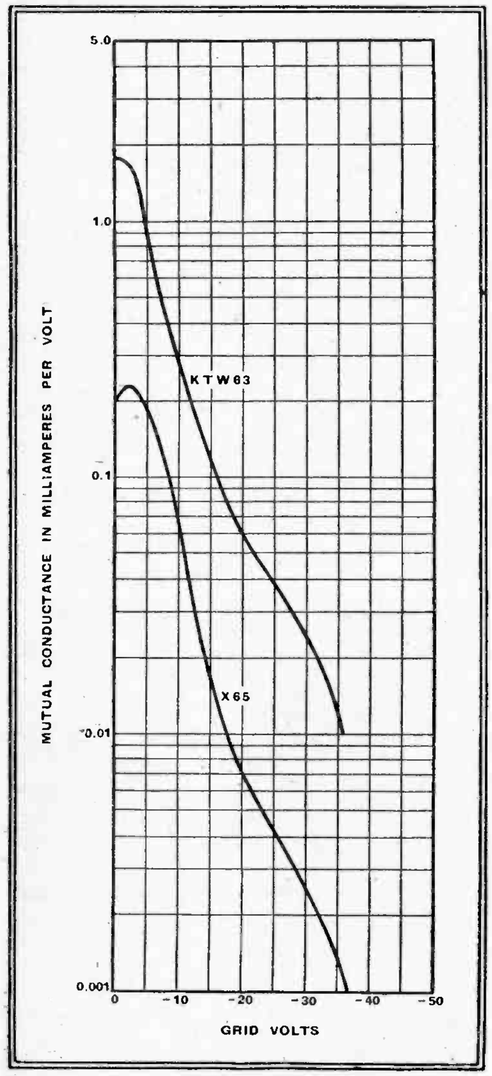


Fig. 7.—Mutual conductance—grid bias curves for the KTW63 and X65 valves are given in this illustration.

critical and may be varied within wide limits without appreciably affecting the performance. Experience shows that a suitable value for R7 is 10,000 ohms.

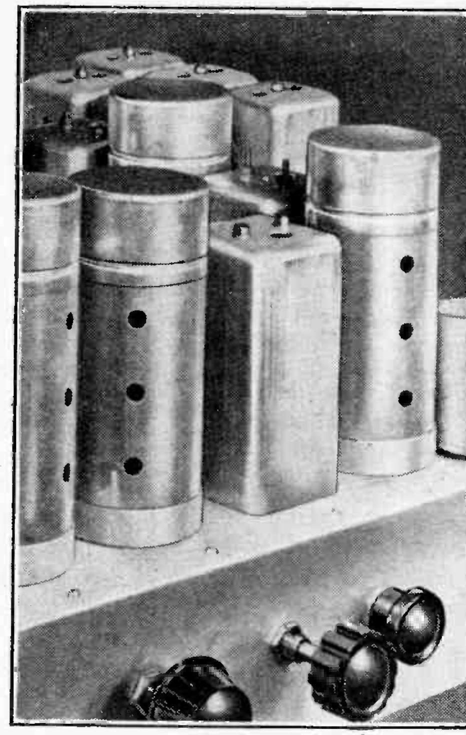
To determine precise values from the equations is troublesome and usually leads to non-standard values of components. It is consequently rather easier to pick likely values and then to see whether they will be suitable. Now R4+R6 must not be greater than 0.66 MΩ, and if RAC/RDC is to be reasonably large R4 must be fairly large compared with R6. Suppose we make R4=0.5 MΩ, then R6 can be 0.1 MΩ and R4+R6 will be 0.6 MΩ only. The DC load resistance will be RDC=0.11 MΩ and the AC load RAC=0.09 MΩ; the ratio RAC/RDC=0.82; consequently, the detector will be distortionless up to 82 per cent. modulation only. This is not as good as we should like, so let us try R6=0.05 MΩ; this gives RDC=0.06, RAC=0.0545, and RAC/RDC=0.91. Distortion will not occur until the modulation depth exceeds 91 per cent. This would appear good enough and we can settle on these values and write them in on Fig. 6. As the effective value of R4+R6 is 3×0.55=1.65 MΩ only, as far as each of the controlled valves is concerned, R1, R2 and R3 can be as high as 0.35 MΩ and we shall still be within the 2 MΩ limit.

The efficiency of the detector is usually reckoned as the ratio of the steady voltage across RDC to the peak unmodulated carrier voltage applied to the detector, or EDC/ERF. In the ideal case the AVC voltage eAVC would equal EDC and the AF output voltage (peak) would equal EDC for 100 per cent. modulation. In practice both are smaller, and $e_{AVC}=E_{DC}\times R_6/(R_6+R_7)$ while $e_{AF}=E_{DC}\times\frac{R_6}{R_6+R_7}\times\frac{R_{AC}}{R_{DC}}$. In this case eAVC=0.83 EDC and eAF=0.76 EDC.

Detector Input Required

The actual rectification efficiency depends upon the valve, and also upon C7, but is not likely to exceed about 60 per cent. for the low value of RDC which we have decided to use. Taking this value, we have 0.5 and 0.455 as the ratios eAVC/EAF and eAF/ERF respectively. As the first AF stage needs 0.707 volt peak for full output, the minimum detector input must be 0.707/0.455=1.55 volts peak if the output stage is to be fully loaded on 100 per cent. modulation. The AVC voltage will then be 0.78 volt. During 100 per cent. modulation the RF input will vary at modulation frequency between zero and 3.1 volts.

The predetector amplification must be sufficient to provide a detector input of 1.55 volts peak from the weakest signal from which full output is required. When receiving strong signals, however, this gain must be reduced by the AVC voltage; this must naturally rise and the detector input will also rise in the same degree. For



The detector and last IF stage of an experimental receiver embodying the principles discussed in this article.

instance, if 30 volts AVC bias is needed for a strong signal, the detector input must be 60 volts peak and up to double this figure on deep modulation. The AF output is, of course, then much more than is needed, but it can be thrown away in the volume control R5.

The point is, however, that the IF stage feeding the detector must be capable of giving quite a large undistorted output and this is made difficult by the low input impedance of the detector. It is about 36,000 ohms only in this case. Before we can design the last IF stage we must determine at least approximately the maximum detector input on a strong signal. For the time being we shall assume that non-delayed AVC is used and

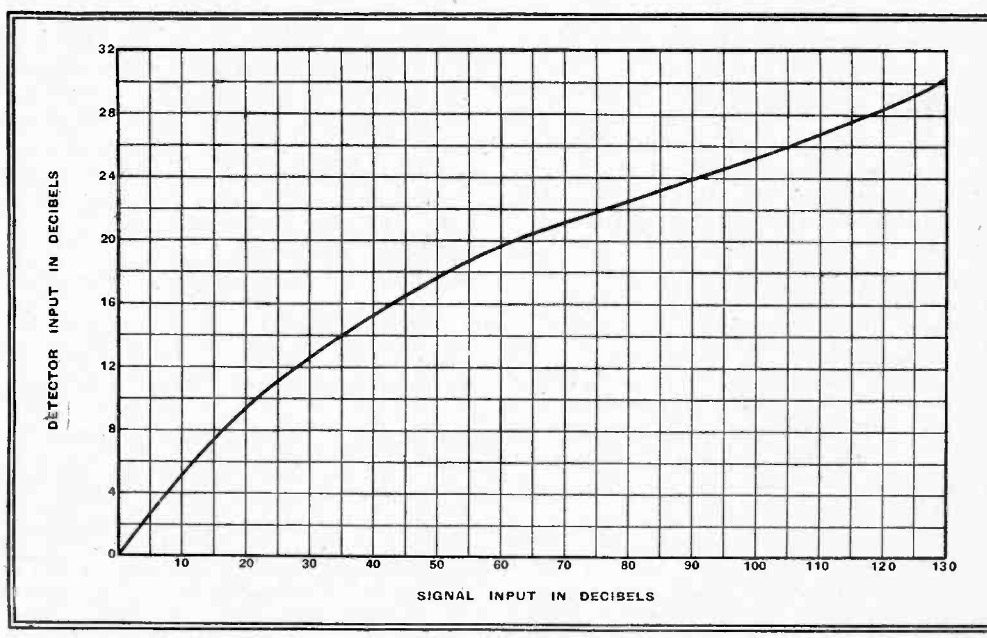


Fig. 8.—The AVC characteristics for three controlled stages with non-delayed AVC are shown by this curve.

High-Quality Communication Receiver—

that there are three controlled stages, two employing KTW63 (6K7) valves and one the X65 (6J8); we shall also assume that the steady voltages apart from the AVC bias on the valves remain constant irrespective of the AVC voltage. Furthermore, we will assume that a detector input of 1.55 volts peak will be obtained for a signal input to the first valve of, say, 50 μV. (peak) and that the strongest signal will be 5 volts peak. We know that for the 50 μV. signal there will be a detector input of 1.55 volts peak and 0.78 volt AVC bias will be developed; the problem is to determine the detector input and AVC bias for a signal of 5 volts peak.

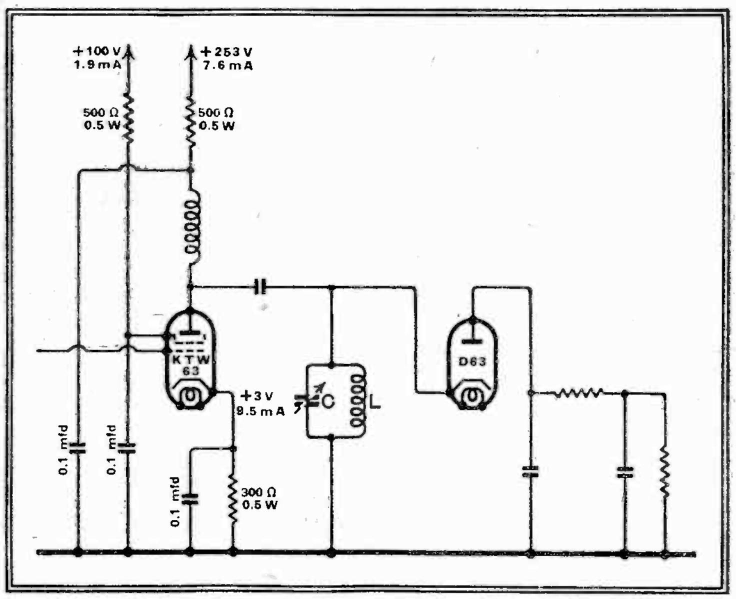


Fig. 9.—The simplest coupling between the IF valve and the detector is the familiar "tuned-grid" type.

The ratio of signal inputs is 100,000 : 1 or 100 db. The first step is to plot the curves of valve mutual conductance against grid bias, as in Fig. 7. The normal bias for the valves will be -3 volts, to which must be added 0.78 volt for the AVC bias at a signal input of 50 μV. This gives -3.78 volts bias for our normal "zero level." We next prepare a table as shown. In the first column is listed a series of bias voltage values and in columns 5 and 8 the corresponding values of mutual conductance for the KTW63 and X65 respectively. The second column is prepared from the first by deducting the value of initial grid bias (-3 volts); this gives the variations in AVC bias which are expressed as a ratio in column 3 and in decibels in column 4. Mutual conductance for the KTW63 is expressed in terms of ratios in column 6 and in decibels in column 7; similarly for the X65 in columns 9 and 10.

Since the AVC bias is proportional to detector input, column 4 gives the detector input in decibels relative to our "zero level" of 1.55 volts peak. Since the amplification is very nearly proportional to mutual conductance, columns 7 and 10 represent the change of gain for single stages. For three stages the total change in gain is expressed by multiplying column 7 by two and adding column 10; this gives us column 11. We want to correlate detector input and signal input to the first valve and we do this by adding the figures of columns 4 and 11, which gives column 12. We then plot column 12 against column 4 and obtain the curve of Fig. 8.

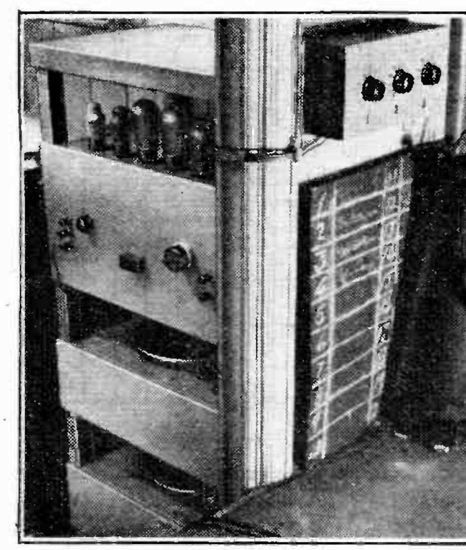
From this curve we can read off the rise in detector input for any change in signal input. We decided to choose a maximum input of 100 db. over our arbitrary zero, which gives 1.55 volts peak detector input and 0.78 volts AVC bias. Fig. 8 shows that the detector input will rise by 25.2 db. or 18.2 times. AVC thus smooths out a signal input variation of 100,000 : 1 to a detector input variation 18.2 : 1. The maximum detector input will be $1.55 \times 18.2 = 28.2$ volts peak, and on 100 per cent. modulation it will rise to twice this figure, or 56.4 volts peak. The maximum AVC bias will be $0.78 \times 18.2 = 14.2$ volts.

We thus have to provide a last IF stage capable of developing nearly 60 volts peak without distortion in the input impedance of the detector—36,000 ohms.

The simplest type of coupling is that shown in Fig. 9. We are unlikely to attain a circuit with a dynamic resistance higher than about 200,000 ohms and it will be near enough to take the effective dynamic resistance of the circuit when shunted by the detector at the round figure of 30,000 ohms. With the KTW63 operated at -3 volts grid bias, the required output can be obtained with the circuit of Fig. 9 for a second harmonic of about 4.5 per cent. This does not represent second harmonic of the modulation but of the carrier—the modulation distortion will be less. This is satisfactory for our purpose and we shall accordingly adopt this arrangement.

The stage gain is 42.1 times, so that for a detector input of 1.55 volts peak the last IF valve needs an input of only $0.0369 = 36.9$ mV. peak $= 26.1$ mV. RMS. The amount of amplification needed before this stage depends on the weakest signal we require; if we take this, as before, as 50 μV. peak $= 35.4$ μV. RMS, the gain needed is obviously 735 times. This could easily be obtained from an RF stage and the frequency-changer, except on very short wavelengths. We have not yet considered the question of selectivity, however. Taking this into account, as well as the short-wave performance and stability and whistle problems, we shall be wise to use an additional IF stage. The details of this, however, must be deferred until we have considered the selectivity problem.

Grid bias 1	AVC bias 2	Ratio of AVC bias increase. 3	db 4	KTW63 g(mA/V) 5	KTW63 Ratio of g 6	KTW63 db 7	X65 g(mA/V) 8	X65 Ratio of g 9	X65 db 10	3 stages (2 × KTW63 1 × X65) db 11	Signal input db 12
−3.78	−0.78	1	0	1.38	1	0	0.21	1	0	0	0
−5	−2	2.565	8.2	0.9	0.652	3.72	0.18	0.857	1.36	8.8	17
−10	−7	8.96	19.04	0.28	0.203	13.84	0.07	0.333	9.54	37.2	56.2
−15	−12	15.4	23.76	0.12	0.087	21.2	0.0155	0.0737	22.64	65	88.8
−20	−17	21.8	26.8	0.06	0.0435	27.2	0.007	0.0333	29.54	84	110.8
−25	−22	28.2	29.0	0.04	0.029	30.72	0.0041	0.0195	34.2	95.6	124.6
−30	−27	34.6	30.8	0.024	0.0174	35.2	0.0025	0.0119	38.5	108.9	139.7
−35	−32	41.0	32.22	0.012	0.0087	41.2	0.0014	0.00666	43.5	125.9	158.1



BEHIND THE SCENES: Stage amplification, on a rather smaller scale than was described in our recent article, is used in the Little Theatre, Jesmond, Newcastle-on-Tyne, which seats only 200. The 8-watt amplifier, installed by Mr. W. A. Davis, of Newcastle, is used mainly for sound effects, but can also be adapted for music.

THE WIRELESS INDUSTRY

TANNOY sound equipment, installed temporarily at Westminster Cathedral some six months ago, has now been converted into a permanent and complete installation feeding no fewer than 38 speakers. Automatic gain control is employed, and provision is made for automatically switching off speakers adjacent to the microphone actually in use.

Antiference, Ltd., 176, Wardour Street, London, W.1, has sent us a pamphlet describing the "Rod" vertical aerial, designed for mounting on the gutter-board of a building.

Film-Strips, a substitute for the old-fashioned lantern slides, are described in a booklet issued by Ranald Small and Partners, Ltd., Bush House, London, W.C.2. The uses of the strips in conjunction with sound-reproducing equipment are described.

Superhet Alignment

SIGNAL-FREQUENCY AND OSCILLATOR CIRCUITS

(Concluded from page 539 of last week's issue)

By "TRIMMER"

In the preceding instalment a detailed description of the process of trimming an IF amplifier was given; the author now deals with the remaining circuits of a superheterodyne and also discusses the question of carrying out adjustments without the help of test gear.

ATTENTION may now be directed to the signal-frequency circuits. By this expression we mean those which come in front of the frequency-changer valve, including the input circuit coupled to the aerial or a band-pass input, and also all tuned circuits associated with any HF stages that precede the frequency changer.

The setting at which the oscillator trimmer condenser has been left is not necessarily to be regarded as final. If the receiver has variable oscillator tracking a return will certainly have to be made later to the oscillator trimming, but before proceeding to the question of tracking it will be as well to attend to the trimming of the signal-frequency circuits.

Keeping the test signal frequency unaltered the various signal frequency circuits should be adjusted for peak output, working from the frequency-changer valve towards the aerial. Do not forget to seize every opportunity of cutting down the test signal amplitude.

If there happens to be a band-pass coupling on the signal-frequency side of the receiver the final touch on the band-pass trimmers can be left over until the tracking is done and the receiver is practically "in shape."

With regard to the oscillator, different tracking arrangements will be found in various cases, and it can be anticipated that one of the following systems will be found:—(i) tracking by specially shaped vanes in the oscillator tuning condenser, (ii) by a fixed series condenser, (iii) by an adjustable series condenser (which may, or may not, be associated with a fixed condenser in parallel, according to circumstances).

The oscillator circuit of Fig. 3 shows an example of tracking by an adjustable series condenser, C6. It will be noted that in this particular case there is a fixed parallel condenser connected to the tracker. It should perhaps be mentioned here that tracking condensers are often referred to as "padders."

It must be noted that with a receiver containing specially shaped vanes in the oscillator section of the ganged condenser the tracking only holds correctly, without circuit modification, on one waveband. Generally, the medium waveband is the one chosen, and extra condensers must be looked for on the other wavebands, as (ii) and (iii) above.

If specially shaped oscillator condenser plates completely control the tracking, the initial trimming should be all that is necessary, as far as the oscillator circuit is concerned, but it will be advisable to check the accuracy of the tuning against the receiver scale calibration. If it is found that the calibration does not fit in with the tuning over the waveband then the possibilities of either the original choice of IF being wrong, or the oscillator having been trimmed to the wrong beat must be considered. Circumstances will generally indicate which of these two alternatives is the more probable.

If the IF value becomes suspect a careful note should be made of the nature of the calibration discrepancies. The IF alignment should be gone over again at a slightly different frequency, the oscillator and signal-frequency circuits trimmed again, and then a second check made over the scale. It should now have become readily apparent as to whether the original IF value was the cause of the trouble, and, moreover, in what sense (up or down) will it be necessary to make further alteration to put matters right.

A similar story to the above applies to the case of the receiver with a fixed tracking condenser.

When the tracking is brought about by an adjustable condenser, should be made in the following sequence:—

After trimming the oscillator and signal frequency circuits at 1,400 kc/s, the receiver tuning and the frequency of the test signal should be set to a value near the upper end of the waveband. The manufacturers' specified frequency ought to be used, but if this is not known try 600 kc/s (500 metres). The tracking condenser should be adjusted for a peak indication on this signal, but since the trimmers of the oscillator and signal-frequency cir-

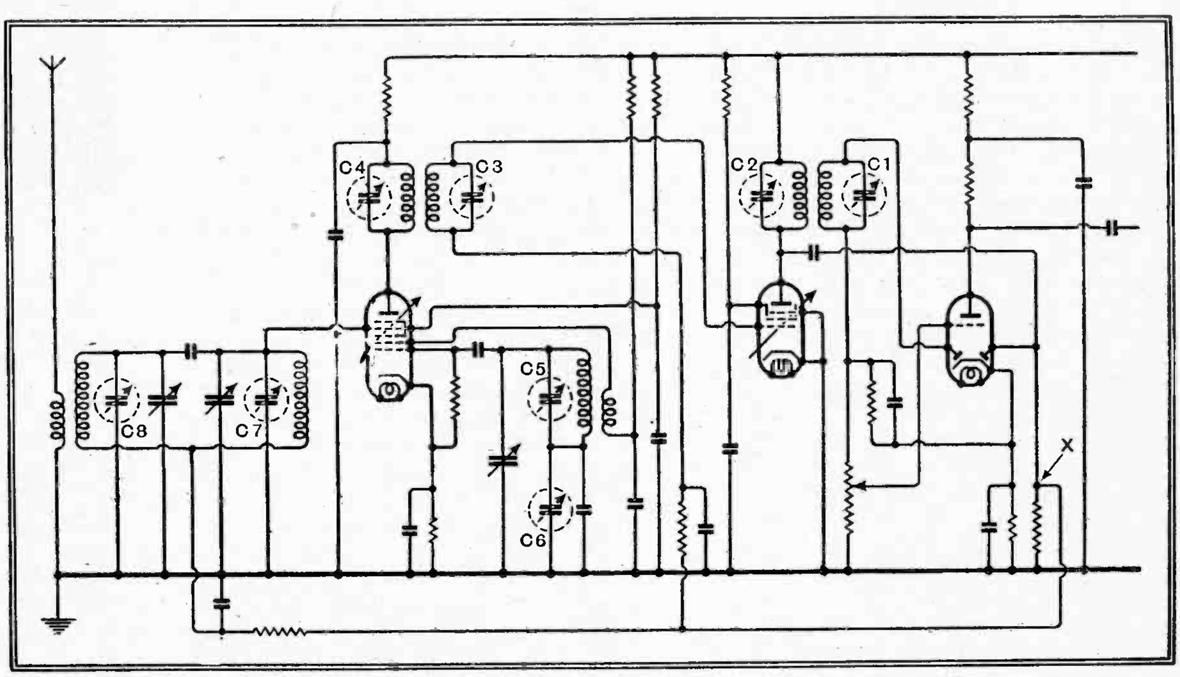


Fig. 3.—A typical superhet circuit (omitting output and rectifier). The condensers that would have to be adjusted for complete alignment are indicated by the dotted circles. C1, C2, C3 and C4 are the IF trimmers, C5 the oscillator trimmer, C6 the oscillator tracker, C7 and C8 the signal-frequency band-pass input trimmers. Signal frequency and oscillator coils for one waveband only are shown.

Superhet Alignment—

cuits must not be disturbed while the tracking is being done the ganged condenser tuning control should be rocked slightly, and the best combination of tracking condenser capacity and ganged tuning setting chosen.

The adjusting of the tracking condenser is bound to upset the original oscillator trimming, so a return must be made to the trimming frequency, and the oscillator trimmer must be readjusted. In some cases it may even be necessary to go back for another touch on the tracker, but, generally, "trim, track, trim" will be all that is necessary.

If it is found that "trim, track, trim" still leaves wide adjustments to be made, if, in fact, no amount of trimming and tracking work will pull the calibration into line, then the possibilities of wrong oscillator beat, or of incorrect IF value, should be investigated.

If all has gone well the final touch on the oscillator trimmer should be the last job required on the particular waveband concerned, unless there is a band-pass input system, in which case a slight readjustment of the band-pass trimmers may be beneficial, from the selectivity point of view. With a band-pass input it is advisable to apply a test signal and to rock the test oscillator tuning control. A slight touch on the band-pass trimmers should be made if there is any sign of lack of symmetry in the behaviour of the output meter readings.

Oscillator trimming and tracking and signal frequency circuit trimming on the long waveband obey similar rules to those given above for the medium waveband.

It will be found that with certain receivers there is only oscillator trimming to attend to on long waves. In such a case it is advisable to rock the ganged condenser control while trimming. In other cases, however, there will be just as much (and similar) work to be gone through on the long waves as on the medium waves.

The manufacturers' specified trimming and tracking test frequencies should, if possible, be ascertained and used. If in doubt try 300 kc/s (1,000 metres) and 1,600 kc/s (1,875 metres) for trimming and tracking respectively.

On the SW Bands

Alignment on short waves is more tricky than on MW or LW, partly because of the sharpness of response to trimmer adjustments, and partly because there is greater risk of getting on to the wrong beat when trimming the oscillator. It is necessary to be particularly careful regarding the latter point, and the reader may like to make a note of a useful check. This consists of pushing up the amplitude of the test signal (after the oscillator trimming has been done) and searching with the receiver tuning for the second-channel "image" signal. With a very strong test signal it should be possible, if all is correct, to find an image signal when the receiver is tuned to a frequency equal to test signal frequency minus twice IF.

Trimming and tracking should, of course, be carried out near the lower and upper ends of the waveband respectively, but there is not much point in suggesting particular frequency values, as those specified for different receivers vary quite considerably.

It is hoped that those readers who do not possess ganging test equipment have studied the foregoing, because half the battle when tackling superhet alignment without test gear is to know just where the chief difficulties will arise.

One of the most obvious of these is in connection with IF alignment. A test signal at the intermediate frequency is out of the question, and the aligning must necessarily be done on a signal picked up on the aerial. Since the signal will only reach the IF stages if the oscillator and signal-frequency circuits are in some sort of shape it needs little imagination to picture the complexity that may arise if complete alignment of the receiver is required.

We cannot say that complete alignment is impossible with no other help than that given by outside signals, but considerable time and patience will be required. We would most certainly advise against the attempt if the IF stages are designed for band-pass characteristics, however.

Judging by Ear

The question as to what will be done about peak indications is one of the first to settle, for we are now assuming that no test gear is available. If the worst comes to the worst the ear will have to be used, judging the intensity of the loud speaker output.

Receivers containing tuning indicators can, with one possible complication, be aligned with the aid of the tuning indicator. The complication referred to is in connection with the trimming of the last IF secondary and arises when the AVC diode is fed, not from the secondary, but from the last IF primary. Although it is possible under favourable circumstances to use the tuning indicator (minimum indication) for trimming the last secondary it is perhaps advisable to use the ear when adjusting this particular circuit.

If a tuning indicator is going to be made use of when carrying out aligning work it necessarily follows that signals sufficiently strong to give clear peak indications must be chosen, and it is obvious that the AVC action is being utilised. On the other hand, if the ear is going to be used for the alignment it will be important to use the weakest signals that can be found of suitable frequencies. Alternatively, and perhaps better, the AVC could be temporarily cut out.

This is usually an easy matter. In the case of the receiver shown in Fig. 3 the AVC line could be disconnected from the AVC diode load resistance (see point marked X). The AVC line should be earthed to chassis, to avoid leaving the grids of the valves "in the air."

If complete alignment is required the IF stages must receive first attention. The first problem will probably be that of finding a signal to work on, for quite possibly the alignment may at the commencement be so badly out that the receiver is "dead."

Preliminary Adjustments

Set the IF trimmers at approximately half-way between maximum and minimum capacity and then search on LW for a signal with the ganged tuning control. As soon as one can be heard bring the signal frequency and oscillator trimmers roughly into line (rocking the gang if necessary).

Then peak the IF trimmers on the signal. Needless to say, it is a case of "hope for the best" as regards the frequency upon which the IF stages are being aligned. Later it may be necessary to realign them at a different frequency.

When nothing more can, for the meantime, be done with the IF stages, verify the setting of the receiver tuning pointer, switch the receiver to the proper waveband, and search for a suitable oscillator trimming signal. Look for a signal near the lower end of the waveband and preferably choose an identified station, so that the receiver's tuning can be set to the correct point on the scale. Then trim the oscillator and signal-frequency circuits.

If tracking adjustment is necessary look for a suitable signal near the upper end of the waveband.

As the IF value is a doubtful factor it will be most advisable, before proceeding to other wavebands, to make a close check over the scale to see how the calibration holds. If there are signs of trouble try tracking and trimming once again, but if this is of no avail there will be nothing for it but to return to the IF stages and start all over again. Do not tackle the other wavebands before it is certain that the IF stages are correct.

Fortunately, the majority of cases that arise away from the production benches are cases where partial realignment only is required. Such cases can arise from a variety of circumstances. A misguided non-technical owner may have "had a go" at the trimmers; usually only the very accessible ones will have been altered. A coil or condenser replacement may have been made which will necessitate only partial readjustments. Vibration (and insufficient sealing) may have caused a trimmer to shift.

In the absence of ganging test equipment the art of handling such cases is to restrict the first test readjustments to the trimmers or trackers which obviously need adjustment and to avoid touching any of the others, unless circumstances finally compel one to do so.

Every advantage should be taken of the fact that those trimmers which are still in correct adjustment can act as "guides" for the setting of the others. A typical case would be that of a receiver that has had its IF alignment upset. If there are no band-pass complications the

Superhet Alignment—

IF trimmers can be peaked on a signal and with the comfortable knowledge that the oscillator circuit will force the IF alignment on to the correct corresponding frequency.

Where extreme caution is required is in the case where lack of alignment is suspected, although it is not definitely known that there has been any tampering with the adjustments or that any trimmer has shifted. It is vitally important here to put the receiver through its paces and to take careful note of the results. If results are satisfactory on, say, medium waves but are below standard on long waves it can be taken as practically certain that the IF stages are in order, and that the trouble, if it is due to alignment, is associated with the LW trimming or tracking.

The fact that the oscillator frequency takes charge of the tuning settings of a superhet is useful to keep in mind. If a calibration check over a waveband shows that stations are tuning in accurately but the sensitivity of the receiver is below normal the oscillator trimming or tracking should not be disturbed.

If "pulling" is experienced when adjusting signal-frequency circuits on short waves, i.e., if the signal-frequency circuit adjustments have the effect of changing the oscillator frequency, it is advisable to rock the gang control while carrying out the signal-frequency trimming and to work to the best combination of settings.

There remain two adjustments, which, though perhaps not strictly associated with alignment, should be mentioned for the sake of completeness. To set an IF filter the receiver should be switched to LW and tuned to maximum wavelength. From a modulated test oscillator a strong signal at intermediate frequency should be applied to the receiver's A and E terminals and the filter then adjusted to give minimum receiver response. The adjustment of an image rejector can easily be done on the signal from a local transmission. Tune the receiver until the second-channel whistle (or a second-channel "image") is heard, and then adjust the rejector for minimum response.

Telefunken TO 1001 Pick-up

SUPPLIES of the improved Telefunken pick-up are now available in this country through Pye, Ltd., Cambridge. Such changes as have been made are chiefly of a mechanical nature since the electrical characteristic of the earlier model published in *The Wireless World* of October 22nd, 1937, was as near perfect as makes no matter. As a check, a characteristic of the new model was taken without a transformer and found to agree within less than 2 db with the curve first published. The output of the new design has not been reduced by the wider air gap which it has been given, and the longer magnet system gives if anything a higher sensitivity. Surface noise was too low to be measured, and the light weight of the pick-up head, combined with the lateral spring loading which makes the permanent sapphire needle follow one side of the groove, reduced the effects of eccentrically pierced records to a minimum.

A really clever idea is to be found in the roller device for protecting the sapphire from damage if the pick-up should be accidentally dropped on to the record. The roller, which is rubber-covered, rotates against an internal coil spring, and there is a distinct flat on one side which is normally held uppermost against a stop. The round part of the roller stands out more than the needle point from the underside of the pick-up, so no matter how far it is dropped it cannot damage either the sapphire or the record. On the instant of contact the rotation of the record drags the roller round until the flat surface is reached, when the needle is lowered the remaining $\frac{1}{16}$in. on to the record at a speed depending only on the linear speed of rotation of the record, and quite independently of the care or otherwise with which the tone-arm is lowered during the first stage. During the playing of the record the return spring in the roller is pressing the trailing edge of the flat on the record, but as the pressure is on the "land" between grooves and the spring tension is light no wear will take place, though dust might be pushed into the grooves.

No bass boost is allowed in the pick-up as this would result in harmonic distortion, but a tone correction transformer is available. The price of the TO 1001 pick-up remains at 5 guineas.

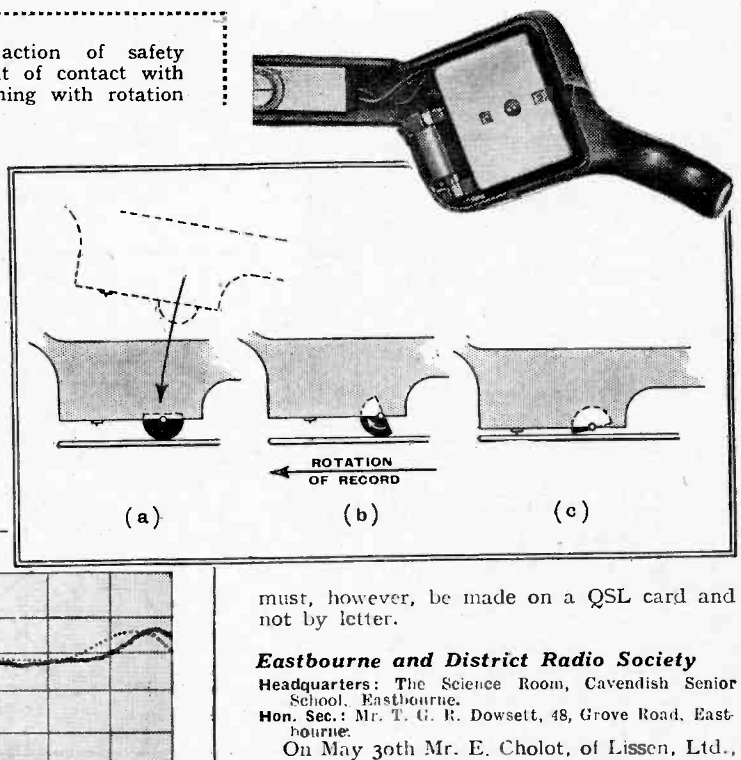
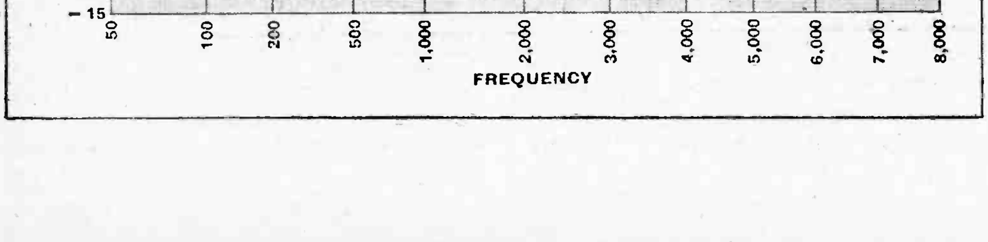


Diagram showing action of safety roller: (a) at instant of contact with record, (b) roller turning with rotation of record, and (c) needle lowered in groove. (Inset) Underside of latest Telefunken TO 1001 pick-up showing safety device.



Curve of Telefunken pick-up through a 1:15 transformer. Zero db = 1 volt RMS and dotted curve is characteristic of test record.

News from the Clubs

Edgware Short-wave Society

Headquarters: Constitutional Club, Edgware.
Meetings: Sundays at 11 a.m. and Wednesdays at 8 p.m.
Hon. Sec.: Mr. F. Bell, 118, Colin Crescent, London, N.W.9.

On June 8th a lecture on "Meters" was given by Mr. Lawton, of Ferranti, Ltd.

A series of lectures on transmitting apparatus and recent aerial developments will shortly be given by the President of the Club.

The Club is now affiliated to the R.S.G.B. and a party visited the divisional field day camp on June 12th.

The Club has now a membership of thirty, over twenty of whom attend regularly. It has been decided to continue the meetings during the summer, providing that 50 per cent. of the members attend.

London Transmitting Society

Headquarters: 40, Raeburn Road, Edgware.
Meetings: Thursdays at 8 p.m.
Hon. Sec.: Mr. G. Yale, 40, Raeburn Road, Edgware.

A successful junk sale was held on June 9th.

On June 30th the Society are erecting a 50ft. aerial mast. It has been decided to employ a 28-megacycle system using 4 in-phase aerials backed up by four reflectors concentrating the radiation in the direction of the transmitter which is being received.

Membership is free to holders of transmitting licences. Application for membership must, however, be made on a QSL card and not by letter.

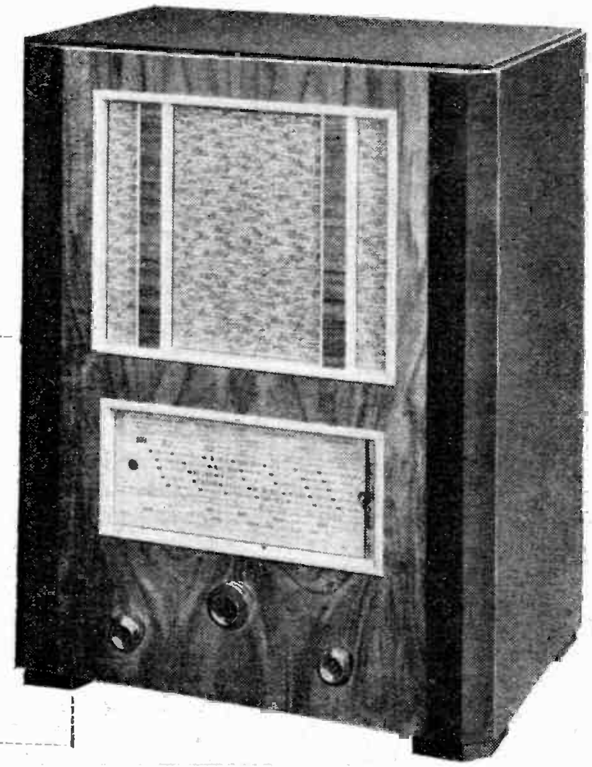
Eastbourne and District Radio Society

Headquarters: The Science Room, Cavendish Senior School, Eastbourne.
Hon. Sec.: Mr. T. G. R. Dowsett, 48, Grove Road, Eastbourne.

On May 30th Mr. E. Cholot, of Lissen, Ltd., gave a lecture and short-wave demonstration. He showed a large number of Lissen Hi-Q short-wave components. He also stated that the firm are bringing out several sets to compete with the American communication receivers.

Pilot MODEL B.43

Battery Superhet, Making Efficient Use of Moderate HT Current



FROM the outside this receiver is not immediately recognisable as a Pilot product, for the characteristic clock-faced tuning dial has given place to a typically English rectangular scale with vertical pointer. It is a boldly printed scale and one which makes the search for station names a much more comfortable process on all wave bands, but more particularly on medium waves where the settings have been grouped in echelon.

An ingenious indicator has been devised to show in which position the waverange switch happens to be; an arrow, pointing to the appropriate scale, appears successively in apertures at the right-hand end of each scale. There is also a pilot light to show when the set is in operation—an important point, as the background noise of a battery set, and this set in particular, is extremely low between stations.

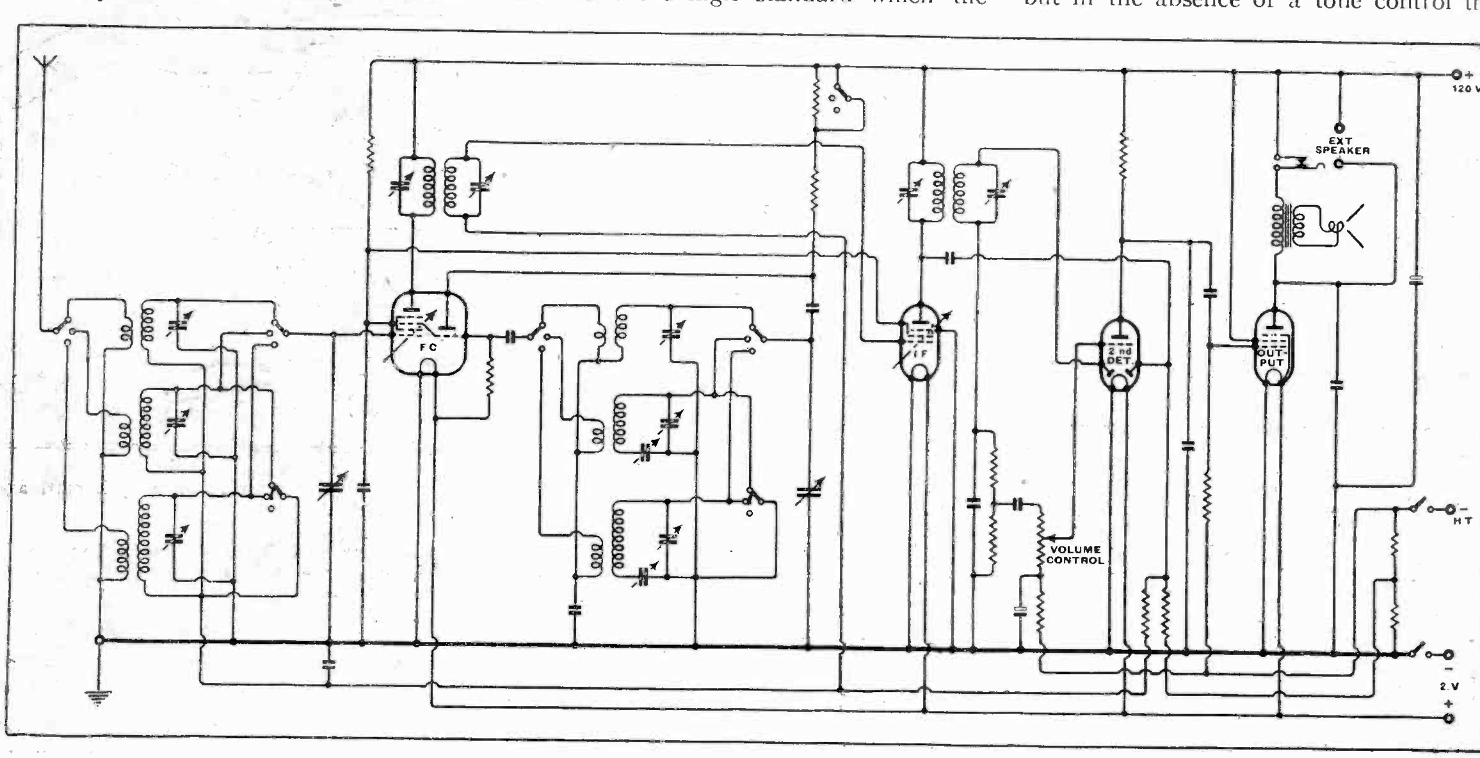
The rectilinear character of the tuning scale is repeated in the loud speaker fret which is lined with light-coloured birch-wood. The unit behind this grille is a very efficient 8-inch permanent magnet moving coil well matched to the pentode output valve. One's first impressions are of a three-watt triode, for not only is the volume much higher than that usually provided by single output valves in a battery receiver, but the quality is remarkably free from harmonic distortion and the blurring associated with cross-modulation.

FEATURES. — ***Waveranges.*** —*(1) 16.5-52 metres. (2) 180-565 metres. (3) 750-2,200 metres.* ***Circuit.*** —*Triode pentode frequency changer—var.-mu pentode IF amplifier—double-diode-triode 2nd. det., AVC rect. and 1st AF ampl.—pentode output valve. Automatic grid bias.* ***Controls.***—*(1) Tuning. (2) Volume and on-off switch. (3) Waverange.* ***Price.***—*9 guineas (without batteries).* ***Makers.*** — *Pilot Radio Ltd., 87, Park Royal Road, London, N.W.10.*

There is no tone control, but this is not necessary as the balance is just right for medium and long waves and the slight excess of top for short wave work can be used by those with the necessary skill as an indicator for accuracy of tone. We were particularly impressed with the good reproduction of pianoforte tone, which is a searching test for clear quality, and on other types of transmission the results were such as to invite longer listening than was strictly necessary to arrive at an estimate of the tonal balance.

In the matter of sensitivity the receiver maintains the high standard which the Pilot designers have always set themselves, and the short-wave range is outstandingly good from this point of view. American transmissions were picked up in the places where one expected to find them at full programme strength and the only indication that this was not one of the more expensive mains models with an RF stage was the prevalence of double tuning points and self-generated whistles. In some cases, however, it was possible to avoid a whistle by going to the repeat point of the station higher up the dial.

Selectivity on long waves was sufficient to enable the Deutschlandsender to be heard between Droitwich and Radio Paris, but in the absence of a tone control the



Circuit diagram of the Pilot Model B.43. As the extension loud speaker jack switch breaks the anode circuit of the pentode output valve the jack should not be inserted without connecting the external loud speaker or an equivalent load.

Pilot Model B.43—

side-band splash was a little too strong for prolonged listening. Elsewhere on the long-wave range separation of stations adjacent in wave length presented no difficulty, and on the medium waves not more than 2 channels were lost on either side of the London Regional transmitter at a distance of 15 miles.

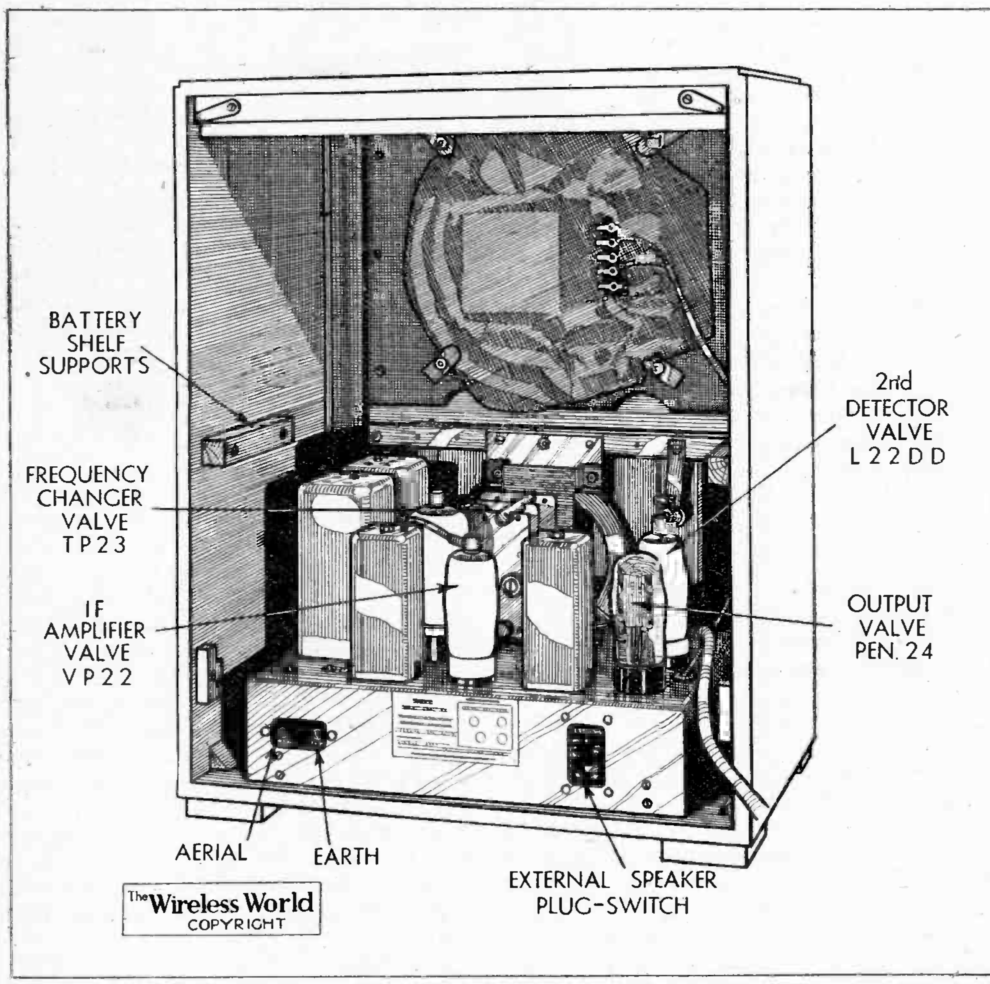
Measurements of current consumption gave 0.74 amp. from a 2-volt accumulator and an average of 10 mA from a 120-volt HT battery. Fluctuations of total HT current under the influence of AVC or from outer causes did not amount to more than 1 mA.

The circuit is simple and straightforward with a single-tuned circuit preceding the triode-pentode frequency changer on all three wavebands. On the short-wave range the anode potential on the oscillator is increased. The intermediate frequency is 451 kc/s and the first IF transformer is iron cored. AVC derived from the primary of the output IF transformer is applied to the grids of both IF and frequency changer valves. A delay voltage is taken from a tapping point on resistance providing automatic bias for the pentode output valve.

There is provision of an external loud speaker of the high-impedance type which is connected through a plug switch with a two-position rotary action.

Without batteries the set is remarkably light, but the cabinet is well put together and screws are used for many of the strengthening fillets which in the ordinary way would be pinned. The overall dimensions are $17\frac{3}{4}$ in. × 14 in. × $9\frac{1}{2}$ in.

To sum up, the B.43 is a battery set with unusually bright and clear quality of reproduction, a lively performance on all three wavebands and only second channel interference to distinguish it from more expensive models. An ideal second set for the week-end retreat in the country or by the sea.



General view of interior of Pilot B.43 with battery shelf removed to show positions of valves.

New Tungsram RF Pentodes

BATTERY VALVES FOR USE ON SHORT AND ULTRA-SHORT WAVES

TWO battery RF pentodes just introduced by the Tungsram Electric Lamp Works (Great Britain), Ltd., will interest battery set users, as these new valves have been designed to give a good performance on the short- as well as on the ultra-short wavelengths.

The control grid is brought out to the top cap in both valves, while the other electrodes connect to a seven-pin base of standard pattern.

Particularly good for battery valves is the mutual conductance of these new pentodes, it being 1.7 mA/V for the SP2D, and 2 mA/V for the VP2D. The first mentioned is a "straight" RF pentode, and the other is a variable-mu type.

The screen grid will take the same potential as the anode, and 150 volts is the maximum for these electrodes. However, the mutual conductance values just given are for operating voltage of 120 only, which is the usual amount of HT supplied for a battery set. The filament current is 0.1 amp. at 2 volts in both cases, and the valve will stand a maximum of 10 mA "cathode current," by which is meant the sum of the anode and screen currents. The valves are, of course, directly heated.

With 120 volts on anode and screen grid, the SP2D requires $-1\frac{1}{2}$v. grid bias, under which conditions the anode current is 1 mA. The VP2D would in the quiescent state be giving a grid bias of -3 volts when the anode current is about 3.5 mA. The anode current cut-off point for this valve is approximately -10 volts grid bias.

Even when the valves are operated with lower screen potentials, quite good mutual conductance values are obtained; the VP2D, for example, with 75 volts on the screen and $-1\frac{1}{2}$ volts GB, has a slope of 1.05 mA/V. The anode current then falls to 1.3 mA, and the screen current is 0.6 mA. Thus quite economical operation is possible if necessary, yet still maintaining quite high efficiency in the valve.

Some tests were made with these valves in the detector stage of a short-wave receiver, regeneration being obtained by joining the negative of the filament to a tap on the coil and inserting an RF choke in the positive filament lead.

There was little to choose between the two valves on wavelengths down to about 12 metres, but below this the VP2D was definitely the better, as oscillation was much easier to obtain. Indeed, the valve oscillated readily down to just below 5 metres using quite an orthodox circuit.

The top grid connection contributes to its efficiency on the ultra-short waves, as the input capacity is reasonably small.

The valves are not particularly small physically, for they measure $4\frac{7}{8}$in. high overall, and the bulb diameter is $1\frac{3}{4}$in. at the widest part. They cost 11s. each.

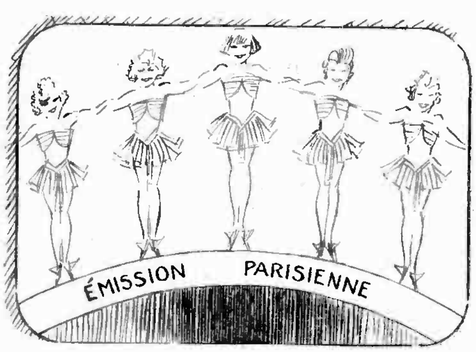
PORTABLE PA. Intelligible speech can be heard up to 600 feet on a 20-degree beam with this new Telefunken outfit. The amplifier output is rated at 20 watts.

UNBIASED

By FREE GRID

The Real Reason

I HAPPENED to drop into my local radio dealers the other morning with the cathode-ray tube from my television set in order to get its emission tested, as, when carrying out some experiments the other day, I accidentally got the HT and LT connections mixed up, and it has never seemed quite the same since. While the dealer was searching round frantically for his test gear among the other old junk which usually clutters up the counter of the average radio retailer, I fell into a conversation with him about the excellent results which the B.B.C. have had lately in connection with their outside telemissions, more especially the Derby. In the course of our conversation he warmly commended the recent Editorial in *The Wireless World* wherein it was stated that, in



Its so-called gaieties.

spite of these outstanding successes, the public still remain apathetic towards television.

The most interesting fact which emerged from our conversation, however, was that during the few weeks preceding the Derby sales of television sets had been comparatively good and had only recently suffered a decline. This situation seems very paradoxical, as one would have expected that the great success of the Derby telemission would have boosted sales still further. The dealer had, however, his own explanation of this apparently contradictory state of affairs, and I must say that there seems to be something in it, and I am, therefore, passing it on to you for what it is worth.

He contended that the increased sales of a few weeks ago had nothing whatever to do with Derby Day anticipations, but were brought about by the fact that there had been rather a lot of talk about the recently started regular series of television programmes from the Eiffel Tower station. The increased sales, said the dealer, were solely due to the totally false idea which people possess of the supposedly much greater gaiety of Paris television programmes compared with those emanating from Alexandra Palace, and it was only natural that a slump should follow when the reception of these programmes in Brighton and one or two other places had revealed that from the gaiety point of view the Paris programmes left a lot to be desired.

On mature consideration I cannot help feeling that there may, after all, be a good deal in this suggestion, as I know full well from personal experience that people who have never been to Paris have an altogether erroneous impression of its so-called gaieties and have got in their minds a totally wrong idea of what a casual stroller would be likely to see were he passing through Montmartre on a fine Sunday morning.

Television and the Daily Drool

IF there is one thing more than another which pleases me about the development of television it is that when it becomes really universal it will, to a very large extent, counteract the horrible habit which many people have of letting their loud speakers drool away all day as a sort of background to whatever activities they are pursuing. Although it will not occur for many years, eventually, of course, all programmes will be accompanied by vision and this pernicious habit will be checked.

If I had my way I would fill in the interim until the full consummation of the great invention of television by cutting out the 10s. licence business and fitting each receiver with a coin-in-the-slot meter. People would think twice before they kept on putting their pennies in to listen to some of the rubbish that is churned out on the ether, while, at the same time, owing to the large number of programmes to which people really are pre-

pared to pay to listen the B.B.C. would reap a far bigger revenue than it does at present, and the extra money could be devoted to a speeding up of the television development plan, thus hastening still further the final end of this horrible habit.

This diurnal drooling business, although fostered to a large extent by broadcasting, had its origin many years ago, of course, when orchestras were first introduced into restaurants as a background to eating. The orchestra was originally brought into use in restaurants when people's manners in eating were even worse than they are to-day, and the music was intended to drown the noise which some people insist on making when consuming their soup.

The Reward of Invention

IT is always gratifying to an inventor to find that his ideas have proved of value to the community at large even on those occasions when he is not reaping a pecuniary reward commensurate with his labours. It was, therefore, with a warm glow in my heart that I observed in the pages of *The Wireless World* the other week a brief note which indicated that it is now possible for people practising on an electronic organ to wear a pair of headphones to ensure that only they can hear the horrible noises they are producing.

Only they can hear the horrible noise.

I find on reference to my laboratory notebook that it was just four years ago that I invented this device in connection with one of the little female Grid Leak's piano lessons, and I actually published details of it in *The Wireless World* of June 29th, 1934. This problem of the distracting din made by children at their piano lessons is, of course, centuries old, and evidence is available that it was not unknown in the Stone Age, as specimens of primitive pianos have been discovered by the side of which have been found the fossilised remains of children whose skulls bore the evidence of having been struck with what police surgeons usually describe as "some blunt instrument."

In the case of my invention my first efforts consisted of merely enclosing the entire piano, with the exception of the keyboard, in a sound-proof cabinet, a microphone being connected to the headphones worn by the little Grid Leak and its music instructress. This crude idea did not satisfy me for long, however, as the whole piano had to be taken out of its sound-proof case when I wished to use it personally to entertain Mrs. Free Grid. Eventually, therefore, I rigged up a PA system in the room, a switch being arranged so that this could be connected to the microphone inside the piano whenever I gave a personal performance.

The Great Ohms Muddle

—AND THE WAY OUT

By

"CATHODE RAY"

As my fan-mail does not amount to such dimensions as to necessitate the help of a calculating machine for its analysis, after the manner of a recent effort by the B.B.C. Listener Research Department, the following classification of readers is pure surmise. There are some who are properly trained and can knock off impedances with a slide rule as easily as grandma tells the time by looking at the clock. At the opposite extreme there are those who make no attempt to understand even such elementary technicalities as my highly simplified and predigested explanation of Ohm's Law published some time ago. But I believe that the vast majority belong to what might be described in current political terms as the centre party. That is to say, they—probably you—can talk about shoving in a bit more capacity here, or dropping a few more volts by increasing the resistance there, and can ask the man in the shop for a three-o's-five condenser, but want to change the subject when somebody starts talking about reactance.

Confusing the Ordinary Mind

It always seems to me that unless one has had the advantage of a proper technical-school training, or possesses that natural brilliance of intellect that one reads about in books with titles like "Pioneers in Science," the theory of radio must be terribly confusing. This sort of thing:

"Ohms are the units of resistance, and the current in a circuit can be calculated by dividing the volts by the ohms (Ohm's Law). But that applies only to DC; in AC circuits the current is equal to volts divided by impedance, and impedance is made up of resistance and reactance (but not just by simply adding them), and reactance is of two kinds, one made up of frequency and inductance, and the other of frequency and capacity, and if you add both sorts of reactance together the result is less and may even be nothing at all (this is resonance). And both sorts of reactance are measured in ohms, too, but they are different ohms from the resistance kind, because they have nothing to do with the power in the circuit, and they depend on frequency. Impedance is measured in ohms as well, but they have to be multiplied by the power factor for calculating power. Inductance and capacity are not measured in ohms (thank goodness!) and do not depend on frequency (until one gets into the advanced class) . . ." and so on. And if that sounds too easy there are always conductance and admittance and reluctance and susceptance and remanence and leakance to bring up as reserves.

It rather looks as if the fellows who worked out these definitions and things tried to make it as difficult as possible so as to keep the reputation for learnedness to themselves. Actually, that is quite wrong, and it may surprise you to hear that calculation in electrical units is so much simpler and more convenient that people who have difficult mechanical problems to solve sometimes convert their masses, forces, and so on, into the analogous electrical units and then back again.

Like learning to swim or drive, or—if we could remember it—walk, the ability to visualise impedance presents its worst difficulties at the start and requires a somewhat determined effort to accomplish, but is worth while to anyone who wants to understand circuits, for it is quite truly the key. In AC circuits impedance takes the place of resistance in Ohm's Law for reckoning the current due to a given voltage. Because I guess that most readers have not yet safely crossed this *pons asinorum* (forgive the veiled insinuation) I usually try to steer clear of impedance and reactance and all the rest of them for fear they would just be confusing. Yet it seems to be permissible to refer to inductance and capacity quite freely in semi-technical circles. I suppose the reason is that one can talk of the inductance or capacity of a component as something definite, without having to drag in frequency. The reactance of a component can be almost anything, and, indeed, several different things at one and the same time if currents of several different frequencies are flowing simultaneously; so it seems to be very much "up in the air" and difficult to visualise. That is unfortunate, for, as regards understanding how circuits act, it is reactance that is easy to apply, and inductance and capacity that are more distantly concerned.

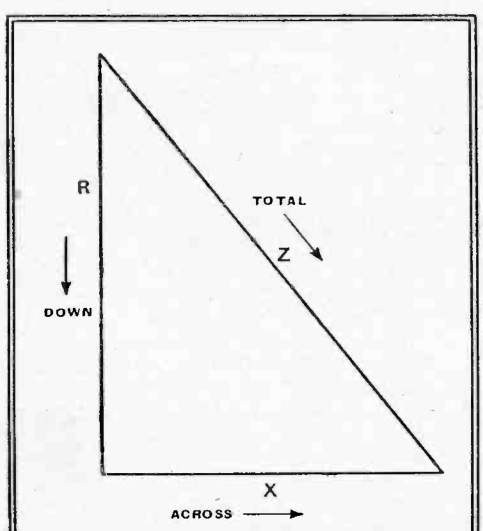


Fig. 1.—One way of adding things that are the same but not quite the same. The lines are drawn to scale to represent the quantities indicated.

Of course, lots of much more capable exponents have taken a hand in explaining the whole business in simple and clear fashion, but they all seem to approach from the inductance and capacity side, which makes the problem seem far more complicated, even if it does inspire a certain amount of confidence by starting off with familiar quantities. I want to try the experiment of starting with what for the time being may be unknown—reactance—and linking it up later with what for many readers must be the comparatively familiar ground of inductance and capacity.

First to dispose of the great ohms muddle. How can there be different sorts of ohms, and why? Imagine, if you will, a game of blow-football (it gives one less of a headache to imagine than to play it). If only one person blows down the table, he brings a certain force to bear on the ball and it moves down the table. The force might be stated in ounces, or preferably a smaller unit, such as grammes. If more people blow in the same direction their forces are added to give the total. That is the straightforward sort of business we all like.

Complications

But now suppose somebody at the *side* of the table decides to complicate matters by blowing. He can blow with a force of so many grammes. But to get the total force acting on the ball you cannot just add his force in with the rest. It is at right angles to the others, and, combined with them, tends to make the ball take an oblique path. If you draw lines representing to scale the forces on the ball you can get the total by the simple geometrical construction shown in Fig. 1, and if you remember anything about the famous Theorem of Pythagoras (all about squares on hypotenuses) you will be able to get it by calculation; thus Z (the total force) = $\sqrt{R^2+X^2}$ where R and X are the forces down and across the table respectively.

And now introduce a third party, sitting opposite the cross-blowing person. He blows across the table in the opposite direction, and if his blow is exactly as strong as his opponent's the two forces

The Great Ohms Muddle—

will cancel out and the ball will be impelled down the table just as if the people at the sides didn't exist. But if the side blowers are not the same strength, then, as they are exactly opposite, it is easy to calculate the total effect due to them by *subtracting* their forces. Or another way of saying the same thing, one that appeals more to the mathematical mind, is to distinguish one of the side forces by calling it *negative* and then adding it to the other. Then, if one sidesman exerts a force of X_L grammes and his opponent blows $-X_c$ grammes, it is easy to see that the total force on the ball due to all three blowers is $\sqrt{R^2 + (X_L - X_c)^2}$.

The object of this game has been to show that you can have a number of things measured in the same unit (grammes, for example, or *ohms*) and yet not quite the same. Just because everybody round the table is blowing so many grammes, it is not right simply to add them all together and say that is the total. If you have ever been so misguided as actually to play this game, you will know that everybody can be blowing his hardest and the ball stands more or less still in the middle. You must be careful not to follow this illustration any farther, because ohms do not correspond with forces or directions, but it does happen that the total of ohms in an AC circuit is calculated in exactly the same way, and for this purpose it is helpful to picture the various sorts of ohms as acting in different directions. But, of course, this must not be applied literally to directions in a circuit. Impedance, the total impeding effect in a circuit, is denoted by Z; resistance, of course, is R, and reactance is X, subdivided into X_L, the reactance due to inductance, and X_c, due to capacity. As with the forces at right angles to one another, R can never be simply added to X to give the total, Z. One must use the formula already given. Or it can be done by drawing lines on paper, as in Fig. 1. But first of all, if there are both X_L and X_c in the same circuit they should be combined into one term X by simple subtraction.

Negative Resistance

X_L and X_c are opposite numbers and can both exist in a circuit together without making any difference to the impedance Z if they happen to be exactly equal. By the way, I suppose you have noticed that if reactance is nil the formula $Z = \sqrt{R^2 + (X_L - X_c)}$ reduces to $Z = R$? That is a very important state of affairs and is the object of *tuning*. But, leaving that for the moment, is there a similar opposite number to R? Well, there is such a thing as negative resistance, although it cannot exist as a property of a simple component, because as resistance *absorbs* power, negative resistance obviously must be capable of putting power into a circuit, and that involves batteries or generators of some sort. One of the simplest forms of negative resistance is provided by a screen-grid valve connected as a dynatron. Reaction coupling is another way of introducing negative resistance. So it is possible to wipe out resistance in a circuit, just as it is possible to wipe out inductive reactance by bringing in an equal quantity of capacitive reactance. That accounts for many of the things one does in radio circuits to get certain effects.

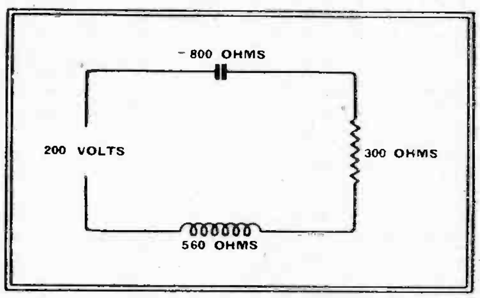


Fig. 2—Example of an AC circuit that can easily be calculated as described.

The foregoing method of reckoning applies only to resistances and reactances *all in series*. Parallel circuits and complex circuits of all sorts can be derived from the same fundamental formula in various ways.

Still granting that we may not be clear about what reactances really *are* (that is one of the next things to tackle), but assuming they are given to us in sealed parcels with their numbers written on the outside, we should now be able to calculate the impedance of any series circuit. To inspire confidence about this, here is a simple example (Fig. 2):—

Inductive reactance (X_L) = 560 ohms.
Capacitive reactance (X_c) = – 800 ohms.
Resistance (R) = 300 ohms.
Impedance (Z) = ?

Well, first of all (as X_c has very properly been fitted already with a minus sign) add X_L to X_c to give the net X. That is – 240 ohms, and, being negative, shows that it is a *capacitive* reactance. Now square it, giving 57,600. Note that the minus sign disappears. The square of R is 90,000. Adding we get 147,600. The square root of this—384—is the impedance in ohms. So if the voltage applied to the circuit in Fig. 2 is, say, 200, the current is given by the simple Ohm's Law as $\frac{200}{384}$, or 0.521 amp. Easy? And if you do not care for square roots you can do it with the help of a ruler on paper, as in Fig. 1, allowing, say, 100 ohms per inch or any convenient scale.

Reactance, Capacity and Inductance

This ability to work out impedances is by itself not of much practical value, because *Wireless World* circuit diagrams never have reactances marked on them, although they do have resistances. And for the very good reason, already mentioned, that the reactance depends on the frequency of the AC that is or may be applied. A single condenser may have to deal with a frequency of 50 c/s from the mains, with anything up to about 10,000 c/s audio signal and anything up to 100,000,000 c/s radio frequency. And its reactance will have correspondingly different values. So the next thing will be to get a firm grasp on the way reactance, capacity and inductance are related. And then we shall have the key to the reasons for the choice of certain values for components, and the innumerable effects that can be got by juggling about with these three things, R, L and C.

Continued in our next!

Television Programmes

Sound 41.5 M/cs. Vision 45 M/cs.

THURSDAY, JUNE 23rd.

3, Cabaret. **3.25,** British Movietonews. **3.35,** 157th Edition of Picture Page.

9, Swing music presented by Eric Wild. **9.20,** Gaumont-British News. **9.30,** 158th Edition of Picture Page. **10,** News Bulletin.

FRIDAY, JUNE 24th.

11.30 a.m.-12.30, O.B. from Lords, the Second Test Match between England and Austrialia.

2.30, O.B. from Lords, continued. **3.30,** "Yours Faithfully," entertainment by Marcella Salzer. **3.30,** Gaumont-British News. **3.50-5,** O.B. from Lords, continued.

9, Starlight. **9.5,** British Movietonews. **9.15,** A.R.P. Demonstration of Gas-proofing a Room. **9.30,** Film. **9.45,** "The Old Firm's Awakening," a comic opera in one act by A. J. Talbot, the music by Alfred Reynolds. **10.5,** News Bulletin.

SATURDAY, JUNE 25th

11.30 a.m.-12.30, O.B. from Lords of the Test Match.

2.30, O.B. from Lords, continued. **3.30,** In Our Garden, C. H. Middleton. **3.40,** British Movietonews. **3.50-5,** O.B. from Lords, continued.

9, Cabaret. **9.25,** Gaumont-British News. **9.35,** "Thread O' Scarlet," a play by J. J. Bell. **10,** News Bulletin.

SUNDAY, JUNE 26th.

8.50, News Bulletin. **9.5-10.15,** "The Tragedy of Julius Cæsar," by William Shakespeare. Title role played by Ernest Milton, Antonius by D. A. Clark-Smith and Marcus Brutus by Francis L. Sullivan.

MONDAY, JUNE 27th.

11.30 a.m.-12.30, O.B. from Lords of the Test Match.

2.30, O.B. from Lords, continued. **3.30,** Hildegarde. **3.40,** British Movietonews. **3.50-5,** O.B. from Lords, continued.

9, Cabaret. **9.30,** Gaumont-British News. **9.40,** Talk. **9.55,** Cartoon Film. **10,** Music Makers. **10.10,** News Bulletin.

TUESDAY, JUNE 28th.

3, Excerpts from "Wild Oats." **3.45,** Gaumont-British News. **3.55,** Cartoon Film.

9, "Badger's Green," comedy by R. C. Sheriff. **10.15,** News Bulletin.

WEDNESDAY, JUNE 29th.

3, "Follies of 1938." **3.30,** British Movietonews. **3.40,** "The Old Firm's Awakening" (as on Friday at 9.45).

9, Starlight. **9.10,** Cartoon Film. **9.15,** Friends from the Zoo. **9.30,** Gaumont-British News. **9.40,** Clothes Through the Centuries. **10,** News Bulletin.

NEWS OF THE WEEK

NEW B.B.C. CHIEF

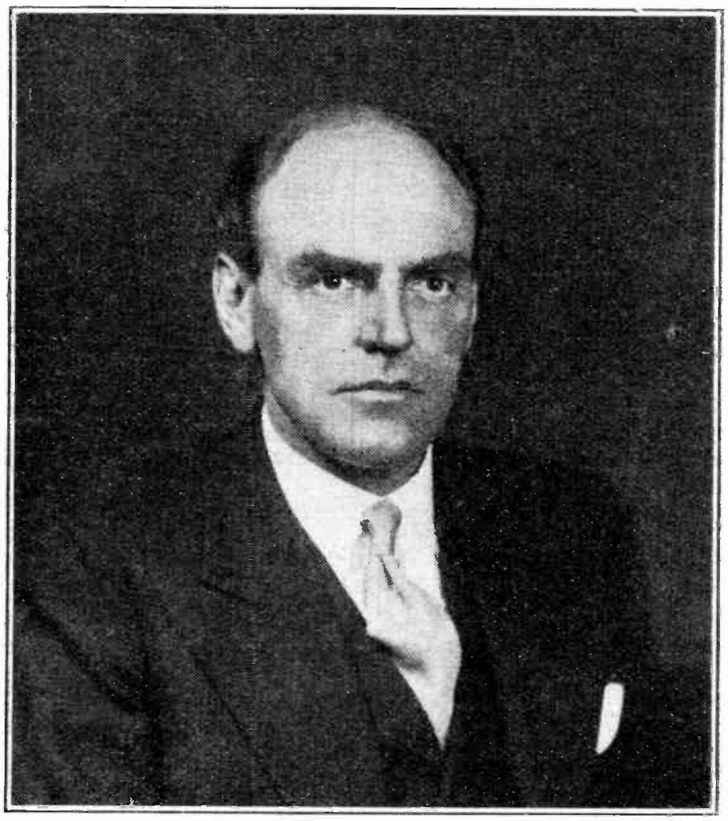
Points Appertaining to the Succession

ALTHOUGH Sir John Reith's successor has not been announced at the time of going to press, it is hardly likely that the B.B.C. will be without a Director-General for any length of time after his final departure. There is no doubt that the Government will influence the Board of Governors in the matter of the new appointment.

Administrative experience must be a necessary quality of the new Director-General, and both Mr. Cecil Graves, Deputy Director-General, and Sir Stephen Tallents, Controller of Public Relations, possess this quality. Mr. Graves has the wider knowledge of broadcasting, and he is commended in certain influential circles for his successful launching of the Empire Service, to which the Government attaches the utmost importance. It is true, however, that there has never been any *right of succession* at Broadcasting House for any position. In fact, it has been the invariable rule to pass over those who appear to be the most likely candidates and make unexpected appointments.

The basic salary of a Director-General is £6,000 a year, but an extra sum is granted by way of honorarium in connection with expenses of the office. In Sir John Reith's case this amounted to £1,000 per annum over some considerable period.

Finally, it is of interest to observe that under the section "Organisation" in the B.B.C. Charter it is stated that: "The Corporation shall appoint such officers and staff as they may think necessary (including any Director-General) for the efficient transaction of their business, and shall fix such rates of remuneration, including that of the Director-General as they think proper."



Sir John Reith

The control of the Corporation is in the hands of a Board of Governors which is constituted by politically appointed members.

Whether a parliamentary grant will be made to Sir John Reith for his services remains to be seen, but it is almost certain that his retirement from the B.B.C. will carry a peerage with it. He is a man of great capabilities, with the profoundest sense of responsibility and devotion to duty.

AIR TRANSPORT

Wireless Components by Aeroplane

A RECENT traffic census carried out by Imperial Airways reveals the remarkable extent to which air transport is used in the wireless industry. Not only does this form of conveyance reduce the time element to a matter of hours instead of days, but it dispenses with elaborate packing and makes breakages practically unheard of.

Firms who at one time found it necessary to keep large stocks of components at their branches abroad, to ensure against running short of supplies, now find that urgent orders can be fulfilled in a few hours. The result is that supplies in hand can be kept down to a minimum with a subsequent saving in floor space and the certainty of stocks being fresh.

While heavy batteries and accumulators still go by steamer, during practically every working day throughout the year a consignment of wireless valves leaves Croydon by air, and the General Electric Co. uses this transport medium for well over 50 per cent. of its deliveries to Paris.

AN AMERICAN ON TELEVISION

They Have a Poor Impression of Our System

BRITISH visitors to the United States, notably B.B.C. officials, several of whom have been over there recently, have been surprised to note the scepticism which exists respecting television in England. The idea appears to be widespread among Americans that such television as has been carried out in this country can but be elementary and unreliable, that nothing in the nature of a regular service is available for viewers. Mr. John Royal, Vice-President in charge of programmes of the National Broadcasting Company, who was in London a few weeks ago, is doing a good deal to correct this impression. He has just stated in an interview that television is far from being a dismal failure in England. While he was here, he says, he was given facilities by the B.B.C. for witnessing many television programmes, and they were very successful. Among his statements in the American Press is the following: "I saw, among other things, the Scotland-England football game on a television screen. I had never seen that sort of contest before; nevertheless, it held my interest. The photographic detail was excellent."

NATIONAL EMERGENCY SERVICE

Three Stations to Cover Britain

TO-DAY'S problem which is exercising the mind of the B.B.C. is whether two, or perhaps three, 100-kilowatt stations could cover the British Isles effectively in the event of a national emergency assuming such serious proportions that the closing-down of most of the transmitters became unavoidable. It is a foregone conclusion that only those transmitters which are more or less remote from air raids would be able to continue in service. In the construction of Start Point, therefore, provision is being made for a power unit of 100 kilowatts, although, it should be added, that power may not be used when the station first comes into service next spring. Burghead, in Scotland, operates at present on a power of 70 kilowatts, capable of increase to 100 kilowatts. These two transmitters, with the addition of Droitwich, can, it is estimated, serve the whole of the British Isles.

EARPHONE INDUCTION SYSTEM

Independent Listening in Public Rooms

THE principle of inducing electrical energy into earphones by means of a widely distributed magnetic field has been receiving enthusiastic attention from the Press. One of its practical applications was demonstrated last week by Mr. C. M. R. Balbi at Grosvenor House, London.

A turn of wire from the extension loud speaker terminals of a wireless receiver was taken round a room in the hotel. Chairs in the room were furnished with coils of wire round their legs, and it was shown that signals of comfortable intensity could be heard by means of earphones wherever the chairs were placed.

The system is particularly well adapted to hotel reception halls and public rooms where the use of loud speakers is obviously impossible.

"IN TOWN TO-NIGHT" ENDING

Its Outstanding Successes

SATURDAY, July 2, sees the last of the present series of "In Town To-night" broadcasts, a feature which, since the lamentable passing of A. W. ("Bill") Hanson, has been conducted by C. F. ("Mike") Meehan. The producer has himself formed a definite opinion as to the most successful of the season's output. Beauty, the

News of the Week—

talking budgerigar from Bradford, heads the popularity list. Mary Lamb, the young Cumberland shepherdess—"the girl with the open-air voice" and a name that stamps her as having been born to the life of a tender of sheep—was the most successful woman broadcaster. Among the men whom "In Town To-night" has featured during the series now ending, the most successful has been Robert Donat.

LOOKING AHEAD

Vault to be Opened in 8113 A.D.

MR. DAVID SARNOFF, President of the Radio Corporation of America, recently delivered the address in dedication of the stainless steel door of "The Crypt of Civilisation" at the Oglethorpe University. This is an airtight vault in which will be stored away every conceivable article (including broadcast receivers) which typifies the period 1900-1950. The inscription on the door is appended by the names of President Roosevelt, Eugene Talmadge (Governor of Georgia), and the President of the University, who was responsible for the founding of the crypt. Posterity is placed upon its honour not to unseal the door until the year 8113 A.D.

SHIP-TO-SHORE RADIO

ABOUT two hundred of Iceland's fleet of seagoing fishing vessels are equipped with Post Office radio-telephonic apparatus. Calls can be put through to any subscriber ashore at the rate of 1.5 kroner (approximately 1s. 4d.) per period of three minutes.

This service is the result of experiments successfully carried out by the Icelandic Post Office in 1932 when the significance of such a scheme was appreciated by the authorities and then quickly taken advantage of by owners of small craft.

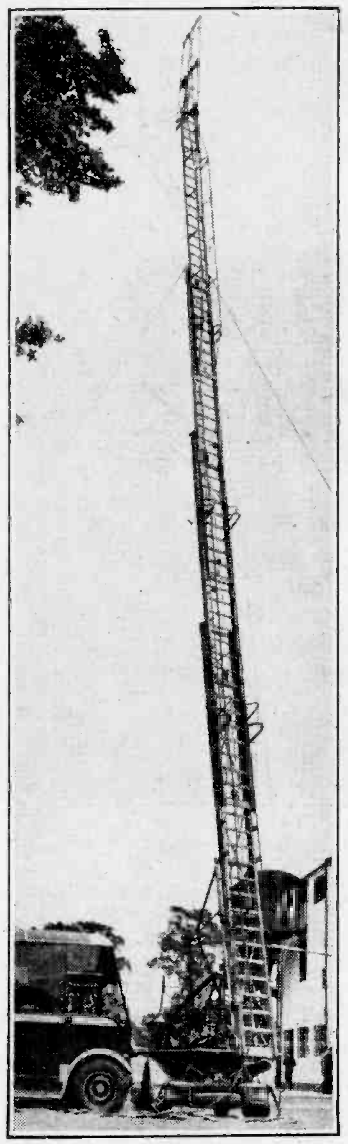
LISTEN TO SNOWDON

A PORTABLE 56-Mc/s station will be operated from the summit of Snowdon by Mr. David Mitchell, GW6AA, from 17.00 to 23.00 hours (BST) on July 2nd. At the close of the tests the associated receiving station GW6AAP will stand by on 1.7 Mc/s for calls from stations which have logged but not contacted Snowdon. 56-Mc. transmissions will recommence on July 3rd at 09.00 hours and continue until 15.00 hours, when GW6AAP will be ready to receive reports until about 17.00 hours. All reports should give the exact time that signals were heard as aerial systems will be continually changed; any type of signal will be dealt with at the receiving station although it is hoped that CW and ICW will predominate.

The tests are held in connection with the RSGB Annual 56-Mc/s. Field Day, and owners of stations wishing to arrange schedules for the Saturday tests should write to Mr. Mitchell, "The Flagstaff," Colwyn Bay, as soon as possible.

EXPERIMENTAL TELEVISION

THE telecommunications division of the Municipal College, Portsmouth, is on the air with television. At present, low definition pictures are being radiated on 30 megacycles and they have been well received by one of the students at his home in Bognor Regis. Progressive experiments with 405-line pictures are in hand at G6PU.



TELEVISION ESCAPE. Not part of an elaborate set ready for a thrilling rescue before the cameras, but the new method of raising the transmitting aerial of the B.B.C. mobile unit. It is an improvement on the mast aerial, which took almost as long to erect as the period of test transmissions

Mr. A. Parsons, senior lecturer in telecommunications of the College, is anxious to hear from those interested in wireless research who would like to take part in the work.

RECORD "O.B." SCHEDULE

A RECORD mileage of Post Office lines will be used by the B.B.C. during July for a series of broadcasts of sporting events. The calendar of sporting transmissions will include the following:—The Wimbledon Tennis Championships on July 1st and 2nd; the King's Cup Air Race from Hatfield on July 2nd; the 'Varsity Cricket Match from Lords on July 2nd, 4th and 5th; the Third Test Match from Old Trafford on July 8th, 9th, 11th and 12th; the Gentlemen v. Players Cricket Match from Lords on July 13th, 14th and 15th; a Village Cricket Match on July 16th; the Fourth Test Match from Leeds on July 22nd and 23rd; Polo from Hurlingham on July 4th; the Open Golf Championship from Sandwich on July 7th and 8th; Great Britain v. Norway Athletic Meeting from the White City on July 9th; the A.A.A. Championships from the White City on July 16; another Athletic Meeting from the White City—Princetown and Cornell v. Oxford and Cambridge—on July 23rd; Water Sports from Wembley on July 9th; the Fourth Speedway Test Match—England v. Australia—from West Ham, on July 12th; and the Final Stage of the King's Prize Competition from Bisley on July 16th.

FROM ALL QUARTERS

Radio in Schools

THE number of schools registered for listening in April, 1935, was 3,656; in April, 1938, it was 8,250; and by the end of last month this number had increased to 8,477. Of the total 8,250, 891 were secondary schools and 7,359 were elementary and other schools.

Thou Shalt Not

MANY amateurs have been heard using the 14 Mc/s band for short-distance messages, thereby preventing trans-oceanic stations on this DX band from being worked by other local stations. Increasing use of the local 1.75 and 3.5 Mc/s bands is being made by the more thoughtful home operators.

Listening Groups

THE rapid development of listening discussion groups in Britain has resulted in spreading an entertainment-with-instruction form of leisure activity throughout the country, and the total number of groups in the spring of the present year comes to 756, as against 407 for the corresponding period in 1937.

U.I.R. Programmes

PRELIMINARY examinations of the readjustment of European wavelengths based on the findings of the Cairo Conference are taking place at the summer meetings of the International Broadcasting Union at Ouchy, Lausanne. These meetings will in all probability be terminated on July 2nd. The eventual settlement of the present wavelength problem will be made during the conference of the European Administration which will take place in Switzerland next February.

New Noise Law

THE operation of excessively noisy loud speakers in Bristol will be a punishable offence under new by-laws which come into force on July 1st.

Daventry ARP Shelter

A SPECIALLY designed ARP shelter for the protection of the staffs of the Empire and Air Ministry radio stations at Daventry is being constructed in Borough Hill.

Traffic Controlled by Radio

IN order to facilitate the management of congested traffic in the Preston and Blackpool districts, radio control boxes are being built for the police.

British Film on N.B.C. Television

"THE Return of the Scarlet Pimpernel," Korda's film production, was televised in its entirety in New York from the Empire State Building. This is the first American broadcast of a full-length feature film, and just how long the film industry will allow such transmissions to continue is a matter for speculation.

W3XAL Expanding

BRITISH listeners to American short-wave transmissions are to be provided with improved facilities by the National Broadcasting Company of America. Two new 25-kilowatt short-wave stations are in course of construction at Bound Brook, designed to give greater signal strength in Europe and all parts of Central and South America. These new stations will operate through four directional beams and two non-directional aerials.

Go-Ahead Columbia

DURING the past six months over seventy per cent. of stations belonging to the Columbia Broadcasting System have increased their power, or have installed various types of new high-fidelity equipment and vertical antennas, besides introducing other improvements. Most of the C.B.S. stations have this year installed a new automatic programme amplifier, which provides an average increase in signal reception that is equivalent to doubling the transmitter power.

Conservation of Matter

THE exceptional demand for current to work wireless receivers picking up the Test Match commentaries in Sydney, Australia, has imposed such a strain on the local power station that 40 tons more coal than usual were used.

Television on the Continent

THE POSITION IN FRANCE AND GERMANY

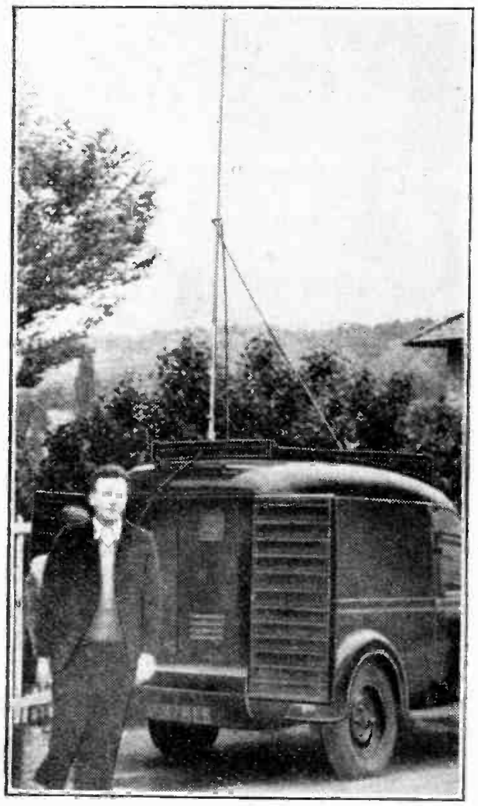
IN Europe we are standing more or less on the threshold of television, which has been promised to the public many times, but, except in England, has failed to materialise as a practical service. We, in this country, have now had a good year's experience, and the B.B.C. presumably know what to expect both as regards the expense of running television and the public response to it. The British wireless industry has also had time to take stock, and clearly intends to make next winter a television one.

Profiting by our experience, France took the plunge last March and opened a 455-line high-power station. Transmission standards will shortly be stabilised officially to allow the industry to embark on a programme of receiver construction in the assurance that no radical change will be made for several years.

Germany is on the threshold, but much less information on future plans is obtainable in Berlin than in either London or Paris. So far as anything approaching a regular service is concerned, the 180-line system, complete with a 25-frame flicker, still prevails in the original form in which it was introduced in 1935. But to anyone who has seen (as I have) demonstrations of 441-line pictures, it is obvious that, technically speaking, German engineers are well capable of producing good high-definition pictures, and in fact a 441-line service is shortly to be established. It is known that two mountain-top transmitters are under construction, but with these and a third low-level station Germany will only be able to serve 25 per cent. of her population; roughly, the same proportion as is served in England by the single transmitter at the Alexandra Palace.

Doubt has been expressed as to whether the extra 50 lines (455 lines as compared with our own 405) of the pictures put out by the Paris transmitter are really worth while. By the time this appears in print the French authorities may have announced a final standard of perhaps 405 or 441 lines. Be this as it may, most French engineers seem to be in favour of the larger number of lines, and, after careful comparison of reception in both Paris and London I have reached the conclusion that the French system gave considerably more detail, particularly noticeable in big scenes. The picture is surprisingly clear and steady. M. Mallein, Chief Television Engineer of the P.T.T., kindly arranged for me to visit the studios and also demonstrated the new film scanning apparatus, which is now undergoing tests. It seems very satisfactory, and is, I believe, entirely French.

A reproduction of this picture forms the Eiffel Tower interval signal.

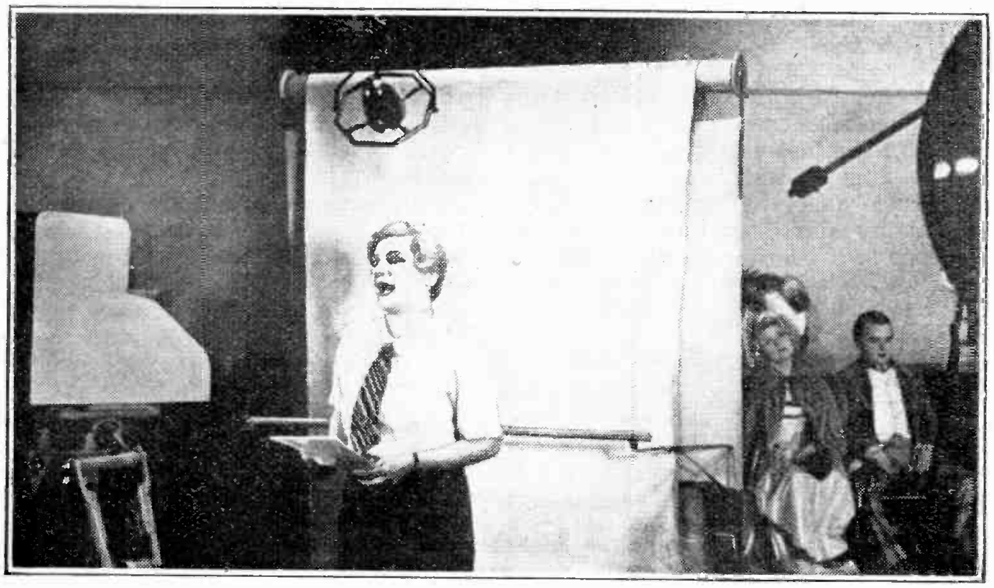


Le Materiel Telephonique (L.M.T.), the firm that installed the Eiffel Tower Station, is carrying out field-strength tests around Paris with the help of apparatus installed in a van.

L.M.T., the firm responsible for the Paris television transmitter installed in the Eiffel Tower, was equally accommodating, and allowed me to accompany one of its engineers on a trip in a motor van to investigate signal strength at various distances. An ordinary commercial receiver was installed in the van, on which was mounted a doublet aerial with a co-axial feeder connected at the centre; maximum height was about 21 feet.

At a position about 21 miles north of Paris near the banks of the Oise, some 220 feet below the direct visual path from the top of the Eiffel Tower, we had satisfactory and clear reception of the afternoon programme. The receiver was operated from batteries through a DC/AC converter, and the only interference encountered was from passing cars. L.M.T.'s engineer is continuing his tour, and hopes to find a spot where both Eiffel Tower and Alexandra Palace will be receivable! He thinks that good pictures should be obtainable from E.T. on the South Coast of England.

Efforts are being made by means of public demonstrations to interest the Parisian public in television, and the industry is busy with the design of receivers, which will presumably be released in time for the Grand Palais Exhibition in the autumn.



In the Paris Television Studio: this photograph, taken from the visitors' gallery through a window, shows Mlle. Suzy Vinker, the announcer.

Magnetic and Ionospheric Storms

Nature of the Recent Disturbances

By T. W. BENNINGTON

A DISCUSSION of the relationship between the severe magnetic storm of April 16th and the associated disturbances of radio propagation. Although these matters are not completely understood, our knowledge of their nature grows with each succeeding disturbance.

ON April 16th of this year there occurred a "magnetic storm" of exceptional severity; in fact, of an intensity which has very seldom been equalled during the present century. This was considerably greater than that of the severe "storm" which occurred on January 25th this year, and in connection with which, it will be remembered, a remarkable display of the Aurora Borealis was seen.

The term "magnetic storm" is here taken to mean only what it actually implies, i.e., violent and abnormal fluctuations of the terrestrial magnetic forces. It does not include (as it sometimes is made to do) the associated abnormalities in radio wave propagation. These are more properly defined by the term "ionosphere storm," since they are evidently due to the ionosphere, and not to the magnetic disturbance. In this article, therefore, the radio fade-out will be referred to as an "ionosphere storm," and this will also serve to distinguish it from fade-outs of the Dellinger or "short-period" type.

Records of the magnetic disturbance were obtained on the magnetographs at the Abinger Observatory, some details of which were published in *Nature* of April 23rd and 30th. From these it appears that the magnetic storm began at 0548 G.M.T. on April 16th, with a sudden change of 45 minutes in the declination. Magnetic declination is, of course, the angle between the magnetic meridian and the geographic meridian, and a change in it thus represents a change in the *direction* of the earth's magnetic field.

Abnormal Magnetic Conditions

Almost immediately after the storm started phenomenally large ranges in the magnitude of the terrestrial magnetic forces began to occur, such as to render it difficult for the magnetographs to follow them. The declination varied by as much as 5 degrees 7 minutes, while both the vertical and horizontal components of the earth's field underwent large changes in magnitude, the maximum changes in the horizontal force amounting to about one-twelfth of the total force in that direction. The greatest activity took place between 0600 and 0800 G.M.T., but it was not until 1630 G.M.T. that day that magnetic conditions again became normal.

It may perhaps appear that terrestrial magnetic phenomena, and even the solar disturbances which give rise to abnormalities in them, are not an essential part of the science of radio communication. But in so far as these occurrences produce, or are associated with, particular characteristics in radio wave propagation, then they do in fact form part of that science. And there are several points in connection with this particular event, or rather sequence of events, which are of sufficient significance to warrant attention.

The first point to notice is that April 16th is 81 days from January 25th, the day on which the Aurora Borealis was seen in England, and previous magnetic and ionosphere storms occurred. The mean time taken for the sun to complete one of its rotations is about 27 days, so that it had made exactly three rotations between January 25th and April 16th. Furthermore, it would present a similar part of its surface to the earth on April 16th as it presented on January 25th.

On April 16th a large number of sunspots were visible, among which two appeared to be in a highly active state. The first appeared on the sun's east limb on April 8th, when their area was 1,500 millionths of the sun's visible hemisphere. Situated in solar latitude 27° N., they crossed the meridian on April 14th and reached the west limb on April 20th. When the magnetic storm started they were thus about two days past the meridian; a very significant point. For if, when on the meridian and, therefore, "pointing" directly at the earth, they had been emitting radiation of a corpuscular type, this corpuscular stream would have been able to reach the earth. Furthermore, it would have done so when the sunspots were past the meridian as seen from the earth. If it is justifiable to assume that the magnetic storm is caused by these corpuscles, then the lapse of time between the meridian passage of the spot and the start of the storm is a measure of the velocity of the corpuscles.

The evidence from the disturbance of January 25th is, however, not as favourable, for on that date no sunspots were in a position just past the meridian. A very large sunspot, and one that has been thought to be responsible for that particular disturbance, was, in fact, just disappearing over the west limb. At first sight it appears that the disturbance of January 25th was one which did not obey the rules at all.

It must be remembered, however, that the 27-day rotation is only a mean. The sun's rotation is, in fact, not uniform over its whole surface, and for the position occupied by the spots of April 16th a slightly longer time would be taken to complete the rotation. This, however, does not help much, as will be evident after a few moments' consideration. It may be possible, however, that the January 25th storm was caused by corpuscles ejected at a different velocity, and so took longer to reach the earth than those of April 16th.

It is of interest to add that the sunspot group of April 16th again appeared on the east limb on May 4th, and reached the meridian on May 10th. Though of smaller area than during its last meridian passage, it still appeared to be active, and was responsible for another magnetic storm which started on May 11th. On this occasion the storm was of a lesser intensity.

Cause of the Disturbances

On the whole, it does seem justifiable to assume that it is corpuscular radiation from the sun which causes these magnetic disturbances, although our knowledge is as yet incomplete. If the corpuscles were ejected at an angle normal to the sun's surface from a position near the meridian they must have travelled at a speed of roughly 600 miles per second in order to cover the distance in the time involved in the storm of April 16th. The sunspots were known to be in an eruptive state long before they reached the meridian, and if the solar radiation producing the disturbance had been of the electromagnetic-wave type the storm would thus have occurred much earlier.

Another point is that the disturbances were, as is usual, more intense near the earth's poles. If the particles possess an electric charge, as seems likely, they would be attracted towards these regions by the magnetic forces of the earth.

There is a further interesting point in connection with the disturbance of April 16th. Although the magnetic storm did not commence until 0548 of April 16th, the ionosphere storm was already in progress by the evening of April 15th. As far as can be ascertained American broadcast stations on the 21, 15 and 11 Mc/s bands faded out some time between 2 and 4 p.m. G.M.T. on that day. Certainly by 6 p.m. G.M.T. very few long-

Magnetic and Ionospheric Storms—

distance signals were audible on these bands, and no American broadcasters were among them. At 9 p.m. G.M.T. only very few 9 Mc/s stations were heard, and these were weak signals and subject to deep and rapid fading. Conditions were still very bad on April 16th and 17th—in fact, it was not until the afternoon of April 18th that reception began to become normal.

A peculiar feature is that at the height of the disturbance some long-distance signals on very high frequencies, i.e., 28 Mc/s, became audible for a short period. This has been noted in previous disturbances, notably during that of January 25th. It seems possible that these waves may be propagated at these times via a lower layer whose ionisation level is somehow increased as a result of the disturbance.

As far as normal propagation is concerned, however, it is generally assumed that in this type of disturbance communication fails because of inadequate bending of the F layer, owing to the fact that the ionisation level there is reduced by the storm. This must be so, because it is always the higher frequencies that fade out first during these disturbances, and, further, measurements of the F layer critical frequencies indicate that on magnetically disturbed days these are always lower than normal. The F layer critical frequency is, of course, that which just penetrates it at vertical incidence. From this it seems certain that during ionosphere storms propagation deteriorates because the waves can penetrate the F layer.

But why should the ionosphere storm commence so long before the magnetic storm? It is almost certain that both are due to the same cause, i.e., bombardment of the ionosphere by corpuscles from the sun. Yet radio-wave propagation failed as a result of this, about 14 hours (in this case) before the earth's magnetic forces became affected. Note also that the magnetic storm did not commence gradually, as one might expect if it were due to some cause to which the ionosphere was more susceptible, but started with a violent change in the magnetic forces, and reached its maximum intensity within an hour.

It will be seen, therefore, that the matter is as yet by no means clearly understood, though, with each succeeding disturbance more and more knowledge is gained. It seems certain that the answer to these problems must eventually be found, and the subject appears to be one which is particularly suitable for future observation and investigation.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Relays

As a considerable amount of debunking is going on in the pages of your journal, (harmonic distortion, for instance) may I take this opportunity of doing a little debunking myself, especially as regards the letter of Mr. T. J. E. Warburton, published in May 19th issue, and the subject of Relay schemes in general?

How very true Mr. Warburton's second paragraph is, until he decides, presumably for anyone else but a Relay Subscriber, that the system is inefficient.

The proof of the pudding is in the eating. The writer is connected with the running of a relay scheme, and from his experience can honestly say that the only limit to the continued expansion of stations is the return expected on capital involved in an enterprise that does not know what the G.P.O. will do.

That a Post Office, or any other Relay, would be a less satisfactory system than a set to the average listener in the long run has not been proved in *The Wireless World*, and the fact that losses to a Relay Service —in some cases 90 per cent.— are nearly always due to circumstances other than dissatisfaction with the service or system makes the writer believe there is, and must continue to be, room for both sets and Relay.

To close, if I may encroach on your space a little more, I would point out that the most delightfully simple method of guiding a wave has eluded your writer of April 7th, who tried carefully to disprove the practicability of relaying television. What I refer to is the use of one line and that good conductor of nearly infinite cross-section, the earth. One company has had an O.H. line insulator in use three years which caters for this method.

"PRAXIS."

Superhet Nomenclature

It still seems to be the custom to refer to the detector stage in superheterodyne receivers as the "second detector." Surely, now that the term "first detector" has been superseded by the more correct terms "frequency-changer" and "mixer," no confusion is likely to arise if the word "second" is omitted.

A. CHESTERMAN.

Christchurch, Hants.

Debunking Harmonic Distortion

Mr. W. E. BENHAM describes my debunking of harmonic distortion as lucid (I rise to bow) but deplorably unnecessary (I drop back again discomfited).

It is very disconcerting to the history master, who is revealing to his class that the date of William the Conqueror's accession to our throne was 1066, when Prof. Oman walks in and says he has heard that one before. The criticism seems unfair, somehow.

So it is when a radio engineer comes into my elementary class and tells it that Mr. C. Ray is putting one across them by representing intermodulation as something hot off the press.

Of course, it has been dealt with before; but so far as my imagined readers are concerned (Mr. Benham is not meant to be one of them) it might never have been. I would like to quote some of Espley's five-year-old *Proc. I.R.E.* paper to show why, but am afraid of provoking a lightning strike of *The Wireless World* compositors. To describe it as mathematical would be putting it very mildly. Then Bartlett wrote some plain English in *The Wireless Engineer* in 1935 that interested me in the subject. And then Harries.

My remarks on harmonic distortion being relatively unimportant were not claimed to be "heretical" on the grounds of novelty or departure from fundamental principles, but because there is singularly little evidence of its being the accepted view even among the highest-browed professionals, much less the humbler devotees. I have hundreds of manufacturers' laboratory valve sheets dealing with harmonic distortion, but except for those prepared by Harries I have seen none at all suggesting that such a thing as intermodulation exists. Can it then be well known among the beginner's section of *The Wireless World* readers to whom I hopefully address my words?

"CATHODE RAY."

Unusual Interference

The interference described by Mr. B. H. Grose in your issue of May 19th appears to be due to cross-modulation, probably caused by an oxydised contact between the water-pipe and some other mass of metal. When the pipe is disturbed this contact is either made good or entirely disconnected, so causing interference to cease.

If this is the case, then efficient bonding and earthing of all metal parts adjacent to the pipe should cure the interference. Alternatively, as the field of this type of interference is usually fairly low, a good outdoor aerial with screened down-lead may effect a cure.

L. J. WALMSLEY.

Nottingham.

Receiving Licence and Buying

I have been a regular subscriber to your journal for years, and have always been under the impression that it was published largely for the keen private experimenter and constructor.

In a recent issue the writer who hides himself under the alias of "Diallist" upholds a suggestion which has previously appeared in your columns, viz., that a receiving licence should be shown when purchasing radio apparatus.

This obstructionist idea would be extremely inconvenient to the home constructor, since, as you must be aware, we have to order most of the stuff we need through the post, and the occasions when components, etc., are bought over a shop counter are comparatively rare. Are we to send our licences to the dealer with every post order?

Again, how would "Diallist" define radio apparatus? I might require valves and components for a gramophone amplifier, and not use a radio receiver at all. Would he propose making a licence necessary for all gramophones?

In case you should imagine that I am a "pirate" and "denounce" me to the P.M.G., I would like to say that I am a licence holder.

H. BLIGH.

London, N.4.

Random Radiations

By "DIALLIST"

Why Sunday Morning?

A PITY—wasn't it?—that the London versus Dublin Spelling Bee was marred by a good deal of interference. Apparently the trouble was with the land lines, so that any "technical hitch" (blessed phrase!) that occurred really was outside the B.B.C.'s control. But why on earth did they choose Sunday morning of all times? Strictly speaking, it was *after*noon since the time was 12.30, though most of us reckon the morning as ending at lunch time rather than when the clock strikes twelve. I should imagine that the number of listeners was very small, for at that time on a fine Sunday most people would be out of doors. Surely the end of the afternoon or the middle of the evening is a far better time for broadcasts of that kind. There may, of course, have been some difficulty in getting the teams together except in the morning, though I should hardly think this could be so.

Words, Words, Words

So much for that particular Sunday; now for a plaint about Sundays in general. The single news bulletins that we have on Sundays are the subject of my grouse. I have never been able to understand why such a large proportion of them is devoted to quotations from speeches. It's true that there is a lot of speechifying done by politicians and others on Sundays; but many of the speeches made (and quoted *in extenso* in the news bulletins) are of the kind which may be described as using a multitude of words to say nothing that really matters. "Speaking to-day at the Annual Conference of Hairdressers at Little Hogsbury, Mr. Bohun-Hedde said that, dark and difficult as the outlook was, he was confident that there was a bright future ahead if every man, woman and child would pull together to ensure the prosperity that is the age-long inheritance of this country." And that kind of thing. As we get only ten minutes in the news on Sundays I think that the B.B.C. might very well cut the cackle and come to the 'osses. Incidentally, if they did so they would lay themselves much less open to those charges of political bias that are flung at their heads by people of such widely different shades of opinion.

The Englishman's Home

TO judge from its recently published report, the Building Research Board of the Department of Scientific and Industrial Research has had a pretty busy time during the past year in dealing with wireless problems. At first blush such things might seem to be rather outside its line of country; but they aren't really. The radio queries that come the way of the Board are concerned mainly with ways and means of preventing the nuisance caused by loud speakers that speak too loudly in the homes of next-door neighbours. It is rather surprising to read, as reported in last week's *Wireless World*, that "the conventional nine-inch party wall in semi-detached buildings does not provide sufficient insulation to reduce to tolerable limits the sounds transmitted from a wireless loud speaker or gramophone working at the sound level normally preferred." The report goes on to say that it has been found so difficult to improve the "sound" insulation of existing buildings that new ones should be most carefully planned. Just what a nuisance a noisy loud speaker next door (or some distance away in summer time, when windows are open, for that matter) many know by bitter and maddening experience. The worst of it is that any distortion present in the receiving set is brought out to the full when the strains of its loud speaker reach you either at close quarters through a wall or at a distance through the air.

No New Thing

As a matter of fact this problem of preventing the transmission of unwanted sounds from one building to the next, or from an upper room to that below, is no new thing, though it has come into prominence during the last few years owing to the fact that something like two homes out of three are now equipped with loud speakers. In the pre-wireless era the nuisance was usually due to little Miss Jemima's scales and five-finger exercises on the piano, or to young Master Willie's painstaking though often fruitless efforts to scrape the fiddle with a minimum of wrong notes. Our forefathers went in as a rule for something rather more effective than mere nine-inch walls. And they knew one most valuable tip which may even be revived by the modern builder. Their method of sound deadening was to use a thick layer of oyster shells or cockle shells packed between the floor of one room and the ceiling of another, or built into a party wall. I don't know why it should have worked, though work it certainly did. One of the quietest houses I ever knew was, strangely enough, the home of a large family of very noisy youngsters. When it was pulled down to make way for new buildings masses of shells were found; there must have been tons of them.

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, JUNE 23rd.

Nat., 7.25, "Rhythm Express," with Ben Frankel and his Orchestra. 8.40, "Airways and the Future of Transport," talk by Nigel Tangye.

Reg., 6, "The Silver Spoon," a comedy with music. 7.30, Talk by F. L. Stevens on Rivers and Canals under London. 8.40, An excerpt from "Follies of 1938." 9.20, "Abracadabra"—Rites, Spells and Incantations.

Abroad.

Munich, 7.15, "The Mastersingers," opera (Wagner), from the Opera House, Nuremberg.

Vienna, 7.25, "Pagliacci," opera (Leoncavallo), from the State Opera.

FRIDAY, JUNE 24th.

Nat., 5.30 and 6.25, Commentaries on First Day's Play of the Second Test Match, England *v.* Australia. 7.30, Madrigals—B.B.C. Singers (A). 8, "The Old Music Hall." 9.20, Your Visit to Scotland; advice by Compton Mackenzie. 9.35, International Society for Contemporary Music; orchestral concert.

Reg., 1.15, Test Match Commentary. 7.30, Sid Merriman and his Music. 9, Hungarian Gypsy Party. 9.45, "A.R.P." Talk by Herbert Morrison, M.P., and Commander Firebrace.

Abroad.

Stuttgart, 8, Festival Concert for first Reich Students' Congress, relayed from Heidelberg.

SATURDAY, JUNE 25th.

Nat., 12.30 and 6.25, Test Match Commentaries. 6.40, "The Playwright and the Box Office"—discussion. 8, Palace of Varieties, including George Robey, Harry Hemsley and Tommy Handley. 9.20, American Commentary.

Reg., 6.40, Roy Fox and his Band. 8.15, Emlyn Williams in "We Are Not Alone," a radio play by James Hilton and Barbara Burnham. 9.15, An excerpt from "Pleasure on Parade."

Abroad.

Cologne, 8.15, "The Merry Widow," operetta (Lehár).

Leipzig, 9 p.m.-1 a.m., Radio Ball from Dresden.

SUNDAY, JUNE 26th.

Nat., 12.15, Olive Groves and George Baker in Musical Comedy Songs. 5.30, Sonata Recital by Arthur Catterall, violin, and R. J. Forbes, pianoforte. 9.5, Theatre Composer Series—II. Franz Lehár.

Reg., 5, Harry Davidson and his Orchestra. 6.45, "Diplomacy," a romantic comedy. Cast includes Yvonne Arnaud, Ronald Squire and Esmé Percy.

Abroad.

Radio-Paris, 8.30, Anglo-French Concert from the Salle Gaveau-Raugel Choir and National Orchestra, conducted by Inghelbrecht.

MONDAY, JUNE 27th.

Nat., 5.30 and 6.20, Test Match Commentaries. 7, The Bungalow Club. 8.40, "Mixed Doubles."—Variety. 9.20, World Affairs. 9.35, Julian Clifford conducts B.B.C. Orchestra (B) with Leopold Meunzer, pianoforte.

Reg., 12.30 and 1.20, Test Match Commentaries. 6.30, Teddy Petersen and his Band from Copenhagen. 8, "Wool," a story of Yorkshire life. 9, "Hail Variety!" 9.45, A Visit to the Empire Exhibition at Glasgow.

Abroad.

Cologne, 7.55, Upper Bavarian Folk Melodies.

Bucharest, 8.35, "Quartet in E Minor," (Verdi).

TUESDAY, JUNE 28th.

Nat., 4.40, The Royal Visit to Paris. Commentary by Thomas Woodrooffe, from the Place de la Concorde, during the passing of Their Majesties. 5.30 and 6.25, Test Match Commentaries. 7, Carroll Gibbons and his Orchestra. 8, Film Musical, "Jack Ahoy." 9.20, My Best News Story.

Reg., 12.30 and 1.20, Test Match Commentaries. 8, "Raggle-Taggle"—through Eastern Europe with a fiddle. 8.30, Canterbury Festival of Music and Drama. The Boyd Neel Orchestra from the Cathedral Cloisters. 9.40, Rhythm Classics.

Abroad.

Vienna, 7.20, "Madame Butterfly," opera (Puccini).

Radio-Paris, 9.30, Shakespeare Gala, from the Comedie Française.

WEDNESDAY, JUNE 29th.

Nat., 6.40, 7.45, 9.50 and 10.50, The opera "Figaro" from Glyndebourne.

Reg., 6.30, "General Release," songs from current films. 7.45, From the London Streets—II, with Jay Wilbur and his Band. 8.30, The World Goes By. 9, Dance Cabaret from Bournemouth. 9.40, Speedway Commentary from New Cross; England *v.* Australia.

Abroad.

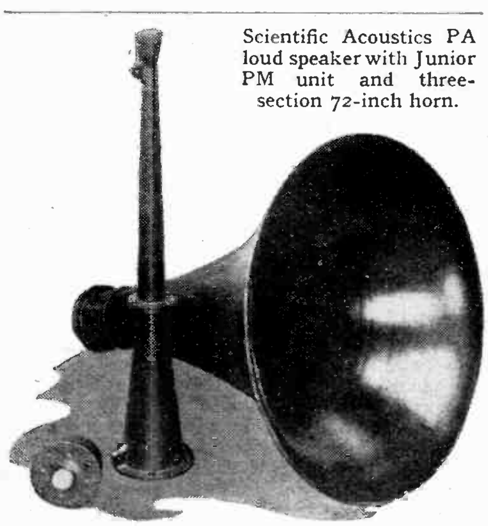
Vienna, 8, "So we Live," German Folk Songs from Klagenfurt.

Not So Bad as All That

IT was rather surprising to find a professional musician of eminence, Mr. Edric Cundell, to wit, Principal of the Guildhall School of Music, roundly accusing the B.B.C. of having missed a golden opportunity of educating the public's taste for good music. I should have said myself, though I am no musician, that the B.B.C. had almost worked miracles in that way in less than sixteen years. Of course, there's light and frivolous music in the programmes, a good deal of the sort of stuff that was once described as sounding like a very sticky sweetmeat, and no small amount of dance music. But can Mr. Cundell seriously contend that the man in the street hasn't now opportunities galore of hearing good music that couldn't possibly have come his way without the aid of the wireless set and the loud speaker? I am sure that in his heart of hearts he can't. There's plenty of good music in the programmes most days, and when you come to think of the "Proms," opera from Covent Garden and Glyndebourne, the Toscanini concerts, relays from Salzburg, Paris, Berlin, Budapest, Stockholm, and other European cities, you'll see how unfounded this charge is. Perhaps the surest proof that the B.B.C. has not missed its opportunities is to be found in the vastly increased knowledge of music shown by the ordinary man and woman now as compared with sixteen years ago.

Long Range Interference

IN the full report of the reception of the Alexandra Palace television programme near Middlesbrough it is stated that most of the interference experienced came from motor cars—or, rather, from their ignition systems. It is also stated that the aerial was some 300 yards from the road along which the cars were passing. Such a long range for interference radiated by ignition systems is probably exceptional; actually, the receiving apparatus had to be made specially sensitive owing to the great distance between its aerial and that of the television transmitter. But even with a normal superhet containing a good radio-frequency stage and one efficient IF stage I should put down the horizontal range of car interference at a good 150 yards. This means that every vehicle with a radiating ignition system that travels on the roads carries with it a circular zone of interference some 300 yards in diameter. And despite published statements that the height to which such interference rises vertically is not more than 25 to 30 feet above its source, I have certain doubts on that point. My own transmission line short-wave aerial is quite 30 feet above the neighbouring road. It certainly lessens this kind of interference, though it doesn't entirely get rid of it. And still we have no legislation on the subject, and still one reads of more and more new cars, many with strongly radiating ignition systems, going on to the roads every week. We certainly can't hope for any immediate relief, for when we do get an anti-interference law at least three years of grace will probably have to be given to cars and strong pressure may be brought to bear to make the period of grace five years or more. And that's that.



Scientific Acoustics PA loud speaker with Junior PM unit and three-section 72-inch horn.

Those Demonstrations

HOW badly receiving sets are often demonstrated to the would-be purchaser by the would-be vendor! It's by no means uncommon to find appallingly bad local interference when a set is switched on; I've known this caused by a charging plant on the premises! The average uninitiated listener who hears any station that is tuned in accompanied by volleys of crackles and bangs quite understandably concludes that the set is not all that it might be and is not particularly impressed by the demonstrator's airy comment, "Oh, that's just local interference; don't pay any attention to those noises!" He can't *help* paying attention to them. And haven't you often heard the set that isn't tuned to exact resonance? And the one that is shown off with its tone control knob in the most boomy position? I'm quite sure that you have.

Scientific Acoustics PA Loud Speaker

THE moving-coil unit upon which tests were carried out was the "Popular" PM model at 5 guineas. Two horns were tried, the "Junior" at £3 5s. for mobile work with 38-inch air column and 18-inch flare, and the 72-inch horn with 32-inch flare at £7 17s. 6d. The latter is built up of cast aluminium sections with a spun metal flare.

In both cases we were very much impressed by the high electro-acoustic efficiency of the equipment and the obvious concentration of the energy in the band of frequencies most likely to give good articulation in speech and clear-cut reproduction of the type of records generally selected for PA work. Percussive transients were projected with excellent attack, and although there was some bias towards the higher frequencies sybilants were not over-emphasised.

The frequency response showed a smooth rise up to 4,000 cycles, and a fairly rapid fall above this frequency, checked at about 9,000 cycles by a subsidiary resonance. The lower cut-off in the case of the small mobile horn was in the vicinity of 200 cycles, but the larger model gives uniform response down to 110 cycles, which conveniently avoids any residual hum which may be present in the amplifiers.

The unit tested has an "Alnico" magnet with a flux density of 12,000 lines and a fabric-reinforced alloy diaphragm. The power-handling capacity is conservatively rated at 10 watts.

The makers are Scientific Acoustics, Ltd., Wembley Hill Estate, Middlesex.

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. A selection of patents issued in U.S.A. is also included.

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

DIRECTION-FINDING

THE directional response of a frame aerial can be represented as a figure-of-eight curve, drawn to polar co-ordinates. In such a curve, the rate-of-change of radius is greater in the minimum or "zero" position than in the position of maximum signals, so that the former is used to give the more accurate bearings of a distant transmitter.

The object of the invention is to improve the sensitivity of a frame or other directional aerial in such a way that the rate-of-change of signal strength is increased both for the maximum and minimum positions. This can be done, for instance, by varying the "gain" of an amplifier valve coupled to the aerial, so that it accentuates any change of signal strength at either of the two "critical" positions. Or a non-ohmic rectifier, the resistance of which decreases with increasing current, may be used to secure the same result.

L. L. Kaess. Application date June 22nd, 1936. No. 481961.

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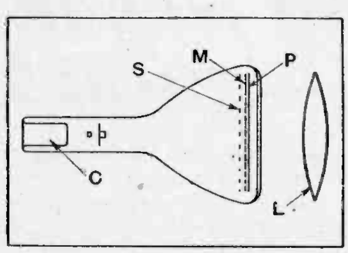
MOSAIC SCREENS FOR TELEVISION

THE picture to be transmitted is projected by a lens L on to a photo-electric screen M of the mosaic-cell type. Electrons are emitted from the screen in varying numbers according to the degree of illumination of each elementary area, and corresponding positive "point charges" are set up and stored on the screen. A parallel mesh-work grid S is located in close proximity to the screen M. The scanning stream from the gun C of the tube is focused (by means not shown) so that it passes through the meshes of the grid S on to the screen M. The potential of the screen must be held negative, relatively to the cathode (or source of the stream), so that the latter is retarded after it passes through the grid S where its density becomes subject to control by the point charges on the screen. The resulting signal currents are collected on a transparent collecting plate P and lead away for amplification.



Television transmitting CR tube described in the text.

Since the negative bias of the screen M makes it difficult to focus the electron stream sharply on its surface, the auxiliary screen S is, according to the invention, given a positive bias relatively to the mosaic screen M so as to produce a positive field in the immediate vicinity of the screen. This is stated to increase the effective storage capacity of the screen S, and to produce a more sensitive response to the incident light from the projected picture.

Baird Television, Ltd., and P. W. Willans. Application dates, October 8th and December 10th, 1936, and February 25th, 1937. No. 482959.

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INCANDESCENT SCREENS

THE usual fluorescent screen of a cathode ray tube is replaced by one consisting of particles of tungsten embedded in carbon, upon which an incandescent picture is formed by the bombardment of the scanning stream. Although it is possible to produce more brilliant effects in this way than can be obtained from fluorescent light, the incandescent screen tends to "lag" somewhat in its response to the action of the electron stream, owing to thermal inertia.

According to the invention, this difficulty is overcome by subjecting the screen (during the interval between successive scannings) to a moderated bombardment by secondary electrons, which are derived from the scanning stream, and serve to maintain the screen at a temperature just below the "glow" point. This not only prevents any "lag," but also reduces the power expended by the scanning stream in producing incandescence.

The metallised screen is spaced a short distance away from a meshwork grid, and a high-frequency voltage is applied between the two. This produces a stream of secondary electrons, which persists for a short time after each scanning interval and serves to keep the screen at a threshold temperature.

Marconi's Wireless Telegraph Co., Ltd., and L. M. Myers. Application date August 10th, 1936. No. 481434.

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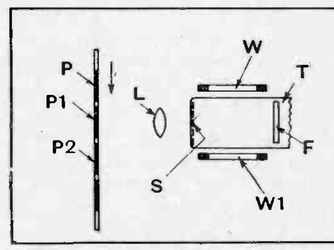
TELEVISING FROM FILMS

INSTEAD of scanning the film directly, the picture is first projected on to a mosaic photo-electric surface of the kind used in the Iconoscope transmitter. This introduces a "storage" effect which helps to intensify the strength of the signals. At the same time, since the film is moved at uniform speed past the projection apparatus, it is necessary to introduce a compensating movement in order to keep the picture, as projected on the photo-electric surface, stationary during the scanning operation.

According to the invention the required movement is applied through an electron-optical system. As shown in the Figure, the successive film pictures P, P_1, P_2 move steadily downwards and are projected one after the other through a lens L on to the mosaic screen S of a cathode-ray tube T. The resulting stream of electrons is focused by the usual means (not shown) on to a fluorescent screen F, and the picture so produced is then scanned by an electron stream



Scanning system for television transmitter when films are used.

from the "gun" or cathode which is located at the far end of the tube from the screen F.

The compensating movement necessary to immobilise the picture on the screen F, in spite of the constant movement of the film P, is imparted to the electron stream by the control field from external windings W, W_1, which are energised by a saw-toothed current supplied from a suitable source.

Telefunken Ges fur drahtlose Telegraphie m.b.h. Convention date (Germany), November 23rd, 1936. No. 482812.

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CATHODE-RAY TUBES

TWO open-mesh grids are placed parallel to each other, just in front of the fluorescent screen of a cathode-ray tube. One carries a higher voltage than the anode, and so serves to accelerate the stream. The other, which is nearer the fluorescent screen, is fed with high-frequency oscillations from an auxiliary valve generator. Each positive pulse from the valve serves to intensify the impact of the electrons on the fluorescent screen, so that the incoming picture signals can be applied to the grid of the auxiliary valve, instead of to the grid of the cathode-ray tube, provided the valve oscillates at a sufficiently high frequency.

A cathode-ray tube of this type requires only comparatively low operating voltages so that it can be worked if necessary from DC mains.

V. Zeitline, A. Zeitline and V. Kliatchko. Application date October 21st, 1936. No. 481917.

o o o o

SHORT-WAVE GENERATORS

THE split-anode magnetron, as used for producing ultra-short waves, consists of a tube in which the cathode is mounted between two half-cylindrical anodes. The latter form part of the main oscillatory circuit, and are connected, usually by a Lecher-wire coupling, to the output aerial or other "load." In assembling the magnetron it is usual to mount the cathode across two supporting wires which are sealed into the glass "pinch" at one end of the tube, the anode being supported from the opposite end.

It is essential for efficient operation that the cathode should be accurately centred between the two halves of the anode, and the normal method of assembling the electrodes renders this difficult. According to the invention, the cathode and the two halves of the anode are both carried by supporting wires which are sealed into the base or "pinch" of the tube. This makes it possible to centre the cathode between the two anode plates, before sealing both the electrodes into the glass in one operation.

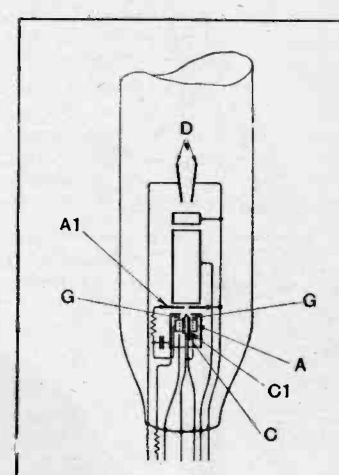
The two anodes are connected together by a single loop of wire, which extends upwards and forms the main oscillatory circuit. This is coupled to a pair of Lecher wires, which are sealed into the top end of the tube and extend downwards.

N. V. Philips Gloeilampenfabrieken. Convention date (Germany) June 12th, 1936. No. 482557.

o o o o

A DUAL-PURPOSE CATHODE-RAY TUBE

IN addition to the main stream of electrons, which passes axially through a cathode-ray tube on to the fluorescent screen, the cathode C is coated with a lower emitting-surface as shown at C_1. This gives off a lateral stream, which is amplified by a cylindrical grid G and anode A, the output being used to supply the operating potential for the first accelerating anode A_1 of the main stream. Or it can be applied to the deflecting plates D. It will be observed that



CR tube which generates operating voltage for one of the accelerating anodes.

although a common cathode is used, separate emissive surfaces are used to supply the main and auxiliary streams.

Radio-Akt D. S. Loewe. Convention date (Germany), October 14th, 1935. No. 483012.

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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.

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EDITORIAL COMMENT

Television Progress

Demonstrations in the Home

IN the Editorial of our issue of June 9th we enquired why television, in spite of its recent technical triumphs, still failed to attract the general public. None of the reasons that are generally adduced seem to be in any way convincing and we put forward the suggestion that a carefully planned questionnaire should be instituted.

Some of our correspondents have implied that in this article we ignored what is, to them, the obvious reason—the smallness of the picture reproduced on ordinary television receivers. It is, perhaps, significant that almost without exception those who put forward this view (with which incidentally we cannot agree) do not claim to be viewers themselves ; in many cases they admit that their ideas of television and its possibilities have been formed as a result of attending public demonstrations.

Those who actually possess receivers in their own homes are almost unanimous in agreeing that the present size of screen is amply sufficient for domestic purposes, and one is forced to the conclusion that the demonstration of domestic television receivers to unduly large audiences fails to achieve the object of stimulating desire for a set.

On the subject of television demonstrations in general the opinions of Mr. G. R. M. Garratt, of the Science Museum, South Kensington, seem worthy of the closest attention. During the long series of public demonstrations at the Museum, which were attended by upwards of half a million visitors, Mr. Garratt must have had an unrivalled opportunity of studying public reactions. He suggests that the psychological atmosphere of public demonstrations is not such as to fill the average spectator with a burning desire to possess a television set, even though he may be more than willing to agree that it is a marvellous technical achievement. But the psychological reactions of such a man to television in his own home are entirely different ; put a receiver into his sitting room and he will probably become wildly enthusiastic, even up to the point of making every effort to retain the set in his possession.

The inference of this is obvious. If demonstrations fail to attract, the industry must, if only to break the ice, devise a selling scheme whereby receivers are installed on approval, without any obligation, in the home of the prospective, but lukewarm, purchaser. Technically there should be little difficulty, as a transportable aerial for temporary installation could easily be devised. Commercial difficulties in the way of this plan undoubtedly exist, but if home demonstrations are indeed so valuable as has been suggested in inculcating the desire for television, it should be worth while taking some trouble to get even a few receivers into homes, as each one so placed would help to sell others to the newly converted "viewer's" friends.

B.B.C. Publicity

Apart altogether from the question of demonstrations, however, there is a widespread feeling among television enthusiasts that the B.B.C. does not make effective use of the power at its command to give sufficiently wide publicity to the attractions of television and its achievements. Within the last week or so an improvement in this direction has been made by giving details of the evening television programmes at the end of the early news bulletins, but we believe that far more could be achieved by the televising of popular sound programmes, such as the variety shows from St. George's Hall. There can be no insuperable technical difficulties, and the idea of being able to see such shows as well as hear them would be a tremendous "draw." Skilfully phrased announcements during the show itself would have a wide influence in stimulating public interest in the advantage of vision. Further, no opportunity should be lost of giving publicity to television broadcasts of national events. We are convinced that such "actuality" transmissions are extremely attractive to the public.

Choke and Transformer Testing

THE IRON-CORED COMPONENT IN PRODUCTION

By "TEST ENGINEER"

METHODS of routine testing as used in factories for checking audio-frequency chokes, iron-cored transformers and similar components. Tests for insulation resistance, short-circuited turns, inductance value, etc., are described.

TO many enthusiastic amateurs the LF Choke is perhaps the least interesting item in a receiver. Tucked away in some obscure corner of the chassis, it does its appointed job without "blue-glow" or noise, needing no adjustment, the strong, silent member of the electrical fraternity. Yet to the engineer responsible for mass-production testing, these iron-cored inductances present problems quite as intriguing and often more involved than do the more spectacular components.

The Test Specification for a typical inductance will probably stipulate the following:—

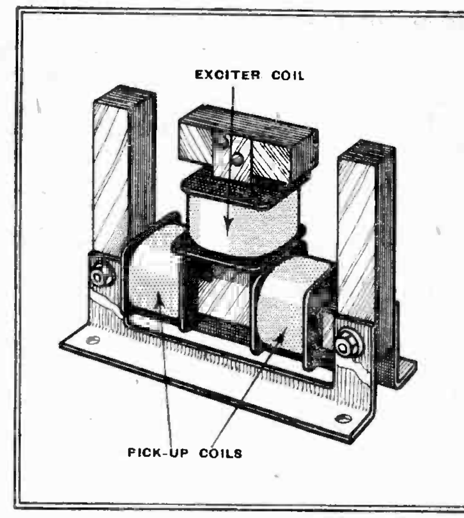
1. DC Resistance—usually with wide tolerances. 2. Shorted turns test details. 3. Breakdown test. 4. Insulation resistance test. 5. Inductance, and for transformers, both output and intervalve. 6. Ratio.

With test No. 1 the engineer's troubles begin. As the completed bobbins leave the winding machines, each is tested for continuity or DC resistance on a simple galvanometer circuit, and if satisfactory is passed to the short-circuited turns test.

An inductance with short-circuited turns would prove unsatisfactory in use, its value being low, while the induced current in the short-circuited section would cause local heating and probably a burn-out.

The system adopted for detecting shorted turns is fundamentally simple, but is capable of various applications. A laminated iron core is constructed, with projecting limbs over which the test winding will be placed. Balanced "pick-up" windings are arranged symmetrically on the core, and an energising winding located to excite the iron circuit at a frequency usually between 250 to 500 cycles per second. A high-frequency excitation current will allow an increased flux density in the test limb, and hence produce a higher voltage in the test coil. This will obviously increase the possibility of breakdown in a coil where the insulation between turns is suspected. A schematic drawing is given in Fig. 1.

When a coil with shorted turns is placed on the test limb, the induced current in the shorted winding will react on the flux in the limb and upset the balance of the "pick-up" circuit. The "out of balance" signal is fed to an indicating device, usually an amplifying valve voltmeter, and a limit figure is given, derived from an average of a number of production coils.



Arrangement of core and bobbins for the short-circuited turns test shown in Fig. 1.

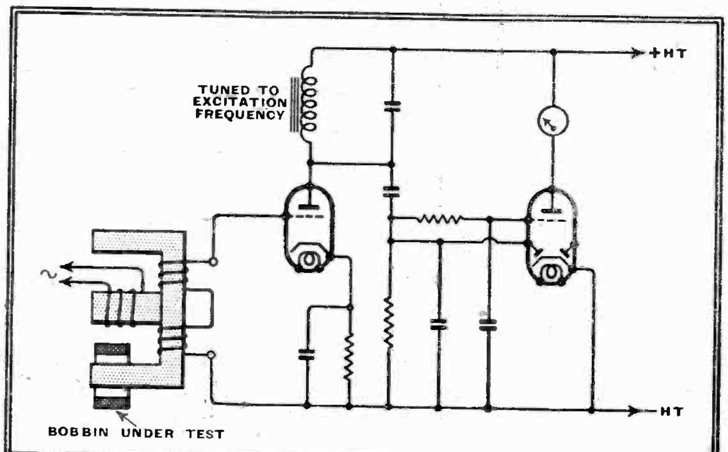


Fig. 1.—Connections of the iron core, shown above, on which bobbins are tested for short-circuited turns.

The windings are then "ironed up" and the gap pieces inserted. These may be bakelite or fibre strips, the dimensions of which are standardised by the laboratory. The completed component then passes to the test bench.

This section includes the equipment necessary for the final tests of iron-cored components, and is located at some strategic point between the winding and assembly shops. Here the completed article is given the third of its specification tests for breakdown.

The component must withstand a pressure of 1,000 volts AC at 50 c/s. The safety of the operator is ensured by arranging for the parts to be jigged, a number at a time, and enclosed in a steel cage. On closing the lid, the test pressure of 1,000 volts is "jumped" from windings to windings, and from windings to core. A breakdown will show by blowing out a trip device or lighting a lamp or similar indicator.

A megger or insulation resistance test follows, consisting of the application of 500 volts DC through a limiting resistor, the leakage current showing on a micro-ammeter calibrated in megohms.

Test 5, for inductance, has given the designer furiously to think. The limit tolerances for inductance are usually wide,

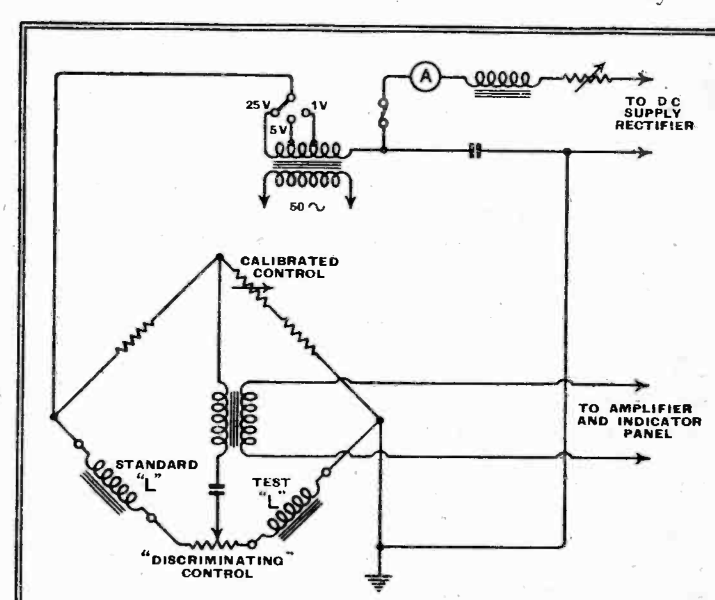


Fig. 2.—A simple form of bridge for routine checking of inductance values. Calibration of the control is in percentage inductance.

Choke and Transformer Testing—
the minimum value alone may often be stated, while for different ranges of receivers different test conditions will be stipulated. Power factor readings are of small interest to production and limits are seldom given.

It will therefore be necessary to provide equipment covering a wide range of inductance values, say from 0.5 to 50 henrys, to supply ripple voltages varying from 0.5 to 25, RMS, and standing currents up to 100 milliamperes DC.

The obvious solution is a form of AC bridge, and this is adopted by many manufacturers. To cover production requirements it may be decided to supply comparison standards, with the attendant disadvantage of storing some 25 standard inductances. Alternatively, a single standard inductance may be included in the bridge with switched multipliers covering the necessary ranges. A simple form of test bridge is shown in Fig. 2.

Provision is made for adjustment of DC and ripple volts, while a resistor is included to increase the discrimination of the bridge; this can be calibrated to give a direct indication of power factor.

In connection with general test procedure, a few points occur which are worthy of interest. It is preferable to provide clamping devices to reproduce the gap dimensions obtained when the component is screwed to the chassis. It is also advisable to provide shock-proof connections to such gear, the "kick" experienced when breaking quite small currents through a high inductance is one to be remembered.

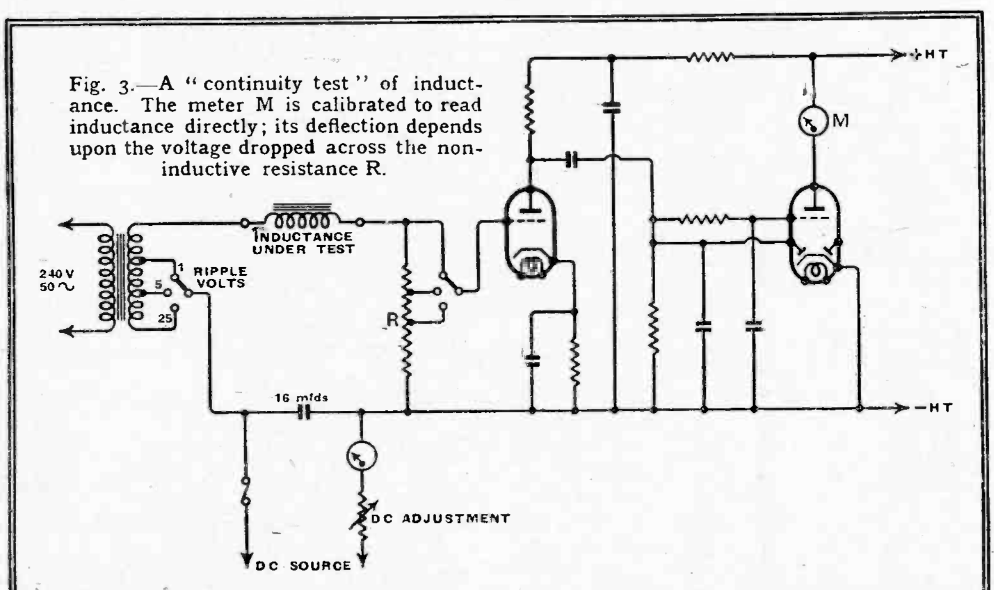


Fig. 3.—A "continuity test" of inductance. The meter M is calibrated to read inductance directly; its deflection depends upon the voltage dropped across the non-inductive resistance R.

A bridge test may be considered too expensive or too slow, and a form of continuity test, as shown in Fig. 3, may be substituted. The accuracy of the bridge method is, in such a case, sacrificed in order to gain a saving in operation times.

The question of ratio testing on transformers is finally to be considered. The simplest test, and one which is sufficiently accurate for most purposes, is to apply the mains voltage—presupposing AC mains—to the transformer primary and to measure the output voltage across the secondary. Precautions to be observed when so doing are to load the secondary to the approximate working impedance, and to use a high-resistance voltmeter. A valve voltmeter is almost essential, even a high grade, 2,000 ohms-per-volt instrument will at best give approximate readings when dealing with intervalve transformers.

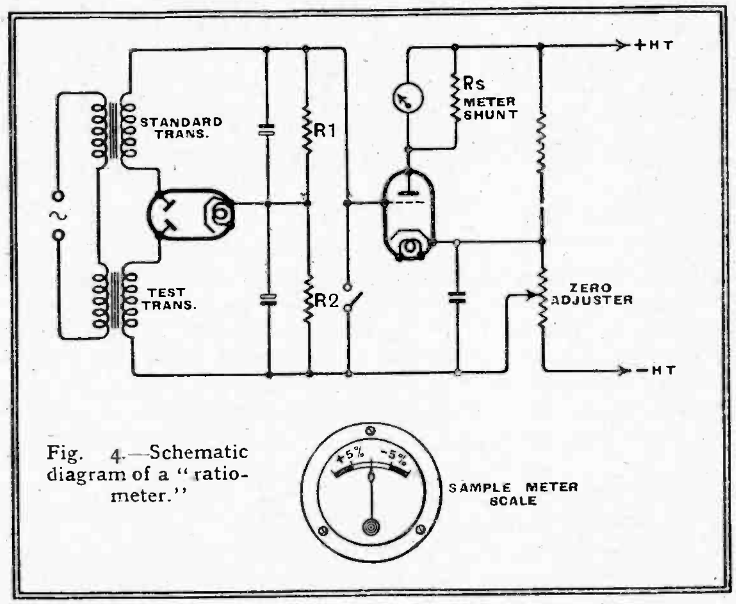


Fig. 4.—Schematic diagram of a "ratio-meter."

Production, again, requires rapid and more effective tests, and the "ratiometer" has been developed to cope with this demand. The basic circuit is simple, the principle being to "back" the test transformer against a standard, and to measure any out-of-balance volts on a suitable indicator. A typical test circuit is shown in Fig. 4.

The transformers are connected to the anodes of a double diode, the rectified output developed across load resistors, R1, R2, being applied to a valve-voltmeter. If suitable "plug in" standard transformers are used, correction shunts, Rs, can be simultaneously thrown across the milliammeter, and a simple scale calibration made to cover a wide range of transformer ratios.

Two further circuits for ratio testing are given in Fig. 5. The first method (a) gives a direct comparison against the applied primary voltage and has the virtues of simplicity and convenience. The resistor R is calibrated directly in ratio, so the application of the test is limited, but both methods are independent of test voltage variation.

The second test (b) simulates the output stage in a receiver, the test transformer and the standard comprising the anode load of the output valve. The test frequencies are applied to the grid, the supply main forming a convenient 50-cycle source, while a local oscillator is arranged to provide an upper test frequency, usually 4,000 c/s. The middle register is hopefully disregarded.

It is not claimed that such equipment will give laboratory accuracy; present production requirements do not call for such refinements. But there are signs of the long-awaited public interest in quality reproduction, and the test engineer, in designing equipment to cover such requirements, will perhaps not regret the headaches developed in so noteworthy a cause.

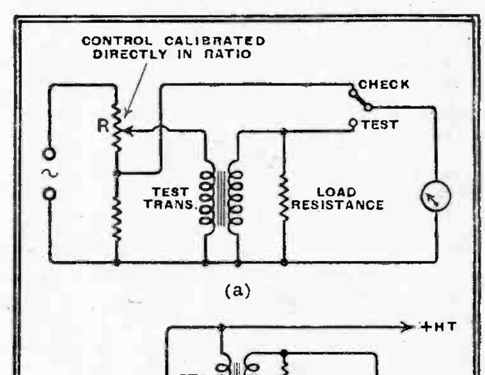


Fig. 5.—Two other methods of checking primary-to-secondary ratio. In circuit (a) the resistance R is varied until "test" and "check" readings of V are equal. The control potentiometer of (b) is calibrated in "percentage ratio."

Developing a High-Quality Communication Receiver

How a Receiver is Designed—XVII.

THE I.F. AMPLIFIER—Amplification and Selectivity at Intermediate Frequency

IN the preceding article we finished at the point where we had decided upon details of the last IF stage and the detector. We now have to consider the IF amplifier as a whole, together with the circuits which are responsible for providing the adjacent channel selectivity. The attainment of the necessary amplification is quite an easy matter, and it is also easy to obtain it with almost any desired degree of selectivity. In practice, however, difficulties come in because we usually want higher selectivity than is possible if the highest modulation frequencies are to be reproduced.

VARIABLE selectivity is an important item in the design of any large receiver, and in this article some of the difficulties encountered with the usual arrangements are discussed. The development of a new system to overcome these difficulties is described and curves illustrating its performance are given.

Since stations are spaced some 9 kc/s apart, it is hardly possible to build equipment which will always eliminate interference from an adjacent channel and at the same time reproduce modulation frequencies higher than about 5,000 c/s. This particular case probably represents the best compromise between the conflicting requirements of selectivity and quality if a receiver is to have one degree of selectivity only. Actually, however, the best compromise will vary on different stations because the amount of interference present will vary according to the relative strengths of the wanted and unwanted signals.

In local reception it is possible to reproduce the highest modulation frequencies, and no interference is found in spite of the use of an unselective receiver, because the local station is so much stronger than any other. For the reception of a very weak signal, however, immediately adjacent to a strong one, we shall need all the selectivity we can get and usually have to tolerate a very large degree of sideband cutting. Obviously, therefore, best results are obtained by making the selectivity variable so that the optimum compromise for any conditions can readily be found. This has been recognised for a long time, and many methods of obtaining variable selectivity have been developed.

The usual arrangement is to build a conventional IF amplifier using pairs of coupled tuned circuits between the valves and to vary the coupling for variable selectivity. In general, with two IF stages three coupled pairs are used and the coupling in two of them is mechanically variable by a panel control. What should happen with such an arrangement is illustrated by the diagrams of Fig. 10, in which curve (a) shows the selectivity at "high," curve (b) "medium," and curve (c) at "low." It is possible for these theoretical expectations to be realised in practice, but, unfortunately, it can be done only if extreme care is taken. What usually happens when the selectivity is varied is that there is some shift in the peak frequency. This is illustrated by curve (b) of Fig. 11, and when the coupling is further increased the correct approach to a flat top is not obtained. Instead of a response such as that shown by curve (c) of Fig. 10, it often approaches curve (c) of Fig. 11.

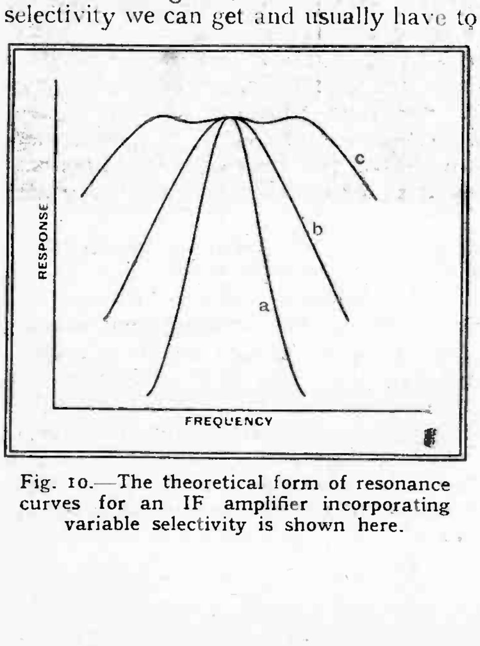


Fig. 10.—The theoretical form of resonance curves for an IF amplifier incorporating variable selectivity is shown here.

Stray Inter-coil Capacity

One reason for this behaviour is a change in the tuning capacity of the IF cells, generally accompanied by an alteration in the capacity coupling between each coupled pair of circuits, and often assisted also by feed-back effects. The coupling between the circuits is usually supposed to consist of mutual inductance only. In all ordinary transformers, however, there is some stray capacity coupling as well, and when the coils are moved physically in relation to one another this is changed in some degree. Moreover, the movement of the coil in relation to the screening can change the capacity between the coil and the can, and therefore the tuning of the circuit. Furthermore, even screen-grid valves have an input impedance which is not entirely negligible and which is dependent upon the applied grid bias. Any change in the coupling affects the gain of the amplifier, and therefore the AVC bias applied to the valves, and so affects the tuning slightly. These effects are often quite noticeable in the operation of a receiver, and the particular distortion of the curve shown by (c) of Fig. 11 often results in audible distortion. These effects are well brought out if a cathode-ray oscilloscope is used with a frequency-modulated oscillator to show the resonance curve, and such gear affords a very good demonstration of how critical the tuning of over-coupled circuits is.

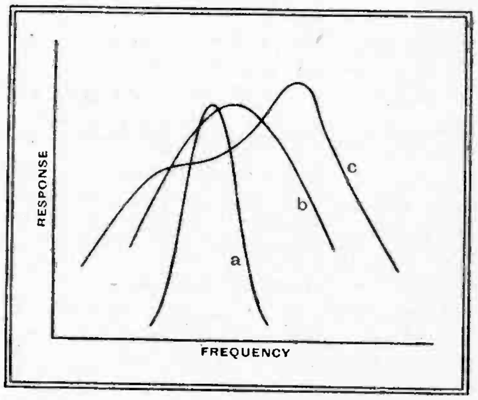


Fig. 11.—In practice, resonance curves like these are usually secured instead of the symmetrical ones of Fig. 10.

We all aim at producing an approach to the ideal resonance curve shown in curve (a), Fig. 12, which has steeply sloping sides and a flat top. In practice we can approach this by using tuning circuits correctly damped and coupled to the correct degree and we obtain a curve such as (b), which is a very good approach to a flat top but is actually somewhat rounded. It is found, however, that it is almost impossible to adjust such circuits without the aid of cathode-ray equipment.

A Simplified Method

If the trimmers are adjusted in the usual way for maximum response the curve invariably degenerates to the form shown in (c). How critical the tuning is with such circuits can be realised when it is said that the mere pressure of the screwdriver on a trimmer screw will shift the peak of curve (c) from one side of resonance to the other. Very good-quality trimmers are needed to adjust a circuit of this nature to give the correct response curve, and for this

High-Quality Communication Receiver—
response curve to be maintained afterwards.

In view of these difficulties and because comparatively few people have cathode-ray equipment available for the adjustment of their receivers, it has been felt

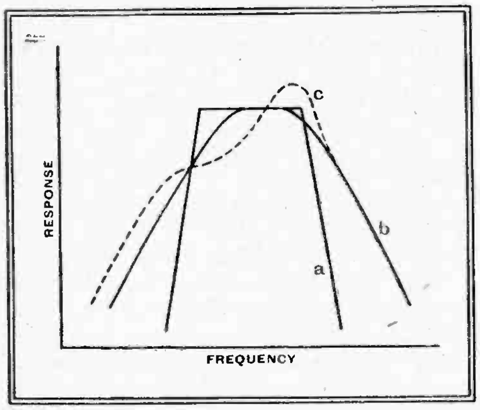


Fig. 12.—The square-shaped curve (a) shows the ideal form of band-pass curve, while the more rounded curve (b) shows the results which can be obtained in practice. Unless cathode-ray equipment is used, however, the curve invariably becomes lop-sided as in (c).

that the only course is to abandon the use of over-coupled circuits and to adopt methods which can be trimmed properly with the aid of nothing more elaborate than an ordinary test oscillator. These difficulties prevent us from adopting the conventional methods of variable selectivity because we shall have to employ fixed coupling between circuits. We shall need at least six good circuits, i.e., three coupled pairs, to obtain the requisite degree of selectivity for bad conditions. The obvious method of reducing selectivity is to shunt each circuit with a variable resistance, but it is clearly impracticable to go to the length of using six variable resistances ganged together. Furthermore, this course would not actually be very satisfactory because the change in selectivity would be accompanied by a very large alteration in the gain of the amplifier.

Continuous Variability Unnecessary

Now, extensive experience with receivers incorporating variable selectivity has shown that it is not necessary for the selectivity to be continually variable. All ordinary requirements are met by a step-by-step variation, and, in general, three degrees of selectivity are sufficient. These three degrees, which we may term low, medium and high, should give at low selectivity a very well-maintained response up to 10 kc/s off resonance, and at high selectivity the response should be at least 1,000 times down at 10 kc/s off resonance. The medium selectivity should approximate more to the degree obtained in an average small superheterodyne, but can well be a little lower if anything. A response of the order of 30-50 times down at 10 kc/s off resonance would seem adequate.

Such step-by-step variation of selectivity can be obtained with a conventional amplifier design by using switches to connect damping resistances across the coils. This is certainly more practicable than the use of variable resistances, but is open to the same objection of varying the gain considerably, and it usually offers mechanical difficulties in the layout of components since everything requires well screening. There is, however, no reason why the conventional IF amplifier should be adhered to. In this amplification and selectivity are obtained together, i.e., the circuits which provide the selectivity are used as intervalve couplings. As an alternative it is quite possible to build an IF amplifier which gives the required gain and very little in the way of selectivity and then to obtain the requisite selectivity from a series of circuits inserted together at a suitable point. For instance, we might build an IF amplifier using, say, heavily damped tuned-anode couplings, which is substantially flat over the sideband range of frequencies and then insert between this amplifier and the frequency-changer our selective circuits.

Use of "Gate" Circuits

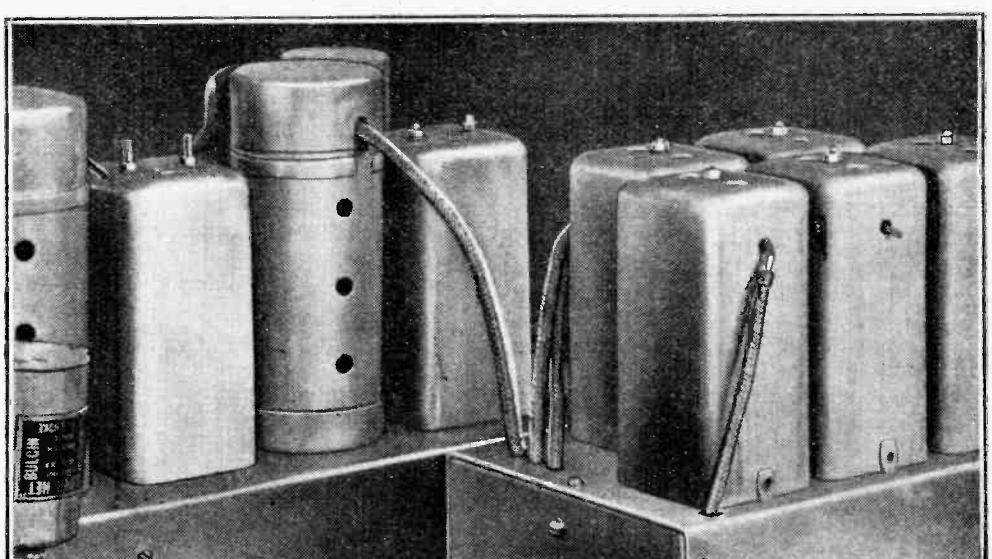
Apart from the convenience of this arrangement there are certain electrical advantages in that at high selectivity the interfering signal is largely eliminated at a point where the signal voltages are very small. When the selectivity and amplification are distributed, as in the conventional arrangement, the interfering signal may reach a much higher value in the IF amplifier and may, in certain circumstances, cause interference through overloading one of the valves. In other words, the suggested arrangement may give less interference than the conventional for the same paper selectivity curve. This is, of course, quite a minor point since the trouble is only likely to arise when one is trying to receive a weak signal on a channel adjacent to a very strong one.

One advantage of the proposed arrangement is that very simple switching can be used if we provide an entirely separate chain of tuned circuits for each degree of selectivity. At first this sounds wasteful, but in actual practice it is doubtful whether it would cost any more than a system utilising the same circuits for the different degrees of selectivity, in view of the complicated arrangements which would have to be made in order to maintain the correct tuning of the various circuits with their different connections.

Some Practical Considerations

The suggested arrangement is outlined in Fig. 13. For low selectivity the switches are in position 3 and a single transformer T5 couples the frequency-changer and first IF valves. This transformer must be designed to pass a wide band, and for this it will require the connection of damping resistances across the windings if the coils are of the usual efficiency. In order to preserve the normal gain as much as possible when the windings are damped the coupling must be much tighter than usual. In fact, it must be of such a degree that in the absence of resistances a double-humped resonance curve would be secured. It is actually possible to employ a standard IF transformer for T5 by picking one which has over-coupled windings so that it normally gives a double-humped response, with a peak separation of the order of 10 kc/s. The resistances are then selected so that a single peaked resonance curve is secured. Usually, with standard components, the resistances will be of the order of 100,000 ohms.

For medium selectivity the switches are in position 2, and T4 then comes into circuit. The precise arrangement adopted will naturally depend upon the precise degree of selectivity required at "medium," but with good coils the writer is of the opinion that a single transformer will just meet the case if the coupling is somewhat sub-optimum and care is taken that the circuits are not damped externally.



This photo shows the experimental IF amplifier with the five IF transformers forming the variable selectivity portion mounted on a small adjacent chassis.

High-Quality Communication Receiver—

When the switches are moved to position 1 a more complex network is inserted, and this is represented by the three transformers T1, T2 and T3. These can coupling are available. The two degrees of coupling involve no mechanical alteration in the interior, but are brought about through the use of a small additional coil tightly coupled to the primary, which can

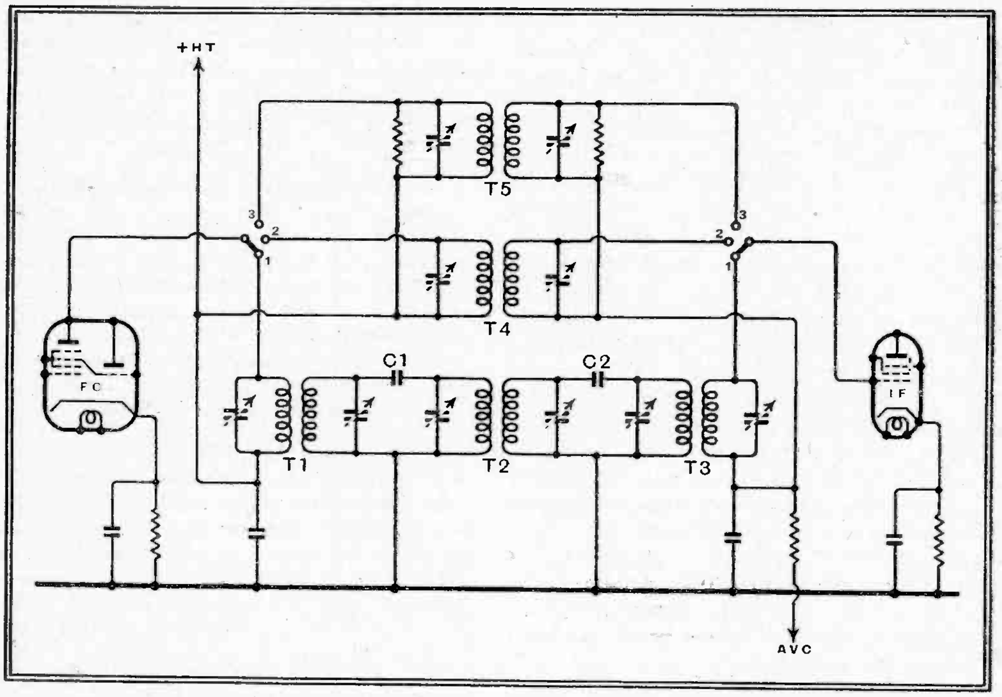


Fig. 13.—A switch-controlled variable selectivity system is shown here which is free from the defects of over-coupled systems. The IF amplifier itself has very low selectivity and is preceded by a chain of selective circuits appropriate to the degree of selectivity required.

actually be three conventional IF transformers of the type employed for T4 coupled together by the condensers C1, and C2. Very loose coupling between the transformers is necessary if correct tuning is to be obtained, for if any attempt at over-coupling is made at this point very peculiar-shaped resonance curves will be secured. In practice C1 and C2 would be about 1 $\mu\mu$F only.

An Experimental Amplifier

Unfortunately, the design of the IF equipment is not so readily carried out as that of AF apparatus, especially if one wishes to make use of standard components, for there are so many unknown factors. Figures are rarely quoted for the inductance of the coils, the mutual conductance between them and the effective RF resistance of the circuits of commercially available IF transformers. It is, of course, always possible to design one's own, but again this must be largely experimental, and it is simpler and more economical to utilise existing components where they are suitable. At this stage, therefore, the design of an IF amplifier usually resolves itself into looking over the IF transformers available and picking out the types which appear most suitable, then building an experimental amplifier, measuring its performance and determining experimentally such factors as damping resistances and coupling condensers. This was done in the case of the circuit of Fig. 13, using the Varley Type BP124 transformer throughout. This transformer was chosen because it embodies high-efficiency coils and two degrees of be included in series with the secondary or not, as desired.

This coil was connected in series with the secondary to give tight coupling in the case of T5, and both primary and secondary were shunted by resistances of 100,000 ohms in value. For T4 the same transformer was used without the damping resistances and without the internal coupling coil connection. Again, these transformers were used for T1, T2 and T3, and again no use was made of the extra coupling coil. C1 had a value of 1$\mu\mu$F, but the connections between T2 and T3 were slightly different. No condenser C2 was used, but advantage was taken of the separate "earthy" end leads for the coil and condenser to use a bottom capacity coupling with a condenser of 0.05 μF.

With this arrangement the curves of Fig. 14 were obtained. Curve A shows the IF amplifier alone and the other curves show the results with the IF amplifier in conjunction with the selective circuits just described. Curve B is for low selectivity, C for medium and D for high. A close examination of the curves shows that the initial lining up was not quite perfect since the peaks are very slightly displaced.

Compensating for Low Gain

Actually, however, this could not be detected in an ordinary listening test and could have been avoided by little more careful initial adjustment. Cathode-ray equipment was not used for the adjustment, which was carried out in the ordinary way for maximum signals just as any constructor would do it. For a drop in response of 6 db. the bandwidths at low, medium and high selectivity are 21.2 kc/s, 6 kc/s, and 3.5 kc/s respectively, while for a drop of 40 db. the bandwidths for medium and high selectivity are 34 kc/s and 10 kc/s. At 60 db. the bandwidth is only 15 kc/s at high selectivity, and at 10 kc/s off resonance the response is 2,000 times down (66 db.).

A general test on signals showed this arrangement to be the best yet handled and to meet all normal requirements. It had, however, one defect. There were considerable changes in gain between

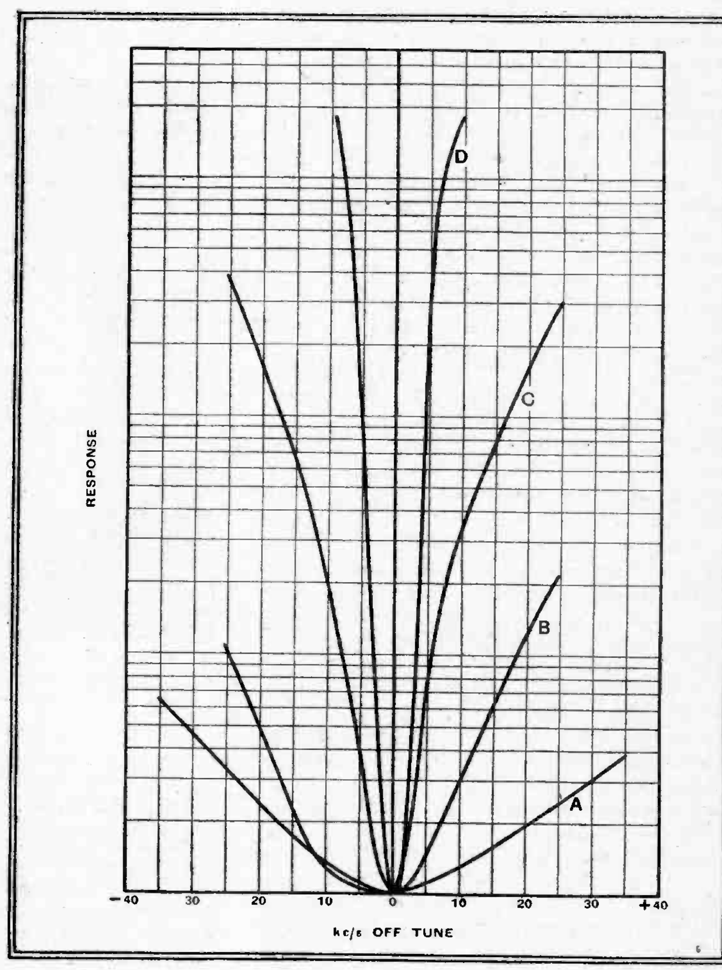


Fig. 14.—Measured selectivity curves are shown here for the arrangement of Fig. 13 in conjunction with an IF amplifier. Curve A shows the response of the amplifier alone, and curves B, C, and D the overall response at low, medium and high selectivity.

High-Quality Communication Receiver—
different degrees of selectivity. The gain was highest at medium selectivity because only a single transformer was used and in its most efficient condition. It was somewhat lower at low selectivity because the transformer was fairly heavily damped. This, however, is no great disadvantage, because one normally wants to use low selectivity chiefly on strong signals. The greatest drawback, however, was that the sensitivity was much lower at high selectivity than in either of the other two positions, and this is the one place where one normally requires sensitivity most.

This is, of course, only to be expected, because even with fairly tight couplings the gain with three transformers can only be about one-third of that with one. In practice one has to employ rather loose couplings, so that the gain is even lower. The remedy is easy, but involves the use of an additional valve. Instead of the high-selectivity chain of Fig. 13, consisting of six coupled circuits, one can use four coupled circuits following the frequency-changer and then introduce a valve before the last two. That is to say, the secondary of T2 in Fig. 13 will be joined to the grid of a valve, and T3 would be fed from its anode circuit. This valve will be utilised, not to increase the gain of the IF amplifier as a whole, but to make up for the losses in the chain of circuits, and it will be adjusted so that the sensitivity of the receiver at high selectivity is the same as, or slightly higher than, that at medium selectivity. The valve will, of course, be only employed in the high-selectivity position of the switches, for in the other two positions it will not be in the signal chain.

In choosing operating conditions for this valve it is desirable to employ the normal anode and screen volts and then pick the bias resistance so that there is little change in gain between positions 1 and 2 of the switches, all circuits, of course, being trimmed accurately. Quite a high bias is likely to be needed, since the stage must give only low gain, and we should consequently pick a variable-mu valve for this position in order to reduce the possibility of distortion through non-linearity. Also, as the valve must be considered as maintaining the efficiency of the selective circuits rather than an amplifier proper, it will not be controlled from the AVC system. The efficiency of AVC will, therefore, remain unaltered in the different positions of the selectivity switch.

On the Short Waves

I DON'T believe that many in high places realise just how efficient an amateur communication network on 56 Mc/s can be. Recently G5MA took out a portable crystal-controlled 'phone transmitter, employing a total of three valves, and with a National One-Ten receiver worked the following stations from Polesden Lacy, near Dorking: G2GG Newbury, G8MG Reading, G8OS Billingshurst, G6OT and G8SK in N. London, as well as G8IX, G2OD, G5RD Abbots Langley, Herts, and G5KH. The most distant station with which good communication was established was G2GG, 44 miles away, and it should be borne in mind that, apart from the 100-volt HT battery on the receiver, the only source of power supply was the 6-volt car accumulator. This transmitter is of the type previously described in these notes, i.e., 6L6 tritet with 20-metre crystal driving a 6N7 double triode as a push-push doubler, this doubler being plate-modulated by another 6L6. A rectifier is not required when the HT is supplied by a self-rectifying device operating from the car battery.

Whatever may be the official opinion regarding amateur co-operation of a general nature in the event of hostilities, this experiment by G5MA only too clearly demonstrates what picked amateurs with "standard" gear of this type could do.

A purely personal observation is that the responsible authorities are not entirely out of sympathy with the idea of obtaining assistance from the amateur, but are appalled at the task of directing the energy which would be released by a general ukase. Then one suggests that, as a basis for further discussion, a limited scheme should be tried, the entry qualification being the possession of a 56 Mc/s crystal-controlled transmitter and receiver having a potential range, 'phone, of 50 miles, and capable of operating for a certain number of hours from one 6-volt accumulator.

The reasons why one chooses the 56 Mc/s band will, I am sure, be apparent to most readers.

These advantages are, roughly (1) for a given mast height the efficiency of an aerial increases as the wavelength is decreased. That is, the "polar diagram" is a function of the height above the ground of the aerial *in wavelengths*, and for an optical path the losses on 5 metres are not appreciably greater than on 10 metres. (2) Signals on 5 metres are, except very occasionally, inaudible outside of a 50-mile radius. (3) There are a great many clear channels in the 5-metre band, and this band is not subject to interference from foreign stations. (4) Car ignition interference is possibly less severe on 5 than on 10 or 20 metres. (6) Only small coils and other components are required, and the apparatus is therefore less bulky. (7) The small physical size of even quite complex directional aerials.

As if to point these remarks on 5 metres, G8TX and G5KH have already been heard testing on 2½ metres, and I believe that a year or so ago G2AW also carried out some tests in the 112 Mc/s band.

Both G8TX and G5KH are, I think, crystal-controlled on 2½ metres, and I hope, too, shortly to be radiating about 10 watts of crystal-controlled 'phone down there.

It will be most interesting to see, as one suspects, whether with a given mast height and power for power, the range on 2½ will not be greater than on 5 metres for quasi-optical transmissions.

To leave the ultra-short waves, it must be recorded that conditions above 10 metres have been very good recently.

The G.E.C. Schenectady transmitter W2XAD on 15.33 Mc/s still continues to head the list for fine and stable performance, but W3XAL on 17.78 Mc/s has been a much improved signal in the early evenings, and is now of good programme value.

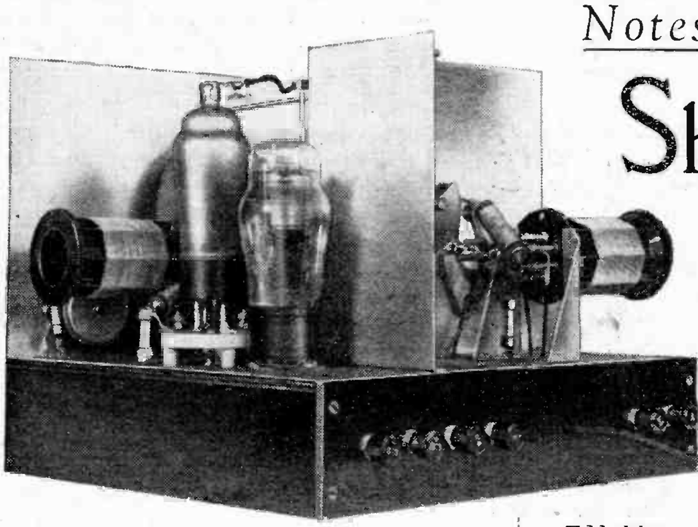
On Saturday, June 18th, W2XE on 17.76 Mc/s was a particularly fine signal in the afternoon, surpassing W3XAL both in carrier strength and modulation depth. With correct tuning a weak heterodyne from DJE was practically unnoticeable until quite late in the afternoon. I believe this use of 17.76 Mc/s by W2XE is a temporary measure, and that he will ultimately revert to 21.52 Mc/s for afternoon transmissions.

Judging from the performance of the Lawrenceville 'phone transmitters, the optimum frequency from the U.S. in our afternoons and early evenings is about 19 Mc/s, which means that the broadcasters must choose between the 21 and 17 Mc/s band. The former often gives excellent results, but the latter is probably the more reliable at this period of the year. It is, however, interesting to note that peak "summer-time" conditions do not generally occur on the England-U.S.A. route until July. Even the ionosphere seems to suffer from a hang-over!

At the time of writing a large stream of sunspots, showing signs of spectroscopic activity, is approaching the sun's meridian, so don't forget to look out for sudden daylight short-period fade-outs, and the ionosphere and magnetic storms which may occur some 36 hours later if the particles emitted by the eruption reach the earth.

ETHACOMBER.

G6CJP working on 14 Mc/s during the R.S.G.B. National Field Day on June 11th and 12th, when the British Isles were represented by 27 portable field stations.



Notes on the—

Short-Wave Three

Improving Detector Efficiency and Extending Waverange to 190 Metres

By
H. B. DENT

In this article the author explains how an improvement can be effected in the detector stage and then gives the winding data for a new set of coils to cover the 1.7 Mc/s amateur band. Five-metre reception on this set is also discussed.

ANYONE who has designed and built a short-wave receiver will agree that, no matter how much thought is given to it before the set takes practical form, there are always a few improvements that can be made after it has been in use for some time.

If all goes well during the early tests and the set is definitely better than any previously handled, one is reluctant to "fiddle" with it, but after a time and when the newness is beginning to wear off, the urge to see the effect of a change here and there becomes overpowering and a few modifications are accordingly made.

Short-wave sets do not wear out; admittedly they go out of date in time, but the set of the enthusiast rarely exists long enough in its original form to become a museum piece.

Extending the Waverange

The Short-Wave Three which was described in the issues of May 12th and 19th last has been subjected to a few searching tests of this nature, mainly, it must be admitted, in regard to investigating the possibilities of extending the wave-band coverage, firstly, to take in five metres and, secondly, to fill in the gap between 80 and 200 metres.

In the process it transpired that a general improvement could be effected by changing the AF coupling in the anode of the detector from resistance to choke-capacity, the modifications suggested being shown in Fig. 1. In addition to this, resistance R6, in the original circuit, which forms one link of the detector screen-grid potentiometer, is reduced to 25,000 ohms and the 50,000-ohm resistance removed is inserted between the slider of R7 and the screen-grid connection on the valve-holder. This is shown in Fig. 1 as Rv. The RF by-pass condenser C10 must be joined from this point to the earth line direct and not left joined to the slider of R7 as formerly.

An AF choke of high inductance is required in the anode circuit of the detector in order to give an adequate impedance at the low audio frequencies, and this is conveniently obtained with a Bulgin type LF37 AF transformer by joining the primary and secondary windings in series.

This transformer has different coloured leads, the series connection being obtained by joining the grey and the green together, connecting the yellow to the anode of the valve and the red to HT. It provides an inductance of about 200 henrys, and in order to maintain the impedance reasonably constant over the audio range it is shunted by a resistance (Rx) of 100,000 ohms.

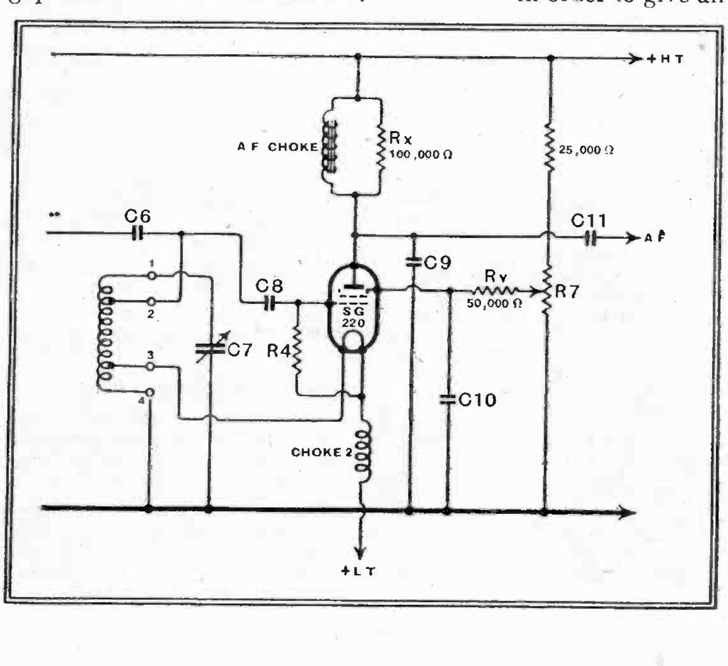
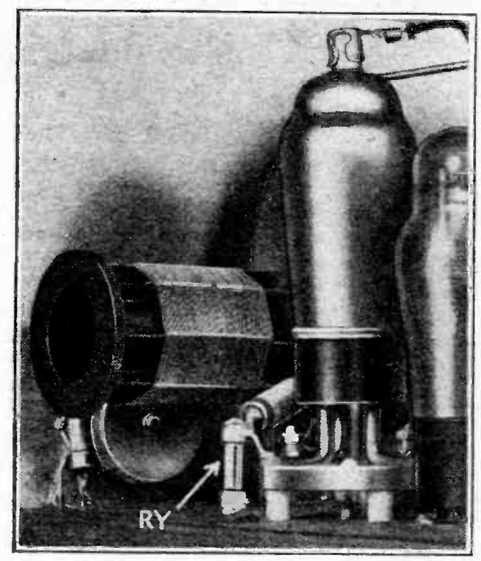


Fig. 1.—Revised circuit of the detector stage in which choke capacity coupling is used. Values of the few extra components required are also given.

Better detector efficiency and an improvement in the quality of reproduction accompanied this change and many stations hitherto only a good headphone signal became strong enough to put on to the loud speaker. It was also noticed that oscillation on the ultra-short wave range, covering the sound transmission from Alexandra Palace, was more readily obtainable.



One of the new coils is shown plugged into the detector coil-holder while just in front of it is seen the 50,000-ohm resistance RY joined to the screen grid terminal of the valve-holder.

Very little success has so far attended the attempts to bring five metres into the range of the set. Such difficulties have, in fact, been experienced with other TRF receivers not intended primarily for ultra-short wave reception. The fact must be faced that for really satisfactory five-metre reception a set designed especially for the ultra-high frequencies will have to be used.

The position is that some SG 220 valves will oscillate down to five metres but others will not. Out of three tried, one oscillated quite readily when the metallising was removed; another oscillated down to about 5.5 metres when treated in the same manner, but the third specimen

Notes on the Short-Wave Three—

ceased to oscillate below about 6.5 metres.

In view of this uncertainty of operation, it is felt that no good purpose would be served by proceeding further with the matter.

The fact that oscillation was not obtained does not necessarily mean that the valves are unsuitable for use on the ultra-high frequencies; it only indicates that a different kind of circuit with a more suitable layout is required.

One can, however, with confidence undertake an extension of wavelength at the other end of the range, though a departure from the practice adopted on the four ranges for which coils were given has to be made. It will be recalled that identical windings were used for both aerial and RF coils, but this no longer holds good for the fifth range.

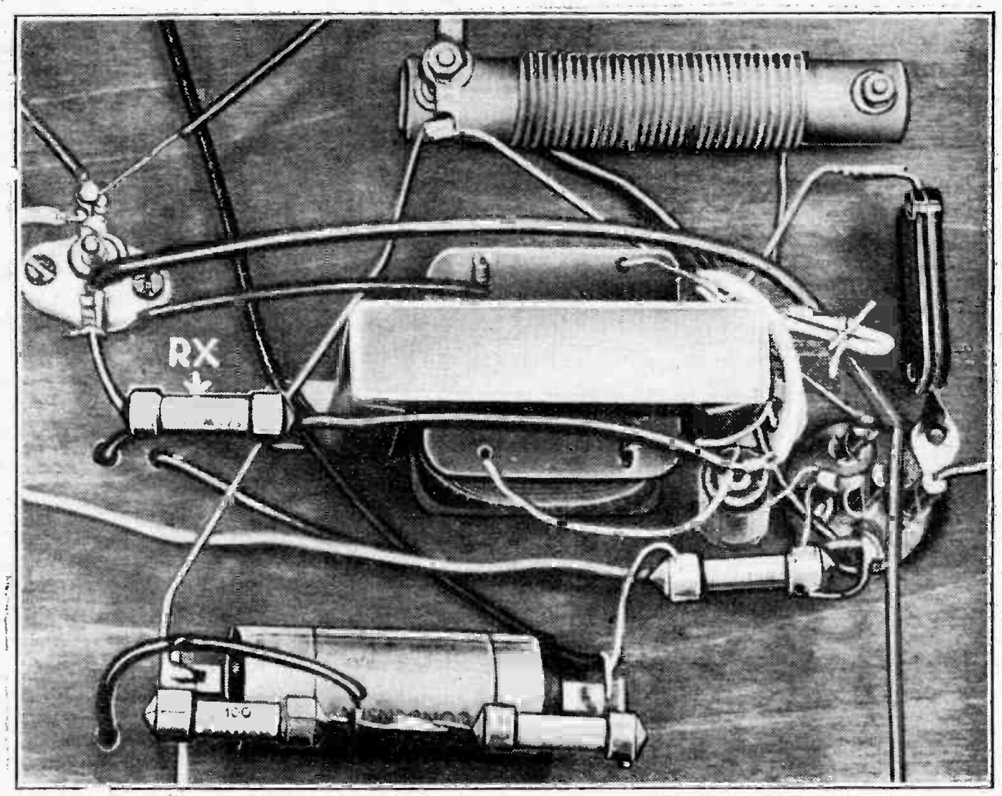
Coils for 1.7 Mc/s Band

The coils for this range cover 80 to 190 metres; they are wound with No. 24 SWG DSC wire and in three sections, the connection being the same as the coils for ranges 3 and 4. Both coils have 60 turns which are close-wound, that is to say, the turns are not spaced as on all the other coils.

On the RF coil the section nearest the top of the former has six turns, the next one down 39 turns and the lower section 15 turns.

In the case of the aerial coil, the top section consists of 15 turns, the middle one has 30 turns and the lower one 15 turns. This dissimilarity comes about because while six turns are adequate to produce oscillation in the detector stage they are not sufficient for aerial coupling. On the other hand, 15 turns are far too many for the detector stage, as the valve oscillates with such a low screen voltage that the detector is not operating at its best. To avoid confusion, identifying marks should be inscribed on the top of each coil former.

This opportunity will be taken to point out that when assembling the two Bulgin volume controls R3 and R7 the insulating washers must be used, as their spindles are in electrical contact with the moving arm. Incidentally, R3 is intended to be used as an RF volume control. It could be omitted and a fixed resistance of the same value used in its place, though it is a useful control when wearing headphones, as there is no other means of cutting down the volume of signals when receiving CW transmissions.



The AF choke can be accommodated quite easily underneath the chassis, being shown here mounted between the output valve-holder and the small stand-off insulator. The resistance RX is the 100,000 ohms shunted across the choke.

News from the Clubs

Bootle and District Amateur Transmitting Society

Hon. Sec.: Mr. C. E. Cunliffe, 368, Stanley Road, Bootle, Liverpool, 20.

This Society is open to any person interested in amateur transmitting, SW reception, quality or high-powered amplifiers, and general radio engineering. Those interested are invited to apply to the Secretary for full particulars and an application form.

Dollis Hill Radio Communication Society

Headquarters: Braintcroft Schools, Warren Road, London, N.W.2.
Meetings: Alternate Tuesdays at 8.15 p.m.
Hon. Sec.: Mr. E. Eldridge, 79, Oxgate Gardens, London, N.W.2.

On May 22nd a party took part in the Field Day organised by the Golder's Green Society. On June 19th a 5-metre Field Day was held in the Hatfield district.

Owing to holiday arrangements the series of talks to be given by Mr. S. C. Ash has had to be postponed.

Surrey Radio Contact Club

Headquarters: The Alhambra, Wellesley Road, Croydon.
Meetings: First Tuesday in the month at 8 p.m.
Hon. Sec.: Mr. A. B. Wilshire, 14, Lytton Gardens, Wallington.

On June 7th a meeting was held at which members were selected at random and called upon to give a talk of not less than five minutes' duration on a technical subject chosen by the Committee.

Several of the club members co-operated in erecting a station for the R.S.G.B. Field Day. The 14-megacycle band was used. The transmitter was a single 6L6 tri-tet, using members' 7-megacycle crystals in order to provide changes of favourable frequencies. The input was 12 watts. The receiver was the Club's 56-megacycle O-V-1, which uses plug-in coils.

The next meeting will be on July 5th, when a member will give a talk entitled, "Hints and Kinks."

Sound 41.5 Mc/s.

Television Programmes

Vision 45 Mc/s.

THURSDAY, JUNE 30th.

2.30, O.B. from the Centre Court at Wimbledon of the Tennis Championship Meeting. **3.40,** 159th edition of Picture Page. **4-5,** O.B. from Wimbledon continued.

9, Cabaret, including Talbot O'Farrell and the Music Hall Boys. **9.25,** British Movietonews. **9.35,** 160th edition of Picture Page. **10.5,** News Bulletin.

FRIDAY, JULY 1st.

2.30-5, O.B. from the Centre Court at Wimbledon of the Tennis Championship Meeting.

9, Speaking Personally. **9.10,** Film. **9.20,** Cooking Demonstration by Marcel Boulestin. **9.35,** Gaumont-British News. **9.45,** "Rogues' Gallery," a revue of the songs of law-breakers. **10.15,** News Bulletin.

SATURDAY, JULY 2nd.

2.30-5, O.B. from the Centre Court, Wimbledon, of the Tennis Championship Meeting.

9, "On the Spot," the play by Edgar Wallace. Cast includes Arthur Gomez, Gillian Lind and Queenie Leonard. **10.30,** News Bulletin.

SUNDAY, JULY 3rd.

8.50, News Bulletin. **9.5,** Colonel W. de Basil's Ballet Russes in a studio rehearsal. **9.35,** Cartoon Film. **9.40,** Gaumont-British News. **9.50,** Scenes from Shakespeare.

MONDAY, JULY 4th.

2.50-4, Polo O.B. from Hurlingham—India v. The World.

9, "Androcles and the Lion," an old fable renovated by George Bernard Shaw. Cast includes Esmé Percy and Guy Glover. **10,** News Bulletin.

TUESDAY, JULY 5th.

3-4.10, "The Tragedy of Julius Caesar," by Shakespeare. Title rôle played by Ernest Milton, Antonius by D. A. Clark-Smith and Marcus Brutus by Francis L. Sullivan.

9, Cabaret, including Ronald Frankau, Afrique, and Charles Higgins. **9.35,** Cartoon Film. **9.40,** Golf Demonstration. **9.55,** Gaumont-British News. **10.5,** Music-makers. **10.15,** News Bulletin.

WEDNESDAY, JULY 6th.

3, Forecast of Fashion. **3.15,** Cartoon Film. **3.20,** Starlight. **3.30,** Gaumont-British News. **3.40,** "First Prize a Lady," an operetta, by Offenbach.

9, Forecast of Fashion. **9.15,** British-Movietonews. **9.25,** "Bardell against Pickwick," scenes from the "Pickwick Papers," by Charles Dickens. **9.50,** Tennis Demonstration by Danny Maskall. **10,** News Bulletin.

UNBIASED

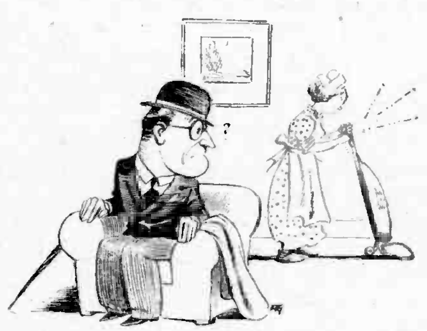
By FREE GRID

Send This to Your M.P.

I HAVE always been one to pride myself on the fact that when I undertake any job I invariably throw my whole heart and soul into it, being a great believer in the old saying that what is worth doing at all is worth doing well. Consequently, when Mrs. Free Grid recently informed me once more that she hadn't a rag to her back and in addition the household vacuum cleaner was falling to pieces, I hastily telephoned through for a bag of the very best assorted rags, together with the most expensive vacuum cleaner obtainable fitted with the latest type of interference suppressors.

Unfortunately, the bag of rags was not well received, but I had at least expected a word of commendation for the vacuum cleaner, which was the very best that money could buy. It was, I noticed, viewed with extreme suspicion and later in the day I noticed that Mrs. Free Grid went out for an hour, during which the maid behaved strangely, constantly switching the cleaner on and off just as though she were endeavouring to signal by means of the morse code.

It was not until Mrs. Free Grid came back that I had any inkling of what it all meant. On her return she peremptorily ordered the thing to be packed up and returned to the shop and a "really decent one obtained." Mrs. Free Grid herself went along to choose the new machine and, somewhat mystified, I awaited its arrival. I must say it looked expensive enough with its gleaming chromium plate, but somehow or other I was suspicious of it and a little investigation proved that my suspicions were not ill-founded, as not



"The maid behaved strangely."

only were there no suppressors fitted but its suction powers were very poor as it completely failed to lift the cat when applied to its back, a rough-and-ready test which I always find very effective. The lack of suppressors was easily remedied, but when I opened up the cleaner I was appalled by the mingy specifications of the motor and was still gazing at it when Mrs. Free Grid came into the room and to my amazement rated me soundly for trying to fit suppressors, and it was only then that I learnt the truth.

It appears that in these degenerate days not only is it every woman's ambition to go one better than her neighbours in clothes, but this state of affairs often extends to vacuum cleaners. The unusual point of the whole affair is, however, the women's method of assessing the value of a vacuum cleaner, which is none other than its ability to create the most noise on neighbouring wireless sets. It appears that when Mrs. Free Grid disappeared on the arrival of the vacuum cleaner I had bought, leaving the maid to do a sort of amateur morse code business, she had immediately gone to a neighbouring house to try and listen in to it.

Modern salesmen have not been slow to take advantage of this aspect of female psychology, and the best selling vacuum cleaner is the one that creates the most interference on neighbouring wireless sets. It is obviously of little use the P.M.G. appealing to the better natures of electrical apparatus manufacturers while this sort of mentality prevails, and the sooner legislation is passed the better. I am sending these rough notes to my M.P., and advise you to cut them out and do likewise to yours.

The Desert Song

I DON'T know if many of you listen to the foreign languages transmission from Daventry. Personally, I don't, as I am bothered by the skip-distance effect and I cannot, therefore, say from my own experience whether these particular programmes maintain the high standard of interest which they ought to do. From time to time, I must admit, I have heard certain derogatory remarks concerning them, but I usually treat such malicious gossip with the contempt it deserves, preferring to make my own criticisms.

Recently, however, I heard a rumour of such a serious *faux pas* which the B.B.C. Arabic programme department were about to commit that I made a special journey by 'plane to the Sahara in order to listen-in, as this happens to be a part of the world where Daventry's "Arabic" sky-wave comes down for a breather, and so signals are abnormally strong. The rumour, which proved only too true, was to the effect that one Auni Daoudi, an Arab gentleman who is a graduate of Cambridge and at present pursuing his studies at Oxford, was to address the B.B.C.'s Arabic listeners on the "History, Organisation and Functions of the Universities of Oxford and Cambridge."

Now, as I have had occasion to mention before, I have a fair smattering of the variations of that great group of languages usually referred to somewhat loosely as Arabic, and at the same time a considerable knowledge of the manners and customs of the peoples who speak these tongues. This knowledge, as my older readers will recollect, was culled during some very specialised radio research work which I undertook "out there" on behalf of the Government in the War years, and about which I wrote at some length in these columns a year or two ago.

It was with considerable misgiving, therefore, that I listened to this ponderous and learned talk on the origin of our great universities, as, frankly, I cannot imagine how it could appeal to an Arab resting

"Beside me in the wilderness."

at a lonely oasis in the burning desert and sitting with his camel and his portable wireless set under the shade of a friendly palm tree; in fact, I think it would be distinctly irritating. When a man and his sweating beast are snatching a brief respite from the scorching heat of the desert, he does not feel in the mood to enter into the scholastic calm and detachment of our great universities, as I found by personal experience.

Coincidence or Piracy?

I HAD occasion the other day to complain of the way in which self-styled inventors "pirate" the various ideas for radio and scientific improvement which I put forward from time to time in the pages of this journal. I gladly publish these ideas without fee or favour, my sole reward being that inward satisfaction that comes of having done something to benefit my fellow-workers in the scientific world. I think, therefore, that the least they might do would be to make some small acknowledgment when they "borrow" an idea from these pages.

I am moved to utter these words of rebuke owing to a newspaper cutting which a kindly reader has sent me in which it is stated that a patent has just been granted in Washington for a "silent horn" for motors. The details given of this device read suspiciously like those which I published in these columns on December 16th last.

The Aerial Connection

Concluded from page 549 of last week's issue

EXPERIMENTS WITH THE HIGH-INDUCTANCE PRIMARY METHOD

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

IN the first instalment of this article the author stressed the importance of the aerial coupling from various points of view. He now describes the result of experiments on the properties of the "big primary" type of coupling, which helps to reduce misalignment of the ganged tuning system of a receiver.

WE are now ready to investigate the effect of connecting the aerial, and Fig. 5 shows the capacity disturbance due to this addition. Evidently the outdoor aerial has a lower capacity than the artificial aerial. Note that the effect of coupling through the high-inductance coil is equivalent to a negative capacity; in other words, an inductance. The outdoor aerial, being low in capacity, therefore resonates at a higher frequency and causes *more* mistuning than the higher capacity aerial.

Looking at these curves, one might suppose the tapped coil (or low-L coil) method to have the advantage. Not only does the high-L coil show the greatest number of $\mu\mu$F mistuning, but the amount varies enormously over the tuning band; whereas with the tapped coil it is so nearly constant that a large part of it could be neutralised by the trimmer. Even with the closest coupling (tap 3) and outdoor aerial, by reducing the trimmer capacity by 4.9 $\mu\mu$F, the mistuning is restricted to ± 0.5 $\mu\mu$F. On the other hand, it must be remembered that it is kc/s mistuning rather than $\mu\mu$F that counts, and in this respect $\mu\mu$F are worse at the high-frequency end than at the low. Also it is clear that the trimmer adjustment recommended would be badly out if another aerial, having the characteristics of the artificial, were substituted; whereas with the high-L coupling coil the change of aerial makes little difference except at the low frequency end where capacity error matters less. And not only do $\mu\mu$F count more heavily at the high-frequency end, but they impair selectivity, which is already relatively poor.

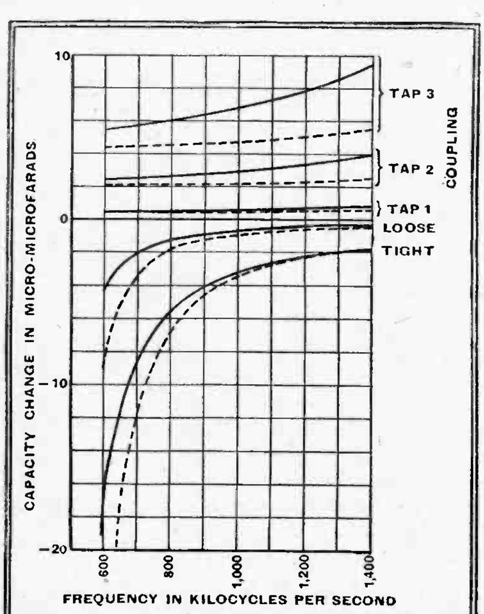


Fig. 5.—Capacity added to the tuned circuit by connecting the aerials in the ways indicated. The full lines refer to the artificial aerial; the dotted lines to the real aerial.

So to give a truer picture the next thing is to work out the kc/s mistuning. Before plotting the results of this in Fig. 6 the capacities have been adjusted by a constant amount (to simulate trimmer adjustment) for each coupling to give what was judged to be the best compromise *for the artificial aerial*. No readjustment has been made for the outdoor aerial. As a matter of interest, here are the actual adjustments, which can be compared with Fig. 5:

Tapped coil : tap 1	... ...	−0.7 $\mu\mu$F.
" " " 2	... ...	−3.8 "
" " " 3	... ...	−9.0 "
High-L coil : loosely coupled...	...	+0.5 "
" " tightly coupled ...	...	+2.0 "

The magnitude of the mistuning which may result if the tapped coil is not trimmed to its particular aerial is now revealed. With No. 3 tap the connecting of the outdoor aerial results in about 3½ channels mistuning at the high-frequency end! Not only is the high-L coupling less dependent on aerial characteristics, but on the whole the mistuning is less. Still, it cannot be ignored that the worst mistuning occurs below 900 kc/s, where the most important medium-wave channels are situated.

Another picture of the situation is Fig. 7, where the selectivity is plotted against tuning. Its story can be summarised by saying that the tapped coil tends to increase the already wide natural difference in selectivity over the waveband, whereas the high-L coupling tends to level it out. No account is taken here of loss of selectivity due to mistuning—only that due to damping introduced by the aerial. The effects of mistuning would of course tend to accentuate the results shown.

Coming at last to what most readers will regard as the essential internal organs of the matter, Fig. 8 shows the signal step-up. One gathers from it that the high-L coupling gives a signal transfer that is rather small, but very uniform over the waveband. The uniformity is particularly marked when account is taken of signal loss due to mistuning, shown by dotted lines. Increasing the closeness of coupling increases the signal transfer (up to a point, which is not exceeded by any of the couplings tested), but it also increases the mistuning, and as can be seen at the extreme low-frequency end the loss may outweigh the gain. The low-L coupling or tapped coil gives a very much stronger signal on the average, but the advantage is mainly towards the high-frequency end. Obviously, on the evidence shown, tap 2 would be chosen in preference to 3, for the net signal strength is almost identical, while the selectivity and mistuning are considerably better.

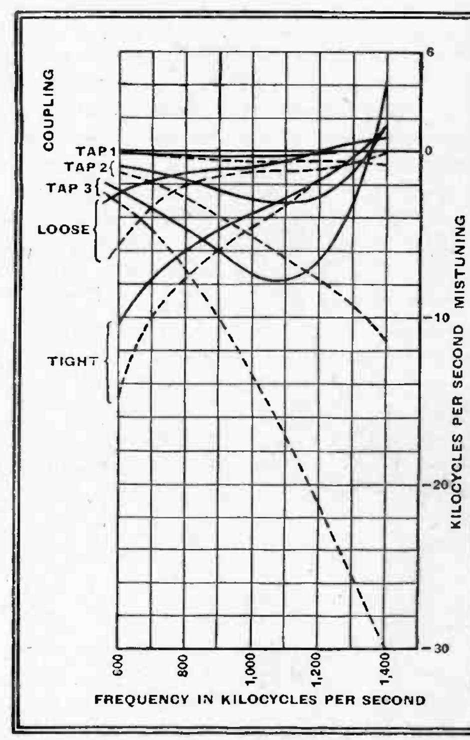


Fig. 6.—The results of Fig. 5 expressed as kilocycles mistuning, after allowing for trimmer adjustment to suit the artificial aerial. Dotted lines again show results with outdoor aerial.

"Cathode Ray" has in the past stressed the importance of a good signal transfer in long-range receivers, not entirely be-

The Aerial Connection—

cause of signal strength as such (for that is easily obtained by using a sufficient number of valves), but to get a good signal/noise ratio. When more than about four valves are efficiently used, one gets into the region where inevitable valve and circuit noise is heard, and further amplification only increases its loudness. It is then important to secure the highest possible transfer of signal from the aerial. In most normal circumstances the best signal/noise ratio is obtained by a coupling even closer than "optimum," but, because of the resultant mistuning, that is generally impracticable except perhaps for reception on one fixed frequency.

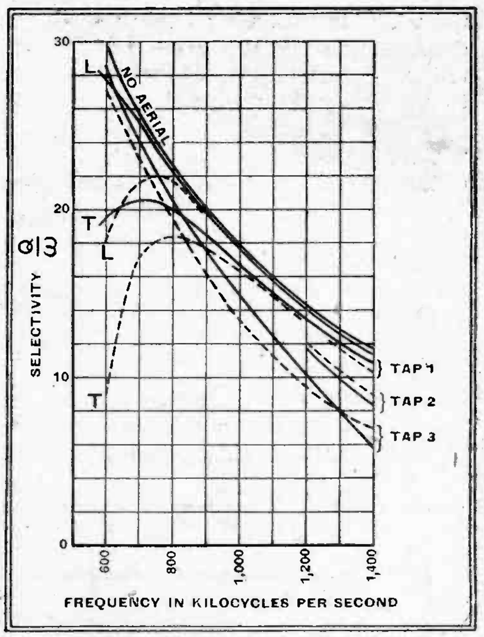


Fig. 7.—Showing effect of aerial coupling on selectivity. The additional loss of selectivity due to mistuning is not taken into account. Full lines, artificial aerial; dotted lines, outdoor aerial. T and L indicate tight and loose coupling respectively.

Signal Transfer

"Optimum" coupling is that which gives the greatest possible signal transfer. Let us look into this a little more closely. At any given frequency the aerial can be represented by a signal generator in series with a resistance and capacity (Fig. 9). There may be inductance, too, but as that is equivalent to a negative capacity it can be allowed for in reckoning C_a. However, in putting together an artificial aerial some inductance is usually included in order to get an approximation to a real aerial over a band of frequencies.

L_p represents the coupling, which may take the form of an actual coil as shown, or may be a tapping on the tuned coil L_s, or may even represent a capacity coupling. L_sC_s is the tuned circuit, which at resonance is equivalent to a comparatively high resistance R, and has a "magnification" Q. The meaning of the latter term can be appreciated by supposing a signal of, say, 1 volt injected at the point X in some way so as to cause no increase in the circuit losses. Then if the circuit is tuned to that signal, a voltage Q times as great is developed across the input to the valve.

But in reality the signal comes from the aerial (it is represented in Fig. 9 by V_1), and the coupling that is necessary to communicate it to the tuned circuit unfortunately communicates some of the aerial's resistance and reactance (capacity or inductance effect) also. This has been confirmed by the foregoing experiments, in which the aerial coupling has caused the parallel resistance R to fall (corresponding to increased series resistance) and the tuning to be shifted due to aerial reactance. It can be proved mathematically that optimum coupling is that which causes R to be reduced by a half. This condition is very closely reached by tap 3 from the artificial aerial at 1,400 kc/s, and it is seen that that happened to be the highest signal transfer gained. The fact that tap 2 is only very slightly lower at that point does suggest that it is nearing the limit or optimum. As the tuned circuit Q is now also down to a half, one might suppose that the signal transfer $\frac{V_2}{V_1}$ could by no means exceed this reduced amount. In fact, as V_1 is only indirectly connected with the tuned circuit, and has aerial losses (r_a) to contend with on the way, there is good reason to expect $\frac{V_2}{V_1}$ to be considerably less than half the original Q. And that is borne out in practice; but it is not universally true. Theoretically there is no limit to $\frac{V_2}{V_1}$, which could even be much greater than the original Q! How that comes about is that if r_a is very small it is possible to employ a high step-up ratio from L_p to L_s without materially increasing the losses of the tuned circuit or losing the signal in r_a. But as aerial losses are generally a good deal worse than those in tuned circuits, such favourable results are not commonly achieved.

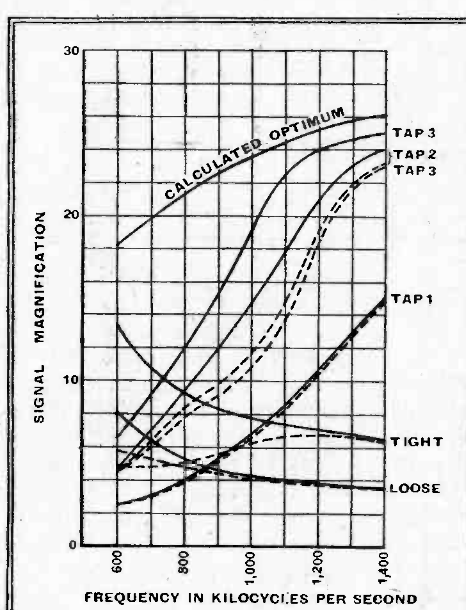


Fig. 8.—Signal transfer, or voltage developed across tuned circuit for each volt picked up by aerial; $\frac{V_2}{V_1}$ in Fig. 9. *All results are for artificial aerial only*; dotted lines include signal loss due to mistuning. The "optimum" line shows the highest result obtainable with the equipment used.

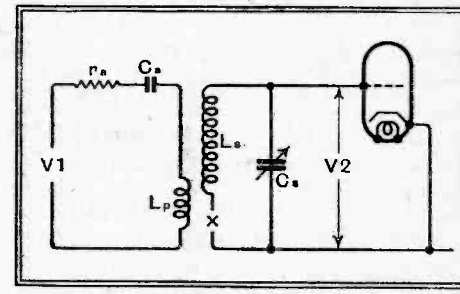


Fig. 9.—Theoretical circuit diagram of an aerial coupling system.

As it happened, the resistance of artificial aerial and generator used in the experiments was rather large, being rated at 52.5 ohms and found by measurement at about 800 kc/s to be 50. There is a very simple formula for optimum signal transfer:

$$\frac{V_2}{V_1}=\frac{1}{2}\sqrt{\frac{R}{r_a}}$$

R being the dynamic resistance of the tuned circuit with no aerial coupling.

Optimum Coupling

Working this out for the experimental circuit, a curve of theoretical optimum transfer is shown on Fig. 8. This confirms that tap 3 satisfies the conditions at 1,400 kc/s. A final experiment was performed with a primary coil L_p approximately the same as L_s. The signal generator was tuned to the frequency that made L_p resonate with C_a (so cutting out the mistuning effect). This frequency was 820 kc/s. The coupling was then adjusted until the greatest reading was obtained on the valve voltmeter. It was 2.0. So $\frac{V_2}{V_1}$ was 20, which falls very near the theoretical curve. It would fall nearer if allowance were made for the resistance of the coil L_p, which in this instance was known to be about 10 ohms. So total r_a is 60, and R (from Fig. 4) is 95,000 ohms. Therefore, by calculation $\frac{V_2}{V_1}$ should be $\frac{1}{2}\sqrt{\frac{95{,}000}{60}}=19.9$. The disagreement of only 0.5 per cent. is not claimed to be evidence of superlative experimental skill, but rather a stroke of luck!

Recapitulating:

(1) For maximum signal and particularly for best signal/noise ratio the required coupling is considerably closer than that commonly employed.

(2) To obtain such a degree of coupling it is necessary for the aerial tuning and coupling to be adjusted for each different frequency and such adjustments hold good for only one aerial.

(3) So for practical receivers it is necessary to sacrifice a large proportion of the signal in the interests of simple gang control and applicability to aerials of differing characteristics. The method of coupling must therefore be a compromise.

The Aerial Connection—

(4) Series condenser coupling causes a large reactance transfer for a reasonable signal transfer, so is not suitable for receivers without separate aerial tuning.

(5) Low-inductance aerial coupling (which includes tapped coils and step-up transformers) gives a good signal transfer for a reasonable mistuning, but, unfortunately, with a condenser-tuned circuit the coupling varies greatly over the tuning band, falling off at the low-frequency end. This is especially serious in "straight" sets employing two, three, etc., tuned circuits, for the non-uniformity is squared, cubed, etc., respectively. With superhet. receivers it does not matter so much because most of the amplification and selectivity are obtained in the IF circuits; and there is the compensating advantage that the coupling efficiency for signals around the IF is very low, thus minimising risk of interference from them. It should be initially trimmed for each aerial as the mistuning approximates to a constant capacity.

(6) High-inductance aerial coupling, resonating at a frequency just lower than the tuning range, has the disadvantage in superhets. with an IF of 465 kc/s of encouraging interference from signals around this frequency. Also the coupling efficiency is relatively poor unless one is prepared for serious mistuning near the low frequency end of the band. On the other hand, it gives very uniform signal transfer and tends to correct the non-uniformity in selectivity experienced with condenser tuning; so is advantageous in "straight" receivers, both for aerial and intervalve coupling. Other advantages are that the mistuning approximates to a constant inductance for all aerials, so trimming to the aerial is not needed; and, because the smaller the aerial the nearer it resonates with the tuned circuit, there is some degree of compensation for reduced pick-up.

G.E.C. Cathode-Ray Tube

New Miniature Type for Oscillographs

A NEW cathode-ray tube of the high-vacuum type has been produced by the General Electric Co., Ltd.; it is known as the G.E.C. Monitor, Type 4051. It has an indirectly heated cathode consuming 0.9 ampere at 4.0 volts and is of the two-anode type. The second anode is rated for 500 volts maximum but can be operated at lower voltages down to 250; the first anode voltage must be adjustable for focusing and should be 50-100 volts, according to the second anode voltage. Brilliancy is controlled by the grid bias, which must be adjustable over the range of 0—20 volts relative to the cathode.

Two pairs of deflecting plates are included and are all brought out, so that push-pull deflection can be employed. The X-plates are those next to the second anode and have a sensitivity of 82/V mm. per volt, while the Y-plates have a sensitivity of 73/V mm. per volt, where V is the second anode voltage.

The tube is cylindrical in shape with a length of about 6¼in. and a screen diameter of 1½in. It has a green screen of medium persistence and is priced at 45s. It is fitted with the standard 9-pin base, the connections being as follows:

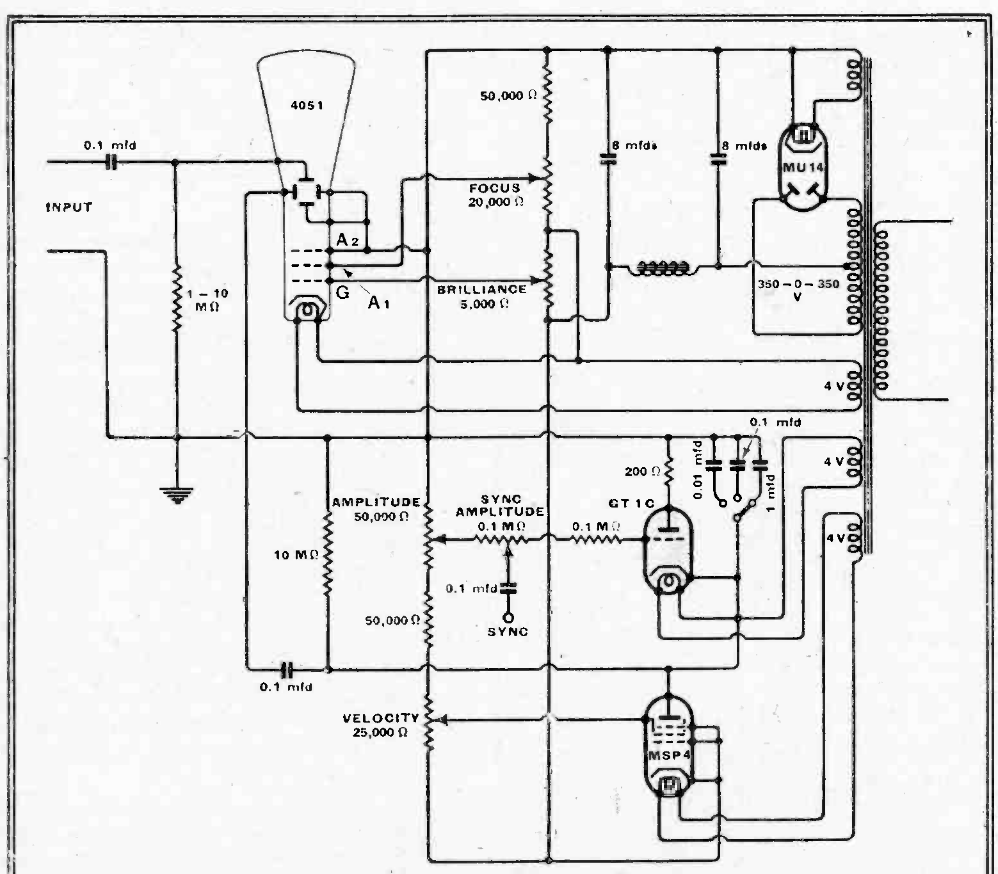
Pin	Electrode
1 ...	... Deflector Plate Y1
2 ...	... Deflector Plate X1
3 ...	... Anode 1
4 ...	... Heater and Cathode
5 ...	... Heater
6 ...	... Grid
7 ...	... Anode 2
8 ...	... Deflector Plate X2
9 ...	... Deflector Plate Y2

The circuit arrangement adopted for the tube depends largely upon the purpose to which it will be put. A suitable circuit for many requirements, however, is shown in the accompanying drawing. The tube voltages are simply obtained from a voltage divider across the HT supply. As the second anode is earthed in most oscillograph applications, however, it is usually advisable to place the smoothing choke in the *negative* HT lead as shown.

The lower part of the diagram shows a simple time-base, which will give a sweep frequency of about 4-4,000 c/s, thus enabling phenomena up to at least 10,000 c/s to be clearly distinguished. A gas-triode saw-tooth oscillator is used with a pentode charging valve to obtain linearity. The frequency of the saw-tooth oscillations is governed largely by the screen voltage of the pentode and the amplitude by the grid bias of the gas triode. As is usual with time-bases, however, each control governs frequency and amplitude to some degree.

The input work voltage needed naturally depends upon the anode voltage. If this is 350 volts, the sensitivity is 82/350 = 0.2345 mm. per volt. For a deflection of 1 cm., therefore, about 42.5 volts peak-to-peak input is required. For a sine-wave this is equivalent to 21.25 volts peak = 15.75 volts RMS. For inputs much smaller than this it is necessary to use an amplifier, which must be carefully designed to give the requisite output without frequency, phase, or amplitude distortion.

As the tube is of the hard type it can be used at radio frequency, but the time-base shown is only suitable for AF work. For many RF applications, however, such as the measurement of modulation depth, a time-base is unnecessary.



Suggested circuit arrangement for use with the G.E.C. miniature CR tube.

THE May issue of the General Radio *Experimenter* contains an article on the psychology of hearing and a description of a new high-frequency thermo-couple element. Copies are obtainable free from Claude Lyons, Ltd., 40, Buckingham Gate, London, S.W.1.

NEWS OF THE WEEK

SIR JOHN REITH

He Tries Not to Think About Leaving

THE Director-General is still at Broadcasting House, and is likely to remain there for two or three weeks to come. The formal leave-taking is to be deferred until the autumn owing to so many of the staff being on leave. Meanwhile, amusement has been created at Broadcasting House by rumours that the staff of Imperial Airways are "trembling in their shoes" over the imminent arrival of this stern disciplinarian.

Sir John Reith will take with him the good wishes of a staff which has always realised that the D.G. has a very human side to his make-up, never more aptly expressed than in a message last week to the Editor of *Ariel*, the B.B.C. staff journal. "The work to which I have been asked to go," says Sir John Reith, "is of great importance, but you can, maybe, imagine how I feel about leaving the B.B.C. and B.B.C. staff. I try not to think about it."

ANOTHER CHIEF DEPARTS

Director of Religion at Retiring Age

THE REV. F. A. IREMONGER, B.B.C. Director of Religion, will, it is understood, retire from the Corporation in July on attaining the age limit of 60. It has been suggested in some quarters that Mr. Iremonger's departure is attributable to disagreement on the lightening of the Sunday programmes, but this is not the case.

It can now be disclosed that one of the duties of the Director of Religion has been to "vet" plays intended for Sunday broadcasting. Of these, only 1 per cent. have been rejected by Mr. Iremonger as unsuitable for inclusion in the Sunday programmes

VOICE OF THE MINORITY

German Station in Czechoslovakia

MELNIK, the Czechoslovakian Broadcasting Company's German-speaking station, is the only station which provides for a foreign language minority.

The transmitter, erected by a British firm, operates with a power of 100 kW, and can transmit on 269.5 or 470 metres. Studios are located in Prague, and the entire programme staff belong to the German-speaking minority.

S. P. B. MAIS has compiled a programme designed to give B.B.C. listeners a panorama of holiday-making. Records typifying the holiday spirit have been made at well-known seaside resorts and Mr. Mais is seen here interviewing a charabanc conductor on the front at Brighton. A recording of this interview will be included in the programme "Britain on the Bust," to be broadcast at 9, on Monday (Nat.). On the following day Brighton will again be on the air, when it is to be the subject of the first of the series of visits to favourite coastal towns.

COPYRIGHT IN TELEVISION BROADCASTS

Preventing Unauthorised Reproduction

VIEWERS who watched the Foord-Phillips fight by television will have noticed that a copyright warning notice was displayed at odd intervals throughout the transmission. It is understood that this new practice has been adopted in order to guard against big screen displays in places of public entertainment. Hitherto it has been possible for the organisers of such demonstrations to defer screen projection until after the copyright warning notice had been transmitted at the beginning of the programme. The B.B.C.'s latest little dodge may have interesting results.

FIVE-METRE TESTS

An Opportunity for Short-wave Enthusiasts

THE National five-metre field day, organised by the Radio Society of Great Britain for Sunday next, July 3rd, will provide an excellent opportunity for readers to test their five-metre receivers. All over the country amateurs with five-metre transmitters will, from vantage points, conduct tests through the day.

In America during the weekend of June 11th-12th amateurs took part in the annual field day, conducted by the Amateur Radio Relay League. This served as a proving ground for the portable emergency stations which are so frequently needed in flooded areas for maintaining contact with the outside world when all other means of communication have broken down.

B.B.C. ENTHUSIASM

Busmen's Holidays for Television Producers

AT least three producers at Alexandra Palace will use their holidays as opportunities for developing their television programmes in the autumn and winter. Reginald Smith, one of the variety producers, is touring the seaside shows of the Isle of Wight, and will probably discover some new photogenic faces. His colleague, Harry Pringle, is off to Mentone, where he will meet some of his leading artistes.

But the most romantic holiday plans are Jan Bussell's. A great believer in the use of puppets for television, he is touring Greece, Italy and France in search of marionettes and puppet shows.

BROADCASTING IN GROSSE DEUTSCHLAND

Reichsender Wien

ALTHOUGH the name of the Vienna broadcasting station changed to Reichsender Wien in March on the annexation of Austria by Germany, the former Austrian broadcasting company, Ravag, still exists, but under the direction of Dr. Glasmeier, Director-General of German broadcasting in Berlin. He has been appointed acting D.G. of Ravag until the company has been liquidated and the shareholders (the Government and Municipality of Vienna) have been paid out.

We understand that the rumours regarding the treatment of Herr Czeija, the former D.G. and founder of Ravag, are unfounded. He was sent on "leave" until the end of his contract, and is now in his home in Vienna.

The Austrian transmitters were not Government-owned, but on the completion of the winding-up of Ravag they will become the property of the German Post Office, as are all the transmitters in Germany, where the broadcasting authorities only provide the programmes.

Another change with the anschluss was the cessation of the publication of the official radio paper, *Radio-Wien*. This was amalgamated with another paper, *Radio-Woche*, under the title *Rundfunkwoche*. Another Austrian paper, however, *Das Kleine Kino und Radioblatt*, which is most popular among Austrian home-constructors, continues under its original name.

ENGLISH IS PREFERRED

Foreign Titles in Programmes to be Translated

IT is a wise new move on the part of the B.B.C. to issue instructions to its programme staff that henceforth programme items with foreign titles must be announced in English, wherever possible. Thus, "Marche Hongroise" becomes in the B.B.C. vocabulary "Hungarian March," and "Die Meistersinger" will be called "The Mastersingers." Where an English composer saw fit to give his work a foreign title, as, for instance, Elgar's "Salut d'Amour," this will be retained, as also will titles which do not appear to necessitate translation, such as "La Bohème," which would not look or sound so well as "The Bohemian World."

NEW MAURETANIA

Elaborate Wireless Equipment

THE most lavishly wireless-equipped liner in the world will undoubtedly be the *Mauretania*, new Cunard-White Star liner to be launched at Birkenhead on July 28th. Provision is made for the distribution of three different broadcast programmes throughout the ship by means of carefully concealed loud speakers, and in the big public rooms the volume will be increased according to the number of people present. Acoustic characteristics in the restaurant have been improved by placing the speakers in the hollow pillars.

All interference arising from the vessel's electrical mechanism is suppressed, and filters are fitted in the communication circuits. The telegraph and telephone receiving room is completely lined with copper, and the room housing the direction-finding apparatus is similarly lined.

ALL-WELSH BROADCASTING

Regional Development Scheme Taking Shape

WORK will soon begin on the construction of the new B.B.C. station at Clevedon, Somerset, now that the differences between the Air Ministry and the B.B.C. have been amicably adjusted. When Clevedon is working—approximately a year after the opening of Start Point this summer—Washford Cross will go "all-Welsh."

When the Welsh Regional Director recently received a party of Welsh journalists, he was pessimistic regarding a site for new offices in Cardiff, though undoubtedly these would be needed at a later date. The trouble was lack of money, and he did not want to encourage his Welsh friends into thinking that such an important development was immediately in the offing. Nevertheless, we are able to state that a site on the Bute estate has already been found which will ultimately be the home of Welsh broadcasting.

B.B.C.'S EMPIRE AUDIENCE

Licensed Listeners in the Dominions and Colonies

EMPIRE listeners are more far-flung than numerous, according to the data recently collected by the B.B.C. concerning the number of licensed listeners in the Dominions and Colonies. Actually they number fewer than a third of the licence-holders at home, the approximate figure being a little over two and a half million.

Canada leads the way with approximately 1,050,000 licences, and Australia is the runner-up with about 1,030,000. Next comes New Zealand, with 280,000. Other licence figures are as follow:—

South Africa	190,000
India	50,000
Palestine	29,000
Newfoundland	11,500
Southern Rhodesia	6,500
Ceylon	5,000
Trinidad	2,500
Burma	1,500

A relatively small proportion of these, of course, pick up the Daventry programmes.

ANTI-PIRATE MEASURES IN ITALY

WIRELESS pirates in Italy must be brave and resourceful, for the new regulations give them as much scope as a cat in a kennel of hounds. Each radio dealer keeps a register in which all transactions are registered, with the name and addresses of set purchasers. Every owner of a broadcast receiver is given a "broadcast listener's book," in which licence payments are recorded, and this must be produced on demand. If a licence is to be cancelled, notice must be given not later than November in the current year, otherwise the licence must be renewed. If the listener cannot continue to use his set, but does not wish to dispose of it, the Post Office places it in a sealed case.

Certain authorised radio dealers may install receiving sets on trial for a period not exceeding ten days. For this a special licence is obtainable.

FROM ALL QUARTERS

Tele-News Theatre

A SITE has been acquired at British Industries House, Marble Arch, London, for the erection of a Monseigneur News Theatre which will incorporate facilities for public televiewing.

Inventor of U-Boat Detector Retires

AFTER completing forty years' service at Queen Mary College, Mile End Road, London, Prof. J. T. MacGregor-Morris retires to-day (Thursday). He will be remembered by many for his work in the invention of apparatus for detecting enemy submarines during the Great War. His department (Electrical Engineering) was a pioneer in the work on the development of cathode-ray tubes and oscillographs.

New Radio Title

FOR the first time, the Minister of Posts in the Belgian Cabinet holds the added title of Minister of I.N.R. (Institut National de Radiodiffusion), the Belgian broadcasting organisation.

Exhibitions

TELEVISION STREET will be a feature of the Vienna Fair to be held from September 4th to the 11th. It will provide Austrians with their first public television demonstration.

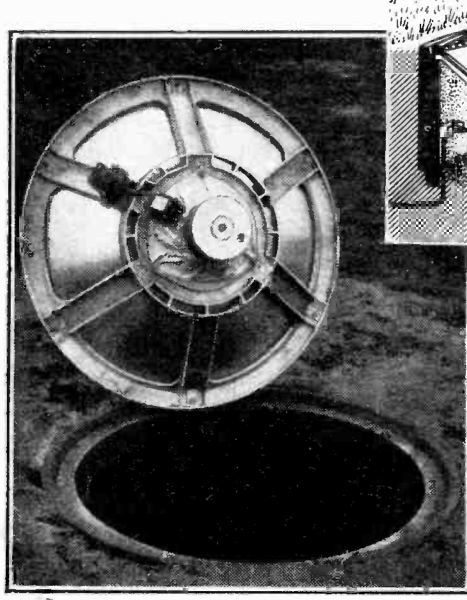
The slogan of the Berlin Radio Exhibition, which opens on August 5th, has been changed from "Voice of the People" to "Broadcasting: Voice of the Nation."

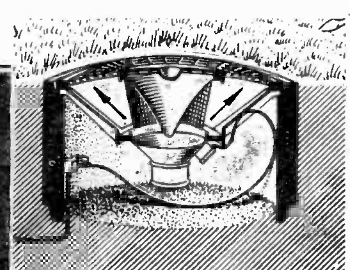
Seeking the Golden Fleece

THE B.B.C. is badly in need of a television commentator and last week tests were taken by nine young men at Wimbledon. Each took the microphone for ten minutes, and described the tennis going on before him, while the recording unit relentlessly registered every word. The results are to be judged at leisure.

Institute of Wireless Technology

ON Friday, July 15th, at a special meeting of the Institute, the President, Mr. Sydney A. Hurren, M.C., M.I.W.T., will deliver a lecture entitled, "A New System of Pianoforte Electro-Acoustics," which will be followed by a demonstration.





LOUD SPEAKERS bedded in the ground are the latest Telefunken PA development in Germany. Inconspicuously located in their foot-level water-tight housings, these 10- and 20-watt units will be used in large open-air arenas for mass sports meetings.

Celestion and Magnavox

FROM to-morrow, July 1st, the technical and production resources of the Celestion and Magnavox concerns will be combined in a single company. Celestion, Ltd., have acquired the technical designs, patents, etc., of the Magnavox concern and will continue under the name of Celestion, Ltd., with Mr. R. B. Page as managing director. Mr. Guy Campbell and Mr. Aytoun Kay, of the Benjamin Electric, Ltd., have joined the Board of Celestion, Ltd.

British Standards for Prague

THE Czech Post Office are conducting, on 6.1 metres, tests on their recently completed experimental television transmitter. 405-line pictures are being radiated so that viewers have the advantage of being able to use British receivers. Two public viewing halls will be opened in Prague in the autumn, and decisions regarding the introduction of a regular television service are largely dependent on the reaction of the man-in-the-street.

Development on the Short Waves

FOLLOWING the Cairo Resolution which states that only short-wave broadcasting stations with a power of more than 5 kW are entitled to the channels they claim, it has been decided to increase the output of the 1-kW Finnish transmitter near Helsinki to 10 kW. This expansion is now being carried out, and in addition to this the Government will shortly grant 10,500,000 marks (approx. £40,000) for the erection of a 50-kW short-wave broadcasting station on a site which has been selected near Bjorneborg.

American Listeners

IT is estimated by the Joint Committee on Radio Research in America that 26,641,000 homes are equipped with radio in the United States. This represents 82 per cent. of the families in the country as calculated in July, 1937. It was also estimated that there are 3.96 persons per family. (In England there are 3.6 persons per family.)

Last Year's Sets are Not Luxuries?

AN interesting clause in the regulations for poor relief formulated by the Canadian Board of Control concerns the possession by relief families of such luxuries as cars and radio. Radio sets, it has been decided, must be forfeited, and their value deducted from the relief if bought since 1937. In the case of cheap and second-hand sets, adjustments may be made to suit individual circumstances. It is realised that obsolete sets in relief homes may be the only form of entertainment available for the destitute.

Laughter and Cheers

QUESTIONS regarding the appointment of a new Director-General for the B.B.C. were raised in the House of Commons last week. Mr. De La Bere said hopefully to the Assistant Postmaster-General: "Will the hon. gentleman press on the Governors (of the B.B.C.) the importance of not appointing a successor who will provoke Members of Parliament?"

The Key to Circuits

By "CATHODE RAY"

WORKING OUT REACTANCE VALUES

LAST time I tried to bring a certain amount of light to readers who can deal with simple DC circuits by the application of Ohm's Law but who are thrown into confusion by the different sorts of ohms that are talked about in connection with AC circuits. I showed that, in addition to the ordinary ohms, in which resistance is measured, there are other ohms that cannot be added or subtracted straightforwardly, but require square roots and things in the calculation, or if one fights shy of that one can do it very simply by measuring out lengths on paper in the form of a right-angled triangle, representing to scale the different lots of ohms in the circuit. Anybody can calculate an AC circuit in this way without any mathematical knowledge at all. We had got this far, that in an AC circuit there may be resistance (R) and two sorts of reactance (inductive, X_L, and capacitive, X_c); and by the method explained they can all be combined to give a single number of ohms, impedance (Z), armed with which one is in a position to use the good old Ohm's Law, putting Z where one is accustomed to put R.

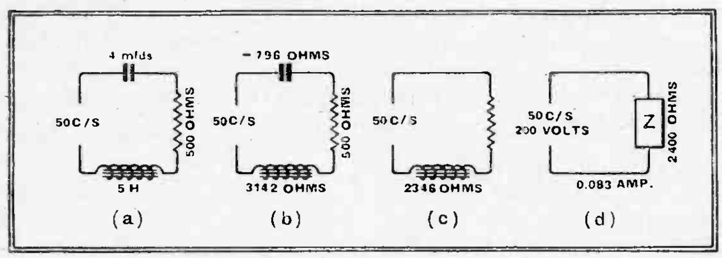


Fig. 1.—(a) is a simple circuit diagram as it usually appears. Before the way it works can be seen, the reactance values must be worked out (b). Then it can be simplified by combining the two reactances (c). Lastly by combining resistance and reactance it is in a fit state for applying simple Ohm's Law.

Unspecified Reactances

This is all very well if one is supplied with all the necessary figures, the numbers of ohms corresponding to R, X_L, and X_c. But while circuit diagrams usually oblige with R, they never say anything about the reactances, for the disconcerting reason that reactances do not exist apart from current of a definite frequency. DC, as Mr. Scroggie likes to have us realise, is current of zero frequency, so reactance doesn't come into the picture at all, and that is why DC circuits are so simple. But in AC circuits the frequency of the currents present may be constantly changing, and often there are currents of several different frequencies in the same place at the same time. So each component in the circuit may have any number of different reactances. An individual person may be a bank manager and a Justice of the Peace and a husband and a father and a churchwarden and president of the bowls club, or several of them at once, according to the circumstances; but we cannot write all that down whenever we address a letter to him. The practical method is to give him a name and leave his various purposes in life to be taken account of when the occasion arises.

In the same way, the reactances of components in a circuit are never marked on diagrams, because they depend on circumstances (i.e., the frequencies of currents flowing), but for reference they are given labels that ordinarily do *not* vary to any important extent with frequency. These labels are the familiar ones of *inductance* and *capacity*. The values of inductance and capacity marked on circuit diagrams do not in themselves tell us very much, any more than a person's name in a directory tells us whether he is grey-haired or works hard or beats his wife or has a golf handicap of 20. If inductance and capacity were the significant quantities, then it would be impossible to do most of the things that are required of radio circuits. It is the ability to be several things at once that comes in so useful.

Fortunately, it is very easy to calculate reactance, given the inductance (or capacity) and frequency. Here are the formulæ:—

$$X_L = 2\pi fL$$

$$X_c = \frac{1}{2\pi fC}$$

As most people know, π is the number of times greater the circumference of a circle is than the diameter, and needs an infinite number of decimal places to write down in full; but that need not worry us. For very rough estimates 2π can be regarded as 6; a better approximation $6\frac{1}{4}$; and for greater accuracy still it can be taken as 6.283. If X_L and X_c are to be in ohms, L and *c* must be in henrys and farads. For working out the reactance of a LF choke, this is usually very easy. Suppose a choke is 20 henrys, then the reactance at a frequency of 50 c/s is roughly 6 × 50 × 20, or 6,000 ohms. If you want to be very precise, it is 6,283 ohms, but generally you don't know the inductance within a henry either way, and if you do it hardly matters.

When it comes to HF tuning coils, the inductances are in millihenrys (mH) or microhenrys (μH), and the frequencies in kilocycles per second (kc/s) or megacycles per second (Mc/s). This is still quite easy if, when L is in mH we write down the frequency in kc/s and when it is μH take *f* in Mc/s. For example, a 160-μH tuning coil at a frequency of 750 kc/s (0.75 Mc/s) has a reactance of roughly 6 × 0.75 × 160, or 720 ohms. A long-wave coil of 2,000 μH at 150 kc/s is more conveniently written as 2 mH. And so on.

A Convenient Unit

X_c is a little less simple. Farads are never used in practice. The commonest unit is the microfarad (μF, or sometimes mfd.), but if it involves a lot of decimal places it is more sensible to use the millionth part of it, the micro-microfarad ($\mu\mu$F or mmfd.). To calculate X_c most easily, take it as $\frac{1,000,000}{2\pi fC}$ in which if C is in μF, *f* must be in c/s, and if C is in $\mu\mu$F, *f* must be in Mc/s. By doing this there is least likelihood of tripping up among rows of decimal places. Example: an 8-mfd. smoothing condenser at 100 c/s (which is the chief ripple frequency resulting from a full-wave rectifier). X_c is $\frac{1,000,000}{628 \times 8}$ or almost exactly 200 ohms. To avoid these calculations, a chart has been published several times in *The Wireless World*; one of the sort in which you just lay a ruler or a piece of thread across the page and read the result.

The most important general feature about all this is that increasing the frequency makes X_L increase, but X_c decrease. And *vice versa*.

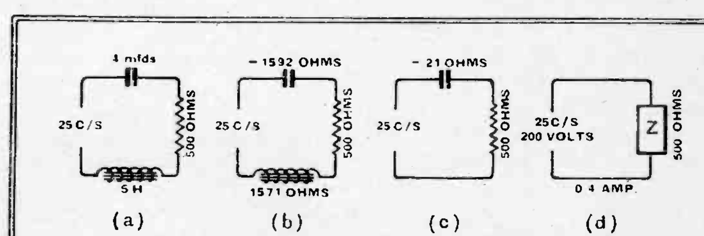


Fig. 2.—If the frequency is changed, everything otherwise being the same as in Fig. 1, filling in reactance values shows how the working is completely changed.

Now we are ready to calculate an AC circuit from the information given on any ordinary diagram such as you find in every *Wireless World*. Fig. 1 (a) is a simple example including all three elements in series with a 50-cycle supply. Working out the reactances as just explained we get Fig. 1 (b). Remembering that X_c is negative and therefore can be

The Key to Circuits—

subtracted from X_L, we get a total X of 2,346 ohms, which being positive is inductive, and so Fig. 1 (b) is equivalent to (c). Boiling this down still further as described in the previous article, Z is

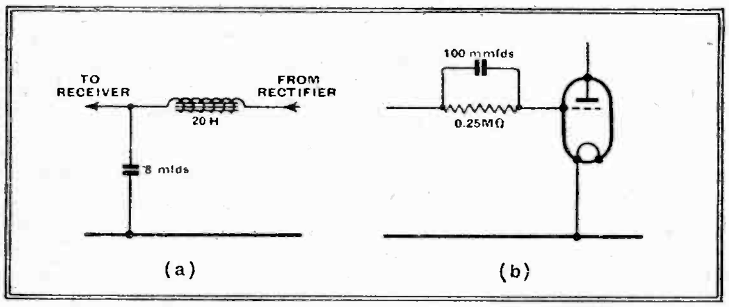


Fig. 3.—Two fragments of circuits—a smoothing filter, and a grid-leak type of detector—in which the working depends on different treatment given to different frequencies, which can only be seen by working out the reactances.

$\sqrt{R^2 + X^2}$, in this case 2,400 ohms, and as impedance as a single item has no recognised symbol in a circuit diagram I have put it in Fig. 1 (d) as a labelled box concealing the "works." Having reduced the original diagram to this single element, it is in a form where Ohm's Law can be applied to find the current in the circuit. Suppose the supply is 200 volts, then the current is $\frac{200}{2,400}$, 0.083 or 83 mA.

Going back now to Fig. 1 (b), by multiplying each number of ohms in turn by 0.083 we get the voltage across each element. The voltage across the condenser is −66.4, across the resistance 41.7, and across the coil 262. At first sight this may seem to be a contradiction of Euclid's axiom about the part never being greater than the whole. But then the voltage across the condenser is negative, which means that it is in opposition to that across the coil. Even when that is deducted, giving 195.6, this added to 41.7 (the voltage across the resistance) is much more than 200. But I explained last time why you can't just add resistances and reactances, and the same applies to the voltages across them. Now we seem to have done quite a lot of work in getting the low-down on this simple circuit, and might hope that it has been done once for all. But not so; directly a different frequency is applied the whole thing has to be gone through again. Suppose the frequency is changed to 25 cycles. You may like to check my working in Fig. 2. In this, the voltages across condenser and coil both rise to over 600. So although the supply voltage is only 200 it is not safe to use a condenser rated to work at 250 or even 500 volts. The −21 ohms in (c) is the reactance at 25 cycles of a capacity of 300 mfd. So although only 4 mfd. is actually in circuit, the addition of the coil is equivalent to replacing it by a 300-mfd. condenser.

The Z in Fig. 2 (d) is, of course, actually more than 500 ohms, but only by a fraction of one ohm, so the difference is negligible. The two reactances almost exactly cancel out, leaving practically resistance only. This occurs at one particular frequency—the resonant frequency—and, as everybody knows, is the object of tuning. If at the same time the resistance is made very small—say 50 ohms—the current at resonance is large—4 amps.—and the voltages across coil and condenser exceed 6,000. That is how "sharp" tuned circuits step up the applied voltage, often several hundredfold.

Mark that the same voltage applied to the same circuit gives conspicuously different results, simply by a change in frequency. This is how circuit values can be selected so as to pass currents of one frequency and impede those of another, and is the basis of circuit design. Why are 20 H. and 8 mfd. suitable values for smoothing circuits? Because at the lowest ripple frequency usually present in the output from the rectifier they are reactances of 12,600 ohms and 200 ohms respectively, so only a small proportion of the ripple appears across the condenser. But at zero frequency (DC) the reactance of the choke is nil and of the condenser infinity; so except for the drop in the resistance of the choke the whole of the desired DC is obtained. Why is the grid condenser across a $\frac{1}{4}$-megohm leak in a detector circuit for good quality reproduction chosen to be about 100 mmfds.? Because if it were larger its reactance at the higher audio frequencies would act as a shunt to the leak and cause a loss of high notes; and if it were smaller its reactance at the lower radio frequencies would impede them and cause inefficient detection (Fig. 3). And so on, and so on. I think I was quite justified in describing the calculation of impedance as the key to understanding and designing circuits, and therefore worth some effort in coping with the apparent ohms muddle.

SUMMING UP

For DC circuits, and AC with resistance only ...	Ohm's Law :—$I = \frac{V}{R}$	$\text{Amps} = \frac{\text{Volts}}{\text{Ohms (resistance)}}$
For all circuits	$I = \frac{V}{Z}$ for Z see below.	$\text{Amps} = \frac{\text{Volts}}{\text{Ohms (impedance)}}$
Impedance	$Z = \sqrt{R^2 + X^2}$ for X see below.	Or can be got by drawing right-angled triangle to scale with Z, R, and X as the sides: Z the longest.
Reactance...	$X = X_L - X_C$ for X_L and X_C see below.	Easy!
Inductive reactance ...	$X_L = 2\pi fL$	Ohms = 6.283 × c/s × henrys. or 6.283 × kc/s × mH or 6.283 × Mc/s × μH.
Capacitive reactance ...	$X_C = \frac{1}{2\pi fC}$	$\text{Ohms} = \frac{1,000,000}{6.283 \times c/s \times \mu F}$ or $\frac{1,000,000}{6.283 \times Mc/s \times \mu\mu F}$

Or X_L and X_C can be found without calculation by using *The Wireless World* alignment chart.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

A.R.P. and Amateurs

THANK you for publishing Mr. N. P. Spooner's timely letter on the subject of "Amateurs and A.R.P. Work." While agreeing in general with his remarks, I do not think the authorities are wise in so definitely closing the door against amateur co-operation. I do agree, however, that any idea of a general amateur communication network would be foredoomed to failure from the outset. Any professional operator who listened to the recent National Field Day operations would be immediately convinced that the average amateur is quite incapable of handling traffic in sufficient volume to be of the slightest value to the authorities.

But these remarks do not apply to the considerable number of amateurs who are highly skilled operators. It may interest your readers to know that a First-class Operators' Club has recently been formed among British amateurs with the object of encouraging and maintaining a high standard of operating on the amateur bands. All the members of this club are expert operators, and the majority of them are professional or ex-professional men who would be fully capable of rendering invaluable service in an emergency.

Let there be no misunderstanding. The F.O.C. does not seek to organise communication networks or engage on A.R.P. work unless called upon to do so by the appropriate authority. F.O.C. members, being British amateurs, are primarily concerned with experimental work, but they are able to supplement their work with first-class operating technique.

Referring again to Mr. Spooner's letter, one cannot help deploring the short-sighted viewpoint of Sir Samuel Hoare's technical advisers, who state that "the use of wireless for A.R.P. communications is not considered practicable," and that the telephone "must be regarded as the normal means of communication." If anyone can think of a means of communication more vulnerable to air attack than the telephone I should like to hear of it.

Should any of your readers desire further

Letters to the Editor—

details of the First-class Operators' Club I shall be pleased to give full information if they will write to "Radio G5BW, Willingdon, Eastbourne." R. B. WEBSTER.

Eastbourne, Sussex.

Debunking Intermodulation

IN the article by "Cathode Ray" in your May 19th issue, the evidence in favour of the superiority of intermodulation to harmonics as a criterion of distortion appears to be:—

(a) on a test comparing two receivers with different types of output stage, it is considered that a pentode stage exhibits audible intermodulation at a lower output than a push-pull triode stage. The only data supplied is the output rating of the system, presumably valve maker's ratings, which takes no account of loss in the output transformer. It would be interesting to know the relative outputs of the two receivers at 50 c/s and at a lower harmonic level.

(b) Mr. Harries' experiments are quoted to suggest that the only connection between intermodulation distortion and old-fashioned harmonics is that the first appears at the point where the amplitudes of two particular harmonics happen to go in opposite directions.

The views expounded by "Cathode Ray" are supported by Mr. Benham in his letter of June 2nd, and as, after intermittent research during the past three years we find it possible to take up a rather different view by the consideration of additional, and very important, factors, we offer the following comments.

Everyone is agreed that the present system of specifying distortion by the total RMS harmonic content bears little relationship to the audibility or the unpleasantness of the distortion. This is to a great extent due, *not* to the unsuspected presence of intermodulation products, but to the fact that at all frequencies and intensities except those > 2,000 c/s at very low levels, the sensitivity of the ear, as modified by the masking effect of the fundamental, increases rapidly with the order of the harmonic. This increase is so rapid that the suggestion quoted by "Cathode Ray" of weighting the harmonic amplitudes by multiplying each by the order of harmonic involved, is quite insufficient to represent the relative audibility of the different harmonics.

When "Cathode Ray" invokes the aid of musical theory to establish the relative *unpleasantness* of different harmonics he is on thin ice, for the appreciation of musical intervals is a complicated function of the height of the subject's brow. A devotee of modern compositions enjoys nothing better than a good hearty discord and considers octaves, fifths and thirds as painful afflictions. Even if we do adopt an arbitrary sequence for the relative discord of musical intervals we find that the relative discord of the intermodulation products from the two tones of a simple musical interval is only slightly greater than that for a harmonic of a single tone: on the other hand, if the original tones are discordant, the discord of the intermodulation tones is not so annoying. All things considered, it may be better not to attempt to estimate a quality such as "annoyance value" which we cannot even define. Let us then concentrate on audibility.

The fact that, as Mr. Benham points out, the intermodulation tones produced by the combination of two tones of widely different amplitudes may have amplitudes large compared with the smaller primary tone, does not mean that in the general case this tone will be more audible than the harmonics of the larger primary tone; it is surely more logical to compare the power in the alien tones with the *total* power in the primary tones.

The masking effects mentioned above, which affect the normal audibility threshold level and cause the higher harmonics to be so much more audible, operate also in the presence of two or more primary tones, and it is found that, except for a few special cases, the masking of the individual intermodulation tones is greater than the masking of the corresponding harmonics from a single tone of frequency equal to the higher of the two parent frequencies.

Of the special cases just mentioned one is that of two high-frequency tones producing different tones of lower frequency which are therefore subject to only a small degree of masking. This type of distortion is rarely bad owing to the small amplitude of high-frequency tones in music. Another special case is that of a high-amplitude low-frequency tone combined with a low-amplitude high-frequency tone. This is the flute and drum combination which is so attractive to the intermodulation protagonists Duets for the flute and drum are not common and it would appear that musical composers have realised that this combination produces a nasty noise. This it does without the intervention of any non-linearity additional to that already present in the ear, which leads us to another consideration, i.e., subjective harmonics and intermodulation tones.

Alien Tones

The strongest argument in favour of intermodulation tones as producers of distortion has been that they are in general alien tones which were not present in the original sound, whereas harmonics are always present in some degree. The production of new tones might be expected to be much more noticeable than the variation of amplitude of existing tones. If, as we surely must, we include the ear in our transmission system, then we must recognise the fact that among the frequencies the sensation of which is experienced in the brain, the intermodulation tones will always be present (see "Speech and Hearing," Figs 90, 91, 92 and 93). Harmonics and intermodulation tones are produced in the ear at quite low sensation levels, particularly at low frequencies, and at normal listening levels correspond to comparatively large distortions. From this, intermodulation products are seen to lose their unique value and cannot really be considered as a phenomenon separate from harmonics. For harmonics are really only that special case of intermodulation tones when the two or more parent frequencies coincide. It can also be shown that for ordinary types of non-linearity the RMS total of harmonics is not widely different from the RMS total of intermodulation tones (produced by a number of tones of total power equal to that of the single tone). The amplitudes of both intermodulation tones and harmonics are directly related to the coefficients of the power series representing the characteristic of the system so that any particular intermodulation tone could be predicted from measurements of the harmonics obtained with a single input.

It has frequently been suggested that distortion should be measured using a two-tone input, but even if all the high order intermodulation tones were measured, there is still the necessity for a weighting system to give emphasis to those components which are most audible. The test is more difficult and no more informative than a harmonic test. Harries' criterion of a falling second merely marks the onset of fourth harmonic while the sharp rise in third harmonic indicates the appearance of fifth harmonic. There is no reason why these phenomena should occur simultaneously, while it is conceivable that in some systems the onset of fourth harmonic might cause the second harmonic to *rise*, while the fifth might cause the third to *fall*.

A complete specification of harmonic distortion in any system would require tests of all measurable harmonics to be made at all frequencies and at all output levels. Additional tests made with multiple tone inputs would provide additional information quite incommensurate with the labour involved. It is fortunate that in most radio receivers the greater part of the distortion occurs in the output stage and there is little frequency discrimination subsequent to the distortion, so that a test at a single frequency (400 c/s) is fairly satisfactory, although it may with advantage be supplemented with a test at 50 c/s.

A harmonic test at 50 c/s on the two receivers compared by "Cathode Ray" would show the difference in performance at this frequency just as well as the two-tone test. The difference need not be due to the different types of output systems but may be attributable to the great reduction of load value at 50 c/s due to the shunting effect of the primary inductance in the pentode output transformer.

Fortunately again it is found that the relative audibility of the harmonics does not vary very greatly either with frequency or with intensity level over the ranges 200-1,000 c/s and -40 to -10 db intensity levels (relative to 1 dyne/cm^2) so that a single weighting circuit designed to give an RMS weighted harmonic in the 400 c/s test gives a good indication of the average performance over the most important range of audible frequencies.

A distortion meter using such a weighting circuit has been in use (in the Pye works) for more than twelve months and its indications have many times been compared with aural estimates on pure tones and on musical programmes with reasonably satisfactory results. Even so, we cannot agree with "Cathode Ray's" assertion that the subject is on "a satisfactory footing"; as a matter of fact it was his remark to this effect that caused us to adopt the counter provocative heading to our notes.

L. V. CALLENDAR, M.A.,
G. F. CLARKE, B.Sc.,
Research Department,
Cambridge. Pye, Ltd.

The above letter has been shown to "Cathode Ray," who makes the following reply.

I AM glad to see that my remarks on the subject of intermodulation have at last drawn fire, even though one shot (fired by Messrs. Callendar and Clarke) says they are not true and another (by Mr. Benham) says they are too obviously true to be worth printing. Perhaps it would be wiser for me to withdraw and let these opposing forces fight it out. But as I have already replied to Mr. Benham, I had better say something to Messrs. Callendar and Clarke too.

Their contribution is a valuable corrective to too great an enthusiasm for intermodulation as against harmonics, and is so convincing as almost to persuade me that there is something in it, were it not that it entirely fails to explain the results of my little experiment in which tones that separately sound practically undistorted are found to give rise to gross distortion when played together.

The effect of masking is quoted. That is a very important factor, too often neglected. I have looked up Wegel and Lane's Bell Telephone Laboratories data, and here are some deductions therefrom:—

No. of harmonic.	db. below fundamental to be just audible.	Corresponding percentage.
2	16	16
3	10	32
4	7	45
5	4	63
6	4	63
7	5	56

Now I want to make clear that I am not necessarily backing these figures; in fact, it is one of my contentions that an exact harmonic is less obtrusive than something slightly different in frequency—an effect that is not exhibited by the data referred to. But the figures do not help Callendar and Clarke either.

Then they seem to be on even thinner ice than I am, in relation to musical theory. To mix the metaphor, they are barking up the wrong tree. The reason a devotee of modern composition considers octaves, fifths, etc., as "painful afflictions" is that they are so insipid and unobtrusive. Which proves my point admirably.

"The relative discord of the intermodulation products from the two tones of a simple musical interval is only slightly greater than that for a harmonic of a single tone." No! Suppose the two tones are 100 and 800 c/s. They harmonise simply, for one is three octaves above the other. Harmonics also are simple harmonics. But intermodulation tones are 700 and 900. Try striking three adjacent keys of the piano simultaneously (black keys included) instead of the middle one only, in a piece of Mozart, and compare the "distortion" with that produced by throwing in an octave or two. The former represents the effect of the intermodulation tones mentioned.

The flute and drum argument is hardly worthy of your correspondents' qualification. The combination is admittedly rare, but I would remind them that the fife and drum is a recognised combination. Not that I think any the more of it for that; but if composers have realised that loud low tones simultaneously with high ones "produce a nasty noise," they have been most unkind, for every organ recital and symphony concert I have ever heard has included this, more or less frequently. Loud pedal notes on the organ, or bass drum work in the orchestra, on their own are indeed rare. But in combination with high notes from violins, wood-wind, etc., they hardly deserve to be considered as a "special case." It is just this frequent combination that sounds so unpleasant when intermodulation exists.

The subjective argument is a more valid one. But without denying that the ear itself produces intermodulation, if the engineer were to be allowed to use that as an excuse for tolerating it in his apparatus, where would we end? The fundamental rule for all concerned in the various links in sound reproduction is to give the ear what it would get if it were present at the original performance. What the ear does with it then is no business of theirs. Moreover (I only throw this out as a suggestion) may not the type of intermodulation produced by a pentode be more foreign to the ear than that by a triode? It seems highly probable that it should be so.

I am sorry that I cannot gather from Callendar and Clarke's description of their distortion meter what precautions, if any, they take to cover the masking effect they refer to earlier in their letter. A fuller description would be appreciated.

Finally, if your correspondents will re-read my article they will see that I did not say that the subject was on a satisfactory footing, but that Harries' experiments were not altogether on a satisfactory footing because no explanation for the alleged relationship between harmonics and modulation products was given.

"CATHODE RAY."

Relays

ON the excuse of doing a little debunking, "Praxis," in his letter in *The Wireless World* of June 23rd, has succeeded in making out a better case against the relay system than its opponents have done. If, as he states, the relay companies are involved in heavy losses, in some cases reaching 90 per cent., whatever this may mean, can there be any excuse for their continuing to operate? The matter need not be further argued, however, for it will obviously settle itself in a very short time.

When he deals with television relay systems, "Praxis" deals equally hardly with the system he advocates. He does not make it at all clear what method of connection to the subscribers he favours, but it would appear to be an open wire line with earth return. On the face of it, this system is unsuitable on account of the susceptibility of such lines to interference, especially in urban and suburban districts.

The alternative interpretation of his letter is that he is referring to wave-guides. As far as I am aware, these are at present in the experimental state, are suitable only for centimetre wavelengths, and are, by their bulk, unsuitable for a relay system.

C. G. J.

Muffled Broadcasting

SURELY Mr. T. J. E. Warburton (June 9th) is wrong. The percentage modulation at any instant is independent of the carrier volts in the aerial.

In any case I should advise him to make, as I have done, the *Wireless World* Quality Amplifier fed by a high fidelity receiver such as the Pretuned Quality Receiver. If the muffled effect were noticed on a good loud speaker fed from these, I should believe that the transmission was at fault. Even with a speaker whose high note response is not as good as it might be I do not notice any muffling.

H. S. SAXTON.

Nottingham.

I READ with interest the letter in your issue of June 9th from Mr. T. J. E. Warburton entitled "Muffled Broadcasting."

Mr. Warburton suggests that the main cause of the above effect is insufficient modulation of the carrier wave. But I suspect that the trouble is in Mr. Warburton's receiver, and is probably caused by poor HF rectification, in addition to which the signal diodes may be getting hot owing to their close proximity to the cathode, and, therefore, be emitting electrons.

I have had a number of cases of this nature, and would strongly advise your correspondent to remove the chassis from the cabinet so that the heat which is generated in the receiver may dissipate more quickly.

It is an unfortunate fact that most commercial receivers have poor provision for heat dissipation, as, after they have been switched on a little while, you can virtually fry eggs in 'em!

Surely the B.B.C. are not to blame for this!

M. MISTOVSKI.

London, S.E.11.

THE WIRELESS INDUSTRY

A.C.S. RADIO, formerly of Bromley, has moved to more central premises at 16, Gray's Inn Road, London, W.C.1. The firm specialises in short-wave apparatus, communication receivers, etc.

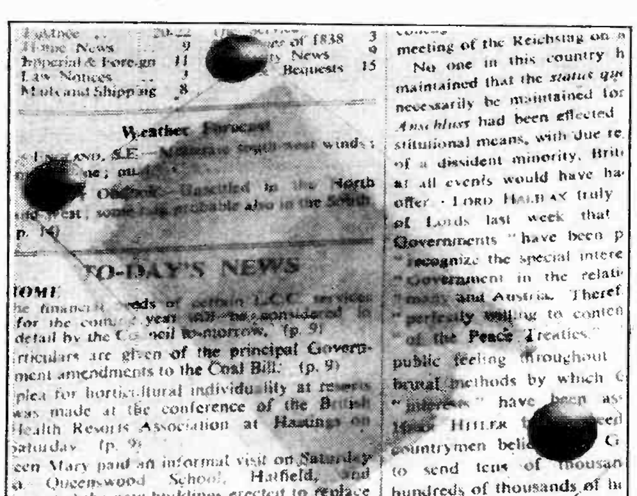
Ferranti announces the introduction of a range of American-type valves with Octal bases. The range comprises a heptode, variable-mu RF pentode, double-diode-triode, output pentode, and a full-wave rectifier.

The 1938-9 catalogue of Kabi products, dealing with potentiometers and rheostats (standard and heavy-duty), rotary stud switches and similar components, is obtainable from F. W. Lechner and Company, 5, Fairfax Road, London, N.W.6.

Transparent Metal

THE advantage of metal films for wireless and instrument fuses lies essentially in their quick action, the time taken to heat up the small amount of metal to fusing point being negligible.

A special technique is required for the production and handling of these films, and Microfuses, Ltd., 4, Charterhouse Buildings, Goswell Road, London, E.C.1, who have been responsible for the development of fuses of this type, have recently produced a gold film so thin that it is easily possible to read print through it in ordinary light. Although of molecular thickness the film is perfectly continuous, and is stable from the chemical point of view.


Weather Forecast
TO-DAY'S NEWS

Gold film thin enough to read through has been produced for use in "Microfuses" of low current rating

RANDOM RADIATIONS

By "DIALLIST"

It Really Is Coming

AND so at long (very long!) last we are going to have a Bill before Parliament which will include clauses dealing with radiation of interference with wireless reception. Some of the lay papers have written as though the new Wireless Telegraphy Act were coming almost at once. I am afraid that it isn't; it may just possibly be introduced during the autumn session, but the odds are that it won't make its appearance until next year. Still, it's something to know that it *is* coming. We've waited sixteen years for it—broadcasting in this country began in the autumn of 1922—so I suppose that we can wait a little longer. The trouble is that the Wireless Telegraphy Act, under which the transmission and reception of both broadcasting and television are controlled, is an ancient hotch-potch which became law long before the full possibilities and the implications of wireless were realised. Rather than add further bits and pieces to this quaint miscellany, it is proposed to draft an entirely new Bill, dealing with radio communications as a whole. This is necessarily a mighty task. The drafting of the Bill will take time, and its passage through the two Houses of Parliament is likely to be a somewhat lengthy process.

Looking Ahead

One only hopes that on its way through Parliament the Bill won't become so watered down that its anti-interference clauses lose half their effect. There is sure to be strenuous opposition to some of the proposed regulations by vested interests, such as those who control electric railways or tramways, cinema theatres, or factories equipped with electrical machinery. Owners of flashing signs and such things will lift up their voices, and motorists may object to the expense of having their ignition systems rendered innocuous. Then there are householders and shopkeepers who have installed domestic and trade appliances which radiate badly. And something will no doubt be said by hospitals, doctors, masseurs, and others possessing electrical equipment which, however beneficial it may be to the human body, is quite the reverse to the human listener's and viewer's reception.

A Strong Line Needed

All these people may do their utmost to cut the claws of anti-interference regulations; but really, when one comes to think of it, they don't deserve any kind of kid-glove treatment. It has been known for ages that anti-interference legislation was in the offing, and those who have possessed themselves of any kind of apparatus which creates interference with radio reception have done so more or less at their own risk. It is a pity, of course, that official warnings to those affected were not issued long ago; but that is no very important point. Certainly it is no excuse for the movie theatre people or the railways or the tramway concerns, or those who possess flashing signs that radiate. They have known for years that they were causing interference because the Post Office engineers have brought it home to them when investigating the thousands of complaints that come in annually from listeners. And in these days of "all-wave" sets there must be few motorists who couldn't have found out, when trying their cars before purchase, whether or not they caused short-wave interference. What I am afraid of is that we shall see a delay of at least a year after the passing of the Act before it comes into operation, and that, even then, those who own radiating devices may be given a long period of grace. My rather gloomy forecast is that it won't be in less than five years from now that anti-interference legislation becomes genuinely effective.

Fixing the Portable

MY better-half possesses a first-rate portable set from which she will not be parted, mainly because it can be used in any room, at any time, or taken out of doors if need be. Great though its virtues are this set is, like many of its kind, rather hard on its batteries. If a portable is to be portable, both HTB and LTB must be light and therefore small. The result is that filament accumulators must frequently be recharged and dry HTB's often renewed if reasonable quality is to be maintained. Now this set probably does at least 80 per cent. of its work in one room. It occurred to me that it wouldn't be at all a bad idea to make the set workable from big batteries of both kinds when it was there, though still retaining its own batteries for use in other rooms.

Working It Out

This set has automatic grid bias and only two HT battery leads, as all sets should have nowadays. The problem wasn't, therefore, a very formidable one. I made a small block upon which are mounted two terminals and two sockets to take standard wander plugs. This stands beside the set, whose own leads, slightly lengthened if need be, are disconnected from the batteries inside its cabinet and connected respectively to the LT terminals and the HT sockets when it is in use in the room where it does most of its work. To the block are permanently connected HT and LT cables, the former terminating in a large two-point plug and the latter in a smaller one, so that mistakes can't be made. A neighbouring cupboard conceals a 50-

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, JUNE 30th.

Nat., 7.45, Eddie Carroll and his Orchestra. 8.30, "The Future of Roads"—Transport Discussion. 9.20, Variety from Northampton. 10.20, Commentary on London and Home Counties Individual Darts Championship.

Reg., 6, Adaptation of the film success, "Sunny Side Up." 8.30, Irish Dance Music. 9, "The Tower," a pageant in sound.

Abroad.

Breslau, 8, "The Magic Flute," opera (Mozart) from the Municipal Theatre.

Poste Parisien, 9.5, International Stars, presented by Adolphe Borchard.

FRIDAY, JULY 1st.

Nat., 7.30, A Recital of Modern Part Songs. 8, "Conversation in the Train." 8.15, The Western Brothers present "Cads' College." 9.20, A.R.P. and Scotland—talk by Lt.-Col. D. J. Colville. 9.35, Chopin Studies, played by Irene Scharrer, pianoforte.

Reg., 7.30, Oscar Rabin and his Band. 9, "General Release"—Songs from Current Films.

Abroad.

Leipzig, 8, Dresden Philharmonic, conducted by Hilmar Weber.

Bucharest, 8, "Der Freischutz," opera (Weber).

SATURDAY, JULY 2nd.

Nat., 7.30, 166th and final edition of present series, "In Town To-night." 8, Music Hall, including Vic Oliver and Lily Morris. 9.20, American Commentary. 9.35, Act 4 of the opera "Macbeth" from Glyndebourne.

Reg., 8.15, Harry Welchman in "The Shooting of Kara-Wenzel," play. 9.10, Act 3 of the opera "Macbeth" from Glyndebourne. 9.30, Quintette du Hot Club de France.

Abroad.

Radio Eireann, 10.45, The Dublin Motor Car Race in Phoenix Park.

Prague, 8.30, Concert of Czech Music.

SUNDAY, JULY 3rd.

Nat., 9.25, Service from Lichfield Cathedral. 11.30, Students' Songs. 12, Morton and Kaye, pianofortes. 7, Alfredo Campoli and his Orchestra. 9.5, Sermons in Stone.—Canterbury Cathedral.

Reg., 5.30 and 6.15, "Don Pasquale," Act 1, from Glyndebourne. 6.50, "Liebelei," the play by Arthur Schnitzler. 9.50, Recital by Jelly D'Aranyi, violin, and Myra Hess, pianoforte.

Abroad.

Radio Paris, 8.30, "La Jolie Parfumeuse," operetta (Offenbach).

MONDAY, JULY 4th.

Nat., 7, The Bungalow Club. 8.10, Frank Mannheimer, pianoforte. 9, "Britain on the Bust," a panorama of summer holiday-making, compiled by S. P. B. Mais. 9.45, "The Past Week," talk by the Rt. Hon. Harold Nicolson.

Reg., 8, Sulgrave Manor and Mount Vernon, a programme arranged for Independence Day by the B.B.C. and the C.B.S. 8.20, "Mr. and Mrs. Neemo," with Billy Caryll and Hilda Mundy.

Abroad.

Radio Paris, 8.30, Symphony Concert from the Casino, Vichy.

TUESDAY, JULY 5th.

Nat., 7, "Horner's Corner." 8.30, Brighton: the first of a series of visits to seaside resorts.

Reg., 6, Sokol Festival, music from Prague. 8, Victor Sylvester and his Orchestra. 8.30, "Granton Street," a play by P. H. Burton. 9.30, "Daylight Robbery," a burlesque by the Melluish Brothers.

Abroad.

Kalundborg, 8.15, "The Merry Widow," opera (Lehár).

Paris PTT, 8.30, "Lilac Time" (Schubert-Berté).

WEDNESDAY, JULY 6th.

Nat., 8, Musical Comedy, "Bianca." 9.40, The Story of the Bombing of Barcelona. A.R.P. talk by John Langdon-Davies. 9.20, Al Bollington at the B.B.C. Theatre Organ.

Reg., 6, Jack Wilson and his Five. 8, Arthur Benjamin, pianoforte. 8.30, "China Clay," an account of the "white" industry. 9, The Coventry Festival—from the precincts of Coventry Cathedral.

Abroad.

Warsaw, 6.10, Concert of American Music for American Independence Day.

Brussels I, 8.30, Falla and Ravel, Concert.

ampere-hour filament accumulator and a high-tension accumulator battery which was surplus to my own requirements. Each battery is connected to an inconspicuous socket on the outside of the cupboard. It doesn't take more than a minute or so to change over from portable to fixed batteries, and I find that the change is very willingly made owing to the much better quality obtainable with the latter in use. The quality is better not only because the accumulator HTB keeps always up to the mark, but also because, the set having automatic grid bias, I found that a higher HT voltage could be used than that which the set's own HTB supplies even when brand new.

Now We Know . . . . . . Or Do We?

FOR a long time now there has been agitation in the United States for an authoritative definition of what constitutes a radio tube, or, as we should say, a wireless valve. The trouble was that Uncle Sam's citizens had got into their heads the idea that the more tubes it contained the more "powerful" must a receiving set be. Hence, Uncle Sam's manufacturers, ever on the alert for what are termed "selling points," did their best to ensure that their products contained the maximum possible number. I have mentioned previously some of the tricks of the trade in that country, such as the use of four small half-wave rectifiers to do the work which could perfectly well have been undertaken by a single full-wave rectifier of reasonable size, and even the mounting of dummy valves, of which only the heaters were connected to anything. It has become the practice in the U.S.A. to include in the number of tubes rectifiers, neon, or cathode-ray tuning indicators, barretters, thermal delay switches, and even, so I am told, dial lights. It was hoped that the long-awaited definition would clear up the position.

Something Better Wanted

Here is what the American R.M.A., in its wisdom, has laid down:

"A radio tube is a device used in radio equipment in which an electric or magnetic field causes or controls the electronic or ionic conduction through a vacuum or a gas. This definition shall not be construed to include dial lamps used for illumination only, ballast or other resistance devices.".

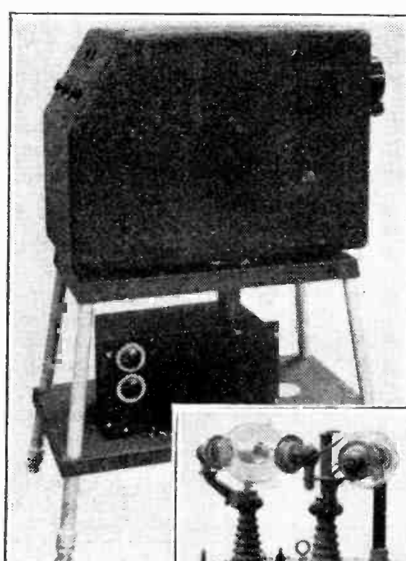
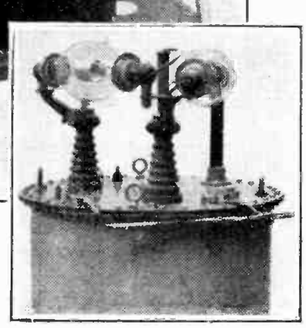
And where does that leave our American cousins, or us if we buy American wireless sets? Pretty well where we were before, I think, except that the dial lamps, the barretters, and the ballast resistances come out of the tale of valves. Either a neon or a cathode-ray tuning indicator clearly conforms with the definition, for each is a device used in radio in which an electric or magnetic field causes or controls the electronic conduction through a vacuum or a gas. The rectifier (or a group of small half-wave rectifiers, for that matter) also passes the test with flying colours. I am afraid that the American R.M.A.'s definition, though it looks well enough at first blush, leaves the position very much as it was.

A Big Query

SOMETIMES I've wondered what is going to be the fate this coming season of a wireless dealer who sells a number of the less reliable sets with automatic tuning, and undertakes, as so many do, to keep them in order for a period. I can quite see him having a busy time running round with a signal generator to adjust levers or banks of pre-set condensers, some of which are so placed that their screws are not too easily accessible. But that such sets will go off tune is more than likely. Even those with automatic frequency control can do so. I had one under test which I left alone for a month to see what would happen, and by the end of that time the motor-driven automatic arrangement was quite a long way out on the London Regional station.

Ingenious

THE newest Ekco receiver, I observe, has, besides motor-operated press-button tuning, a device which automatically operates the wave-change switch. It is claimed for this set that it will tune in any station on any wavelength automatically—there is, perhaps, just a *leetle* of set makers' natural enthusiasm for their products in that statement. Somehow I don't quite see this (or any other set) automatically picking out some feeble short-wave station from between two strongish neighbours on frequencies close on either side—perhaps that is rather a carping criticism. The system is certainly an ingenious one, and I look forward to trying one of these sets some time. I am possibly rather sorry to see that this firm is also going in for cheaper press-button sets without motor tuning, for I stick to my point that there are better ways of spending the money that goes to make low-priced sets than in providing any kind of automatic tuning. But with its customary ingenuity, the firm has arranged the trimmer screws of the press-button circuits in such a way that they can be adjusted by the user from the front of the cabinet.

THE PROJECTOR UNIT of the Baird Television Theatre receiver, in which is incorporated the time base and focusing chassis and the final stage of the vision amplifier, is extremely compact. This apparatus is being used for the demonstration at the Tatler Theatre, London, and was shown on the stand of G. B. Equipment Ltd. at the Cinema Exhibitors' Association Exhibition at Folkestone. The inset shows the top of the EHT unit, which, using a voltage doubling circuit, is capable of giving an output of 60,000 volts at 10 mA. although in the present apparatus it is giving 30,000 volts at 300 microamps. for the projection CR tube.

Recent Inventions

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

"BEAM" VALVES

RELATES to the type of valve in which electrons from the cathode are first focused into a clear-cut beam, which is then swung to and fro between two anodes by lateral deflecting grids. Such valves can be used as amplifiers, generators and rectifiers, but with positive-biased deflection grids—such as required to keep the beam focused—it becomes difficult to handle high-frequency currents.

According to the invention negatively biased deflecting-grids are interposed between a series of positively biased focusing wires, the whole being arranged along the path of the electron beam, between the first accelerating anode and the split-anode output.

N. V. Philips Gloeilampenfabrieken. Convention date (Germany) April 23rd, 1936. No. 482226.

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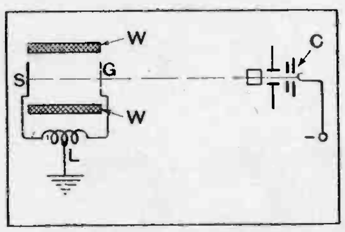
TELEVISION BY INCANDESCENCE

TELEVISED pictures are reproduced by incandescent light —as distinct from the glow of fluorescence—on a screen composed of particles of tungsten metal mixed with colloidal graphite. The mixture has a low thermal conductivity, in order to prevent the glowing spot, formed by the bombardment of the scanning stream, from "spreading" and so losing definition.

On the other hand, the screen mixture shows a certain amount of thermal inertia, which tends to introduce an undesirable "lag" between the impact of the scanning stream and the resulting rise in temperature, necessary to produce incandescence. To overcome this defect, the screen is subjected, during the intervals between successive scannings, to a steady bombardment of secondary electrons, which maintain it at a constant temperature just below the glow point. It will then incandesce more quickly under the action of the scanning stream.

As shown in the figure, the



CR tube in which televised pictures are produced by means of incandescent light

scanning stream from the cathode C of the tube passes through an open meshwork grid G, and through a magnetic field from windings W, before reaching the incandescent screen S. An alternating potential is applied (from a source not shown) to a coil L which is shunted across S and G, and the secondary electrons first produced by the impact of the scanning stream on the screen S are forced, by the AC voltage, first on to the grid G, and then back again with diminished intensity to bombard the screen S.

Marconi's Wireless Telegraph Co., Ltd., and L. M. Myers. Application date, August 10th, 1936. No. 481434.

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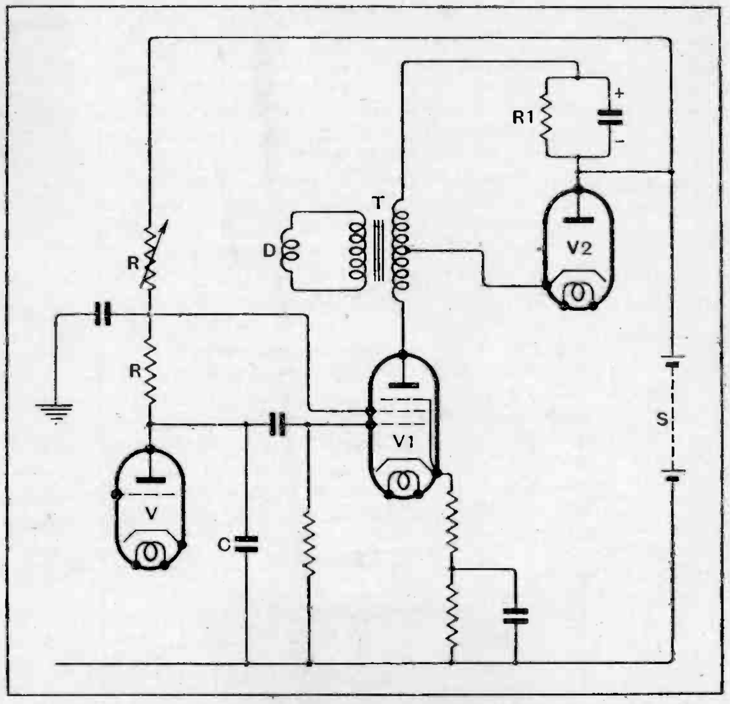
TIME-BASE CIRCUITS

THE object is to prevent unnecessary loss of power when generating saw-toothed oscillations for scanning.

During the time the blocking oscillator valve V is non-conducting, the condenser C charges up



Scanning circuit designed to prevent unnecessary loss of power in the production of saw-toothed oscillations.

from a source S through a resistance R. The control grid of a valve V1 follows the saw-toothed voltage produced by the ensuing discharge, the output from the latter valve being fed to the deflecting coils D of a cathode-ray tube (not shown) through the primary winding of a transformer T. Usually the whole of this primary winding is shunted by a diode rectifier in series with a resistance which dissipates the current taken by the diode when the current in the primary coil reverses.

According to the invention, the ohmic losses are reduced by tapping the diode V2 across the upper half only of the primary coil T, so that the current to be dissipated by the resistance R1 amounts only to the difference between the current flowing through the diode V2 and the current flowing through the valve V1. As this is much less than the average current taken by the diode when it is shunted across the whole coil, the drain on the HT source S is reduced accordingly.

E. L. C. White and A. D. Blumlein. Application date, August 27th, 1936. No. 482370.

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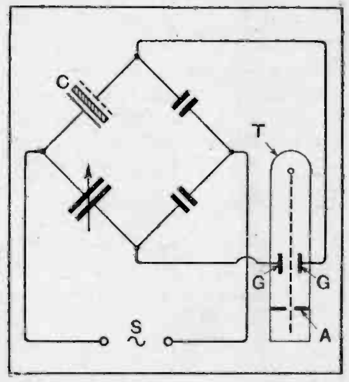
A LIGHT-SENSITIVE DIELECTRIC

IT has been known for some time that phosphorus shows a change in specific inductive capacity under the action of light, and will therefore vary the capacity of any condenser of which it forms the dielectric. Hitherto it has been difficult to turn this "actino-dielectric" effect to practical advantage owing to its small magnitude.

The figure shows an arrangement for amplifying the effect in question, and utilising it to modulate the electron stream passing through a cathode-ray tube. The "sensitive" phosphorus forms the dielectric of a condenser C, one plate of which is made as a transparent wire-mesh, so that the image of a picture to be transmitted can be projected directly on to the phosphorus. The condenser is inserted in an arm of a Wheatstone bridge, one diagonal of which is branched across a high-frequency source S, whilst the other diagonal is connected to the two deflecting or control electrodes G of a cathode-ray tube T.

The incidence of the light on the phosphorus, by upsetting the balance of the Bridge, applies an alternating potential to the elec-



Modulation system for a television transmitter using a phosphorus dielectric condenser.

trodes G. This diverts more or less of the electrons away from the aperture in an anode A, so that the stream passing through is modulated by picture signals.

Telefunken Ges. fur drahtlose Telegraphie m.b.H. Convention date (Germany), September 24th, 1935. No. 482208.

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THERMIONIC AMPLIFIERS

THE electron emission from the cathode of a valve is known to depend upon its temperature, so that an input current or voltage, applied directly to the cathode, should produce an increased emission corresponding to the change of temperature. This "emission-sensitivity" of the cathode might therefore be used to control the output from a valve, as an alternative to the present method of grid control.

In practice, however, it is found that the "thermal inertia" of the ordinary cathode is too high to allow this method to be successfully used, either for high or low frequency amplification. That is to say there is too much "lag" between the applied current or voltage, and the resulting rise in temperature required to produce a corresponding increase in electron emission.

To overcome this difficulty it is proposed to use for a cathode a ribbon or band of tungsten reduced by a special method of rolling to a thickness of less than the one-thousandth part of a millimetre. Such a cathode is sufficiently "heat-sensitive" to respond either to small or high-frequency inputs, and to produce corresponding variations in the electron stream flowing through the valve.

N. V. Philips Gloeilampen-Fabrieken. Convention date (Germany) May 13th, 1936. No. 482552.

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.