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Wireless for Private Communication

Is the Post Office Monopoly Too Rigid?

UNDER the Wireless Telegraph Act the Post Office is granted a monopoly in this country for the control of wireless communications. It is for this reason that all wireless stations are subject to a licence from the P.M.G., including transmitters and receivers for reception of broadcasting.

The Post Office also grants licences to commercial companies for the establishment of wireless services from point to point whilst the Wireless Telegraph Act specifically states that, subject to suitable regulations, the Postmaster-General shall not withhold licences for experimental purposes. When wireless licences are granted to amateurs and others for experimental purposes it is expressly stated in the licence that the stations must not be used for the transmission of ordinary messages but that all communications must be relative to the experiments. It is for this reason that amateurs in this country may often be heard stating the nature of the apparatus they are employing, or describing alterations to the equipment, but one seldom hears any communication radiated which extends beyond this scope or a few words of greeting.

Other Countries More Generous

In some other countries, notably in the United States of America, experimental licences are granted on much more generous terms and messages may be freely transmitted from point to point, provided that these transmissions are not made for financial gain.

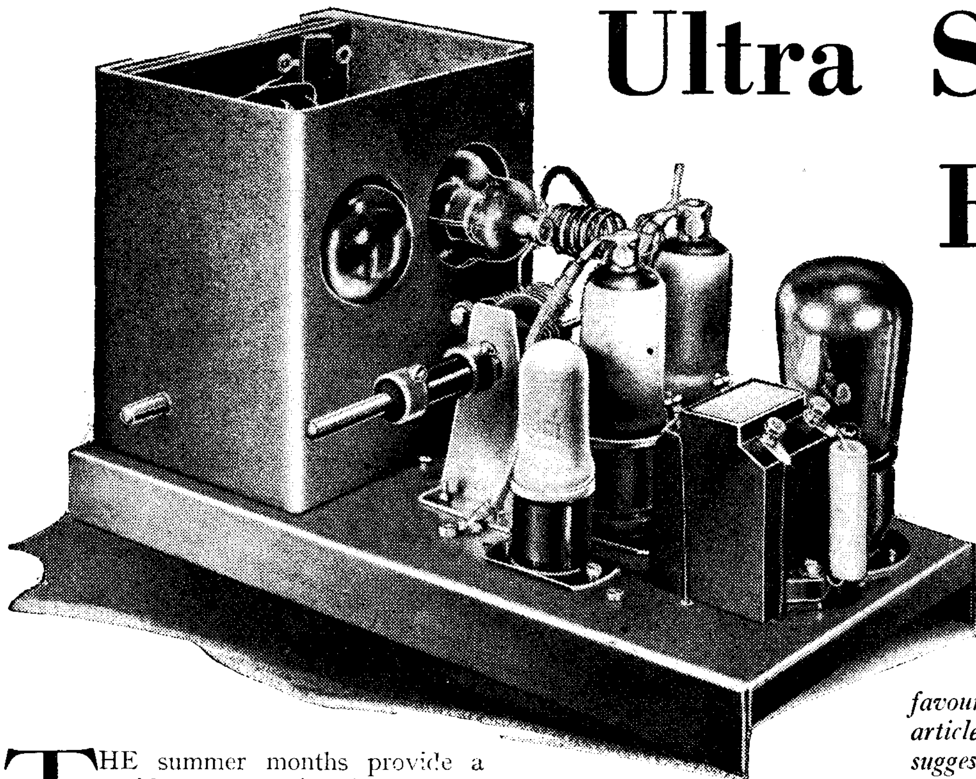
Since the date of the Wireless Telegraph Act, possible applications of wireless for communication purposes have been very greatly extended, and on ultra-short waves in particular a very valuable and convenient means of communication has been developed. Whilst recognising that these wavelengths are likely to be in great demand for a multitude of important purposes, it nevertheless seems desirable that some opportunity should be given for the establishment of private stations for point to point communication. A new industry could be built up from the sale of compact telephony receivers and transmitters suitable for the equipment of trains, buses and cars requiring to communicate with other points, whilst a little more latitude to amateurs to make use of apparatus would undoubtedly stimulate interest in experimenting.

Morse Code and Qualification

Whereas, at present, a knowledge of the Morse code and Morse procedure is required of those who apply for a licence, this should surely not be necessary in the case of those intending to confine themselves to the use of the ultra-short waves, for there would not be the risk, which applies on longer waves, that communications at a distance could be interfered with.

For general use transmitters and receivers could be supplied pre-tuned to fixed wavelengths to ensure that they were not used to intercept transmissions not intended for them.

An adequate charge for a licence would, of course, be made by the P.M.G. with such regulations as were considered necessary, but no change in the Wireless Telegraph Act would be required as the necessary powers for such modifications in the present policy are provided for therein.



Ultra Short-wave Reception

Portable Sets for Field-day Use

By H. B. DENT

AT this time of the year many amateurs turn their attention to outdoor wireless activities, the five-metre band being a particularly favourite one for these experiments. This article deals with some suitable receivers and suggests an alternative to the ubiquitous super-regenerative set that has for long served on these occasions.

THE summer months provide a golden opportunity for outdoor wireless activities which offer a welcome change to the more active pastimes, yet enable full advantage to be taken of the fine weather. Those contemplating taking a part in wireless field days this year might well consider the idea of utilising these occasions to obtain some experience in the handling of ultra short-wave receivers and the compiling of useful data on wave propagation at these very high frequencies.

Many amateurs operating transmitting stations are active on the five-metre band, but helpful data is difficult to obtain unless a particularly favourable transmitting site is available, for it is not always possible to erect an aerial sufficiently high in residential districts to clear all nearby buildings.

There is much that the amateur desires to know regarding the performance of different aerial arrays, and these experiments are capable of being carried through successfully only in fairly open country. The ideal arrangement is for the transmitter to be located on a prominent point, and there are several excellent sites to be found within a reasonable distance of most large cities.

Field days organised on these lines offer a welcome diversion during the summer for radio societies and institutions interested in the experimental side of amateur wireless.

Subsequent reception should be recorded in a section log, containing such information as strength of signals, time, position and nature of the surrounding country with details of any hills or other topographical features lying between the receiver and the transmitter, for this information when compiled into a report of of the earlier experiments. The writer has obtained very good results with simple super-regenerative receivers using short vertical aerials, dipoles and also loops for directional reception. *The Wireless World* Ultra Short-wave Two, the circuit of which is shown in Fig. 1, is an example of a set of this type.

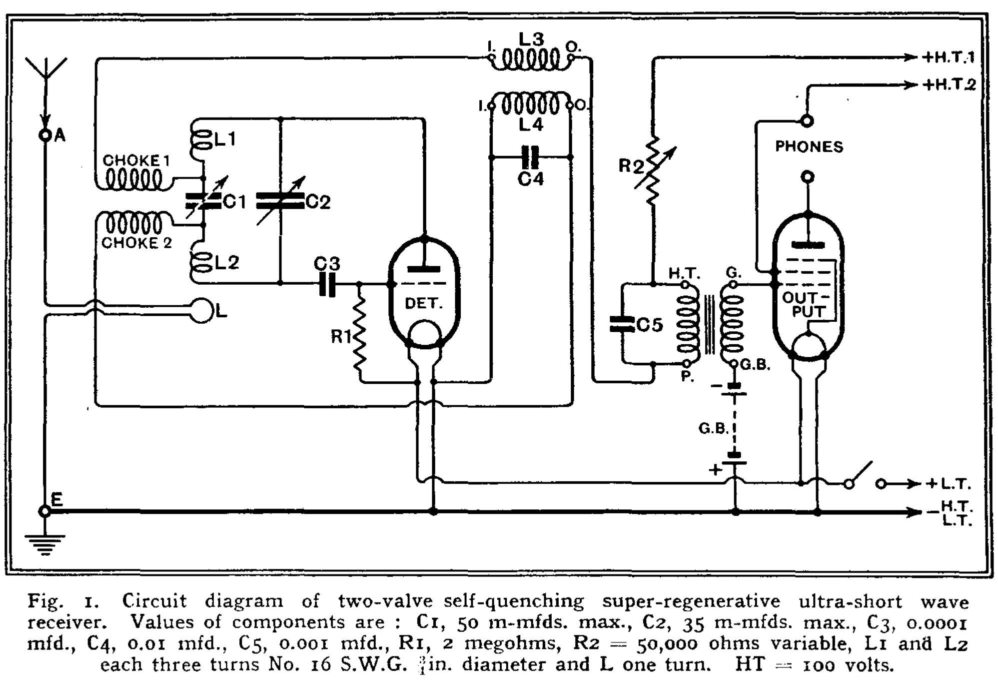


Fig. 1. Circuit diagram of two-valve self-quenching super-regenerative ultra-short wave receiver. Values of components are : C1, 50 m-mfds. max., C2, 35 m-mfds. max., C3, 0.0001 mfd., C4, 0.01 mfd., C5, 0.001 mfd., R1, 2 megohms, R2 = 50,000 ohms variable, L1 and L2 each three turns No. 16 S.W.G. ¾in. diameter and L one turn. HT = 100 volts.

Field Day Procedure

The receiving parties could be equipped with one or more receivers so as to compare the performance of different sets under the same conditions. Each takes a prearranged section of country and tests are made at frequent intervals, the first not more than a mile from the transmitter in order to tune in the station and note its position on the dial.

the day's work will provide extremely useful data for future experiments of a like nature.

One advantage of the five-metre wavelength is that it does not necessitate elaborate or bulky apparatus. Self-contained receivers can be built in easily portable form whilst a comparatively low-power transmitter will suffice for many

For outdoor use the receiver should be easily portable and entirely self-contained and, if directional reception using a loop or dipoles is attempted, provision should be made to operate the set in an elevated position, for it was revealed during some five-metre outdoor experiments last year that the aerial required to be raised at least four feet above ground level. This

Ultra Short-wave Reception—

does not apply, of course, when a non-resonant vertical aerial is employed or an elevated dipole with feeders to the receiver. These arrangements, however, are not very conveniently applied to portable-type sets unless the apparatus is fitted in a car and the aerial supported on quickly erected poles in sockets.

A portable receiver embodying a separate quenching valve is shown in Fig. 2; this was designed for use with a loop aerial, though it would be quite an easy matter to modify the input circuit for use with dipoles arranged either horizontal or vertical according to the polarisation of the transmitted wave.

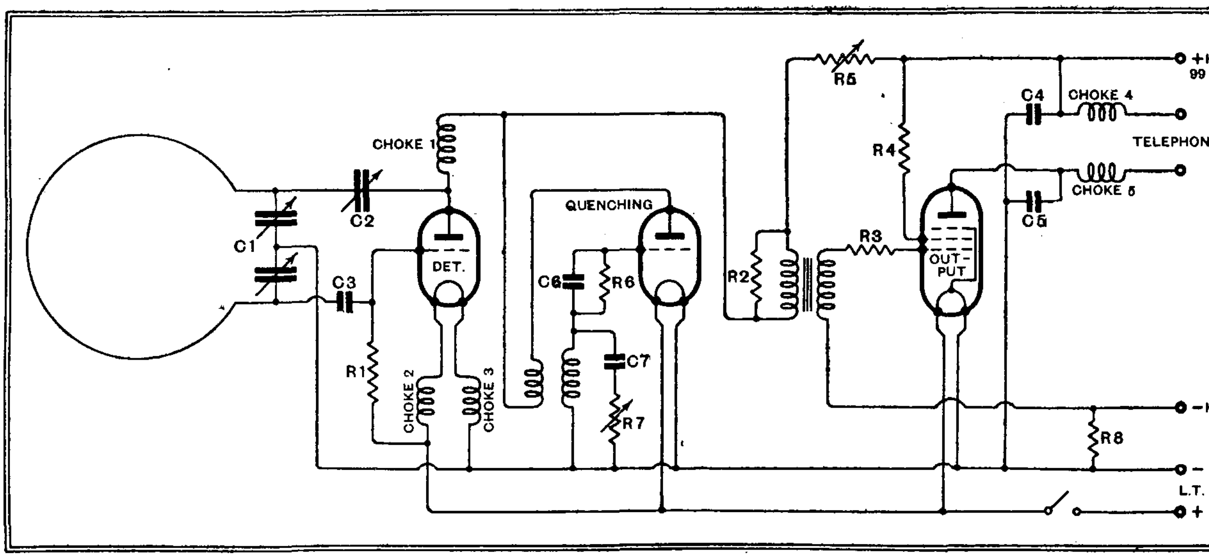
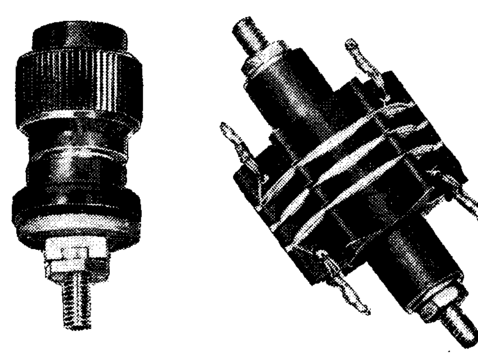


Fig. 2. Three-valve super-regenerative 5-metre receiver; value of components are: C1 = 30 m-mfds. each section, C2 = 15 m-mfds., C3 = 0.0001 mfd., C4, C5 = 0.006 mfd., C6 = 0.005 mfd., C7 = 0.01 mfd., R1 = 1 megohm, R2 = 30,000 ohms, R3 = 50,000 ohms, R4 = 5,000 hms, R5 = 50,000 ohms variable, R6 = 50,000 ohms, R7 = 1,000 variable and R8 = 500 ohms, HT = 100 volts.

Whilst the super-regenerative receiver is simple to construct and to operate its sensitivity is not very high, though undoubtedly superior to the ubiquitous Det.-LF arrangement. The obvious alternative is the superheterodyne. Even a set of this type can be built for battery operation in a very compact form if a little ingenuity is applied to adapting existing components for the purpose.

The intermediate amplifier employed for normal broadcast sets, and for that matter in some special short-wave receivers, is operated at far too low a frequency for really satisfactory results on the ultra short waves. A more suitable frequency would be about 4,000 kc/s (75 metres), and with modern valves a useful stage gain is possible even with the battery type and quite a low HT voltage. Two such IF stages gave an overall amplification of just on 200 in a small portable set operating from a 100-volt battery and intended for headphones only. As we might reasonably expect the frequency changer to contribute about three whilst



Miniature IF transformer used in the 5-metre superheterodyne described in the text. Its size can be gauged by comparison with the terminal alongside.

the detector and one transformer coupled LF amplifier will add a further 200, the overall amplification that such a set will give amounts to approximately 120,000.

Compared with ordinary broadcast sets this is not very good, but a super-regenerative set working at its best and fitted with a similar LF circuit could hardly be expected to exceed the 5,000 mark. The figure given for the superheterodyne could be improved upon by applying reaction to the IF amplifier, for in its experimental form it was found to be perfectly stable.

Compact Superheterodyne

The circuit employed is given in Fig. 3, and some idea of the compact form in which it can be built is shown by the illustration of the receiver chassis, which measures 12in. × 6in. and is intended to be housed in a metal cabinet 12in. × 12in. × 6in., with the batteries below the chassis. The cabinet that held the small super-regenerative portable shown on the next page will be used for this set, so that it occupies no more space than the three-valve set. It must be admitted, however, that to accommodate everything in such a small compass requires care in the choice of the components used.

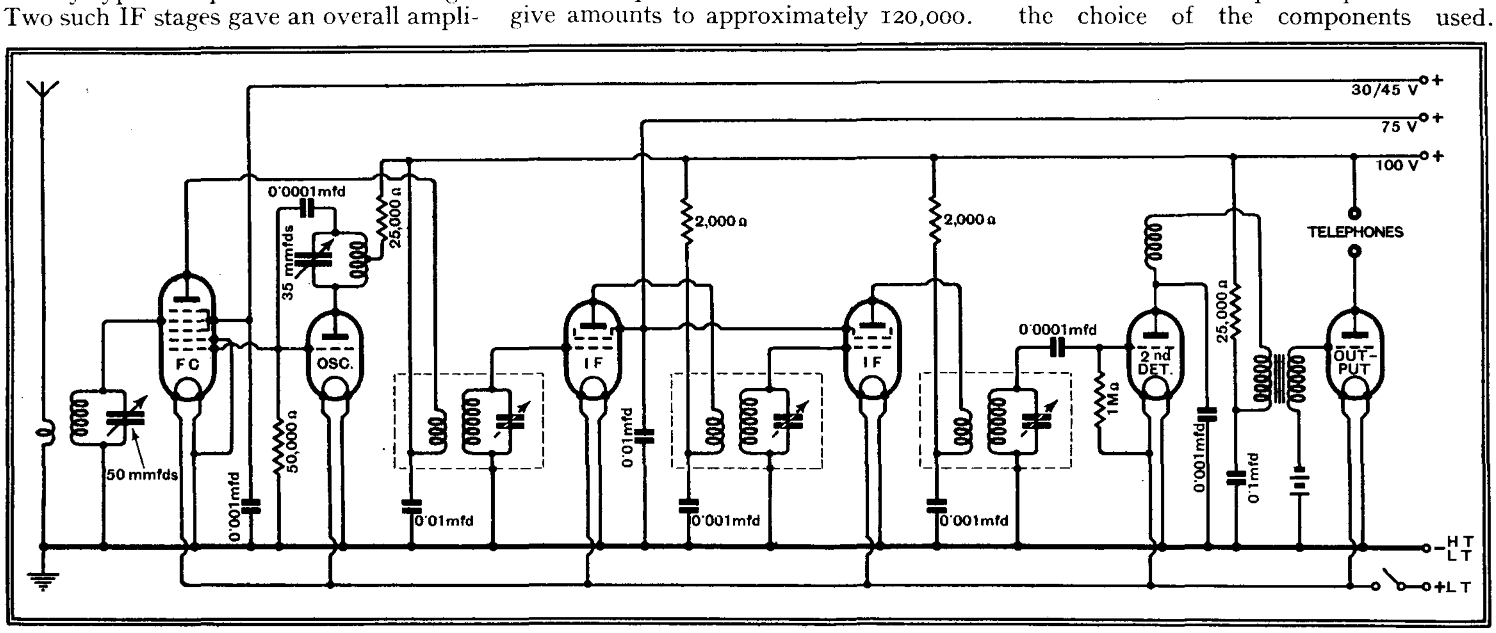


Fig. 3. Circuit diagram of the experimental 5-metre six-valve superheterodyne.

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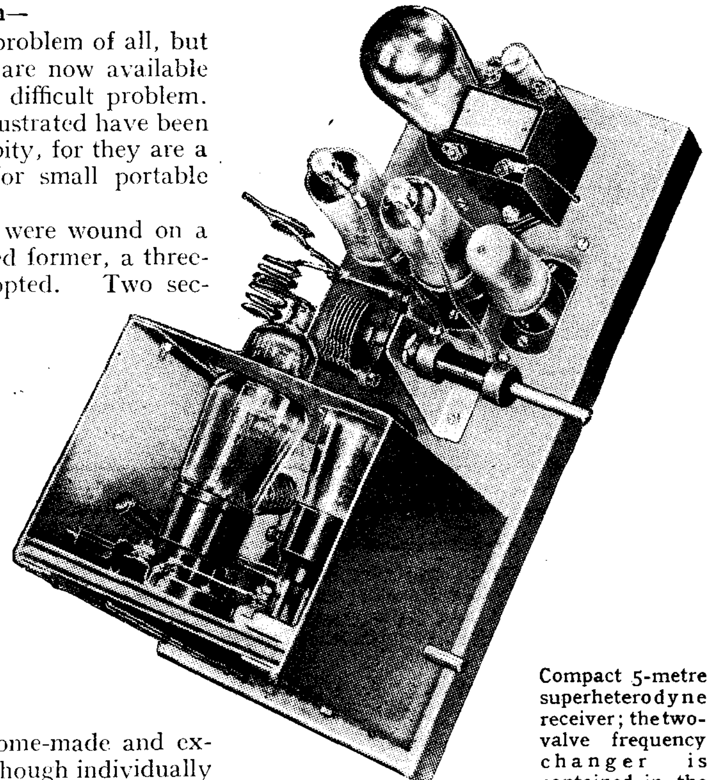
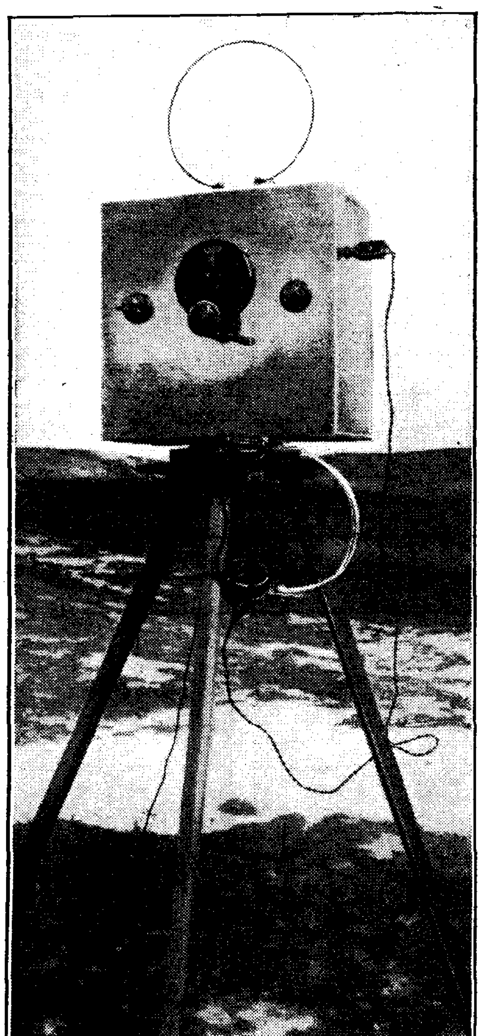
Valves are the biggest problem of all, but quite miniature valves are now available so that it is not a too difficult problem. Those used in the set illustrated have been withdrawn, which is a pity, for they are a most convenient size for small portable sets of this nature.

The IF transformers were wound on a one-inch diameter ribbed former, a three-slot winding being adopted. Two sections form the secondary and one the primary, and they measure $\frac{3}{4}$in. deep only. The illustration shows the form of construction adopted. The grooves are 1/64in. wide, and each contains 25 turns of No. 32 DSC wire. They are enclosed in small metal cans $1\frac{3}{8}$in. in diameter and $1\frac{1}{2}$in. high. The small trimmers were home-made and external to the coil cans, though individually screened. Very small condensers are wanted, as the bulk of the capacity is made up of the valve and wiring, the trimmers merely making good discrepancies in the various circuits. Only by employing the highest inductance possible is a reasonable stage gain attainable at these high frequencies.



Compact 5-metre superheterodyne receiver; the two-valve frequency changer is contained in the screened compartment on the left. The IF transformers are mounted below the chassis.



Five-metre self-contained receiver fitted with loop aerial for directional reception.

It was not possible to improve the IF gain to any appreciable extent with the layout and the limited HT voltage employed. Increasing the primary turns tends to convert the IF transformers into band-pass circuits, the primary then resonating at a frequency approaching that of the secondary, for although these circuits are tuned by small additional capacities the trimmers account for a small part only of the total capacity across the coils, which are tuned mainly by the valve and other stray capacities. Furthermore, HF instability was encountered.

Limited Amplification

Applying reaction to the detector stage gives a slight gain, but has the disadvantage of detuning this circuit unless reaction is pre-set and the circuit trimmed with full reaction applied.

It was further revealed that if an amplification of more than about fourteen per stage is attained the background becomes rather objectionable, and this is a point that must be kept always in mind, for it will preclude intelligible reception of very weak signals, which is of particular importance in sets of this type intended solely for headphone use.

Practical tests have shown that of two sets the one that was considerably more sensitive than the other but having a higher background level did not prove as good when listening to weak telephony signals.

In order to better the sensitivity it would seem necessary to rearrange the circuit and add an extra IF stage, making three in all, and accompanying this by a reduction in the gain of the individual IF stages. This line of development is being followed at the present time, and it is hoped that in the near future some further data on the matter will be available.

It is not proposed to give a detailed description of the set at this juncture, since it is still very much in the experimental stage, but the circuit diagram, on which has been marked values of most of the components and the brief description of the 4,000 kc/s IF transformers, may prove of some assistance to those sufficiently interested in this aspect of radio to turn their hand to investigating the possibilities of the superheterodyne for five-metre reception.

Readers desiring further details regarding the two super-regenerative 5-metre sets mentioned in the early part of this article can obtain them from *The Wireless World* of June 16th, 1933, where the construction of the Ultra Short Wave Two was given, while the portable three-valve set was dealt with in the September 28th, 1934, issue of this journal.

Preventing Collision in the Air

Wireless Aid to Safety in Aerial Navigation

At the present rate of increase in the number of aircraft in commission the risk of collision will soon become a very real one, especially in the vicinity of aerodromes. Dr. J. Robinson, the inventor of the Stenode and the pioneer of the direction-finding system known as Homing, is now responsible for introducing apparatus which he describes as an Altimeter-controlled Wireless Klaxon, with the object of minimising this danger to aerial navigation. This apparatus is now being developed.

Briefly, it is proposed that an aircraft in positions where the risk of collision exists should send out, either from a special low-powered transmitter or from the modified main transmitter, a signal to be modulated automatically by the altimeter in order that its presence and height may be made known to other aircraft in the neighbourhood, which would be fitted with suitable receivers.

As an example of "altitude modulation," it is suggested that transmitters of aircraft at ground level should be modulated at 256 c/s per second, corresponding to middle C; at 1,000ft. by 512 c/s equal to an octave higher, and so on.

The success of this scheme obviously depends on the accuracy of the altimeters of all aircraft concerned. As is well known, these instruments are simply specially calibrated barometers, and clearly their accuracy depends on the zero being suitably set to correspond with the prevailing atmospheric pressure at ground level below.

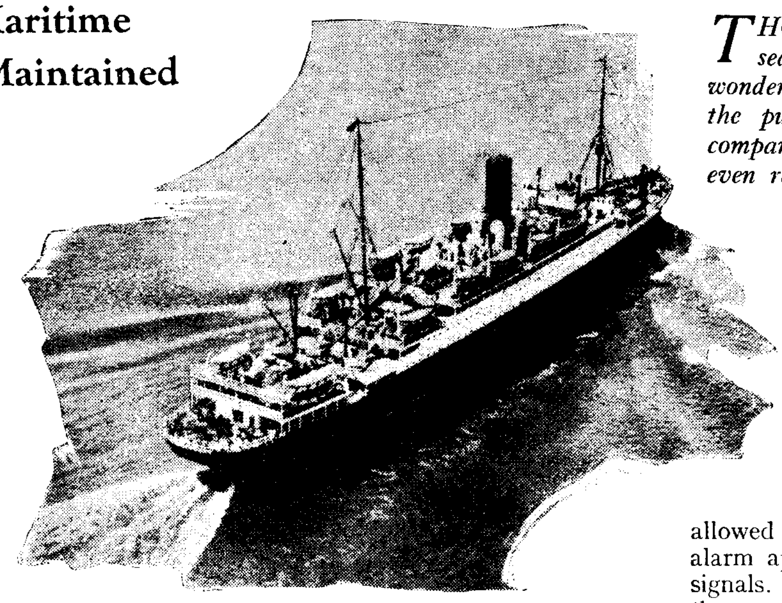
Dr. Robinson proposes, therefore, that at aerodromes or at definite points on air routes where the possibility of collision exists, a wireless transmitter should send out a signal which automatically resets the zero of all altimeters within range. Accuracy will be thus assured, and a pilot could safely depend on warnings received through his "Wireless Klaxon" apparatus.

Wireless Working with Ships

How the Maritime Services are Maintained

By LT.-COL. CHETWODE CRAWLEY, M.I.E.E.

THOUGH the use of wireless at sea has ceased to arouse the wonder and admiration which gripped the public mind in pre-war days, comparatively few "landlubbers"—or even radio amateurs—are aware of the actual conditions governing the operation of the various services. Stringent rules are applied to every department of maritime wireless, the primary aim of which is to secure maximum safety for all ocean travellers.



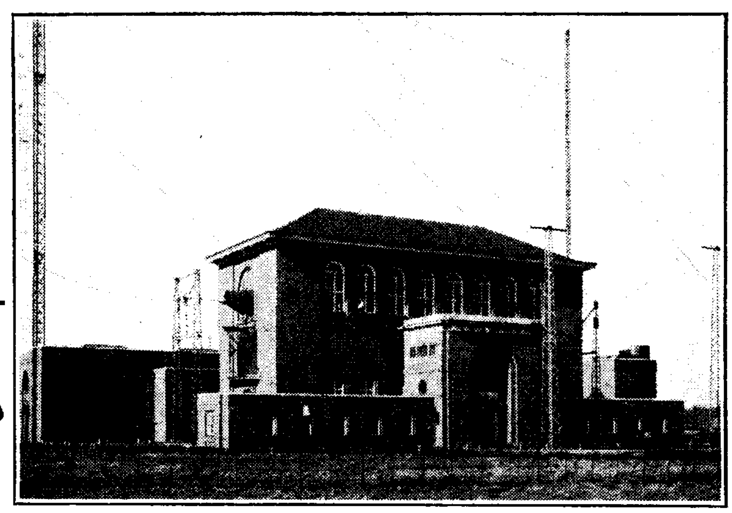
By courtesy of Cunard White Star Ltd.

Air photo of RMS "Alaunia."

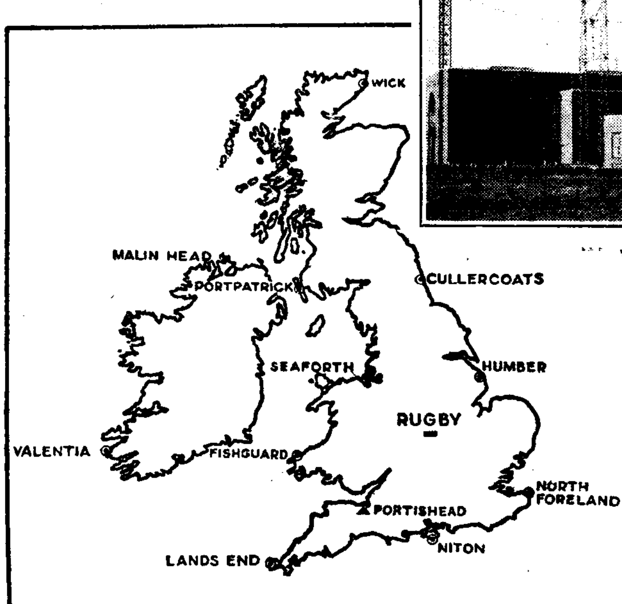
THE regulations in this country and in nearly all others lay down that passenger ships and all other ships of 1,600 tons gross and above must be fitted, for safety purposes, with wireless telegraphy; and that all passenger ships of 5,000 tons gross and upwards must be fitted, in addition, with directional receiving apparatus. In a compulsorily equipped ship the equipment may be simple, such as a ¼-kilowatt installation, as the specified range of working is only 100 miles; and one operator only need be carried for certain periods of watch, provided all other periods are covered for the reception of distress signals by an auto-alarm receiver or a watcher. Many ships, however, find it necessary for traffic purposes to employ a number of operators and to fit far more elaborate installations. For example, in a large liner a dozen operators may be employed, and there may be as many as four transmitters, comprising two medium-wave transmitters for the 600 metre and 2,000 metre bands respectively, and two short-wave transmitters for telegraphy and telephony respectively. This outfit, including the receivers, may require eight aerials, and in addition there would be a receiving aerial for broadcast reception and another for directional purposes, making ten aerials in all, arrangements being made, too, for simultaneous transmission and reception on certain waves.

Ships' installations are inspected periodically to ensure that they are in accordance with the licence issued by the Postmaster General, and for this purpose inspectors are stationed at the principal ports. These inspectors act also as Surveyors for the Board of Trade, which is responsible, with the Post Office, for the observance of the regulations in connection with the wireless equipment which must be fitted for safety purposes. This applies to about 3,200 of our ships out of a total of about 4,000 fitted with wireless apparatus. In addition to British ships a number of foreign ships also are inspected to ensure that their installations conform to British requirements when in British ports.

All operators in ships registered in this country must be in possession of a certificate of proficiency issued by the Postmaster General. There are various classes of certificates appropriate to the work to be performed and the class of ship concerned. Ships are allowed to carry watchers instead of auto-alarm apparatus for listening for distress signals. A watcher may be any member of the crew, but even he must be examined and have a certificate of proficiency in these listening duties.



The transmitter building and machinery hall at Rugby, the world's largest wireless station.



Thirteen stations in the British Isles are used by the Post Office for communication with ships.

Throughout the world there are now some 15,000 ships equipped with wireless installations. Of British ships there are about 4,000, and of these about 800 are voluntarily fitted. Of these 800 about 500 are small craft, fishing vessels, etc., which are fitted with wireless telephony.

The shore operation with ships is carried out by the Post Office, with the exception of the Beacon Stations, and a few stations belonging to Railway Companies for communication with their own ships. Twelve stations round the coast, and those at Rugby and Baldock, are used for this ship-and-shore communication, and they perform two services, the safety service and the traffic service.

The twelve coast stations are used for the safety service, signalling the Morse Code by hand on a wave of 600 metres. The range of the stations is about 300 miles

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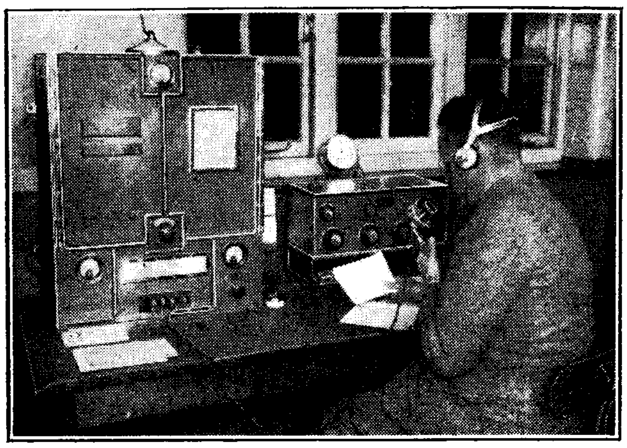
—much more, of course, at night, and very often more in the daytime—so that they well overlap one another, and a ship anywhere near the British Isles is always in touch with one or more of them.

The most important safety service is the SOS service. When a ship is in distress, i.e., if the ship itself is in danger, it sends out this signal. The ship then sends out a message giving her position and saying what is the matter. The nearest coast station directs communications, and if necessary repeats the distress message by wireless telephony, so that small ships not fitted with telegraphy may possibly receive it. The coast station communicates on the land side by telephone and telegraph with the coastguards, the Admiralty, Lloyds, and very often with the Air Ministry, harbour authorities and tug owners.



A telephony set at North Foreland Radio for communication with small ships.

During an SOS case all ships and stations within range, other than those engaged on the case, remain silent, so as not to interfere with the distress communications, and it is often many hours before the coast station can give the all clear signal for normal communications to be resumed.

Before the SOS is sent out the alarm signal may be sent, many ships being now fitted with an automatic receiver so that if the alarm signal is received by wireless a bell is rung to call the operator to the wireless room.

Safety Signals

The most important signal after the SOS is the urgency signal, consisting of the group XXX. This signal precedes a message of urgency, and the coast station proceeds in the same way as for the SOS, informing the authorities concerned and taking whatever other steps are required by the circumstances of the case.

The coast stations also broadcast safety messages on 600 metres—weather reports, etc.—at fixed times, which are published. This broadcast is preceded by the Group TTT, which means that what follows is a safety signal. Similar reports are sent out from the high-power station at Rugby, and the B.B.C. broadcasts weather reports by telephony every night for small craft such as fishing vessels, which do not carry wireless operators, but may be listening on telephone receivers. Arrangements, too, are made for collecting by wireless from ships in the North Atlantic, weather messages for the assistance of the Meteorological Office in making up forecasts.

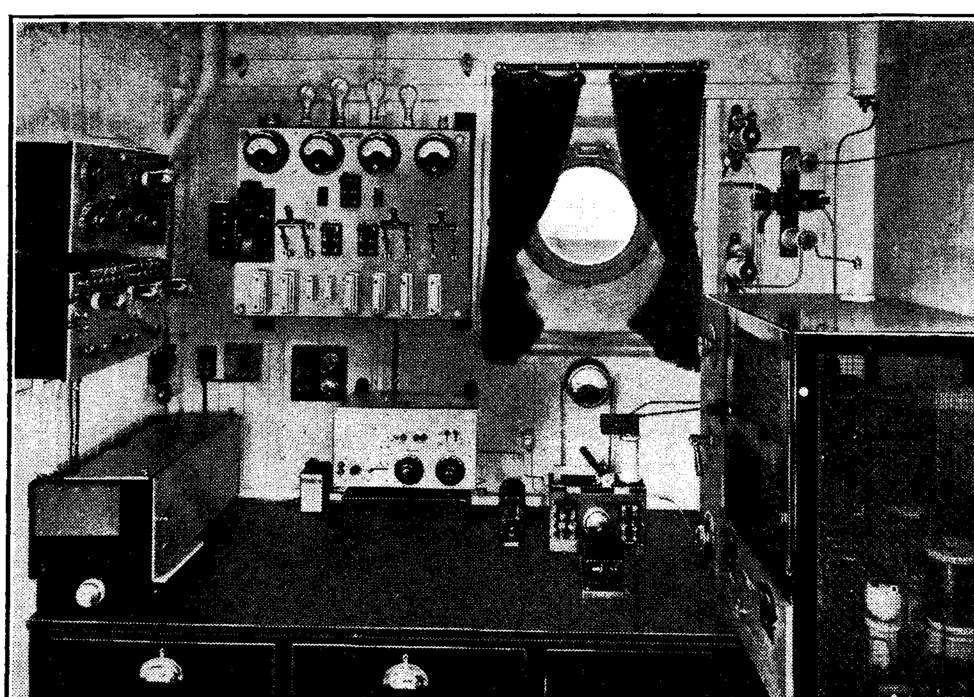
An important safety service to assist the navigation of ships in thick weather is the direction finding service in which the station informs the ship of its bearing from the station. Seven of the coast stations are fitted for this work—Wick, Cullercoats, Humber, Niton, Land's End, Portpatrick and Malin Head. The accuracy of the bearings, which are given on 600 or 800 metres, is within 2 deg., which is quite sufficient for ships as a rule. Bearings are not given all the way round as those in certain sectors are inaccurate owing to the configuration of the coast, etc.

Another important navigational aid is provided by twenty-five beacon stations round the coasts from which ships fitted with directional receivers can obtain bearings. Nearly all these stations in England are worked by the Trinity House, in Scotland by the Northern Lighthouse Board, and in Ireland by the Irish Lights Commissioners. All except two send out waves in all directions like a lighthouse. They operate every six minutes in fog and every half hour in clear weather. The two exceptions are the rotating beacons at Orfordness and Tangmere, where the emissions are rotated, and a ship even without a directional receiver can easily calculate by means of a stop watch its bearing from the station. These rotating beacons allow of a bearing being taken every 12 minutes, day and night, in clear or thick weather. Five of them are synchronous beacons, transmitting sound waves and wireless waves at the same time. By noting the difference in time between the reception of the wireless and the sound signal, the ship can easily calculate its distance from the beacon, in addition to obtaining its bearing. These stations send the sound signal through the sea and the wireless signal in the ordinary manner, with the exception of the Cumbrae, which sends the sound signal through the air.

Photo : Marconi International Marine Communication Co. Ltd.

A senior operator on an Atlantic liner establishing a ship-and-shore telephony link on behalf of a passenger.

The coast stations which use the 600 metre wave for the safety services, with the exception of some of the directional



Siemens Brothers' ICW and emergency transmitter in the "Clan Macalister." On the left is the Auto-alarm.

Wireless Working with Ships—

work which is carried out on 800 metres, use it also to a great extent for traffic as well as using working waves between 600 and 800 metres, but the most important traffic station is Portishead Radio, which is fitted with medium and short continuous wave sets as well as the ordinary coast station equipment. About 250 ships are fitted with continuous wave sets for traffic purposes. Rugby Radio, too, broadcasts Press and other messages to ships, and is the telephony transmitting station for liners.

Transmitter Operated by Distant Control

Portishead Radio and the coast stations are fitted with telephony as well as telegraphy, for the purpose of communicating with small craft which are equipped with telephony but not telegraphy because of the expense of carrying an operator. Telephony is less efficient than telegraphy for ship communications. The waves used for this telephone service are between 100 and 200 metres, and about 500 of our small ships are now equipped.

Portishead Radio consists of a transmitting station at Portishead operated by distant control from a receiving station at Burnham. At Portishead there are three medium-wave and two short-wave transmitters. The former work up to about 2,000 miles, the latter to world-wide ranges.

The medium wave transmitters have an input power of 15, 6 and 6 kilowatts respectively, the short wave transmitters have each 10 kilowatts. The medium waves are transmitted from T aerials supported by 300ft. masts, the short waves from dipoles, or directional arrays (of which there are 10), or a rotating beam aerial (whose rotation is worked from Burnham), according to the positions of the ships communicating and the waves in use. The medium waves used are in the 2,000-2,400 metre band, and the short waves in the 18, 24 and 36 metre bands. In addition, there is equipment for sending on the ordinary coast station band, and there is a telephone transmitter for small craft communications.

The receiving equipment at Burnham consists of three medium-wave and nine short-wave receivers, and the coast station and telephone receiver. The aerials for the medium-wave receivers consist of Bellini-Tosi loops; those for the short-wave receivers being similar to the short wave transmitting aerials, including a rotating beam aerial.

Short wave working with ships is still much more erratic than medium wave working, and though its range may be considered as world-wide under favourable conditions there are certain areas, such as the North and South Pacific, where difficulty is nearly always experienced.

The transmitting station at Rugby is the largest Post Office station, and is, indeed, the largest station in the world. Messages for ships in any part of the world are broadcast by telegraphy, the actual keying being carried out in the General Post Office in London. Official Press messages are broadcast thrice daily, news agency messages four times daily, and private messages for individual ships twice daily. These messages are sent on an 18,750 metre wave on Rugby's main transmitter of 350 kilowatts input, and are simultaneously sent on a short wave transmitter from the station at Leafield (Oxford) so as to give ships all over the world the best possible chance of reception.

A weather shipping statement is broadcast from Rugby twice a day and a time signal is sent out at 6 p.m. These transmissions are made on long wave only.

Rugby Radio, it will be noticed, is used only for broadcasting messages *to* ships, so far as telegraphy is concerned, and does not deal with any telegraph traffic *from* ships. Its most important use is, of course, for point-to-point communications, not communications with ships.

Rugby is also used, as mentioned above, for a telephony service with certain Atlantic liners. The subscriber on shore is connected, through the radio terminal at the Faraday House Exchange in London, to Rugby Radio when speaking and to Baldock Radio when receiving, and conversation is carried on in the ordinary way over a telephone so far as the subscriber is concerned. Communication with the ship is first established by telegraphy through Portishead Radio, and arrangements made for putting through the call at a certain time. Short waves are used for this telephone service, five waves being utilised between 17 and 94 metres, according to the time of day, the season of the year, and the range. This service can be extended through London to many countries all over the world; and a passenger in mid-Atlantic has no difficulty in holding a conversation with, say, a friend in Sydney.

Short-wave receivers at Burnham.

Will Performance Specifications Become Popular?

Solid Facts Against Meaningless Superlatives

By "CATHODE RAY"

"I KNOW nothing about Wireless!" confesses the humble enquirer on the Exhibition Stand when the Technical Gentleman finally comes back from lunch and starts to talk. "Yes, but what is the sensitivity?" interrupts the hard-head when the chorus of Sales Gentlemen begins murmuring "Marvellous . . . . Colossal . . . !"

Here we have the two types of buyers. The latter fails to understand why manufacturers cannot supply definite technical information about the performance of their products, instead of a lot of meaningless superlatives; and the former fails to understand anything at all, except that all sets seem pretty much alike.

On the face of it, there seems no room for doubt that people who are intending to part with their earnings in exchange for a box of tricks should demand definite and unequivocal information as to what it can do. It is no help to be told that it is "perfect," because that is simply not true; and it is not enough to be told that it can receive 60 stations, because there is no knowing where, at what time of year or day, and by whom this result was obtained—and all these other particulars are quite necessary. Performance figures enable a set operated by a farmer on an outdoor aerial in Cornwall to be compared with another on an indoor aerial in Hampstead handled by an engineer, without fear of argument at cross-purposes.

The technically minded admit that the general use of performance data has been retarded by the difficulties of measuring

Will Performance Specifications Become Popular ?--

them, but assume that as these difficulties are already largely overcome there is no further excuse for delay.

Far be it from me to discourage any move towards replacing the present panegyrics by exact numerical specifications, but I see a good many more blocks in the road than that just mentioned.

A Simpler Formula Needed

There is no difficulty about selling cloth by the yard. Even female purchasers demand to know exactly what they are getting for their money. But notice why there is no difficulty; and compare it with radio. It is easy to measure the cloth. There is universal agreement (within this country, at least) as to the units of measurement. Measuring instruments are everywhere available. There are no lawful means whereby a yard at one shop can be made to mean something different from a yard at another shop. The customer can herself check the amount supplied. The method of reckoning is simple and easy to understand. And it can be very directly related to the use for which the material is intended.

I think one may be allowed to hope that quite a lot can still be done to simplify receiver measurements, to agree as to how and what measurements should be specified, and to cheapen the necessary instruments. But whatever happens it seems likely that receivers will always be fairly complicated pieces of work, because simplification of detail is more than neutralised by the added features needed to woo the interest of the public. One thinks of television, for instance. . . .

And the history of the motor trade does not lead one to suppose that the proportion of owners that know all about the inner working of the machine will substantially increase.

But to understand the figures necessary for specifying even the leading characteristics of a receiver one must have a fairly comprehensive grasp of technique. It is difficult to see how it can be otherwise. Who could blame the poor public for supposing a receiver with a sensitivity of 100 microvolts to have more than one with a sensitivity of 20 microvolts? One does not have to go to evening classes to attach a meaning to miles per hour, or even miles per gallon; but radio data seems to bear little relationship to real life. Then there are conflicting requirements. If the P——— set has a band-width of 5 kc/s, the vendor would point out its manifest superiority in selectivity to the Q——— set with a band-width of 8 kc/s. But his competitor, not to be beaten, would with equal justice boast of the obvious advantage in fidelity of the Q——— set compared with the P———. It takes an expert to interpret the figures, and the temptation to make statistics prove anything is too great.

Then I hope I am not libelling the general public, but the poor dears really don't want to know about decibels and microvolts; they want to know whether they can get good entertainment. The advertising agents do not even give them credit for ordinary intelligence—by the way, they are another obstacle; nearly all the big advertising is done by people whose philosophy appears to be that of the Cynics. At any rate, they set the public mind at an even lower standard than I do.

One might be unkind about some of the manufacturers, too, and suggest that they are reluctant to invite direct numerical comparison. Nobody can tie down general ascriptions of praise. Even in the motor world we do not get definite figures with regard to springing, road holding, and engine efficiencies; though they may have them somewhere in laboratories.

All this seems pretty hopeless. But not quite. There is no likelihood that characteristic curves (of receivers) will be exhibited in neon over Piccadilly or that the front page of *The Daily Mail* will tell us all about second-channel ratios, but the man who really wants to know ought to be able to go to any radio dealer and pick up a leaflet full of them. More; the dealer himself ought to make it his business to demand such information from the makers who want him to sell their sets, and be able to interpret it for the benefit of his less technical customers.

The amateur photographer worthy of the name would not be put off with the statement that the focal length of a camera was colossal, and that the prints were the very soul of light. He does not even expect to get an instrument that simultaneously possesses wideness of aperture and depth of focus, and would have nothing but contempt for an advertisement that told him he could.

Even although the proportion of listeners who comprehend mutual conductances of valves is very small, they have been enough in the aggregate to make it worth while for the makers to supply the information on leaflets and other places accessible to them. In this way the figures do not interfere with the enjoyment of the majority who prefer to be told that Z's valves turn all the bad qualities of their sets into good ones. What valve-makers think to-day, set-makers may possibly think to-morrow.

PIEZO-ELECTRIC MICROPHONES

Rothermel-Brush Types for All Purposes

THE advantages of the piezo-electric principle as applied to microphone construction are now receiving wide-spread recognition, and R. A. Rothermel, Ltd., Canterbury Road, London, N.W.6, are now in a position to supply a range of models suitable for public address, film recording, and calibration work.

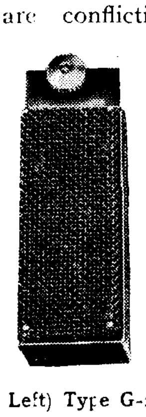
The general-purpose Model D-104 is a diaphragm-type instrument of robust construction housed in a circular chromium-plated case. It is sensitive and should commend itself to amateur transmitters as well as designers of public address outfits. The price is £5 17s. 6d.

Some representative microphones in the Rothermel-Brush range.

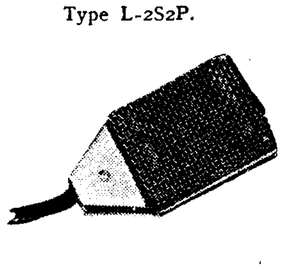
The more ambitious models make use of the "sound-cell" form of construction described on page 275 of the September 8th, 1934, issue. In the model G-2S2P, two pairs of two cells in series are connected in parallel. The price is £15 and modified designs for theatre footlight use and as a speaker's lapel microphone are available at £20 and £13 respectively.

A calibration curve taken in terms of the Rayleigh disc in *The Wireless World* laboratory was given in the March 29th issue in connection with the recent loud speaker tests.

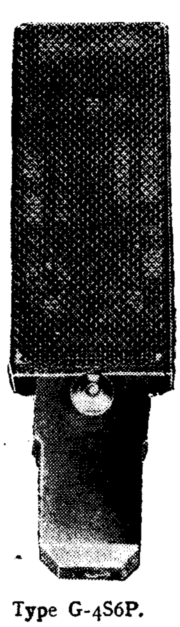
Similar to the above as regards frequency characteristic but with a higher output for a given sound pressure, the G-4S6P at £30 is an ideal microphone for broadcasting or film work. Its lower impedance and higher sensitivity permit the use of much longer leads, an important advantage where mobility is essential.



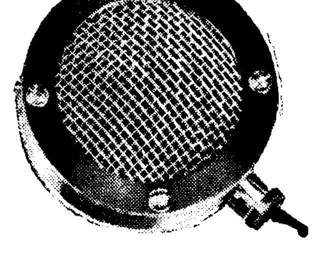
Left) Type G-2S2P.



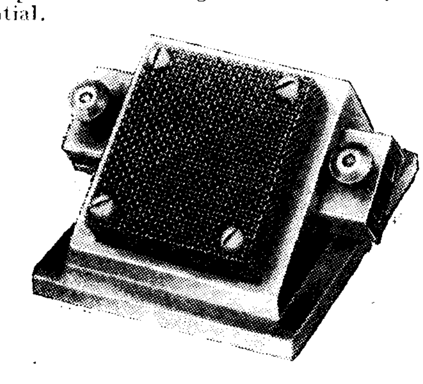
Type L-2S2P.



Type G-4S6P.



Type D-104.



Type T-2S4P.

Current Topics

Events of the Week in Brief Review

SIR NOEL ASHBRIDGE, Chief Engineer of the B.B.C., whose knighthood was announced in the Jubilee Birthday Honours list.

Leipzig on Low Power

THE Leipzig station is at present using an auxiliary low-power transmitter pending aerial alterations. A single mast anti-near-fading type is to be employed.

Television and Fashion

PARIS, PTT station, now has its television fashion specialist, who will give advice on the best tones and colours to wear when appearing before the television transmitter.

Bus Radio

THE Great Missenden (Bucks) Parish Council is opposing the installation of radio receivers on the local buses as likely to divert the attention of drivers.

Boys' Wireless League

PORTSMOUTH leads the rest of the British Isles in having a "Boys' Wireless League," the members of which are recruited from schools and colleges in the district. The hon. secretary is Mr. L. Harrison, 20, Salem Street.

A Surprise

ROUMANIAN listeners switching on to hear a well-known general describing his recent visit to a foreign country were amazed by the opening sentence: "Ladies and Gentlemen, we find ourselves in a scene of complete devastation . . . clouds of smoke . . . mothers, mad with grief, are calling their children . . ." Then the talk broke off and the announcer apologised for having started up the wrong record. Instead of the general's speech, listeners had heard a running commentary on a village fire.

Eleven Hours' Talk

TWO Californian amateurs have just been in communication for eleven hours on end with the object of putting up a "record" for long contacts. British amateurs are not attempting to emulate the feat.

Television Congress

GERMANY'S first television congress was held in Berlin on May 29th when a tablet was unveiled in honour of Paul Nipkow in the presence of the veteran inventor, who patented the famous Nipkow scanning disc in 1885.

English from Rome

THE Northern Italian stations will broadcast a talk in English at 7.40 p.m. on Tuesday next, June 11th, on "How to See Rome in a Month."

New Broadcasting House

M. NILS HOLTER has won first prize in the competition for a design for the new Norwegian Broadcasting House. There were fifty-nine entries. M. Holter's building will cost about one-and-a-half million kroner and will take at least a year to build.

MR. GERALD COCK, Director of Television, who receives the M.V.O.

Taxi Radio and Noise

HELSINGFORS police are objecting to the introduction of radio taxis on the ground that they will be incompatible with the new anti-noise campaign.

Broadcasting Gramophone Records

GERMAN gramophone record manufacturers virtually lost their case in the Berlin Civil Court last week against the German Broadcasting Company. The gramophone firms sought an injunction against the indiscriminate broadcasting of records, but they secured judgment only in regard to records of the "spoken word." Their plaint was rejected for records of music or of music and words. As the broadcasters hardly ever use "spoken word records," they have practically won the day.

A representative of the gramophone manufacturers informed a *Wireless World* correspondent that an appeal would be lodged with the Kammergericht and, if necessary, with the Reichsgericht, the German Supreme Court. Pending the result, it is unlikely that records will figure in the German programmes.

Broadcast Brevities

By Our Special Correspondent

Sir Noel Ashbridge

KNOWN throughout Broadcasting House as "The Chief," Mr. Noel Ashbridge is exceedingly popular, and his knighthood is generally welcomed.

The Chief Engineer can be said to have gained notoriety through sheer modesty. At a banquet not long ago Sir John Reith had some gracious things to say about Mr. Ashbridge's splendid work in the technical development of British broadcasting. Almost immediately Mr. Ashbridge rose to his feet . . . to catch his train.

Mr. Gerald Cock, M.V.O.

Mr. Gerald Cock, who receives the M.V.O., put outside broadcasting "on the map" many years ago in a way that enabled the B.B.C. to give a lead to the broadcasting organisations on the Continent. During the Jubilee celebrations Mr. Cock surpassed all previous efforts in organisation on a large scale and personally supervised the Royal broadcast from Buckingham Palace.

As Director of Television he can be relied upon to score as big a success in the field that is just being opened up.

An Engineer's Life

SCOTTISH engineers of the B.B.C. have spent several days during this week carrying out tests for to-day's transmission from the Isle of May.

The cable for one of the six microphones has had to be led over the cliff base to a narrow, shingly beach, and even up to the last moment it has been debatable whether the broadcast would have to be given up.

Living on Goats' Milk

The engineers have been leading a primitive life on the island. There is no water supply, and all water, not to mention other beverages, has had to be brought by boat.

For the most part they have subsisted on goats' milk, as a number of the animals are kept on the island for the benefit of the lighthouse-keeper and his assistants. It is even rumoured that their solid food has consisted of wild berries which they snatch from the bushes in the intervals between line tests.

The New Programme Controller

MR. CECIL GRAVES, who will succeed Colonel Dawnay as Controller of Programmes on October 1st, recuperated after his serious illness on the Northumberland estate he inherited from his uncle, the late Viscount Grey of Falloden. He is now visiting Newfoundland.

Steady Promotion

Since he joined the B.B.C. in 1926 his promotion has been continuous. By 1929 he was an assistant director of programmes, and on the opening of the Daventry Empire service he became Director of the Empire programmes. Last year he combined this office with that of Foreign Relations.

NEW PROGRAMME CONTROLLER. Mr. Cecil Graves, who succeeds to the important B.B.C. post which Col. Dawnay will vacate on October 1st.

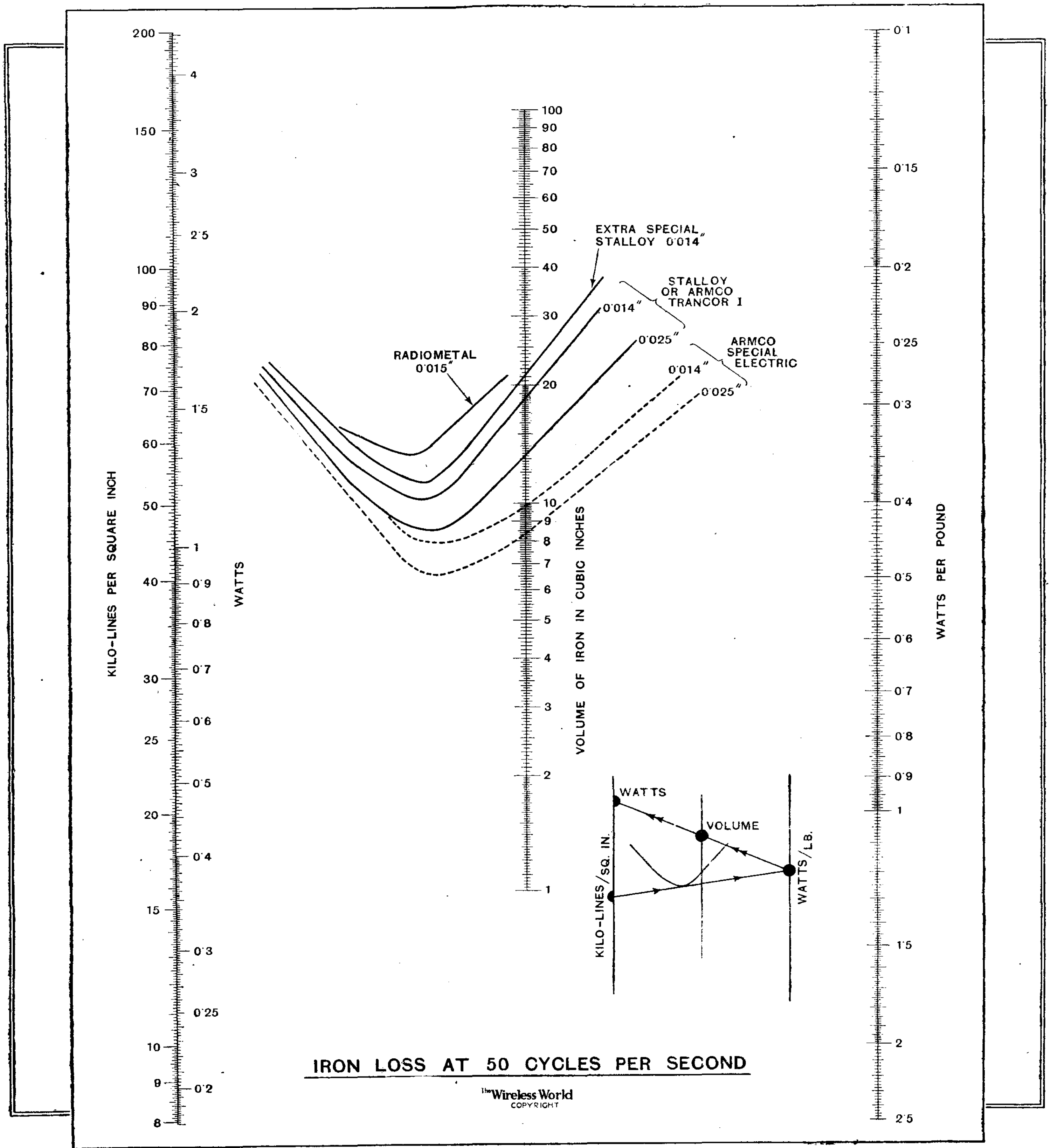
Radio Data Charts—IV.

Iron Losses in Mains Transformers

By R. T. BEATTY, M.A., B.E., D.Sc.

IN designing a mains transformer to supply power to a radio receiver from an alternating-current mains supply, we usually begin by making a guess at the area of the core section through which the alternating magnetic flux must pass. We then work out the number of turns of wire per volt and are thus enabled to find the total number of turns required for the primary and each of the secondary windings. The wire diameter is fixed by the power required for the output, and so we finally obtain the size of window required to accommodate the windings. In fact, we are now in a position to choose the most suitable size of iron stamping and to make a preliminary calculation of the copper losses.

All this is straightforward work and is carried out in Radio Data Charts, No. 24 (a-c), and it is remarkable that up to this



Power transformer design: estimation of iron losses with various core materials.

Radio Data Charts.—IV.—
stage the transformer has taken shape without any reference to the quality of the iron to be used or to the thickness of each stamping. But now we come to the question of the efficiency of the transformer, and for this calculation we must know the total iron loss for the material used, in watts per pound weight.

Loss of power, appearing as heat in the core, is due to two causes. In the first place, the alternating magnetic flux, by virtue of its variation in magnitude during each cycle, sets up an EMF in the primary windings in opposition to the mains EMF. If this *flux* were in phase with the magnetic *force* set up by the primary current, the current would be 90° out of phase with the induced EMF, and no power would be consumed apart from copper losses. Actually, however, the flux lags behind the magnetic force, and consequently the current has a component in phase with the EMF, so that power is consumed even when the secondary circuit is opened.

This is known as *hysteresis loss*: it increases as the magnetic flux increases; it is large in ordinary iron, small in iron alloyed with silicon, such as Stalloy or Armco, and very small in iron alloyed with nickel, such as Mumetal, Radiometal, and Laminic. Moreover, it is unaffected by the thickness of each stamping.

The second source of iron loss is due to *eddy currents*. As the magnetic flux surges to and fro, whirlpools of electric force are induced in the iron, and alternating current flows in circles round each magnetic line of flux. By splitting the iron into thin laminæ, we diminish the cross-section available for these currents and thus diminish the eddy currents by increasing the resistance. This *eddy loss* is proportional to the square of the thickness of stamping. Silicon iron has a greater resistivity than ordinary iron, and the consequent reduction of eddy loss is the chief reason for its use in mains transformers.

The chart shows at a glance the total iron loss in watts per pound for various transformer materials, and the total loss can be obtained as soon as the volume of iron is known. In choosing the material we must bear in mind that the lower the loss the more expensive is the iron, so that an economic balance must be struck between initial cost and running cost. Thus, in spite of the high efficiency of Radiometal, its high price is an objection to its use in mains transformers except in cases where the primary current runs continuously, as in door-bell transformers; its utility lies chiefly in other directions, such as in intervalve and output transformers and chokes.

With silicon-iron alloys, such as Stalloy or Armco, the chart shows that a wide latitude in iron losses is available to the designer. Thus, in the case of a certain transformer with the specification given in the accompanying table, the iron loss works out at 1 watt. Hence the efficiency is $50/54.25 = 0.92$. If now we use instead Special Electric 0.025in., the iron loss rises to 1.8 watt and the efficiency falls to $50/55.05 = 0.905$. The choice of material now becomes a matter of economics.

SPECIFICATION.

Output	50 watts.
Material	Stalloy 0.014in.
Volume of iron	9.15 cubic inches.
Working flux density	50 kilo-lines per square inch.
Copper loss	3.25 watts.

DISTANT RECEPTION NOTES

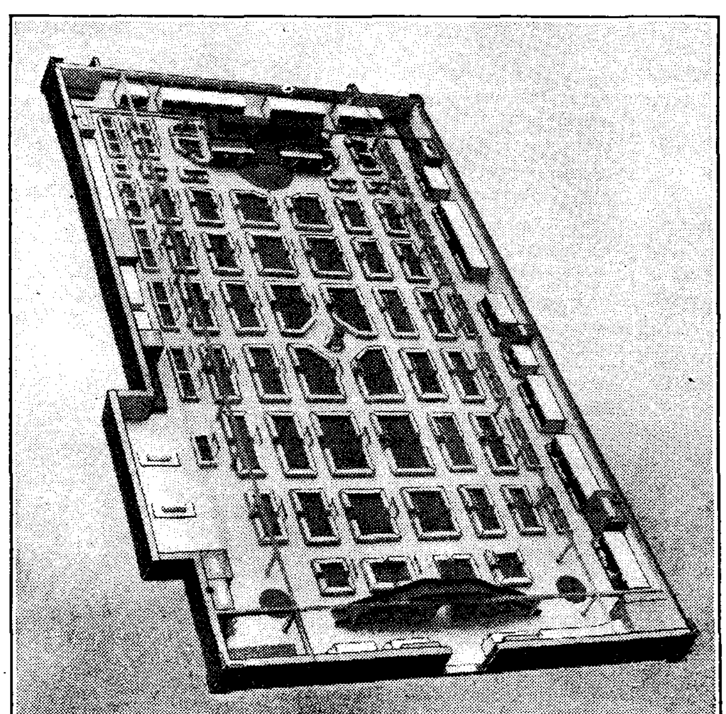
LIKE most long-distance enthusiasts, I have been watching anxiously for Radio Roumanie's appearance, for it was announced some time ago that the station, complete to the last terminal, was ready to begin operations. So far I have heard nothing of it, and it is now stated that the preliminary tests have been delayed. They should be under way by the time that you read this note, and the station is likely to be occupying the 1,875-metre wavelength with its full-time service before the end of June. Motala is also late in getting its new 150-kilowatt transmitter into action. Some time ago the authorities stated that the work was so far forward that the station could be taken over for broadcasting almost at once. Since then there seems to have been no official pronouncement, but from the entries in my log I am inclined to think that the new plant, working probably with considerably less than its full output power, is in use at a rather late hour on one or two nights each week.

All through March there is no entry opposite Motala more encouraging than W, which stands for weak. On most days and nights the station was not heard at all. On April 6th the station was found coming in at splendid loudspeaker strength, though it was only twice heard and this at very poor strength—during the following week. Subsequent entries show that Motala was giving excellent loudspeaker reception on April 14th, 22nd, 25th and May 1st, 7th, 8th, 13th and 23rd. Intervening dates are mainly blank. Since reception conditions were on the whole distinctly good during the period, the natural inference is that on the dates when "V.G." is shown in the log the new transmitter was experimenting, the old one being in use at other times. Perhaps some Swedish reader will be kind enough to send me information on the subject straight from the horse's mouth. *Tack sa mycket!*

The elections of the Regional Committees for the control of broadcasting in France were postponed until Sunday, May 26th, though it was intended originally they should take place a week earlier. Good though it is, the Committee scheme does not appear to have got on very well amongst listeners. Less than 10 per cent. of those entitled to vote took the trouble to do so, though the number of candidates was surprisingly large. In Paris alone there were 163 of these. I note rather sadly that many of them came forward as representatives of political groups. That is perhaps the one big drawback to the elected Committee; it will be difficult to keep the atmosphere free from politics, and politics don't go hand in hand with satisfactory broadcasting control.

In the United States stations are spaced out, as readers may know, on a 10-kilocycle basis, which gives rather better opportunities for the high-quality receiving set than the 9-kilocycle separation which Europe has under the Lucerne Plan. But even 10 kilocycles are not sufficient to allow the high notes to be reproduced properly, and there is a movement on foot in the States to increase the separation to 15 kilocycles or more, with a corresponding reduction in the number of stations at work. Something of the kind would be very welcome in Europe, but I am afraid that it will never take place, for Europe's many countries seem intent upon increasing rather than reducing the number of their stations.

On the whole, distant reception conditions remain good, though naturally the best time for listening to the foreigners is becoming somewhat later. From 9 o'clock onwards alternative programmes are usually receivable with good strength and quality from about a score of stations. As usually happens in summer, the upper part of the medium wave-band between 450 and 550 metres now shows a distinct falling off. The best belt of wavelengths is that from a little below 300 metres to somewhere about 450 metres. The long-wave stations are not much affected by summer conditions, and most of them continue to be well received. D. EXER.



A model of the Main Hall, Olympia, showing how stands will be arranged for this year's Radio Show in August. The model is on view to prospective standholders at the headquarters of the Radio Manufacturers' Association.

★ Listeners' Guide for the

Outstanding Broadcasts at Home and Abroad

DRAKE THE EXPLORER. "The Golden Hind," next week's radio drama, will set forth the adventures of Sir Francis Drake on his voyage round the world. Above is a scene from the new British International Pictures film "Drake of England," with Matheson Lang as the explorer. He is seen stepping off "The Golden Hind" after the world voyage.

THE MICROPHONE AT PLAY

POMPOSITY, ultra-seriousness, sentimentality—these are faults difficult to avoid by regular broadcasters, especially on ceremonial occasions. A valuable antidote is promised by the new "O.B." series —"The Microphone at Play" the second of which Midland supplies to the Regionals on Whit Monday evening, when the microphone will be taken to Evesham for the annual Regatta on the Avon.

The chief feature will be a radio impression of the Senior Fours final for the Bell Tower Trophy—a beautiful silver model of the Evesham bell tower given to the club by the citizens who raised £400 in 1921 to mark Evesham's unbeaten record at regattas.

GRACE MOORE IN "LA BOHEME"

GRACE MOORE became suddenly famous in this country in the film "One Night of Love." The distinguished singer of the New York Metropolitan Opera makes her British radio debut to-morrow evening (Saturday) in the relay of Act III of Puccini's "La Bohème" at Covent Garden.

"La Bohème," which was first produced in Turin in 1896 and three years later at Covent Garden, gives a splendid picture of Bohemian life in the Latin quarter of Paris a hundred years ago. With this opera Puccini surpassed all his previous triumphs and placed himself definitely at the head of the younger Italian composers.

"MUCH ADO ABOUT NOTHING"

JAN BUSSELL will be the producer of next Sunday's Shakespearian play, "Much Ado About Nothing," on the National wavelengths. Gwen Ffrangçon Davies, who has a wonderful broadcasting voice, will take the part of Beatrice, niece to Leonarte, and Leonarte's part will be taken by Ben Webster.

"GONE AWAY"

A PLEASANT innovation on Sunday evening will be a short story sandwiched between two sections of Albert Sandler's broadcast from the Park Lane Hotel. The storyteller will be Mr. S. P. B. Mais, and the title of his fifteen-minute tale will be "Gone Away."

DRAMA OF DRAKE

THE Elizabethan period promises to be the new rage in literature and drama, and in this the B.B.C. is well to the fore with "The Golden Hind," a Peter Cresswell production dealing with the travels of Sir Francis Drake "unto the South Seas, India, Chile, Peru, the hither side of Nuova Espana, the mighty empire of China, or Cathay, begun in the year of our Lord 1577."

"The Golden Hind," which will be broadcast on Monday (Nat., 8) and Tuesday (Reg., 8.30), has a strange dedication. It is "offered to the Publique hearing, both for the honour of the Actor but especially to the stirring up of heroick spirits, to benefit their country and eternize their names in noble deeds."

THE WHITE COONS

How many listeners know that the original White Coons concert party was founded by Will C. Pepper in 1889? A modernised edition of the "White Coons" comes to the studio on Thursday evening (Nat.) with Harry S. Pepper and Doris Arnold at the pianos. Tommy Handley will take part.

ALDERSHOT TATTOO

THE central theme of this year's Aldershot Tattoo, excerpts of which are to be broadcast at 11.25 p.m. on Thursday next, June 13th, is to be the British Crown and its illustrious history, but the broadcast will of necessity be confined to the music of the massed bands, numbering twenty-six, and the singing of favourite songs and hymns. As befits Silver Jubilee Year, however, the Tattoo will probably be the most spectacular in the history of this annual event, and it is well for listeners that the commentator will be Major J. B. S. Bourne-May, who last week gave such a graphic description of the Trooping of the Colour.

REHEARSING FOR THE TATTOO. The Commanding Officer inspects "Henry the Eighth" in readiness for the Pageant of the Kings in the Aldershot Tattoo, part of which will be relayed with a running commentary at 11.25 p.m. on Thursday next.

Week

SOUTH SEA BUBBLE

As an experiment in radio drama "The South Sea Bubble" on Thursday next (Reg., 8) should be worth staying in for. Cecil Lewis, who has written this play on the first great financial crash in the City of London, describes it as the first Expressionist broadcast play ever heard in this country, and a special technique has been evolved for re-picturing the tragic six months when the country indulged in monetary hysteria.

The cast will include Bruce Belfrage, D. A. Clarke-Smith, John Cheatle, Norman Shelley and Gwendolen Evans. John Morel will be the singer, and it will be interesting to hear what he has to sing about.

LOCH NESS MONSTER

THE Loch Ness Monster may be forgotten in England; it is a green memory in Hungary. To-night (Friday) Budapest will broadcast a talk on the Loch Ness Monster at 8 o'clock.

SCHUMANN

THERE are several broadcast concerts to-night (Friday) and to-morrow to celebrate the 125th anniversary of the birth of Schumann at Zwickau in Saxony. To-night Munich transmits a Schumann programme from 10.30 to 11.30 by Martha Martensen (soprano) and Richard Staab (piano). To-morrow Sottens will give a Schumann concert at 8.15, and another comes from Oslo at 10.15, given by the Station Orchestra.

At midnight until 2 a.m. Sunday, Stuttgart will broadcast a Schumann concert by the Kergel Quartet, with Emma Mayor (contralto), Müller (baritone), Haagen and Sonnen (pianos).

OPERA

"OTELLO," probably Verdi's greatest opera, is being relayed by Vienna this evening (Friday) at 6.55 from the Opera House. To-morrow at 8.10 Munich will give a concert of the opera music of four nations—Italy, Russia, France and Germany, and on the same evening Rome, at 9, will broadcast Donizetti's "L'elisir d'amore."

Bellini's ever-popular "Norma" comes from Radio-Paris at 8.15 on Tuesday next.

MAURICE WINNICK AND HIS BAND, who will give tea-time dance broadcasts next week on the National wavelengths.

30-LINE TELEVISION

Baird Process Transmissions
Vision 261.1 m.; Sound 296.2 m.

MONDAY, JUNE 10th.
11.15–12.0 p.m.

Items from "Let's Go Gay." John Hendrik and John Rorke in songs; Freddie Carpenter with Jessie Blane in feature dances; Jane Carr and Charlotte Leigh in songs; Elinor Shan in mimes and dances; Sydney Jerome's Quintet.

WEDNESDAY, JUNE 12th.
11.15–12.0 p.m.

Programme of Folk Songs and Dances from India, Ceylon and Tibet. Surya Sen, the Sinhalese Singer, assisted by Nelum Devi.

"FREEDOM." Mr. G. K. Chesterton, the famous wit, novelist and critic, who contributes to the series of talks on "Freedom" at 10 p.m. on Tuesday next (National).

WAGNER

A WAGNER concert on historic ground comes from Frankfurt at 9 o'clock on Monday, June 10th. This will be relayed from the Biebrich Castle Gardens on the Rhine. It was in the castle of Biebrich that Wagner, in 1862, worked from February to the end of October on his opera "The Master Singers of Nürnberg."

PRENEZ GARDE . . .

THOSE who saw the play or the film, "The Late Christopher Bean," may be interested to know that the original play by Fauchois, "Prenez garde à la peinture," is being broadcast on Wednesday next, June 12th, at 8.30 from Lyons-la-Doua.

TRAGEDY TO MUSIC

MENDELSSOHN'S march from "Athalie" is well known, but not everyone is aware that it is taken from incidental music to Racine's five-act tragedy, "Athalie." This play is to be broadcast on Thursday next, June 13th, by Strasbourg. The 1852 Choral Society and the Station Choir will be conducted by Maurice de Villers.

MUSIC BY YOUNG GERMANS

YOUNG German composers will have an hour to themselves in the Munich programme from midnight onwards on Wednesday, June 12th. There will be three first performances, one of a work by Heinz Schubert, born in 1908 in Dessau, one by Paul Coenen, born in 1908 in Saarlouis, and one by Karl Walter Meyer, born in 1902 in Frankfurt.

THE AUDITOR.

HIGHLIGHTS OF THE WEEK

FRIDAY, JUNE 7th.

Nat., B.B.C. Orchestra (E), conducted by Boyd Neel. 9.15, Anona Winn and her Four Winners.

Reg., 8.10, The Isle of May—a Bird's Eye View (from Scottish). 8.40, A. J. Alan. 9, Act II "Carmen" (Bizet), relayed from Covent Garden.

Abroad.
Radio-Paris, 8–10.30, Operetta Music.

SATURDAY, JUNE 8th.

Nat., "Music Hall." 10, Act III "La Bohème" (Puccini) from Covent Garden.

Reg., Russian Church Choir. ¶The Grinke Trio. ¶Henry Hall's Guest Night.

Abroad.
Frankfurt, 8.15–10, Variety Programme from Speyer.

SUNDAY, JUNE 9th.

Nat., Morning Service from Bristol Cathedral. ¶Morris Motors' Band. 5.30, "Much Ado About Nothing." ¶Albert Sandler and the Park Lane Hotel Orchestra.

Reg., Broadcast Septet. ¶B.B.C. Military Band. ¶B.B.C. Orchestra (D), conducted by Aylmer Buesst.

Abroad.
Brussels No. 1, 8–10, Viennese Music from the International Exhibition.

MONDAY, JUNE 10th.

Nat., 8, "The Golden Hind"—a Drake Programme ¶Griller String Quartet.

Reg., B.B.C. Dance Orchestra. 9.55, "Carmen," Act III, from Covent Garden.

Abroad.
Eiffel Tower, 8.30–10, Orchestral Concert.

TUESDAY, JUNE 11th.

Nat., The Celebrity Trio. ¶"Music Hall." 10, "Freedom," by G. K. Chesterton.

Reg., B.B.C. Orchestra (E), conducted by Leslie Heward. ¶"The Golden Hind."

Abroad.
Warsaw, 9–10, Symphony Concert by the Station Orchestra.

WEDNESDAY, JUNE 12th.

Nat., The Mills Brothers. 8.30, Toscanini conducting last Concert of London Music Festival.

Reg., B.B.C. Theatre Orchestra ¶Will C. Pepper's "White Coons."

Abroad.
Kalundborg, 10, Classical Music by the Radio Symphony Orchestra.

THURSDAY, JUNE 13th.

Nat., Will C. Pepper's "White Coons." ¶Leslie Bridgewater Quintet. 11.25, Aldershot Tattoo.

Reg., Oratorio Programme—B.B.C. Choir and Orchestra, conducted by Joseph Lewis. 8 "South Sea Bubble."

Abroad.
Strasbourg, 8.30, "Athalie"—a tragedy with incidental Music by Mendelssohn.

UNBIASED

By FREE GRID

Written by a cross between a senior wrangler and a congenital idiot.

My Set Revue

FOR some time past readers have been urging me to commence the publication of test reports of the various commercial receivers which accidentally fall into my hands from time to time. I have now decided to comply with their wishes.

The following report deals with the set which I purchased at last year's exhibition for home consumption. Set manufacturers who are interested are invited to submit their products to me so that I may deal with them in future issues.

Since the conservation of time and energy is my watchword it goes almost without saying that I did not bother to open the packing case in which the set arrived but returned it immediately with a polite request for the working model. After the usual exchange of courtesies and sets to which I have referred so often in these columns I was able to commence my tests.

Upon unpacking the instrument I noticed that the valve boxes bore the customary rubber stamp intimating that their contents had been tested by the set makers and sufficiently "aged" to bring the set into a state of stability. Putting myself in the position of the ordinary man in the street who would be the set's ultimate purchaser, I picked up the instructional booklet in order to see how to get her going. In the end I decided that it was not for me, having evidently been written by a cross between a senior wrangler and a congenital idiot. As life is short I was reluctantly compelled to fall back on my common sense.

My first test was for sensitivity and selectivity, and on switching on I was reminded of the old proverb which extols the virtues of expecting nothing in order to avoid disappointment.

On investigating the matter I was surprised to notice that there were no tuning coils, and that the fixed and moving plates of the moving condensers were not insulated from each other. This seemed so strange that I hastily retrieved the instructional book from the W.P.B. and gave it to the *Wireless World* office boy to decipher, as he has so often proved his worth at cross-word puzzles.

At length I wrote to the maker, but he insisted that the circuit was a secret one which he did not intend to disclose. Upon taking the set to pieces and worrying the circuit out for myself I found, to my immense surprise, that his statement was true; at least, I had never come across the circuit before.

Eventually, however, the manufacturer relented sufficiently to give me the grudging information that the designer of the set, struck by the prevalence of jamming in spite of all that superhets could do, resolved to go the whole hog in the matter of sideband cutting and tone correction. He had voraciously studied the "Readers' Problems" section of this journal, and among a medley of knowledge therein, ranging from Sanskrit to starting prices, he had learned that so far as selectivity and the number of turns in a tuning coil are concerned, the higher the fewer.

Reductio ad absurdum

In his preliminary experimental model, therefore, he had reduced the turns on his tuning coils until there was nothing left but a piece of wire short-circuiting the condensers. In his final model he had gone even farther, for he found that, by simply leaving out the insulated material which supported the fixed plates, he could dispense even with the short-circuiting wire.

Even as it is, however, the designer is of the opinion that the ratio of inductance to capacity is still too great to permit of real selectivity, owing to the relatively high inductance of the condenser plates, and eventually he intends to tackle this ticklish problem so that he may produce a still better set for next year's exhibition. I must confess that, as the result of my tests, I fail to see the use of increasing the selectivity, since at present tuning is so sharp that not only are the sidebands removed but the carrier wave also. The manufacturers of the receiver are overcoming the difficulty, however, by arranging to supply purchasers with a weekly consignment of gramophone discs containing the missing notes of the week's programme.

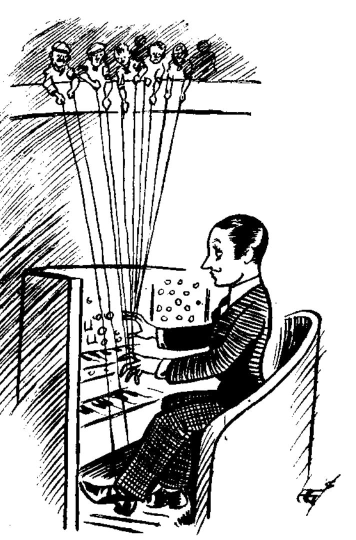
I may say that I gave the gramophone side of the instrument a thorough test, and, apart from the question of quality, I found nothing to criticise.

Economy

THE passion which some people have for labour-saving devices is truly extraordinary, and nothing more strikingly illustrates this than a new economy scheme adopted by certain continental cinema proprietors whereby wireless is used in an entirely novel manner to take the place of highly paid organists.

This scheme does not, as you might be tempted to think, involve the electrical reproduction of canned music, but is something quite different.

It appears that in continental cinemas the same pernicious habit is followed as over here of picking out the organ manual in coloured floodlights during the orgy of sugary sob-stuff which is dignified by the name of music and is churned out during the so-called organ interlude. Actually there is an organ in only one cinema of a given town, and his organ manual is electrically coupled to those of all the other cinemas in the town. This coupling was at first accomplished by cable, but now apparently all go-ahead firms are using short-wave wireless as the connecting link.



Salaries of organists are saved.

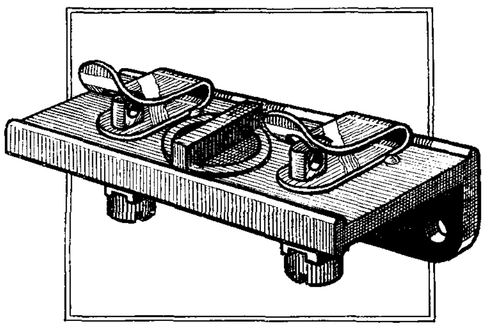
The programmes are arranged, of course, so that the organ interludes occur at the same time in all "controlled" theatres. In this manner the four-figure salaries of several cinema organists are saved. The patrons of the subsidiary theatres are not, of course, aware of this subterfuge, as ingenious dummies—life-sized marionettes, in fact—are employed. What the eye doesn't perceive the heart doesn't grieve over, as the doctor said when he mixed up the babies in the clinic.

New Apparatus Reviewed

Recent Products of the Manufacturers

GRAHAM-FARISH TERMINAL BRACKET

A NEAT moulded bakelite bracket mounting a pair of terminals fitted with spring clip attachments for the external wires in place of the more orthodox screw



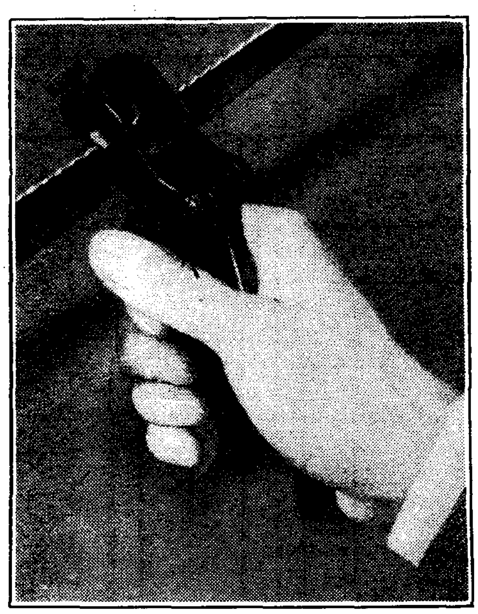
Graham-Farish spring clip terminal bracket.

head has been introduced by Graham-Farish, Ltd., Mason's Hill, Bromley, Kent.

This should appeal particularly to experimenters, as battery and other leads can be connected quickly to their respective points, and the connections are both secure and electrically sound. It is known as the Pop Terminals on Bracket, and costs 6d. for a pair as illustrated.

ECLIPSE SAW SETTING TOOL

ALL who take pride in their handiwork naturally like to keep their tools in first-class condition and many, no doubt, prefer to sharpen and set the saws used for wood working. The latter process requires some



Eclipse No. 77 Direct Reading Saw Set.

skill unless a special tool is employed. Such a tool is now made by James Neill and Co. (Sheffield), Ltd., Composite Tool Works, Napier Street, Sheffield, 11, and is known as the Eclipse No. 77 Direct Reading Saw Set. It is simple to operate and sets the teeth accurately and evenly throughout. It embodies an adjustable anvil which is graduated from 4 to 12 points.

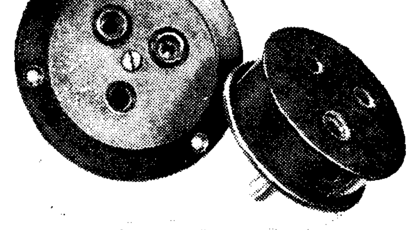
An important feature is that the teeth of the saw are clearly visible during the setting operation and no other tool is needed. The initial pressure on the handle grips the saw and further movement applies the setting. The return action is spring controlled.

The Eclipse Saw Set is a strongly made, well-finished tool, and its price is 6s. 6d.

SANTON THREE-PIN MULTI-PLUGS

IN response to Free Grid's request in *The Wireless World* of April 26th last for information as to where a three-pin wall plug adaptor of the two- or three-way type can be obtained, Santon, Ltd., Somerton Works, Newport, Mon., and 54, Bloomsbury Street, London, W.C.1, have sent in one of their standard types embodying this feature.

The plug is a 5-amp. model with the pins on the back and three sockets on the face.



Santon Multi three-pin wall plug and socket.

It is known as the Multi type, and when an additional supply is needed the extra plug fits tandem-fashion in the one already in use.

This firm manufacture a similar plug for reducing 15-amp. sockets to 5-amp. size, also in the Multi pattern, so that a combination of 15- and 5-amp. models with one reducing plug would meet all the requirements mentioned by our contributor.

The Multi three-pin 5-amp. plugs cost 16s. 6d. per dozen and the 15- to 5-amp. reducing model 21s. per dozen.

EDISWAN RECTIFIER

THE tendency in television reception is towards the use of higher voltages on the cathode ray tube. At one time a supply of 2,000 volts was deemed adequate for all requirements, but it is not uncommon to find that voltages of double this figure are now being used. The Ediswan

The MU2 high voltage rectifier.

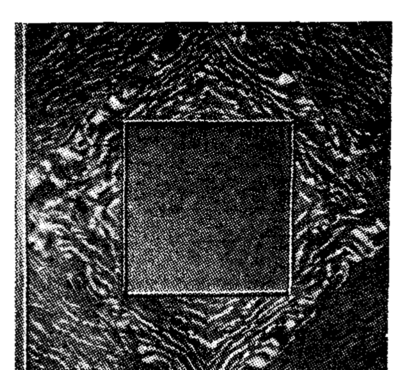
MU2 rectifier, which is of the half-wave mercury vapour type, has recently been redesigned and is now rated for a maximum peak reverse voltage of 10,000. This has necessitated the removal of the anode connection from the four-pin base, and the fitting of a top-cap.

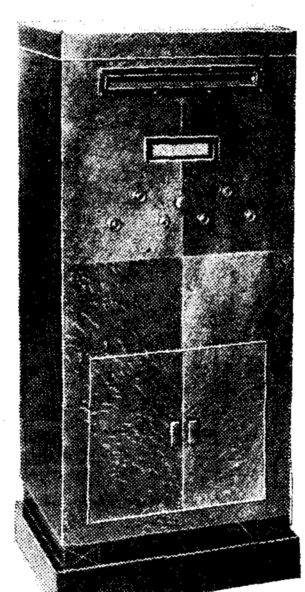
Its filament is rated for 1.0 ampere at 2.0 volts, and the anode is rated for an input of up to 4,000 volts RMS. When the anode and filament supplies are switched simultaneously the maximum rectified current is 25 mA., but the peak emission current is 150 mA. It is priced at 17s. 6d.

C.A.C. Sets Pass Test

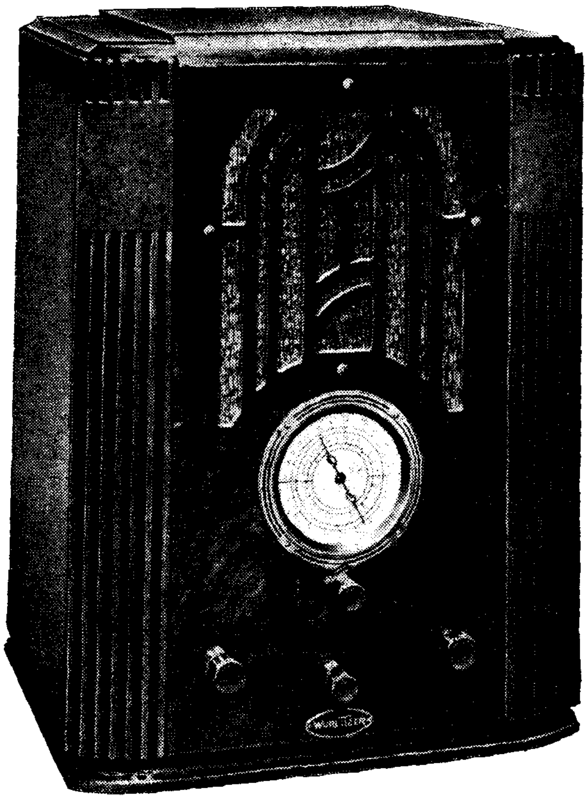
AS many readers know, a scheme has been in operation for some time whereby prototypes of sets intended for the reception of the B.B.C. educational transmissions are approved by the Central Council for Schools Broadcasts; receivers submitted to this body must attain a high standard of quality, and the requirements are particularly exacting with regard to reproduction of speech.

It is just announced that three of the C.A.C. receivers made by the City Accumulator Co., Ltd., of 18-20, Norman's Buildings, Central Street, London, E.C.1, have passed the tests. The first is an AC radio-gramophone, of which the circuit design is based on that of *The Wireless World* Quality Amplifier; a separate loud speaker is provided, in accordance with the Central Council's requirements. Both the C.A.C. "Austin" Superheterodynes have also been approved, and it is noteworthy that these are standard models, modified only by the fitting of external loud speakers.





The C.A.C. high-quality radio-gramophone with separate speaker, as officially approved for the reception of broadcasts to schools.



Wurlitzer-Lyric Model 47

An All-wave Superheterodyne of High Sensitivity and Good Tonal Quality

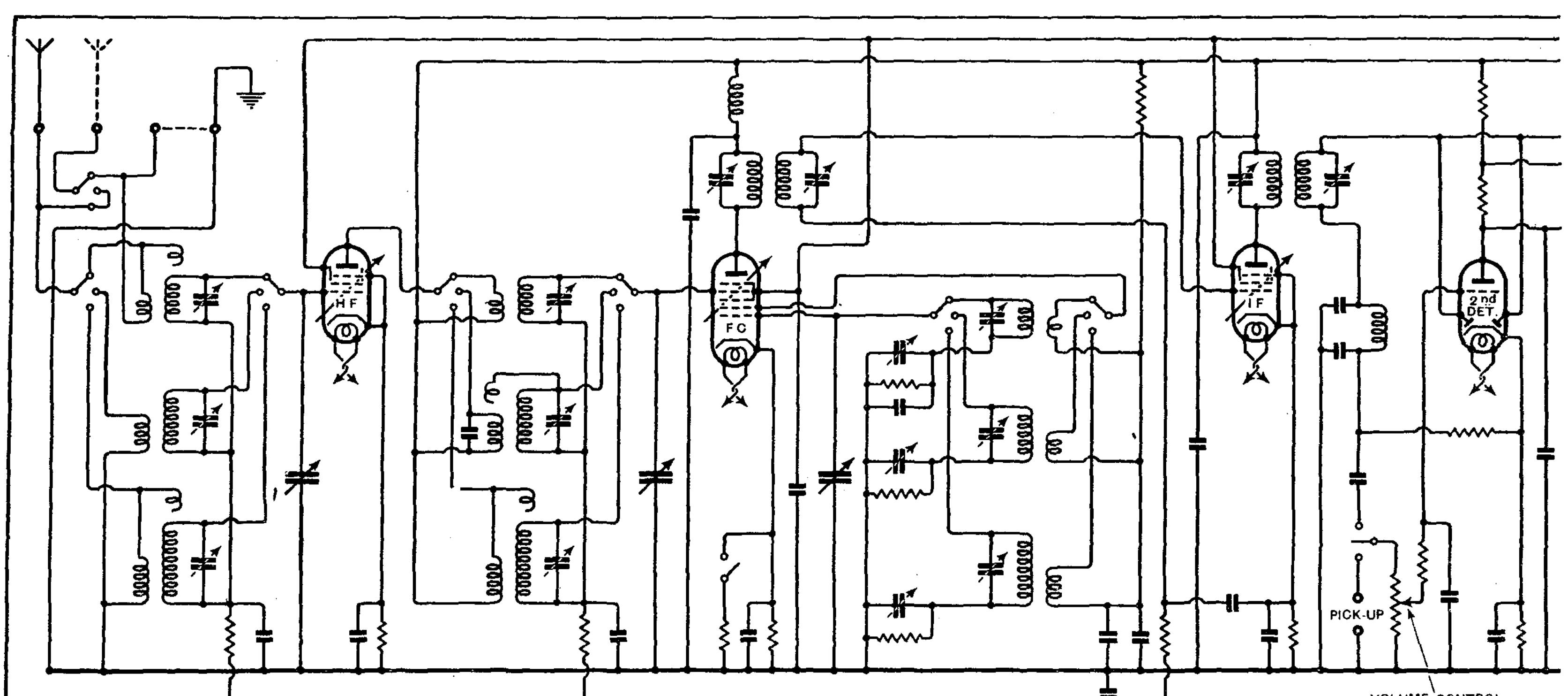
FEATURES.—***Type.***—*Table model AC superheterodyne for long, medium and short wavelengths.* ***Circuit.***—*Var.-mu pentode HF amplifier—heptode frequency-changer—var.-mu pentode IF amplifier—double-diode-triode second detector—separate AVC rectifier—power pentode output valve. Full-wave valve rectifier.* ***Controls.***—*(1) Tuning, calibrated in kc/s. (2) Volume and on-off switch. (3) Waverange switch. (4) Tone control.* ***Price.***—*20 guineas.* ***Makers.***—*Wurlitzer-Lyric Radio Ltd., Leicester Square Chambers, Leicester Square, London, W.C.2.*

THE Wurlitzer superheterodyne is made in two types, one, the 470B, being designed for American conditions with two short-wave ranges and the usual medium-wave range, while the other, the Model 471B, now under consideration, has been modified to conform with European requirements and has a long-wave range in place of one of the short-wave ranges. The band covered by this remaining range is from 18 to 55 metres, which includes the most interesting of the transatlantic and Continental transmissions.

In many all-wave superheterodynes the treatment of the short-wave range is often a compromise. This is not so, however, in the Wurlitzer set, for short waves receive exactly the same treatment as the medium and long waves both as regards signal-frequency amplification and the number of tuned circuits. The frequency-changer is preceded by a signal-frequency amplifier in which the input and output circuits are tuned on all three wavebands. The method of coupling the HF transformers receives different treatment on each range in accordance with the requirements of the coil characteristics and in order that the sensitivity may be equalised as far as possible throughout the full range of the set.

It is interesting to see that there is provision for the use of a doublet or di-pole aerial, a system of reception which has found special favour with the American short-wave enthusiasts. The receiver is quickly converted from the normal type of aerial to the doublet connections by removing a connecting wire between two terminals at the back of the set.

The frequency-changer is of the heptode type and the oscillator coils are properly tracked on all three ranges. The single IF amplifier is of the variable-mu HF pentode type and the input and output transformers are tuned to 465 kc/s. The second detector is a double-diode-triode in which the diodes are connected in parallel for signal rectification. A separate diode consisting of a triode valve with grid and anode strapped together is used to provide the AVC bias. Both rectifiers are fed from the secondary of the output IF



Complete circuit diagram. The HF amplifier is tuned on short as well as the normal broadcast waveranges, and a separate diode re

IB

transformer, and there is some tendency to side-band distortion as the set is brought into or out of tune, but the amount present is not sufficient to cause irritation.

The controls show little variation from standard English practice, there being the usual tuning, combined volume and on-off switch, wave range and tone control. The dial, however, will be unfamiliar to English eyes. It is only 3½in. in diameter and the pointer consists of a double-ended and rather ornamental clock finger. It has been found possible to include, in addition to the three wave ranges calibrated in kilocycles and megacycles, a spare 100-degree scale from which the exact settings of one's favourite stations may be noted. In the absence of the usual English and European station calibrations most users will find it necessary to refer to a list of stations such as that published from time to time in this journal in order to find their frequency settings in kilocycles. On the short-wave band, however, approximate wavelength calibrations and the settings of some American stations are included.

There are two features of the performance which are certain to create an immediate impression, viz., the ample reserve of over-all amplification and the high standard reached in the matter of quality of reproduction. The audio-frequency response is exceptionally well balanced and the solidity of the cabinet precludes the establishment of wood resonances and consequent colouration of the bass. There was a noticeable difference in quality between the sound emitted from the back and front of the instrument. At the back the set sounded like any ordinary table model receiver, but at the front the sound did not appear to radiate from the loud-speaker aperture only, but from a much wider area, without any suggestion of focusing. Any faults in the reproduction have been carefully hidden away, as such diverse tests of reprodution as the full organ and the transients inherent in the pianoforte and guitar failed to reveal any obvious deficiencies.

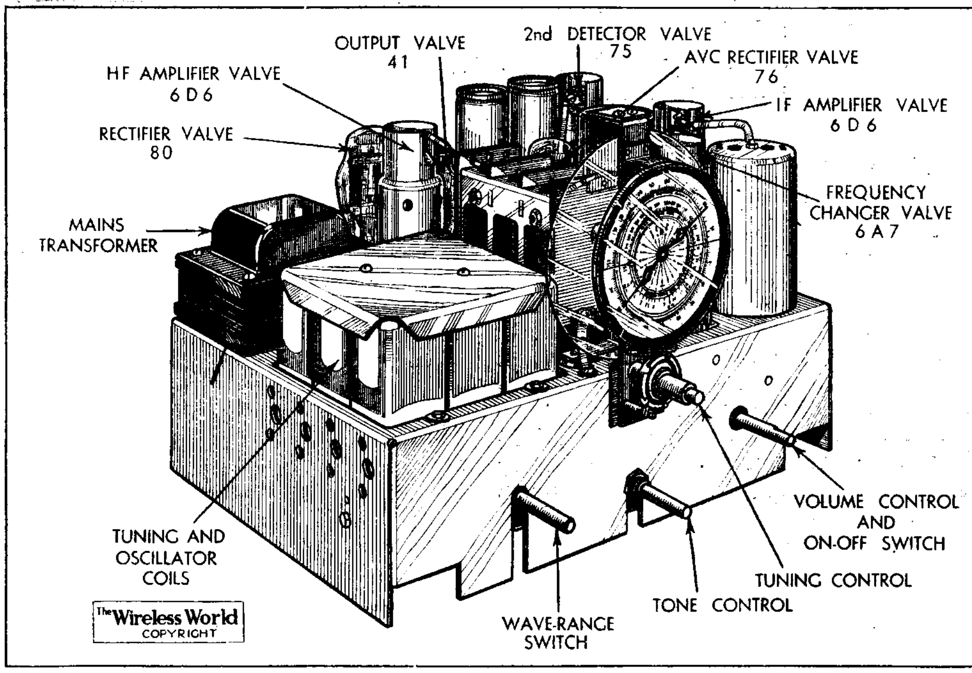
The signal-frequency HF stage quite definitely improves the range of the set by comparison with the average four-valve superheterodyne and also results in a much lower level of background noise on distant stations. The extra HF stage, however, does not appear to have conferred any additional selectivity, two channels being lost on either side of both the Brookmans Park National and Regional transmitters when being received in central London. On long waves there was an ample reserve of volume from the Deutschlandsender and the programme value of this station was quite fair, though there was some sideband interference from both Droitwich and Radio-Paris.

A careful exploration of the full wave-range of the set revealed only one self-generated whistle at about 850 kc/s on the medium waveband. In view of the high IF frequency this was probably an oscillator harmonic and not second-channel interference.

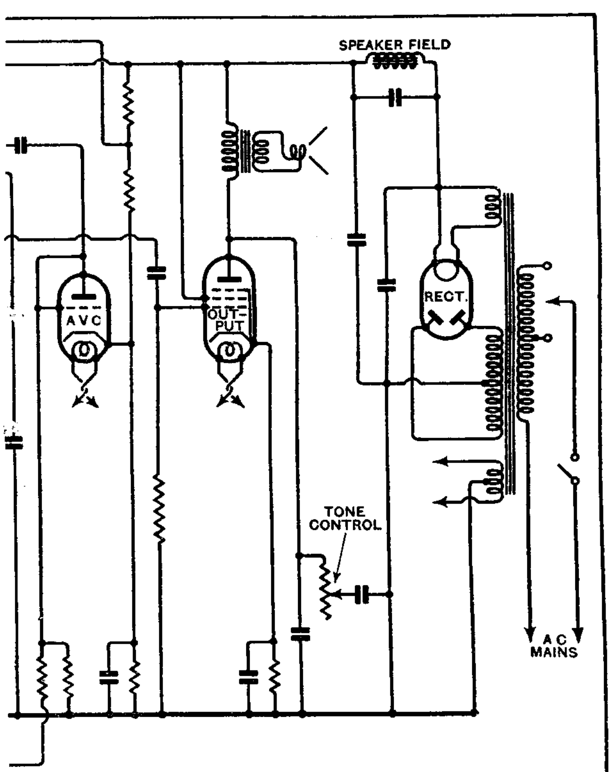
The performance on the short waveband was distinctly good, the ratio of signal to background noise being even greater than on the medium and long waves. Unlike the majority of all-wave sets employing autodyne reception on short waves, the Model 471B shows no repeat tuning points, so that there is very much less confusion in identifying stations. The only fault we could find with the short-wave performance was a tendency to low-frequency instability with the volume control at maximum (a setting rarely required owing to the reserve of amplification provided). There was also some mains modulation hum on powerful unmodulated carriers.

The twin-ratio slow motion dial operates the ganged condenser through a disc of transparent insulating material so that there is a complete absence of contact noise. The two ratios chosen appear to be just right for the short and normal broadcast wavebands respectively.

The servicing of these sets in this country has been thoroughly organised, and purchasers need anticipate no trouble with regard to such matters as valve replacements.



Interesting features of the chassis include a non-metallic condenser drive, complete valve screening and compact grouping of tuning coils.



ctifier supplies the AVC bias.

The Radio Industry

THE Radio Development Company, of Aldwych House, Aldwych, London, W.C.2, announces the withdrawal of the 99K and 99½ series of Epoch speakers, which will be replaced by Model D3. A new series of mains-energised models is shortly to appear.

Specimen books of sectional and graph papers and graph data sheets of various kinds, many of which would be eminently suitable for use by radio engineers and designers, etc., have been sent to us by Wightman Mountain, Ltd., of 15, Artillery Row, London, S.W.1.

It is announced that the development of a Philips television receiver is proceeding satisfactorily. With a view to continuing the laboratory experiments on a larger scale it has been decided to establish at Eindhoven (Holland) an experimental television transmitter to work on about 7 metres.

R. A. Rothermel, Ltd., point out that the pre-amplifier illustrated on page 537 of last week's issue has a three-valve circuit and not a two-valve as originally stated.

Wireless and the Atmosphere

V.—Absorption of Wireless Waves, and Wireless Echoes

THE Heaviside layer acts as a mirror by night and a blanket by day and it is shown why this should be so. The Appleton layer may rise and fall by 200 miles in 24 hours, like a great tide in the atmosphere. A trip round the earth reveals how certain wave-lengths remain strong and steady, while others fade and reappear a thousand miles away, while occasionally signals return to earth after long intervals ; and, strangest of all, we continually receive short waves from a fixed point in the heart of the Milky Way.

IN the last instalment we have regarded an ionised layer as a refracting medium containing free electrons, which, as they vibrate under the influence of radio waves, set up alternating currents out of phase with the electric force in the wave. Like capacity current the current is ahead of the force by a phase angle of 90 deg., and consequently absorbs no power from the incident radiation.

But when we remember that this jostling mob of electrons is continually colliding with atoms and that any electron which has acquired a surplus of energy will give it up to atoms with which it collides till it once more sinks to the average energy level of the other electrons, we see that our picture must be modified. An electron in a gas moves about irregularly as in Fig. 1. In detail its motion seems to be chaotic; sometimes its path is short, sometimes long, and its speed may vary enormously. But if a large number of observations could be taken it would be found that each electron has the same *average* speed and the same *average* frequency of collision. For example, at a height of 60 miles an electron in the Heaviside layer makes about a million collisions per second. Any energy imparted to an electron by a radio wave will be shared with atoms during subsequent collisions and be transformed into heat, and hence power is abstracted from the train of radio waves which, as they advance through the ionised layer, leave a wake of heated air behind them.

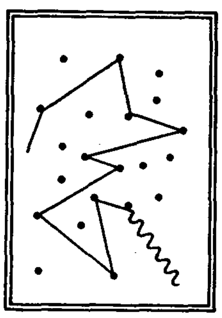


Fig. 1.—Path of an electron moving among the atoms of a gas. Under the influence of radio waves it acquires surplus energy and undulates as shown.

Our former analogy, in which we compared the layer with a purely reactive circuit, must now be altered by the insertion of resistance into the circuit.

If a large number of waves had time to act on the electron between two collisions, as in Fig. 1, then the percentage of energy lost by the waves would be small. Thus, if we imagine the gas becoming more and more rarefied, as happens when the Heaviside layer rises at night from 60 to 70 miles along the curve of Fig. 2, then collisions become more infrequent and the waves suffer less attenuation while traversing the layer. Or if while the layer remains stationary we use waves of higher frequency the same thing happens, since more waves pass across before a collision occurs. Thus, it is the ratio of wave frequency to collision frequency that is of importance, and when this ratio is large the attenuation is small.

This is the state of affairs at one end of the scale ; at the other end, where the ratio is very small, only a fraction of a wave has time to act on an electron between collisions, and the electron has acquired but little energy by the time a collision occurs, the result being that there is not much surplus energy to be shared with atoms, and so, in this case also, the attenuation is small.

It appears, then, that absorption is negligible both for very short and for very long waves, while it rises to a maximum value for some wavelength in between. This is well shown by the average ranges for transmitters operating on various wavelengths shown in Fig. 3. This chart, compiled by the American Bureau of Standards, shows the sort of range to be expected in summer over the daylight zone of the earth's surface, and it appears that for such a wavelength as that of the 18 kilometre Rugby station communication is established everywhere, even at the most distant possible point, 12,500 miles away, while with short waves in the region of 15 metres the range is also very great. In both these cases the great range shows that absorption in the ionised layers is small. But at an intermediate wavelength of 130 metres the range is only 140 miles ; this is the wavelength region where absorption is a maximum and its effect in cutting down the range is seen to be enormous. The broken curve gives corresponding results for an average night in winter, when, owing to the ascent of the Heaviside layer into more rarefied regions the absorption is smaller for all wavelengths. All ranges are now greater, but there is still a pronounced minimum, which, it is interesting to observe, occurs at wavelengths of from 200 to 600 metres, corresponding to the medium broadcasting band, which is thus seen to be most unsuitable for long-distance communication.

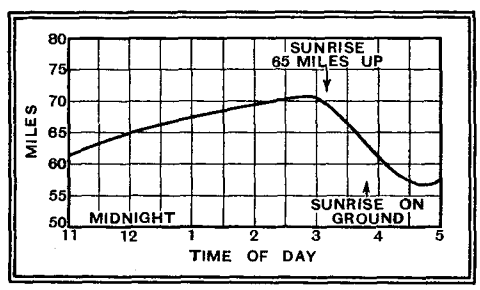


Fig. 2.—Typical picture of the rise of the Heaviside layer at night and its fall at sunrise.

Questions and Answers

No doubt the reader has by now come to the definite conclusion that the effect of ionised layers upon radio waves is a most complicated affair, as indeed it is if we wish to take into account all the factors on which range depends. But the broad outlines are simple enough, and we shall now attempt to make the matter clear by a series of questions and answers.

If all ionised layers were to disappear from the earth's atmosphere what would happen to radio reception?

The ground wave would be the only wave to be received. Long waves would have the greatest range, since they bend more easily round the earth's surface. Rugby would fade out at about 1,000 miles, the little Regionals would cover 100 miles or so, and 10-metre waves would have a negligible range.

Now imagine a single ionised layer to be formed in the atmosphere, what would be the result?

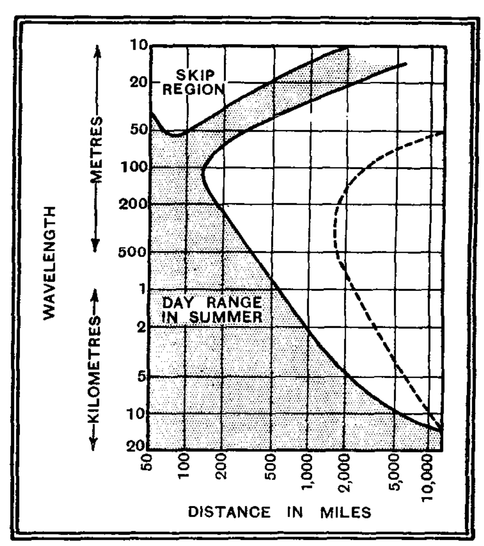


Fig. 3.—Ranges of transmitting stations on an average day in summer. Corresponding ranges on a night in winter are shown by the broken curve.

Wireless and the Atmosphere—

It is quite impossible to say. It depends on the height of the layer, its thickness and the density of free electrons.

Well, then, let the thickness be 10 miles, the height of the lower edge 70 miles, and let the number of electrons gradually increase from zero to, say, 100,000 per cubic centimetre. What then?

Rugby would be the first station to be affected. The horizontal part of the beam would strike the layer obliquely 750 miles away and be completely reflected, even if there were only a few electrons per cubic inch. So the skip distance would be $2 \times 750 = 1{,}500$ miles, and beyond that distance the station would be received everywhere. With greater electron density the higher angle rays would also be totally reflected so that the skip distance would diminish, and with four electrons per cubic centimetre even vertical rays would be reflected, the skip distance would vanish, and the rays would reach all parts of the earth's surface.

What about shorter waves?

As the electron density increases the same behaviour would be shown by shorter and shorter waves. But smaller ranges would be obtained as in Fig. 3 owing to increasing absorption. Below the medium broadcast band range would again increase owing to diminishing absorption after the maximum has been passed.

Would any waves penetrate a strongly ionised layer?

With 100,000 electrons per cubic centimetre which corresponds to the density existing at noon on a winter day in the Heaviside layer, waves of less than 100 metres would get through if projected vertically but would be reflected if projected obliquely. The critical wavelength for vertical projection is given by $N\lambda^2 = 1{,}100$, where N = millions of electrons per cubic centimetre, λ = wavelength in metres.

What happens to waves which get through the Heaviside layer?

They meet the Appleton layer, which is on the average four times as strongly ionised as the Heaviside layer, and reflects vertical waves down to wavelengths of about 50 metres. Still shorter waves will never get back to earth unless they are projected obliquely, and so a skip distance begins to be observed at 50 metres, as in Fig. 3. With the Appleton layer at 200 miles up the maximum skip distance is $2 \times \sqrt{200 \times 8{,}000} = 2{,}500$ miles for rays projected horizontally and Fig. 3 shows this distance being approached for 10 metre waves. 8.5 metres is about the limit for reflection; waves shorter than this are lost in space.

The Heaviside layer moves up and down like a daily tide. It rises at night because the positive and negative ions in the comparatively dense air at its lower edge are the first to recombine. By day the sun's rays pour down and the lower edge is formed again. The variation in height is usually about ten miles. Much more extensive movements are observed in the Appleton layer, which may climb 200 miles upwards at night. In Fig. 4 a rise of 200 miles is shown between 10 p.m. and 2 a.m., and subsequently the layer was completely lost to observation till it came down again with sunrise. Such a picture gives us a glimpse of the difficulties with which radio communication companies have to deal in the course of establishing a reliable day and night service employing different wavelengths to cover the whole earth.

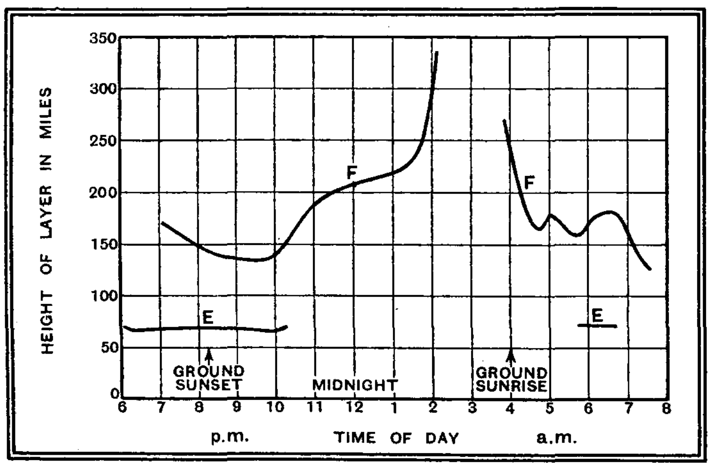


Fig. 4.—Vertical movements of the Heaviside (E) and Appleton (F) layer.

We have said that waves below 50 metres, when sent vertically upwards, penetrate both layers and are heard no more. But now and again they return in remarkable fashion after a delay of seconds, or even minutes. It was in 1927 that these echoes were first observed on a 30-metre wave, the echo occurring from three to fifteen seconds after the signal. Professor Størmer, of Copenhagen, attributed them to reflections from a great ring of electrons which on his theory encircles the earth at a distance of millions of miles. This ring, he says, is due to corpuscles shot out from the sun and deflected by the magnetic field of the earth to form a great anchor ring in the plane of the earth's equator, like the rings of Saturn, and narrowing towards the poles to form a complete envelope—a third ionised layer.

It is doubtful whether this explanation can now be accepted, for longer and longer echoes have since been reported, culminating in one of 4 minutes 20 seconds. To deal with this echo Størmer's ring would require a radius of ten million miles!

Another explanation is that the waves may have travelled with greatly reduced velocity in the Appleton layer. Though continuous waves actually travel faster in an ionised layer, a complex wave such as is produced in morse signalling, and whose component frequencies travel at different speeds in a layer, may be slowed down as regards the speed of travel of the *energy* of the group of waves. It appears, however, that this process only allows for a ten-second echo. So that the cause of very long interval echoes still remains a mystery.

Still more mysterious is the persistent high-frequency signal which continually reaches us from a fixed direction in space. It was first detected in 1933 by Dr. Gansky of the Bell Telephone Laboratories, who was using a direction finder to locate the origin of a hissing sound in his superheterodyne receiver. The first observations showed that the bearing of the signal was not fixed on the earth but travelled right round the horizon in the space of twenty-four hours, and in fact followed the path of the sun round the earth.

Did it then come from the sun? Further observation showed that it did not, for as the year wore on the bearing lagged more and more behind the sun's track. In six months it had worked round to a position opposite to the sun, and when a full year had gone by it had returned to its original position. It was now evident that the true position from which to reckon the bearing was not a point fixed in the earth or in the sun, but a point fixed in the celestial sphere, a point in the heart of the Milky Way, in the region which astronomers regard as the centre of the galaxy which contains our sun and planets, and towards which our solar system is heading at a speed of eleven miles per second.

As to the cause of this radiation, only surmise is as yet possible. But it is a plausible theory that if radiation of this kind is emitted by stars the direction from which it comes in most strongly should be the region at the centre of our galaxy where the stars cluster most thickly.

Not a Radio Cathedral but the new "Broadcasting House" erected in Auckland, New Zealand, where a considerable improvement in broadcast services is being carried out.

Random Radiations

By "DIALLIST"

Well Worth Trying

AUTOMATIC volume expansion, to which *The Wireless World* made further reference a week or two ago, is well worth the attention of those who are interested in experimental work in general and in methods of obtaining high-quality reproduction in particular. It certainly enables one to obtain a much more realistic reproduction from a gramophone record than is possible by ordinary methods. The trouble is that while recording is in progress loud passages are rather toned down and soft ones somewhat strengthened, with the result that the contrasts between *fortissimo* and *pianissimo* are not sufficiently emphasised on the disc itself. Hence when it is played by the radiogram it fails to be realistic since its loud passages are not loud enough though its soft ones come through rather too strongly. Automatic volume expansion by restoring the original contrasts accomplishes the miracle of enabling one to obtain rather more from a gramophone record than is actually upon it.

"Quality" in Years to Come

All this makes one wonder what will be done in the matter of high-quality reproduction of broadcasting and gramophone records in the future. It is a curious fact that we never realise fully the shortcomings of any kind of mechanical or electro-mechanical sound reproduction to which we have become accustomed until we hear what improved methods can do. Then we begin to wonder how on earth we could ever have put up with things as they were. It is just ten years since electrical recording was introduced for gramophone discs. Prior to its coming we thought the mechanical gramophone playing mechanically recorded discs pretty good. But if you want to see just how poor was the quality with which we were then satisfied, procure a pre-1925 record and try it over. You will more fully appreciate the magnitude of recent advances if you can unearth an ancient gramophone (or sound-box) with which to make the trial. Ten years from now shall we regard the 1935 reproduction of records and of broadcasting as just as horrible as that of 1925 seems nowadays?

Divine Discontent

Talking of reproduction brings to mind a question that I would like to ask readers. Has any genuine wireless enthusiast ever been completely content for more perhaps than a few weeks with a set that he has built? I am quite sure that I never have. When first made the new set was so overwhelmingly superior to its predecessors that any further improvement seemed hardly possible. Then when we began to read about harmonics, or transients, or resonance effects, or high-note cut-off, doubts immediately set in. Was all really well? In a matter of days one was quite sure that most emphatically it was not. Alterations were undertaken; sometimes even a complete rebuilding of a large part of the apparatus. At last the trick had been done —or hadn't it? Probably it hadn't! Some new refinement produced a further urge for better things. And so it goes on. That is one of the joys of making wireless a hobby. You never get to the end of it: there is always something thrilling to be done.

The Range of Ultra-Short Waves

SOME time ago I ventured to predict in these Notes that we might find, as more and more experiments were made, that the ranges of transmissions on wavelengths between 6 and 10 metres were in reality in excess of the quasi-optical. I suggested that there might be an extensive skip area, outside which signals might again be picked up. Whether or not such a skip area exists still remains to be proved; but the Radio Research Board announce that they have received reports of reception in this country of Buenos Aires on 9 metres, which means a range of some 7,000 miles!

Mr. R. A. Watson Watt, superintendent of the radio department of the National Physical Laboratory, says that reception of ultra-short wave transmissions at great distances is due to reflection of the sky waves from what is known as the E region of the upper atmosphere. Everything depends upon the intensity of its ionisation.

Breaking New Ground

In exploring the doings of ultra-short waves we are really entering quite new territory, and no complete data can be obtained for something like eleven years, the duration of a whole sunspot cycle. We know, for instance, that short waves, as distinct from the ultra-short, have their greatest ranges just before, during and just after a sunspot maximum; but how ultra-short wave transmissions are affected by the pressure or absence of sunpsots is as yet not known with any certainty. We are now approaching a sunspot maximum period, which should occur between 1938 and 1939. Whether the ranges of ultra-short wave transmissions will show increases during the next few years, followed by a decline as we progress towards the next minimum period, no one can yet say. I feel, though, that there can be little doubt that sunspots will be found to have a profound influence upon the distances that they cover.

An Erratic Effect

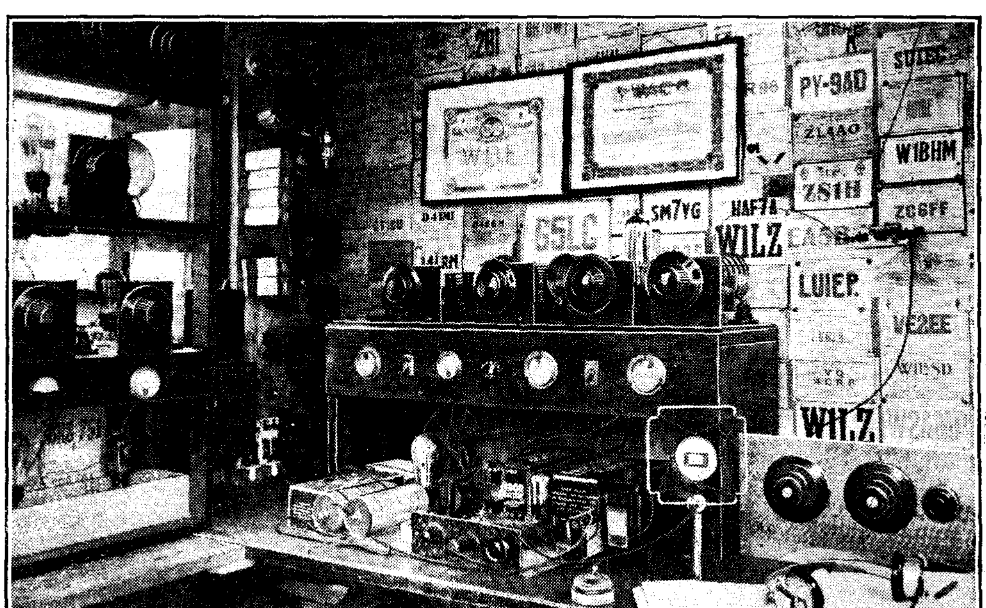
From what was said above it will be realised that such a thing as regular communication over long distances by means of ultra-short waves is not, so far as we know, a possibility; there is a more or less periodic increase and decline in the distances that they can cover. Hence no such thing as a television service from one side of the globe to the other is practical politics.

There is, though, another consideration of real importance. It was believed that if every country covered itself with a network of ultra-short wave transmitters for both sound and vision all interference problems, such as we know to-day, would disappear, since each transmission would, so to speak, begin and end in its own service area. This may turn out to be but a fond hope, and, at any rate at certain times, stations thousands of miles apart may cause interference with one another.

Cheap Interference Suppressors

THOSE who equip domestic electrical appliances with interference suppressors should make sure that they are obtaining devices of good quality made by firms of repute. I give this warning because certain cheap suppressors have found their way on to the market which are by no means satisfactory. Some of them incorporate condensers and other components whose test-voltage rating is far below the standards of the Board of Trade, the insurance companies and other authorities. It is exceedingly important that the parts used in interference suppressors should be up to their work, for a breakdown might easily result in the frame of an unearthed set becoming very much alive.

It is not unlikely that electricity supply authorities will take action in the matter.



A COMPACT AMATEUR STATION. G5LC, East Molesey, Surrey, which is owned and operated by Mr. Leslie Cooper. The transmitter in the centre is a crystal oscillator, neutralised buffer amplifier, locked T.p.—T.g.rig for 20 and 40 metres. On the left is the 80 and 160 metres transmitter using a pentode crystal oscillator and power amplifier. The station has worked all continents and 52 countries.

Amongst the Short Waves

By GODCHAUX ABRAHAMS

IN view of the ease to-day with which the average possessor of a short-wave receiver can tune in a number of European and North American transmissions, it is fascinating at times to make an effort to pick up broadcasts from lesser-heard localities. The interest in short-wave transmissions is a growing one, and most countries in all five continents are steadily experimenting with transmissions on channels below 60 metres, in fact, most of them are anxious that their programmes should be heard by distant listeners!

For this reason, in order that they may be identified—if only that reports of reception may be sent to them—the stations, as a rule, put out their calls and make announcements in a number of languages. The choice of wavelengths, however, is not always so easy, as in view of the number of services to be dealt with suitable channels which may be used for the broadcast of radio entertainments are limited; in some portions of the band congestion already exists. To avoid interference, however, frequent adjustments are made and in consequence alterations in wavelength are often carried out. The DX listener should keep an accurate log of his captures, and register all detail relating to stations for which he may wish to search.

As it is, since the publication of my South American list in *The Wireless World* (April 12th, 1935), not only have some wavelengths been altered, but new stations have also appeared on the horizon. Corrections or modifications to the original list and details of experimental broadcasting stations in Central America and the West Indies are given below.

CENTRAL AMERICA AND WEST INDIES.

Call	Station	Metres.	Kc/s.	Remarks
	BARBADOS.			
VP6YV	Garrison (T. A Archer, Craigston, Aquatic Gardens, Garrison, Barbados.)	42.42	7,072	English announcements.
	BERMUDA.			
ZFD	St. George	29.03	10,335	Commercial telephony also relays programmes. English announcements.
	COSTA RICA.			
TITR	San José (Margarita de Girton, San José, Costa Rica.)	25.445	11,790	Relays medium wave station (225 m.).
TI60W	Puerto Limon (E. Manoel Rosat, Puerto Limon, Costa Rica.)	42.43	7,070	*Ondas del Caribe.*
TIEP	San José (Gonzales Pinto, Apartado 257, San José, Costa Rica.)	44.71	6,710	Call: *La Voz del Tropico.*
TIPG	San José (Casa Victor, San José, Costa Rica.)	45.8	6,550	—
TIGPH	San José (Apartado 775, San José, Costa Rica.)	51.46	5,830	*Radiodifusora TIGPH, Alma Tica.*
	CUBA.			
CMHB	Sancti Spiritus (Apartado 85, Sancti Spiritus, Cuba.)	29.41	10,200	—
COH	Havana (Calle B. No. 2, Vedado, Havana.)	31.7	9,460	*Estacion COH, Vedado, Habana.* Interval Signal: chimes similar to Big Ben.
CO9GC	Santiago de Cuba (Laboratorio Radio Electrico, Gran y Caminero, Apartado 137, Santiago de Cuba.)	48.78	6,150	Relays CMKC (1,250 kc/s).
COC	Havana (Estacion de Onda Corta, COC, Apartado 98, Havana, Cuba.)	49.92	6,010	*Estacion Radiotelefonica COC.* Interval Signal: Bugle call.
	DOMINICAN REPUBLIC.			
HIH	San Pedro de Macoris. (Sr. Domingo Dominguez, San Pedro de Macoris, D.R.)	44.05	6,810	*Radiodifusora HIH, La Voz de Higuamo.*
HI4D	Santo Domingo (Dr. Luis D. Santamaria, Santo Domingo, D.R.)	46.25	6,842	*La Voz de Quisqueya.*
HIZ	Santo Domingo (Calle Duarte 68, Santo Domingo, D.R.)	47.5	6,316	*Estacion Radiodifusora HIZ.*
HI1A	Santiago de los Caballeros. (Sr. Rafael Western, Box 423, Santiago de los Caballeros, D.R.)	48.08	6,240	(Phon): *Estacion Achay-ee-uno-ah, La Voz del Yaque.*
HIX	Santo Domingo (Secretaria D.E. de Trabajos y Communicaciones, Santo Domingo, D.R.)	50.17	5,980	*Radiodifusora Naçional HIX.*
	GUATEMALA.			
TGX	Guatemala City	50.5	5,937	*Radiodifusora Naçional.*
	HAITI.			
HH2R	Port au Prince	31.43	9,559	French, Spanish and English announcements.
	HONDURAS.			
HRP1	San Pedro Sula	42.6	7,042	—
	NICARAGUA.			
YN3RG	Granada	44.68	6710	Radio Club of Granada.
YN1GG	Managua	46.98	6,385	*La Voz de los Lagos.*
YNLF	Managua (YNLF, Emprisa le Franc, Calle 15, de Setiembre 206, Managua, Nicaragua.)	50.42	5,950	*La Voz de Nicaragua.* Interval and Closing Signal: Bugles and drums.
	REPUBLIC OF PANAMA.			
HP5J	Panama City	31.28	9,590	The Voice of Panama.
HP5B	Panama City (Radiodifusora Miramar, Box 510, Panama.)	49.75	6,030	Announcements in Spanish and English. Several slogans include: *Cross Roads of the World.*

ALTERATIONS AND ADDITIONS TO LIST PUBLISHED ON APRIL 12.

Call	Station	Metres.	Kc/s.	Remarks
	CHILE. *Additions:*			
CEC	La Granja, Santiago.	28.12	10,670	Relays programmes.
	COLOMBIA. *Additions:*			
HJ4ABA	Medellin	25.64	11,700	Ecos de la Montana.
HKV	Bogota	34.09	8,800	Ministry of War.
HJ1ABI	Cienaga	49.18	6,100	—
HJ3ABI	Bogota (G. Pradilla y Cia., Box 513, Bogota.)	49.59	6,050	—
HJ1ABK	Barranquilla	50.0	6,000	—
HJ2ABD	Bucaramanga	50.17	5,980	(Reports to: J. T. Spalding, 3,524, N. Westernparkway, Louisville, Kentucky.)
	COLOMBIA. *Alterations:*			
HJ4ABF	Medellin	31.25	9,600	—
HJ5ABF	Popayan	37.41	8,020	—
HJ1ABD	Cartagena	41.21	7,280	—
HJ5ABG	Cali	42.74	7,020	—
HJ5ABE	Cali	42.86	7,000	—
HJ4ABI	Medellin	45.45	6,600	—
HJ5ABD	Cali	46.22	6,490	—
HJ2ABA	Tunja	48.23	6,220	—
HJ3ABF	Bogota	48.39	6,200	—
HJ1ABE	Cartagena	49.02	6,120	—
HJ4ABN	Manizales	49.02	6,120	—
HJ4ABD	Medellin	49.5	6,060	—
HJ1ABF	Barranquilla	49.5	6,060	—
HJ1ABJ	Santa Marta	49.5	6,060	—
HJ3ABH	Bogota	49.9	6,012	—
HJ1ABF	Barranquilla	50.0	6,000	—
HJ4ABE	Medellin	50.85	5,900	Interval Signal: Morse letter "M."
HJ2ABC	Cucuta	51.11	5,870	—
HJ5ABC	Cali	53.57	5,600	—
	ECUADOR. *Additions:*			
HC2AT	Guayaquil	35.71	8,400	—
HCK	Quito	45.94	6,530	—
	ECUADOR. *Alterations:*			
El Prado	Riobamba	19.45	15,430	—
HCJB	Quito	36.59	8,200	—
HC2JSB	Guayaquil	38.96	7,700	—
HC2RL	Guayaquil	45.05	6,659	—
	MEXICO. *Additions:*			
XECR	Mexico City	40.6	7,390	—
	PERU. *Additions:*			
OA4AD	Lima (Cesar Benites, Humboldt 365, Lima.)	38.36	7,820	*La Voz de Peru.* Woman announcer.
OA4AB	Lima (Walter Butz, Casapalca.)	48.0	6,250	—
	VENEZUELA. *Alteration:*			
YV6RV	Valencia	46.01	6,520	—

Readers' Problems

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers. Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page.

A Definite Test

A SIMPLE "ganging" problem is propounded by a reader who believes that the alignment of the three tuned circuits of his straight receiver is not accurately maintained over the whole of the medium waveband.

This querist will find it easy to assure himself on the matter by lining up the circuits accurately at a short wavelength (250 metres or lower) and then tuning-in a station at the other end of the scale (about 500 metres). If it is now possible to bring about any improvement in signal strength by adjustment of the trimmers he will know beyond doubt that either the tuning condenser or coils are inaccurately matched.

A Short-Circuited Condenser

REFERRING to the ordinary type of double - condenser anti - interference filter, several readers have recently noticed that, when connected to the mains in the usual way, one of the condensers appears to be short-circuited; one of its terminals is joined directly to earth and the other is earthed through the mains.

This matter will be made clear by reference to Fig. 1, and it cannot be denied that so far as DC or low-frequency AC is concerned, the condenser is actually short-circuited. But it must not be forgotten that the earthed mains lead—or, at any rate, that part of it that is likely to give trouble as a radiator of interference—is not always at true earth potential so far as high-frequency currents are concerned. Consequently the short-circuit is more apparent than real, and the condenser in question is still capable of doing useful work in disposing of impulses that might otherwise cause interference. Still, it is true enough that in certain cases one of the mains leads may be found to be "dead" with regard to disturbing potentials, and in such cases a single by-pass condenser connected from the "live" main to earth may provide an effective remedy.

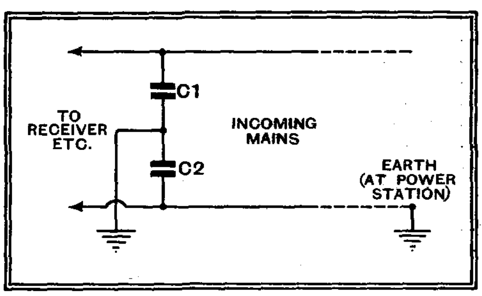


Fig. 1.—Although one of the pair of condensers used in a mains filter is normally short-circuited through earth, it may still be effective in deflecting HF impulses.

Fully Tuned Aerial Circuit

SEVERAL readers have asked for further information as to the practical application on a scheme discussed in "Random Radiations" a few weeks ago. Our contributor "Diallist" drew attention to the benefits that will sometimes result from abandoning the almost universal aperiodic aerial coupling system in favour of a fully tuned arrangement.

In theory, at any rate, the conversion is simple enough and one or other of the methods shown in Fig. 2 should be applicable to almost any set. The first (diagram *a*) would apply to an old type of set with unscreened coils; it makes use of variable magnetic coupling which, although rather clumsy, is at least effective and inexpensive. The method of diagram *b*, applicable to sets with screened coils, involves the use of capacity coupling by means of condenser C and is generally to be preferred for any type of receiver. The coupling condenser may have a capacity of 20 or 30 micro-microfarads.

Minor difficulties associated with tuning the aerial are mainly confined to the fact that this circuit cannot be ganged, and that the wave-range coverage for a given fixed value of tuning inductance is small, due to the fact that the relatively large capacity of the aerial is in parallel. The latter disadvantage may be minimised—but at the expense of some losses—by fitting a small series condenser in the aerial circuit. Instead of switched coils, as shown in the diagram, interchangeable inductances may, of course, be employed.

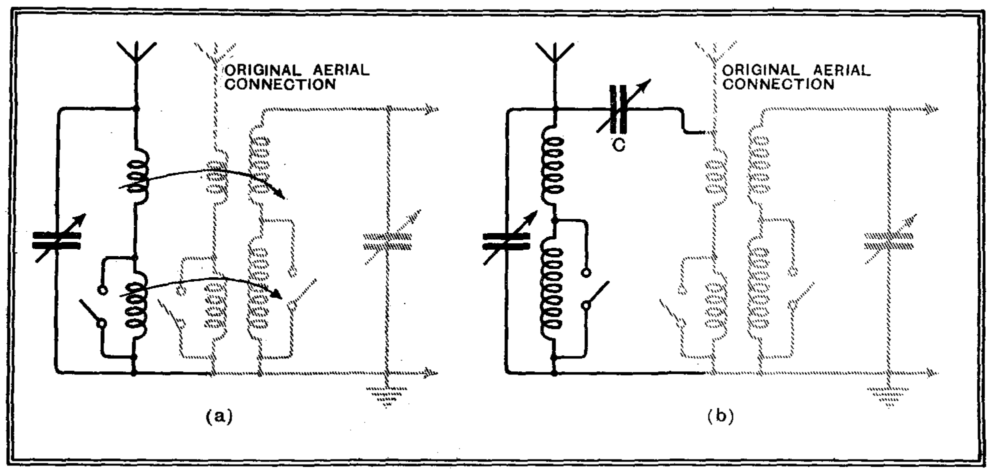


Fig. 2.—Two methods of adding a tuned aerial circuit to an existing receiver; additional connections in full lines.

Lagging Volume Control

THE user of a portable set complains that the volume control is slow in action; in other words, the effect of turning the regulating knob in either direction does not become fully evident until a second or so afterwards. This is considered to be inconvenient, and we are asked to say whether operation of the control may be speeded up in a simple manner.

It is fairly certain that our querist's set is fitted with a volume control which operates by variation of filament voltage of the HF valve. We fear that if this is so the lag of which he complains is inevitable and, in all probability, the type of valve in use would not lend itself readily to the fitting of any other form of pre-detection regulation.

Wired Wireless

PROBABLY every user of a frame aerial set, and particularly of a portable, has noticed that apparently inexplicable variations in signal strength occur when the set is moved from place to place. A correspondent, writing on this subject, asks us to explain why clear and loud signals are receivable from a broadcasting station about one hundred miles away at a certain point, while a few hundred yards away, in a position apparently more favourable for reception, the same transmission is weak.

Although we can seldom be definite in these matters, a sketch map which accompanies our correspondent's letter provides us with a good clue.

Position (A) where signals are good, is within a few yards of a main road, presumably with telegraph or telephone lines running alongside it. Experience shows that in many cases the overhead lines act as fairly effective conductors and re-radiators of signals, and it is certain that abnormal ranges with portable sets are often obtained with their help. In position (B) on the map there appears to be no such adventitious aid to reception.

The Wireless World INFORMATION BUREAU

THE service is intended primarily for readers meeting with difficulties in connection with receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be by letter to *The Wireless World* Information Bureau, Dorset House, Stamford Street, London, S.E.1, and must be accompanied by a remittance of 5s. to cover the cost of the service.

Personal interviews are not given by the technical staff, nor can technical enquiries be dealt with by telephone.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

High Fidelity

WE have read with interest Mr. Holiday's letter (in your issue of May 17th) on the question of whether good quality is worth while.

We have collected the experience of users of high-quality public address apparatus, and it can be summed up as follows:—

(1) So-called good quality in which the upper register is mainly concentrated into one peak is objected to.

(2) High quality in which the top register is smooth and not peaky or harsh is generally appreciated, but heterodyne whistle and/or gramophone scratch may be complained of. When tone controls are fitted they are often used at first to eliminate these two faults, but as the user appreciates what is happening to the reproduction he uses the tone control less and less.

(3) The only cases where high-class reproduction has been found unsuitable is when public address announcements are so natural that the general public assumes it is someone talking nearby and takes no notice of it.

In these cases it is preferable to cut the bass so as to leave the announcement clear and intelligible above the normal noises.

We note that your correspondent's trouble is particularly noticeable with gramophone reproduction. In view of the fact that the majority of pick-ups have a very prominent peak around 3,000 cycles, his experience fits in perfectly with our experience that the public objects to anything peaky.

VOIGHT PATENTS, LTD.
P. G. A. H. Voight.
London, S.E.26.

"Aida" from Milan

IT is customary, almost fashionable, to criticise the B.B.C., but I hate being in this kind of fashion. I wish to congratulate them on the excellent broadcast of "Aida" from Milan a month ago.

Is it greedy to ask for more? There are constant occasions when opera is available from the Continent, and there is especially an opportunity for more Italian broadcasts in the B.B.C. programmes.

London, S.W.3. JASPER PLOWDEN.

North National Transmitter

I CANNOT too strongly endorse the comments of Mr. Ironfield in his interesting letter in your issue of May 3rd, on the performance and quality of the North National Transmitter, since the synchronisation. Fading is marked, being accompanied by severe distortion and the deep thudding which he mentions.

Incidentally, as no other listener of my acquaintance had mentioned this latter phenomenon, I must be forced to the conclusion that their apparatus will not reproduce these low frequencies! Surely, however, it is an arrogant assumption that there are only two listeners both possessing good apparatus and in the habit of listening critically to North National?

Certainly, Droitwich is an alternative, but atmospherics are much worse and the quality is not as good as the pre-synchronisation North National.

Might I presume to start another discussion by suggesting that it is high time that the B.B.C. reduced the ratio announcer volume/orchestral volume from that suitable for a crystal set (with phones) to some value more compatible with the capabilities of a modern set—or even of one four years old?

J. B. T.
Sale.

The Cardiograph

IN his interesting letter, published in your issue of May 10th, 1935, your correspondent, Mr. Robert J. Parris, has put forward a number of criticisms of the Cathode Ray Electrocardiograph. I hope that you may allow me, without trespassing too far on your space, to make a reply to the points which he has raised.

I would like to make it quite clear at the outset that, in the remarks which follow, I do not in any way at all wish to disparage either the string galvanometer or the Cambridge Scientific Instrument Company, who, as is well known, are responsible for beautifully made string galvanometers, both portable and otherwise. The string galvanometer is, in fact, the instrument with which the whole structure of the science of electrocardiography has, so far, been built. Any depreciation of this instrument which appears in this letter is directed against it from a purely comparative standpoint, and it will be understood that it is only because, in my estimation, it falls short, in many respects, of the cathode ray electrocardiograph that it might seem that I am underrating its very real merits.

Mr. Parris is obviously himself an expert in the handling of the string galvanometer if he has had no broken string in four working years. But that does not prove that the string galvanometer is not a delicate instrument—certainly in comparison with the cathode ray oscillograph. Most cardiologists wish to work their own electrocardiographs, and it is surely a big advantage for them to have an instrument which *cannot* be damaged by an overload voltage. For the same reason it is obviously a considerable advance to have an immediate visible record of the electrocardiogram by the patient's bedside, for the doctor will obviously take his records away for development if there is no dark-room immediately available; so that his inspection of the curve must necessarily wait till then, in the case of string galvanometer records.

There is, however, some justice in your correspondent's statement that "there seems little point in using this (the cathode ray oscillograph) with an amplifier having a 'high note' cut-off of 30 cycles per sec." But I would respectfully submit that the statement as it stands is misleading, and needs amplification and explanation. The real question is: How does the cathode ray oscillograph, in conjunction with a suitably designed amplifier, compare with the string galvanometer in the correct delineation of the more rapid components of the electrocardiogram?

Sir Thomas Lewis, whose work, "The Mechanism and Graphic Registration of the Heart Beat," is a magnificent and model contribution to the study of electrocardiography, states (*idem*, 3rd edition, p. 34): "For clinical purposes the (string) deflection time should be at least as low as 0.02 of a second." The statement that the "high note" cut-off of the amplifier is 30 cycles per second is, baldly so stated, misleading, and for two reasons. It will be realised that the equivalent in "cycles per second" of "string deflection time" is a quarter of a cycle (a cycle between 0 and $\frac{\pi}{2}$ radians), so that 30 cycles per second is equivalent to a string deflection time of 1/120th of a second (0.0083 sec.), which is less than half Lewis's maximum. Further, the high note cut-off is not, of course, abrupt at this value. Amplification is still 100 per cent. at this frequency, and the frequency up to which it remains 100 per cent. can be made whatever appears desirable, by alteration (within limits determined in practice by the stability of the amplifier) of the time constants of the resistance-condenser

180-LINE IMAGE. An untouched picture of the lady announcer at Berlin "Post Office" station shown on the screen of an experimental equipment of Manfred von Ardenne, who is working in conjunction with the firm of C. Lorenz.

filter units. Moreover, according to variations of each individual string, the frequency characteristic of the string galvanometer must vary from instrument to instrument, whereas that of the correctly designed amplifier is uniform, exact, and predeterminable.

His penultimate paragraph raises two points which have been carefully considered by the designers of the Cossor-Robertson Cardiograph. With one of these I am in entire agreement; an electrocardiogram seen as a black line on a white ground is a deal more pleasing to look at than the reverse. Although the earliest models of the Cardiograph used Leica film (which, incidentally, was intended to be looked at directly, by transmitted light), for the past year the camera has been adapted for the use of 35 mm. ciné-bromide paper, specially made for the purpose by Messrs. Ilford. This, in contradistinction to the shadow-recorded negatives of the string galvanometer, needs no further printing to give the desired black on white effect. The requisite amount of record is obtained by exposing a suitable length of paper; and there is the additional advantage that the recording of such a cardiac event as might happen at infrequent irregular intervals is made far more certain than is the case with the usual length of string galvanometer record (representing only three to five seconds). Paper equivalent to two minutes (at 2 cms. per second) continuous record can be exposed in the present Cardiograph camera.

The other point concerns time and voltage markings on the record. I, personally, so much agree that a clean black on white record is desirable that I prefer not to have the electrocardiogram confused by a criss-cross ruling. I fail to see the advantage of having time markings actually across the record, or even in having a simultaneous time marking at all, allowing that a time indication is provided, that one is certain that the speed of the paper conforms to a given time scale, and that this speed is uniform; because, in assessing an electrocardiographic record, measurement by dividers from point to point (e.g., P wave to P wave) is at least as important as the actual time taken by any particular cardiac event (e.g., a P-R interval). With the earlier models of camera used for electrocardiography it was necessary to have the time marking actually on the record, since dependence on a uniform rate of fall of the photographic plate could not be guaranteed; but nowadays, with improved camera mechanisms, it is an easy matter to ensure that the rate of movement is uniform. Nevertheless, the designers of the Cossor-Robertson Cardiograph have found that there are many cardiologists who prefer a time marking of the traditional type, and accordingly the latest model of the Cardiograph is fitted with a time marker, which, however, can be switched off at will. Its camera motor is also provided with two speeds, so that the paper can be moved at either two or four centimetres per second, as desired.

I cannot really believe that Mr. Parris is serious when he states that "a valve amplifier in a commercial wireless set is lucky if it does not go back to the works after three months." The cathode ray electrocardiograph, if correctly designed and properly constructed, has not only numerous advantages, both scientific and practical, over the string galvanometer, but has the great economic advantage that it can be produced as a workmanlike reliable instrument at a great deal lower price.

ONE OF THE DESIGNERS
of the Cossor-Robertson Cardiograph.

Ferranti's New Radio Works

Production of Complete Sets, Including Valves Under One Roof

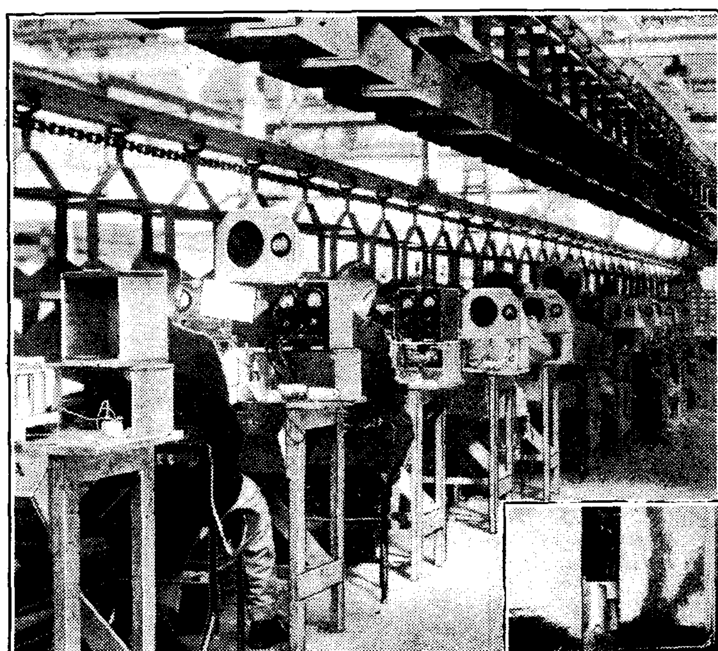
THE transfer of the radio section of Ferranti, Ltd., from the main Hollinwood works to the new factory at Moston is now complete. The removal of each department, a section at a time, without interrupting supplies, has been a triumph of organising ability, of which there is still further evidence in the layout and smooth working of the new factory now that it has settled down to production.

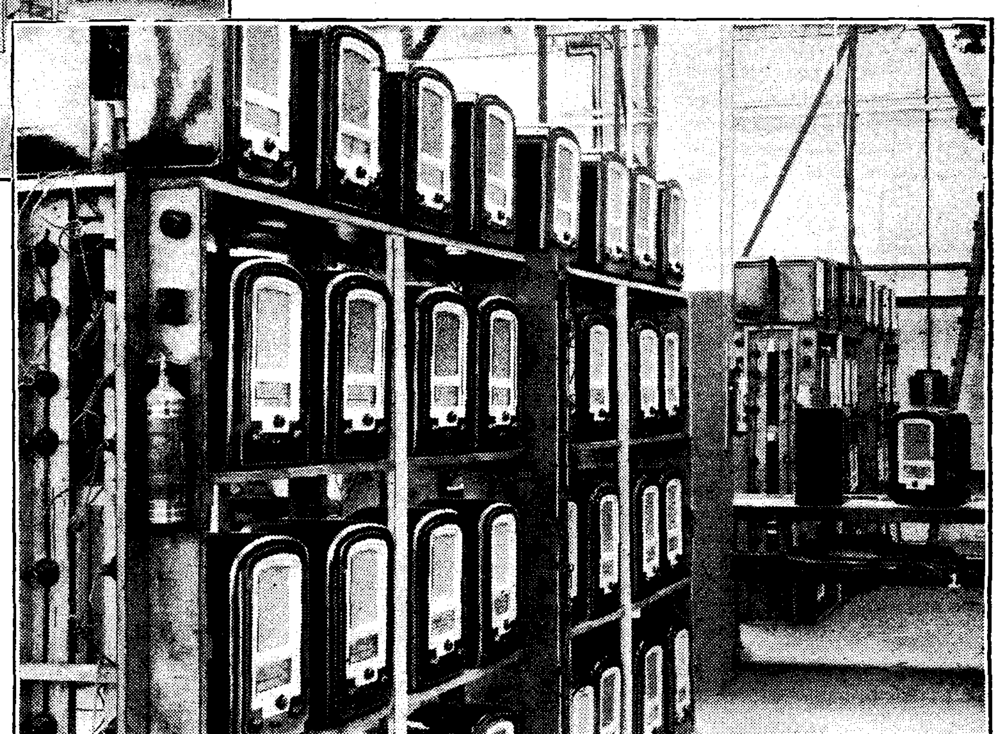
The parallel component benches feeding parts to the main assembly line just at the point where they are required is no doubt a familiar feature of wireless receiver production, but there are few manufacturers who can claim to have under unified control in the same building the supply not only of wood and moulded cabinets, but also loud speakers, condensers, and even valves of their own design and manufacture.

The whole factory of 270,000 sq. ft. is on one floor only. It is exceptionally well lighted and there is no overhead shafting, every machine being independently electrically driven.

On the occasion of a recent visit we were duly impressed by the 750-ton press for turning out the new dual colour cabinets and other spectacular processes, but more so by the unobtrusive efficiency of the organisation. Another point which seemed worthy of note was that research and development departments were distributed throughout the works in close proximity to the actual work of production with which they were concerned. There was also a school through which all new recruits to the factory have to pass before being allowed to take up their responsibilities in the works.

There can be little doubt that the new season's Ferranti sets will be well and truly made.





Testing bays alongside the main assembly line, and (right) a batch of the new season's sets undergoing a final test in Ferranti's new factory at Moston, Lancs.

PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength

(This list is included in the first issue of each month. Stations with an aerial power of 50 kW. and above in heavy type)

Station.	kc/s.	Tuning Positions.	Metres.	kW.
Kaunas (Lithuania)	155		1935	7
Brazov (Romania)	160		1875	20
Huizen (Holland). (*Until 3.40 p.m.*)	160		1875	7
Kootwijk (Holland) (*Transmits Hilversum programme after 3.40 p.m.*)	160		1875	50
Lahti (Finland)	166		1807	40
Moscow, No. 1, RW1 (Komintern) (U.S.S.R.)	174		1724	500
Paris (Radio Paris) (France)	182		1648	80
Istanbul (Turkey)	187.5		1600	5
Berlin (Deutschlandsender Zeesen) (Germany)	191		1571	60
Droitwich	200		1500	150
Minsk, RW10 (U.S.S.R.)	208		1442	35
Reykjavik (Iceland)	208		1442	16
Motala (Sweden). (*Relays Stockholm*)	216		1389	30
Novosibirsk, RW76 (U.S.S.R.)	217·5		1379	100
Warsaw, No. 1 (Raszyn) (Poland)	224		1339	120
Ankara (Turkey)	230		1304	7
Luxembourg	230		1304	150
Kharkov, RW20 (U.S.S.R.)	232		1293	20
Kalundborg (Denmark)	238		1261	60
Leningrad, RW53 (Kolpino) (U.S.S.R.)	245		1224	100
Tashkent, RW11 (U.S.S.R.)	256.4		1170	25
Oslo (Norway)	260		1154	60
Moscow, No. 2, RW49 (Stchelkovo) (U.S.S.R.)	271		1107	100
Tiflis, RW7 (U.S.S.R.)	280		1071.4	35
Rostov-on-Don, RW12 (U.S.S.R.)	355		845	20
Budapest, No. 2 (Hungary)	359.5		834.5	70
Sverdlovsk, RW5 (U.S.S.R.)	375		800	50
Geneva (Switzerland). (*Relays Sottens*)	401		748	1.3
Moscow, No. 3 (RCZ) (U.S.S.R.)	401		748	100
Voroneje, RW25 (U.S.S.R.)	413.5		726	10
Oulu (Finland)	431		696	1.2
Ufa, RW22 (U.S.S.R.)	436		688	10
Hamar (Norway) (*Relays Oslo*)	519		578	0.7
Innsbruck (Austria). (*Relays Vienna*)	519		578	1
Ljubljana (Yugoslavia)	527		569.3	5
Viipuri (Finland)	527		569.3	10
Bolzano (Italy)	536		559.7	1
Wilno (Poland)	536		559.7	16
Budapest, No. 1 (Hungary)	546		549.5	120
Beromünster (Switzerland)	556		539.6	100
Athlone (Irish Free State)	565		531	60
Palermo (Italy)	565		531	4
Stuttgart (Mühlacker) (Germany)	574		522.6	100
Grenoble, P.T.T. (France)	583		514.6	15
Riga (Latvia)	583		514.6	15
Vienna (Bisamberg) (Austria)	592		506.8	100
Rabat (Radio Maroc) (Morocco)	601		499.2	25
Sundsvall (Sweden). (*Relays Stockholm*)	601		499.2	10
Florence (Italy). (*Relays Milan*)	610		491.8	20
Cairo (Abu Zabal) (Egypt)	620		483.9	20
Brussels, No. 1 (Belgium). (*French Programme*)	620		483.9	15
Lisbon (Bacarena) (Portugal)	629		476.9	20
Tröndelag (Norway)	629		476.9	20
Prague, No. 1 (Czechoslovakia)	638		470.2	120
Lyons, P.T.T. (La Doua) (France)	648		463	15
Cologne (Langenberg) (Germany)	658		455.9	100
North Regional (Slaithwaite)	668		449.1	50
Sottens (Radio Suisse Romande) (Switzerland)	677		443.1	25
Belgrade (Yugoslavia)	686		437.3	2.5
Paris, P.T.T. (Ecole Supérieure) (France)	695		431.7	7
Stockholm (Sweden)	704		426.1	55
Rome, No. 1 (Italy)	713		420.8	50
Kiev, RW9 (U.S.S.R.)	722		415.5	36
Tallinn (Esthonia)	731		410.4	20
Madrid, EAJ2 (Radio España) (Spain)	731		410.4	3
Munich (Germany)	740		405.4	100
Marseilles, P.T.T. (France)	749		400.5	5
Katowice (Poland)	758		395.8	12
Scottish Regional (Falkirk)	767		391.1	50
Toulouse, P.T.T. (France)	776		386.6	2
Leipzig (Germany)	785		382.2	120
Barcelona, EAJ1 (Spain)	795		377.4	5
Lwow (Poland)	795		377.4	16
West Regional (Washford Cross)	804		373.1	50
Milan (Italy)	814		368.6	50
Bucharest (Romania)	823		364.5	12
Moscow, No. 4, RW39 (Stalina) (U.S.S.R.)	832		360.6	100
Berlin (Funkstunde Tegel) (Germany)	841		356.7	100
Bergen (Norway)	850		352.9	1
Sofia (Bulgaria)	850		352.9	1
Valencia (Spain)	850		352.9	1.5
Simferopol, RW52 (U.S.S.R.)	859		349.2	10
Strasbourg, P.T.T. (France)	859		349.2	35
Poznan (Poland)	868		345.6	16
London Regional (Brookmans Park)	877		342.1	50
Graz (Austria). (*Relays Vienna*)	886		338.6	7
Helsinki (Finland)	895		335.2	10
Hamburg (Germany)	904		331.9	100
Toulouse (Radio Toulouse) (France)	913		328.6	60
Limoges, P.T.T. (France)	913		328.6	0.5
Brno (Czechoslovakia)	922		325.4	32
Brussels, No. 2 (Belgium). (*Flemish Prog'mme*)	932		321.9	15
Algiers, P.T.T. (Radio Alger) (Algeria)	941		318.8	12
Göteborg (Sweden). (*Relays Stockholm*)	941		318.8	10
Breslau (Germany)	950		315.8	100
Paris (Poste Parisien) (France)	959		312.8	60
Belfast	977		307.1	1
Genoa (Italy). (*Relays Milan*)	986		304.3	10
Hilversum (Holland). (7 *kW.* till 6.40 p.m.)	995		301.5	20
Bratislava (Czechoslovakia)	1004		298.8	13.5
Midland Regional (Droitwich)	1013		296.2	50
Barcelona, EAJ15 (Radio Asociación) (Spain)	1022		293.5	3
Cracow (Poland)	1022		293.5	2
Königsberg (Heilsberg Ermland) (Germany)	1031		291	17
Parede (Radio Club Português) (Portugal)	1031		291	5
Leningrad, No. 2, RW70 (U.S.S.R.)	1040		288.5	10
Rennes, P.T.T. (France)	1040		288.5	40
Scottish National (Falkirk)	1050		285.7	50
Bari (Italy)	1059		283.3	20
Tiraspol, RW57 (U.S.S.R.)	1068		280.9	4
Bordeaux, P.T.T. (Lafayette) (France)	1077		278.6	30
Zagreb (Yugoslavia)	1086		276.2	0.7
Falun (Sweden)	1086		276.2	2
Madrid, EAJ7 (Union Radio) (Spain)	1095		274	7
Madona (Latvia)	1104		271.7	50
Naples (Italy). (*Relays Rome*)	1104		271.7	1.5
Moravska-Ostrava (Czechoslovakia)	1113		269.5	11.2
Fécamp (Radio Normandie) (France)	1113		269.5	10
Alexandria (Egypt)	1122		267.4	0.25
Newcastle	1122		267.4	1
Nyiregyhaza (Hungary)	1122		267.4	6.2
Hörby (Sweden). (*Relays Stockholm*)	1131		265.3	10
Turin, No. 1 (Italy). (*Relays Milan*)	1140		263.2	7
London National (Brookmans Park)	1149		261.1	20
North National (Slaithwaite)	1149		261.1	20
West National (Washford Cross)	1149		261.1	20
Kosice (Czechoslovakia). (*Relays Prague*)	1158		259.1	2.6
Monte Ceneri (Switzerland)	1167		257.1	15
Copenhagen (Denmark). (*Relays Kalundborg*)	1176		255.1	10
Kharkov, No. 2, RW4 (U.S.S.R.)	1185		253.2	10
Frankfurt (Germany)	1195		251	17
Prague, No. 2 (Czechoslovakia)	1204		249.2	5
Lille, P.T.T. (France)	1213		247.3	5
Trieste (Italy)	1222		245.5	10
Gleiwitz (Germany). (*Relays Breslau*)	1231		243.7	5
Cork (Irish Free State) (*Relays Athlone*)	1240		241.9	1
Juan-les-Pins (Radio Côte d'Azur) (France)	1249		240.2	2
Kuldiga (Latvia)	1258		238.5	10
Rome, No. 3 (Italy)	1258		238.5	1
San Sebastian (Spain)	1258		238.5	3
Nürnberg and Augsburg (Germany) (*Relay Munich*)	1267		236.8	2
Christiansand and Stavanger (Norway)	1276		235.1	0.5
Dresden (Germany) (*Relays Leipzig*)	1285		233.5	1.5
Aberdeen	1285		233.5	1
Austrian Relay Stations	1294		231.8	0.5
Danzig. (*Relays Königsberg*)	1303		230.2	0.5
Swedish Relay Stations	1312		228.7	1.25
Magyarovar (Hungary)	1321		227.1	1.25
German Relay Stations	1330		225.6	1.5
Montpellier, P.T.T. (France)	1339		224	5
Lodz (Poland)	1339		224	1.7
Dublin (Irish Free State) (*Relays Athlone*)	1348		222.6	0.5
Milan, No. 2 (Italy) (*Relays Rome*)	1348		222.6	4
Turin, No. 2 (Italy). (*Relays Rome*)	1357		221.1	0.2
Basle and Berne (Switzerland)	1375		218.2	0.5
Warsaw, No. 2 (Poland)	1384		216.8	2
Lyons (Radio Lyons) (France)	1393		215.4	5
Tampere (Finland)	1420		211.3	0.7
Paris, (Radio LL) (France)	1424		210.7	0.8
Béziers (France)	1429		209.9	1.5
Miskolc (Hungary)	1438		208.6	1.25
Paris (Eiffel Tower) (France)	1456		206	5
Pecs (Hungary)	1465		204.8	1.25
Bournemouth	1474		203.5	1
Plymouth	1474		203.5	0.3
International Common Wave	1492		201.1	0.2
International Common Wave	1500		200	0.25
Liepàja (Latvia)	1737		173	0.1

SHORT-WAVE STATIONS OF THE WORLD

(N.B.—Times of Transmission given in parentheses are approximate only and represent G.M.T.)

Metres.	kc/s.	Call Sign.	Station.	Tuning Positions.
70.2	4,273	RV15	Kharbarovsk (U.S.S.R.). (Daily 06.00 to 14.00.)	
58.31	5,145	OK1MPT	Prague (Czechoslovakia). (Experimental)	
55.56	5,400	HAT	Budapest (Hungary). (Mon. 01.00 to 02.00.)	
52.7	5,692	FIQA	Antananarivo (Madagascar). (Daily ex. Sun. 08.00 to 08.45, 15.00 to 16.00, Sat. 17.30 to 19.00, Sun. 07.30 to 08.00.)	
50.26	5,969	HVJ	Vatican City. (Daily 19.00 to 19.15, Sun. 10.00 also.)	
50.0	6,000	—	Bucharest (Romania)	
50.0	6,000	RW59	Moscow (U.S.S.R.). (Relays No. 1 Stn.) (Daily 20.00 to 23.00.)	
49.96	6,005	VE9DN	Montreal (Canada). (Daily 04.30 to 05.00)	
49.96	6,005	HJ3ABH	Bogotá (Colombia)	
49.85	6,018	ZH1	Singapore (Malaya). (Mon., Wed., Thurs 23.00 to 01.30, Sun. 03.40 to 05.10.)	
49.83	6,020	DJC	Zeesen (Germany). (Daily 22.30 to 03.30, 17.00 to 21.30.)	
49.67	6,040	W1XAL	Boston, Mass. (U.S.A.). (Sun. 22.00 to 24.00, Wed., Fri. 00.30 to 01.45.)	
49.67	6,040	YDB	Sourabaya (Java). (Daily 03.30 to 06.30)	
49.59	6,050	GSA	Empire Broadcasting	
49.5	6,060	W8XAL	Cincinnati, Ohio (U.S.A.). (Daily 12.00 to 01.00, 04.00 to 06.00.)	
49.5	6,060	W3XAU	Philadelphia, Pa. (U.S.A.) (Relays WCAU.) (Daily 01.00 to 04.00.)	
49.5	6,060	VQ7LO	Nairobi (Kenya Colony). (Daily 16.00 to 19.00, Sat. to 20.00, Mon., Wed., Fri. 10.45 to 11.15 also, Tues. 08.00 to 09.00 also, Thurs. 13.00 to 14.00 also, Sun. 17.45 to 19.00 also.)	
49.5	6.060	OXY	Skamlebaek (Denmark). (Relays Kalundborg.) (Daily 18.00 to 21.00, Sun. 16.00 also.)	
49.43	6,069	VE9CS	Vancouver, B.C. (Canada). (Sat. 04.30 to 05.45, Sun. 16.00 to 04.00.)	
49.42	6,072	ZHJ	Penang (Malaya). (Relays Empire Broadcasting.)	
49.42	6,072	OER2	Vienna Experimental. (Daily 14.00 to 22.00.)	
49.33	6,080	W9XAA	Chicago, Ill. (U.S.A.). (Relays WCLF.) (Sun. 19.00 to 20.30.)	
49.3	6,085	2RO	Rome (Italy). (Mon., Wed., Fri. 23.00 to 00.30.)	
49.26	6,090	VE9BJ	St. John (N.B.). (Daily 00.00 to 01.30)...	
49.26	6,090	VE9GW	Bowmanville, Ont. (Canada). (Mon., Tues., Wed. 20.00 to 05.00, Thurs., Fri., Sat. 12.00 to 05.00, Sun. 18.00 to 02.00.)	
49.2	6,097	ZTJ	Johannesburg (S. Africa). (Daily ex. Sun 04.30 to 05.30, 08.30 to 12.00, 14.00 to 20.00 (Sat. to 21.45), Sun. 13.00 to 15.15, 17.30 to 20.00.)	
49.18	6,100	W3XAL	Bound Brook, N.Y. (U.S.A.). (Relays WJZ.) (Mon., Wed., Sat. 22.00 to 23.00, Sat. 05.00 to 06.00 also.)	
49.18	6,100	W9XF	Chicago, Ill. (U.S.A.). (Daily ex. Mon., Wed., Sun. 21.00 to 07.00.)	
49.1	6,110	VUC	Calcutta (India). (Daily 07.06 to 08.06 irregular 13.06 to 16.36, Sat. from 12.36, Sun. 04.36 to 07.36, irregular 12.36 to 03.36.	
49.1	6,110	VE9HX	Halifax N.S. (Daily 14.00 to 16.30, 21.00 to 04.00.)	
49.1	6,110	GSL	Empire Broadcasting	
49.02	6,120	YDA	Bandoeng (Java). (Daily 10.30 to 15.00)	
49.02	6,120	W2XE	Wayne, N.J. (U.S.A.). (Relays WABC.) (Daily 23.00 to 04.00.)	
48.92	6,132	ZGE	Kuala Lumpur (Malaya). (Sun., Tues. Fri., 11.40 to 13.40.)	
48.86	6,140	W8XK	Pittsburg, Pa. (U.S.A.). (Relays KDKA.) (Daily 21.30 to 06.00.)	
48.78	6,150	CJRO	Winnipeg (Canada). (Daily 00.00 to 05.00, Sat. 21.00 to 06.00 also, Sun. 22.00 to 03.30.)	
48.4	6,198	CT1GO	Parede (Portugal). (Daily ex. Tues. 00.20 to 01.30, Sun. 16.30 to 18.00 also.)	
46.69	6,425	W3XL	Bound Brook, N.J. (U.S.A.). (Experimental)	
45.38	6,610	RW72	Moscow (U.S.S.R.). (Relays Stalin Stn.)...	
38.48	7,797	HBP	Radio Nations, Prangins (Switzerland). (Sat. 22.30 to 23.15.)	
37.33	8,035	CNR	Rabat (Morocco). (Sun. 20.00 to 22.30)...	
31.58	9,500	PRF5	Rio de Janeiro (Brazil). (Daily 22.30 to 23.15.)	
31.55	9,510	GSB	Empire Broadcasting	
31.54	9,518	VK3ME	Melbourne (Australia). (Wed. 10.00 to 11.30, Sat. 10.00 to 12.00.)	
31.48	9,530	W2XAF	Schenectady, N.Y. (U.S.A.). (Relays WGY.) (Daily 23.30 to 04.00, Sat. 19.00 to 22.00 also.)	

Metres.	kc/s.	Call Sign.	Station.	Tuning Positions.
31.33	9,572	LKJ1	Jelöy (Norway). (Relays Oslo.) (Daily 10.00 to 13.00.)	
31.45	9,540	DJN	Zeesen (Germany). (Daily 08.45 to 12.15, 13.00 to 16.30, 22.15 to 03.30.)	
31.38	9,560	DJA	Zeesen (Germany). (Daily 13.00 to 16.30, 22.15 to 02.00.)	
31.36	9,565	VUB	Bombay (India). (Sun. 13.30 to 15.30, Wed., Thurs. Sat. 16.30 to 17.30, irregular Mon.).	
31.35	9,570	W1XK	Springfield, Mass. (U.S.A.). (Relays WBZ.) (Daily 12.00 to 06.00.)	
31.32	9,580	GSC	Empire Broadcasting	
31.32	9,580	VK3LR	Lindhurst (Australia). (Daily ex. Sun. 08.15 to 12.30.)	
31.28	9,590	W3XAU	Philadelphia, Pa. (U.S.A.). (Relays WCAU.) (Daily 17.00 to 24.00.)	
31.28	9,590	VK2ME	Sydney (Australia). (Sun. 06.00 to 08.00, 10.00 to 14.00, 14.30 to 16.30.)	
31.27	9,595	HBL	Radio Nations, Prangins (Switzerland). (Sat. 22.30 to 23.15.)	
31.25	9,600	CT1AA	Lisbon (Portugal). (Tues., Thurs. Sat. 21.30 to 24.00.)	
31.13	9,637	2RO	Rome (Italy). (Tues., Thurs., Sat. 00.45 to 02.15).	
31.0	9,677	CT1CT	Lisbon (Portugal). (Thurs. 21.00 to 23.00, Sun. 12.00 to 14.00.)	
30.43	9,860	EAQ	Madrid (Spain). (Daily 22.15 to 00.30, Sat. 18.00 to 20.00 also.)	
29.04	10,330	ORK	Ruysselede (Belgium). (Daily 18.30 to 20.30.)	
28.98	10,350	LSX	Buenos Aires (Argentina). (Daily 20.00 to 21.00.)	
25.6	11,720	FYA	Paris, Radio Coloniale (France). (Colonial Stn. E-W.) Daily 00.00 to 03.00, 04.00 to 06.00.)	
25.6	11,720	CJRX	Winnipeg (Canada). (Daily 00.00 to 05.00, Sat. 21.00 to 06.00 also, Sun. 22.00 to 03.30 also.)	
25.57	11,730	PHI	Eindhoven (Holland). (Daily ex. Tues., Wed. 13.00 to 15.30 (Sun. Sat. to 16.30.)	
25.53	11,750	GSD	Empire Broadcasting	
25.49	11,770	DJD	Zeesen (Germany). (Daily 17.00 to 21.30)	
25.45	11,790	W1XAL	Boston, Mass. (U.S.A.). (Daily 23.00 to 00.30.)	
25.4	11,810	2RO	Rome (Italy). (Mon., Wed., Fri., 23.00) ...	
25.36	11,830	W2XE	Wayne, N.J. (U.S.A.). (Relays WABC.) (Daily 20.00 to 22.00.)	
25.29	11,860	GSE	Empire Broadcasting	
25.27	11,870	W8XK	Pittsburg, Pa. (U.S.A.). (Relays KDKA.) (Daily 21.30 to 03.00.)	
25.23	11,880	FYA	Paris, Radio Coloniale (France). (Colonial Stn. N-S.) (Daily 16.15 to 19.15, 20.00 to 23.00.)	
25.0	12,000	RW59	Moscow (U.S.S.R.). (Relays No. 2 Stn.) (Sun. 03.00 to 04.00, 11.00 to 12.00, 15.00 to 16.00.)	
24.83	12,082	CT1CT	Lisbon (Portugal). (Sun. 14.00 to 16.00, Thurs. 20.00 to 21.00.)	
24.2	12,396	CT1GO	Parede (Portugal). (Sun. 15.00 to 16.30, Tues., Thurs., Fri. 18.00 to 19.15.)	
23.39	12,830	CNR	Rabat (Morocco). (Sun. 12.30 to 14.00)...	
19.84	15,123	HVJ	Vatican City. (Daily 10.00, 15.30 to 15.45)	
19.82	15,140	GSF	Empire Broadcasting	
19.74	15,200	DJB	Zeesen (Germany). (Daily 08.45 to 12.15)	
19.72	15,210	W8XK	Pittsburg, Pa. (U.S.A.). (Relays KDKA.) (Daily 13.00 to 21.15.)	
19.71	15,220	PCJ	Eindhoven (Holland). (Experimental) ...	
19.68	15,243	FYA	Paris, Radio Coloniale (France). (Colonial Stn. E.W.) (Daily 12.00 to 16.00.)	
19.67	15,250	W1XAL	Boston, Mass. (U.S.A.). (Daily 15.50 to 18.30.)	
19.66	15,260	GSI	Empire Broadcasting	
19.64	15,270	W2XE	Wayne, N.J. (U.S.A.). (Relays WABC.) (Daily 16.00 to 18.00.)	
19.56	15,330	W2XAD	Schenectady, N.Y. (U.S.A.). (Daily 19.30 to 20.30.)	
19.52	15,370	HAS3	Budapest (Hungary). Sun. 13.00 to 14.00.)	
17.33	17,310	W3XL	Bound Brook, N.J. (U.S.A.). (Daily 16.00 to 22.00.)	
16.89	17,760	DJE	Zeesen (Germany) (Daily 13.00 to 16.30.)	
16.87	17,780	W3XAL	Bound Brook, N.J. (U.S.A.). (Relays WJZ.) (Daily except Sun. 14.00 to 15.00, Tues., Thurs., Fri. 20.00 to 21.00 also.)	
16.86	17,790	GSG	Empire Broadcasting	
13.97	21,470	GSH	Empire Broadcasting	
13.93	21,530	GSJ	Empire Broadcasting	
13.92	21,540	W8XK	Pittsburg, Pa. (U.S.A.). (Daily 12.00 to 14.00.)	

National Radio Research: The N.P.L. Report

THE report of the National Physical Laboratory for 1934 [1] deals at length with the varied scientific activities of our national research institution and, as is natural, a considerable amount of space has been allotted to the Radio Department for putting on record the results of its labours.

During the past year much data has been accumulated on the behaviour of short-wave signals emanating from the other side of the Atlantic, and notable contributions to our knowledge on the effects of the eleven-year cycle of solar activity on radio communication have been made. Vagaries of waves returned to earth from the ionosphere are shown to be closely connected with practical difficulties of direction finding.

Effects of temperature changes on the inductance value of coils will naturally have a bearing on the performance of ganged receivers; these problems have been investigated, and for laboratory use a coil has been constructed which is completely immune from inductance variations through changing temperature.

[1] Published by H.M. Stationery Office; 260 pp. quarto, 59 illustrations, price 13/- net.

The Wireless World

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

EDITORIAL COMMENT

Empire Wireless

British Programmes on Foreign Sets

THE radio manufacturer in this country, with certain rare exceptions, is so engrossed in the problems of supplying the home market that he neglects, and in most cases totally ignores, the overseas and Empire requirements. Although these markets are still open to him, with the present rate of foreign competition and absence of British enterprise they may not long remain so.

From information which has come to us from different parts of the Empire there is evidence that, whereas a year or two ago sets of British manufacture would have been welcome and bought in preference to all other makes, that attitude scarcely holds to-day because American and other suppliers have been so enterprising that the suitability of their products, added to the service which goes with them, loads the scales far too heavily, even when a large amount of pro-British inclination is added in favour of the British set.

All-wave Sets

For more than a year the sets exported from Germany, United States, and some other countries have been almost exclusively all-wave receivers which include the short-wave bands. Here such sets have only recently made their appearance, and even now comparatively few manufacturers have produced them. Coupled with this must be added evidence that service depots, where real service can be given and spare parts kept in stock, must be established locally at the time exporting is begun, so that customers have some assurance that their receivers can be cared for after purchase. But the British exporter is either indifferent to any service troubles which may arise after purchase or assumes that there will be none. Our correspondence indicates it is for this reason that in far too many localities overseas the popularity of British sets is not being maintained where foreign competition has stepped in.

Customers are Waiting to Know

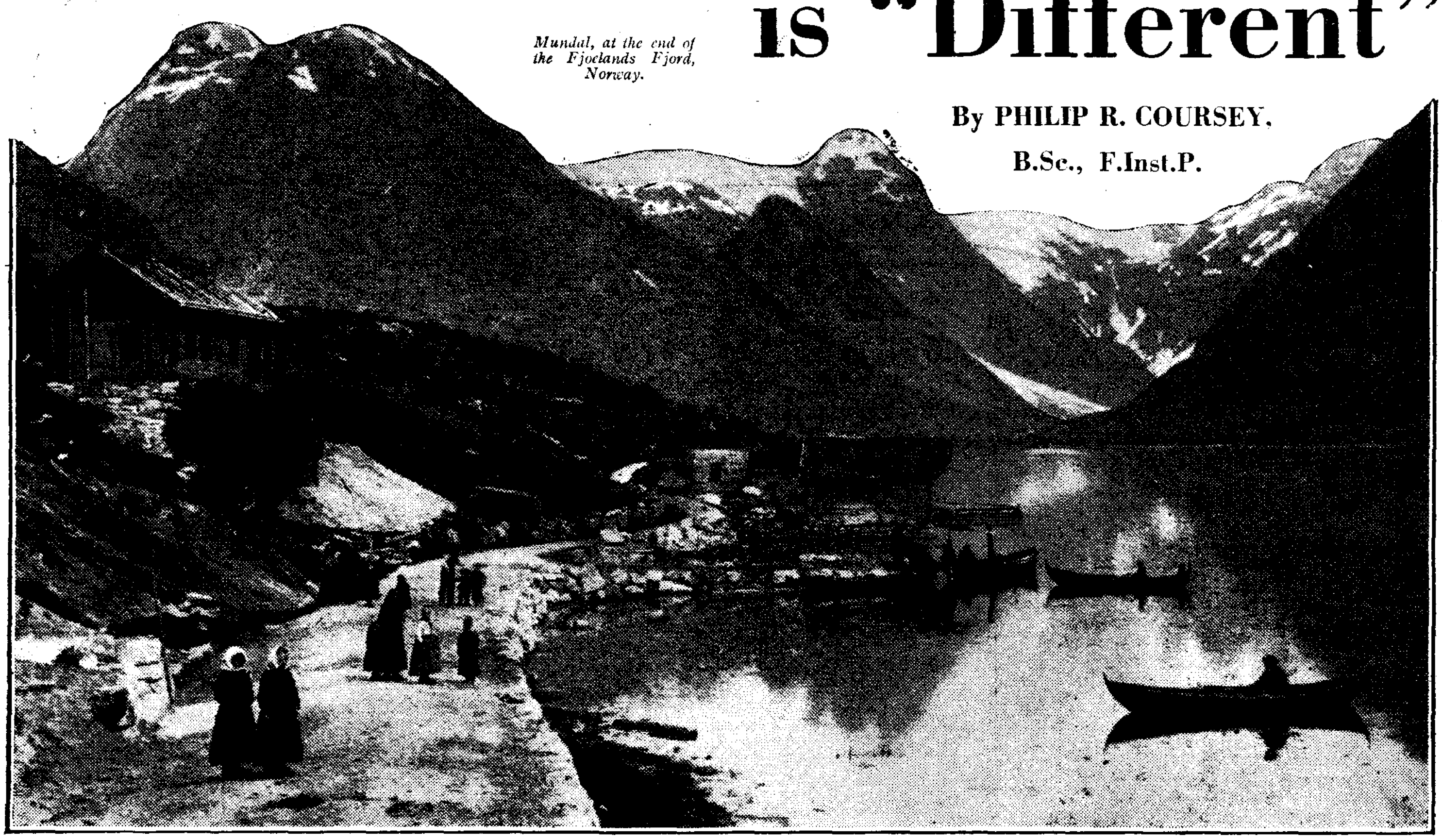
There are hundreds of thousands of prospective purchasers of British receivers overseas who are anxious to know what is the attitude of manufacturers at home. Are they prepared to supply all-wave receivers which will compete in performance with the products of foreign rivals and to organise adequate service arrangements?

To export half-heartedly apparatus which is not competitive in performance and without proper service arrangements is not only dangerous to our trade prestige as a whole but is the surest way of giving competitors further advantages.

Our manufacturers are capable of supplying what is needed, and if once they show themselves willing and determined to meet the demand they will find ready co-operation in every part of the Empire, since a preference for our manufactures still remains strong, and natural ties give the home manufacturer an asset which his foreign rivals cannot compete against.

But the whole matter is urgent, because delay is only making the task of competing harder. It is a case, too, for co-operation between British manufacturers to eliminate competition between themselves in any area. Agreement on these lines would not only assist the manufacturer to meet foreign competition more firmly, but would have the additional advantage of simplifying service and the supply of valves and spares for one type of receiver instead of a variety of types.

Scandinavian Radio is "Different"



Mundal, at the end of the Fjoelands Fjord, Norway.

By PHILIP R. COURSEY, B.Sc., F.Inst.P.

"Readable" Scales : A Strange Museum : Chasing Thunderstorms

VALUABLE lessons for British radio professionals and amateurs can be had from a trip through Norway, Sweden and Denmark, as this article reveals. Norway, determined to profit by her mistakes, has opened a museum of faulty components in the set-testing laboratory. Interference phenomena are studied by original methods by the Swedish Government at Uppsala, and the campaign against atmospherics includes the pursuit and "recording" of thunderstorms.

COMPARING radio receivers as they are used in two of the Scandinavian countries—Norway and Sweden—one is struck at once by a pronounced difference in the proportions of imported and locally manufactured sets. While there are radio set manufacturers in both countries it is noteworthy that in Norway a much larger proportion of the receivers are imported. This applies chiefly to the larger and more powerful apparatus, the smaller two- and three-valve sets being almost entirely of local manufacture.

The sets themselves show a wide range of physical forms, not dissimilar in many respects to those on the British market. Some of them have recently passed through the phases that have been marked here during the last few years. Such as almost concealed tuning scales, which, while they may, in the opinion of some critics, prevent the marring of the design as "a piece of furniture," do not make for ease of operation or increased utility. Furniture should be bought as such, not as a means of entertainment.

Some of the newer designs of receivers in both the above mentioned countries, however, reveal praiseworthy attempts to introduce really useful and clear scales or indicators, readily visible without marring the general appearance of the apparatus, while at the same time free from confusion in reading them, e.g., as to wavelength range, and consequent station to which the receiver is tuned. Not all British sets are entirely free from criticism in this respect, although the general trend is improving.

Ingenious Tuning Scales

From this viewpoint, one of the best designs was noticed in Stockholm with a tuning scale disposed round the surface of a drum some three inches in diameter, occupying nearly one-third of the face width of the receiver, and exposing a sector of its surface through an ample window. Altering the waverange of the receiver rotates the drum so as to expose another sector with its appropriate wavelength scale and station name indicator. The whole of each waverange is thus visible at any one time, so that the tuning position is readily ascertained without the necessity for peering through a small window to read some tiny, and to many, meaningless numbers. The range switching mechanism is housed in the interior of the drum and operated thereby.

A somewhat similar feature, but with the indicator drum forming a central curved and recessed part in the front top edge of the receiver cabinet, was noted also in some German sets in Berlin. In both cases the appearance of the receiver is good, making a distinctive, well-balanced, good-looking design that makes no pretence to be something that it is not.

Regulations drawn up to ensure a certain standard of quality of the components used in the sets exist in most countries to a greater or less extent. In the Scandinavian countries they are enforced by compulsory "type-testing" of both sets and parts, and the regulations there cover a wide range, with several fairly stringent details. It is rather humiliating to find that much British radio apparatus and many components will not pass these tests;

Scandinavian Radio is "Different"—

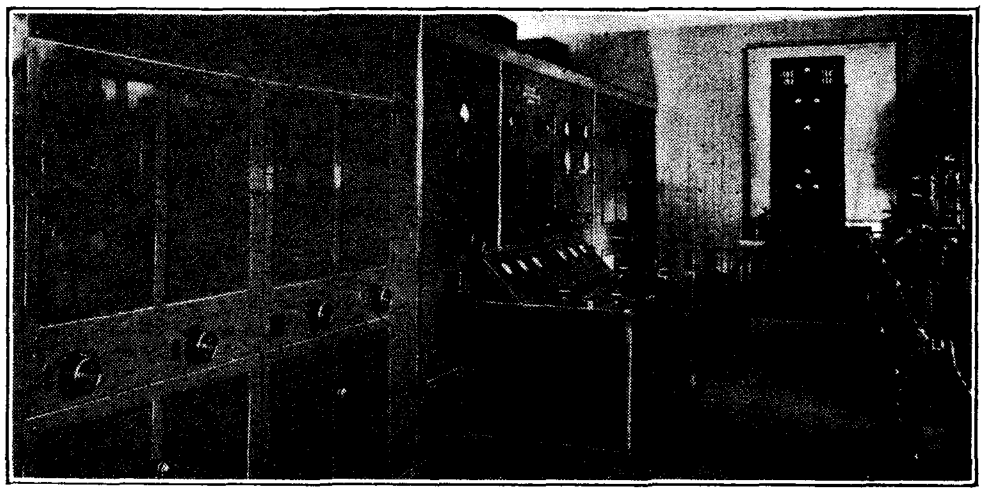
and that imported British sets need to be modified in certain details before they are considered safe enough to be allowed to be sold and used there. While we have regulations and specifications here covering many similar features, there is no compulsion to ensure their adoption and regular use by manufacturers. While in general I am personally much against too many laws and rules, there is quite a great deal to be said for the methods there adopted. They do ensure a reasonable standard of quality and reliability, and tend to eliminate cut-price or shoddy construction. They provide the "hall-mark" or "sign of straightforward shopkeeping" to the uninitiated in radio matters.

In Oslo I had an opportunity of being shown over the electrical testing or proving station where radio sets and other electrical apparatus are examined. The director of it had reason to be proud of the gadgets he had devised for putting the parts through their paces in such a way as to show up quickly their little weak-

A typical Danish-built set manufactured by the TO-R Radio Company, of Copenhagen.

nesses. For complete radio receivers he has an artificial weather box that he guarantees will find any bad spots or defects inside a few hours; while his museum of antiquities in the form of pieces that have failed would, I am sure, well repay months of study by designers.

It was interesting also to find here that it was insisted that the current must be entirely cut off a mains set before it is possible to open it at all. The problem whether or not it is really necessary to take such precautions has been much debated in this country; and it has been solved in Norway by a simple moulded plug-and-socket arrangement, so arranged that the mains flexible and its contacts are taken away entirely from the rest of the apparatus when the back is removed and



The controls of the new Tröndelag Broadcast Transmitter, Trondheim, Norway.

cannot be replaced before first closing the set.

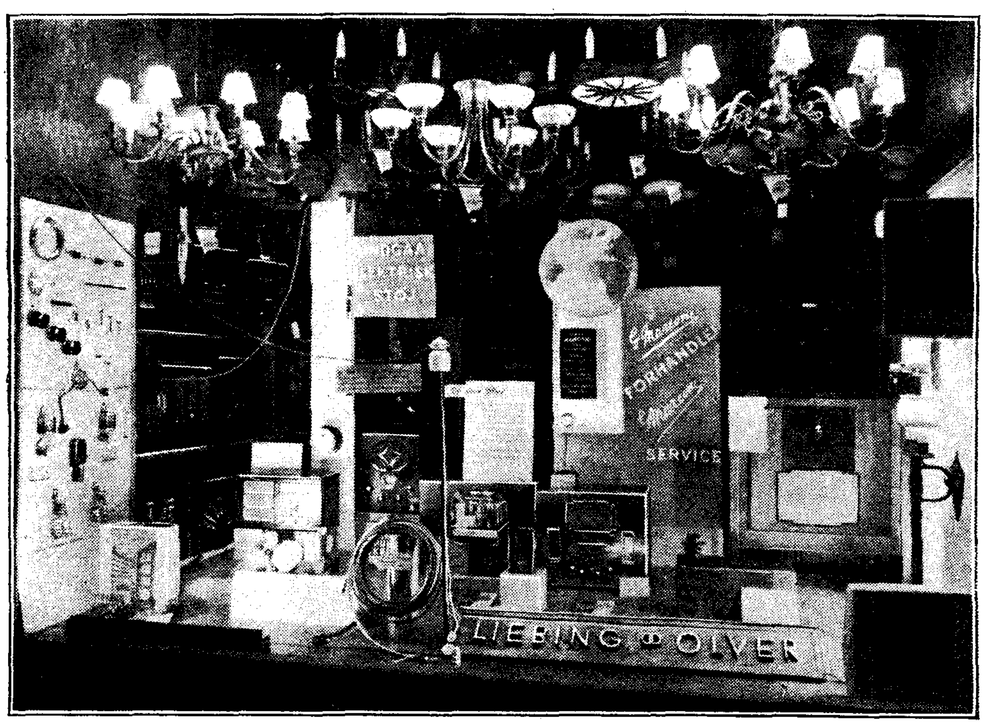
The cost of running this testing laboratory is met by a sales tax of approximately ¾ per cent. on radio sets, and a scale of additional charges for any special tests carried out at the request of manufacturers or others. The same laboratory is also concerned with other and related radio matters, such as interference prevention or elimination on electrical apparatus, and they make tests on such devices as well. So far, however, they have not arrived at any definite definitions by which the magnitude of interference with radio reception can be measured; and they have been compelled in the meantime while awaiting the development of an internationally recognised method to fall back on an approximate aural comparison which is far from being scientifically accurate.

This reminds me that in a store window in Copenhagen I observed the most complete display of interference prevention devices that I have ever seen outside of a manufacturer's catalogue. They evidently want in that city to encourage everyone to be "radio interference free."

B.B.C. Transmission Methods

Both Norway and Sweden are in the fashion as regards new or increased power for their broadcasting stations. The former are proud of their recently opened 25 kW. station at Trondheim, and the latter of Motala, with its new 150 kW. set, which is very like Droitwich in its general design. Both use the series modulation control which is favoured by the B.B.C. for high-quality transmission.

In Stockholm I learned of a curious case of interference with broadcast transmission that has troubled listeners to the Falun station—interference not due to local neon signs or somebody's beauty parlour, but



The shop window referred to in the article, with its printed slogan, "Avoid Radio Noise." The display includes screened aerial down leads, internally screened sets and numerous devices for eliminating interference at the source. Passers-by are invited to step inside for advice on cutting out unwanted noise.

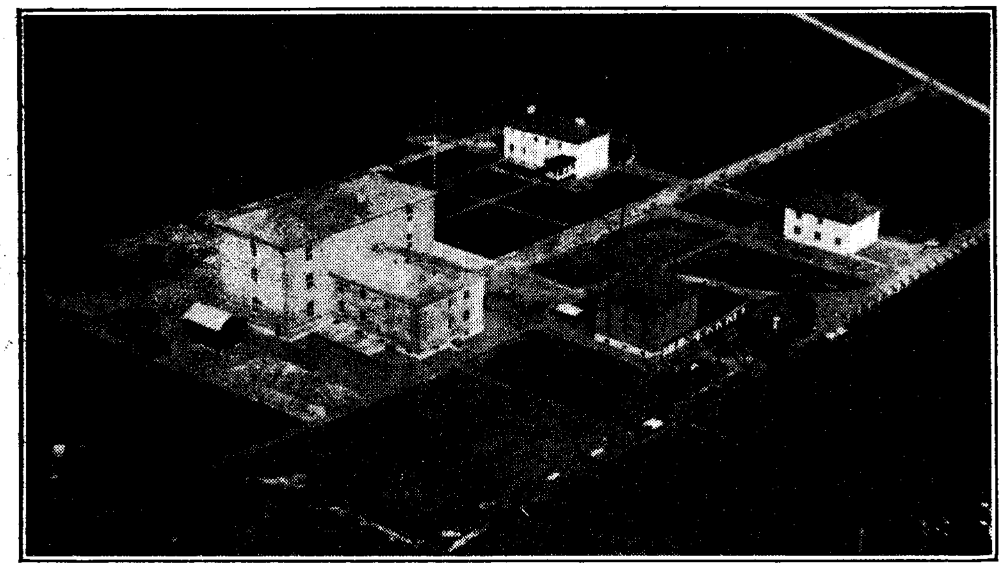
Scandinavian Radio is "Different"—

true radio interference in the form of C.W. morse, which apparently originated in our own Rugby Post Office station and in some other long-wave European transmitters—and this in spite of the fact that their wavelengths are almost poles apart in the radio spectrum. Investigation at first deepened the mystery by showing that the interference occurred only when another broadcast station in a far-away Baltic State was working—though only when it was operating over a long programme line from a distant studio. The conclusion ultimately reached was that the modulation amplifiers of this particular (and, incidentally, new) station were so efficient that the long-wave C.W. signals picked up by the long overhead studio programme wires, acting as long-wave antennæ, were being dealt with as audio frequencies and actually modulating the transmission with a frequency of the order of 18,000 cycles. This modulation was inaudible in an ordinary receiver tuned to the signals of that station, but the resulting side-band was directly able to heterodyne the transmission of Falun, although their two carriers were sufficiently spaced apart to be quite free of heterodyne interference. Such occurrences serve to emphasise that there may be quite unknown perils in striving for too high a fidelity in the more modern of our transmitting stations.

National Research Laboratories

These brief notes would be incomplete without a word in praise of the enterprise of the Swedish Government in establishing their new High Voltage Research Laboratories and Institute at Uppsala, which are under the control of Professor H. Norinder. In addition to a lavish equipment of offices and laboratories for high-voltage researches on electrical power transmission lines and on the apparatus used with them—including a 2½ million volt impulse generator of artificial (but very near real) lightning—their "terms of reference" for research work have been drawn up so that they can include radio transmission researches as well. Many interesting investigations are in progress into the properties of atmospherics and the manner in which they are propagated, which are being carried out with the big cathode ray oscillographs developed by Prof. Norinder himself. He has also a set of these instruments installed in a portable van so that he can send them around the country and make tests when and where he will. He is, in fact, one of the few men who really love a thunderstorm so much as to want to go out and follow its wanderings and varying moods.

A special feature of these cathode ray tubes on which the records are taken is an arrangement whereby they wait patiently, so to speak, in a more or less quiescent state for something to happen, and then, as soon as an atmospheric comes along, burst into activity and catch its signature on a photographic plate before it passes away on its journey through space. By a study of their sign manuals in this way Prof. Norinder is learning much of the ways of thunderstorms as atmospheric producers; and when the equipment in the laboratory is completed we should be able to look forward to some very interesting results.



The Swedish Institutet för Högspänningsforskning at Uppsala, where high-voltage and radio researches are carried out by Prof. Norinder and his staff.

Short-wave Broadcasting

"Programme Value" or "Radio Interest"?

CONDITIONS seem to have settled down to a fairly constant level nowadays, and short-wave listeners are beginning to find that there are certain transmissions on which they can definitely count for real entertainment value.

It certainly is to be hoped that the all-round improvement which is anticipated during the next few years will show itself in greater reliability, rather than in mere freak reception on "peaks," with the troughs as dull as ever.

On the subject of short-wave programme-value one reader, in the course of a long letter, enquires whether any short-wave enthusiast can really claim to have switched on to a given station at a given time simply because he knew that an item that he wanted to hear would be on. That, he says, is the one and only test of programme-value!

One could argue about this for hours without getting anywhere; but one is inclined to suggest that the main reason why one never does this particular trick is that one never has the short-wave programmes in advance. One switches on to any convenient station and takes the programme-value as it comes! Sometimes it is conspicuous by its absence, but that is usually the fault of the programme rather than of the short waves.

The Glamour of the Shorts

Short-wave reception has its own particular charms, but it has very little in common with medium-wave broadcast reception. There must be very few short-wave enthusiasts who feel the slightest desire to tune in to one station and to leave the set there for the rest of the evening.

The truth of the matter is that the short-wave broadcast listener has recaptured the glamour of the old days when ordinary broadcasting was an exciting business; in other words, he is interested in it from the *radio* aspect rather than for mere amusement. Which, surely, is all to the good—or is it?

The most brilliant star of the short-wave firmament continues to be W2XAD, whose 19-metre transmission between 8 and 9 p.m. is surely the most consistent, loudest, and best-quality transmission ever heard from America. "XAD" has been held for the complete hour on a loud speaker with only two valves for at least ten consecutive nights, and on a larger receiver with AVC he can honestly be compared with a powerful European medium-wave station.

The type of "serial programme" put out does not attract British listeners tremendously, although it is amusing for the first few nights. If short waves have not taught us anything else, they certainly have shown us how fortunate we are with our medium-wave programmes.

Several new transmissions appear to be cropping up, mostly outside the broadcast bands. HCJB, Quito, Ecuador, has been heard on about 36.5 metres in the early morning; PSK, Rio de Janeiro, also works on about the same wavelength. W3XL, at Bound Brook, N.J., has started up again on about 46.7 metres, and YV6RV, at Valencia, Venezuela, is active on 46 metres.

The only space that does not seem to be occupied by "stray" broadcast stations is that between the 19- and 25-metre bands. Anywhere between 25 and 31 metres one is liable to come across new stations, while the entire range between 31 and 49 metres seems to be extensively used by them. Some new international agreement is long overdue; as well as freeing many broadcast stations from Morse interference (and vice versa!) it would make the listener's lot easier by giving him a smaller "acreage" to cover, thereby facilitating the design of a really good band-spread receiver.

MEGACYCLE.

Super-Regenerative Midget Sets

Methods of Taming the Most Sensitive of Receiving Circuits

By COLIN BEGBIE (G5QH)

FOLLOWING on the introduction of miniature valves, batteries and components, the time cannot be long distant when the truly portable or "pocket" broadcast set will become a regular article of commerce. No circuit yet evolved seems to be more suitable for the extremely small set than the super-regenerative arrangement. The contributor of this article, who has been concerned with the development of the pocket set used by the Brighton police, offers some suggestions as to how the normally erratic behaviour of this type of circuit may be improved.

MUCH has been said for and against the super-regenerative principle of reception, but very little information has been made available as to how this admittedly somewhat erratic circuit arrangement can be made more controllable than in its usual form. It has long been realised that the super-regenerative circuit is, in many ways, ideal for the smallest type of portable broadcast set, and it has already been demonstrated that a highly sensitive receiver can be built into a small container as a cigar box or into an even smaller space. The difficulty has always been to stabilise the circuit so that the effect of handling it does not provoke a state of uncontrollable oscillation. This has now been done, and it is noteworthy that sets of this kind are in regular use by the Brighton police force.

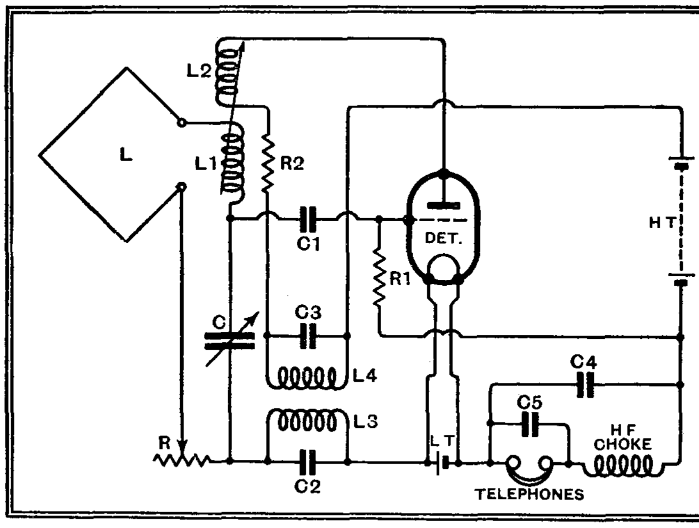
The Circuit in Detail

Referring to the accompanying circuit diagram of a super-regenerative receiver, L represents the frame aerial which may be as small as 6 x 4in., although a larger size will naturally afford greater pick-up.

A stabilised single-valve super-regenerative pocket set as used by the Brighton police.

Six to eight turns are ample, and this winding is connected in series with L1, which will accordingly have a slightly lower inductance than the corresponding grid coil of a normal receiver. Similarly, the reaction coil L2, for which provision for very close coupling must be made, will also have rather more turns than usual. In series with the tuned circuit is a variable resistance R with a maximum value of from 200 to 300 ohms.

The grid circuit quenching coil L3 may have an inductance of about 270 microhenrys and should be of high resistance—about 1,000 ohms; in parallel with it is a condenser C2 of about 0.002 mfd. Semi-variable coupling should be provided between L3 and the anode quenching coil L4, the latter with an inductance of about 250 millihenrys and a DC resistance of some 750 ohms; normal values of 0.0005 mfd., 0.0001 mfd., and 0.25 megohm may be assigned respectively to the tuning condenser C, the grid condenser C1 and the grid leak R1. The values mentioned have been found to give the best results for wavelengths between 100 and 400 metres.



Circuit diagram of super-regenerative midget set. C3, 0.004 mfd.; R2, 1,000 ohms; other values are given in the text.

An HF choke is connected in series with the headphones and bypass condensers C4 and C5 of the order of 0.01 mfd. are provided.

It should be emphasised that the resistance R plays an important part in stabilising the set and without it oscillations are practically uncontrollable. A reasonably wide spread of wavelengths can be covered by quenching circuits with the constants given.

With the aid of the information given, the constructor should be able to make a super-regenerative receiver of his own. Naturally the size of the valves and other parts will determine the dimensions of the finished receiver, and where extreme compactness is desired, it is useful to point out that it has been possible to compress the set into a case of 6 x 4 x 1in.

On switching on the set a high-pitched whistle will be heard, together with a heavy background of mush, but when a carrier wave is received, the mush will disappear, leaving a clear signal. Reaction between coils L1 and L2 should not be pressed too far or signals will be distorted, but, of course, the circuit must be in a state of self-oscillation in order that the super-regenerative principle may come into operation.

As to range, stations 500 miles away have been received with a frame measuring only 6 x 4in. Of course, LF amplification can easily be added, and with a two-stage amplifier good loud speaker results over long distances can be effected.

The receiver may also be used on short waves, but this necessitates an alteration in the constants of the circuit which cannot be gone into here. It does, however, present a field of experiment for those interested in short-wave reception.

EDITORIAL NOTE.—Quenching coils with approximately the inductance values given may be wound in "slab" form in a slotted former of $1\frac{1}{2}$in. external diameter. The slot width is $\frac{3}{16}$in. and its internal diameter $\frac{5}{8}$in. Cheeks $\frac{1}{8}$in. thick are suitable.

An inductance of 270 millihenrys, as required for the grid coil L3, is obtained by winding 4,000 turns of No. 42 enamelled copper wire in the slot, while an inductance of 250 millihenrys for L4 is obtained from 3,500 turns of the same wire. The DC resistance of these coils will be rather lower than that given, but, as wire finer than No. 42 is difficult to handle, it is suggested that the ohmic value should be made up by adding an external resistor in series.

Television IF Amplifiers

Designing Wide-band Intermediate Frequency Circuits

By W. T. COCKING

THE IF amplifier of a receiver intended for high-definition television reception is of great importance on account of the wide range of frequencies with which it must deal faithfully. In this article the chief problems are discussed and it is shown that a solution is by no means difficult, although the gain per stage is inevitably low.

IT has previously been pointed out in *The Wireless World* that high-definition television involves modulation frequencies up to roughly 1,000,000 c/s, and that transmission must consequently take place on the ultra-short wavelengths. Reception is most conveniently carried out by the superheterodyne, and the problems involved in the frequency-changer were recently dealt with.[1] The IF amplifier is a matter of great importance, however, for it must provide the major portion of the amplification required without introducing any form of distortion.

If frequencies up to 1,000,000 c/s are to be fully reproduced, the band-width of the amplifier must be twice this figure—2 mc/s. That is to say, the amplification must be constant for all frequencies up to 1 mc/s on either side of the carrier. The intermediate frequency cannot be lower than the highest modulation frequency, and it is usually inadvisable to make it lower than twice this frequency. We thus find the lowest permissible intermediate frequency to be some 2 mc/s. There is, however, no theoretical upper limit to the frequency.

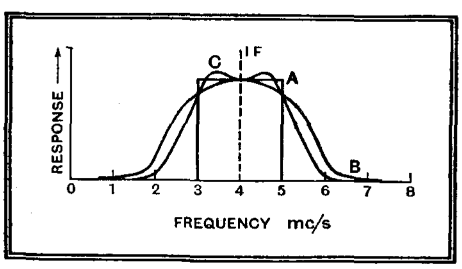


Fig. 1.—The ideal resonance curve of the amplifier is shown by curve A and more practical ones by B and C.

We have now to consider the question of amplification. It is usually considered that a low intermediate frequency is beneficial from this point of view, and this is true under ordinary conditions where the limit to amplification is set by the efficiency of the tuned circuits which we can build, or by the appearance of instability caused by feed-back through the grid-anode inter-electrode capacity of the valve. We shall find, however, that to obtain the wide band-width necessary for television purposes it is necessary to damp the tuned circuits so heavily that the amplification will be too low for feed-back effects in the valve capacity to be important. Under these conditions it is easy to show mathematically that the amplification obtainable is independent of the intermediate frequency, but is inversely proportional to the highest modulation frequency to be reproduced, and directly proportional to the inductance of the tuning coil. Since for a given frequency the product of inductance and capacity is a constant, this is the same as saying that the amplification is inversely proportional to the tuning capacity employed.

Single Circuit Couplings

We need not, therefore, consider the question of amplification when choosing the intermediate frequency, and practical convenience will usually be the deciding factor. A frequency of the order of 4 mc/s meets all requirements admirably, for it is not too high to make the accurate measurement of circuit constants unduly difficult, and it is not so low that the design of a satisfactory detector becomes impossible.

The problem, therefore, resolves itself into designing an amplifier to give the requisite gain with the fewest number of stages, the amplification being constant, or nearly so, over a band of 3 mc/s to 5 mc/s. The ideal shape of resonance curve is shown by curve A of Fig. 1, and more practical curves by B and C. There are two points to consider in the design of the circuits—uniformity of amplification over the wanted band and amplification. If we use a single tuned circuit for an inter-valve coupling, it is easy to show that the selectivity and uniformity over the modulation band, the same thing in this case, depend only on the ratio of reactance to resistance in the tuned circuit—on the "Q" of the circuit, where $Q = \omega L / R$. The amplification, however, depends only on the dynamic resistance, which is equal to $\omega L Q$.

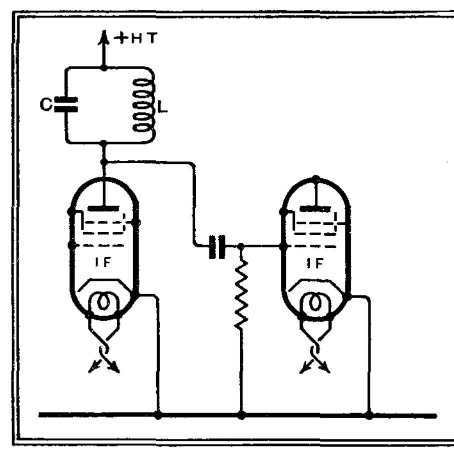
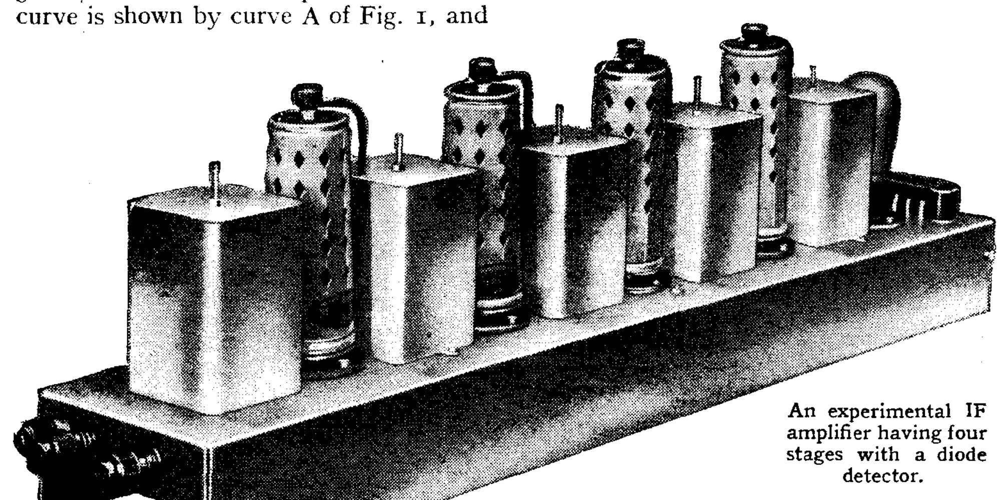


Fig. 2.—A single IF coupling using only one circuit. In practice C is the stray capacity of the circuit.

In order to see what can be done with a single circuit, let us work out the values for an arrangement such as that of Fig. 2. If we decide to tolerate a drop of 20 per cent. at 1 mc/s off resonance, we can work out the maximum permissible value of Q from equation (1) in the accompanying panel, for an intermediate frequency of 4 mc/s, by inserting the following values: $S = 1.2$, $f = 4 \times 10^6$, $n = 10^6$, and we find



An experimental IF amplifier having four stages with a diode detector.

[1] *The Wireless World*, March 8th, 1935.

Television IF Amplifiers—

$Q = 1.33$. This seems an absurdly low figure, for it would be by no means impossible to obtain a value of 100, and this would be quite acceptable for sound broadcasting. The amplification obtainable with such a tuned circuit can be calculated from equation (2), and we have only to choose the values of g, the valve mutual conductance, and C. A normal value for g with typical modern valves is about 2 mA/V, so we write $g = 0.002$ A/V.

For a single circuit the efficiency necessary to produce a given drop in response at a given frequency different from resonance is given approximately by

$$Q = \frac{\omega L}{R} = \frac{f\sqrt{S^2 - 1}}{2n} \quad .. \quad (1)$$

L = inductance in henrys of tuning coil.

R = effective series HF resistance of tuning coil.

f = resonance frequency (cycles per second).

ω = $2\pi f$.

n = modulation frequency (cycles per second).

S = ratio of voltage at resonance to voltage at frequency $f \pm n$.

With this value of Q the stage gain is given by

$$A = \frac{g\sqrt{S^2 - 1}}{4\pi n C} = \frac{Qg}{\omega C} \quad .. \quad (2)$$

where g = mutual conductance of valve in Amps/Volt.

C = tuning capacity in farads.

When two circuits are employed with optimum coupling

$$Q = \frac{\omega L}{R} = \frac{f\sqrt[4]{S^2 - 1}}{n\sqrt{2}} \quad .. \quad (3)$$

$$A = \frac{g\sqrt[4]{S^2 - 1}}{2\pi n C\sqrt{2}} = \frac{gQ}{2\omega C} \quad .. \quad (4)$$

When two circuits are over-coupled so that $\omega M = \sqrt{2}\,R$ and the response at the highest frequency required is equal to that at resonance so that S = 1 the response at the peak frequencies is 1.25 times that at resonance, and

$$Q = \omega L/R = \frac{1.225 f}{n} \quad .. \quad (5)$$

$$A \text{ (at resonance)} = \frac{0.8\,Qg}{2\omega C} \quad .. \quad (6)$$

It is obvious that the smaller we make C the greater will be the amplification, so let us go at once to the limit, where C has no physical existence as such, but consists merely of the stray circuit capacities. The output capacity of the first valve will be about 12 $\mu\mu$F, and the input capacity of the second some 14 $\mu\mu$F; the valves alone give a capacity of 26 $\mu\mu$F, to which we must add at least 6 $\mu\mu$F for the self-capacity of the coil and the wiring. We can say, therefore, that $C = 32\ \mu\mu F = 3.2 \times 10^{-11}$ F. On inserting these values in equation (2) we find $A = 3.3$!

A good modern screen-grid valve thus gives a stage gain of a little over three times when a single-tuned circuit is used as an intervalve coupling, and its efficiency is reduced to the point necessary to give a loss of 20 per cent. at the highest modulation frequency. When it is remembered that with normal efficiency circuits there would be little difficulty in obtaining a gain of fifty times, and probably one hundred times, the appallingly low efficiency of such a stage is very apparent.

Coupled Circuits

With such a circuit there are only two ways of increasing the stage gain without cutting sidebands still more—we can increase g or reduce C. Here, however, we are entirely in the hands of the valve manufacturer, and there are few valves which have a g much greater than 2 mA/V *under working conditions*. In the example quoted, C consists chiefly of the valve capacities, so that we cannot reduce it further unless the valve maker can produce a valve with lower input and output capacities. Although it is highly probable that some improvement can be made in this direction, the tendency is for the capacity to increase with g. It is not necessarily the valve with the highest g which will give the highest amplification in this case, therefore, but the one having the highest ratio of g/C.

We are not tied to the use of a single-tuned circuit, however, and it is quite feasible to employ a pair of coupled coils, as in Fig. 3. Although, when optimum coupling is used, the efficiency with this arrangement is one-half of that with a single circuit, the stray capacities across each circuit are only half the former value, so that we can use double the inductance. We thus come back to the same efficiency for the same value of Q. The question thus resolves itself into whether we can use a higher Q with a pair of coupled circuits than with only one. Equation (3) deals with this case, and inserting the same values as before we find $Q = 2.35$, and, since C now equals 16 $\mu\mu$F, from equation (4) the amplification is 5.85 times. This is a considerable improvement, for the stage gain is nearly double that with a single circuit; it is still not very good, however.

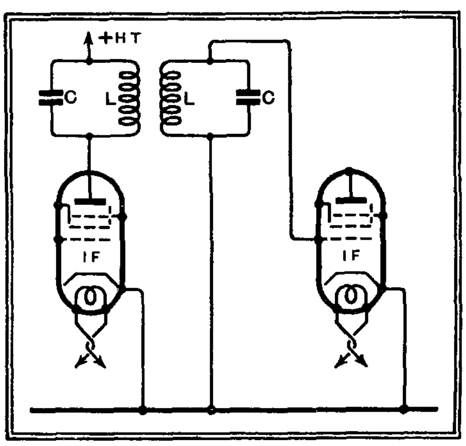


Fig. 3.—A pair of coupled circuits as an intervalve coupling permits higher amplification to be obtained for a given degree of sideband cutting.

At this stage it was decided to check the investigation by building an amplifier and measuring its characteristics to see whether they checked with theory. A single stage was first built to the circuit of Fig. 3, and as it was found impossible to make coils of high enough resistance, even by winding them with resistance wire, each tuned circuit was shunted by a 5,000 ohms resistance. The resonance frequency of the complete transformer when connected in circuit was found to be 3.4 mc/s, and its resonance curve is shown at (A) in Fig. 4.

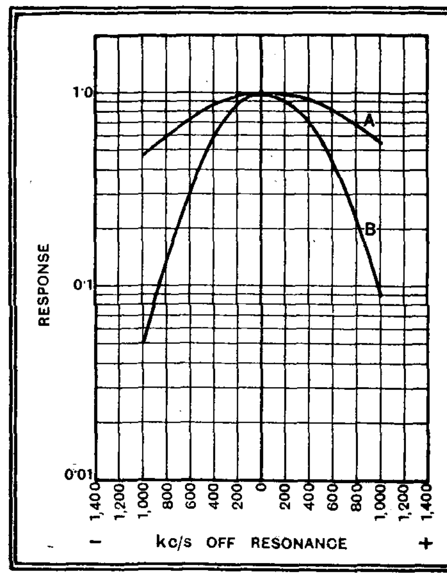


Fig. 4.—Curve A shows the measured response of a single experimental IF transformer and curve B that given by the amplifier with four stages in cascade.

The curve is nearly symmetrical, the response at 1 mc/s lower than resonance being 0.47 as compared with 0.54 for a frequency 1 mc/s higher than resonance. We can, therefore, take the average of the two figures—0.5—as representing the response to modulation frequencies of 1 mc/s. This is greater than the value which has been assumed hitherto, due either to the circuit resistances being lower than the calculated or to the coupling being somewhat below optimum. The stage gain, however, was 5.4 times, which is only very slightly below the expected value. The probability is, therefore, that both circuit resistance and coupling were too small.

An Experimental Amplifier

In spite of its defects it was felt that this transformer would be good enough for initial experiments in television reception, for although it was known that theory demands the full reproduction of frequencies up to 1 mc/s, it was felt probable that this requirement would be unnecessarily rigid, at any rate in the early stages of development. Information was also desired upon the degree of amplification which would be necessary, and upon how the characteristics of the amplifier would be modified by stray internal regeneration. A four-stage amplifier was accordingly built and found to give a total gain of 845 times, which is exactly 5.4^4. The resonance curve is shown at (B) of Fig. 4, and is almost exactly the fourth power of the ordinates of curve (A), showing that stray couplings in the amplifier exercise a negligible effect.

Very extensive de-coupling was used, each grid and anode circuit being decoupled, but the screen grids were commoned with a single by-pass condenser to

Television IF Amplifiers—

earth. Mica condensers of 0.01 μF capacity were used as offering a lower impedance than higher capacity paper types on account of the residual inductance of even non-inductive condensers. The decoupling embodied was found to be unnecessarily thorough, and in a practical amplifier it should readily be possible to dispense with a large part of it. It may be mentioned that this amplifier has been used a great deal in experimental work and has been found entirely satisfactory, save for the excessive degree of sideband cutting. It has proved to be perfectly stable, and it requires no initial adjustments.

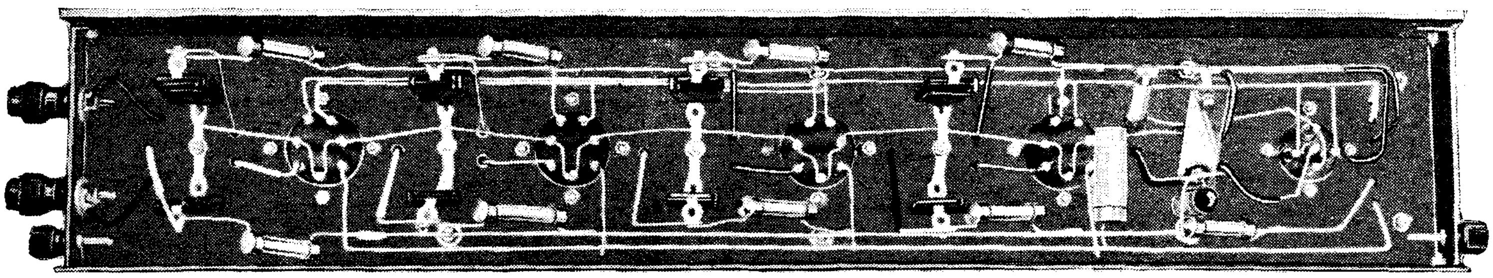
The obvious step in development is to retain the essential coupling system of Fig. 3, but to employ tighter coupling between the coils so that the response curve becomes of the double-peaked variety. Heavy damping must still be imposed on the circuits, of course, otherwise the trough between the peaks will be too marked. The resonance curve will then take the general form shown by curve (C) of Fig. 1. If we decide that the response at the highest frequency required shall be equal to that at resonance, and that it shall be 1.25 times the resonance value at the peak frequencies, the approximate formulæ (5) and (6) apply. On inserting the same values as before we find that $Q = 4.9$ and the amplification of a single stage is 9.75 times.

This is a considerable improvement over the previous case, and with four stages we should expect to obtain an amplification of $9.75^4 = 9{,}000$ times, as compared with the gain of 845 times obtained before. Three stages only would, in fact, give a slightly greater amplification—925 times—so that the use of overcoupled transformers is economical of apparatus.

There is, however, one point of which we must beware. At a frequency between that of resonance and the limit of the modulation band the amplification per stage will be 25 per cent. above normal. This is not serious in one stage, but with four stages it will amount to 243 per cent. This is by no means as great as it sounds, for expressed in decibels it only amounts to 7.7 db. Nevertheless, it is greater than is desirable, and we may find it advisable to use a combination of single-peaked and double-peaked transformers in order to obtain a more generally even response. This will, of course, inevitably entail some loss of amplification.

The calculated resonance curve of a single transformer of the overcoupled type is shown by curve A of Fig. 5, and curve B shows the results to be expected when three are used in cascade. Curve C illustrates the results when three such transformers are used in conjunction with one of the type described earlier—the individual response being given by curve A of Fig. 4. This curve is very nearly ideal for the amplification remains even within ±2.3 db. for frequencies up to 900,000 c/s, and even at 1,000,000 c/s the loss is only slightly greater than 6 db. Using four valves a stage gain of 9.75 times should be obtained for three stages, and of 5.4 times for the fourth, or a total amplification of 5,000 times.

At the time of writing no attempt has been made to build an amplifier incorporating such circuits, for the one already described meets all present requirements. There seems to be no reason why any difficulty should be met with in producing it, however, for experience has shown feed-back effects to be of secondary importance when the gain per stage is so low. In the case of an HF or IF amplifier for sound reproduction, it is rarely possible to prepare an exact design on paper, since the stray couplings, for which it is almost impossible to allow, so greatly modify the performance. When the stage gain is as low as that obtained with present television amplifiers, however, this is no longer true, and it seems possible to make the design of an IF amplifier as exact as that of one for use on low frequencies.



An underbase view of the experimental amplifier in which the extensive decoupling equipment can clearly be seen.

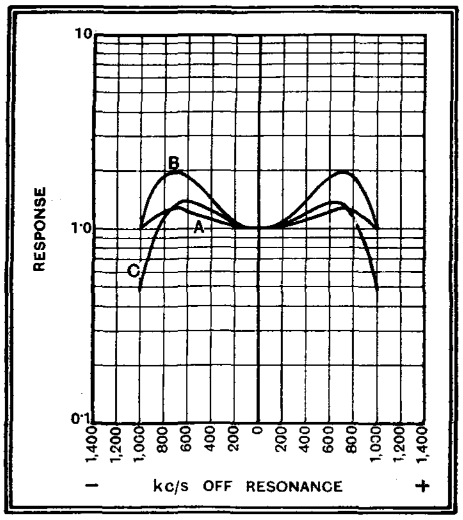
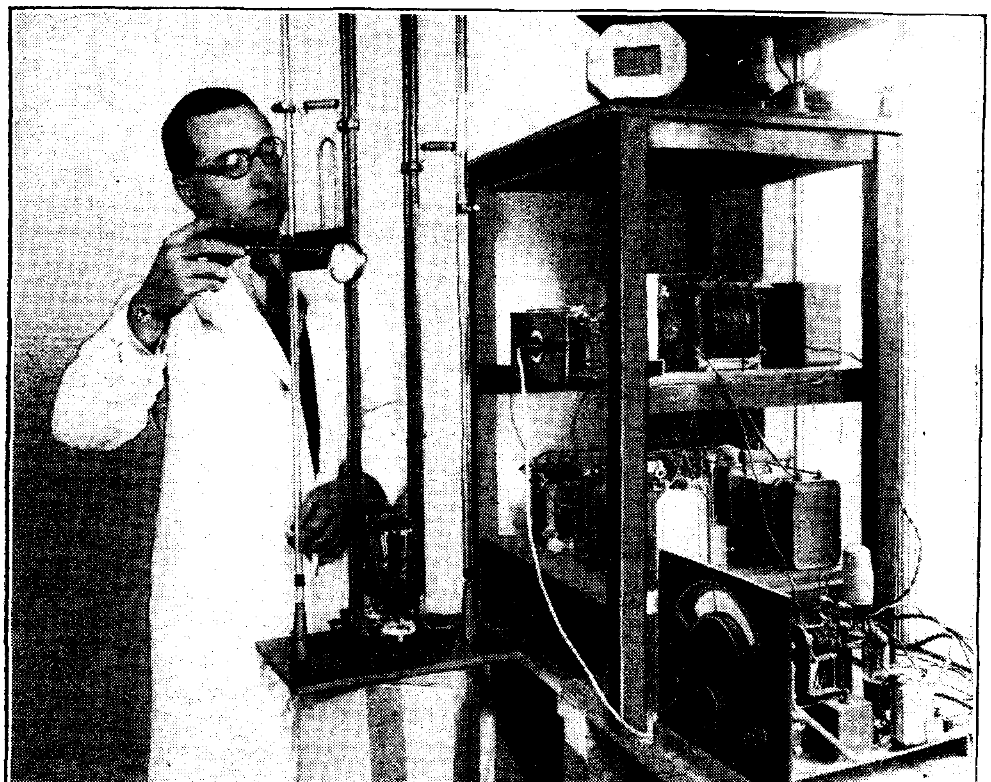


Fig. 5.—Curve A shows the calculated response of a transformer of the overcoupled type and curve B that obtainable when three are used in cascade. Curve C shows how the response is modified by adding a further stage having optimum coupling.



ULTRA SHORT WAVES IN THE MIDLANDS. Station G6SL at the works of Stratton and Co., Ltd., Birmingham, which transmits regularly on Sundays with beam and omni-directional aerials.

Current Topics

Events of the Week in Brief Review

Radio Gown

A LEADING Paris dressmaker announces "a most elegant radio gown" which puts a finishing touch to the enjoyment of a good wireless programme.

Russian Broadcast from British Ship

RUSSIAN radio reporters are to don diving suits to give a running commentary from the British ship, "The Black Prince," which sank on November 2nd, 1854, near Balaclava.

Philips Television

THE Philips Company is starting ultra-short-wave television transmissions at Eindhoven on a wavelength of 7 metres. A transmitter working on 3 metres has already been in use for some time. We understand that a television receiver is being developed.

The Wireless P.M.G.

AMID the storms and tempests of French politics M. Mandel is expected to retain his Portfolio of Postmaster-General—a thought which gives great satisfaction to wireless amateurs in France. More than any of his predecessors, M. Mandel is credited with having the will to *act* in the matter of broadcasting development.

5 Metres from Snowdon

ON Saturday, June 15th, commencing at 5 p.m., a special 5-metre transmission will be carried out from the top of Mount Snowdon, continuing to midnight and recommencing on Sunday, terminating midday. Beam and omni-directional aerials will be used. The call-sign is G5CV, and reports should be sent to Mr. Douglas Walters, Acre House, 72 Long Acre, London, W.C.2. A listening post will be established at Snowdon for reports on 40 and 80 metres.

Russo-Japanese Conflict

JAPAN has protested against the transmission of bulletins in Japanese from the Vladivostock station, which interferes with the Hamamatzu transmitter. The Soviet has consented to change the wavelength, but declines to cease transmissions in Japanese.

Late French Concerts

THE French State stations are to transmit special concerts every Friday from 11 p.m. to 1 a.m.

New P.M.G.

WITH the Cabinet changeover the country's wireless communications come under the control of a new Postmaster-General, the Rt. Hon. Major G. C. Tryon. After a military career in the Grenadier Guards, Major Tryon became Under-Secretary of State for Air in 1919. In 1922 he became Minister of Pensions, and has held this post at intervals up to the present time.

FRAULEIN URSULA PATZSCHKE, the world's first woman television announcer, stage-manages the high definition programmes transmitted by the German Post Office.

Looking for a Wavelength

TO-MORROW (Saturday) is the date fixed for the first test transmissions from the new 150-kilowatt Roumanian station at Brasov. Engineers are in a dilemma regarding the choice of wavelength, for, according to a correspondent, they feel that a clash is inevitable if they use the 1,875-metre wavelength granted by the Lucerne Conference, as this is shared by Huizen. The Dutch station shows no inclination to surrender the wavelength, so Brasov may have to seek another channel.

The fact that a new high-power station is trying to find a place in the long waveband is not comforting. It is only recently that comparative peace has been restored in this region.

"Ultra-shorts" in the Midlands

GREAT interest has been aroused by the ultra-short-wave transmissions from G6SL, Birmingham, operated by Messrs. Stratton and Co., Ltd. The schedule of transmissions for the next few weeks is as follows:—

Dates.—June 16th, 23rd, July 7th and 14th.

Times.—10.30 a.m. to 11.30 a.m. Beam aerial.

11.30 a.m. to 12.30 p.m. Omni-directional aerial.

3 p.m. to 4 p.m. Beam aerial.

4 p.m. to 5 p.m. Omni-directional aerial.

The beam aerial is directed 50 degrees east of south, and the omni-directional is an orthodox vertical di-pole. The transmissions on 50 watts are telephony frequently interspersed by signals of three dash seconds of 500-cycle note for identification purposes. Transmission periods are of ten minutes' duration, commencing 10.30 a.m. until 12.30 p.m., with ten-minute intervals for listening or for possible two-day communication. Recommencing: 3 p.m. to 5 p.m. Written or telephoned reports will be welcomed at Eddystone Works, Bromsgrove Street, Birmingham, 5.

Broadcast Brevities

By Our Special Correspondent

Droitwich in Miniature

DROITWICH is everybody's station, so the B.B.C. has hit upon the happy idea of displaying scale models of this giant broadcaster at Radiolympia in August. I hear that one model gives a bird's-eye view of the station in its setting of well-wooded countryside, with every technical detail faithfully reproduced, down to the cobweb-like aerial wires and tiny insulators.

The other model gives a sectional view of the interior, showing the engineers at their respective duties and each unit of the transmitters marked in such a way that the operation of the station can be seen at a glance.

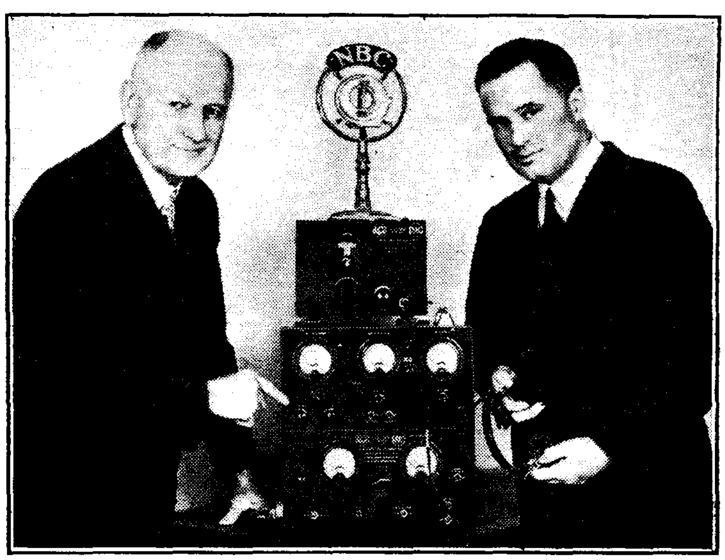
Sir Charles Carpendale

VICE-ADMIRAL SIR CHARLES CARPENDALE is due to retire at next Tuesday's annual general meeting of the International Broadcasting Union. For more than ten years now Sir Charles has represented Britain in the presidential chair, but this year it is probable that a German or a French representative will succeed him.

Warsaw is the venue of this year's meeting. Last year, it may be remembered, the delegates met in London as the guests of the B.B.C. Poland, however, considers that representatives from more than thirty countries should be entertained by no less an authority than the Government itself.

No Secrecy This Time?

The Polish Government is highly skilled in the arts of publicity, so the Conference is not likely to rest under such a cloud of secrecy as surrounded its deliberations in Park Lane last year. True, your Special Correspondent obtained a glimpse of the delegates through the smoke-laden atmosphere, but only by masquerading as the Postmaster-General of Ruritania.



BROADCASTING FROM THE STRATOSPHERE.—Major-General James G. Harbord (left) Chairman of the Radio Corporation of America, inspecting the radio equipment to be used by Captain A. W. Stevens and Captain O. A. Anderson, when they make a balloon ascent into the stratosphere this month. The transmitter weighs 40 lbs. and the receiver 15 lbs.

UNBIASED By FREE GRID

Landladies' Race

AT this time of the year your fancies lightly turn to thoughts of love and landladies, according to whether you are still unmarried or have been less fortunate in life. I am very delighted therefore to see that at long last the mouldering early-Victorianism of "Seaview" and such-like establishments is giving place to something modern, for a seaside landlady's advertisement has actually appeared in which "headphones over every bed" is cited as one of the amenities of the establishment.

It might seem strange at first that no mention is made of the provision of wireless in the dining room. From bitter experience of these establishments, however, I can well understand that something is needed to while away the weary night hours as one lies tossing and turning on the concrete slabs which these good ladies provide for their guests.

Talking of landladies reminds me of a most excellent opportunity which the outside broadcast department of the B.B.C. have apparently overlooked. I refer, of course, to the annual seaside landladies' race held at one of our popular coastal resorts. The B.B.C. ought to know that this race would provide food for a running commentary of vital interest to every listener, for what one of us has not been deceived at some time or another by the misleading "two minutes from sea" clause in landladies' advertisements?

The town council of the resort long ago decided to put a stop to this misleading sort of statement and therefore inaugurated an annual "landladies' race to the sea" in which all who use this statement in their advertisements are compelled to participate. Non-starters and all who fail to reach the sea in the advertised time are heavily pilloried in the local Press and their future advertisements refused. I can assure you, from personal experience, that the great annual race is one of the most entertaining and thrilling events in the holiday programme of this particular resort, and the B.B.C. is missing a great opportunity in not getting Mr. Allison to give us his familiar commentary: "Mrs. Miggs is leading easily, she has reached the cliff steps, now she has fallen, she's up again, no, she isn't, yes, she is."

"Mrs. Miggs is leading easily."

Train Radio de Luxe

I NOTICE that it has been left to a foreign country to lead the way in the improvement of the train radio service in which a pair of headphones is provided for every seat on certain long-distance trains. Not only are different programmes available, by means of several receivers, to any of which the passenger can connect himself by means of an automatic telephone dial, but he can also obtain, if he so desires, a running commentary on the scenery and objects of interest which the train is passing. This is made possible by a microphone presided over by a special commentator.

Multi-Lingual Film

I SUPPOSE that I possess all the average British distrust of the foreigner and his wicked ways, but even the devil must be given his due. I cannot do less than place on record my profound admiration at the ingenuity shown by the manager of a certain foreign cinema in overcoming difficulties which radio and its off-shoot, the talkies, have thrown in his path.

I happened last week to be paying what was literally a flying visit to Alexandria in pursuit of an errant daughter. As many of my readers may be aware, Alexandria is a truly cosmopolitan city where the harassed shopkeeper has to speak about half a dozen different languages if he is to keep his customers from straying to rival establishments.

Having an odd half-hour to spare during my visit I dropped into a cinema and was very surprised, on paying my half-piastre at the cash desk, to be smilingly handed a pair of 'phones enclosed in a hygienic germ-proof envelope. Naturally I at once assumed that the headphones were, as in certain cinemas in this country, intended for deaf patrons, and in halting Arabic I politely declined them. Apparently, however, my Arabic was not understood, as the grinning Gippo behind the grille still forced the 'phones upon me. In the end, in order to avoid a breach of the peace, I took the phones, thinking that, after all, they might be useful, as I was still suffering from the effects of one of Mrs. Free Grid's tirades.

After a few moments of Greta Garbo gibbering in the local lingo my attention wandered and I longed for the old days of the silent cinema when, in the leading cinemas of Egypt, sub-titles used to be flashed on the screen in a multiplicity of languages, including English. I idly donned the phones and plugged in to one of the numerous sockets that were attached to the back of the chair in front of me. To my astonishment I was addressed in French instead of the local lingo that I had anticipated. A few moments' listening sufficed to show me that I was hearing the dialogue of the picture, and I settled down to follow it as best I could.

The grinning Gippo behind the grille.

A little later it occurred to me to wonder why there were so many sockets, and I tentatively inserted my plug into another. I found that I was being addressed in English. Rapidly withdrawing my plug and inserting it into socket after socket I was amazed to hear the whole gamut of languages which one is accustomed to expect in the streets of this cosmopolitan city.

As soon as the show was over I sought out the manager. Politeness itself, he readily consented to show me the "works." The various lingoes were provided by separate talkie turntables and discs, all of which were synchronised. It is hoped eventually to bring the installation completely up to date by substituting for the turntables and records a film having several parallel sound tracks on it, this film being run through a special sound-reproducing projector synchronised to the ordinary movie projector.

The idea is, I think, worthy of greater recognition than has so far been accorded it, for it has great possibilities for the future. There is no reason at all, for instance, why provincial visitors to London cinemas should be compelled to listen to the refined accents of Elstree. By adopting this scheme each metropolitan cinema seat could be wired for the reproduction of all the multitudinous dialects of this fair land, thus making the country visitor feel really and truly at home; in fact, I see no earthly reason why even the wretched foreign tourist should not be catered for and be made to feel we want his money.

On Learning Morse

Memorising Sounds : Not Symbols

ALTHOUGH ability to read morse signals adds enormously to the interest of wireless listening, comparatively few amateurs are able to acquire the art. The author contends that this is because the usual method of learning is basically wrong

By AUSTIN FORSYTH (G6F0)

THE amateur interested in wireless as a hobby usually progresses in three stages. First, he is a broadcast listener and constructer; then he graduates to short-wave reception and finds an entirely new field of interest; thirdly, he starts to learn morse, with the limitless possibilities it opens up. And it is here that his first serious difficulty arises, a difficulty which, only too often, debars all but the most enthusiastic from enjoying to the full what is probably the most fascinating side of wireless.

Learning the Morse Code is not easy, but it is certainly not as hard as it is sometimes made out to be if the problem is tackled in the right way. There are some who are able to attend classes at technical institutes, and others who can obtain the guidance they need from a friend, possibly an amateur transmitter, or other qualified operator. But beginners in this position are fortunate and comparatively rare, by far the majority of those who aspire to learn the code not being able to obtain qualified instruction or any sort of help. They attempt to learn alone and either achieve their object only after months of arduous labour, or else just give it up in disgust. The reason for this is that generally they have drawn their inspiration from the wrong source, for much that has been written about learning morse is calculated more to hinder than to help the beginner.

The Wrong Way

In the first place, do not adopt either of the two methods which are nearly always recommended: (1) Buy a buzzer and key and attempt to send before you can receive, and (2) further complicate matters by practising with a friend who knows as little about it as you do yourself! For reasons which will be clear later, trying to learn on a buzzer before you can read makes the process much longer and usually results in the development of a bad style. Also, it is not even practice, for all the time you know what you are sending. Learning with a friend who is a beginner is quite as bad, for he, not being able to read himself, will be unable to transmit even tolerably good morse, as no operator can send till he knows what good keying sounds like. His efforts will, therefore, bear very little resemblance to what you hear on the air.

Sounds Instead of Symbols

This looks like the vicious circle, but here is the way: Put away your buzzer and key, forget about the receiver, and look at the Morse Code on the next page. The letters are made up of combinations of dots and dashes which, to you, must represent not dots and dashes but *sounds*. And here the first point emerges. You have to train your brain to read the letters by their *sound*, and not as dots and dashes. In other words, the letter C is not dash-dot-dash-dot, but dah-dit-dah-dit. It is on this that the beginner usually stumbles. He hears dah - dit - dah - dit, translates that in his mind as dash-dot-dash-dot, and then searches his memory for the letter to which dash-dot-dash-dot corresponds! He then finds that he has lost the rest of the message, and this procedure, repeated over and over again, becomes so wearisome that he finally comes to the conclusion that the faculty for learning morse must be a heaven-sent gift.

First, then, you must learn the alphabet by its sound equivalents, actually saying to yourself the sounds which correspond to the various letters. A dash should be uttered as "dah," and a dot as "dit," a dash being equal in length to three dots; "dah," drawn out, and "dit," short and sharp. The space between a dash and a dot is equal to one dot, between two letters of the same word three dots, and between two words five dots. Before going on to word-formations, soak yourself in the code till you are able immediately to make the sound equivalent of any letter in the alphabet, for the thing you have to remember is that you must *impress the sound of each letter on your brain*. When the code has been thoroughly mastered in this way word-formations can be attempted, and, in this connection, the great value of learning morse in the manner here suggested is that you can practice anywhere and at any time. Any piece of print constitutes a practice, such as newspaper-headings, advertisements, car-registrations (for numbers), and so on endlessly. As you buzz your exercises, the letters will be impressing themselves on your mind, till you find you can read repetition signals, such as call-signs, "Test" and "CQ" calls, which can be heard, sent slowly, at any time of the day or night on the various amateur wavebands. For instance, you might hear signals like this: "Test Test Test *de* (from) G5ML G5ML G5ML," or "CQ CQ CQ *de* ON4BV ON4BV ON4BV." In the first instance, the British station G5ML is asking for tests, while in the second case the Belgian ON4BV is putting out a general call. If G5ML wished to work ON4BV, the procedure would be "ON4BV ON4BV ON4BV *de* G5ML G5ML G5ML," repeated several times.

By listening to these repetition signals, you will instinctively appreciate the value of correct timing, or spacing of the characters, which is the next important point. Do not try and read complicated matter sent fast, but concentrate at first on what you can actually read and study spacing,

The correct method of manipulating a morse key.

On Learning Morse—
for the next step should be buzzer practice with a key.

Gaining Confidence

The value of having learnt to read, however little, before sending will now be apparent. You will come to the key with confidence, knowing how correctly transmitted signals should sound, and you will therefore be able to correct your own sending mistakes. The essentials of good sending are clean-cut formation of characters and accurate spacing, so that your first practices should be concentrated on the alphabet, till you can send any letter as you think of it. Above all, avoid trying speed. Both reading and sending speed come naturally with practice and, as legibility is the first requirement, it is no use sending fast if the signals are unreadable. Therefore, start slowly and comfortably, and when the alphabet has been thoroughly learnt, go on to words and sentences. But all the time, keep good formation and spacing as the prime considerations.

The receiver will provide examples of every kind of sending; good, bad, and a large number of indifferent. Having started right, you will be cultivating your own style, and you should aim at making your morse as readable as print to the other man. The hall-mark of the proficient operator is good style, which means nothing more than clean-cut characters and accurate spacing.

Operating Procedure

It has been well said that any fool can send, but it takes an operator to read. It is no use being able to send at twenty-five words per minute if you can only read at eight words per minute. Reading and sending should keep pace and develop together, and this will be found to involve more time on reading practice than work on the key, since after a certain stage is reached sending speed is easily acquired At no time should the practices be overdone; about half an hour a day is usually ample after the alphabet has been mastered.

If the problem is attacked conscientiously along the lines indicated, it should be possible to copy repetition signals in about three weeks. The rest comes naturally, and if attention is devoted to the amateur bands, many stations will be heard "sending double," *like like this this,* so that complete transmissions can be followed, giving valuable experience in procedure. Not that QSZ (or sending double) is to be encouraged or admired, as too much attention to it will mean that real reading speed will take longer to acquire, but it is most useful to the beginner struggling with his first code messages.

Like wireless itself, the learning of morse can be taken up at any age. It is an art, and can be made to express personality in the same way that a painter uses his canvas, or a writer his pen. And if there is any thrill comparable to getting a reply to one's own first "Test" call, it is that which rewards the listener who copies his first morse signals from an unknown station.

THE MORSE CODE
With Numbers and Commonly Used Punctuation Marks

A	· —	N	— ·	0	— — — — —
B	— · · ·	O	— — —	1	· — — — —
C	— · — ·	P	· — — ·	2	· · — — —
D	— · ·	Q	— — · —	3	· · · — —
E	·	R	· — ·	4	· · · · —
F	· · — ·	S	· · ·	5	· · · · ·
G	— — ·	T	—	6	— · · · ·
H	· · · ·	U	· · —	7	— — · · ·
I	· ·	V	· · · —	8	— — — · ·
J	· — — —	W	· — —	9	— — — — ·
K	— · —	X	— · · —		
L	· — · ·	Y	— · — —		
M	— —	Z	— — · ·		

Full Stop (.)	· · · · · ·
Break Sign	— · · · —
Exclamation Mark (!)	— — · · — —
Interrogation Mark (?)	· · — — · ·
Erase (or Error)	· · · · · · · · ·
End of Message (AR)	· — · — ·
Closing Down (SK)	· · · — · —

Television
A Post Office Statement

THE Postmaster-General announces that he has received a communication from the Television Advisory Committee regarding the choice of a site for the projected London Television Station and other matters relative to the proposed experimental television service.

After having carefully considered a number of possible sites, the Committee have recommended the adoption of the Alexandra Palace for the station. This recommendation has been approved by the Postmaster-General; and the British Broadcasting Corporation have made arrangements with the Alexandra Palace Trustees for the use of a portion of the Palace buildings for the station.

The ground at the Alexandra Palace is 306ft. above sea-level; and it is proposed to erect a 300ft. mast on the site, thus providing an aerial height of 606ft. above sea-level, which, it is considered, should enable a high-definition television service to be provided for the London area.

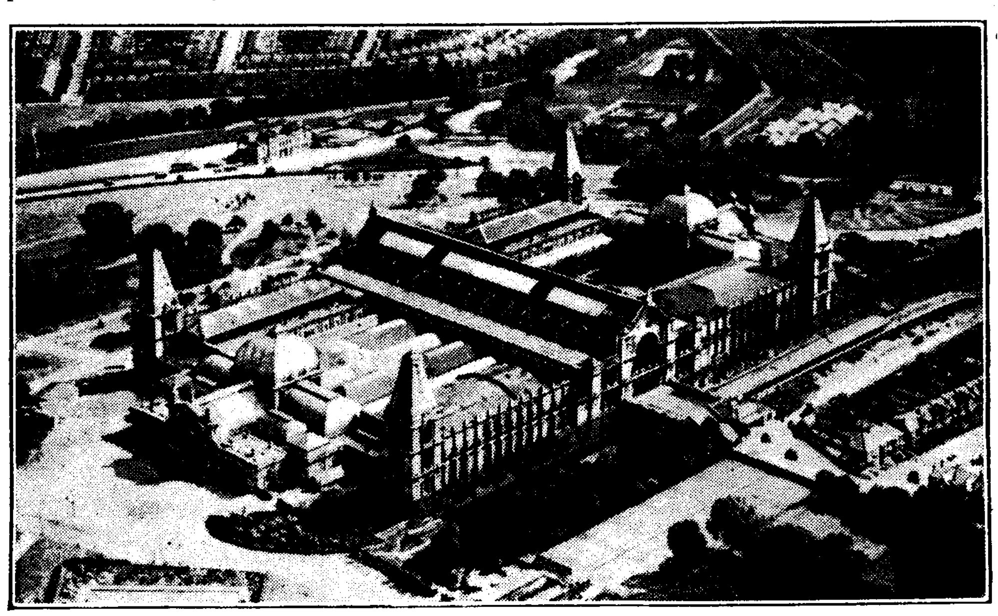
As recommended in the Television Committee's Report, the Baird Television Company and the Marconi-E.M.I. Television Company are being invited to tender for the supply of the necessary apparatus for the operation of their respective systems at the London station.

The Baird Company propose for their system the adoption of a standard of picture definition of 240 lines sequential scanning, 25 picture traversals per second, 25 complete frames per second; and the Marconi-E.M.I. Company propose for their system a standard of 405 lines, 25 pictures per second, interlaced to give 50 frames per second, each of 202½ lines. Subject to satisfactory tenders being received, the Advisory Committee recommend the adoption of these standards for a public service during the trial period. Whilst it is contemplated that each system will be operated mainly on the standard proposed for it by the relative company, the alternative standard may be employed by permission of the Advisory Committee with either system. In such event due public notice would be given of the change.

The Committee have satisfied themselves that receivers can be constructed capable of receiving both sets of transmissions without unduly complicated or expensive adjustment.

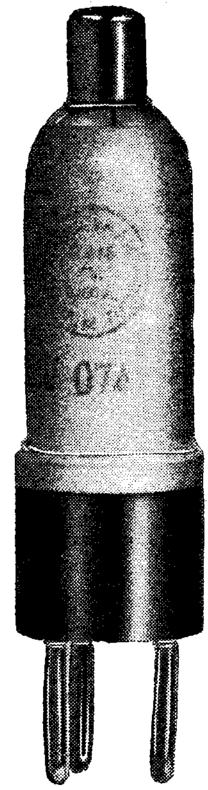
The Committee propose that the vision signals should be radiated on a wavelength of about 6.6 metres, and the associated sound signals on a wavelength of about 7.2 metres.

If the tenders submitted by the two companies are accepted, such technical information regarding the characteristics of the television signals radiated by the two systems as will facilitate the designing of television receivers capable of picking up those signals will be made available to manufacturers by the respective companies.



Looking down on a familiar North London landmark. The Alexandra Palace has been officially chosen as the site for the first television transmitter.

A New Detector Valve



Diode for AC or DC Operation

THE detector of the modern receiver is of great importance if distortion is to be avoided, and there is hardly any alternative to the diode in a set having any pretensions to quality reproduction. In this article, contributed by Tungsram Electric Lamp Works, a new diode of very low resistance is described, and it is shown that it can be applied to the measurement of AC voltage as well as to the detection of wireless signals.

ALTHOUGH the diode was the first type of valve ever devised, it is only recently that it has come into wide use. The amplifying action of the ordinary valve made it much more desirable in the earlier days of wireless, but designers now realise that the diode has much to commend it for any rectification purpose.

There are two schools of thought. One prefers to use diodes built into the valves used in other parts of the set—such as duo-diode-triodes, duo-diode-output pentodes, etc. The other school prefers to use entirely separate diodes, which is theoretically better, since the valves can then all be made really efficient. Various forms of double diode have been on the market for some time, and Tungsram have recently placed on the market a single diode with an indirectly-heated cathode, known as the D 418.

This little valve has several interesting points. In the first place, it only measures ¾in. diameter by 3¼in. overall. It is metallised to avoid any danger of instability or pick-up of hum, and thirdly, the diode connection is brought up to a cap on top of the bulb so that the capacity across the tube is something around one micromicrofarad only. Moreover, its

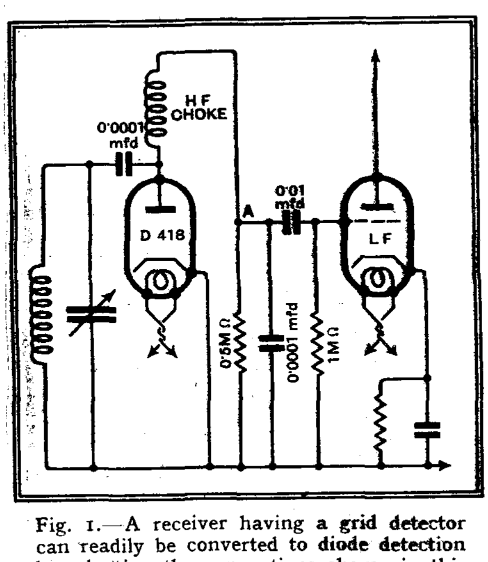


Fig. 1.—A receiver having a grid detector can readily be converted to diode detection by adopting the connections shown in this illustration. It is recommended that the point A be the slider of a volume control resistance connected in place of the 0.5 megohm resistance shown.

heater rating of 4 volts at 0.18 ampere renders it suitable for use both in ordinary AC sets and in AC-DC receivers employing the 0.18 ampere type of universal valve.

Most people to-day seem to think of diodes in connection with AVC systems. There are, however, some thousands of sets of simple type using grid (triode) detectors. The diode has an immediate application to these sets.

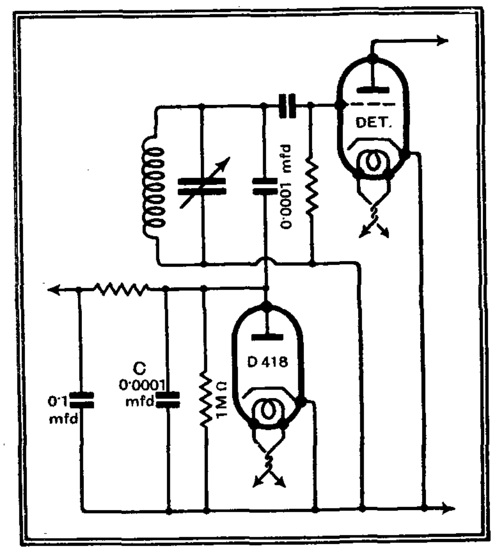


Fig. 2.—In this diagram, a method of connecting a diode for AVC purposes is shown.

It is a well-known fact that the ordinary grid detector is not really efficient on anything but weak signals. This is because the comparatively large high-frequency voltages applied to the grid on a strong signal overload the amplifying action of the valve. A signal, modulated 30 per cent., which develops one volt effective low-frequency signal at the detector would have a high-frequency component of over three volts, which is more than the ordinary detector can handle comfortably.

A grid detector is, in effect, nothing but a diode coupled to a triode amplifying valve. The grid of the valve acts as a diode and the low-frequency voltages set up on the grid are then amplified by the triode action. Much better results are obtained if the two actions are separated as shown in Fig. 1, for the HF or IF components no longer need be applied to the amplifier. The extra cost is small and the result is better quality, more output, and greater freedom from overloading.

Where automatic volume control is required the addition of a separate diode enables the circuit to be modified without affecting the existing arrangements. Most readers will be familiar with the customary superhet AVC circuit. Fig. 2 shows how AVC could be applied to a 2-HF straight set. The diode is coupled across a detector and a small delay is applied, so that the control does not come into operation until after the certain critical strength has been reached. Good control will, of course, only be obtained on weak signals, where a grid detector is retained, and for the best results a diode detector is advised.

Many other circuits will suggest themselves to the reader. The introduction of the small metal rectifier has done much to popularise such arrangements, but the diode has one advantage. Its efficiency is higher than any other form of detector, and it has the further advantage that on the reverse half-wave it does not absorb any power. The efficiency is still greater where one uses a separate diode, for with combination valves both the amplifying section and diode portion are forced to suffer owing to the limitations of space.

Detector Characteristics

As an example, the diodes of a duo-diode-triode may have an internal resistance approaching 10,000 ohms. With the D 418 diode, however, the internal resistance is only 1,500 ohms. The valve will give several milliamps safe emission, and this is in excess of all normal requirements.

The characteristics of the valve are given in Figs. 3 and 4, and it can be seen that the valve is almost completely linear for signal inputs exceeding 2.5 volts RMS; in fact, with a load resistance of two megohms it is linear down to about 1.5 volts. Completely distortionless rectification of 80 per cent. modulated signals can thus be expected for any carrier input exceeding

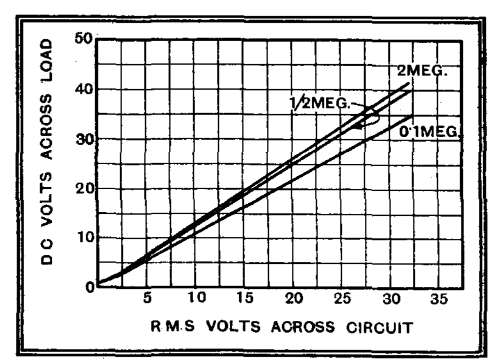


Fig. 3.—The input-output curves of the D418 valve are shown here for various load resistances.

A New Detector Valve—

some 12.5 volts RMS. In practice one could work with a much smaller input without noticeable distortion being introduced.

A final but not widely known application of the diode is to measurement. If a

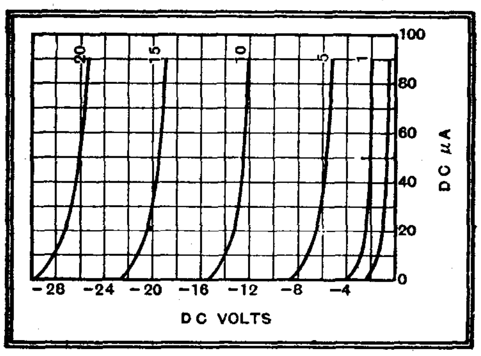


Fig. 4.—The DC input-output curves of the diode for a range of AC input voltages enable the performance under almost any conditions to be predicted.

single diode be connected in series with a resistance across a source of alternating voltage the current flowing will be 0.32V/R, assuming a pure waveform. The resistance R includes the diode resistance, but this is usually small by comparison. For example, if R is 10,000 ohms a voltage of 4 volts will give a current of 0.12 milliamp.

A.C. Voltmeter

Larger readings may be obtained by connecting a condenser across the resistance as shown at C in Fig. 5. This condenser then stores up the voltage during the idle half-cycle when the diode is not working. The value of C should be such as to make the impedance small compared with the resistance at the frequency in use. For instance, for low frequencies a 50 μF electrolytic condenser could be used, and if added to the circuit quoted above it would increase the reading to about 0.25 milliamp. For high-frequency work a paper condenser of 1 μF would be ade-

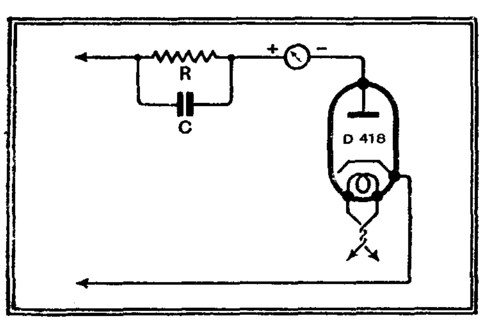


Fig. 5.—The connections of a diode as an AC voltmeter. If the condenser C be omitted, the current is lower, but no calibration is necessary.

quate. With a condenser, however, the arrangement must be calibrated as the reservoir action of the condenser is indeterminate.

These are just a few of the possible uses of diodes. In view of their low cost their use is well worth considering, for the number of places where they can be used is amazing.

Random Radiations

By "DIALLIST"

Folly Incredible

IT is difficult to believe that anyone in his right mind could set out to climb a pylon carrying the high-voltage cables of the grid system. But it was done the other day by a person who appears to have come into contact with the 132,000-volt cable itself and was killed instantly. The coroner described this performance as the act of a madman; but almost equally senseless things are done by people who are in the ordinary way as sane as the best of us. Some time ago a man who was erecting an aerial found his style rather cramped by the fact that a medium-voltage supply line passed close to his house. An aerial suspended under the line was not high enough for his liking, so he decided to swing it above. With the help of a friend he managed to carry his aerial wire over the line, but at the critical moment it became slack for an instant and contact was established. I forget whether both the enthusiast and his friend were killed, but one of them certainly was.

The R.S.G.B.'s Field Days

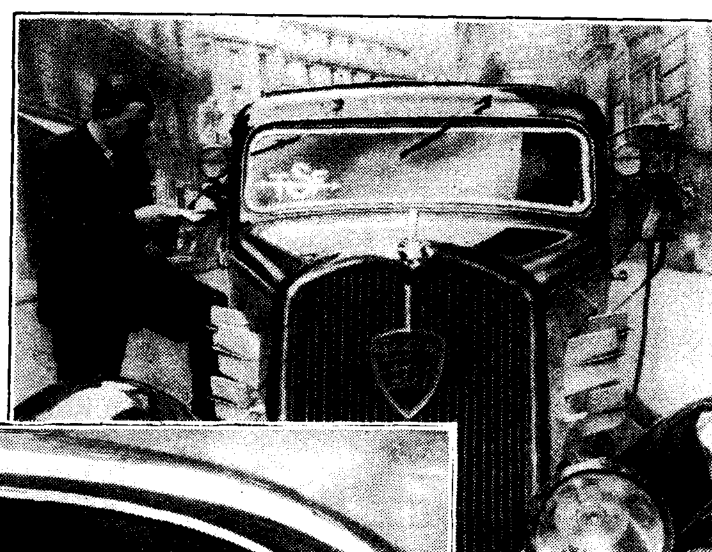
THE Radio Society of Great Britain has just concluded one of the most successful three-day field events. The idea was for amateurs working entirely in the open—buildings were barred—to establish as many contacts as possible in order to see over what distances communication could be accomplished with simple apparatus in cases of emergency. Amateurs in all parts of the Empire and in North America were co-operating, over 100 transmitters being in use. England and Scotland were divided into twenty-two districts, each of which had two official stations. Some parties were working on the 80-160 metre band; others on the 20-40 metre band. Naturally, the latter were by far the more successful in making long-distance contacts. Few of them, in fact, scored less than fifty, and the total number of contacts must have run into some thousands. Africa, America and India could be "worked" satisfactorily, but Australia and New Zealand proved very difficult at this particular time.

All-wave Sets

AT the present time I am using an "all-wave" receiving set which is a sheer joy. The appellation "all-wave" is, of course, a misnomer, since the wavelength range of the set is limited to three bands. But so many of our wireless terms *are* misnomers that one more makes little difference. This set tunes roughly from 16 to 60 metres, from 190 to 550, and from 1,000 to 2,000. The great thing about it is that you can ring the changes on short, medium and long waves by merely flicking the knob of a switch clockwise or *vice versa*. You can change, for instance, from New York to Droitwich in a second or so, and either is just about as easy to tune in. Automatic volume control is in action whatever the wavelength which you are receiving, and it

TAXI RADIO

TWO or three weeks ago Paris taxicabs showed great enterprise by adopting car radio, and to-day as many as one in three of the taxis on a rank may be so fitted. No extra charge is made for the use of the set, and every car so fitted is prominently labelled "T.S.F." Perhaps one reason why such success has attended the introduction of car radio to Paris taxis is that their clients can always choose a taxi from the rank without having to accept the custom which has grown up here of always taking either the first on the rank or the consequences of not doing so! A combined tuning and volume control is fitted in a convenient position for the passenger.



certainly makes an enormous difference to the entertainment value of short-wave transmissions. I am a great believer in the future of the all-wave set, particularly as in the natural order of things reception on the medium and long waves should deteriorate as we approach the coming sunspot maximum, whilst that on the short waves should grow better and better.

Band-spreading

One of the drawbacks of the short-wave set in former years was that, even if you had the slowest of slow-motion dials tuning, it did demand a considerable amount of skill, owing to the minute adjustments that were required to bring a signal up to its best possible strength. Band-spread tuning is one of the biggest boons that modern developments have conferred upon the short-wave enthusiast. It does away entirely with hair's-breadth adjustments and makes the tuning-in of the average short-wave station a perfectly simple business. Combine band-spreading with a visual tuning indicator, and you have a short-wave set that is delightfully easy to use.

Do We Radiate ?

If the report which appeared some days ago in the lay Press is correct, your "Diallist" is not alone in emitting random radiations. Everybody, in fact, does it (so we are assured, at any rate) and so hefty are the "rays" unconsciously sent out by the human body that they think nothing of penetrating many feet of solid masonry. A new form of burglar-alarm has, we are told, as its basic principle the use of an "electrically charged wire." Directly anyone approaches this wire the radiations from his body "upset the frequency" and relays cause lights to glow, bells to ring and all kinds of other exciting things to happen. Of course, we may be radiating like anything for all I know; but somehow the device seems to suggest the infra-red beam and the photo-electric cell, does it not? I can't help wondering whether one effect of that electrically charged wire may not be the administration of a shrewd pull at the leg of any lay reporter who ventures near it.

The Age of Miracles

Speaking the other day at a Jubilee luncheon Sir Frank Smith referred to the times in which we live as the age of miracles, and so indeed they are. He went on to suggest that the greatest of the miracles accomplished during the twenty-five years of the King's reign was the harnessing of the electron in such a way that it is now possible for one man to speak to the entire world. Progress in wireless has been utterly astonishing. Though it is but thirty-four years since the Atlantic was first spanned with crude telegraphic apparatus, you can now tune in on your short-wave or all-wave receiving set the evening news bulletin from Schenectady with almost the same certainty as that from the local station. From your own home you can telephone by means of the wireless link to almost any part of the civilised world. And, thanks to the use of wireless, the cost of telephone calls over great distances is surprisingly small.

Best of all, perhaps, in the thirteen short years of its existence in this country wireless broadcasting has entirely altered the lives of millions of people, bringing music and entertainment into homes where previously there was none.

Noise The Science Museum Exhibition

By N. W. McLACHLAN

On May 31st the Prime Minister opened an exhibition at the Science Museum, South Kensington, organised by the Anti-Noise League. This exhibition, which is free to the public, continues till the end of June. Noise is a subject with which we are all concerned directly or indirectly, so the following paragraphs will be of general interest. If they stimulate readers to visit the exhibition and to study the problem of noise and its reduction more closely, their purpose will have been fulfilled.

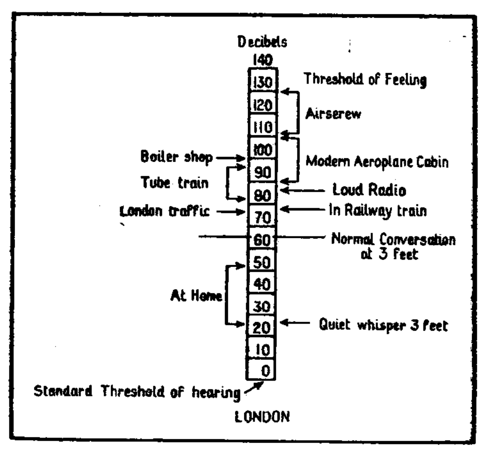
Instruments for making measurements are absolutely essential in the scientific study of any subject, so various types of noise meter are to be seen at the exhibition. In one type comparison is made between the noise and a source of sound whose level in decibels above a certain datum is known. If the reference tone used for comparative tests were 1,000 cycles, then the level of the noise is taken to be the level of this tone when the two sounds appear to be equally loud. Elsewhere* I have designated this the "reftone level," and it is given in decibels. It does not represent the loudness of the noise, but that of the equally loud 1,000-cycle tone. Loudness is not measured in decibels, as one might imply from the noise "thermometer" (a misnomer, since noise is dissociated from heat) to be seen at the show. Also, it is important to point out that the datum level from which the reference tone level is now taken is 0.0002 degree per square centimetre, so that all the levels shown on the "thermometer" should be increased 14 db. Thus, the "danger" line, which is taken to represent the level of normal conversation, should be 64 db., as shown in the accompanying noise ladder, and not 50 db.

Instruments are also shown for obtaining "objective" measurements of noise, and for analysing the noise into its main frequency components. For example, an analysis of the various constituent frequencies of the sound from a motor horn is shown on a chart. In one exhibit a neon lamp lights up when one coughs or talks loudly. A switch is operated by amplified microphone currents when a certain value is exceeded, and the light comes on.

The internal (or should it not be infernal) combustion engine, particularly in the case of motor cycles, is a source of considerable noise, as also is the pneumatic drill used to disintegrate the road whilst one is having lunch. Demonstrations are given in which the noise level of the exhaust is reduced more than 20 decibels, i.e., a power ratio of 16/1. The effect is quite convincing, and the added aural comfort welcome. The type of silencer used does not impair the performance of the machine.

Those who dwell in flats or in modern houses know that, whatever advantages the habitations may possess in some respects, they are likely to be offset by the activities of their neighbours filtering through in the guise of sound waves. A number of exhibits illustrate the various ways by which noise can penetrate into one's domestic preserves, and also how it can be prevented from doing so. Working models enable a good idea of the difference in noise level between a room of ordinary design and one in which precautions have been taken to guard against noisy conditions. It is not generally appreciated that when there is a certain noise level outside a room, that within the room can be reduced materially by the use of suitable damping material in the room, e.g., by treating the ceiling with some form of sound absorption material. In this way a reduction in noise level of from 5 to 7 decibels can be obtained.

Readers are familiar with the well-known electrical filter whereby unwanted frequencies can be suppressed. The mechanical analogue of the electrical filter is applied in various exhibits to deaden the impact noises due to footsteps on an overhead floor, or the vibration transmitted from an electric motor to its foundations. There are working models by aid of which the visitor can corroborate that beneficial results accrue from applying scientific principles to the problem of vibration reduction. In one exhibit there are two long metal ducts about 6in. × 8in. section, each terminated at the far end in a chamber housing an electric bell. One duct is lined, whilst the other is not. On pressing buttons the bells can be made to ring in succession. The reduction in noise level due to the absorbent material is striking, but we did notice that on testing the two bells out of their chambers, that the lustier of the two was on the unlined side! There is also a working model.



A model of Broadcasting House shows the elaborate system of construction for preventing noise reaching the studios. Microphones of the ribbon, moving-coil and probe-tube types are shown. There is a working model of the Rayleigh disc, which has been developed into an instrument of precision for calibrating microphones.

These and many other exhibits of interest are to be seen at the Science Museum. On the whole a visitor leaves with the impression that if only scientific methods were applied universally to the manufacture of machinery and the construction of buildings, the level of the noise, from which we are seldom free, would be 10 decibels or so lower than it is now. We might add that the greater part of the principles of noise reduction and measurements as exemplified at the exhibition, have been treated at some length in the book cited above and entitled *Noise*.

* *Noise:* A Comprehensive Survey (Oxford University Press, 1935).

Listeners' Guide for the

CANTERBURY FESTIVAL. Concerts in the cloisters and the Cathedral itself will be broadcast next week, the B.B.C. Choir and Orchestra being conducted by Adrian Boult. The cloisters form a unique "studio," producing unusual echo effects.

CLOISTERS AS STUDIO

No other broadcasting "studio" in the world is quite like the cloisters of Canterbury Cathedral, whence a "Serenade" in the Canterbury Festival of Music and Drama will be broadcast on Tuesday next (Reg., 8.45).

Dr. Adrian Boult will conduct the orchestra of forty players. On the following evening Dr. Boult will conduct the B.B.C. Choir and Orchestra (Section B) in the Cathedral itself, the programme including Bach's Fantasia and Fugue in G Minor and Bruckner's Seventh Symphony in E. Harold Williams will sing "Five Mysterious Songs" by Vaughan Williams. The acoustics in the Cathedral are exceptionally fine.

"THE GEISHA"

ONE of next week's highlights will be "The Geisha," the Japanese musical favourite in which many well-known artists will appear, including Huntley Wright, who created the rôle of Wun-Hi; Betty Huntley Wright, his daughter, playing Molly Seamore; and Lawrence Baskcomb, who will take the comedy part of Imari. Marie Tempest, who featured in the original production in 1896, will be heard in reminiscences of the play.

Arnold Matters, who recently appeared at Covent Garden, plays Lieutenant Fairfax, and Anne Ziegler, who has scored several successes in recent radio performances, will sing the part of O Mimosa San. (Tuesday, Reg. 7.30; Thursday, Nat. 8.)

CRICKET AT THE LOUD SPEAKER

CAPTAIN H. B. T. WAKELAM will give the running commentaries on the first Test Match, England v. South Africans, at Trent Bridge, Nottingham, which begins to-morrow (Saturday). Broadcasts from the ground will be given at intervals each day and in these brief accounts Captain Wakelam may be depended upon to give in distilled essence all those thrills which the actual onlookers have to sit long hours to obtain.

30-LINE TELEVISION

Baird Process Transmissions
Vision 261.1 m.; Sound, 296.6 m.

MONDAY, JUNE 17th.
11.15—12.0 p.m.

Rosarito and Julian (Spanish Dancers); Roy Royston (Musical Comedy); Leonard Henry; Sydney Jerome's Quintet.

WEDNESDAY, JUNE 19th.
11.15—12.0 p.m.

Ruth Markand (première danseuse); Naxim Turgenoff (Russian tenor); Olga Alexeeva (soprano); Stanley Judson (première danseur of the Levitoff ballet); Eleanora Harra (late of the Diaghileff Russian ballet).

AT THE SIGN OF THE RED SARAFAN

TUESDAY night is "Red Sarafan" night, and Emilio Colombo will again transport us to a Russian restaurant with his distinguished orchestra (National, 8.45). Local colour will be strengthened by the presence of Olga Alexeeva and Lev Holiloff singing Russian folk songs, and there will be the Novaya Derevinna gypsies and a number of visitors and guests.

Emilio has put on paper from memory many of the traditional songs which we shall hear during this visit to the "Red Sarafan."

RICHARD TAUBER

THE long-awaited programme by Richard Tauber takes place on Wednesday next, when at 10 o'clock on the National wavelengths the famous tenor will devote an hour to favourite songs from the Lehár operettas as well as many of his own compositions. The Lehár numbers will include the "Volga Song" (Der Zarewitsch), and "Villa" (The Merry Widow).

Herr Tauber will also conduct the B.B.C. Theatre Orchestra in the Overture to "Gipsy Love" and a selection from his own opera, "The Singing Dream."

A VIENNESE DEBUT

SERGE KRISH with his Septet is a great exponent of the Viennese style of light music, and on Thursday next, in the Regional programme, he will give listeners a concert in the same tradition, though it promises to be more than usually interesting, for his singer will be Halga Motte, a young Viennese soprano, who will be making her microphone debut.

MURDER TO MUSIC

JUST enough of "The Mystery of the Seven Cafés" to whet our appetities will be heard in the Prologue on Thursday next, June 20th. This serial thriller, with incidental music by Walford Hyden, has been written by Sydney Horler and Holt Marvell. The story concerns the

LEADING BARITONE of the Dresden Opera House, Paul Schoeffler takes part in a Viennese programme with the B.B.C. Theatre Orchestra on Sunday evening. (Reg., 6.30).

mysterious death of a secret service chief, who has stumbled on a world-wide conspiracy to destroy the stability of the world's finances. The Prologue leads up to the hue and cry of Tiger Standish (to be played by Norman Shelley) through all the most delectable cafés of Europe. On Thursday evening we shall hear the sinister violin tune that insinuates itself whenever trouble is afoot.

Serials have not so far been a success "on the air," but this café business, with its mixture of music and murder, may set a new fashion.

Week

Outstanding Broadcasts at Home and Abroad

AS WE SEE OURSELVES

BRITONS enjoy jokes against themselves—when the perpetrators are fellow Britons, and this partly accounts for the success of the talks series, "Among the British Islanders," satirising modern customs and conventions. To-night the critical visitor from Mars is A. G. Macdonnell, author of that clever novel, "England, Their England."

WATERLOO ANNIVERSARY

WHETHER Waterloo was won on the playing fields of Eton or somewhere not far from Brussels may be decided at 9 p.m. on Tuesday, June 18th, when Brussels No. 1 is broadcasting a talk in French on the battle, fought 120 years ago.

On the previous evening at 8.15 Frankfurt will commemorate the battle with a dramatic programme, in which the Third German Infantry Regiment will co-operate with band music.

OPERAS FOR ALL

OPERA lovers have a good choice during the next few days. To-morrow night (Saturday) Hilversum broadcasts Puccini's "Tosca" on records at 7.55; Radio-Paris gives to-morrow, at 8.45, "La rôtisserie de la Reine Pédauque," Levadé's opera comique in four acts; at 8.50 on the same evening Rome broadcasts Wagner's "Tannhäuser," and early on Sunday morning, from 12.50 to 2 a.m., Stuttgart will give Flotow's "Allessandro Stradella." Needless to say, the performance will be on records.

RICHARD TAUBER gives an hour's programme of light opera selections on Wednesday. The world-famous tenor is here seen listening to one of his own recordings on an H.M.V. radiogram.

On Tuesday, June 18th, at 8.30, Lecocq's opera comique "La fille de Madame Angot" will be broadcast from Paris PTT, and all the French State stations except Radio-Paris and Eiffel Tower. The National Orchestra and Choirs will take part.

THE MESSIAH

No one will dispute that "The Messiah" is the most popular oratorio ever written. It took Handel, in 1742, twenty-four days to compose, and although it was soon performed in London and Dublin, it was not heard in his native Germany until thirteen years after his death. "The Messiah" is to be broadcast to-night (Friday) at 8 o'clock from the Deutschlandsender and all German stations by the Bruno Kittel Choir and the Station Orchestra.

NATIONAL MUSIC

ALTHOUGH we are told that Art has no boundaries, the broadcasting of national music seems to be increasingly popular. To-morrow (Saturday) at 7.30, Kalundborg gives a concert of Danish music with the Radio Orchestra. At 9 o'clock, from the same station, the Workers' Reading Society Choir will give Old Russian Folk Songs. On Monday at 8.20 the same station will broadcast Scandinavian music. Walloon music comes from Brussels on Tuesday, June 18th, at 6.30.

From the Brussels Exhibition on Thursday next, June 20th, at 8, comes a concert of folk dance music.

THE WALTZ

THE traditional German band always excels at waltzes, and we may expect a very fine performance at 8 p.m. on Sunday, when the Deutschlandsender devotes a special programme to the famous rhythm. There will be a dance orchestra, the Chamber Choir, the Deutschlandsender Main Orchestra, pianoforte duettists, and singers.

THE AUDITOR.

MANTOVANI and his Tipica Orchestra will be heard in a tea-time broadcast to-day (Nat.).

HIGHLIGHTS OF THE WEEK

FRIDAY, JUNE 14th.

Nat., Variety. ¶"Among the British Islanders—'Sport,'" A.G. Macdonnell.

Reg., 8.30, Toscanini conducting last London Musical Festival Concert.

Abroad.

Budapest, 7.30, Opera: "Madame Butterfly" (Puccini) from the Royal Opera.

SATURDAY, JUNE 15th.

Nat., England v. South Africa Test Match Commentaries. ¶Harold Ramsay's Rhythm Symphony. 9.45, Borodin's "Prince Igor," Act II, from Covent Garden.

Reg., "Good Pull-up for Cyclists." ¶The American Half-Hour—II.

Abroad.

Rome, 8.50, Opera: "Tannhauser" (Wagner).

SUNDAY, JUNE 16th.

Nat., B.B.C. Military Band. ¶Violin Recital by Szigeti. ¶Leslie Jeffries and Grand Hotel, Easthourne, Orchestra. ¶Alfredo Campoli Trio.

Reg., Sydney Baynes and His Band. ¶Eugene Pini and His Tango Orchestra. ¶B.B.C. Orchestra (E) conducted by John Barbirolli.

Abroad.

Radio-Paris, 8.30, "Le mystère de la Passion" relayed from Notre Dame.

MONDAY, JUNE 17th.

Nat., Test Match commentaries. ¶Act I, "Yeomen of the Guard" (Gilbert and Sullivan) relayed from Sadlers Wells.

Reg., B.B.C. Military Band, ¶B.B.C. Dance Orchestra. ¶B.B.C Orchestra (E) conducted by Joseph Lewis.

Abroad.

Brussels No. 1, 8, Orchestral Concert from the Universal Exhibition.

TUESDAY, JUNE 18th.

Nat., Test Match commentaries. ¶"Peter Porcupine" (Life of Wm. Cobbett). 8.45, "The Red Sarafan."

Reg., 7.20, "The Geisha." ¶Canterbury Festival of Music and Drama.

Abroad.

Kalundborg, 10.20, Concert by the Radio Orchestra.

WEDNESDAY, JUNE 19th.

Nat., 7.15, Canterbury Festival. 10, Richard Tauber's Hour.

Reg., "Variety," with Sandy Powell, Ronald Gourley, Gaby Vallée. ¶Gershom Parkington Quintet.

Abroad.

Brussels I, 8, Concert by the Symphony Orchestra. Yvonne Bartholeyns (pianoforte).

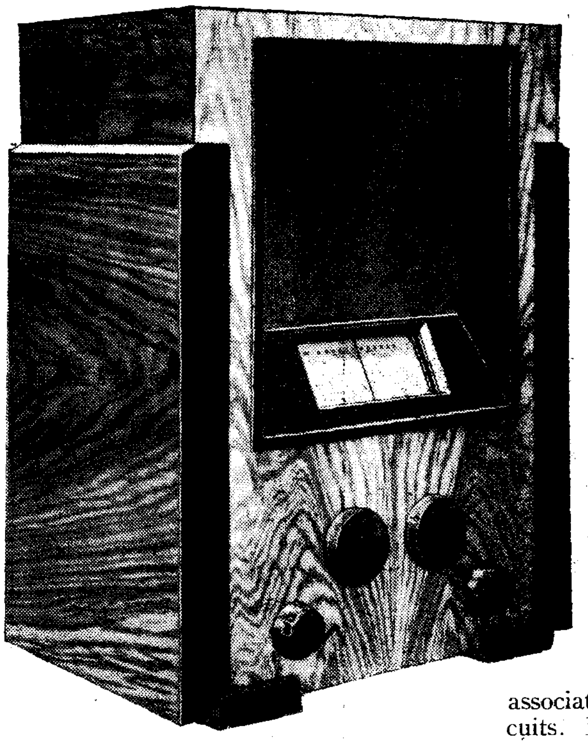
THURSDAY, JUNE 20th.

Nat., 8, "The Geisha." ¶"The Mystery of the Seven Cafés"—1st instalment. ¶Boyd Neel String Orchestra.

Reg., B.B.C. Military Band. ¶"Soft Lights and Sweet Music" (last presentation). ¶Recital by Edna Thomas (soprano) and Harriet Cohen (pianoforte). ¶Scarborough Spa Orchestra.

Abroad.

Berlin, 8.10, "A moonlit night on the Havel."



Halcyon AC7

A Four-valve Superheterodyne with Some Interesting Departures from Standard Practice

FEATURES.—**Type.**—*Table model superheterodyne for AC mains.* **Circuit.**—*Octode frequency changer—var.-mu pentode IF amplifier—double-diode-triode second detector — pentode output valve. Full-wave rectifier.* **Controls.**—*(1) Tuning. (2) Volume and on-off switch. (3) Tone. (4) Waverange.* **Price.**—*11 guineas.* **Makers.**—*Halcyon Radio Ltd., Sterling Works, Dagenham, Essex.*

A NEW Halcyon receiver is always a source of interest to students of design, as the makers generally manage to incorporate some feature, or features, which lift the receiver from the rut of current convention. In this respect the AC7 is no exception, and although most of the points of interest are to be found in the arrangement of the circuit, the cabinet design, the controls and the tuning indicator all have their points.

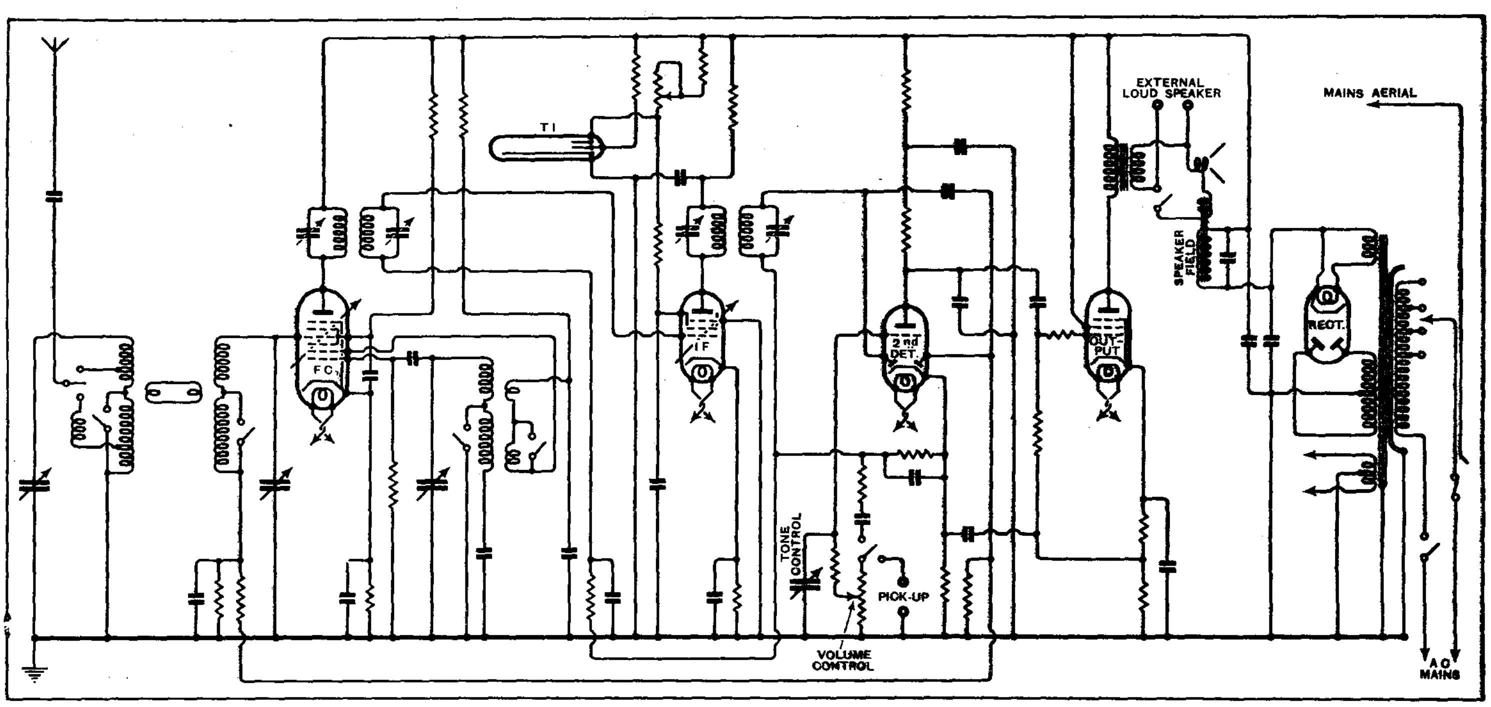
The foundation of the circuit is the customary four-valve superheterodyne arrangement of a frequency-changer followed by an IF amplifier, double-diode-triode second detector and pentode output valve. An inductively coupled band-pass filter precedes the frequency-changer, which is of the octode type. The IF amplifier functions at a frequency of 110 kc/s, and there are four tuned circuits in the transformers associated with the input and output circuits. It is interesting to note that the neon tuning indicator is not operated from the anode circuit but from the screen circuit, where the effect of damping is negligible.

Tone Compensated Volume Control

In the double-diode-triode second detector valve both the AVC and signal diodes are fed from the secondary of the output IF transformer. The rectified signal is passed to the grid of the amplifying portion of this valve through the usual resistance-capacity network. The volume control is also incorporated at this point and is compensated so that the bass response is increased as volume is reduced and the usual thinness of tone associated with low volume levels is thereby avoided. The variable tone control takes the form of a simple shunt condenser.

The AVC bias, derived from the second diode, is fed to the frequency-changer and IF valves through separate circuits. There is no delay on the frequency-changer bias, but the IF amplifier carries a delay voltage which is variable and depends upon the strength of the incoming signal. In effect, the delay voltage is the difference between the cathode potentials of the IF and second detector valves. With this arrangement there is no discontinuity between the amplification afforded to weak and strong signals, and better control should be experienced on stations of intermediate strength.

The triode portion of the second detector stage is resistance-capacity coupled to the high-amplification pentode output valve, and some degree of tone correction is applied at this point by coupling the cathode of the second detector to a point on the output valve bias resistance through a condenser of large capacity. The effect of this arrangement is considerably to improve the LF response.



The tuning indicator is connected in the screen circuit of the IF amplifier. Other interesting features of the circuit include variable AVC delay voltage and compensated low-frequency response.

Halcyon AC7—

A hum-bucking coil is included in series with the secondary winding of the loud speaker speech coil. Sockets are connected in parallel with the secondary winding for the attachment of a low-impedance external loud speaker and a link is arranged to disconnect the internal loud speaker if desired.

The mains voltage adjustment is accessible and the connecting link incorporates a fuse. There is also a mains aerial connection deriving its pick-up through capacity from the mains leads.

Judging from the results, the special AVC circuit adopted appears to be thoroughly justified as far as weak stations are concerned, for the majority of the border-line stations which, in an average four-valve superheterodyne, hardly give results which can be claimed to be of good programme value, are received by this set with unusual steadiness of volume and freedom from background noise. As far as the reception of strong signals was concerned the London National transmitter was kept well in control when being received in Central London, but in the particular receiver tested there was some evidence of overloading prior to the second detector in the reception of the stronger London Regional station. No doubt this is a matter of some minor adjustment in the circuit values.

Good Selectivity

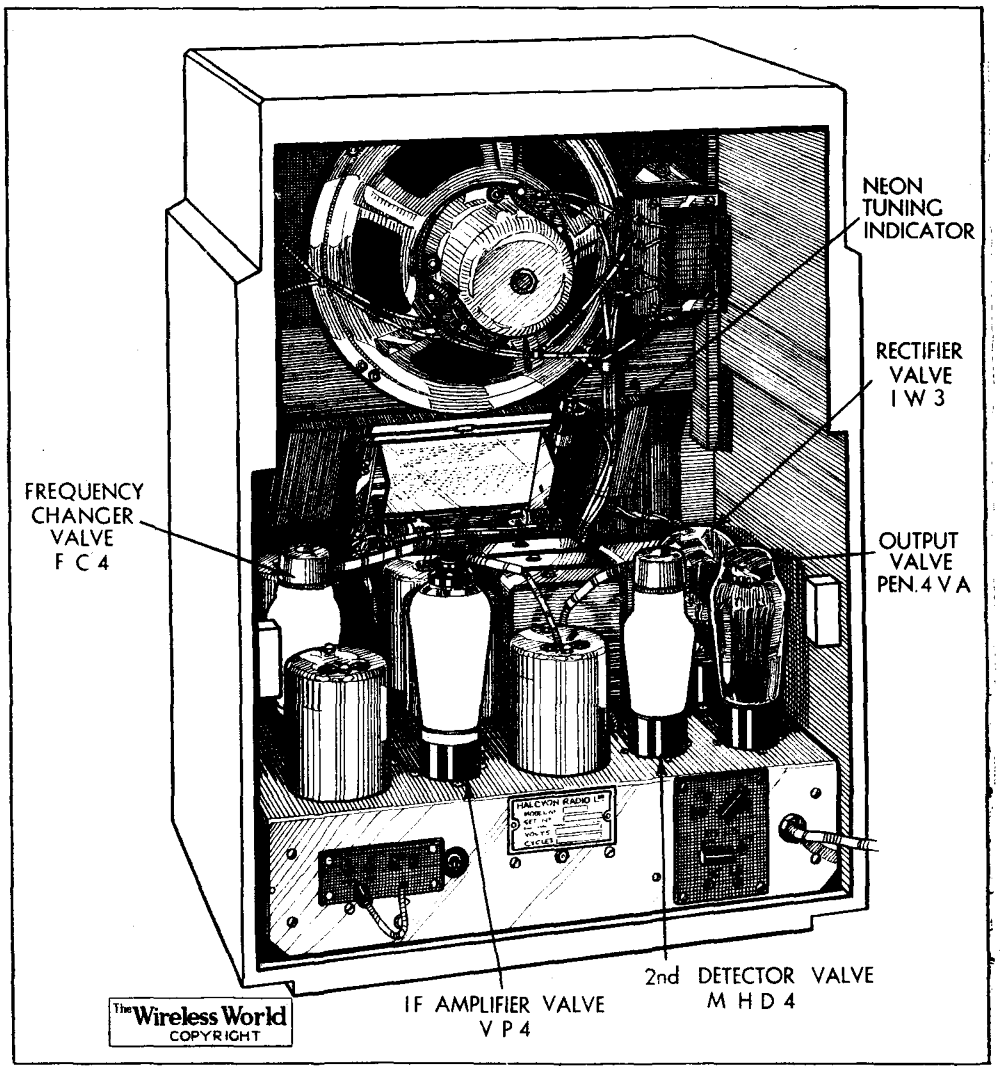
The selectivity is remarkably good, particularly on long waves, the reception of the Deutschlandsender being very much above the average. There was very little side-band interference from Droitwich, and the use of the tone control was not required in order to effect an improvement in the programme value of the German station. On the medium waveband the selectivity is sensibly uniform throughout the range, and both on the National and Regional transmitters not more than 1½ channels were lost on either side of the normal settings.

The high selectivity does not appear to have seriously affected the high-note response, though there is, perhaps, less on long than on medium waves. The reproduction is notable for its round and full quality in the medium and lower registers, the quality in the bass being quite different from that usually associated with cabinet or loud speaker resonance.

Due, no doubt, to the fact that both the AVC and signal diodes are fed from the same point in the IF circuit, there is some accentuation of sidebands as the receiver is tuned through a station, but with the neon tuning indicator no difficulty should be experienced in avoiding distortion from this cause. There was one prominent second-channel whistle between North Regional and Cologne, and one or two self-generated heterodyne notes could be detected on the long waveband, though they were not of sufficient strength to call for criticism. Some mains hum could be detected within a radius of two or three feet of the loud speaker, but only when the set was otherwise silent.

The loud speaker fret is recessed in the front of the cabinet, and the lower part of the frame is occupied by the tuning scale, which is inclined upwards at a convenient meter. Incidentally, the tone control works in the opposite direction to that usually adopted, the maximum high-note response being obtained with the control turned fully in an anti-clockwise direction.

The neon tuning indicator is mounted at the left-hand edge of the tuning scale



Removal of the chassis for testing and adjustment is unnecessary as access to the underside is obtainable after removing a panel in the base of the cabinet.

angle. No less than eighty-seven station settings are indicated, and, in addition to being quite up to date, the scale deserves special commendation for its unusual accuracy to calibration.

An innovation is to be found in the tuning and volume controls, which are given positions of equal importance on the front panel and are both of large dia- and is graduated by a series of black stripes, which provide a convenient scale for judging the position of exact tuning.

The chassis is finished in the characteristic Halcyon blue, and access to all the components and wiring is obtainable by removing a panel from the base of the cabinet and without the necessity of dismantling the chassis from the cabinet.

Next Set Review: **PYE TP/B**

Fluorescent Screens

THOSE fluorescent materials which produce the most brilliant effect under the action of the electronic bombardment inside a cathode-ray tube are handicapped by the fact that the colour they produce is too green to please the eye. Other fluorescent substances are known to produce different tints, and, by using a suitable combination, it is possible to achieve an effect approximating to natural black and white.

Cadmium tungstate, for instance, produces a light blue fluorescence under comparatively low anode voltages, whilst zinc phosphate gives a reddish colour. A mixture of the two, in the proportion of three to one by weight, has, however, been found to give a substantially white response for operating voltages between 600 and 2,000.

The screen is prepared by first coating the carrier surface with a solution of sodium silicate and then dry-spraying it with the fluorescent mixture. The sensitivity of the screen is stated to be fully up to standard.

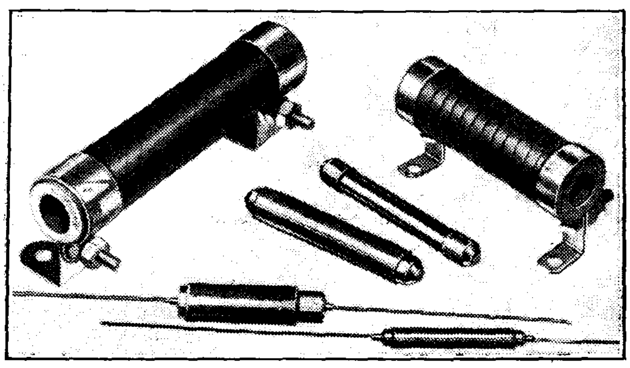
New Apparatus Reviewed

Recent Products of the Manufacturers

SEMPER IDEM RESISTANCES

THESE resistances are of the composition type and are made in a wide range of sizes rated for continuous loading from a half-watt to 20 watts. Certain of the 3-watt models are available as low as one ohm, this series extending from one to 10,000 ohms, whilst there are one- and two-watt type ranging from 10 ohms upwards; the half-watt models start at 100 ohms and extend to 5 megohms.

In the lower wattage models the resistance material is moulded in the form of a rod with metal end-caps fitted either with wire-ends, with screw terminals, or with chamfered ends for inserting in clips as required. The heavy-duty type have the resistance material deposited on heat-resisting tubes,



Selection of Conradty Semper Idem Resistances.

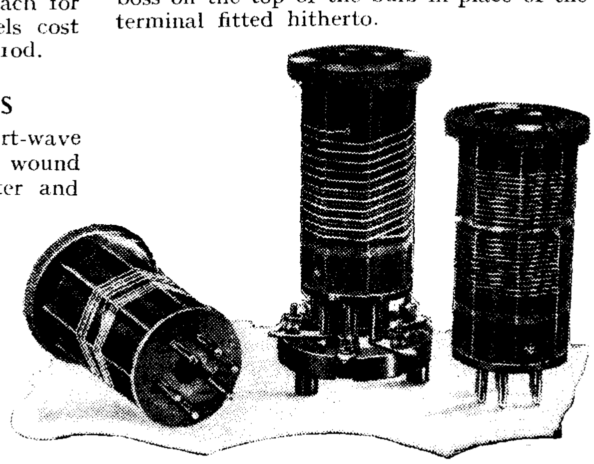
contact being made by metal clips which serve also for mounting the resistor on an insulated base.

Tests have been made with several specimen resistances, each carried its maximum load current without a trace of overheating or giving any indication that the resistance was being stressed in the least. Their measured resistances were very close indeed to the marked values; the resistance does not change appreciably under full load, and they are noiseless in use.

Semper Idem resistances are obtainable from Conradty Products, Ltd., 101, Wardour Street, London, W.1, and prices range from $4\frac{1}{2}$d. each for $\frac{1}{2}$-watt to 4s. each for the 20-watt size. One-watt models cost $5\frac{1}{2}$d., two-watt 7d., and three-watt 10d.

B.T.S. SHORT-WAVE COILS

THE particular set of B.T.S. short-wave coils sent to us for review are wound on ribbed formers $1\frac{1}{2}$in. in diameter and 3in. long fitted with a six-pin base. Each former carries three separate windings which can be employed as aerial, grid and reaction coils, or as primary, secondary and reaction, according to the position of the coil in the circuit.



B.T.S. six-pin plug-in short-wave coils and base.

The grid coils are in every case space-wound and one of the other coils is interwound with it. The latter is the primary, or aerial, winding, as the case may be. With some circuit arrangements, and also with certain valves, the interleaved winding served best for reaction and the looser coupled winding employed as the aerial coil, but with a small condenser in series.

The three coils are clearly marked with the waverange each covers for identification, thus 13-26, 24-52 and 46-96 indicates the band each covers. Actually, in a circuit where the stray capacities are reasonably low the tuning range of the coils using a 0.00016 mfd. condenser was 10.2 to 22.4 metres, 21.1 to 45.6 metres and 34.2 to 84 metres respectively.

Their performance in a simple one-valve receiver was particularly good and the coils are obviously very efficient. A good feature in the design of the coil former is the large milled-edge ring at the top; this provides a secure grip for the coil when removing it and replacing it by another.

The two shorter-range coils cost 4s. 6d. each and the 46-96 metre coil 5s. A six-pin base of skeleton construction and mounted on pillars to avoid undue capacity to a metal chassis costs 2s. The makers are British Television Supplies, Ltd., Bush House, London, W.C.2.

FORREST DUAL-WAVE REPRESSOR

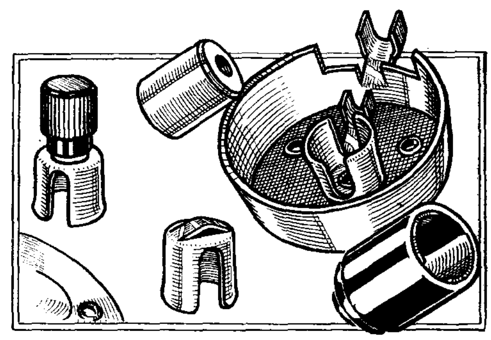
IN our review of this unit in *The Wireless World* of May 10th last, it should have been stated that the unit is designed especially for Midland conditions, being intended for use where break-through is experienced from Droitwich and the Midland Regional stations.

NEW BULGIN VALVE CONNECTORS

SEVERAL new items have been added recently to the Bulgin range of components, among which is a series of connectors and adaptors for valves having a metal boss on the top of the bulb in place of the terminal fitted hitherto.

The P41 model is a plain clip-on connector to which the wire can be either soldered or clamped, and the price is 2d. for three. A similar model, but fitted with an insulated outer sleeve, costs 1d. each and is listed as the P43, whilst a clip-on connector having a small terminal is available at 3d. and is known as the P66 adaptor.

There are two styles of screened top connectors, one, the P64, is of such depth as to completely enclose the top plug, whilst the P65 is shallower and will not contact with the metallising on the average valve, it being intended for use where the metallising of the valve is not directly earthed. Either model costs 6d. each.



Bulgin range of valve top connectors including plain, insulated and screened models, also an adaptor boss.

Specimens of all these connectors have been fitted to several different makes of valves, and in all cases they make a sound and secure connection. A point of interest regarding the enclosed model is that a lug is provided on the screened cap for anchoring the metal braiding of the lead.

Where it is required to convert the screw-top valve terminal to a boss so that a plug-on connector may be used there is a small adaptor in this series that replaces the terminal; this costs 2d.

The makers are A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex.

The Radio Industry

LESLIE DIXON & CO., of Electradix House, 218, Upper Thames Street, London, E.C.4, tell us that they are now able to supply from stock public-address amplifiers with ratings from $2\frac{1}{2}$ to 10 watts, both universal and AC models. Some of the amplifiers are described in a leaflet just issued. In most cases these amplifiers are fitted with the new Piezo-Lesdix crystal microphone.

Cyril French, of 29, High Street, Hampton Wick, Kingston-on-Thames, who, as recently stated in these columns, has been appointed sole distributor for Celestion speakers to the wholesale and retail trade, has just issued leaflets describing the various Celestion models, including the high-note tweeter.

Higgs Motors, Ltd., Witton, Birmingham, has sent us a copy of a well-bound pocket-book containing much useful information on the subject of electric motors in general.

Tannoy public address equipment will be used at the forthcoming inspection by H.M. the King of the Royal Air Force at Mildenhall, and also at the "Fly Past" at Duxford. The equipment will be used both for giving orders to pilots and to keep spectators informed as to what is going forward.

McMichael portables were installed on both the up and down "Flying Scotsman" trains for reception of the Derby broadcast.

FOUNDATIONS OF WIRELESS

By A. L. M. SOWERBY, M.Sc.

Part XXIV.—The Outlines of Set Design

THE present instalment is, in effect, a summary of the ground already covered by the series; its presentation is in the very useful and practical form of a discussion of the problems confronting the designer of a typical "straight" receiver.

WE have covered, fairly fully, all the essential points necessary for the full comprehension of every part of an ordinary receiver not of superheterodyne type, but the references are scattered about over the twenty-three preceding parts. Before going on to consider the peculiar properties of the superheterodyne, it is proposed to devote this one part to the practical discussion of the design of a typical simple set, with the idea of making a kind of summary of the ground already covered. Whenever reference, direct or indirect, is made to an earlier section of this series, the number of the part concerned appears in brackets.

We will suppose that we have been asked to design a set which will have an average sensitivity of about one millivolt. By this is meant that if a carrier-voltage of this magnitude, modulated to a depth of 30 per cent. (14) is applied to the aerial terminal, the overall magnification of the set will be such that the "standard output" of 50 milliwatts of modulation-frequency power will be delivered to the loudspeaker. The selectivity of the set is to be that associated with three tuned circuits—since their L/r ratio is bound to vary widely over the wave-range covered (20) no numerical specification of selectivity is practicable. The whole is to be driven by batteries, and, for the sake of economy in upkeep, is to consume a maximum of 10 milliamps. in the anode circuits.

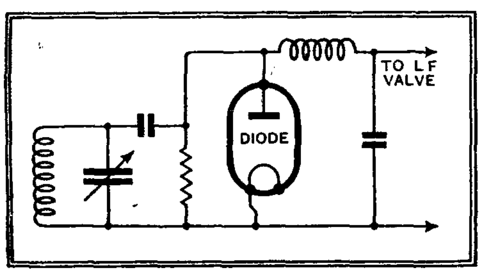


Fig. 128.—Since the diode does not amplify, this type of detector cannot be used to produce reaction.

The first points to be settled are the type of output stage to be used, the kind of detector we shall choose, and whether the three tuned circuits shall be associated with one or with two high-frequency amplifying valves. These points are interrelated, and involve also the limitation in total anode current already imposed.

This latter limitation immediately suggests the choice of a quiescent output stage (QPP or Class "B"), but also implies that a small-size HT battery is likely to be used. Now small batteries generally fail, except when new, to hand out the large instantaneous currents (23) demanded by quiescent output stages, and, by so failing, introduce very evident distortion. We will therefore play for safety and choose as output valve a pentode, on the grounds that it makes more noise per milliamp. than does a triode (23).

Four Milliamps Left.

A battery pentode, if of the high-impedance type, takes about 5 mA. at 120 V., in return for which it will deliver some 250 to 300 mW. before overloading. This, though small, is an acceptable output for a set of the type contemplated. Allowing another milliamp. for the screen of the pentode, 6 of our available 10 mA. are already accounted for.

With only three tuned circuits in the set it is quite certain that occasions will arise when the selectivity will not be adequate for separating the station required from others on neighbouring frequencies. In order that selectivity can be enhanced when desired, reaction will have to be available to the user (17 : 20). The use of fairly flatly tuned circuits with adjustable reaction as an auxiliary will enable the inevitable selectivity-quality compromise (17 : 20) to be readjusted by the user as he tunes from station to station.

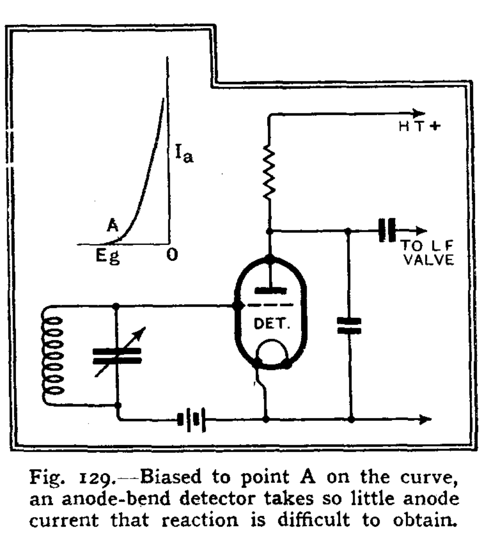


Fig. 129.—Biased to point A on the curve, an anode-bend detector takes so little anode current that reaction is difficult to obtain.

For providing reaction the diode detector (14) is obviously useless. It is less evident that the anode-bend detector is not good from this point of view, but it is found in practice that owing to the very small anode current drawn by this type of detector (15) there is not enough power available in the anode circuit for satisfactory reaction to be available. We shall therefore choose a grid detector (15).

Either a screened pentode or a triode may be successfully used for this purpose, the former giving much the higher amplification. To set against this advantage it has so high an AC resistance (about 0.5 MΩ) that the use of a transformer to couple it to the output pentode is out of the question if we have any respect at all for our low notes (22). Shunting the transformer by a resistance would limit the high-note gain to that available for low notes, but in so doing the gain would be reduced to about that of a simple triode. If we try to use resistance coupling the voltage at the anode will be found to be seriously restricted by the voltage-drop in the resistance, and detector overload (15) will set an uncomfortably low limit to the available output, especially at low modulation depths. To provide our output pentode with the signal (approx. 3 V. peak) that it needs to develop full output, and at the same time to make reaction behave satisfactorily, it will be safest to choose a triode detector followed by a transformer of step-up ratio not less than three to one.

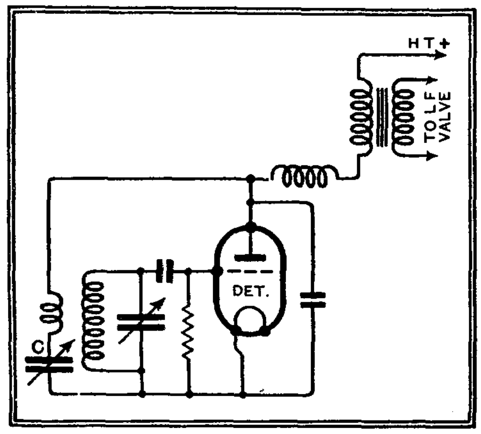


Fig. 130.—With a standing current of 1 mA. or so, a grid detector readily provides reaction—controllable, in the circuit shown, by adjustment of C.

True we shall now have serious input damping (16), which we could have avoided by choosing a screened valve, but reaction will take care of this (17). Unless a little reaction is used this input damping will make tuning rather flat, and sensitivity perhaps a shade disappointing. But by attention to tuned-circuit design

Foundations of Wireless—

this effect can be considerably reduced, as we shall shortly see.

To avoid all risk of overloading even on low modulation we shall hardly be safe if we allow the detector less than about 1 to $1\frac{1}{2}$ mA. of anode current—which, with the 6 mA. of the output valves, leaves us $2\frac{1}{2}$ to 3 mA. for the HF side of the set. This is about the current of a single screened valve, but by biasing back we could keep the total current of *two* valves within this limit, and still have more gain than one valve could yield. What gain do we need? To find this we must work back from the output valve, as in Fig. 131.

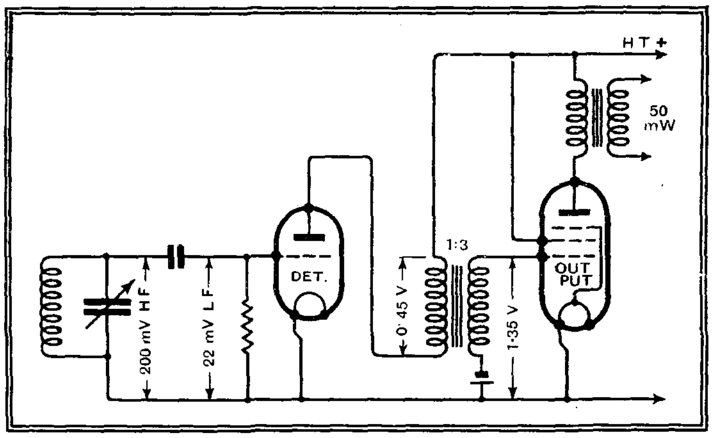


Fig. 131.—Approximate evaluation of voltages on pentode and detector for 50 mW. output.

The pentode gives 250 mW. for a 3-V. peak signal; 50 mW., therefore, for a signal of $3/\sqrt{5}=1.35$ V. peak across the secondary of T. Across the primary, assuming a 3 : 1 ratio, we shall require 0.45 V. If the detector valve has $Ro=$ 20,000 Ω, $\mu=24$, under operating conditions, we can reckon on a low-frequency gain of getting on for 20 times from grid to anode, so that we shall require a rectified signal, inside the grid condenser, of about 0.022 V. or 22 mV.

For so low an input as this implies, detector efficiency will be very low (18), and, over-emphasising this inefficiency so as to be on the safe side, we might reckon that 200 mV. of carrier-voltage, modulated at 30 per cent., will be needed to produce a rectified signal of this magnitude.

This tells us that for a sensitivity of one millivolt we must have a high-frequency gain of about 200 times between aerial terminal and detector grid. The gain given by one valve, ignoring detector-damping, will be about 60 times (19; but those figures referred to a *mains* valve) from grid of HF valve to grid of detector, so that we shall need some 3 to 4 mV. at the first valve's grid. Across the second of two coupled circuits the voltage is usually about four to eight times that actually applied to the aerial terminal, owing to the step-up effect of the tuned circuits (8); we see, therefore, that 1 mV. on the aerial terminal will comfortably give us the required 50 mW. output with only a single HF valve, provided that, as assumed, reaction is used to an extent just sufficient to offset detector damping. We shall certainly not need a second HF valve; in fact, if we were to use one, the sensitivity of the set would be too high for its selectivity. By this is meant that the additional stations brought in by the extra sensitivity, being necessarily those which give only weak signals at the aerial, would all be liable to serious interference from stronger ones. Unless it were added simply with a view of making up for the deficiencies of a tiny aerial, the extra sensitivity would therefore be of no value in practice.

Our set, then, will be arranged thus: two tuned circuits, HF valve, tuned circuit with reaction, grid detector, transformer, output pentode. Such a bald skeleton description as this does not prescribe an exact circuit; a dozen designers would produce a dozen circuits all differing from one another in minor ways. One of the many possible variations on the theme is shown in Fig. 132, where the complete receiver, including wave-band switching, is shown.

Careful inspection of this rather elaborate diagram will show that it really consists of an assembly of separate circuits, each of which, regarded individually, is by now

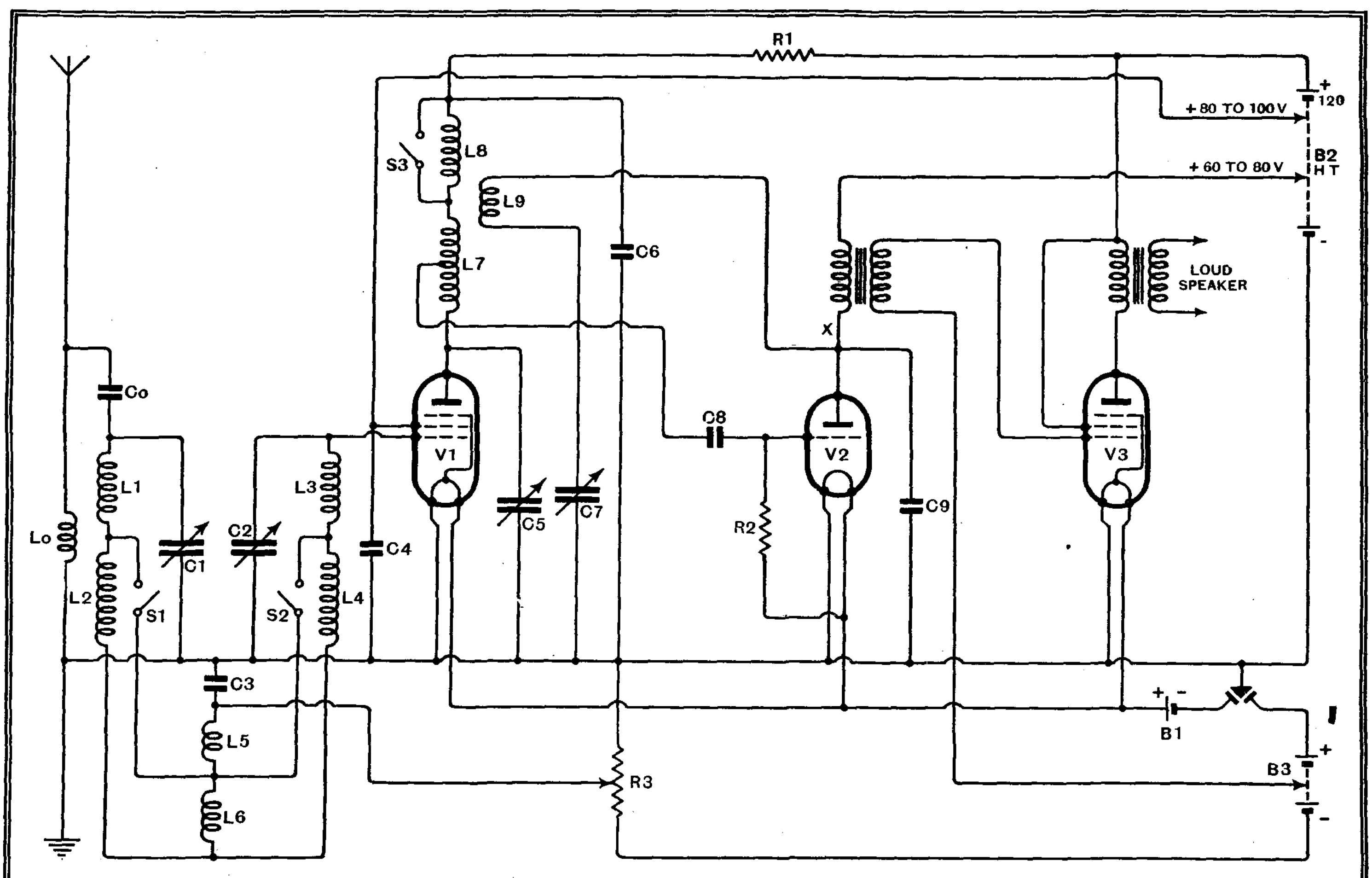


Fig. 132.—Complete circuit of three-valve set to conform with specification laid down at the beginning of this part.

Foundations of Wireless—
perfectly familiar. With but one or two unimportant exceptions, every separate circuit has been discussed somewhere or other in this series. Dissection of the diagram is best performed by tracing grid, anode and screen circuits right through, starting at the electrode in question and continuing, through HT or bias battery, until the cathode of the valve is reached. Observe that sometimes the same components can be common to two circuits—for example, the tuned circuit C5L7L8C6 is included both in the anode circuit of V1 and in the grid circuit of V2.

Some small points in the circuit may be puzzling at first sight, even though their meaning could be seen by arguing from basic principles. The coupling of aerial to first tuned circuit is done by the combination of the primary winding L*o* and the condenser C*o*, of capacity about 20 $\mu\mu$F. The two together, if suitably dimensioned, can be made to give more or less constant step-up at all wavelengths on the lower (medium-wave) band. On long waves S1, S2 and S3 are open so that the tuning inductances in use are L1+L2, L3+L4, and L7+L8. One section of each composite coil is shorted out for medium-wave reception.

Energy is transferred from the first tuned circuit to the second by making the coil L5+L6 (on medium waves, L5 only) common to both circuits (compare 19), so that the voltage developed across it by the current in the first circuit acts as driving voltage for the second. L5 will need to be about 3 μH., while L5 and L6 together will be about 30 μH. The condenser C3 is inserted to close the circuit for HF currents while allowing a variable bias, taken from the potentiometer R3 connected across the bias battery B3, to be applied to the grid of the variable-mu screened pentode V1 to control its amplification (21).

The tuning condenser C5 goes from anode to earth instead of directly across its coil L7L8 in view of the fact that C1, C2, and C5 will normally be in the form of a three-gang condenser, with rotors on a common spindle. The tuned circuit is completed through the non-inductive condenser C6, which, in order to maintain the ganging of the set, should have the same capacity as C3. Each may be 0.25 μF. or over; much less would begin to reduce the tuning-range appreciably.

Since HF currents flow in the anode circuit of the detector, which is completed through the HT battery B2, any HF voltage developed across this will be conveyed to the anode of V1, and so to the grid of V2. The resistance R1, of some 5,000 Ω, serves as protection against instability from this cause.

Damping imposed by the detector on the tuned circuit is decreased, if only for medium waves, by connecting the detector grid to a tap on L7. If the tap is at the centre of the coil, damping will be reduced to one-quarter (10). The reaction-coil L9 is coupled to both L7 and L8, and the current through it is controlled by the variable condenser C7. The inductance of the reaction coil must be such that C7 does not tune it to any wavelength within the tuning range of the receiver, or reaction control will be difficult. The increase in sensitivity and selectivity (17) produced by applying reaction will also be felt in the circuit L3L4C2, owing to a certain amount of energy feeding back through the screened valve and by way of stray couplings.

As shown, the circuit does not include a high-frequency choke in the anode circuit of the detector, the primary of the LF transformer T1 serving as substitute. This attempted economy may lead to difficulty in obtaining proper reaction effects. Alternatively, by allowing HF currents to stray into the output valve, and then back, *via* loud speaker leads, to the aerial side of the set, it may lead to hooting and grunting noises when receiving a signal, especially when much reaction is being used. In such cases an HF choke must be inserted at X, making sure that the anode by-pass condenser of the detector (16) is still directly connected to the anode.

As shown, the set requires three positive connections to the HT battery. This enables the technically-minded user to adjust the voltages at detector anode and pentode screen either for maximum sensitivity or for economy of current. In a commercially-built set, to be handled by non-technical users, it would be better to provide a resistance of fixed value in each of the movable leads, and to take them all to maximum HT voltage.

It is hoped that this part has given the reader a glimpse of the way in which all the various matters discussed in earlier parts have to be brought together when considering the design of a set, and of the process by which a concrete design emerges from a brief specification of intended performance. Any reader who may be taking this series really seriously may like to complete the design here only begun; by a sufficiently close study of earlier parts he could find a suitable value for every component in the set, after which, adding some data from a valve catalogue, he could work out, at least approximately, the overall sensitivity, selectivity, and fidelity of the receiver at a number of different wavelengths.

New Short-wave Development

Reducing Background Noise

AN interesting account is given in American reports, commented upon here in the lay Press a few days ago, of test transmissions on a wavelength of 6 metres by Major Armstrong, the well-known radio engineer and inventor. The tests, which apparently caused some bewilderment in New York radio circles, were carried out on a frequency-modulated wave, and therefore could not be satisfactorily received on the standard type of short-wave receiver.

Major Armstrong's object is to enlarge the normal service-area covered by a 6-metre carrier. This he does by making it possible to increase the effective HF amplification which can be applied to the signal at the receiving end.

On the normal wavelengths used for broadcasting a limit is set to intensive amplification by the growing background of static, but down in the region of 50 megacycles—where the static content of the ether is comparatively slight—a second difficulty arises. This is the so-called Schottky effect, which is due to irregular electron emission inside the amplifiers. Electrons are not liberated from a heated wire in a perfectly uniform stream, but in a succession of overlapping spurts or gushes, which naturally give rise to slight variations in the output current.

Normally such fluctuations are not heard in the headphones, but as amplification is intensified a "hiss" develops, and finally grows into a sustained roar which effectively swamps the signal.

Major Armstrong attacks the problem first at the transmitting end, where he replaces the usual amplitude-modulation by a system of frequency-modulation. Having once produced a frequency-modulated sub-carrier, he increases the spread of the resulting sidebands by a process of repeated frequency-multiplication, until they cover a much wider area than the normal 10 kc/s used in ordinary broadcasting. Although such a system is, of course, unthinkable in the more congested parts of the ether, it is, at all events for the time being, practicable in the fairly uncrowded region below 10 metres.

"Valve noise," being of the nature of an amplitude variation, is limited to the usual 10 kc/s band on each side of the carrier, which is relatively insignificant, by contrast with the frequency-spread of the transmitted signal.

For reception Major Armstrong uses a circuit of the superhet type with a second-detector stage consisting of two valves fed in parallel from the IF amplifiers. The input circuit of one detector has a reactance characteristic which varies from zero at, say, 50 kc/s below the IF frequency to a positive value for higher frequencies; whilst the input reactance of the second detector varies from zero to a point, say, 50 kc/s above the IF frequency to a negative value for lower frequencies.

The two detectors are arranged so that their response to the frequency-modulated signal is cumulative, though they act in opposition on the relatively-narrow band of amplitude "interference" due to valve noise. The latter is therefore substantially balanced out, and the receiver operates with much higher HF gain than is normally practicable.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Interference on SW

IT is with interest that I observe in a recent Editorial reference to Morse interference on the short-wave broadcasts.

I personally have had to endure this, particularly on the 99-metre Pittsburgh transmission, which is shockingly marred by a Continental telegraph station.

This is definitely not second channel, as my set is a well-known make of 16-valve superhet, the selectivity of which can be increased to 3 kc/s, and even then it is not possible to eliminate this nuisance.

A friend who also has a particularly powerful and selective set is also troubled by this same station, which appears to work from approximately 7 p.m. to 11.30 p.m., Sundays included.

I have even taken the trouble to write to W8XK Pittsburgh, but they claim to have no special knowledge of this interference apart from the fact that its source is European.

Perhaps some clever gentleman, with possibly a direction finder, will, if he persists long enough, be fortunate enough to trace the culprit. NORMAN L. PARLETT.
Oxford.

I THINK short-wave listeners at home and abroad are indebted to Mr. H. R. Meredith for raising this question of Morse interference on the so-called short-wave broadcast bands and for putting his views so bluntly.

The five bands allotted cover a very small fraction of the channels available below 50 metres, and are crowded with telephony transmissions already, some working within 5 kc/s of each other, and in many cases sharing a wavelength at different times.

Considering the large number of wavelengths available about these bands, I confess I cannot see why Morse transmitters should be allowed to "squat" at will among the broadcasts whenever they have a mind to.

The 49-metre band is a good, or rather a bad, example in a band of 150 kc/s; there are nearly forty stations listed, yet reception in this narrow strip is often marred by a hideous hash of Morse, some irregulars and one or two perennials, who occasionally spread over 30 kc/s or so.

The 31-metre band, which is equally crowded, suffers also, but not to the same extent; the 25- and 19-metre bands are usually less infested, at least in this locality.

With all the channels available outside these strips, what is the reason for interference? Is it a case of the best apples always being on the other side of the wall, or is it a case of priority or plain pig-headed obstinacy?

On many nights when broadcast reception was being jammed I have found large tracts in the commercial channels where not a whisper was audible even with a fairly powerful set; one would think the Morse operators wanted a musical or verbal obbligato to liven the routine of listening mechanically to code.

It may only be a matter of irritation to us; we have all Europe to fall back on for alternative programmes; but for Empire and overseas listeners it is serious.

The various national short-wave broadcast transmitters cannot be classed as being of local interest; they are of world-wide importance, whether they are keeping touch with their nationals abroad or exchanging views between the peoples of the earth; surely these channels should be kept as clear of interference as the ordinary medium-wave broadcasts and not be at the mercy of any garrulous commercial Morse station sending either news or private messages. As someone wrote recently, there seems to be a policy of hush-hush regarding these dot-and-dash interlopers. Can anyone explain why?
Edinburgh. G. R. GOUDIE.

QA Receiver and Amplifier

I SHOULD be very pleased if you could put me in touch with any reader who has built, and is prepared to demonstrate, the push-pull quality amplifier in conjunction with either the QA set or single-span receiver in the area of Brighton, Worthing or Littlehampton.

The conditions here are notoriously bad, and before building such a receiver I should like to be quite sure of the performance I may expect here.
Worthing. ARTHUR D. HILL.

Empire Broadcasting Through Other Ears

HAVE a new all-wave receiver—RCA Model 262—and got fine reception of the Jubilee celebrations. Early in the morning, when the networks had taken all they intended to take of St. Paul's Cathedral part of the show, I switched over to a short-wave and got the rest of it direct. During the afternoon, when the evening (London) show was on which terminated in the King's speech, I was at business. Got it in the evening, however, by recording from one of the Daventry transmitters. By the way, why do the B.B.C.'s recordings of special events have to be so rotten? They could easily be improved in quality. B.B.C. special-event announcers might be a little more adequate in their descriptions, too. Some weeks ago I tuned in late on the launch of a new P. and O. liner at Barrow. I gathered that "His Royal Highness and the Duchess" were somewhere in evidence, but just who they were and what they did remains a mystery, as also the name of the liner, which was mentioned just once and lost under a momentary fade. The commentator jabbered away for a time and then said, "I will now interrupt this commentary until after the launch." Silence for about five minutes, punctuated by many violent "hits" (somebody striking the mike), distant band music, distant crowd noise, and roarings which might have been short-wave roar or the actual launch. A female voice came in for a second and apparently christened the ship, but the engineers were too late on the gain control, and what she said was lost. Now, my contention is that the commentator should have given us a complete word-picture of the entire launch, explaining what was happening every second. He should have introduced the lady who christened the ship—even if she was the Queen—and then taken over the mike again as soon as she got through. A point to remember is that although the British audience may know it all, the Dominion audience, and especially the foreign audience, may not. And if the show is going out on short-wave, the world is listening and, willy-nilly, it's British propaganda, and might as well be sent out as a slap-bang-up job which will do credit to the country instead of producing annoyance and derision at the provincial methods. Similarly, piano recitals of involved classical but dull stuff, vocal recitals of equally dull stuff, etc., may be OK for the British audience, if that's their taste, but I'm sure the rest of the world doesn't appreciate it. What's it to be—Provincial or Empire broadcasting?—with the world listening on the side-lines and judging Britain and the Empire accordingly. Personally, I'd like to listen more to the "G" string (as they call the Daventry's here), but I can't stomach the dull programmes which fill most of the time. How about it? Can you shake up the complacent somnolence of Bedcrashing House?
A NEW YORK READER.

Volume Expansion

YOUR recent article on volume expansion brings to the fore what I consider to be the most pressing need for modern quality reproduction.

I am a keen follower of the Symphony Concerts given by the Bournemouth Municipal Orchestra, and, having built the finest receiving outfit of to-day—your own Single-span Quality Amplifier Receiver—I naturally like to have records of my favourite pieces to play when I wish. It would be indeed a dull person who, after hearing the music at first hand—e.g., "Finlandia," by Sibelius—cannot immediately notice the lack of lustre of the electrically reproduced music.

It is time for the B.B.C. to drop entirely manual control of volume, and, having adopted a standard for the automatic control, for the gramophone companies to abide by that standard. Then can the wonderful quality receivers of the present day be brought almost to perfection, and actual realism be possible in every home.

This attainment is the B.B.C.'s own responsibility, and it is to them we must look for immediate action. And is it too much to hope that when they decide to move they will do so? Not promise, as they did over the emanating of a frequency scale when Droitwich came, and here a year, almost, later we still sit and hope!
Bournemouth. GEO. F. DAY.

Crystal Set Range

ON seeing your contributor D. Exer's subtitle, "300 Miles on a Crystal Receiver," in your issue of May 24th, 1935, I thought it might be of interest to record the fact that towards the end of March, 1919, I heard Eiffel Tower's (FL) time signals on a Marconi crystal receiver Type 26 when about 5 deg. south latitude off the coast of Brazil, a distance of over 4,000 miles. This was during darkness, and the wavelength 2,600 metres. R. E. RICHARDS.
Rhyl.

The Wireless World

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

EDITORIAL COMMENT

High Fidelity

Importance of Variable Selectivity

WE have previously commented upon the *apparent* increase in electrical interference with broadcast reception which has occurred during recent months ; this interference being out of proportion to any increase in the use of electrical equipment likely to be responsible. In seeking the reason we expressed the view that the increase in frequency response of modern receivers was the principal contributory cause.

It is easy to appreciate that the greater the width of frequency band to which the receiver responds the greater is the interference which will be let through at the same time. To this we must add the fact that a very large proportion of the electrical interference from which our sets suffer occurs at the higher frequencies, whilst further observation indicates that the lower frequencies of the programme will mask interference noises to a much greater extent than will be the case at the higher frequencies.

An interesting investigation of this problem has recently been made public by the Bell Telephone Laboratories. Tests were carried out with a number of observers to ascertain what degree of noise to signal ratio could be tolerated at various frequency band-widths.

Some of the results of these experiments are very interesting. Amongst other conclusions a number of observers decided that when the band-width was reduced from 10,000 cp/s to 3,500 cp/s they could then tolerate an increase in noise level superimposed upon the programme amounting to no less than 13 decibels.

High fidelity broadcasting is likely to depend for popularity very much upon the noise to signal ratio and, therefore, close proximity to the transmitter or, alternatively, very high transmitter power is required, in order that the field strength shall be adequate to mask the interference.

These considerations bring us all the more forcibly to the conclusion that a means of varying selectivity is essential to all high fidelity receivers which are expected to serve the purpose of distant listening as well as local reception.

Efforts should be made, too, by the designers of high fidelity sets to arrange for the purchaser to be adequately informed, not only as to the conditions under which the set should be used but also the reasons why an unpleasant noise will result if wide-band reception is indulged in when a weak station is providing the programme. Unless proper precautions of this nature are taken we foresee that high fidelity receivers may quickly get a bad name amongst the public. Once again we would urge the necessity for supplying proper instructions which will remain permanently with the set, so that the purchaser at least can have no excuse for lack of knowledge in operating the variable selectivity control.

Television

Is the New Service Experimental?

IN the Post Office statement published in last week's issue we find the new television service referred to as "the proposed experimental television service." We believe this is the first official reference to the proposed high definition service as "experimental." It would be interesting to know whether the use of this word implies a more cautious attitude on the part of the Advisory Committee than the former Television Committee adopted, or whether it is merely accidental.

LOADED TRANSFORMERS

The Design of Transformers Working Between Resistances

By W. T. COCKING

TRANSFORMER design is a matter of importance in any apparatus required for high-quality reproduction, and the important factors are discussed in detail in this article. The components dealt with are all types which are intended to operate with a secondary load, and include output, driver, and microphone transformers.

NEARLY every wireless receiver incorporates a transformer of some kind for coupling purposes, and the types used fall into two general categories—loaded and unloaded. The loaded transformer is one which works between two impedances of finite value, and practical examples are the output transformer, the Class "B" driver transformer, and some microphone transformers. The unloaded transformer, on the other hand, has no load on its secondary, although its primary is usually connected to a source of power having a definite impedance. The usual intervalve transformer is of this type, for the input impedance of the valve which follows it is generally considered to be nearly infinite; some microphone transformers also fall into this class.

The two types of transformers exhibit markedly different characteristics, and the factors influencing their design are by no means all the same. In this article only loaded transformers will be considered, and it will be shown that it is by no means difficult to design a component with the characteristics required for any particular purpose.

In its most general form the purpose of the transformer is to transfer power from one circuit to another of different or similar impedance with as little loss as possible. Referring to Fig. 1, in which E represents an alternator having an internal resistance R1, we require as much power as possible in the working load which is represented by R2. It is easy to show mathematically that the power in R2 is a maximum when it equals the power lost in R1, and this occurs when R1 and R2 are equal in value.

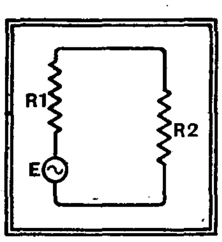


Fig. 1.—In a simple circuit with an alternator E having an internal resistance R1 maximum power is secured in the load R2 when it equals R1.

The two resistances need not be directly coupled as in Fig. 1, but may be coupled by a transformer as in Fig. 2 (a). The conditions are then exactly the same if the transformer be ideal; and if the transformer be of unity turns ratio, the maximum power will still be found in R2 when this resistance has the same value as R1. We need not, however, vary R2 in order to secure the optimum condition, for we can obtain the required result by altering the turns ratio of the transformer. If R2 be four times as great as R1, matching will be secured if the secondary turns on the transformer be twice as many as the primary, and the power in R2 will equal that in R1. The voltage drop across R2, however, will be twice that on R1, and the current through it one-half.

It is customary in transformer theory to base the design upon the input and output loads, R1 and R2 respectively, but, while this is not incorrect, it is sometimes confusing when, as in many wireless cases, the transformer is not used to match the input and output impedances for the optimum power condition. It is usually more convenient, therefore, to base the design on the secondary load and on the effective impedance presented by the transformer when its secondary is loaded. This will be clear from Fig. 2 (b), in which the secondary load R2 has been transferred to the primary by multiplying its value by the square of the ratio of primary to secondary turns. If we call this resistance Rp its value is given by $Rp = n^2 R2$ where n is the turns ratio. Throughout this article the turns ratio will always be referred to as the primary divided by the secondary turns, thus a ratio of 10-1 means that the primary contains ten times the turns of the secondary and the transformer is of the step-down type. A ratio of 0.1-1 (often written 1-10) means that the secondary has ten times the turns of the primary and the transformer has a step-up ratio.

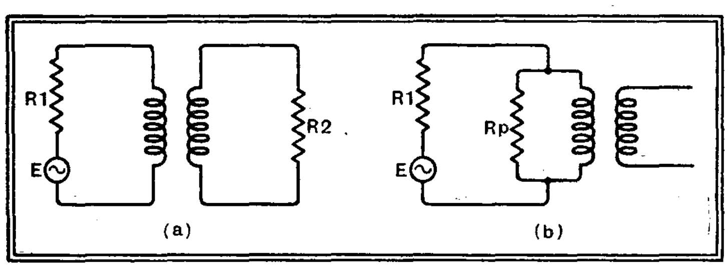


Fig. 2.—Where R1 and R2 are equal the insertion of a 1-1 ratio transformer (a) between them does not affect the results save for the losses in the component, and the equivalent circuit is that of (b) as explained in the text.

Referring again to Fig. 2 (b), it can be seen that Rp is the load into which the generator of internal resistance R1 works, and maximum power is obtained when R1 = Rp. The transformer ratio required to give the desired value of Rp when the secondary is loaded by R2 is given by $n = \sqrt{Rp/R2}$, and for the particular case when Rp = R1 this becomes $n = \sqrt{R1/R2}$, the usual formula. The difference is brought about by the fact that in most wireless circuits Rp is several times greater than R1. In the case of an output transformer, for instance, R1 is the AC resistance of the output valve, and Rp is the load impedance required by this valve. Although maximum power is still secured when R1 and Rp are equal, this is only the case if we disregard distortion. For a given degree of amplitude distortion in the output valve, there is one particular value of Rp for which the power in Rp is a maximum and for triode valves this value of Rp is usually several times R1, whereas for pentodes it is considerably less than R1.

If we could obtain an ideal transformer the only calculation involved would be the turns ratio, which can be obtained from a knowledge of the circuit impedance. In the case of an output transformer, Fig. 3 (a), the secondary load R2 is the average speech-coil impedance of the loud speaker,

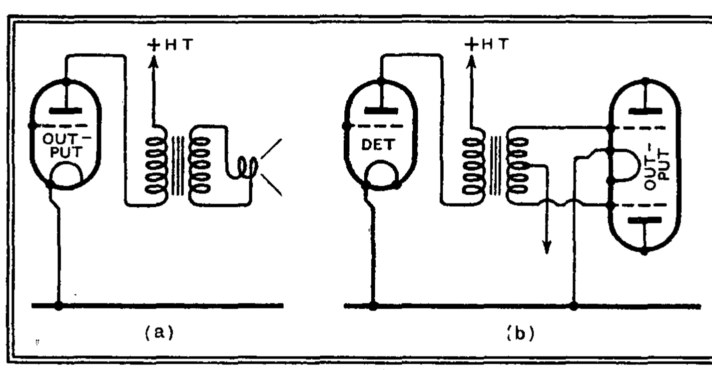
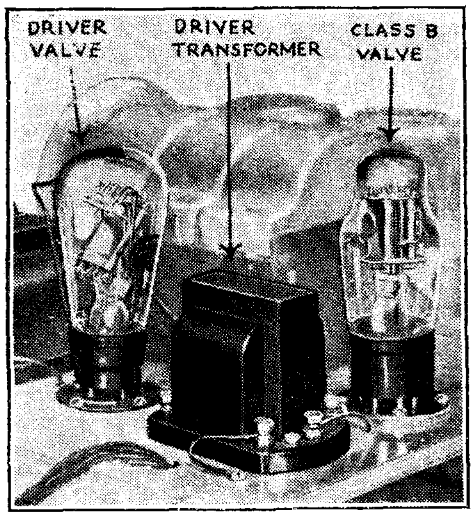


Fig. 3.—The connections of an output transformer are shown at (a) and a driver transformer at (b).

Loaded Transformers—

and the value of Rp to be used in the formula is the load resistance required by the valve and is the figure listed in *The Wireless World* Valve Data Supplement. If the output stage contains several valves in parallel Rp must be divided by the number of the valves, while if two valves be used in push-pull Rp must be doubled. With Class "B" and QPP valves a figure for "anode-to-anode load resistance" is usually quoted, and this can be substituted for Rp directly. With a driver transformer, Fig. 3 (b), Rp is the load impedance needed by the driver stage, and the figure is derived in the same way as for an output valve. R_2, however, now becomes the input resistance of the following stage, and in the Valve Data a figure is quoted as "grid-to-grid input resistance." The ratios calculated for push-pull transformers are, of course, always whole-primary to whole-secondary.



A typical small driver transformer is shown with its associated valves in this illustration.

A microphone transformer can be of two types. If it be connected, as in Fig. 4 (a), it is essentially the same as an inter-valve transformer except in the matter of ratio, and will not be considered here. If connected as in Fig. 4 (b), however, it functions in the same way as an output transformer, for the secondary is loaded by the volume control, and Rp becomes the load required by the microphone, R_1 being the AC resistance of the microphone itself and having a value between 1 and 1.5 times the DC resistance in the case of carbon types. In most cases we can make $Rp = R_1$.

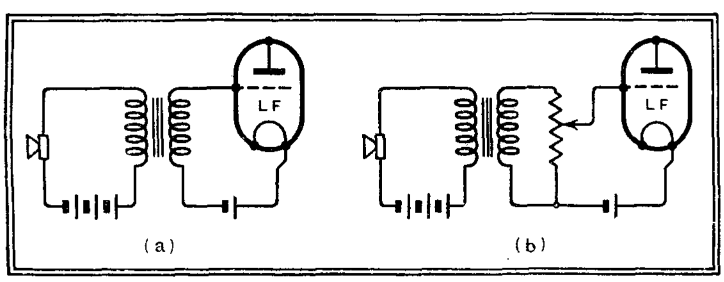


Fig. 4.—Two types of microphone transformer are shown here; at (a) the transformer is unloaded, but at (b) it is loaded by the volume control, and the design is straightforward.

Whatever type of transformer we use, whether it be output, driver or microphone, it will not be perfect. It will not transfer all frequencies equally, and there will be a general loss. The frequency characteristic of the transformers depends upon two factors—the primary inductance and the degree of coupling between primary and secondary. The coupling is usually of the order of 99 per cent., but even with this the leakage is sufficient to affect the highest frequencies. The transformer primary acts as a shunt to Rp, with the result that it lowers the effective value of the load on R_1. This affects the operation in two ways—first, there is a change of power in the secondary circuit due to the change of load in the primary circuit, and, secondly, the reduced load may lead to amplitude distortion if the transformer be operated from a valve. Since the transformer primary is an inductance, the primary reactance falls as the frequency is reduced, and these effects occur only at low frequencies.

In general, the reduction in bass response due to the falling reactance of the primary is less serious than the possibility of amplitude distortion, and the avoidance of the latter defect demands a higher primary inductance than the former. If we decide to permit a loss of power of 3 db. at the lowest frequency which we require this will occur at the frequency for which $\omega L = R_1Rp/(R_1 + Rp)$ in which L = primary inductance in henrys and ω = 6.28 times frequency. If, as usual, we base the design upon frequency, we find that the inductance required is $L = R_1Rp/\omega(R_1 + Rp)$. Thus, if we can tolerate a loss of 3 db. at 50 c/s, and we are using a valve of 1,000 ohms AC resistance which requires a load of 5,000 ohms, so that R_1 = 1,000 and Rp = 5,000, we have $L = 5{,}000/6 \times 314 = 2.65$ H.

Now, although such a primary inductance will meet the requirements as regards frequency distortion, it will not satisfy us, for it is so small that it will seriously affect the load imposed on the valve. At 50 cycles the valve no longer works into Rp alone but into this resistance in parallel with the reactance of the transformer primary. In the case just considered the total load on the valve at 50 c/s becomes only 805 ohms, which is so far below the optimum value of 5,000 ohms assigned by the valve maker that serious distortion is likely to occur through non-linearity in the valve in the anode circuit of which the transformer is connected. It will be clear, therefore, that we must choose the primary inductance so that the load on the valve is maintained reasonably well rather than for the avoidance of frequency distortion, but if we satisfy the former condition the latter is automatically secured, so that we need not further consider frequency distortion at low frequencies.

For the highest quality of reproduction, the load at the lowest frequency should not be less than 90 per cent. of the optimum load, and this is obtained when the primary reactance at this frequency is twice Rp, or $\omega L = 2Rp$, so that $L = 2Rp/\omega$. Taking the same values as before, we find L = 31.8 H, and this is just twelve times as great as the value calculated on the basis of frequency response. With an inductance of this value, the response will be maintained within 3 db. for frequencies much lower than 50 c/s.

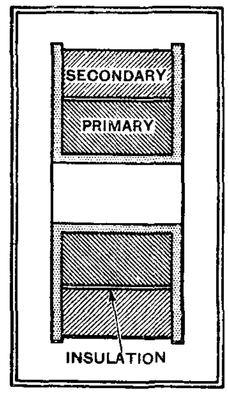


Fig. 5.—The simplest method of arranging the windings leads to a considerable loss of high notes and is not recommended.

Where a lower standard of quality will suffice, it will be sufficient to make the reactance and the load equal at the lowest frequency, and this will lead to just half the primary inductance given by the above formula, while the load on the valve will be 70 per cent. of Rp.

We have seen that the turns ratio and the primary inductance of a loaded transformer can readily be calculated. Over the middle range of frequencies the transformer approximates to the ideal, for the primary reactance is too high to have any adverse effect and the leakage reactance is too small. At high frequencies, however, the leakage inductance is very important. It is easy to calculate the maximum inductance which can be tolerated for a given frequency, but this is, unfortunately, of little practical use, for it is practically impossible to calculate the leakage inductance of a transformer and it is quite difficult to measure it accurately. It is proportional to the primary inductance, so that this winding should not be

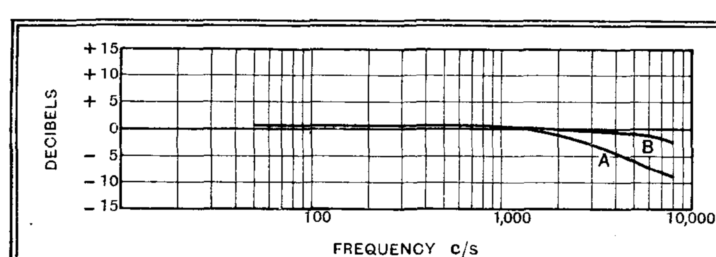


Fig. 6.—Curve A shows the performance to be expected with the type of winding of Fig. 5, while curve B illustrates the improvement given by the modest degree of sectionalisation adopted in Fig. 7.

Loaded Transformers—

any larger than is necessary to maintain the proper conditions at low frequencies, but for a given primary inductance it depends chiefly, if not entirely, upon the relative disposition of the primary and secondary windings.

The leakage inductance is really an imaginary inductance which, if connected in series with the primary of an ideal transformer, will give to it the same characteristic as an actual transformer. Its effect exists because both primary and secondary cannot occupy the same space, with the result that the whole of the flux surrounding the primary does not link with the secondary. In order to obtain low leakage, therefore, the two windings must be coupled as tightly as possible.

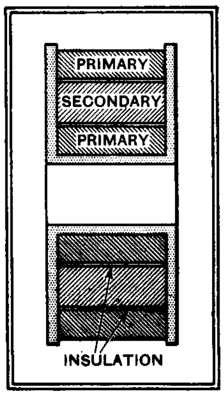


Fig. 7.—By dividing the primary into sections and sandwiching the secondary between them, the leakage is reduced and the performance improved.

At one time the favourite transformer construction was one which is mechanically the simplest. The primary was wound straight on a bobbin in one section, covered with a layer of insulating material, and the secondary wound on outside, also in one section, as shown in Fig. 5. With this style of construction the leakage is quite large, and the high-frequency response is not at all good if the primary inductance be adequate for the low frequencies. The frequency characteristic of an example of this kind with the primary wound inside the secondary is shown in Fig. 6, Curve A, and the poorness of the performance is very apparent.

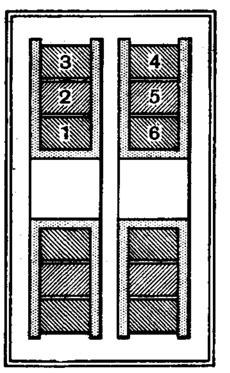


Fig. 8.—A push-pull transformer is easily wound by using two bobbins, the different sections on each bobbin can be interconnected in several ways, as explained in the text.

The leakage can be greatly reduced by winding the coils in several sections which are interleaved. The simplest case of this sort is shown in Fig. 7, where the secondary is still wound as a single section but is interleaved between the two primary sections, each of which contains one half the total primary turns. The next step would obviously be to split the secondary into two sections, and, carrying the idea farther, one would use three sections of one winding to two of the other, then three of each, and so on. The greater the number of interleaved sections used the lower is the leakage inductance, and the higher the frequency at which the transformer is still efficient, but it is obvious that every additional section increases the difficulties of winding, and hence the cost, and also increases the space wasted by the insulation between sections. One should not, therefore, go any farther than is necessary in this direction, and Curve B, Fig. 6, is a good example of the results obtained with a simple form of sectionalised interleaved winding, the whole secondary being wound between two half-primary sections. The improvement due to the correct distribution of the windings is readily seen by a comparison with Curve A.

So far we have not considered the losses in the transformer; these are due to the resistance of the windings and to the core. For minimum copper losses, primary and secondary should be allotted equal winding spaces and the primary gauge should be as large as the space allowable will permit. The resistance of the secondary winding should be $1/n^2$ times the primary resistance, where n is the ratio primary/secondary turns. The resistance is inversely proportional to the area of the wire used, and the area is proportional to the square of the wire diameter, so that the resistance is inversely proportional to the square of the diameter. We thus find that the diameter of the secondary wire should be n times that of the primary.

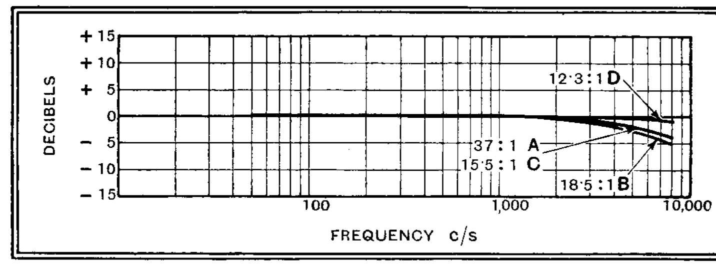


Fig. 10.—The response curves of a multi-ratio output transformer illustrate how the performance varies with the differing degrees of sectionalisation obtained on the various ratios.

In practice it will not always be possible to follow this rule because it may lead to inconvenient gauges. Thus, where the ratio is high, the gauge of wire demanded by the secondary (of a step-down transformer) may become unmanageably heavy, or, in the case of a step-up component, too fragile for safety. Where the gauge demanded by theory is too heavy, the difficulty can be got over very easily where the secondary is to be wound in an even number of sections. Thus, suppose we adopt the construction of Fig. 7 but transpose the windings so that the secondary is in two sections and the primary in one. Normally, each secondary section will contain one-half the total turns and the two sections will be connected in series. If the correct gauge of wire be too large for convenient handling, choose a gauge having an *area* of one-half, and wind the full (instead of one-half) number of turns for each section. The two sections are then connected in parallel instead of in series, and this is likely to give slightly lower leakage than the series connection. It is possible to employ up to No. 16 gauge wire, but it is difficult to handle, and, if possible, nothing heavier than No. 20 should be used.

In the case of push-pull transformers, it is necessary to adopt a symmetrical construction if the best results are to be secured, and the writer has found that the use of two bobbins is a distinct advantage. Each bobbin is wound in the usual way with sandwiched primary and secondary sections, as shown in Fig. 8, in which sections 2 and 5 are secondary, but only one-half the total turns needed are used for each bobbin. The two sets of coils are wound in opposite directions, so that the two outer ends of each half primary are joined together and form the centre tap. The whole arrangement is perfectly symmetrical and easy to wind, and the secondary sections can be connected in series or parallel as desired. A transformer of this type was described some time ago in *The Wireless World*,[1] and with a primary inductance of no less than 69 H. the response at 10,000 c/s falls by no more than 3 db., as shown by the curve of Fig. 9.

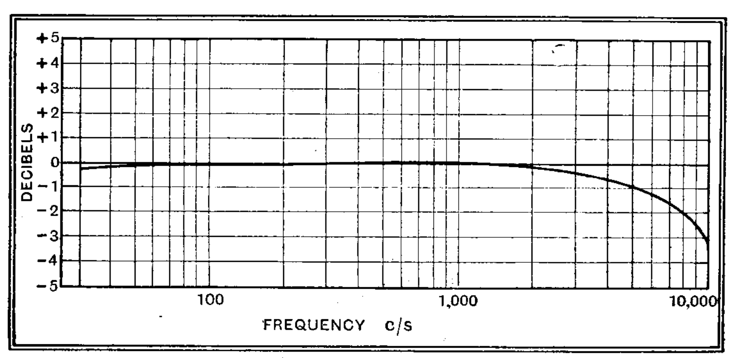


Fig. 9.—The response curve of a well-sectionalised push-pull transformer is shown here. The decibel scale is much more open than in the case of the other curves, and the drop at 10,000 c/s is actually quite small.

In some cases it is advisable to adopt a method of cross-connecting the primary sections which leads to still closer coupling. Referring to Fig. 8, instead of connecting sections 1, 3, 4 and 6 in series in the order named, they are connected in the series 1, 4, 3, 6. This gives somewhat tighter coupling between the two halves of the primary and lowers the chances of parasitic oscillation occurring with quiescent output stages of the Class "B" and QPP type.

[1] *The Wireless World*, September 8th, 1933.

Loaded Transformers—

It will be clear from this why multi-ratio transformers are not as good as single-ratio ones of equally good design. If primary or secondary be tapped so that the ratio can be varied, the whole winding space is not utilised to the best advantage except on the one ratio where the whole windings are in circuit. Consequently either the primary inductance is too low or the leakage inductance too high. Where the windings are sectionalised, however, it is possible to obtain a number of ratios by connecting sections in series or in parallel, and the performance need not then depart widely from the optimum. A transformer of this type was described in *The Wireless World* for December 1st, 1933, and the response curves for several different ratios are given in Fig. 10.

So far nothing has been said about Class "B" and QPP output transformers. These do not differ from the ordinary push-pull type save that, strictly speaking, only one-third the winding space should be occupied by the secondary and two-thirds by the primary, for with this system of amplification the two half-primaries are not used together but alternately.

It has now been shown how to choose the ratio and primary inductance of any transformer working between two finite impedances, how to allocate the winding space between primary and secondary and choose the wire gauge for minimum copper losses, and how to sectionalise the windings for minimum leakage inductance. Nothing has been said about winding the primary, however, and this is the basis of the design. This has been purposely omitted, for full information has been published elsewhere in *The Wireless World Abacs,* which are now available in booklet form.[2] These charts contain full details for the design of iron-cored chokes carrying DC, and a transformer primary is nothing but such a choke occupying one-half or two-thirds the total winding space. In order to make use of the charts it is necessary to know, in addition to the inductance required, the DC through the windings. With an output transformer this is the anode current of the last valve, but with a push-pull output transformer, including QPP and Class "B," the effective current is zero. The charts do not cater for this condition, and, as it is rare for the current to be exactly zero in practice, it is wise to assume a small current of from 5 mA to 10 mA. One other consideration is the flux density at which the core is worked, for if this be too great harmonic distortion will occur in the core. For Stalloy it is inadvisable to work at a flux density much greater than 20,000 lines per sq. in. It depends upon the volume of iron in the core, the number of primary turns, the voltage developed across the primary, and hence the power handled by the transformer. The RMS voltage across the primary is equal to $\sqrt{P\,Rp}$ where P is the maximum power output of the stage in watts. In cases where the output is great, a large core and many primary turns will be needed and the inductance may then turn out to be even higher than that needed for the fulfilment of the circuit conditions laid down earlier.

[2] *Radio Data Charts.*

DISTANT RECEPTION NOTES

A High Power Anomaly

SOME time ago the writer of an article in *The Wireless World* suggested that the wide adoption of high power for broadcasting transmitters had tended to reduce rather than increase the number of stations receivable at long distances. He mentioned that in the old days of modest power outputs we had no difficulty in receiving at full loud-speaker strength stations rated at from 2 to 4 kilowatts, and asked what Continental stations of anything like such low power can be regularly received nowadays. His view is borne out to some extent by conditions in India.

Remarkable Indian Reception

In that sub-continent, some 2,000 miles from north to south and rather more from east to west, there is a mere handful of broadcasting stations, and the power that they use is at present minute in comparison with Europe's giants. Yet a young relative of mine tells me that he receives the little Bombay station clearly and well with a 3-valve set at Dera Ghazi Khan, which is 750 miles away as the crow flies, or rather further than Vienna, Florence and Stockholm are from London. When the 20-kilowatt Delhi station is completed I have no doubt that it will cover a very large part of India, at any rate during the hours of darkness.

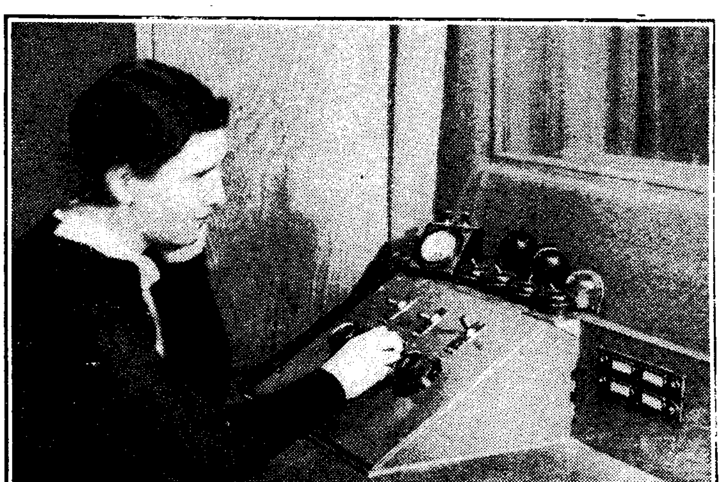
Quite a number of listeners seem to have the idea that Sottens is to close down within the next few weeks for alterations. I don't know how this rumour got abroad among long-distance enthusiasts, but several of them have mentioned it to me. What is going to happen is that Sottens will be "off the air" for the greater part of the month of September. It will then reopen as a fully-fledged 100 kilowatt station. Why should September be chosen instead of June or July, which used to be regarded as the months when the smallest amount of listening took place? I hazard the guess that Switzerland, being a tourist country, wanted to have plenty of broadcasting available during her busiest months. September is one of the slackest from the tourist point of view. QED.

Readers already know that Leipzig is using the old low-powered transmitting plant, which is kept as a standby, during the alterations to its aerial system. They probably do not know, however, that the work of erecting the anti-fading aerial will take the best part of three months to complete. We shall not, therefore, be able to rely upon Leipzig for programme purposes for the rest of this queer summer. If the work goes according to schedule Leipzig's big transmitter should be in action once more during the first part of September.

Tribute to French P.M.G.

Before now I have mentioned that the somewhat chaotic state of broadcasting in France, of whose privately-owned stations it has been said "one word from the authorities and they do exactly what they like," is due in no small part to the rapid changes of government that have occurred in that country. For this reason it is good to see that M. Mandel now seems more or less firmly in the saddle as Minister of Posts and Telegraphs. He is now a Cabinet Minister for the third time, though his second period of office lasted for only a matter of hours. His is a difficult task, for once stations had established a kind of prescriptive right to wander as they listed over the medium wave-band in the years of somewhat nebulous regulations it was no simple business to bring home to them that the provisions of the Lucerne Plan had to be taken seriously. M. Mandel has done splendid work in this direction and in furthering the anti-interference campaign. Whatever the French may think of his doings he may rest assured that he has the heartiest good wishes of British listeners, who thoroughly appreciate his noble efforts to bring to heel various small but annoying stations which have been responsible for a diversity of heterodynes.

D. EXER.



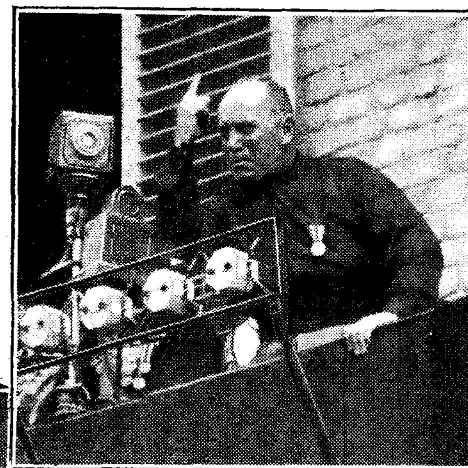
ANOTHER WOMAN ENGINEER. The claim of Mlle. Piskor, of Warsaw, of being Europe's only woman broadcast engineer, has not long gone unchallenged. Here is the young lady who has controlled the Bucharest musical programmes for several years. Electrical engineering is a popular profession among Rumanian women.

Italy's New Broadcasting Plans

Increased Power for Propaganda ?

By a Special Correspondent

BECAUSE of the pleasant climate, the people's love of outdoor life, and their natural aptitude for music-making on their own account, broadcast listening has not made the progress in Italy that it has in most other European countries. Our correspondent, who has just travelled through Italy, suggests this as a reason why Italian broadcasting tends to become an instrument of the State rather than a medium of entertainment.



Signor Mussolini does not suffer from "mike fright."

THE lure of Italy is not only the call of the Sunny South. To listening enthusiasts all over the world the sweet-toned contralto voices of the announcers, the nightingale interval signals, and the inimitable operatic programmes ensnare the fingers at the receiver dial.

Italy well knows that her radio voice has a definite mission as one of the most powerful means of proclaiming the beauty of the country, its history, culture, and political ideals. Geographically, Italy is the centre of South-western Europe, and the Italian broadcasting stations are eagerly listened to by Yugoslavs, Albanians, Greeks, and many others in whose countries there are inadequate broadcasting services or none at all.

To her own nationals Italian broadcasting is not all-important. It is just ten years old. In 1928 the Italian licences numbered only 63,000, and now they are still below the half-million mark. On December 31st, 1934, Italy had 453,000 registered licences.

Broadcasting House, Rome, with the aerial of the 1 kW. local transmitter.

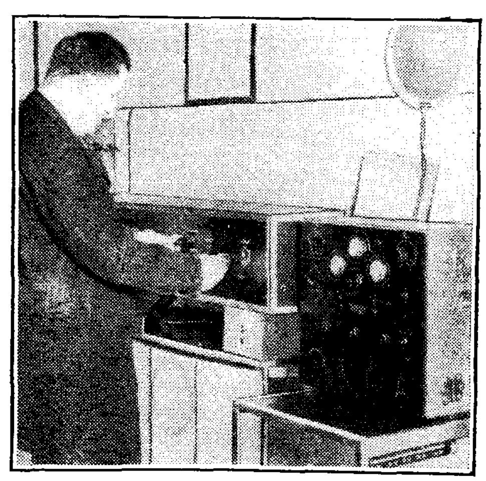
Signorina Maria Corsini, one of the best-known Italian announcers, in a sound-proof cabinet attached to the large studio.

Operated by a private company Italian broadcasting makes full use of the natural facilities of the country. The total power of the Italian stations is at present 190 kW. By the end of this year 250 kW. will have been added. The power of Bolzano will be increased from 1 to 10 kW., and a new station will be opened at Bologna with 50 kW. in the aerial; the Rome station will also have its power increased from 50 to 120 kW. Moreover, a second medium-wave station is to be erected in Rome with a power of 120 kW. in the aerial.

When I was in Rome recently the station director very kindly drove me out to see the two new 20 kW. short-wave transmitters at Prato Smeraldo, a few miles from the city. Beam aerials have been installed for the regular programme services to North and South America and the Far East. These transmitters have just been completed, and readers will remember that the new regular short-wave programmes were inaugurated on October 28th last. The wavelengths employed are: 25.4, 31.13, 42.9, and 49.3 metres. The programmes for North America are broadcast on 49.3 metres. The 25.4-metre wavelength works on an omni-directional aerial, and the 42.9-metre wave is employed for programmes to the Italian colonies, also from an omni-directional aerial.

The Two Networks

The Italian stations are linked up by special music circuits contained in the telephone cables, with the exception of part of the line to Bolzano, in

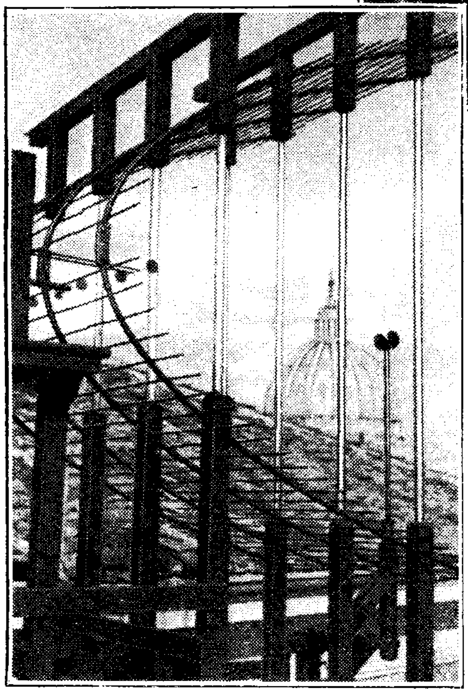


A Naples engineer synchronising the wavelength with that of Madona. Both stations tune to a harmonic of Vienna.

Italy's New Broadcasting Plans—

which "wired wireless" is employed. There are two great programme groups—one for Northern, the other for Southern Italy. Turin is the programme centre for the North, Rome for the South. Listeners in Milan, Turin, and Rome are fortunate enough to have both the Northern and Southern programmes, as each of these towns has small local transmitters, which, in the case of Turin and Milan, take the Southern programme; and in the case of Rome it is the Northern. Palermo is the exception that proves the rule. The cable connecting Palermo to the mainland has only just been completed, but is not yet in operation. At present Palermo's programmes are produced independently.

The Italian broadcasting stations recently started a series of language lessons for foreign listeners. The most popular are those conducted for English people by a young lady in Rome. Response from listeners is very good indeed, and this departure has certainly been one of the happiest ideas on the part of those who are interested in disseminating Italian thought.



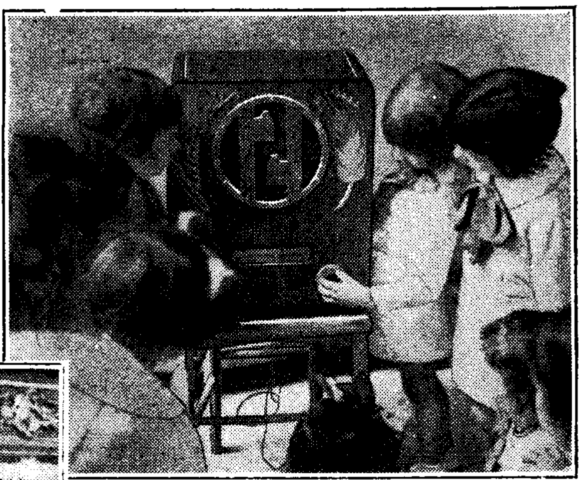
Micro-wave beam aerial at Vatican City for regular communication with the Pope's summer villa at Castelgondolfo.

One day during my stay in Rome I decided to leave the country and cross the borders into the Vatican City. This had been a comparatively simple business in 1931, but since then Vatican City has completed its programme of building, and the Swiss guards at the gates seem to look one through and through to see if a camera is carried, or, possibly, a bomb. The door-keeper farther on was very much more friendly, and gave me the required pass permitting me to clamber up to the short-wave station. Here there had been very few changes since my last visit, except, of course, that Father Gianfranceschi, the engineer-in-charge, was no more. He died a year ago, and I missed the friendly smile and ready hand-shake. The Vatican station has been equipped with micro-wave telephony apparatus to provide straight-line communication with the Pope's summer villa at Castelgondolfo. The opening of the two 20 kW. stations in Rome has placed the Vatican short-wave station second on the list with ordinary listeners as the two E.I.A.R. stations seem to enjoy better range.

The Teatro de Torino has been acquired for broadcasting in the same manner as St. George's Hall, London. A scene during rehearsal.

The special broadcasts in Albanian, Arabian, Serbo-Croate, Greek, and Bulgarian are of prime importance to the nationals concerned, as those countries have not got adequate broadcasting services. The special Greek, Albanian, and also the Bulgarian programmes are, I was assured, arranged in friendly contact with the national authorities concerned, who greatly appreciate the service made available to them by the Italian broadcasting stations.

Signorina Margherita Tasolini, an announcer at Florence, speaks English, French and German.



A typical Radiorurale receiver—a standard 5-valve superhet. for school broadcasting.

The broadcasts in French, English, German and Hungarian are mainly tourist propaganda and "listener's service," like the language lessons. At the office of the Under-Secretary of State for Propaganda in Rome I was told that all steps were taken to prevent unnecessary friction with neighbouring States, and for that reason these foreign broadcasts were limited to matters concerning Italy and the Italian outlook.

It would be wrong to assume that Italian broadcasting is primarily international in aim. I have stressed this side of it, as, to us who live outside Italy, this is the most important aspect, and directly affects us. In the interior Italian broadcasting is forging steadily ahead, and it is assumed that the number of pirates not paying licence fees is at least as large as the number of licence holders. Italian receiving sets have taken the place of imported ones. and the special "school receiver" (five-valve superhet.), sold at the reduced price of 500 liras, is a fine example of concerted Italian industrial action.

But radio progress in Italy is bound to remain slow, for plenty of sun, blue skies, a beautiful country, and in inborn talent for executive music are not naturally conducive to broadcast listening.

INTER-COMMUNICATION ON FIVE METRES

FURTHER satisfactory tests of the Hermes "transceivers" (portable combined transmitter-receivers) are reported. Good communication was maintained between a network of the four stations located at Guildford, Haslemere, Ewhurst, and Bognor Regis, the most notable feat being the exchange of clear signals between the "transceivers" at Guildford and Bognor. The distance between these points puts them out of visual range, and, in addition, there is intervening screening by high ground. The radiated power of all the stations throughout the tests was kept below 1 watt.

Hermes "transceivers" were described and illustrated in *The Wireless World* of April 19th, 1935.

Broadcast Programmes from Records

Recent Developments in Disc Recording for Immediate Replaying

By J. C. G. GILBERT, A.M.I.R.E.

THERE are several alternative systems, each with their special advantages, for making permanent records for rebroadcasting, and for mobile vans the "sound-on-disc" method undoubtedly offers the best solution. In this article the author describes the latest types of cutting heads and the materials used in the manufacture of records.

UNDOUBTEDLY many of the readers of this journal are aware that the British Broadcasting Corporation and other broadcasting authorities make considerable use of recorded programmes.

There are three main systems in use, namely:—

(1) The Blattner-Stille magnetic tape.

(2) The cinema film, using the variable area or variable width systems.

(3) The gramophone record.

The first two systems have been used with considerable success but are not without their disadvantages for some purposes, since it takes a considerable time to rewind the tape or film (they are bulky), and in the case of the cinema film an appreciable time is taken to develop the negative and print the positive.

During the past two years several companies in England have developed recording apparatus which utilises the disc, and the results which can be obtained by this means are so good, and the advantages so great, that the B.B.C. now use this method for a considerable number of their recorded items.

The advantages claimed are:—

(1) Very low running cost.

(2) Recording with constant velocity up to 10,000 c/s.

(3) Background noise, or scratch, is at a very low level, and is definitely considerably less than the standard commercial record pressings.

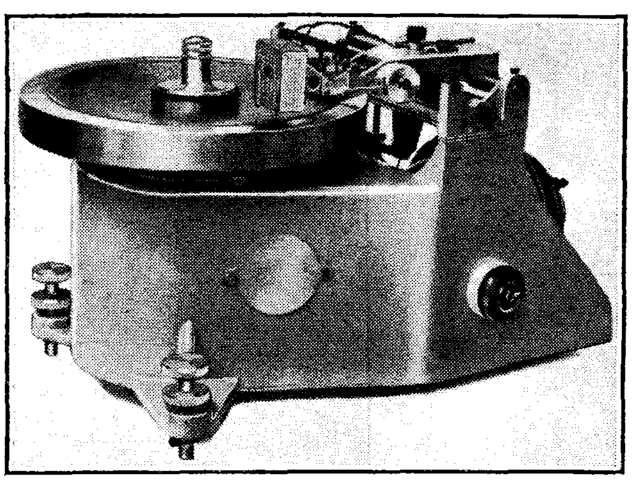
(4) The record is completely processed and can be played back within two minutes of "cutting."

(5) Records are easily stored and are not easily damaged.

The recording machine is constructed in several ways, but the principles involved apply to every case. It is necessary to obtain a driving power which causes the turntable to revolve at a very accurate and constant angular velocity. The gravity motor is undoubtedly the best system to adopt, but, due to its extreme weight and consequent lack of portability, special dynamically balanced self-starting synchronous motors are frequently used. Thereby a constant speed is obtained but precision in the subsequent gears is necessary to ensure that no mechanical fluctuations reach the turntable. Usually this is accomplished by using compound mechanical filters and mounting the motor on "Sorbo" or other vibration-absorbing material.

Recorder Details

It is necessary to reduce the speed of the synchronous motor to the desired turntable speed by gears, although belt driven reduction is used in some cases. By means of a special gear box the turntable speed can be set to $33\frac{1}{3}$, 60 or 80 r.p.m. Again, by a train of gears a lead screw is driven which carries the tracking arm across the record. This arm gives straight-line tracking, i.e., the amplitude of the cut is displaced 90 deg. as regards the direction of the groove, and adjustments are provided for obtaining the correct cutting needle angle and weight of the cutter on the disc. Also, means are available so that the run-out groove at the end of the record can be made.



An example of modern tendencies in recorder design—the "Parmeko" recording machine.

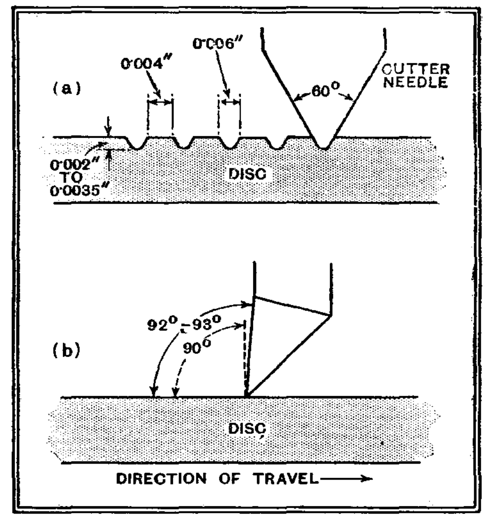


Fig. 1.—(a) Section through disc showing depth and spacing of grooves. (b) Side elevation of cutting stylus.

In some cases the recording machine is designed so that the first groove starts at the inside and the tracking arm traverses to the outer edge. By this means an approximately equal top note cut-off in the reproduction is obtained. It will be seen from inspection of a commercial record that the diameter of the inner recorded groove is about four inches, and as the record is designed to be played at 78 r.p.m. the velocity *under the needle point* is approximately 16 inches per second. In the case of the outer groove of a 12-inch disc the velocity is approximately 46 inches per second, and therefore the length of the groove occupied for a note of the same time duration is nearly three times as long. Thus the distance between successive peaks of constant frequency notes is compressed three times at the centre as compared with the outer groove, and as the needle point is sharper at the commencement of a playing it can more easily cope with small wavelengths. As the needle tracks outwards the finite size of the needle point increases, and as the peak separation also increases a sensibly constant level is maintained. The average pitch of the spiral is 0.01in., i.e., 100 grooves to the inch, the groove occupying 0.006in., and the wall separating the grooves 0.004in. Hence the maximum amplitude of the cut on consecutive grooves cannot exceed 0.0015in. lest the walls break down. Therefore, if we record a note of 250 c/s with an amplitude of 0.0015in. the corresponding amplitude at 10,000 c/s is 0.0000375in., as the amplitude is inversely proportionate to frequency. This figure is approximately the granular size of the special material used in the manufacture of the record. Below 250 c/s special means are adopted so that the maximum amplitude never exceeds 0.0015in. and the reproducing system is compensated for the loss.

The cutter head works on the electro-

Broadcast Programmes from Records—
magnetic principle and is similar to a balanced-armature loud speaker unit. It records at approximately "constant velocity" over the 250-10,000 c/s range, and by means of spring and rubber damping the notes below about 250 c/s are cut at approximately constant amplitude. The armature consists of special soft iron having a low permeability figure and is actuated by the AC current passing through the surrounding coils.

The cutting stylus or needle is manufactured from exceedingly hard steel, and is ground to be about 0.04in. wide, the cutting edges having an angle of 60 degrees. During cutting the needle is arranged to cut a groove between 0.002in. and 0.0035in. in depth, the angle of the needle to the face of the record being 2 to 3 degrees from vertical against the direction of travel, thus enabling the "swarf" to be thrown clear of successive grooves.

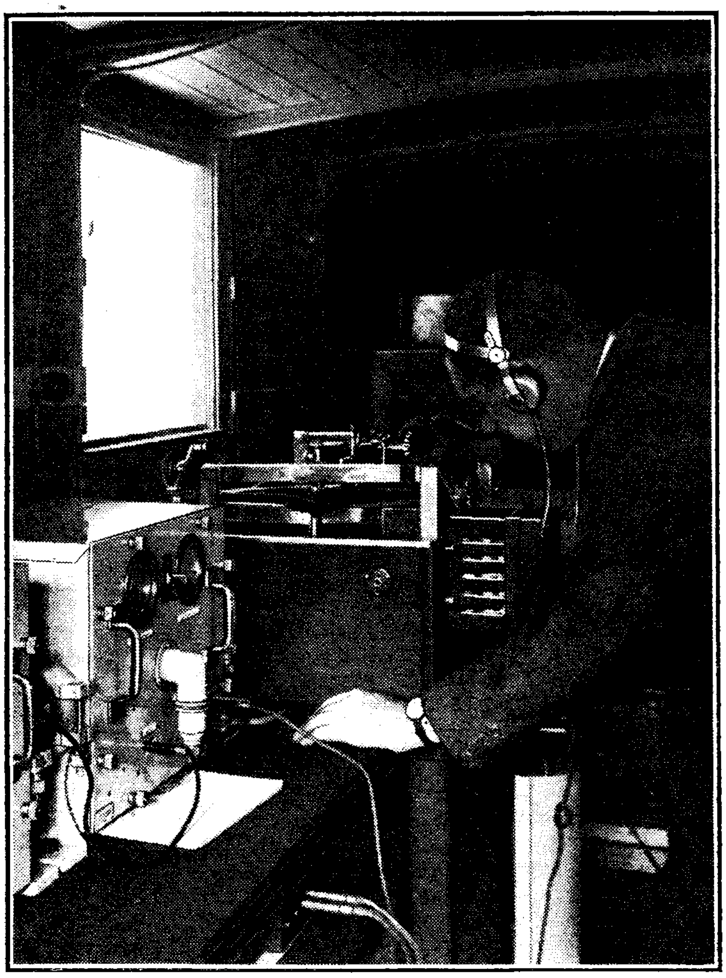
The most important item is the record itself. In Germany and France a disc of glass or aluminium coated with gelatine is popular. Latterly, developments in Germany have led to the manufacture of a disc coated with a soft synthetic resinous compound, which, when cut, is hardened by baking at a constant temperature in an oven. Both gelatine and the resin suffer from a common defect, such that if the consistency thickens and chemical mixing is not perfect, the hardening process causes unequal minute shrinkages which create distortion.

The English developments have been in the direction of producing aluminium discs coated with a cellulose and/or acetate compound. Various manufacturers have produced different formulæ and the records have a beautifully even and glistening black surface. The "swarf" which is thrown off during cutting does not powder but consists of a long thread which is brushed away to the centre of the record. When the record is cut the surface is wiped with a chemical solution which rapidly hardens the outer skin and allows the operator to complete the record ready for replaying within about two minutes.

As this recording system can produce results which are comparable with direct broadcasting it is essential that the associated apparatus should be of the highest quality. At the Stroud Recording Studio in Baker Street, where a number of the Continental programmes are recorded, a piezo-crystal microphone and two-valve pre-amplifier is used. The mixer panel allows the operator to mix two incoming circuits, and the whole amplifying apparatus is resistance-capacity coupled, terminating with an output stage giving an undistorted output of 8 watts at 2 per cent. and 11.5 watts at 5 per cent. harmonic content.

Avoiding Distortion

Although the cutter head requires an input of only three or four watts to cut the maximum allowable amplitude it was found desirable to have a very large factor of safety, and thereby exclude any suspicion of amplitude or frequency distortion in the amplifying equipment.



The "sound-on-disc" principle has been adopted for the B.B.C.'s mobile recording unit.

It is a well-known fact that all electro-magnetic reproducers possess a number of resonances with a major one caused by the mechanical resonance point of the armature. The same holds good in the electro-magnetic recording cutter head, and this resonance, which occurs usually between 3,000-5,000 c/s, is suppressed by means of electrical damping and a filter circuit.

The over-all frequency characteristic of the amplifiers, cutter and record is checked by the very simple optical method evolved by G. Buchnan and E. Meyer

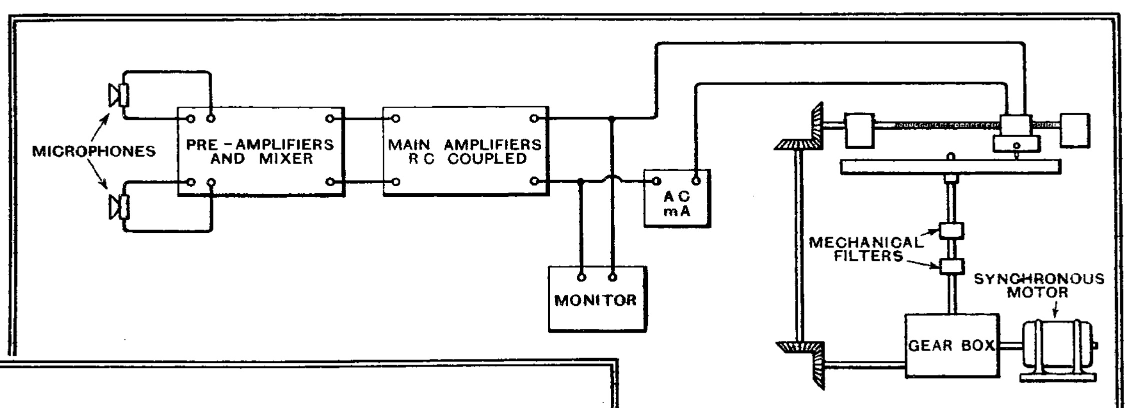


Fig. 2.—(Right) General layout of recording apparatus. A gear box is included to give turntable speeds of 33⅓, 60 or 80 r.p.m.

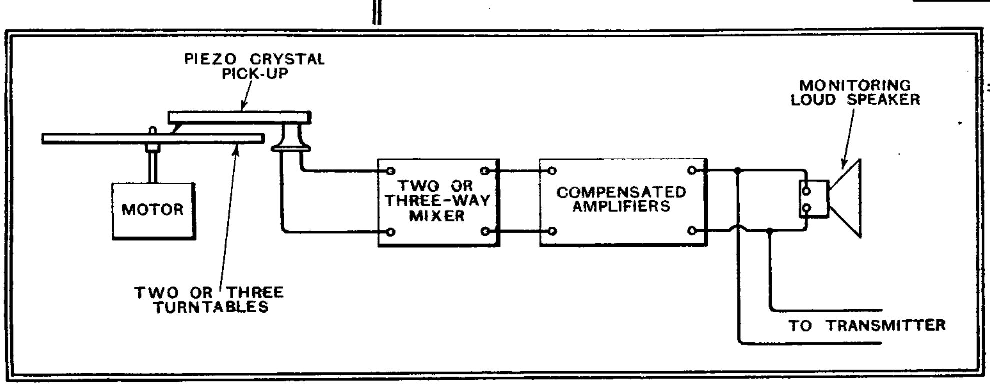


Fig. 3.—(Below) Connections of "play-back" apparatus. Steel needles can be used on the special records if the pick-up is of the piezo-electric type.

Broadcast Programmes from Records—

(described in E.N.T., vol. 7, page 147, 1930). It was found that the cut produced on lateral velocity or velocity amplitude records could be measured if a constant sine wave input was fed into the amplifier by means of a beat frequency oscillator. If a parallel-sided ray of light falls on the record from an oblique angle the reflected ray shows a bright band, the width of which is directly proportional to the velocity amplitude. In other words, if the over-all characteristic is flat and the input constant the reflected beam will have parallel sides.

The finished record can be replayed by means of a trailing needle on ordinary acoustic machines, and where the reproducer has a piezo-electric pick-up, due to the light weight of the needle on the record and the extremely light lateral damping, one can take the advantage of using ordinary loud steel needles.

This type of recording apparatus is finding a large number of applications as, for instance, in broadcasting stations where it is necessary to record a speech or any item which is to be played back later. Again, it is used for rehearsals and, in film studios, for checking the sound before the actual film is taken. Also colleges of music are taking up this apparatus, for, by means of records, pupils can hear their mistakes and more easily rectify them.

The B.B.C. have now fitted out a mobile recording van which will tour the country to record interesting items for later transmission.

Several amateur film societies have installed duplicate recording machines, and by coupling these to the cameras either mechanically or electrically can synchronise sound with the film and produce talkies which, from a "sound" point of view, compare very favourably with the best commercial talkie productions.

Gas-filled Amplifier Valve

New American Output Valve for Low-voltage System

DETAILS of a new valve of unusual interest which would appear to solve the problem of obtaining a large undistorted output when only a low HT voltage is available are given in the June issue of *Q.S.T.* by J. R. Nelson and James D. Le Van. The data shows that for an HT supply of 110 volts an output of over 7 watts can be obtained for less than 5 per cent. third harmonic distortion!

The valve is fitted with an indirectly heated cathode, the heater consuming 0.6 ampere at 6.3 volts, which is surrounded by two grids and an anode. The inner grid is termed the cathanode, for it serves the dual purpose of anode and cathode to the two halves of the valve. It acts as the cathode of a conventional triode, of which the other grid and the anode are the remaining electrodes, and it also functions with the true cathode as the anode of a gas discharge tube. The valve is filled with mercury vapour and the cathanode is maintained at a positive potential of some 10 volts. The discharge, therefore, occurs between the true cathode and the cathanode. The velocity of the electrons, however, is great enough for many to shoot through the cathanode, which may consequently be regarded as a cathode emitting electrons with an initial velocity equivalent to about 1 volt. The control grid and anode then function in the manner of an ordinary triode.

Two points result from this construction. It is readily possible to make the grid and anode physically large and so capable of dissipating a considerable amount of heat, and a very high mutual conductance with a low AC resistance is obtainable. With the RK-100 valve the mutual conductance is 12.0 mA/V with 100 volts anode potential and 2.5 volts negative grid bias when the ionising current to the inner grid is 150 mA., and it rises to no less than 20 mA./V when this current is increased to 250 mA. The AC resistances for these conditions are of the order of 4,100 ohms and 2,500 ohms.

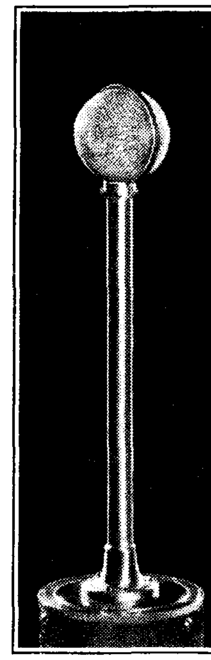
Unlike the conventional triode, the control grid takes an appreciable current under all conditions. It is, however, small, with a negative grid bias, so that the input resistance of the valve is high, although lower than that of an ordinary evacuated valve. The valve is not confined to the output stage of a receiver, for it may also be used as an HF amplifier in transmitters and as an oscillator, in which rôle it will function at as low a wavelength as 2 metres.

For receiver use the valve will undoubtedly find its chief function in the output stages of sets designed for operating from 100 volts DC supplies, for the provision of an adequate output in such sets has hitherto been a matter of extreme difficulty. There is no doubt, however, that it would prove extremely useful in small transmitters also.

Brush "Laboratory" Microphone

Designed and Calibrated for Frequencies up to 20,000 c/s.

THE majority of high-quality microphones give an output free from irregularities in the bass and middle register, but the curve generally "breaks-up" towards the top, calling for correction by means of either mechanical or electrical filters.



The Brush laboratory standard piezo-electric microphone is mounted directly on its pre-amplifier.

In the Rothermel-Brush piezo-electric microphones employing "sound-cell" construction it has been observed that departure from constant output—although negligible for most purposes—commences at a frequency approximately half that of the resonant frequency of cells. Consequently in the laboratory standard microphone, designed to be free from errors up to 20,000 c/s, the cells have natural periods of 41,000 c/s. They are only 7/32in. square, and do not introduce appreciable diffraction effects for sound waves in the plane of the cells. Their natural frequencies are measured electrically by plotting an impedance curve, and four cells connected in series-parallel are used in each microphone.

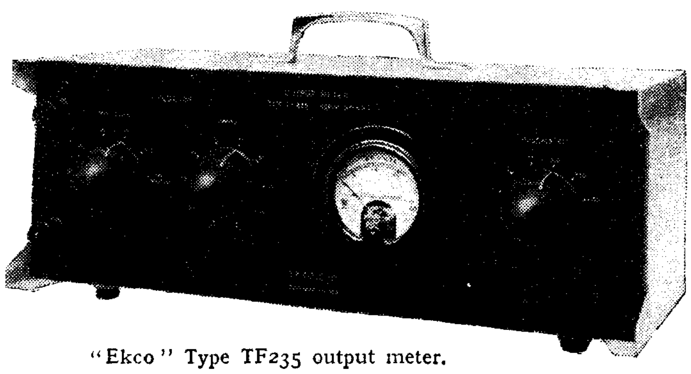
With a natural period as high as 41,000 c/s it is reasonable to infer that the response up to 20,000 c/s will be flat. The makers, however, have not been content with that assumption, and have devised a method of direct calibration. The source of sound is a Rochelle salt crystal with a natural period of 100,000 c/s, to which a constant voltage is applied at different frequencies. Good agreement has been established with other reliable, if less direct, methods of calibration, and the microphone may be safely assumed to be flat up to 15,000 c/s, with a 1 db. rise at 20,000 c/s.

The output is about 14 db. below the larger standard Brush cell, and the microphone is mounted directly on a pre-amplifier, one conductor being the supporting tube and the other a fine bronze wire stretched tight and mounted centrally in the tube. The group of cells is protected by a spherical gauze shield approximately 1½in. in diameter.

The microphones are built and calibrated only to special order, and full particulars are obtainable from R. A. Rothermel, Ltd., Canterbury Road, London, N.W.6.

UNIVERSAL OUTPUT METER

THE impedance range of the latest power output meter made by E. K. Cole, Ltd., is adjustable from 2 to 20,000 ohms in 40 logarithmic steps. Frequency errors do not exceed 2½ per cent. up to 12,000 c/s and the voltage range of the instrument is from 0.3 to 200 volts. This is equivalent to a power range of 5 micro-watts to 2 watts, but for short periods powers up to 5 watts may be absorbed. The price of the new instrument is £20.



"Ekco" Type TF235 output meter.

Current Topics

Events of the Week in Brief Review

"Hush-Hush" Regional Scheme

DISCONTENT in France over the delay in launching the Regional Scheme is becoming more pronounced. Several French radio journals publish the dates on which it was officially announced that certain stations would open, namely, Lyons and Toulouse, November, 1934; Lille and Paris P.T.T., January, 1935; and Marseilles, February, 1935. These stations are still silent.

Germany's Radio Trial

OFFICIALS of the former German broadcasting organisation are appealing to the German Supreme Court against sentences passed upon them last week after a trial which began in the autumn of 1934. Dr. Hans Bredow was sentenced to six months' imprisonment and a fine of 5,000 marks for offences against German company law, and Dr. Kurt Magnus, for the same offences, was sentenced to five months' imprisonment and a fine of 4,000 marks.

Woman Stops Man-made Static

ALTHOUGH Mlle. Piskor, of Warsaw, and the lady engineer at Bucharest, whose portrait appears in this issue, may be the only women engineers regularly employed at broadcasting stations, Norway has a woman static hunter in Mlle. Agnes Moe, who is in charge of the Post Office campaign at Kragero against electrical interference. According to our Scandinavian correspondent, Mlle. Moe has traced and silenced 122 cases of man-made static.

5-metre Opportunities

EVERY Friday afternoon, between 3 and 5 p.m., 5-metre transmissions are made from the Portsmouth Municipal College tower with the call sign G6PU. Reports will be welcomed by Mr. Albert Parsons at the College.

From station G2IN, Southport, special 5-metre tests will be carried out on June 30th without a break from 10 a.m. to 3 p.m., when attempts will be made to work other ultra-short wave stations. Transmissions will be from a hilltop eight miles from Southport. Reports will be welcomed by Mr. W. Johnson, Harmony House, 116, Cambridge Road.

Tests on 5 metres are conducted on Sundays from 10 a.m. onwards by Mr. T. H. Streeter, G5CM, The Schoolhouse, Alfold, Surrey. Reports are welcomed.

Colour Television

ACCORDING to the Brussels correspondent of *The Times*, M. Leon Damas, of Charleroi, has invented a television system by which sound and image are transmitted simultaneously on the same wave, the natural colours of the televised object being clearly reproduced.

For Goose-hunters Only

FROM our Washington correspondent:—

"Goose-hunting is duck-soup for one ingenious Nimrod, who has contrived a way of using electrical transcriptions and loud speakers as decoys.

"Tobe Deutschmann, radio manufacturer of Canton, Mass., has made himself the envy of most goose-hunters by recording the conversation of two live geese, each record playing fifteen minutes of that kind of chatter. Around the gunning stand of his Cape Cod retreat he has mounted four loud speakers, with control dials running to the turntables. As a flock of geese approach, the speakers are given the juice, and the babble of a thousand geese is simulated. Closer and closer come the visiting geese, and off go the guns.

"Until the geese get acquainted with the ramifications of radio, this decoy system should be the real 'McCoy.'"

I.E.E. Wireless Section

MR. R. A. WATSON WATT, B.Sc. (Eng.), has been elected Chairman of the Wireless Section of the Institution of Electrical Engineers for the year 1935-1936.

Trolley Bus Interference

ELECTRICAL interference was keenly debated at the Annual Conference of the Tramways, Light Railways and Transport Association in Llandudno last week. The author of a paper on the equipment of trolley bus routes (a member of the staff of the English Electric Co.) mentioned the difficulty of fitting effective choke coils on the trolley bus collector gear. An effective method had, he said, been tested which involved the use of condensers, with earthed centre points, across the line at intervals of a furlong. Several speakers in the ensuing discussion reported better results in bus operation, with less interference, from the use of cast-iron sliding collector shoes in place of trolley pole wheels.

5-Metre Field Day

A SERIES of field days for testing 5-metre receivers, types of transmitting aerials and their directional properties, is being organised by the Golders Green and Hendon Radio Society, and the first will be held on Sunday next, June 23rd. The transmitters co-operating are 5RD, 2JU, 5BO, 2GG, 6SI and 5CD.

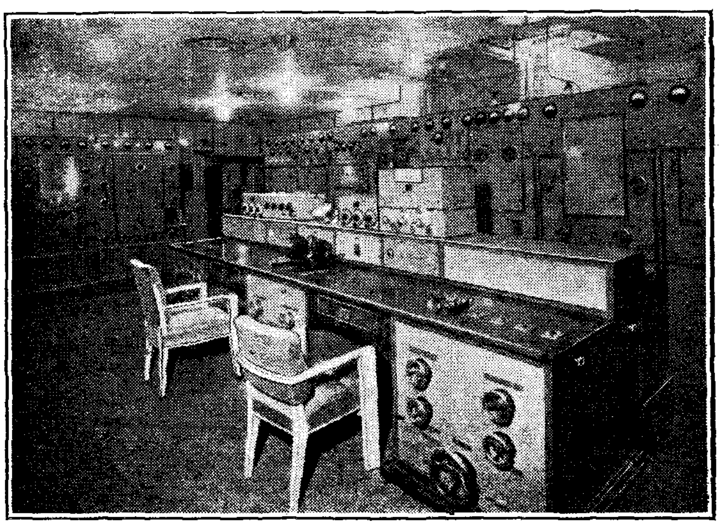
Amateurs interested are invited to join the party at 9.45 a.m., at the top of Brockley Hill, Elstree.

Broadcast Brevities

By Our Special Correspondent

Bountiful and Free

IT is so rare, in this world, to obtain something for nothing, that many listeners, I feel sure, "smell a rat" in the offer of free seats for the B.B.C. variety broadcasts. I can assure everyone interested that there is no catch in it; this offer of free seats is no plot to get together a submissive crowd to be drilled into applauding or booing at appropriate moments. No one is even invited to contribute to the current "Week's Good Cause," though why not, I fail to understand.



RADIO ON THE "NORMANDIE." France's record-breaking liner carries three separate radio installations working on long, medium and short wavebands respectively, the maximum transmitting power being 2.5 kilowatts. As our picture shows, the radio room is exceptionally large.

Applications Welcomed

There are still some vacancies for the variety broadcasts in St. George's Hall, and applications are welcomed. They should be addressed to the B.B.C., Broadcasting House, Portland Place, London, W.1, and envelopes should be marked "Audience" in the top left-hand corner.

Empire Service Surprise

THE B.B.C. Empire service has taken an amazing leap towards popularity in the last four months, to judge from the number of letters received from listeners in all parts of the world. No doubt the Jubilee broadcasts are partly responsible.

Mr. J. B. Clark, Empire Programme Director, says that in 1933 his department received 11,250 letters. In 1934 the figure increased to 13,500; yet the first four months of 1935 brought in 13,574—slightly more than the total for the whole of the previous year.

Recordings on Cable Ships

CABLE laying is a rare process nowadays, as most of the work has already been done. The main function of the cable fleet is repair work.

Laurence Gilliam's "Cable Ship" programme, to be broadcast on July 10th, largely concerns the cable ship "Mirror," which is one of the biggest of a fleet owned by a large British cable company. It will depict a panorama of cable routes, including the despatch of a message to London which is interrupted. Listeners will hear how the fault is traced and go with the ship to the scene of the interruption, thus getting an outline of the delicate navigation needed to locate the exact spot. The whole operation will be illustrated in detail by actual recordings made in the ship.

UNBIASED

By FREE GRID

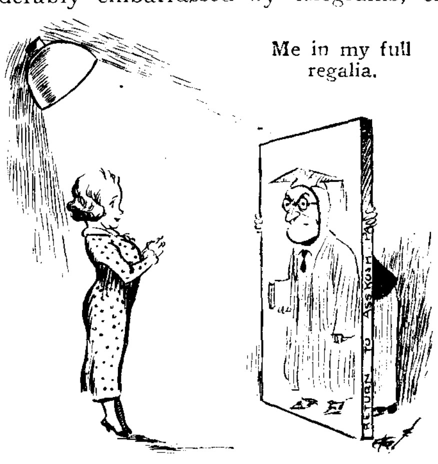
Misinterpreted

SOME little perturbation has arisen in the minds of several good folk by my report of a station sending out a programme of a type which "would bring a blush of shame even to the hardened cheeks of a boulevardier of Montmartre or Manchester." As one correspondent puts it, "The programme you heard must indeed be beyond the pale if it would shock the susceptibilities of the type of person you mention."

I fear that readers have quite misinterpreted my meaning, and I can assure anxious mothers that they need not forbid the children to listen to foreign programmes; in any case, such a veto would naturally serve merely to strengthen their resolution to do so. One good lady in a somewhat lengthy epistle paints a lurid picture of what television programmes are likely to consist of if even ordinary broadcasting can thus offend good taste, and she tells me that she has definitely forbidden her nephew to purchase the high-definition television receiver for which he has been saving up his pennies. I can assure her quite definitely, however, that such programmes as she describes are never broadcast, and in any case no high-definition television is, as yet, radiated from Paris.

M.A. (Oxon), D.L.W. (Ass.)

I DID not intend my recent brief résumé of my academic career to be taken as a hint to universities and other seats of learning to bestow upon me honorary degrees. It is quite evident, however, that my intentions have been thus wrongly interpreted, for I have been considerably embarrassed by telegrams, ex-



Me in my full regalia.

press letters and other urgent communications from the various agents which foreign institutes and other seats of learning maintain in this country on the look out for business.

Not only have I been troubled by these communications offering me "their best terms," but in some cases I have received parcels from the agents containing cap and gown, and full academicals sent C.O.D. The hoods, with their pretty colours, certainly look very tempting, and Mrs. Free Grid has spent a long week-end trying them on herself and endeavouring to choose a hood to match my complexion. After much vacillation I have at last decided to accept a doctorate of long waves conferred on me by the university of Asskosh, Pa., and in the accompanying sketch you see me in my full regalia. This degree must not be confused with the D.S.W. (Doctor of Short Waves) referred to in the "Current Topics" section of this journal for May 31st, as having been mooted by the International DX'ers Alliance.

I suppose that sooner or later I shall have to make the long journey across the Atlantic in order to visit the Senate House of the university and have the degree officially conferred on me by the chancellor. I shall be glad if, in future, readers will remember that, when writing to me, politeness demands that they add the letters D.L.W. after my name, and, of course, address me as doctor.

A Flagrant Case

SHAKESPEARE, or maybe it was Homer, once put it on record that in his opinion there was nothing half so sweet in life as love's young dream. I would prefer not to express an opinion on the matter myself, but, judging by the number of "estates" which are springing up everywhere and disfiguring the countryside, it is quite evident that the average jerry builder is in full agreement with the remark.

Many and ingenious are the wiles by which these gentry induce intending Benedicts to put down the necessary half-crown deposit and sign away the greater part of their income for the rest of their lives, but up to the present their conduct has at least been honest, legally if not morally. I regret to observe, however, that certain of them have now adopted tactics which bring them into direct conflict with the law, and I trust that the competent authority will take the necessary action. The circumstances are as follows.

As many people know, when young folk are at a romantic age, before the hard facts of life in the form of the monstrous charges of our educational establishments have brought them to earth with a healthy thud, their one desire is to dwell and bring up their families in sylvan surroundings amid the sound of the birds. Certain estate builders have, for a long time, been catering for this sort of thing, and have been inserting in their advertisements the statement that one of the principal attractions of their hideous bungaloid excrescences is that the songs of thrushes and nightingales are on tap day and night.

I had, of course, regarded such statements as merely the usual builder's lie, and I was therefore pleasantly surprised on visiting a certain estate in the company of a prospective son-in-law to find the air filled with the melody of the mavis, which seemed to emanate from every tree in the neighbourhood. I was considerably astonished, however, to find that the same song was coming from the various branches of all the trees. I was still more astonished to find that a stone flung into the foliage failed to frighten the songsters.

Mistaken for a blackbird.

Becoming suspicious I shinned up a neighbouring tree and, carefully climbing out on to one of the branches, I found a tiny loud speaker, while others could be seen on neighbouring branches. As I descended I was struck by a missle from a catapult fired by a small boy below who had evidently mistaken me for a blackbird.

Poking about at the base of the tree, I very soon came across an ultra-short wave receiver coupled up to the loud speaker in the branches. Other trees were similarly equipped.

Naturally, I suspected that the transmitter was in the builder's office, and so indeed it was, but instead of the gramophone turntable which I had expected to see I found a small boy chivvying half a dozen wretched thrushes in a cage, from the top of which was suspended a microphone. He was, he explained, paid sixpence an hour to keep the thrushes stirred into activity. As it was Saturday afternoon I was unable to get into touch with his rascally superiors, but I had the satisfaction of releasing the thrushes and broadcasting, *via* the microphone and loud speakers, a suitable commentary on the whole affair.

Such a state of affairs is so obviously a flagrant violation of the laws of this country regarding cruelty to animals that I think that at last these gentry have overstepped the mark, and I invite the various animal protection societies to take the necessary action.

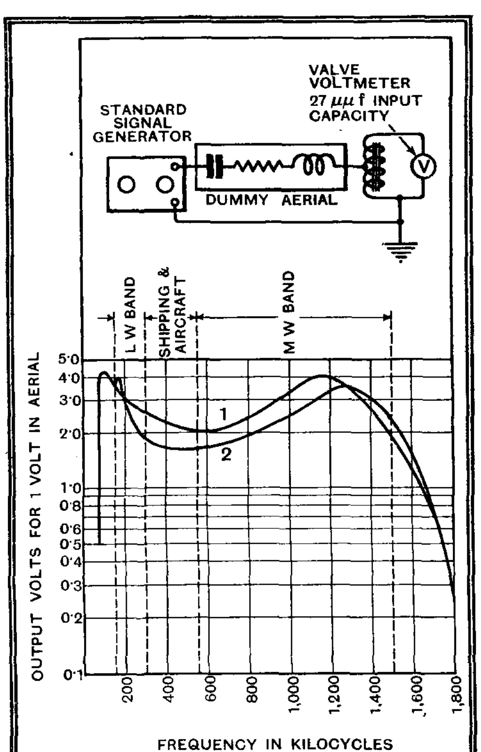
Aperiodic Aerial Transformers

A New Design : Stalloy Iron Cores in HF Circuits

By R. I. KINROSS

WELL-KNOWN methods for increasing the frequency range of low-frequency apparatus often find a similar application at radio frequencies. An example of this appears in the design of an aerial transformer for use with a receiver such as the recently described "Single Span," in which no accurate signal pre-selection is required. What *is* required, however, is as large a step-up as possible over a band of frequencies extending from 150 to 1,500 kc/s, and as sharp a cut-off as possible outside this band.

The impedance of an aerial is seldom less than 3,000 ohms at 150 kc/s. For reasonably high efficiency on long waves the primary of the transformer should therefore have an impedance of about 30,000 ohms, which is equivalent to an inductance of 25 millihenrys. For a step-up ratio of 2 : 1 the secondary, assuming unity coupling coefficient, would then have to be 100 millihenrys. In practice it is found impossible to wind such a coil without either: (1) introducing so much self-capacity as to ruin the performance towards 1,500 kc/s; (2) obtaining a very low coupling coefficient in order to avoid introducing this self-capacity.



Characteristics of the transformer described in the text when used with two different aerials.

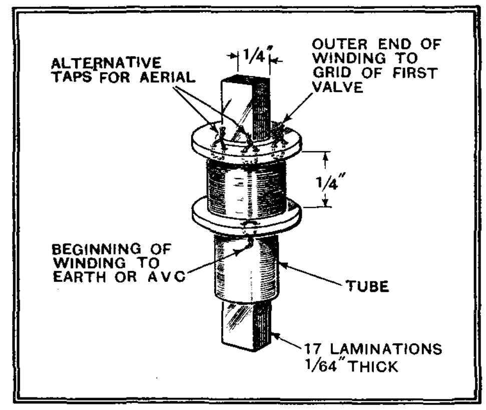
The alternative is to aim at reasonable efficiency in the middle of the band as a straightforward transformer, and arrange for a resonance at each end of the range to be covered. The primary of the transformer tuned by the aerial capacity will provide a resonance towards 150 kc/s, while the leakage inductance, together with the self and external stray capacities, will boost up signals towards 1,500 kc/s. A core of high effective permeability should be used, and Stalloy stampings, as employed in LF circuits, have been found suitable. The introduction of such a core has the effect of increasing the primary and secondary inductance values and coupling coefficient, but hardly affects the leakage inductance, thus enabling a bigger band width to be covered between the two points of resonance. The reason the leakage inductance value is scarcely affected by the introduction of the stalloy core is due to the fact that, though the common flux tends to be increased by deflecting some of the original leakage flux through the core, the presence of the latter also encourages an increase in flux round each separate winding, and the two effects are found to cancel out approximately.

Thus the introduction of the iron core will reduce the frequency of the primary resonance and leave the resonance at the high-frequency end of the band unchanged.

Practical Details

In practice these results may very easily be achieved in the form of an auto-transformer consisting of a "scrambled" winding of 600 turns of 41 SWG silk- and enamel-covered copper wire wound on a ½in. diameter former between cheeks ¼in. apart. The aerial should be tapped in somewhere between quarter- and half-way from the inner end of the winding, the bigger the aerial, of course, the lower the tap which should be used. Ordinary Stalloy laminations $\frac{1}{64}$in. thick, and cut to a size 1½in. long and ¼in. wide, should be used. Stalloy is in this case better than special core materials recommended for radio-frequency work, because it has a higher effective permeability at 150 kc/s, and the losses which it introduces are actually beneficial in this case in preventing sharp peaks at the resonant points which, should one fall at a wavelength close to that of a local transmitter, would very probably introduce cross-modulation.

It will be noticed that the input capacity of the valve voltmeter used for taking measurements on this transformer was 27 μμF. This includes stray capacities due to wiring, and is more than need occur when the transformer is actually incorporated in a carefully designed receiver. Even so, care should be taken to keep the stray capacities across the secondary down to as low a figure as possible, since any reduction below 27 μμF will have the effect of shifting the medium-wave hump over to the right of the figure, and so increase the gain at 200 metres. No fears need be entertained of obtaining too low a capacity, since the self-capacity of the actual winding, together with the signal-grid/earth capacity of the first valve and reflected aerial capacity, will always ensure an adequate minimum.



Construction of an untuned aerial transformer, with an iron core of "LF" material.

It is most important that this coil should not be doped in any way. Humidity tests have been carried out without producing any change, but the application of dope reduces the gain at 200 metres by about 15 db.

THE RADIO INDUSTRY

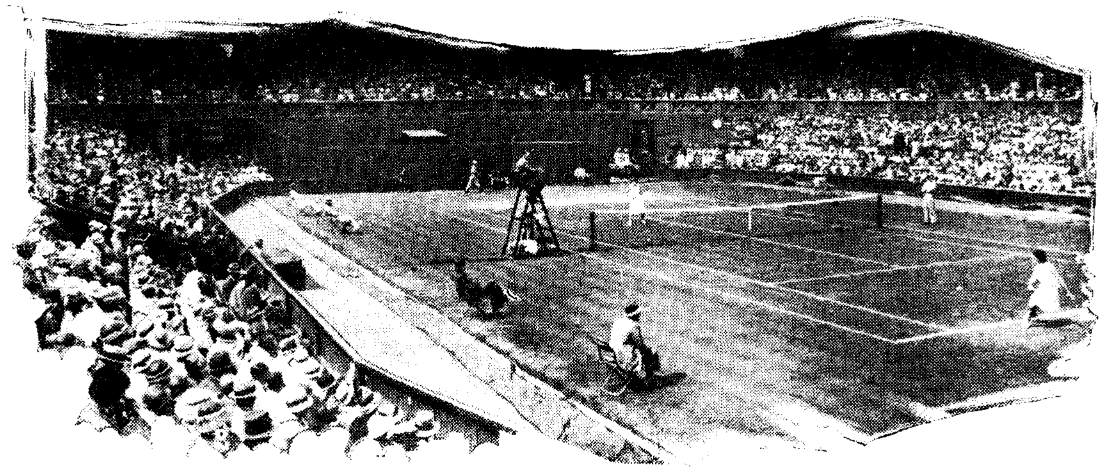
PYE RADIO, LTD., tell us that the low-loss screened cable with ceramic insulation as employed in the latest Pye sets has been made available to the general public. It may be obtained from Pye service agents at a cost of 7d. per ft.

Lavino (London), Ltd., of 43, Fenchurch Street, London, E.C.3, have now produced a comprehensive catalogue of machinery used in the manufacture of dry batteries. The firm also specialise in the supply of materials for the dry-battery industry.

A new folder dealing with the Goltone Statoformer System is now available from Ward & Goldstone, Ltd., Frederick Road, Manchester, W.6.

A new list issued by Burne-Jones and Co., Ltd., of 296, Borough High Street, London, S.E.1, describes in detail the various types of Magnum multi-contact switches manufactured by this firm.

Listeners' Guide for the V



"DEUCE!" Throughout next week running commentaries will be given by Col. Brand and Capt. Wakelam on the All-England Lawn Tennis Club Championship meeting. Regular programmes will be broken into daily at approximately 2.50, 3.30, 4.30 and 6 p.m.

A SPORTING WEEK

SPORTING events are well to the fore in the broadcasts for the next seven days. Wimbledon tennis naturally takes the first place, and it is good news that those very experienced commentators, Col. R. H. Brand and Captain H. B. T. Wakelam, will be sharing the task of translating sight into sound.

The Petersen v. Neusel fight promises almost as much excitement for listeners as for those in the ring seats.

THE HIGH JUMP

No event in the International Horse Show at Olympia is more spectacular than the competition for the King George V Gold Cup. The finest military riders and jumpers in the world take part. On Monday afternoon next on the National wavelengths Major H. F. Faudel-Phillips, one of the greatest authorities on horsemanship, will give a running commentary which can hardly fail to be genuinely exciting.

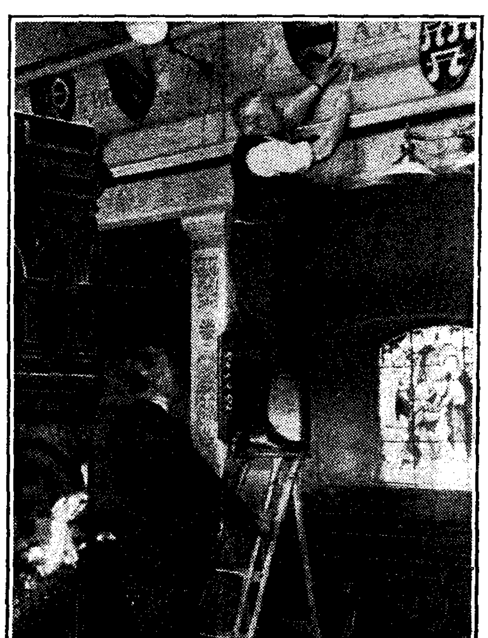
DO WE CARE?

"THAT the B.B.C. Cares Nothing for its Listeners" is the irreverent title of an impromptu debate to take place in the Regional studio on Monday. It is rumoured that a counter debate will be started on the subject: "That Its Listeners Care Nothing for the B.B.C."

AN H. G. WELLS STORY

THE almost complete absence of dialogue in H. G. Wells' short story, "The Country of the Blind," made the work of radio adaptation difficult when E. King Bull undertook it for the broadcast in January, 1933. That he surmounted the difficulty is shown by the fact that the script was approved by the author himself. "The Country of the Blind" will be heard again in the National programme on June 25th and in the Regional on June 27th.

The story deals with a lonely and undiscovered valley inhabited by a sightless race, and the strange adventures which befall a man from the outside world who strays into this mysterious country.



MAGNA CARTA SUNDAY will be observed by a special service to be broadcast in the Regional programme from Egham Parish Church on June 23rd. The Rev. A. C. Tranter, vicar, is here seen decorating the church with escutcheons of the trustee barons.

CROONING

LOVERS of crooning have a treat in store on Wednesday next when Greta Keller, one of the first crooners in America and one of the earliest broadcasters from Savoy Hill, will give a fifteen-minutes entertainment in the Regional programme.

HOLLYWOOD IN B.B.C. VARIETY

THE deep bass voice of Noah Beery, the Hollywood film star, will be heard in the third Jubilee "Music Hall" on Thursday next, June 27th. The remainder of the bill is filled by well-known stars of the music halls. There are the Mills Brothers, famous for their close harmony numbers; Will Fyfe, the irrepressible Scot; Leslie Sarony and Leslie Holmes and the celebrated Billy Bennett, who will appear before the microphone as "Almost a Gentleman."

CREAM OF THE MONTHLY REVUES

WEDNESDAY'S "Review of Revues," presided over by Nelson Keys, will skim the cream from the monthly revues which have been given since January last (National). This may explain why the B.B.C. resolutely refused to give repeat performances of these clever entertainments, nearly all of which deserved a second hearing. In addition to Nelson Keys the cast will include Patrick Waddington, Betty Davis, Joan Carr, Hermione Gingold, C. Denier Warren and the Radio Three. The B.B.C. Variety Orchestra will be conducted by Mark Lubbock.

PETERSEN v. NEUSEL

LIONEL SECCOMBE is again commentator in the broadcast of the International Heavyweight Boxing contest between Jack Petersen and Walter Neusel in the Regional programme on Tuesday next. This will be a return match, Neusel being the winner of the previous contest, when Petersen retired with a damaged eye.

By courtesy: "Film Weekly."

NOAH BEERY, the Hollywood star, who makes his first British broadcast in "Music Hall" on Thursday next in the National programme.

SALVATION ARMY BROADCAST

TO-NIGHT (Friday) at 8.30 Colonel Mary Booth, leader of the Danish section of the Salvation Army, will be speaking in English at the Army's annual Convention in Copenhagen. The ceremony will be relayed by Copenhagen and Kalundborg.

Veek

Outstanding Broadcasts at Home and Abroad

A ROYAL BROADCAST

H.M. King Gustaf of Sweden is to broadcast from Motala to-day at 2.40 p.m. during the celebrations in connection with the 350 years' anniversary of the Swedish harbour city of Härnösand. King Gustaf, in spite of his age, is a notable sportsman, especially at tennis, and in international tournaments he usually appears incognito as "Mr. G."

MIDSUMMER REVELS

Midsummer Day is being celebrated throughout Norway to-morrow night (Saturday). From 10.15 to 11 o'clock Oslo will broadcast a running commentary and sound picture on the festivities on the Kongsten plain near Fredriksstad, where a pageant is performed by young lads and lasses in native dress.

LESSER-KNOWN OPERAS

The European stations seem to have concentrated on lesser-known operas in their programmes for the next seven days. To-night (Friday) at 9.30 Sottens gives excerpts from "Tell," an opera by Doret, and to-morrow at 8.50 Rome offers Sepilli's operetta in three acts, "La nave rossa." On Monday, following the performance of Mozart's one-act opéra comique, "Der Schauspieldirektor" at 8.30, Strasbourg will give "Les trois bossus," a one-act farce with music by Missa, performed by the Station Choir and Orchestra. On Tuesday Paris P.T.T. and all French State stations, except Radio-Paris and Eiffel Tower, will broadcast at 8.30 p.m. "L'étoile," an opéra bouffe in three acts by Chabrier. The National Orchestra will be conducted by Ingelbrecht.

The well-known opera by Berlioz, "Benvenuto Cellini," comes from Radio-Paris on Thursday at 8.30.

TEUTONIC HILARITY

Week-end fare from the German stations is nearly always of the "jolly" type. A case in point will be "All Aboard," Leipzig's variety programme from 8.10 to 10 o'clock to-morrow evening (Saturday) in connection with the 1935 Wireless Announcers' Competition, relayed from Halle. A little later Berlin (Funkstunde) will be broadcasting a week-end variety concert from 10.30 p.m. to 1 a.m. with the Hans Bund Orchestra and Maria Roland's Instrumental Trio.

HUSBAND AND WIFE ANNOUNCERS. Signor and Signorina Scaturchio, who both officiate at Radio Bari. Signorina Scaturchio was formerly announcer at Naples and was known as Rosa di Napoli.

CARILLON. An unusual glimpse of the tower of St. Coleman's Cathedral, Queenstown, from which the chimes are frequently relayed by Athlone.

"THE ART OF FUGUE"

Bach lovers will not miss "The Art of Fugue" which is to be relayed by Leipzig from St. Thomas Church at 8.10 on Monday.

CRIME DETECTION TO MUSIC

Musical detective plays are extremely rare, but the Munich station is not deterred by this fact, for the first performance of such a play, "Take Care of MacDown," is to be broadcast at 8.45 p.m. on Wednesday next.

MUSIC OF THE NATIONS

National music again figures in a number of broadcasts. To-night (Friday) at 7 Leipzig offers a concert of Egerland Folk Music, and at 8 o'clock Stockholm gives Swedish music by Folke Jonsson (songs) and Ingrid Kjellström (piano). Stuttgart, at 10.30, also gives a folk song programme.

To-morrow (Saturday) at 8.10 Luxembourg gives French music by the Station Orchestra with Szigeti as solo violinist.

SUGGIA AT LUXEMBOURG

Suggia, the famous 'cellist, will be heard in to-night's concert from Luxembourg between 9 and 9.50.

THE AUDITOR.

30-LINE TELEVISION

Baird Process Transmissions.
Vision 261.1 m.; Sound 296.6m.

MONDAY, JUNE 24th.
11.15—12.0 p.m.

Billy Kershaw (the Personality Dancer); Dorothea and Jack (variety dancers); Eric Barker (entertainer); Monti Ryan (songs and dances); Sydney Jerome's Quintet.

WEDNESDAY, JUNE 26th
11.0—11.45 p.m.

"Hungarian Goulasch":—Harriet Bennett and John Hendrik (songs); Georgie Harris (comedian) and Derra de Noroda, with Sydney Jerome's Orchestra.

HIGHLIGHTS OF THE WEEK

FRIDAY, JUNE 21st.

Nat., 8.30, B.B.C. Orchestra conducted by Eugene Goossens. 10.15, "The Nightingale," from a story by Hans Andersen.
Reg., 8, "The Mikado," Act I, from Sadler's Wells. 9.15, Leslie Bridgewater Quintet.
Abroad.
Poste Parisien, 8.20, Operetta: "Dix-neuf ans" (Bastial) by Station Orchestra and soloists.

SATURDAY, JUNE 22nd.

Nat., Fred Hartley and His Novelty Quintet. ¶"Music Hall." ¶B.B.C. Orchestra (F).
Reg., Ballet Music by B.B.C. Chorus. ¶"The Nightingale."
Abroad.
Brussels No. 1. Concert by the Don Cossacks Choir.

SUNDAY, JUNE 23rd.

Nat., Walford Hyden's Magyar Orchestra. ¶B.B.C. Military Band. 9, "Justice" (Galsworthy) by Leon M. Lion's Festival Company.
Reg., B.B.C. Orchestra (F) conducted by Julian Clifford. ¶Bournemouth Municipal Orchestra conducted by Richard Austin.
Abroad.
Berlin, 8.50, Opera: "Djamileh" (Bizet).

MONDAY, JUNE 24th.

Nat., Wimbledon Tennis Commentaries from 2.50 onwards. ¶Will C. Pepper's "White Coons." ¶The Lyra Quartet.
Reg., 8, Impromptu debate: "That the B.B.C. Cares Nothing for its Listeners." ¶B.B.C. Orchestra (F) conducted by Adrian Boult.
Abroad.
Munich, 8.10, Musical Comedy: "Love, War and Paprica," by Robert Tants.

TUESDAY, JUNE 25th.

Nat., 8, "The Country of the Blind" (H. G. Wells). ¶"Freedom" by the Lord Bishop of Durham. ¶Eric Cundell Chamber Orchestra.
Reg., B.B.C. Military Band. ¶"White Coons." 9.30, Petersen v. Neusel at Wembley Stadium.
Abroad.
Kalundborg, 8.30, Students' Choirs.

WEDNESDAY, JUNE 26th.

Nat., B.B.C. Orchestra (F) conducted by Darius Midhaud. 10, Nelson Keys in "Review of Revues."
Reg., Greta Keller. ¶"Johann Strauss at Covent Garden"—B.B.C. Theatre Orchestra feature.
Abroad.
Radio-Paris, 8, Gala Evening at the Comédie Française.
Strasbourg, 8.45, Symphony Concert in the Orangerie.

THURSDAY, JUNE 27th.

Nat., "Music Hall." ¶Leslie Bridgewater Quintet. ¶Henry Hall and B.B.C. Dance Orchestra.
Reg., 8, "The Country of the Blind" (H. G. Wells). ¶Boyd Neel String Orchestra.
Abroad.
Paris P.T.T., 8.30, Operetta: "La chanson de Paris," with the National Choirs and Orchestra.

New Apparatus Reviewed

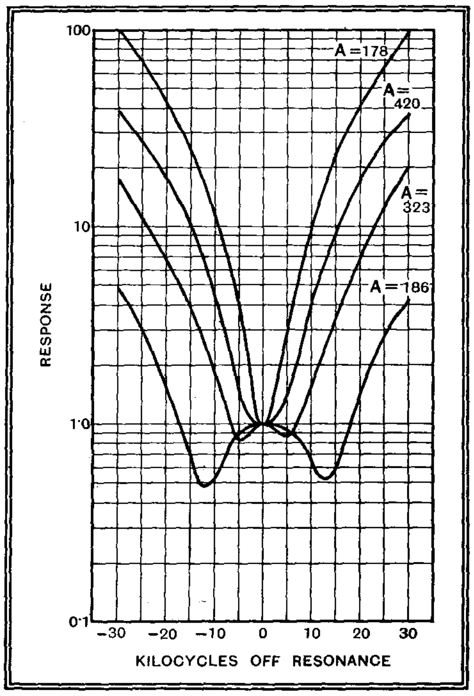
Recent Products of the Manufacturers

465 KC/S IF TRANSFORMERS

THE trend in superheterodyne design is towards the use of higher intermediate frequencies and 465 kc/s is now a popular choice, particularly in all-wave receivers. The Hammarlund transformers are designed for operation at this frequency and are available in two types. The first of these is the type ATT-465, and is fitted in a screening can 5in. high and 2in. in diameter. It is provided with air-dielectric trimming condensers, the adjusting screws of which are accessible at opposite ends of the can. Litz-wound air-core coils are used and the coupling is adjusted to give a single-peak resonance curve. Tested with a VMP4 valve and a valve voltmeter connected to the secondary, a stage gain of 260 times was obtained and the selectivity showed a drop of some 9 times at 10 kc/s off resonance. The transformer is fitted with leading-out wires arranged in such positions as to permit very short leads to the valves, a very necessary precaution when such a high gain is obtained.

The second model, VT-465, is considerably the more interesting since it is of the variable selectivity type. The can is square with 2in. sides and stands 5in. high. Air-dielectric trimmers of small dimensions are fitted at each end of the can, and their adjusting screws are accessible through the sides of the screen. Three-bank litz-wound air-core coils are used, and while the position of one is fixed, the other can be slid lengthwise by means of a rod projecting through the base of the can. An adjustable stop is fitted to limit the movement to the degree necessary for any individual case, and mechanism is available for linking any number of transformers together for operation from a single panel control.

Tested as before with a VMP4 valve, the family of curves shown opposite was obtained for different settings of the selectivity control. With the loosest coupling provided, a gain of 178 times was found and at 10 kc/s off tune the response fell by rather more than 10 times. With optimum coupling the selectivity fell somewhat, being only 4.2 times down for a mistuning of 10 kc/s, but the amplification increased to no less than 420 times. With still tighter coupling, the gain at resonance naturally fell, and double-humped resonance curves were obtained. The maximum peak separation obtainable was 25 kc/s, which is more than necessary for most requirements. The point most noticeable, however, was the unusual symmetry of the curves, showing that the coupling is almost entirely due to the mutual inductance.



Resonance curves of the Hammarlund VT-465 transformer.

The makers suggest that the transformers be used in threes, two being controlled for variable selectivity and the third operated with fixed coupling. In this way excessively pronounced peaks in the low selectivity position can be avoided and a much better approach to a resonance curve with a flat top obtained than if the selectivity of all three is varied.

The ATT-465 model is priced at 25s. and the VT-465 at 30s., and both types are obtainable in this country from R. A. Rothermel, Ltd., of Rothermel House, Canterbury Road, London, N.W.6.

Hammarlund IF transformers, with the can removed from the fixed-coupling model.

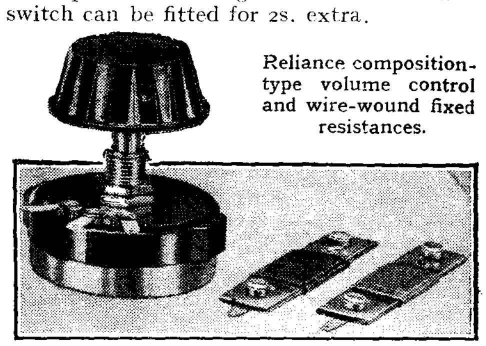
RELIANCE POTENTIOMETERS

RELIANCE potentiometers and variable resistances are made in a very wide range of values and with wire-wound or with composition resistance elements. The latter are quite suitable as volume controls in LF circuits since they are not usually required to carry a DC current, and in this style they are available from 50,000 ohms to 5 megohms. The price is 4s. 9d. each.

This style will carry small amounts of DC and give reliable operation as tests have proved.

Specimens tested have been found to be particularly smooth and quite noiseless in action, whilst the measured values are well within the usual tolerance for this type of component. Where the resistance has to pass DC in addition to LF currents, it is often preferable to employ a wire-wound component, and in the Reliance series these are made from 500 ohms to 50,000 ohms as stock sizes, though resistances as low as 0.5 ohm can be obtained to order, as well as higher values. There is a heavy-duty version of the wire-wound type which is assembled in a bakelite case 2¾in. in diameter and these are rated at 15 to 20 watts dissipation. Resistances or potentiometers up to 500,000 ohms are obtainable in this pattern and prices range from 9s. to 15s. 9d. each.

The standard pattern are of about 3-watts rating and cost 4s. 6d. each, whilst the composition type are priced at 4s. 9d. each, both prices including a knob. A mains switch can be fitted for 2s. extra.



Reliance composition-type volume control and wire-wound fixed resistances.

The makers are prepared to supply these resistances plain or with graded tracks and in ganged units, as resistances ganged with condensers and also including a mains switch if desired. Any combination will be assembled in this manner to order.

A range of wire-wound fixed resistances is included also in their products; these can be supplied from one ohm or smaller upwards and they cost 1s. each.

The makers are the Reliance Manufacturing Co. (Southwark), Ltd., Westbury Road, London, E.17.

Megacite.—A new low-loss dielectric material described as Megacite has been produced by the British Television Supplies, Ltd., Bush House, London, W.C.2, and it is announced that this will be used exclusively in their new season's short and ultra-short wave components.

Receivers for Television

By "CATHODE RAY"

Circuit Diagrams Do Not Tell The Whole Story

THERE is only one way to receive the promised television broadcasts and that is on an ultra-short wave receiver. This means that a great many experimenters will find themselves on unfamiliar ground. There is no fundamental difference in principle as compared with ordinary broadcast wavelength reception, but practical policy has to suffer considerable modification.

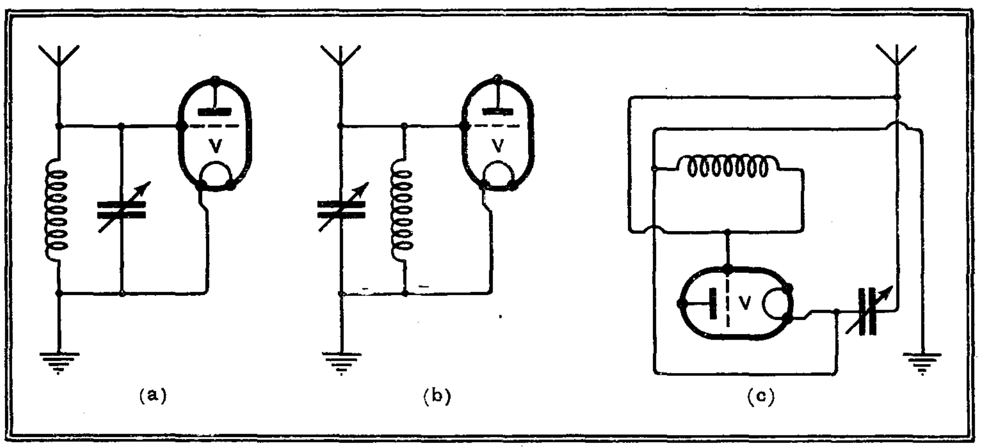


Fig. 1.—Three methods of wiring the same fundamental circuit; on broadcast wavelengths each will give the same performance provided leads are not unduly long.

The difficulty is not so much what one doesn't know as what one does know. Anybody who understands anything about making receivers for medium and long waves knows that for tuning and other purposes it is necessary to have certain measured doses of inductance and capacity at certain definite places in the circuital network of connections; that they are denoted by the symbols -oooooo- and —||— in circuit diagrams; and that in the receiver itself they take the form of coils and condensers which are sold as having so many microhenries of inductance or microfarads of capacity.

The wiring is simply a means of joining up these components so as to ensure that certain of them are brought to the same electrical condition. Thus in Fig. 1 (a), (b), and (c) are all the same and it is a matter of taste which one selects. It may sometimes be more than a matter merely of taste, as, for example, when in the less wirelessly sophisticated 'twenties a well-known authority converted standard receiver circuits into original ones by the labour-saving device of drawing them in unfamiliar sequences (e.g., Fig. 1 (c)).

In wiring up the actual receiver most people are aware that the length and lay-out of the connections are not without influence on the results obtained. The approved policy is to keep them as short and direct as possible, particularly in the radio-frequency quarter. Provided this is reasonably observed it is justifiable to assume that the inductances in the set are indicated by the curly symbols in the diagram, and not elsewhere.

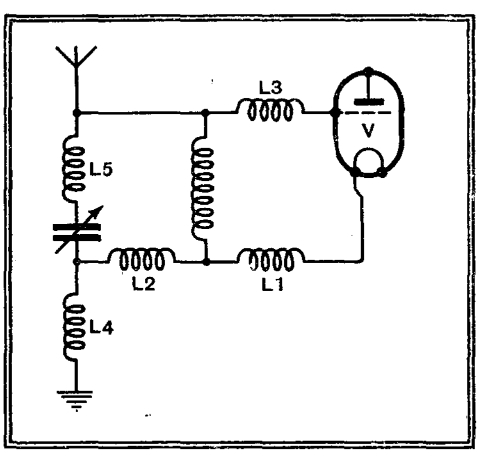


Fig. 2.—The circuit of Fig. 1 (b) as it might appear at the ultra short wavelengths, the wiring being responsible for extra inductances L1, L2, L3, L4 and L5.

Inductance of Wiring

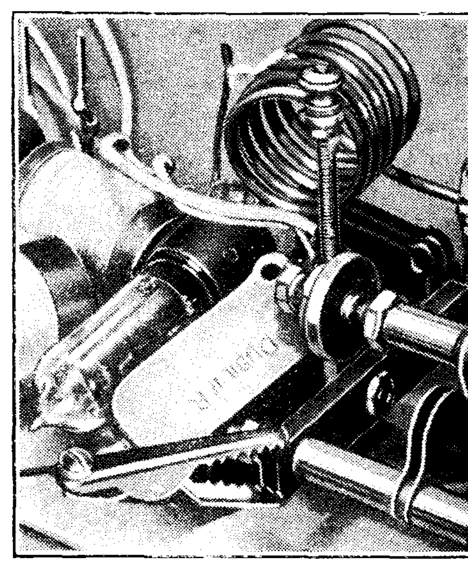
One would take it, for example, that the cathode of the valve in Fig. 1 (b) was earthed. When working at ultra-short wavelengths it is not advisable to be so confident about this. It would be much more true to life if this little circuit were redrawn as in Fig. 2. And when the set-builder protests that he doesn't want all these inductances, the answer of experience is that he will have to put up with some of them. Let me explain.

The capacity in an ordinary tuning circuit is usually about 60 $\mu\mu F$ before anything is done to increase it by turning the variable condenser round from zero. In a receiver tuning to, say, 6 metres, one would cut this down as much as possible by using a low-capacity valve-holder, well-spaced wiring, and a miniature tuning condenser; but it would probably still be at least 20 $\mu\mu F$. Call it 25 to allow a little margin for tuning. This necessitates a tuning inductance of 0.4 μH. If you were to indulge in 10-inch leads spaced 2 inches apart, more than all of this allowance would have been used up before starting to include a coil.

Every inch of lead represents a considerable proportion of the total tuning inductance. With care it is possible to bring the tuning components and valve pins very close together so that the inductances L1, L2, L3 are negligible. It is no good "earthing" several items at different points on a metal chassis or on a "bus-bar" running around the set.

L4 is not so easy. It is hardly practicable to get all the components within an inch of a wet patch of ground for various reasons. When one has done all that can be done they are likely to be several feet from the moist subsoil; and the set is therefore separated from true earth by an inductance L4 that is comparable with the whole tuning inductance.

Then L5 is not just the same sort of thing as L1 and L2. When you buy a condenser you probably expect it to behave as a capacity; mainly, at all events. But at 6 metres all condensers above 0.0005 μF. are predominantly inductances even if they are plainly marked "Non-inductive."



The stray capacity due to a crocodile clip attached to the aerial wire and clipped to the insulating material of a tuning condenser, was employed as a means of coupling in this five-metre circuit.

By-pass condensers are sprinkled freely in most receivers to provide short-circuits for radio-frequency currents between points which cannot be directly joined for fear of short-circuiting DC voltages; such points, for example, as the screens of HF pentodes. Fairly large condensers, 0.1

Receivers for Television—

μF. upwards, are generally used for this purpose, so as to make the short-circuiting effect as complete as possible. At a wavelength of 6 metres not only do such condensers show no advantage over those of smaller capacity; they are actually much inferior to one of 0.0004-0.0005 μF., which is an optimum.

These disguised inductances, of which I have given the foregoing examples, impede the free passage of ultra-short wave currents where they are wanted. One must also be on the look out for paths where they are not wanted. Every part of the circuit behaves as one plate of a condenser towards every other part. Unless the parts are very close together over a wide area the capacity thus formed can often be left out of account. Not so with the ultra-shorts. The stray capacities are so important that the currents are prone to go almost anywhere except where they are required.

We have seen how the whole set is "up in the air" relative to earth. It acts as one plate of a condenser, the ground being the other. If you, the operator, are moving about in the "field" between, you are varying the capacity irregularly and upsetting the tuning. Current can stray across from objects such as batteries or loud speaker instead of confining itself to the proper tuning circuits. This leads to all sorts of irrelevant results, such as improvement of signals when you put your hand on the loud speaker.

The way to deal with this is to put chokes in all the connections leading away from the HF circuits. Here again it is a mistake to use a big choke to gain a big effect. A small dose of medicine may cure when a large dose would fail. A suitable choke for 6 metres and thereabouts is made by winding 45 turns of 22 DSC wire on a half-inch tube. This is so low in DC resistance that it can be used in filament circuits—a very essential precaution in battery sets. A choke of larger inductance chokes less.

It is all rather paradoxical at first but one gets used to it and soon acquires the right outlook for serious short-wave work.

Random Radiations

By "DIALLIST"

The Aerial Question

THERE seems to be a growing demand for radiograms and receiving sets that will put up a good performance without the need for an outdoor aerial. The case against the outdoor wire is threefold: it doesn't add to the beauty of house or garden; some people are nervous about its possibilities as a "lightning attractor" when thunderstorms are about; the set which needs it cannot be operated in any room of the house at will. The first two of these charges are easily answered. There is no need for the aerial to be unsightly, and, though it is difficult to convince some people of the fact, it is no more dangerous in thunderstorms than a telephone wire or a wire clothes-line.

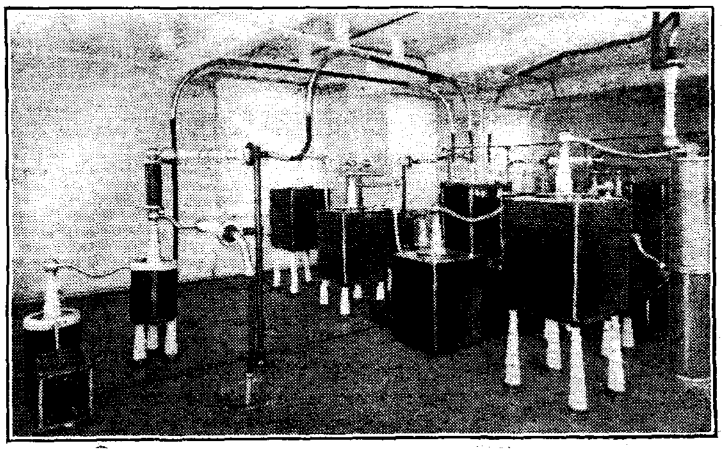
Portability

The last count in the indictment is not so simple. With a "fixed" set ability to receive programmes in any room is best encompassed by means of wiring them for extension loud speakers. This kind of set cannot be used here, there, and everywhere as the portable can, unless a makeshift aerial and earth are rigged up. The real wireless enthusiast will certainly stick to his outdoor aerial, for performance is what chiefly counts with him; but the man (and the woman) in the street is often prepared to sacrifice something in the way of performance to get rid of the outdoor wire.

The Old Lady Shows Her Metals

Speaking of portable sets reminds me of the story—a perfectly true one, by the way—of the old lady who asserted that she always opened her windows when it was warm enough to do so because she heard broadcast programmes so much better than when they were shut. Expert sons and grandsons indulged in polite smiles and told her all about the way in which wireless waves passed through walls more easily than a red-hot knife through butter. But the old lady just smiled back. That might be so, she said; but for all that her portable set gave a much better account of itself when treated to fresh air. Intrigued, the sons and grandsons came to see and hear for themselves. The old lady was delighted to demonstrate. The set reposed upon a table not far from a big window. With this closed the voice of broadcasting was still and small; but the moment that the window was flung wide the volume increased to something quite satisfactory.

The old lady's flat was one of a block made of reinforced concrete. Full of metal, the walls acted as pretty effective screens. And what of the window? That was of the casement type with lead frames and tiny panes. I don't know whether the latter were of lead-glass, but the frames themselves seemed to do a good deal of screening. Lest you feel disinclined to believe this tale, may I add that I have come across more than one home in which a portable worked very poorly.



NEARLY HALF-A-MILLION VOLTS.—This Westinghouse metal rectifier equipment, which has just been installed, provides a pressure of 400,000 volts and is used for X-ray purposes.

The Empire Services

IT was a splendid idea to start those church services for the Empire which are now held in St. Paul's Cathedral on the second Sunday of each month. That they are appreciated by people in this country who have relatives and friends abroad was shown by the big congregation that assembled for the first of them, despite the fact that the time at which they must be held is not a very convenient one for most people. For Empire broadcasting purposes the most suitable hour for the services is 2.15 p.m., which is a rather awkward hour for most of us on Sunday. I am sure that this new plan will be very popular with Britons throughout the Dominions and Colonies. The service itself forms the most intimate of ties with the Homeland, and even those who are not churchgoers cannot fail to enjoy the beauty of the music at St. Paul's.

Empire Links

Wireless broadcasting has already become a most potent factor in linking up the Empire, and its influence will become still greater when the new and more powerful transmitters are in operation at Daventry. The only fly in the ointment is the lack of reliability of short-wave services at the present time. Try as they may, engineers can never be sure that the programmes sent out will be well received all over the zones for which they are intended. But there can't be much doubt that this is a matter which will right itself in the course of time as improvements are made in transmitting and receiving gear and as our knowledge of the queer little ways of the short waves increases. Don't forget that it is not so very long ago that there was hardly a medium-wave Continental station that one could be absolutely certain of receiving on a particular evening. Nowadays, if there is a programme that we specially want to hear we just tune to the right wavelength and there it is.

Why Such Secrecy ?

LONG before the Television Committee made its pronouncement everybody knew that the betting on the selection of the Alexandra Palace for London's high definition television station was at least 10 to 1 on. That being so, what was the purpose of endeavouring to keep the whole business so dark? The Alexandra Palace has really everything in its favour. It is easy to obtain a height of over 600ft. for the transmitting aerial, and the position is such that the station should cover effectively the whole of Greater London and a great deal of the thickly populated counties of Middlesex and Essex, Hertfordshire and Buckinghamshire. One hopes that work upon the new plant will begin soon, but it hardly seems possible that the service can be started now much before the end of the year.

The Rival Systems

So far I have not seen a demonstration of the E.M.I. system of television, but I have witnessed several using the Baird method, and have been very much impressed with both the good quality and the absence of that flicker which is so apt to cause eye-strain. It will be exceedingly interesting to compare the results obtained by the two systems when the opportunity for doing so arrives. The E.M.I. method of interlaced scanning seems wonderfully ingenious, and I am told that it produces an image that is perfectly flicker-free. The Television Committee is satisfied that receiving sets can be readily adapted for either kind of working, and makers will no doubt see to it that the adjustments required can be carried out with a minimum of trouble.

News on the Short Waves

HAVE you, I wonder, discovered how extraordinarily reliable is W8XK on the short waves just now? This station relays the Pittsburg programmes and operates on 19.72 metres from 6 p.m. to 6 a.m. by our time. The evening news bulletins come through at 11 o'clock, and, except when atmospherics are troublesome, you can tune them in night after night with remarkable certainty. Another station which is returning to the form it showed some years ago is W2XAF, which operates on 31.48 metres and transmits the Schenectady programmes from 11.30 p.m. until 5 a.m. Before 11.30 the programmes come from W2XAD, whose wavelength is 19.56 metres. Schenectady news bulletin is at 11.30. At that time there are still, of course, many hours of daylight left in the United States, for the hour over there is but 6.30 in the evening.

There is every sign that short-wave reception is running true to its expected form and showing a distinct improvement as we approach the sunspot maximum period, which is due in 1938-1939.

Mains Sets and Power Circuits

QUITE a few enquiries reach me from people who want to know whether they are contravening regulations if they run mains receiving apparatus from power circuits. To the best of my belief there is nothing whatever to prevent one from doing this unless there is a special prohibiting clause in the agreement with the authority supplying the current. After all, it is only logical that the wireless receiving set *should* be run from power circuits. Its purpose is not to supply light but to magnify electromagnetic impulses and to convert them into sound waves by means of the loud-speaker, which is a power-operated device. It is, however, really worth while to run the set off power mains only if it is a largish affair requiring a considerable number of watts. The ordinary set is no more expensive to run than a single small electric lamp, and the addition that its running costs make to the lighting bill, particularly to those who have a flat rate contract, is too small to be worth worrying about.

The Expanding B.B.C.

LIKE this universe of ours, the B.B.C. is ever in a state of expansion. London's Broadcasting House when it was built was believed to be big enough for all requirements, but it was soon found that it was far from being so. The B.B.C. now has several outside studios and its own music-hall, whilst for office work it has been necessary to acquire houses in Portland Place. In Glasgow the Corporation has just purchased Queen Margaret College for the purpose of studio developments.

The B.B.C.'s activities are now so gigantic that it is no wonder that larger and larger premises are needed. Perhaps one day London and other big towns will, as New York, have their Radio Cities.

How Many Hours ?

OFTEN I have wondered how many hours a day the average listener (if there is such a person) uses his receiving set. Of one thing I am pretty sure, and that is that the time during which the receiving set is in daily operation is steadily increasing. We used to make our calculations on a basis of three hours a day. Valve manufacturers, for instance, design filaments or heaters for a life of a thousand hours, which means roughly a year's working at this rate. Again, running costs, whether of battery or mains-driven sets, were calculated from the same figure. To-day I should say that it was much below the actual mark, though what is the average number of hours I am not prepared to say with any kind of definiteness. Anyhow, I should put down the average at nothing less than four hours, and I have a feeling that it runs to something more than this. Readers' experiences will be welcome.

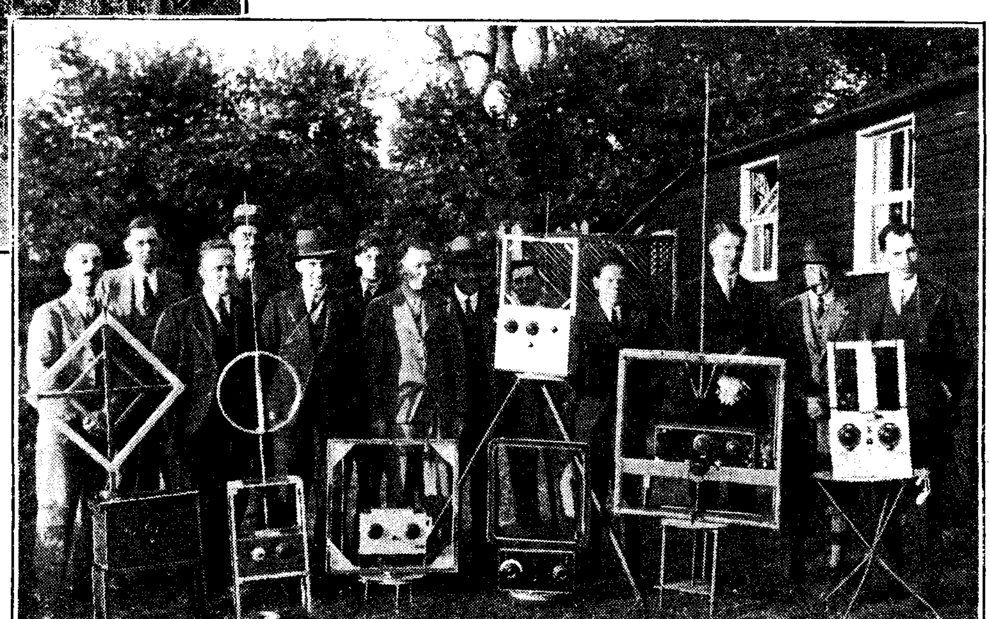
Overdoing It ?

This suggests the question: " Do we now make too much use of our wireless sets? " What I am driving at is this. Wireless should be something of a luxury, to be enjoyed at those times when one is thoroughly in the mood for entertainment. I find amongst my friends that the switching on of the wireless set is in many cases becoming almost an automatic act when they enter the room where it is installed. No matter what is coming through, the loud speaker is in action so long as they are within ear-shot of it. And it is usually people who treat their wireless sets in this way that complain most bitterly about the poorness of the programmes. Can you wonder when the B.B.C. cater for so many tastes?

The most attractive things in the world become dull, flat and commonplace if they are always with us.

AMATEUR DIRECTION FINDING

MORE than sixty amateurs representing radio societies of Southall, Northwood, Belsize, Southgate and Pye Radio took part in the recent fourteenth annual open DF competition organised by the Golders Green and Hendon Radio Society. A mobile transmitter, 5CD, working on 84 metres (seen in the left-hand picture) operated from various points in an area of thirty square miles and a number of receiving groups compiled logs during the day. All the receivers were amateur built, and a high degree of accuracy was obtained. First and second places were taken by the Southall Radio Society. The DF receivers are shown in the lower picture.



Foundations of Wireless

Part XXV.—The Superheterodyne and Its Frequency-changer

By A. L. M. SOWERBY, M.Sc.

THIS Part explains clearly why the superheterodyne has attained its present pre-eminence. The two distinct kinds of selectivity afforded by the typical superhet are discussed, and the frequency-changing mechanism is dealt with at length.

BESIDES the straightforward type of receiver that was discussed in Part XXIV, there is a second, the supersonic heterodyne receiver, which is based on an entirely different approach to the problems of set design.

In the usual "straight" set pre-detector amplification is carried out at the frequency of the received signal. This implies, as we have seen, that all the tuned circuits in the set must be retuned every time it is desired to pass from one station to another. Any attempt to achieve high selectivity in a set of this kind is made difficult and expensive by the fact that it requires a large number of simultaneously tuned circuits. On account of the small but inevitable errors in the matching of the various tuning condensers, it is found almost impossible to control the tuning of all these circuits by a single knob with sufficient accuracy to allow them to develop the high selectivity of which *theoretically* they may be capable.

If ten tuned circuits were proposed, a ten-section variable condenser would be needed to tune them, and all sections would have to have identical capacities at any setting of the tuning dial. At 1,000 kc/s an error of one per cent. in the capacity of any section would result in a detuning of one-half of one per cent., which is 5 kc/s. If the error were in one direction in some of the sections, and in the reverse direction in others, some circuits would be tuned 10 kc/s away from others. This would reduce the effective selectivity of the set far below the figure calculated from the characteristics of the individual tuned circuits, assumed to be all correctly tuned. The alternative of ten separate tuning controls is quite impracticable; even three tuning knobs make a set too difficult for any but an expert to handle with confidence.

When high selectivity in conjunction with simplicity of control is required, the supersonic heterodyne receiver (conveniently known as the "superhet.") is the only possible type of set. In Fig. 133 is given a schematic diagram of a superhet, in which the various parts of the set are shown as labelled boxes. Of their contents we shall speak later.

The signal received from the aerial is first put through a stage of *pre-selection*, containing tuned circuits enough to ensure that signals of wavelengths far removed from that of the station required shall not pass farther into the set. This "box" may or may not contain a stage or two of ordinary high-frequency amplification of the type with which we are now familiar.

The next stage, the *frequency-changer*, operates upon the signal in such a way as to produce a carrier of a new frequency, this new carrier still carrying the modulation of the original carrier. In most cases the new carrier has a frequency lower than that of the original signal, though it is always *supersonic*, or higher than any frequency within the audible range. It is, in consequence, usually referred to as the *intermediate frequency* (or IF), and this name is still retained even when, as in "Single-Span" receivers, the new frequency is higher than that of the original signal.

Selectivity in the IF Stage

To perform its conversion, the frequency-changer has to be *tuned*, and it requires retuning for each new value of received signal. If it is so tuned that a 1,000 kc/s signal has its frequency changed to 110 kc/s, signals at 991 and 1,009 kc/s, if simultaneously present at the frequency-changer, will be converted to 101 and 119 kc/s respectively. It follows that if the IF amplifier is accurately and selectively tuned to 110 kc/s, these two stations will not pass through it, and hence will not reach detector, LF amplifier, or loud speaker.

Adjacent-channel selectivity, or selectivity aimed at removing stations on frequencies closely bordering on that of the desired station, can therefore be provided entirely by design of the IF amplifier without reference to any other part of the set.

Since the IF amplifier is tuned to the one fixed frequency, it becomes practicable to include in it just as many tuned circuits as are needed to provide the selectivity we require; they have only to be tuned once, when the set is first made. Nor is this the only advantage of operating on a fixed frequency; by careful and finicky adjustment we can shape the overall resonance-curve to give us any desired compromise between selectivity and sideband response with the comforting knowledge that this compromise will hold unchanged for every station received. Further, its constancy permits of judicious faking of the LF amplifier to strengthen high notes if we find that we cannot get the selectivity we desire without undue cutting of side-bands in the IF tuned circuits.

Although the highest usable adjacent-channel selectivity can be provided in the IF amplifier, tuning is still required in the pre-selector stage. This is so because the characteristics of the frequency-changer are such that stations *on certain wavelengths widely removed* from that of the station required can set up in it a carrier of the intermediate frequency, so causing interference with the station to which the set is intended to be tuned. It is the duty of the pre-selector to eliminate these outlying frequencies before they can reach the frequency-changer, leaving the task of providing adjacent-channel selectivity to the IF amplifier.

In Part XVII we saw that a modulated carrier current was equivalent to three currents existing simultaneously. Calling the carrier-frequency fc and the modulation-frequency fm, we saw that these three frequencies were $(fc - fm)$, fc, and $(fc + fm)$. That is to say, the combined current contains frequencies equal to the sum and difference of the two frequencies from which it was built up.

In Part XI we discussed the actual formation of the combined current, and saw that the two original frequencies remained obstinately separate if the attempt to combine them consisted of nothing more than

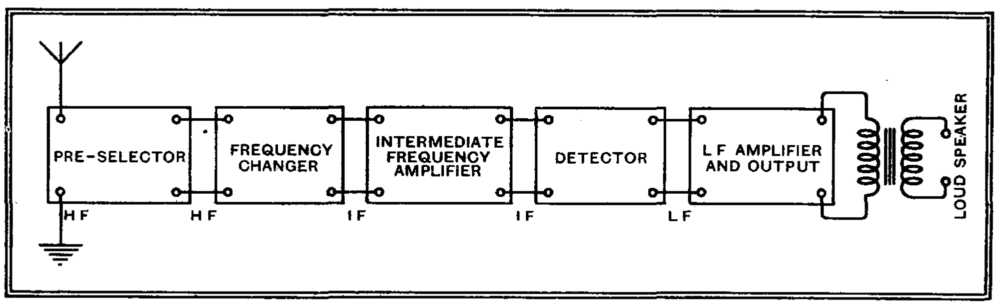


Fig. 133.—Schematic diagram of supersonic heterodyne receiver ("superhet") showing the functions of the various parts and the changes in the signal in passing through it.

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making them flow at the same time through the same circuit. They would only combine to make a composite current if the magnitude of one were made to depend on the magnitude of the other, as would be the case, for example, if a voltage derived from one of them were applied to the grid of a variable-mu valve, the bias of which was being rapidly swung to and fro by a voltage derived from the other.

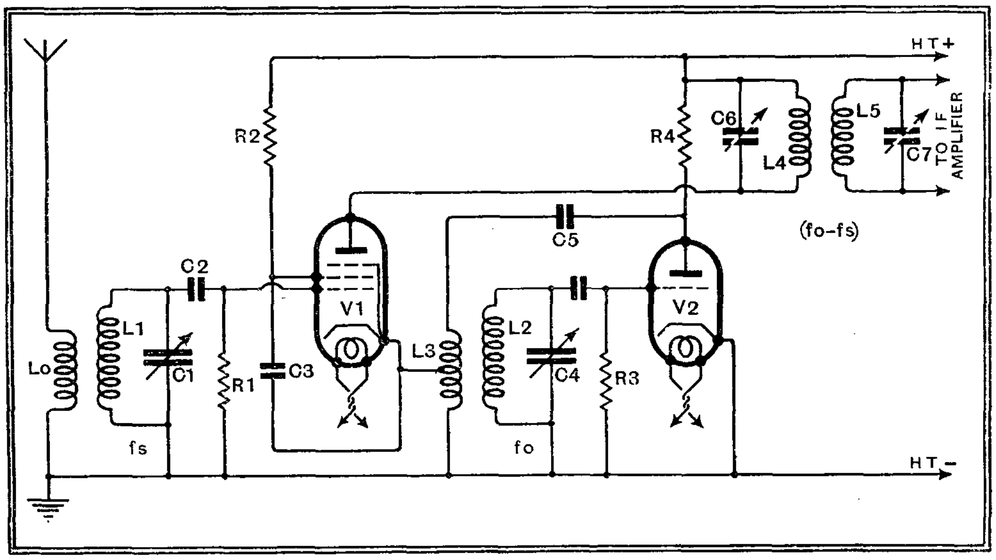

Fig. 134.—Circuit of simple two-valve frequency-changer. The signal, frequency *fs*, is applied to the grid of V1, and the oscillator V2 is tuned to *fo*. Currents at the intermediate frequency (*fo-fs*) appear in the anode circuit.

Mechanism of the Frequency-changer

Taken together, these two facts give the clue to the mechanism of the frequency-changer. The aerial delivers a signal at, let us say, 1,000 kc/s. We wish to manufacture from it a new carrier for delivery to an intermediate-frequency amplifier tuned to 110 kc/s. To do this we shall first of all have to provide a high-frequency current at either 1,110 or 890 kc/s, and then we shall have to provide a circuit in which the two are *really* combined, and not just allowed to exist independently. From this we shall get, not only the original frequencies supplied, but also new frequencies of (1,000 + 1,110) or (1,000 + 890) and (1,110 − 1,000) or (1,000 − 890) kc/s. Either of the last two is the 110 kc/s required.

We shall need, therefore, an oscillator to provide the auxiliary HF current and a distorting amplifier with which to combine the oscillation with the received signal. It is more polite to call the latter a detector; being the first of two in the set (see Fig. 133) it is generally known as the *first detector*. The term *modulator* is also used. Two separate valves—usually a triode and a screened valve—may be used as oscillator and first detector, though modern practice inclines to the use of a single complex valve, specially designed to fulfil the dual *rôle*.

Fig. 134 shows a suitable circuit for a two-valve frequency-changer. V2 is the oscillator which, in essence, is an arrangement in which reaction is pressed so far that continuous oscillation results (Parts XVII and XVIII). The resistance R4 serves in lieu of an HF choke to deflect the high-frequency anode current through the reaction-coil L3, besides being useful in limiting the average anode current of the valve. Further help in this direction is supplied by grid rectification of the oscillation, which biases V2 negatively (Part XIV). The frequency of the oscillation is that to which the tunable circuit L2C4 is adjusted; for convenience of reference we will call this, the oscillator frequency, *fo*.

The signal, of frequency *fs*, is collected from the aerial or other source by the tuned circuit L1C1, and applied to the grid of V1, the screened pentode used as first detector. The grid-condenser C2 is not included for purposes of signal-rectification,[1] but to enable the valve to set itself, by grid-current, at its correct working point. The cathode of V1 is taken to a tapping on the reaction coil L3, thereby including that part of L3 that lies between tap and earth in the grid circuit of the valve. (Remember that the grid circuit includes everything between grid and cathode.)

The amplitude of the oscillation thus applied to the grid of V1 will require to be about 10 to 15 V. peak in a circuit of this kind; suitable choice of tapping point on L3 ensures a correct voltage. Like the oscillator, V1 will bias itself back until the applied oscillation just, and only just, runs the grid into grid current. Assuming a 10-volt peak oscillation at this point, the bias of V1 is being swung, at the frequency of the oscillation, from zero to − 20 and back again. Since bias controls amplification, we are now in possession of a system in which the amplification of the applied signal *fs* is being varied over a wide range at the frequency *fo*.

[1] The reader is left to think out for himself the exact reasons why ordinary grid-detection will not work in a frequency-changer.

By-Products of Frequency-changing

In addition to amplified currents at each of the two original frequencies, *fo* and *fs*, the anode circuit of the valve will therefore contain combination frequencies equal to the sum and difference of these two. By suitable choice of tuned circuits at the anode of V1, we can pick out any of these, as desired, for further amplification. Either the original frequency *fs*, or any combination frequency of which it is one component, will carry the modulation it has brought to the aerial, and so, after being passed through the IF amplifier, will yield the required musical programme at the second detector. Of the various possible combination frequencies, that chosen, and to which L4C6 is tuned, is almost always (*fo* − *fs*).

A second type of frequency-changer is that using a *pentagrid* valve (Fig. 135*a*) as combined oscillator and modulator. As its name implies, the valve has five grids, the uses of which are shown on the diagram. G1 and G2 form the grid and anode of a triode oscillator, the circuit of which, as Fig. 135*b* shows, in no way differs from that of V2 in Fig. 134. G4 and G5 serve as control grid and screen of a screened tetrode performing the functions of V1 in Fig. 134. The additional grid G3, connected within the valve to

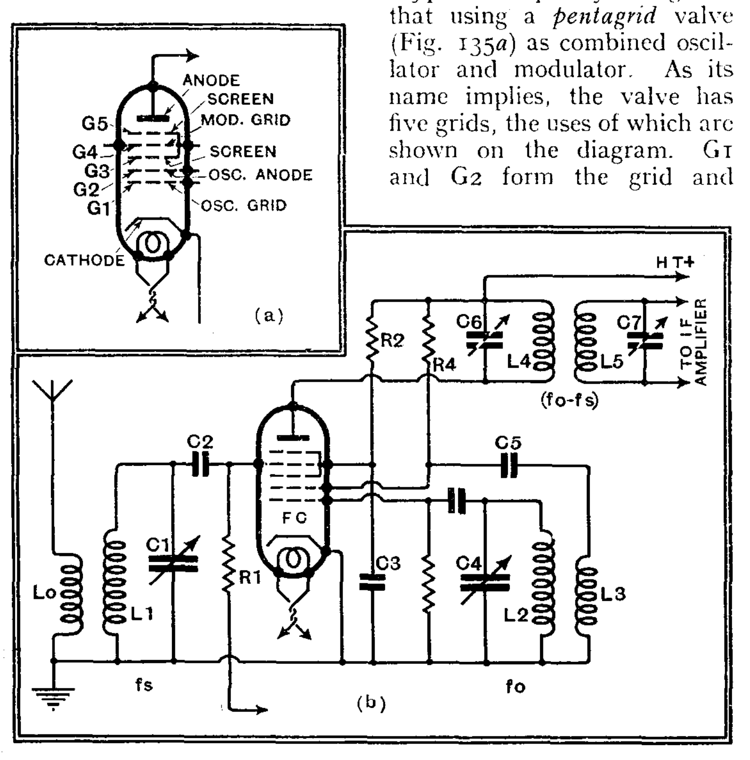

Fig. 135.—Functions of the electrodes in a pentagrid or heptode frequency-changer, and, in diagram (b) the valve in use. The circuit is practically identical with that of Fig. 134, as comparison of correspondingly lettered components will show.

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G5, serves to screen the modulator grid from the oscillator, and so prevents G4 from biasing itself back as does V1 in the two-valve circuit. This valve, therefore, remains responsive to control of amplification by variation of bias; G4 is therefore given variable-mu characteristics, and the controlling bias is fed to it through the resistance R1.

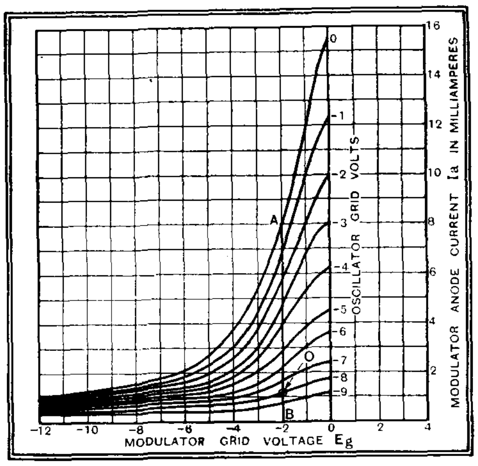


Fig. 136.—Pentagrid characteristics, showing how voltage on G1 controls slope of modulator. An oscillation of some 8 V. peak, swinging G1 from 0 to −16 V. will simultaneously swing the slope from zero to about 4 mA/V.

The almost exact identity of the two frequency-changing circuits is emphasised by the fact that exactly the same components are used in both; for convenience, they have been identically lettered in the two diagrams.

The sole real difference between the two lies in the method of arranging that the oscillation shall vary the amplification of the screened valve that deals with the signal. In Fig. 134 we injected the oscillation into the grid circuit of V1, making it therefore vary the grid-bias of this valve. In Fig. 135 the mixing takes place within the valve itself.

Every electron that reaches the modulator (made up of G4, G5, and the anode) has to pass *through the oscillator* (G1 and G2) on its way; it is therefore evident that when the latter oscillates the total current, and hence the slope, of the modulator will rise and fall in time with the oscillation. The way in which the modulator slope is controlled by the voltage on G1 is shown in Fig. 136, where is reproduced a set of pentagrid curves.

These curves are ordinary $I_a - E_g$ curves for the modulator section of the valve; each of them is taken with a different fixed bias on the oscillator grid. As the inclination of the successive curves shows, the slope of the modulator is low when the oscillator grid is strongly negative, and high when its potential is zero or slightly negative. When oscillations are present on G1, this grid will bias itself back until only the extreme positive peaks cause grid current to flow; the total excursion of the grid will therefore be from approximately zero to double the peak voltage of the oscillation. With an oscillation of 12 V. peak and a fixed modulator grid bias of −2 V., the characteristics of the valve will be swung back and forth through the values shown by the line AB. Since the slope of the curves varies from practically zero at B to about 4 mA. per volt at A, we have drastic variations of modulator slope at the frequency *fo* of the local oscillations generated by the triode portion of the valve. Since the incoming signal, at frequency *fs*, is applied to the grid of the modulator, we have again a system in which the amplification of the original signal is varied at oscillator frequency.

As before, this leads to the production of combination frequencies in the anode circuit. Of these, that desired is picked out by the tuned circuit L4C6, and passed, through a second tuned circuit L5C7, to the intermediate amplifier.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Improving the Gramophone Record

AN improvement to records that would affect the vast majority of gramophone users is that there should be a standard size finishing spiral groove to all records, no matter what their size.

At the present moment it is impossible to adjust an automatic stop, and very few gramophones are without them these days, so that every record, be it 8in. or 12in., will stop at the end correctly. One is usually faced with the unhappy centre course of adjusting for 10in. records, so that all 12in. records will not stop themselves, and only half of an 8in. record can be played.

This could be easily corrected by the record manufacturers adopting a standard size for the finishing spiral groove.

This, I consider, to be far more necessary and important an improvement than that suggested by your correspondent, Mr. Mackechnie, but should both be adopted it would be a far happier state of affairs for all gramophone users. GEO. F. DAY.

London.

A High Quality American Receiver

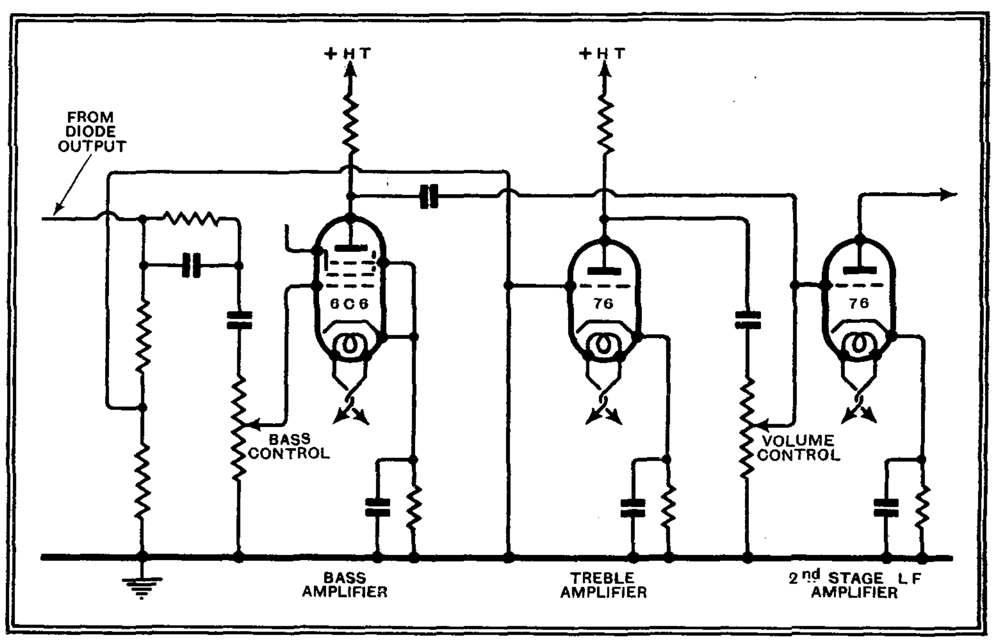
PERHAPS the following points in design in the American "Howard-Grand" receiver which I have been trying out recently may interest you and your readers.

The LF amplifier is the most interesting section, and I would like to deal briefly with it herewith. It makes practical use of a suggestion made about two years ago by Mr. Stuart Ballantine in an address before the I.R.E. whereby the LF amplifier be split in two sections, one covering the range of frequencies below 1,000 c/s, and the other covering the frequencies above 1,000 c/s. Each section fed its own particular speaker, which can be suitably designated the "treble speaker" and "bass speaker" respectively.

From a purely technical standpoint such a system has advantages. First, it permits adequate power outputs without high-frequency distortion due to overload when both a high-frequency and low-frequency note are amplified together, and, secondly, it eliminates the necessity of filtering the "treble" and "bass" speakers to prevent overload and distortion in these units. Thirdly, the use of two amplifiers permits the simpler equalisation of both treble and bass frequencies, as well as simple circuits, for the adjustment of balance between treble and bass response.

The "Howard-Grand" 19-valve receiver uses a double-channel amplifier, rather than two entirely separate amplifiers, and combines the two channels in the second LF stage.

The signals are divided in the first LF stage by the filter arrangement shown herewith. The bass frequencies are amplified the most, since it is in this range greater equalisation is required. The treble fre-



The divided channel amplifier system of the Howard-Grand receiver.

quencies are amplified by a –76 valve, which is a triode, and the bass frequencies by a –6C6, which is a HF pentode. The outputs from these two valves are mixed in the volume control circuit which feeds the grid of the second LF stage.

My general impression of the receiver is that the quality of reproduction is much better than any other commercial receiver I have heard, yet I greatly doubt if it equals *The Wireless World* Quality Amplifier in absolute fidelity. The output of approximately 20 watts from the "Howard-Grand" is certainly inspiring on such music as the Toccata and Fugue in D Minor of Bach. It will be interesting to compare results between this receiver and the Q.A. 10-watt version when I get the low-note horn speaker* developed by the Bell Company, with Bostwick's high-note reproducer coupled to the latter. R. E. BLAKEY,
Chief Engineer, Radio Research Dept.,
Everett, Edgcumbe and Co., Ltd.
London, N.W.9.

Mysterious Roof

IN your issue of May 24th, in the "Current Topics" section, I read about the mysterious roof of a lone spot in the town of Hobol, Denmark, from which the Oslo programme appears to emanate. Since reading this I chanced to read through an American magazine, *Popular Science*, which comments on the apparent behaviour of metallic objects round the broadcasting station WLW in Ohio. Its power of 500 kilowatts has obviously something to do with it, but, according to the magazine, every metal object for more than a mile around becomes charged with electricity, and the base of the broadcasting tower is a highly dangerous location. Around the tower there are brick walls and a few iron gates; if a person holds any metallic object near the gate, he draws off an arc, which vibrates the air in exact time with the modulation of the radio programme being broadcast. Even in houses some distance from the tower fluctuating currents induced in metal objects are powerful enough to vibrate tin roofs or create "singing arcs" between drain spouts and earth. Some resourceful residents around the tower have tapped some of the energy and are able to get enough free power by this means to light their homes and even to run small appliances. This may be the explanation of the mysterious Danish roof, but as for the selectivity it seems to suggest the lack of a band-pass filter on the roof.

Exeter. B. A. E. FITZ-GERALD.

The Push-pull Quality Amplifier with Pentodes

ALTHOUGH real quality enthusiasts are apt instinctively to turn up their noses at the mention of the LF pentode, I should like to say a few words with regard to the results obtained when these much despised valves are used in the output stage of a modified version of *The Wireless World* Push-Pull Quality Amplifier.

The circuit used is identical with that of the original amplifier, but of course the values of certain components are necessarily altered. As each valve requires only half the grid swing of a PX4, namely, 15v. peak, low gain LF valves are used together with as low gain anode resistances as are consistent with the smallest possible amount of amplitude distortion. The amplifier attains full output for 1.5v. peak input.

The two pentodes which are Cossor MP/PENS are stated by *Wireless World* valve data sheet to give 3.5 watts undistorted AC per valve; this provides a good 6 watts overall output as against 4 watts for the PX4s. Moreover, a somewhat greater output can be obtained with a slight deterioration in quality. To obtain this the anode dissipation is only 16 watts as against 24 for the PX4s. In order that this gain in efficiency shall not be set off by a perceptible increase in distortion, the valves have an anode load imposed upon them at which value the 3rd harmonic distortion falls to zero, the 2nd harmonic being cancelled out by the push-pull connection.

I find that although a Rothermel "Tweeter" is used in conjunction with a large energised Baker-Selhurst moving coil, no tone correction is necessary to flatten the response curve at high frequencies, at any rate as judged aurally. The rising characteristic of the pentode at high frequencies compensates wonderfully for side-bands necessarily attenuated in tuning. It is a revelation to hear the striking of a cymbal or the true "ting" of a triangle. In addition the remainder of the audible scale is unusually well maintained, the whole comparing very favourably with the superb quality of the original amplifier.

Before closing I must say that I quite agree that the triodes do theoretically give superior quality, but that it would certainly take a highly trained ear to detect the difference in this respect even when the two types of output are tested together.

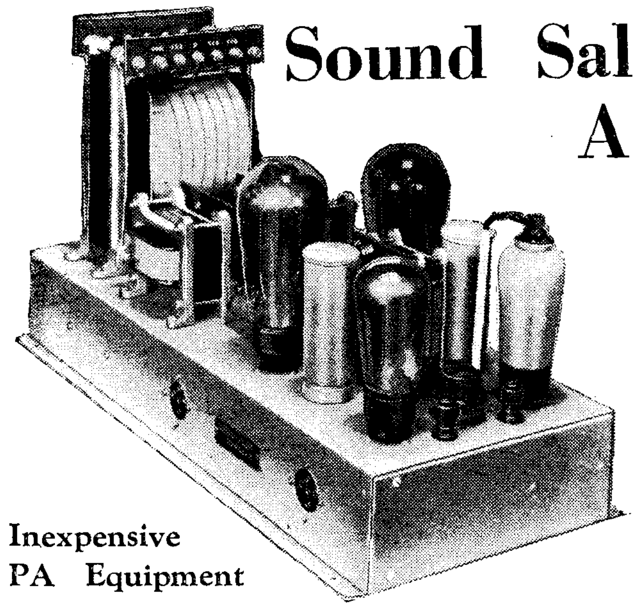
Finally, the output given provides an excellent intermediate stage for those who require a larger output than that available from PX4s, but do not wish to go to the expense of PX25s, which dissipate 50 watts in their anode circuit.

May I congratulate and thank *The Wireless World* for producing such an excellent piece of apparatus as the Quality Amplifier, and, moreover, for providing a journal which can be relied on in every way.

Walsall. A. A. COTTERELL.

* See Dr. McLachlan's "Elements of Loud-speaker Practice."

Sound Sales 30-watt Amplifier



Inexpensive PA Equipment

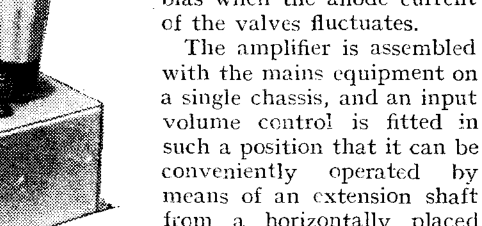
THE growing use of public address equipment has recently stimulated research into methods of obtaining a large output from an amplifier with a minimum of cost, while still maintaining a high standard of reproduction. One of the most successful of these systems was recently described in *The Wireless World*[1] and is colloquially known as the "low-loading" output circuit. Two valves of very low internal resistance are employed in push-pull in the output stage, and are operated under such conditions that while the system can be described neither as Class B nor QPP, the anode current fluctuates with the signal in a similar manner. Using this system, an output of no less than 30 watts can be obtained from a pair of PX25A valves.

This arrangement is employed in the output stage of the new 30-watt amplifier produced by Sound Sales, of Tremlett Grove Works, Junction Road, Highgate, London, N.19. An ML4 valve is used in the preceding stage and is coupled to the output stage by means of a choke-fed push-pull transformer. The first stage is fitted with an HF pentode and is resistance coupled. The mains equipment is of most generous design and a full-wave mercury-vapour rectifying valve is used. A separate metal rectifier is employed for the grid bias source, since it is out of the question to employ automatic bias when the anode current of the valves fluctuates.

The amplifier is assembled with the mains equipment on a single chassis, and an input volume control is fitted in such a position that it can be conveniently operated by means of an extension shaft from a horizontally placed gramophone motor board fitted above the amplifier.

The output transformer is not fitted to the chassis, but is supplied as a separate component wound to suit any loud speaker. The amplifier is priced at £25 complete with valves and output transformer and a radio feeder-unit is available at £6.

On test, the amplifier gave a very good performance, and the curve shows that at 50 c/s the response falls by only 2.4 db. and at 10,000 c/s by only 0.8 db. This curve includes the losses in the output transformer. The input required to obtain an output of 30 watts is of the order of 0.005 volt, so that it can be fully loaded from any pick-up of normal design. The hum-level is below audibility, and the equipment can confidently be recommended for any case where an output of 30 watts or less is needed.



The response curve, showing the very slight fall at each end.

[1] *The Wireless World*, March 15th, 1935.

Readers' Problems

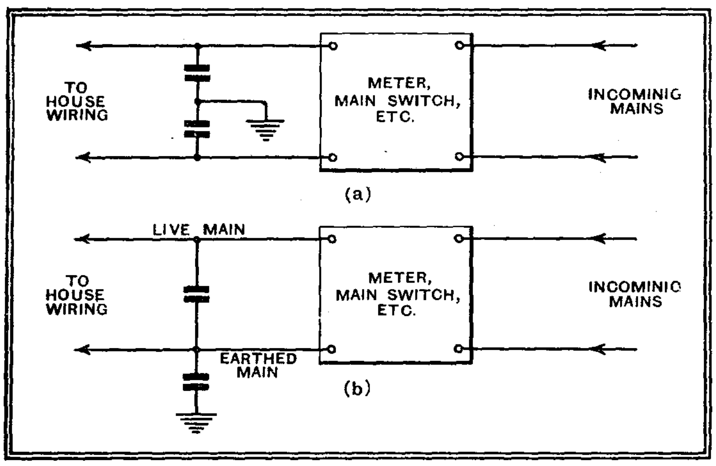
THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers.
Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page.

Leakage Through Suppressors

SEVERAL correspondents have recently written to us on the subject of the leakage that takes place through interference suppressors comprising condensers of standard value when connected to AC mains. From a consideration of Fig. 1 (*a*) it will be fairly clear that, as one of the mains is earthed at the power station, full mains voltage is applied between one of the condensers and earth. Although the leakage current is largely wattless, it is a source of embarrassment to power station engineers, and so should be avoided.

One of the ways of avoiding appreciable leakage is to use condensers much smaller than the standard value of 2 mfds.; a capacity of 0.01 mfd. is generally recommended, and in most cases is effective.

Another method of reducing leakage to negligible proportions is to connect the conventional type of suppressor in the manner shown in diagram (*b*). This arrangement appears to have the official blessing both of the Post Office and of the supply companies. It was discussed recently in a paper read under the auspices of the Post Office by a G.P.O. engineer. Although at first sight it may appear that a leakage to earth due to the full mains voltage might take place between the two condensers in series, actually the only leakage occurring through the lower earthed condenser is that due to the voltage drop along the "dead" main.



Two methods of connecting an interference suppressor. Diagram (*b*) represents an arrangement especially applicable to AC mains, as it reduces the leakage that occurs with method (*a*) and is considered equally effective.

Easy—but Wrong

A QUERIST who has apparently succumbed to the temptation to connect a milliammeter directly between the anode terminal of an SG valve and the flexible lead normally connected to this point, has paid the usual penalty. Presumably the addition of the meter and its connecting leads has caused spurious coupling to other circuits, with the result that the receiver is now unstable.

Our correspondent is concerned to find that the reading of anode current is higher than it should be. It should be pointed out, however, that a measurement made while a valve is in an oscillating condition is quite unreliable, and so he need take no notice of it. In this case there appears to be no alternative to delving into the vitals of the set and finding the most convenient point of connection for the meter at the low-potential end of the anode circuit of the valve concerned

Diesel Engine Interference ?

A QUERIST asks us to say whether there is any possibility that interference with reception can be caused by a Diesel engine for which he is responsible.

Interference from ordinary internal-combustion engines originates in the electrical ignition system, which is absent in the Diesel engine, and accordingly it seems that a compression ignition of any type should be totally incapable of causing electrical interference. Mechanical interference through vibration is, of course, another matter, as is the possibility that auxiliary electrical apparatus driven by the engine is causing trouble.

Microphone Sensitivity

ALMOST all the better types of microphone need rather more magnification than is normally provided by the "gramophone" section of the average receiver or radio-gramophone. It therefore follows that, although the pick-up terminals present themselves temptingly as convenient points of attachment for a microphone, sufficient output will seldom be obtained except when one of the more sensitive—but less faithful—specimens of the ordinary carbon type are employed.

In reply to several readers who have written for information on the subject we can only suggest that if they are unwilling to add amplification to their receivers they should satisfy themselves with poorer quality and take care to choose a microphone giving sufficient output for the amount of amplification included in their sets. High quality and high output do not usually go together.

Peculiarities of the Ear

THE user of a superheterodyne which is giving an entirely satisfactory performance is, nevertheless, puzzled to know why maximum indication of the tuning indicator does not seem to correspond precisely with maximum signal strength as judged by ear.

This effect is by no means uncommon, but it appears to depend, to some extent, on the peculiarities of the ear of the user as to whether the discrepancy is clearly perceptible. Our hearing is often more sensitive to notes in the middle register, and these notes are generally accentuated somewhat by slightly detuning the receiver. From this a useful lesson can be learned; a set should be tuned to give maximum bass response rather than maximum apparent loudness

Choice of a Voltmeter

WHEN choosing a measuring instrument for a specific purpose it is usual to stipulate that the quantity (voltage, current, etc.) to be indicated will correspond roughly to half-scale deflection, or, in some cases, to a considerably higher proportion of the scale. In the interests of accuracy, for example, a 0 to 10-volt voltmeter would be highly unsuitable for permanent connection in a circuit where the pressure was never likely to exceed 1 volt. This is especially true of the scale of moving-iron instruments which is always congested at the lower end.

However, circumstances alter cases, and a reader who proposes to install permanently a cheap moving-iron voltmeter for reading the LT voltage of his portable set (which is fed entirely from dry batteries) has a good excuse for ignoring the "half-scale" rule. He has found that the drain imposed on the LT battery by a 0 to 3-volt instrument (which would otherwise be suitable) is unduly high, and so proposes to install a 0 to 8-volt meter which will consume much less current.

In this case where extreme accuracy is not required, such a course is permissible. Generally speaking, moving-iron instruments give fairly clear indications of readings above one-fifth of full-scale deflection, and so a reading of 2 volts, which will be required in this case, could be made fairly easily on an 8-volt scale.

Bias for Push-pull Valves

WE are asked to say whether it is possible to obtain different values of grid bias (automatically, of course) for each of a pair of directly heated output valves which are fed with LT current from the same secondary winding of the power transformer.

It will only be possible to do this when bias is derived from a common resistance in the negative HT lead; different values of bias for each valve can then be obtained by returning the grid circuits to suitably placed tappings on the resistance.

It should be pointed out, however, that even so the bias of one valve is bound to be affected to some extent by the anode current of the other, and that it would probably be better to feed each filament from an independent transformer winding.

The Wireless World
INFORMATION BUREAU

THE service is intended primarily for readers meeting with difficulties in connection with receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be by letter to *The Wireless World* Information Bureau, Dorset House, Stamford Street, London, S.E.1, and must be accompanied by a remittance of 5s. to cover the cost of the service.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

EDITORIAL COMMENT

Educational Broadcasting

The Problem of Trying to Please

THERE can be no doubt that if we divide broadcast programmes into two parts, educational and entertainment, it is the educational side which presents the more formidable task to the compilers.

If a vote of the majority of listeners were a deciding factor, as in America, where sponsored programmes thrive, educational matter would probably largely disappear from our programmes, but fortunately, in this country, broadcasting is established on a basis where the programme compilers are not dictated to by purveyors of pickled onions or lipstick, and so the tastes of minorities can be catered for as well as the masses.

But we think perhaps the B.B.C., in arranging educational matter for programmes, is still too much influenced by the desire to appeal to the majority. In educational talks such a policy cramps the style of the compilers from the outset. Public taste in talks differs so much more widely than is the case in music that it is quite impossible to make any attempt to include talks of real value in the programmes if at the same time the B.B.C. is obsessed with the desire to be as popular in educational matter as in the average musical programmes. The immediate effect of any such influence is that the talks cannot deal more than superficially with their subject and are consequently foredoomed to "scrappiness" in character. It would be better to have ten talks, each of real interest to a tenth of the listeners, rather than that all should be of doubtful interest to the majority.

Whatever action the B.B.C. takes, there will always be a constant demand for entertainment, so that it would seem that talks and educational broadcasts must, as far as possible, be arranged as alternatives to entertainment. Too often talks are of such short duration that the speaker has no chance to develop his subject fully, or again, connected talks may be arranged in a series in which very few listeners will be able to participate throughout, with the result that they will probably prefer not to listen at all, rather than hear only one or two instalments.

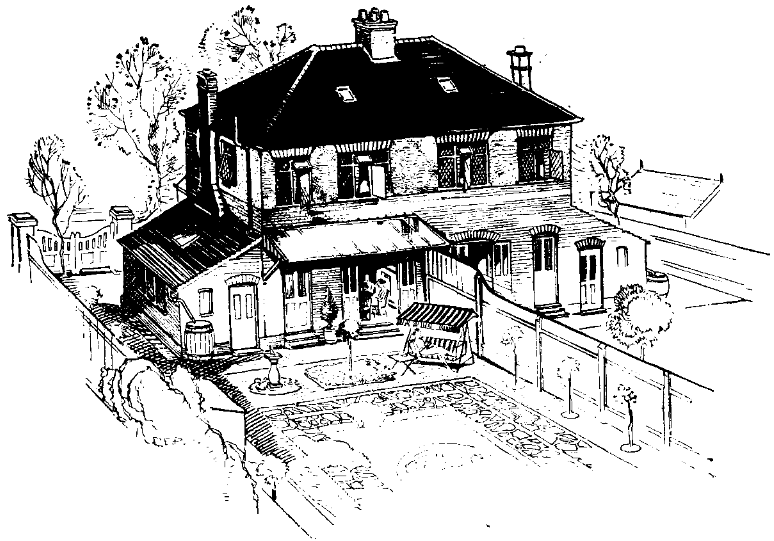
We believe that a partial solution of the difficulty might be arrived at if the B.B.C. could devote the time of one station, such as the long-wave Droitwich, mainly to educational matter and pursue a policy of giving more solid material on specialised subjects, even if the talks were extended in length, and making every endeavour to forget for once what must at present be the constant urge to be popular.

Television

A Grievance

AT the annual meeting of the Baird Television Company held recently, the Chairman, after an interesting speech on the Company's activities and the development of television in general, referred to "the injustice that has been meted out to this Company."

It is deplorable that an enthusiastic staff should be working under the shadow of a grievance against the authorities and still more is it to be regretted that the Television Committees, if they have been aware of the position, should not have taken steps to investigate it. Grievances should be aired not harboured, and we extend to the Baird Company an invitation to state their grievances in the columns of *The Wireless World* in order that they may receive the consideration of all sections of the radio trade and public.



Keep Your Wireless to Yourself

By E. C. WADLOW, Ph.D., B.Sc.

Reducing Sound Transmission from House to House

HERE is a "League of Nations" type of article which will appeal to a large number of readers who wish to "do the right thing by their neighbours." Simple methods of abating the noise nuisance, particularly in semi-detached houses, are described, and the possibilities of co-operative action between neighbours, to the mutual benefit of both, are discussed.

IT is well known that the average radio set or radio-gramophone, if operated at anywhere near full volume, has sufficient sound energy output to cause considerable annoyance to those living in houses adjoining that of the owner of the offending instrument. For instance, a set having a maximum undistorted valve output of 2 watts, with a loud speaker efficiency of 5 per cent., is capable of producing sounds about five times as loud as normal speech, and about twice as loud as loud shouting.

In the majority of cases, walls which are only just adequate to preserve privacy of speech are still used between adjacent houses, and they are incapable of preventing transmission of these louder sounds from one house to those adjoining.

The nuisance is lessened, however, if some simple points are observed by each party, and it is proposed to touch on these briefly in this article.

Unless his neighbours wish to share his entertainment, a person who lives in a house which is attached to others should endeavour, normally, to operate his set no louder than is really necessary. This degree of loudness, is of course, arbitrary. The loudness of ordinary speech might be suggested as a basic standard for loudness of reproduced speech. Most people, however, seem to prefer the loudness of reproduced speech to be well above this suggested standard. This is probably because the intelligibility of reproduced speech is not so good as direct speech for the same loudness, and is generally improved by an increase in loudness.

However, a similar standard to the above can hardly be applied with music. We cannot, even if we wish, obtain the same sound energy output from our 4-valve set as is obtainable from a large orchestra. And even if we could, the loudness in the living room of an ordinary semi-detached house would be quite unbearable. The same difficulty is present with most entertainments of a musical nature.

In practice, a person will operate his set so that the loudness of the sound derived from the speaker, which may be only a few feet away from him, is similar to that which he prefers when listening to a similar performance at first hand. But people have preferences with their radio just as they have when listening to a band performance in a park. Some will like to be right up by the bandstand, while others will remain two or three hundred yards away.

A radio set used by the latter type of person will probably give little annoyance to neighbours, while that belonging to the lover of loud music will probably soon become a nuisance. What, then, can be done to allow a person to enjoy loud reproduction while affecting the comfort of those next door as little as possible?

The prevention or reduction of sound transmission from house to house is a problem which should really be considered when the houses are being planned, for it is difficult and costly to carry out major changes when once they are built. In the majority of blocks of modern houses, and in semi-detached houses, nothing whatever is done to meet the situation which has arisen out of the popularity of radio and gramophone.

Effectiveness of Partitions

Statements to the effect that the buildings are "as nearly sound proof as is practicable," and so forth, appear occasionally in sale or letting advertisements of houses and flats. Such statements can mean very little, and in the cheap type of house being built in great numbers at the present time any "sound proofing" treatment is not likely to be very effective.

The sound reduction factor for a partition is defined as the ratio of the sound intensity on the same side of the partition as the source of sound, to the intensity on the opposite side. For a partition such as a wall between adjacent rooms, it is dependent also on the frequency of the sound, being generally less for low than for high frequencies. The average value given by Sabine[1] for a single wall, over a frequency range of from 128 to 4,096 c/s, is 400, while for a double wall, with a 2in. air space and no structural connection between the two, it is 32,000. Bridging the space with any material reduces the sound reduction factor, and if this bridging takes the form usually adopted in ordinary cavity walls, the sound reduction factor is likely to be no greater than for a single solid wall of the same weight per square foot of surface area. Walls built of hollow blocks of concrete, or of similar material, are likely to suffer from the same defect. For 3-in. solid gypsum tiles, P. E. Sabine found the sound reduction factor to be 88 at 128 c/s, 160 at 512 c/s, and 3,400 at 2,048 c/s, compared with the values of 79, 120, and 1,000, respectively, at the corresponding frequencies for 3-in. hollow gypsum tiles.

It has been found by investigators that the logarithm of the sound reduction factor is roughly proportional to the weight of the partition per square foot of its surface area, and that unless two completely separate walls can be built, the most effective way of reducing sound transmission is generally to increase the weight of the wall per square foot.

The covering of the wall also has an influence, and the sound reduction factor can be multiplied several times at certain frequencies by using a greater thickness of plaster. Plaster only, on expanded metal, can be almost as effective as the double walls at certain frequencies.[2]

The ideal state, obviously, is to have all

[1] P. E. Sabine, Phys. Rev., 27, 116, 1926.

[2] "Acoustics of Buildings," by Kaye and Davis, p. 194.

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houses detached, but this is far from realisation, and is likely to remain so. It is therefore of more interest to a householder troubled by his neighbour's radio to know what can be done, after the houses are built, to reach a state of affairs acceptable to both parties.

A typical case will therefore be considered in more detail. Suppose Fig. 1 to represent the ground floor plan of a pair of semi-detached houses, and that the loud speaker is working in room A of the right-hand house.

Parallel Sound Paths

It is obvious that the speaker will be more easily heard in the left-hand house from room C than from room D. A person living in this house and desiring quietness would therefore select room D as the living room. This is the simplest way of lessening any nuisance from the speaker in room A. If operating loudly, however, it may still be heard very clearly in room D. The sound reaches room D by several parallel paths. Neglecting for the moment any sound transmitted through floors, ceilings, windows, and outside walls, it will be seen on referring to Fig. 1 that the three likely paths for sound waves passing from room A to room D are

(1) Via the walls only and then to the air of room D.

(2) To the air of room C via the 9-in. wall and then via the doors (*u*) and (*v*), and the air spaces round them, to room D. Also via doors (*x*) and (*y*), and the air spaces round them, to the air of room B, and thence via the 9-in. wall to the air of room D.

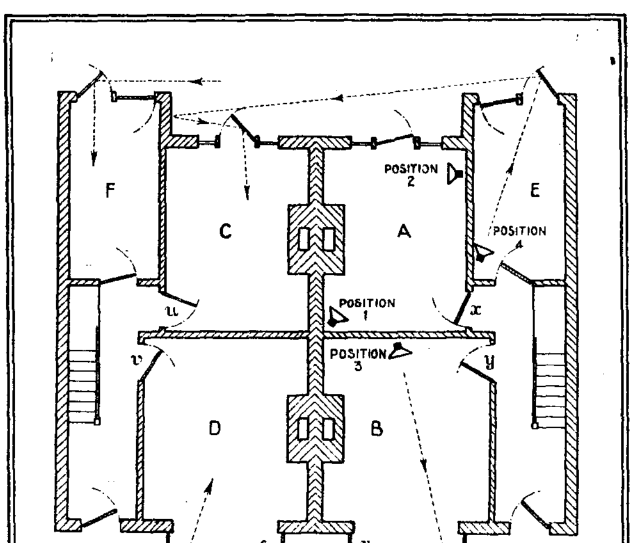

Fig. 1.—Ground floor plan of a typical pair of semi-detached houses, illustrating the positioning of loud speakers and the possibilities of unwanted sound transmission.

(3) To the air of room C via the 9-in. wall, and to the air of room B via the 4½-in. wall. Thence via the appropriate wall to the air of room D.

These paths are arranged above in the probable order of their importance. This can be demonstrated roughly in the following ways. Suppose a loud speaker operating in room A is audible in room D and in room C, and that the relative loudness in the two rooms has been gauged approximately by ear. If the speaker in room A is then switched off, and another one is operated in room C so that to a listener in this room it sounds approximately as loud as the speaker in room A did previously, it will be found, with the doors (*u*) and (*v*) shut, to be less audible in room D than the speaker working normally in room A was in the first place. By opening and closing doors (*u*) and (*v*) an idea of the comparative sound transmission through these and through the 4½in. wall between rooms C and D can also be formed.

Another method of gauging the importance of the walls—path (1) above—in transmitting sound (though it savours of eavesdropping) is as follows. If the ear is pressed against the walls of room D in the corner nearest to room A where the speaker is operating, the sound heard will probably be louder and more distinct than it is in the centre of room C. Both these experiments illustrate how effectively sounds can be transmitted *along* the walls.

The actual transmission of sound through a partition may be either by vibration of the partition as a whole—the partition acting as a large diaphragm—or by true acoustical refraction, analogous to the transmission of light through a slab of glass. However, most rigid surfaces are better reflectors of sound than the best mirror is for light, so that, in general, diaphragm action is the more important.

In a house the transmission is not altogether simple. Sound transmission between adjacent rooms of the house shown in Fig. 1 can readily be pictured. But in passing from room A to room D the vibrations pass along the walls and are also capable of setting them vibrating transversely.

The transverse vibration characteristics of a wall or ceiling are determined by the mass, stiffness, and damping, and follow the well-known laws for maintained forced vibrations. In the case of a wall or ceiling, the natural, or resonant, frequency is fairly low, and hence, for a constant exciting force of any musical frequency, the mass of the partition is the important factor in determining the amplitude of its vibration. Of course, most additions such as chimneys and fireplaces add to the stiffness of a wall as well as to its mass. The one can rarely be altered without changing the other. The damping coefficient for a composite structure such as a brick wall is also very considerable, and in consequence the natural frequency of the wall is not clearly defined.

On account of their own vibration characteristics, walls and ceilings do not transmit all frequencies equally well. Generally they are more opaque to high frequency sound vibrations than to low ones, and the sound reduction factor thus falls as the frequency is lowered. However, the tuning is not sharp at the natural frequency, as the damping is considerable, but in spite of this, music heard through

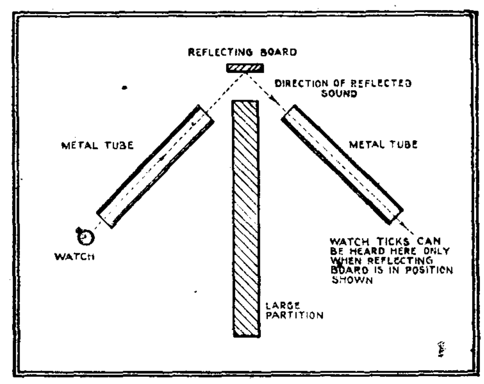

Fig. 2.—Experiment illustrating the transmission of sound by reflection.

a solid partition is considerably distorted.

One can often feel the forced vibrations of wooden panels and floors when these are excited by a suitable agent such as a powerful loud speaker or an organ. Vibrations at the resonant frequency excited by direct contact with the exciting source are often so pronounced that they can travel a considerable distance before their energy is dissipated. In a house they may be minimised by standing the radio set and speaker on a piece of resilient material such as soft rubber. The rubber feet fitted to speaker cabinets are usually much too hard to prevent sound transmission by direct excitation.

Sound-absorbent Materials

When the walls of a house have been built it is generally impossible to make any considerable structural changes. A drastic one would be to increase the thickness of plaster, but the improvement would hardly be worth the trouble and expense. A very slight improvement may be obtained simply by papering the walls, if these are not already papered. Panelling certain walls with sound-absorbent materials would also be helpful, but a more acceptable way would probably be to cover the wall with a well-stocked bookcase. Changes of the above nature should preferably be made to both rooms—that containing the speaker and that occupied by the person desiring quietness.

Noticeable improvements are to be obtained, however, simply by choosing the most suitable position for the speaker in room A. For a constant frequency, the amplitude of vibration of the walls will be proportional to the sound energy which falls on them. The worst case, to a listener in room D, will occur when the speaker, without a back to its cabinet, is placed in the corner of room A nearest to room D—position 1, Fig. 1. If the speaker is moved over to the other side of the room A—to position 2—the sound waves are allowed to spread, and a considerable proportion of the total energy may fall prim-

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arily on parts of the floor, walls and ceiling where it is much less harmful in causing noise in room D.

When the loud speaker is placed in room A in position 2, Fig. 1, the furnishings of the room can also be made to play a useful part.

Absorption by Furnishings

If a loud speaker is operating in an unfurnished room, the sound intensity throughout the room will be practically uniform owing to the repeated reflection of the sound waves from the hard uncovered walls, ceiling and floor. The sound from the loud speaker itself is, however, sharply directional at 4,096 c/s and higher frequencies. The directional characteristics decrease as the frequency is lowered, and below 256 c/s the sound may be regarded as non-directional. If the speaker is in a furnished room, having a carpet on the floor, curtains in the windows, a door curtain, pictures on the walls, and several easy chairs or a settee, a high percentage of the sound energy falling on these objects will be absorbed.

One consequence is that although the speaker has the same sound energy output as before, it will not sound nearly as loud in most parts of the room. The reflected sound waves which existed previously in the unfurnished room are now greatly diminished in intensity. The amount of sound energy actually falling on the walls where it can readily be transmitted to room D is now considerably reduced. When the room is furnished, the loudness of the speaker can usually be heard to decrease as the listener recedes from it, and the directional effect is more pronounced. In consequence, the listener will have to sit a little closer to the speaker, and preferably in the direct beam of the sound waves. This, however, need involve no hardship. A loud speaker placed in position 2, Fig. 1, is convenient for a listener seated by the fireside. The speaker itself is as far away as possible from room D, the main beam of sound is directed away from the corner nearest room D, while a portion of the sound energy directed towards this corner is absorbed by the furnishings, and thus cannot excite the wall.

Floors and ceilings play a more important part when sound transmission between rooms on different levels is considered. Their vibration characteristics are similar to those of walls, but being lighter in weight and construction, they transmit sounds more readily.

It frequently happens that the sound transmission from a ground-floor room of a house to a bedroom on the first floor of a house adjoining seems greater than that to the corresponding room on the ground floor in spite of the greater number of partions between the source of sound and the listener. This increase may be due partly to floor and ceiling resonance at frequencies being reproduced by the speaker, and partly to the lower general noise level prevailing in the upstairs rooms.

The foregoing remarks refer entirely to sounds transmitted through the structure of a house from one room to another. Such sounds are most troublesome in the winter-time, when windows will generally be closed, and it is more quiet indoors. In summer other equally annoying effects are frequently encountered. These occur when sound waves escaping through open windows undergo reflection, and can then be heard in places where, with the windows shut, they would be quite inaudible.

Sound waves of high frequency follow the same laws as light, but as the frequency is lowered, and the wave length becomes comparable with the linear dimensions of the reflecting object, the simple geometric laws cease to apply. Thus, in the school experiment illustrated by Fig. 2 a ticking watch gives a good reflection with quite a small reflecting board. The frequency of the sound is of much less importance when the reflection is from a large object, as, for instance, in the case of echoes from the side of a cliff.

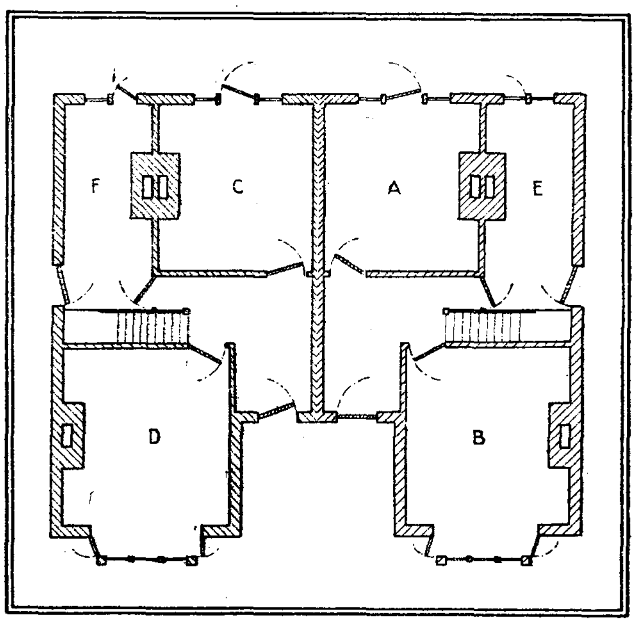


Fig. 3.—Suggested design of a pair of semi-detached houses to minimise the noise nuisance.

Fig. 1 also illustrates some of the reflection effects which are obtained with a typical semi-detached house. Suppose now that the speaker is placed in room B, position 3, where the sound beam falls on the open window (*p*). This is a sufficiently good reflector to direct an appreciable volume of sound in the direction indicated, and this, in turn, is reflected into room D by the other open window marked (*q*). This sound reinforces that which is transmitted through the walls between rooms B and D, giving an unnecessarily high sound-intensity level in room D. If the other windows (*r*) and (*s*) had been opened instead, as shown dotted, or if windows (*p*) and (*q*) opened in the opposite direction, the reflected sound entering the room D would be practically nil.

Another example is also shown in Fig. 1. When the speaker is in the kitchen E, position 4. the sound transmitted through the structure of the houses, with all the doors shut, to the other kitchen opened as shown, the sound entering the room F may be considerable. The illustration also shows how sound may be reflected from room E to room C, the dotted lines indicating the main path of the sound waves.

Avoiding Direct Reflection

A partial remedy is obvious in most cases of this kind. The windows in semi-detached houses should be arranged so that the outsides open back to back as in the case of windows (*r*) and (*s*) of Fig. 1. When more than two houses are joined together this scheme cannot be carried out completely, and some pairs of windows must face the wrong way.

The position may be summarised by stating that semi-detached houses should be designed in such a way that at least one room is separated from the adjoining house by a hall, passage or similar obstacle to sound transmission. Such a house is illustrated by a ground plan view in Fig. 3.

If there is no alternative to the type of house shown in Fig. 1, the following points may usefully be observed by (*a*) the person desiring quietness, and (*b*) the owner of the loud speaker.

(a) For a person desiring quietness:

Do not aggravate the fellow next door, or retaliate, but secure his co-operation.

Live in the room diagonally opposite that in which the speaker is used.

Cover, or partially cover, the walls nearest room A, Fig. 1, with wallpaper, bookcases, or any other sound-absorbent material to reduce sound radiation from these walls as much as possible.

Consider the provision of masking sounds to which one has become so accustomed through long familiarity that they pass unnoticed.

Keep doors closed where possible, to reduce the number and effectiveness of the various sound transmission paths.

Use the windows which avoid reflection effects.

(b) For the owner of the loud speaker:

Do not operate the radio or gramophone louder than is really necessary.

Give a thought to its position relative to the living room, study or bedroom of those next door.

Ensure that the room contains a reasonable amount of sound-absorbing furniture, particularly on or near the partition walls.

Stand the speaker on fairly soft rubber feet to prevent direct excitation of the floor.

Keep doors closed when and where possible to reduce the general sound level throughout the house.

Give a thought to possible sound-reflection effects when windows are open.

The Insufficiency of Meters

Accuracy Must be Demanded but Not Intelligence

By "CATHODE RAY"

PRIDE of possession is seldom more convincingly displayed than by the new owner of a high-quality meter. If it bears the name of a famous maker, and perhaps even a certificate of accuracy, he becomes almost offensively dogmatic about the results of his tests. But although it might be unsafe to say so to his face, the accuracy of the instrument is no guarantee that his statements based on it are correct. His faith may mislead him very badly.

Not long ago the manufacturers of a particular type of meter brought a libel action against those who had stated in print that in certain circumstances its indications were not accurate. The Court's decision was that such statements did not reflect adversely on the honesty of the manufacturers, or even on the quality of the instrument.

It may happen that an inferior voltmeter gives truer readings on an HT battery than a good meter. It is perfectly possible for three accurate and reliable meters to be connected simultaneously to read the same thing and yet to give quite different readings. Although an accumulator needs a higher voltage than its own to charge it, yet it is possible to charge it from a supply which an expensive voltmeter shows to be lower.

It is not my intention to damage the trade in high-class electrical instruments, or to discourage the use of meters by uttering confusing paradoxes. I merely wish to call attention to two requirements over and above that of meter accuracy.

Correct Loading

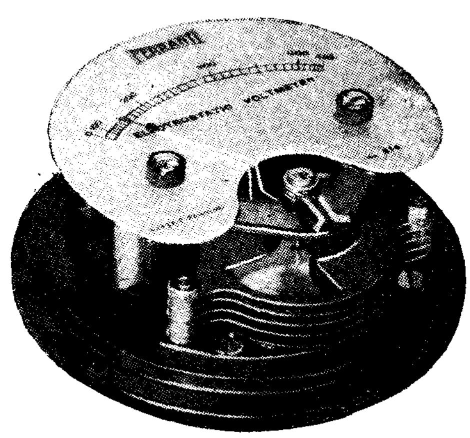
The first is to make sure that the instrument is measuring what it is desired to know. Take an HT battery for example. The voltage reading is a valuable guide to what the insurance companies call the expectation of life. If the battery is nominally 100 volts and the makers have not adopted the shady trick of putting in an extra cell or two to lead one off the scent, a reading of 100 or slightly over should justify a feeling of confidence. A reading of 70 would normally indicate end of life. What one wants to know is the voltage given by the battery when it is actually working, i.e., when it is delivering the normal flow of current. Such a reading is not obtained by connecting a voltmeter to it under working conditions if the voltmeter itself draws so much current that the battery voltage falls. The reading itself may be perfectly correct, but it is not what one wants to know.

The usual advice is to employ a voltmeter of such high resistance that it takes a current negligible compared with the working current. Suppose, now, that the dealer uses such a voltmeter, possessing the very highest credentials, to test a shop-soiled battery in the presence of the customer. As it imposes a negligible load on the battery the reading may appear perfectly satisfactory; but when in actual use the battery voltage would drop. In the absence of a working test it would be better to apply an inferior meter taking a current that approximates to the working current.

AC, DC and Unidirectional Currents

These precautions are even more essential when measuring the voltages of power units and other appliances whose voltage depends more steeply on the current being drawn. And in some circuits—notably the grid circuits of valves—the voltmeter may demand more power than is available and reduce the pressure almost to zero. It is like measuring the speed of a baby car by attaching to it a heavy lorry containing the speedometer. The conditions of measurement do not fairly represent the conditions of use. Sometimes the error can be calculated and allowed for. In other cases a different method of measurement must be adopted.

The second precaution—it really comes first in time—is to make sure that the meter is suitable for the job. It was no use for the March Hare to protest that it was the *best* butter that was used to lubricate the Mad Hatter's watch. It is fairly generally known that a DC meter may not be of any service when one wishes to measure AC, or an ordinary AC meter when the measurement to be made is of the output of a radio transmitter. Such things are obvious to all who are likely to be using meters.



An electrostatic meter is useful for measuring DC voltages where any additional load would cause a false reading.

It is not quite so generally known that besides AC and DC there are some other sorts of current that are not quite either. You may want to charge accumulators from the AC supply. AC is no good as it is because it takes out of the battery just as much as it puts in. A rectifier is required to suppress the negative half waves. The result is unidirectional and up to a point may be regarded as DC. At any rate, a DC ammeter or milliammeter is the correct instrument to indicate the charging current. You may deem it wise to include fuses in the charging circuit; and, basing them on the charging current as measured, may be grieved to find that they burn out prematurely. The trouble is that the *effective* current—effective for heating things—is different from the average current that counts for charging purposes, and must be measured by an AC meter. The output from a rectifier is in the form of relatively brief but intense spurts, and in these circumstances the reading on an AC ammeter may be as much as twice that on a DC meter, without raising any question of inaccuracy.

Peak Volts

Another thing you are quite likely to do if you have built the rectifier unit yourself is to check the output voltage before risking the battery on it. What now; does one use a DC voltmeter or an AC? Trying them both, for luck, you will probably get different readings. By now that is not very surprising; what may tend to disconcert is the discovery that both readings are rather lower than that of the battery to be charged. Yet it comes all right when the battery is connected up. The explanation is that it is the *peak* voltage that is most important. The average may be quite low, because at least half the time there are no volts at all; but the peaks exceed the battery voltage and force the current through.

The metal rectifier AC meters that are now so popular for radio test purposes are scaled to read effective (RMS) values, but are only strictly accurate when used to measure a pure waveform; there would be a large error in a rectifier circuit, for instance. Valve voltmeters can be designed for almost any type of reading—average, RMS, or peak. It is important to remember that some can be used when DC is also present; others cannot. The former usually have a grid leak and condenser.

A precision instrument is a very nice piece of work, but its limitations should be realised and it should not be given credit for intelligence of its own.

The PERMANENT MAGNET Industry

Sheffield's Decade of Research and Progress

III.—MAGNETIC MATERIALS

AN outline of the history of the development of Permanent Magnets, particularly for Moving-coil Loud Speakers, and a description of some of the many processes involved in their manufacture, have been given in two previous articles in the issues of April 26th and March 29th, and in this further contribution a description in broad outline is given of the magnetic properties of the materials used for Permanent Magnets and of the trend of modern design with reference to the applications of the new Nickel-aluminium alloy.

BEFORE the superiority of one magnetic material over another can be appreciated it is necessary to grasp the meaning of some of the terms used to describe the more commonly measured properties. This is best done with reference to a simplified example in which attention will be focused on the major points. Imagine a uniform ring of magnet steel wound uniformly with a coil of wire—Fig. 1. We will suppose that we can measure the strength of the uniform magnetising field imposed on the ring of material when a current is allowed to flow through this coil and we will further suppose that we can measure the total number of stationary closed magnetic lines of force which are present in the ring for any particular set of conditions. Magnetic lines of force constitute a magnetic "flux" and a uniform magnetic field expressed as a "flux per unit of cross-sectional area" is termed the magnetic "flux density." If, therefore, the ring is of known cross-sectional area we can express our results as so much flux per unit of area, or so much magnetic energy per unit of volume, and this is, in fact, done to arrive at a simple basis for comparison purposes. If, initially, we simply use the coil wound in the shape of the ring we shall find that the flux density set up in the core air space is proportional to the magnetising current. If we write B for the flux density set up in the core space and H the magnetising force giving rise to the flux density B, we shall find that we have a curve like Fig. 2, in which B is equal to H numerically. Suppose, now, a ring of cobalt magnet steel is substituted for the air space and the experiment repeated, we shall find that B is no longer proportional to H, which is in turn proportional to current flowing, but a curve like Fig. 3 (a) is obtained. At very large values of H the value of B increases very slowly as H is increased. When this state of affairs is reached the magnet steel core is said to be magnetised to saturation. The end of the curve in Fig. 3 (a) is intended to represent this point. If now the magnetising field H is decreased the flux density B in the core does not fall as rapidly as curve 3 (a) would lead us to expect, and, actually, what happens when the magnetising field H is reduced to zero is seen in the upper portion of the curve in Fig. 3 (b). A new feature has come to light, for it is now evident that there exists a flux density Br in the core of the magnetic steel even after the magnetising force has been removed. In other words, our ring has become permanently magnetised. The value of Br—an important magnetic quantity—is called the "remanence." However, we are interested not only in the maximum flux density Br which can exist in the ring after it has been fully magnetised, but also in the resistance it can offer to demagnetising influences, because on this property its permanence depends. Let us continue our test, therefore, by reversing our current supply to the magnetising coil and again simultaneously observing B and H. Fig. 3 (c) shows the new course of the curve. The flux density Br has been reduced gradually to zero by the reversed magnetising field, and at a certain value of H, equal to Hc, the value of B = O, or the ring is completely demagnetised. The value of Hc is another important magnetic criterion, and is termed the "coercive force." The portion of the curve to the left of the line YOY1 in Fig. 3 (c) is the only portion which seriously interests the magnet designer, and the working value of flux density Bw and working value of demagnetising force Hw are always found at some point on this curve. Let us consider how this occurs and examine the matter from the standpoint of our ring. We noticed that when the ring is complete the working value of flux density Bw is actually equal to the remanence value Br. However, in a permanent magnet circuit it is invariably required that there should be an air gap somewhere in the circuit in which is set up a strong magnetic field. For instance, in a loud speaker magnet there is the annular gap in which the moving coil oscillates and which is capable of vibrating the cone on account of the axial force set up when the current in the coil and the magnetic field in the gap interact. Another example is the magnetic circuit of a voltmeter, or ammeter, in which the current-carrying coil is pivoted in an air-gap between the curved poles of the magnet system. In the case of a simple bar magnet the air-gap is really a rather vague length between the ends of the magnet, and external to it.

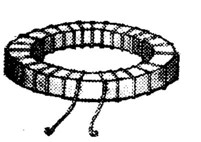


Fig. 1.—Simple uniformly wound ring.

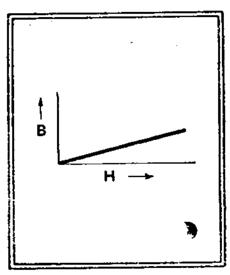


Fig. 2.—Flux density: magnetising force curve for air-cored ring.

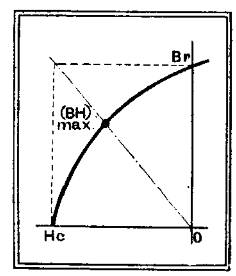


Fig. 4.—Simple geometrical construction to find (B.H.) max point.

Finding the Flux Density

Now, in all these cases we find that the working flux density Bw in the magnet steel is always less than the value of Br, depending on the dimensions of the mag-

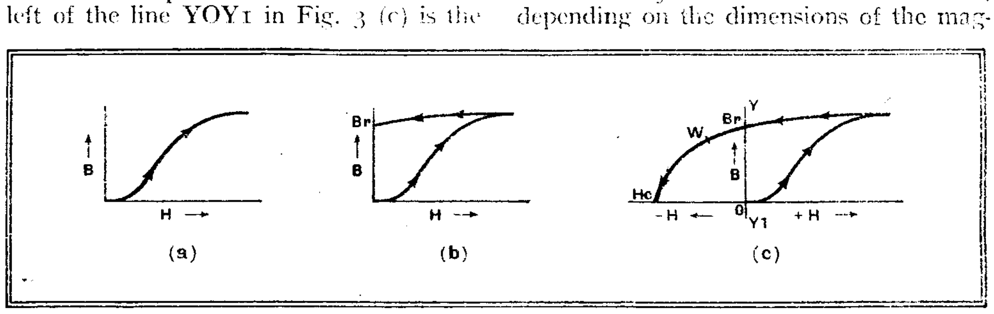


Fig. 3.—Flux density : magnetising force curves for ring of magnet steel.

The Permanent Magnet Industry—

netic circuit, including the air-gap, and further depending on the magnetic properties of the magnet material employed. This occurs because the useful flux in the gap demagnetises the magnet, and this process goes on until there is a balance between the magneto-motive force of the magnet (which measures its ability to set up a magnetic flux in a circuit) and the demagnetising ability of the flux set up in the working air-gap. Hence, when an air-gap is introduced into a complete circuit of magnet steel the flux falls to some such point as W on the demagnetisation curve in Fig. 3 (c).

Without going into any proof of the matter, it is found that when W occurs at such a point that the product of B and H is a maximum, then it can be said that the minimum volume of magnet material has been used to achieve the desired result. This desirable point can be found by the simple geometrical construction of Fig. 4, and is called the "(B.H) max" point, and its value is a measure of the magnetic energy content of the material. It is evident that when we know Br, Hc and (B.H.) max we know a great deal about the material and can proceed to design in detail. These quantities are shown in a simple way in Figs. 5 and 6, from which it will be seen that the new nickel-aluminium alloys are very high in energy content and coercive force, but not so high in remanence. This results in the magnets designed for the new alloy having a shorter length, a larger cross-sectional area, and a smaller total volume relative to, say, 15 per cent. cobalt steel, although the reduction in total volume is not so marked in the case of 35 per cent. cobalt steel. It is not possible to go into further design detail, as the subject becomes very involved, but it is hoped enough has been said to explain the significance of the more important magnetic criteria and in what way they influence practical designs.

How the Alloy is Used

We will now proceed to examine the way in which the new alloy has been applied successfully in the design of moving-coil loud speaker permanent magnets.

It would be as well to say at this point that the nickel-aluminium alloy is a very hard, highly brittle and crystalline material. It cannot be softened and drilled, and, therefore, in general, can only be cast in relatively simple forms. The working faces are then ground to size. Holes of approximately $\frac{5}{16}$in. diameter and above can be cast into blocks of the material, but it is highly desirable to avoid unequal sections, sharp corners and wall thicknesses less than $\frac{1}{4}$in. to $\frac{3}{8}$in., according to the design of the casting. With improving technique, many of the initial difficulties have been overcome, but it is only by unceasing attention to detail that all-round success can be achieved. It has been found possible to cast small pieces of mild steel into the magnet blocks, but as it is not proposed to deal with the details of mechanical strength and construction, this technique will not be elaborated.

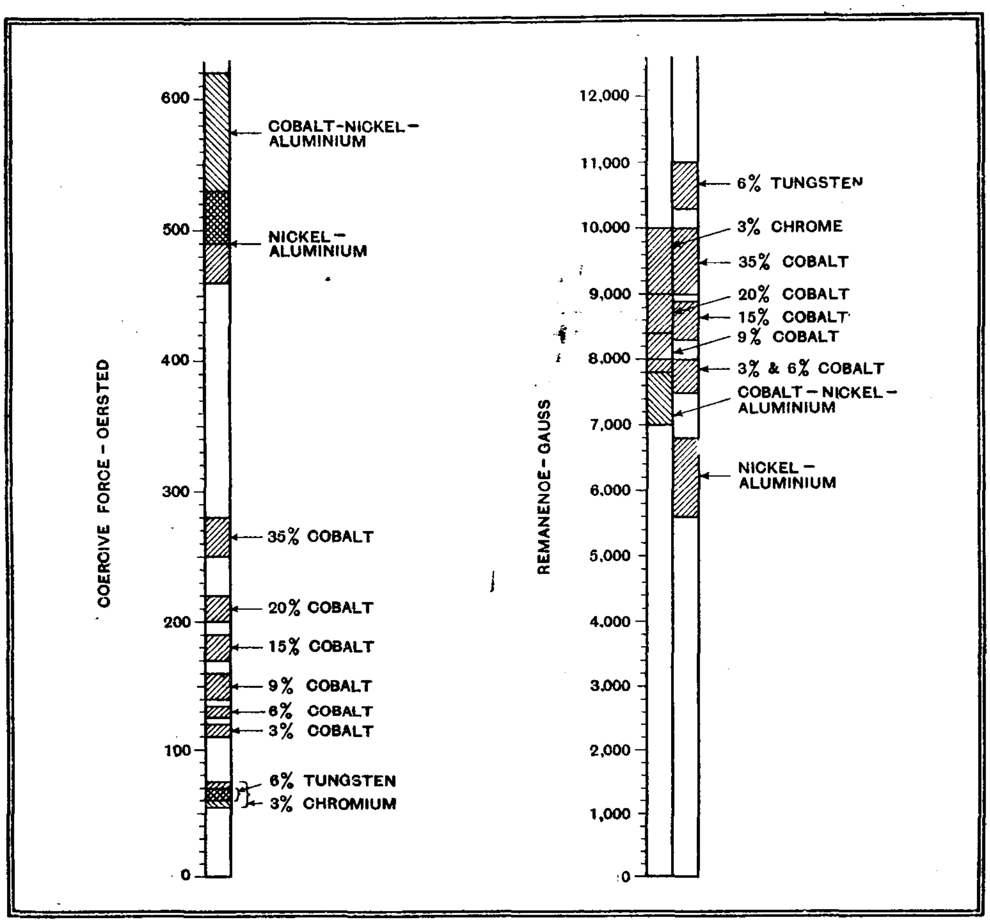


Fig. 5.—Ladder scale of "remanence" and "coercive force" for permanent magnet materials.

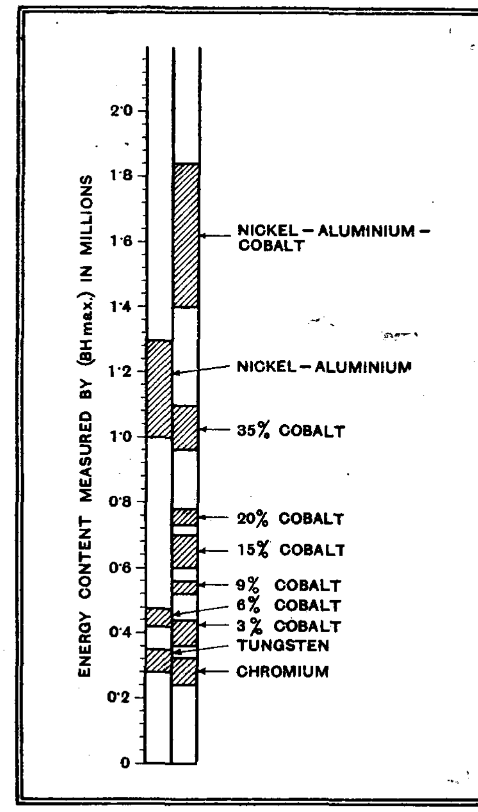
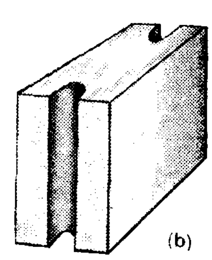


Fig. 6.—Ladder scale of "magnetic energy content" for permanent magnet materials. The percentages for Tungsten and chromium should be taken as 6 and 3 respectively.

Only a short time elapsed before three principal types of moving-coil loud speaker magnets emerged. They were:—

1. The Double-block Type.
2. The Centre-block Type.
3. The Ring Type.

An illustration of the Double-block Type is given in Fig. 7 (a), in which top and bottom plate and centre-pole are made in mild steel, and two blocks of magnet alloy are firmly clamped between the plates at their extremities. Bolts of non-magnetic material, such as hard brass or phosphor bronze, are used for fixing purposes, and these passed either through holes cored in the casting as shown in Fig. 7 (a), or occupied grooves cast into the side of the casting, as seen in the inset Fig. 7 (b). The essential technical requirement of short length and appreciable cross-sectional area


(b)

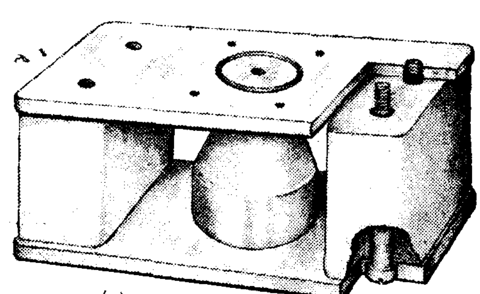

(a)

Fig. 7.—(a) Double-block type magnet. (b) Showing alternative design of block.

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is seen to be satisfied by the design.

The Centre Block Type is seen in Fig. 8, in which a simple magnet block, surmounted by a mild steel pole tip is fixed into a forged mild steel yoke system. This is a good design in many ways, and is rather more efficient than the Double-block type for small sizes of centre block weighing up to about one pound, but it requires rather precise assembly. The magnet block is shown separately and is seen to consist of a simple solid cylinder ground on its top and bottom faces and having a single cored hole through its centre. Many thousands of this type of magnet were used last year.

For simplicity of assembly and for the highest magnetic efficiency, by which is implied minimum mass of magnet material

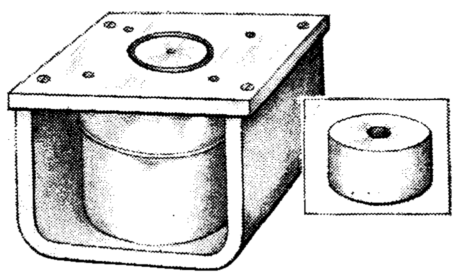


Fig. 8.—Centre-block type magnet.

for a given gap-flux performance, the design which is now becoming popular is the ring type. This is seen complete in Fig. 9, and some of the various shapes of ring employed are seen in Fig. 10. Here the advantage is that there is only one magnet part to cast, heat-treat and grind

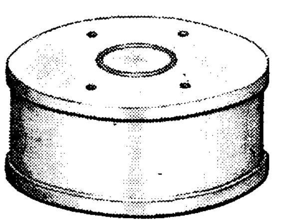


Fig. 9.—Circular ring type magnet.

for each magnet, and the design is therefore economic. A pole-centring device can

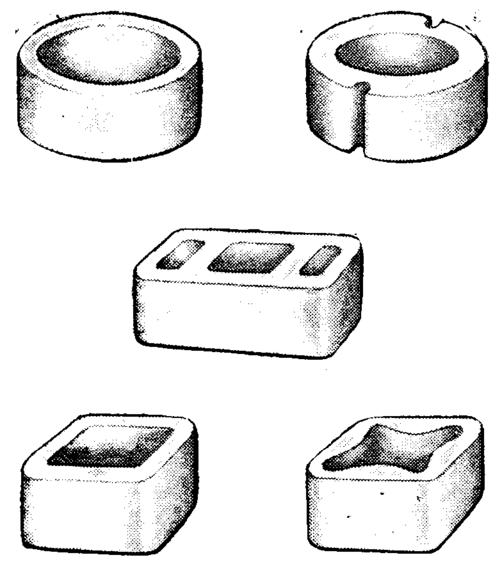


Fig. 10.—Different forms of ring type magnet parts.

be fitted to give the pole increased resistance to sideways displacement under conditions of shock, such as a small fall. This is made clear in Fig. 11, where it should be obvious that relative movement of the centrepole in its outer pole (the top plate) is now prevented, even if the ring of magnet alloy itself moved slightly under the impulsive force of a small im-

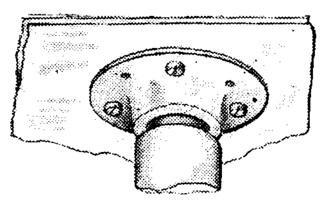


Fig. 11.—Typical form of pole-centring device.

pact. This device is not always necessary, especially in magnets of small mass, but in heavy ring magnets weighing several pounds such an arrangement is highly desirable.

In a concluding article some further points of interest will be mentioned, and a comparison made between the electromagnet and the permanent magnet from the standpoint of set design.

ABSOLUTE LOUDNESS

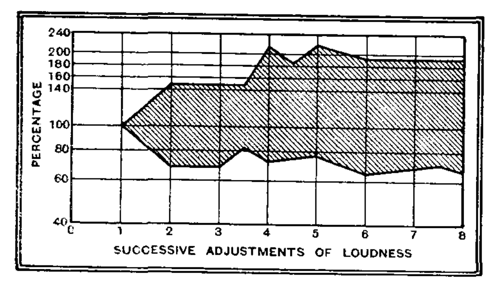
It is well known that some persons—usually, though not invariably, persons with musical ability or with a taste for music—have a faculty described as "absolute pitch." Such persons can name a note struck on a piano without seeing which note it is, or can sing any note within their range and say which note on the piano scale has the same pitch, and so on. To describe this as a sense of absolute pitch is probably misleading, for it is more likely to be of the nature of an unusually accurate memory for pitch. Whatever its nature, however, it suggests an enquiry as to whether any similar faculty exists in relation to loudness, *i.e.*, an enquiry into the accuracy with which normal persons are able to recollect and thus reproduce a given objective intensity.

It is a matter of some interest in connection with receiver design, for the accuracy of the automatic volume control required for slow fading will depend on the ability to detect a slow change in intensity.

There is a well-known law with regard to subjective sensitivity, which states that the smallest perceptible change in an excitation, whether of sight or sound, is, within certain limits, proportional to the intensity of the initial excitation, but here the element of recollection is not so prominent as in a gradual and fairly slow change in intensity, and on this subject, *i.e.*, accuracy of recollection, there has been hitherto comparatively little exact investigation. A brief account of some recent measurements in this field may therefore be of interest to the readers of this journal. The experiments were carried out in the laboratories of a well-known German company (Lorenz Aktiengesellschaft), and were described in the *Funktechnische Monatshefte*.

The conditions of the experiment were made to resemble those of ordinary broadcast reception as far as possible. A moving coil loud speaker was used, in a room of normal dimensions, but as the modulation-intensity variations of broadcast programme material would have confused the issue, the sound-subject was a Morse transmission of a pure tone of about 1,000 c/s. An observer was instructed to adjust the intensity to a level that he considered satisfactory for listening to. This was taken as the "datum level" for this particular observer, and the corresponding voltage across the loud speaker was measured. The sound was then "faded down," and after a minute or so he was asked to readjust it to what he thought was the original intensity, and the voltage was again measured. Six such re-settings were made in the course of fifteen minutes, the observer being left unaware of the closeness of each to the original "datum level" intensity. The whole process was repeated with each of ten observers.

The results are summarised in the figure. The loud speaker voltages for the six settings made by each observer, expressed as a fraction of the voltage of his original setting taken as 100, were joined by a line. The shaded area in the diagram shows the total range of divergence at each setting for the ten observers. There seems to be a tendency for the divergence to increase with time, though not very markedly, and the whole range of the divergence is from about 70 per cent. to 150 per cent., *i.e.*, about six decibels in sound intensity. In so far as



Illustrating a deficiency of the human ear; collective errors made in a series of attempts to adjust reproduction to a predetermined level of loudness.

it is possible to fuse these ten observers into a single average individual, it would seem probable that such an individual would be unaware—or at least uncertain—of a ± 3 decibel variation in his loud speaker intensity during the course of a quarter of an hour, and would accept as steady a transmission fading slowly to this extent.

This set of observations cannot, of course, be regarded as covering the whole ground—indeed, it might be said to raise as many questions as it answers—but it is an interesting beginning, and will probably prompt further exploration of this somewhat neglected field.

CURRENT TOPICS

Events of the Week in Brief Review

Vienna on Long Wave

THE Vienna programmes are now relayed by a 3-kilowatt transmitter on a wave of 1,255 metres on Mondays, Wednesdays, and Saturdays (8 p.m. B.S.T.).

A Big Bag

DURING May the new anti-static department set up by the French Post Office carried out 3,888 investigations, which led to the discovery of 13,465 pieces of machinery creating interference with broadcast reception.

Try This One

ALL wireless set owners can test the theories of a Danish scientist, M. Herideck, who states that flowers respond to music, depending upon their variety. Pinks and cyclamen gradually avert their heads from a loud speaker, whereas roses "show signs of pleasure."

Forbidden

THE Governor-General of Catalonia has forbidden the stations at Barcelona, Lerida and Tarragona to close their transmissions with the Catalonian hymn, "Los Segadores"—"The Harvesters"—because of its unpleasant political associations.

English from Japan

THE new Japanese short-wave station at Nasaki, with a power of 20 kilowatts, is now working daily on 20.6 metres, and can be heard from 2.30 to 3.30 (B.S.T.).

The transmission includes a ten-minutes' news bulletin in English. The call sign is JBH.

Cost of School Wireless

TO equip every elementary and secondary school in this country with a wireless receiving set might cost £400,000, said Mr. Oliver Stanley, President of the Board of Education, in the House of Commons last week.

Mr. Stanley said he understood about 10 per cent. of the total number of elementary departments made use of the wireless for educational purposes. The figure for secondary schools was estimated to be about 20 per cent.

The Frozen Mitt

REFRIGERATORS in the showrooms of an American firm are fitted with temporary photo-cell equipment. When a wandering "prospect" cuts a ray a loud speaker emits sales talk on the advantages of refrigerated food.

After Ten Years

THE bitterest joke of the week comes from Budapest. A radio journal, commenting on the festivities now in preparation to celebrate the tenth anniversary of Hungarian broadcasting, recalls the story of the clerk who, with beaming face, stepped into his employer's office with the remark: "To-day is the tenth anniversary of my joining the firm." The employer merely replied: "Heavens! What patience I possess."

An 80-metre Privilege

FOLLOWING representations by the Radio Society of Great Britain, the General Post Office has granted amateur transmitters the use of the 80-metre band throughout the year except in September. Formerly, they were not permitted to use the waveband (except during week-ends between May and September).

An important condition of this concession is that amateurs using the 80-metre band shall cease transmitting immediately an Army, Navy or Air Force station requests them to do so.

R.S.G.B. Convention

THE Radio Society of Great Britain will hold its tenth annual Convention on Thursday, August 22nd, until Saturday, August 24th, coinciding with the annual Radio Exhibition.

Cathode Ray Tubes

IN the description of the Cossor ray tube given in our issue of May 17th, page 506, the peak voltages for full deflection should be 1,350 and 1,080 respectively. The error occurred in converting from millimetres to inches, where we gave 0.074 instead of 0.0074.

Ensuring Vatican Range

THE Vatican short-wave station is now connected by cable to Beyrout to ensure direct communication with Syria, Palestine, Transjordania, and the Persian Gulf.

BRITAIN'S LOFTIEST "AERIAL." A distant view of Mount Snowdon, from which 5-metre tests are to be conducted by Mr. Douglas Walters (G5CV) on Saturday night and Sunday morning. The summit is 3,600 feet above sea level.

"Ultra Shorts" from Snowdon

THE summit of Snowdon, used for ultra-short wave tests by G6BY and G6UH in August, 1933, will be the scene of another attempt (weather permitting) to communicate with London on Saturday and Sunday next, June 29th and 30th. Mr. Douglas Walters (G5CV) will begin transmissions at 5 p.m. on the 29th and continue at intervals until Sunday midday. Two 5-metre transmitters using 10 and 6 watts respectively will be used, together with receivers for picking up signals from other amateurs. Vertical di-pole aerials will be used. The following schedule will be observed:—

5-5.10 p.m. Transmission—omni-directional — 'phone or I.C.W.

5.10-5.20 p.m. Stand-by on receiver for other 5-metre signals.

5.20-5.30 p.m. Transmission—omni-directional—'phone or I.C.W.

5.30-5.40 p.m. Reception.

This will be continued, unless communication is established with another station, until 6 p.m., when a beam aerial directed towards London, will be employed. Alternate ten-minute transmission and reception periods will continue throughout the evening. Beam transmissions will also be made between 9 p.m. and 10 p.m., and perhaps between 11 p.m. and 12 p.m. On June 30th no definite schedule is fixed, but the transmitter will be in regular operation (call sign G5CV) until midday or 1 p.m.

Amateurs who can co-operate are requested to communicate with Mr. Douglas Walters, 45, Fairfax Road, Bedford Park, W.4 (Chiswick 5982, evening; Temple Bar 7788, daytime).

Germany's Mobile Television Unit

THE first public demonstration by the German Post Office of a new mobile high-power transmitter for high-definition television was staged at Hamburg on Friday, June 21st. The units of the transmitter are contained in fourteen separate vans. 20-metre masts, carrying horizontal di-pole aerials, were erected on a well-known fair ground, and reception was possible in various parts of the town and in four temporary public televiewing rooms.

Press representatives assembled on the Hapag liner "Caribia," in Hamburg Harbour, on which television receiving apparatus is fitted.

The plant is entirely self-contained, being operated by two 135 h.p. eight-cylinder Diesel engines, housed in separate cars. Each of the transmitters also has a transformer van, another for smoothing, an amplifier van and a van containing the HF portion of the transmitter proper.

On the vision side a sixth van contains the film-scanning apparatus (180 lines, 25 frames). Direct scanning is not being used during the present tests.

This imposing television column is shortly proceeding to the summit of the Brocken mountain where tests are to be conducted to prove that from this point a reliable television service range of a 100 to 120 miles will be feasible.

Pye Model TP/B

A Fine Example of Modern Battery Portable Design

FEATURES.— ***Type.***—*Superheterodyne battery portable receiver with self-contained frame aerial.* ***Circuit.***—*Var.-mu pentode HF amplifier—triode-pentode frequency - changer — var.-mu pentode IF amplifier—double-diode-triode second detector — QPP output stage.* ***Controls.***—*(1) Tuning. (2) Waverange and on-off switch. (3) Volume. (4) Tone.* ***Price.***—*15 guineas.* ***Makers.***—*Pye Radio Ltd., Cambridge.*

THOSE who have been acquainted with the radio industry since its early days will need no reminder of the association of the name of Pye with portable receivers, and it seems only fitting that this tradition should be perpetuated by the inclusion of a battery portable in the new season's series of Pye receivers.

There can be no doubt that this type of receiver still makes a very wide appeal, not only on account of the obvious advantages conferred by its portability, but also because of its complete freedom from problems of installation. A year or two ago the portable seemed to be waning in popularity on account of the rather poor performance in the matter of volume and quality returned for a quite considerable expenditure in battery maintenance. The introduction of the QPP principle in the output stage has, however, changed all that, and "mains" quality and volume are now obtainable for less expenditure of HT current than was required for the small single triode or pentode output stages giving little more than 300 or 400 milliwatts of undistorted output.

Although there is provision in this set for the connection of an external aerial, this should be necessary only in remote corners of the British Isles, for the performance from the frame aerial alone under normal circumstances has all the punch and power which one normally associates with outdoor aerial reception. The explanation is to be found in the fact that the superheterodyne circuit includes a signal-frequency amplifier preceding the frequency-changer.

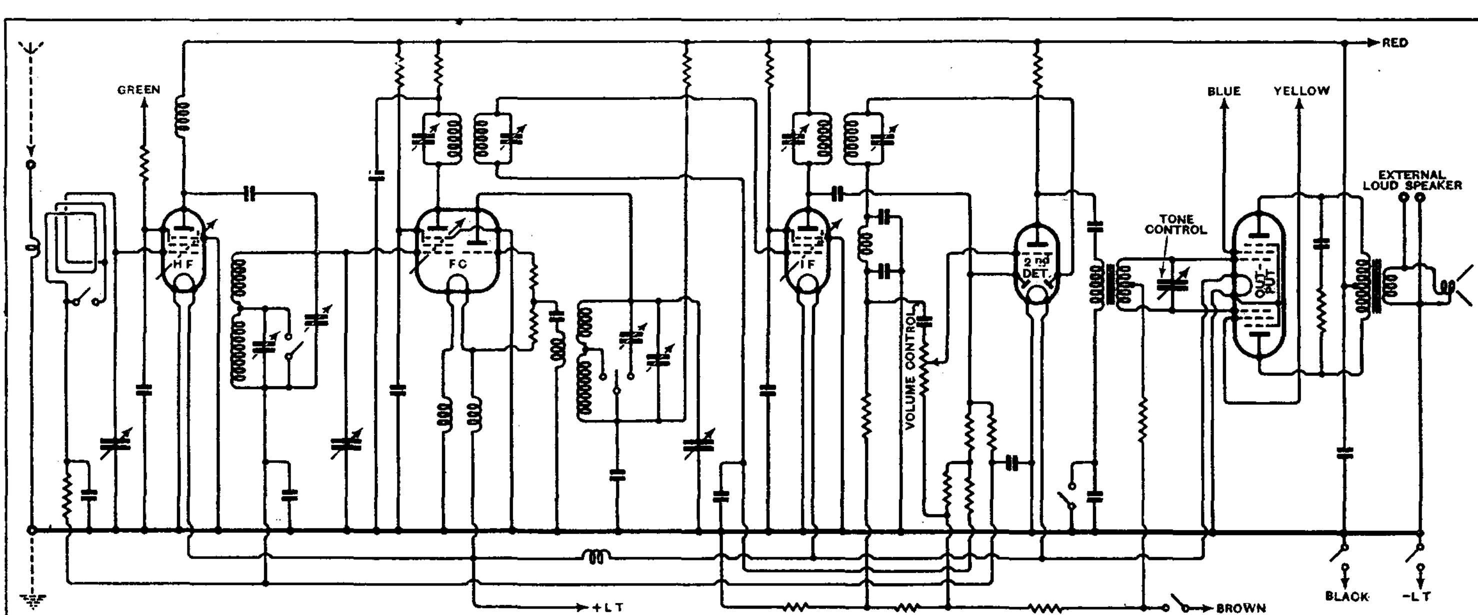
High-efficiency Coils

The valve used in the HF stage is a variable-mu HF pentode, and the coupling to the triode-pentode frequency-changer includes high-efficiency dust-cored coils. The triode and pentode sections of the frequency-changer are coupled by a common filament impedance.

The valve in the IF stage is similar to that in the signal-frequency amplifier, and four tuned circuits are included in the coupling transformers, which are operated at a frequency of 127 kc/s.

The second detector is a double-diode-triode in which one diode is used for signal rectification and the other for supplying the AVC bias. All three of the preceding stages are controlled, but the bias on the IF amplifier is less than that on the HF amplifier and frequency-changer valves. The delay voltage is derived from a potentiometer connected across the grid bias section of the HT battery and a fraction of this negative bias is also applied to the signal diode. The effect of this is to provide a form of QAVC which is, perhaps, better described as fixed noise suppression. In other words, the signal diode does not function until the signal strength of a distant station rises above the threshold bias, which has been adjusted to suppress what may be regarded as the average noise level.

The volume control potentiometer is connected in the resistance-capacity coupling to the triode amplifying portion of the detector valve. The output from this is taken by a specially designed LF transformer in which a tuning capacity connected across the secondary provides a sharp cut-off above a limit which is determined by the setting of the condenser. The spindle operating this condenser



A signal-frequency amplifier preceding the frequency-changer gives ample range with the self-contained frame aerial. The signal rectifying diode is biased to reduce background noise.

Pye Model TPB—

carries a switch arranged so that when the control knob is pulled out an additional condenser is connected in series with the primary winding to reduce the bass response.

The QPP output valve provides an output of 1.4 watts with less than 7 per cent. total harmonic distortion and permanent tone compensation is provided by a fixed condenser and resistance across the primary of the special moving coil loud speaker. Nickel-aluminium alloy magnets are employed and the diameter of the rather shallow angled cone is 9in. The quality of reproduction in undoubtedly a distinct advance on that of the average small superheterodyne to which we were beginning to become inured. There is no obvious focusing and the bass is amazingly broad and full for a set of this size, whether battery- or mains-operated. That is not to say that the quality leans towards over-emphasis of the bass, for most people would say on a first hearing that crispness and clarity were the salient features of the reproduction. In our opinion there was just a little too much edge to the higher frequencies with the tone control in the "brilliant" position, but an ideal balance was obtained by turning the control down by the merest fraction. On all types of transmission, including speech, we found the bass response to be just right and, except for experimental purposes, the necessity for using the bass control was not felt at any time during the tests.

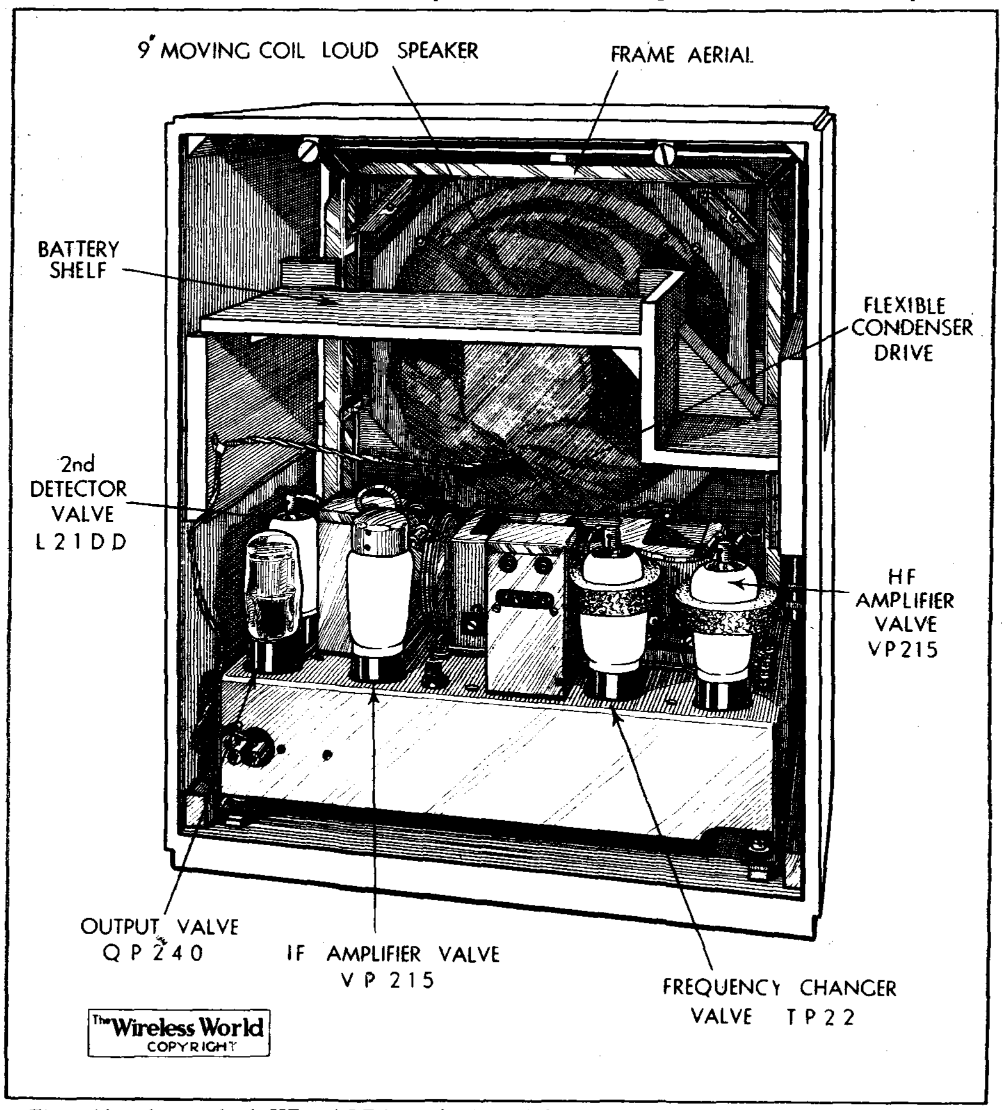
Silent Background

Next to the quality of reproduction the signal-to-noise ratio of the receiver deserves special commendation. When searching round the dial the various stations stand out clearly from an absolutely silent background, yet the sacrifice of threshold sensitivity does not appear to have affected the range, at least as far as any worthwhile station is concerned.

The AVC control is also excellent and there is little difference in volume between North Regional and Cologne and none at all between London National and Radio Normandie when received in Central London. Second-channel whistles are also quite negligible.

In estimating the selectivity of a set of this type it must be remembered that the directional properties of the frame aerial have some bearing on the apparent result, though this is not always obvious on account of the levelling action of the AVC. Accordingly, selectivity tests were made with the frame fixed in the position of maximum signal strength for the station under investigation. Under these conditions, in Central London, both the London Regional and National transmitters occupied exactly one channel on either side of their normal settings. On long waves, however, the Deutschlandsender could only be received by evoking the aid of the directional properties of the frame. Incidentally, the long-wave sensitivity was quite equal to that on the medium waveband, which is not always the case when a frame aerial is employed.

Although under normal conditions of working the volume and quality of different stations may not appear to be affected by the position of the frame aerial, it is as well to bear in mind that this adjustment can have an important bearing on the current consumed from the HT battery. It is always worth while, therefore, to take the trouble to rotate the set into the position of maximum signal strength on the station received in order that the AVC control may reduce the standing anode current taken by the first three valves. The makers suggest that the correct position of the frame should be found by listening for the position of minimum background noise, but the background is, in any case, so low that we found it more easy to turn the set first to the position of minimum signal strength and maximum background noise and then to set the frame at 90 degrees to this position. The HT current drawn by the QPP output stage is proportional to the volume level and an economy will be effected by working at the lowest convenient volume. This will also allow for greater relative modulation peaks without distortion.



The cabinet houses both HT and LT batteries in addition to the frame aerial and a 9-inch moving coil loud speaker. The bottom of the cabinet may be removed for the inspection of the underside of the chassis.

The tuning dial is of the horizontal type and stations and wavelengths are marked in white on a black background. The approximate band-width occupied by each station is also indicated, a feature which will be found especially useful on long waves. The dial is illuminated and the condenser spindle, which runs parallel with the front of the cabinet, is driven through a flexible drive.

The speech coil leads of the internal speaker are connected to plugs fitting into sockets conveniently situated at the back of the chassis. It is an easy matter, therefore, to connect an external low impedance unit either in parallel or in place of the main speaker.

From every point of view the performance of this receiver reaches a very high standard, and those who are not fortunate in having supply mains available need no longer feel that they are excluded from the enjoyment of a type of performance at least equal to that which mains users can buy for 15 guineas.

Next Set Review—

COSSOR MODEL 364

UNBIASED

Stable Information

LATELY I have been trying to get a job as floor sweeper in a wireless factory but have so far failed to pass the necessary rigid tests. My object is to find out exactly what sort of sets the manufacturers have got up their sleeves for the approaching exhibition.

In the meantime I have been spending a good deal of time hanging round the employees' entrance of the various factories, endeavouring to get the desired information by means of spying, coupled with a little judicious bribery and corruption.

The information I have gained so far has been very meagre. To tell the truth I have gleaned only one piece of information, this being obtained from a seedy-looking underpaid publicity expert who

The price of his honour.

demanded a good deal of intoxicating liquor as the price of his honour. The information is to the effect that we are likely to see, in the case of some manufacturers, a return to the old practice of supplying the loud speaker as a separate unit from the set.

Ever since the time, some four years ago, when set manufacturers allowed the cabinet makers to dictate their policy in this respect, my whole soul has revolted at being expected to purchase a loud speaker when I wanted only a receiver.

I notice, by the way, that two or three weeks ago the Editor put in a plea for this very thing. I can only conclude from this that he must have had a surreptitious look at some rough notes I made in the public house and left in the pocket of my overcoat which I hung up to dry in his room on a recent wet day. Obviously, of course, his idea is to take kudos for having suggested them, when they do actually appear at the exhibition.

Highly Indignant

BEFORE I forget it, I want to say that I consider the B.B.C.'s effort at the Derby to have been by far the best that they have so far staged.

It must indeed have been a true genius who thought of the idea of providing a realistic background of hoofs beating on the turf and the laboured breathing of hard pressed horses. It was, I suppose, done by means of gramophone records, specially recorded for the occasion, and mixed-in from the effects department.

A friend who was listening in to my set with me and to whom I put this viewpoint was, however, highly indignant, stating that in his opinion the B.B.C. ought not to deceive its listeners in this manner by fobbing them off with synthetic horses' hoofs, but should give them the real thing. It is a puzzle to me how some minds work and I am sure I don't know what he thought they ought to have done; filled a studio with half-a-dozen horses marking time under the orders of a sergeant-major, I suppose.

Leg Rests, and All That

ALL sorts of things seem to be produced by our hard-working radio manufacturers in their untiring efforts to mitigate the hard lot of those who, for lack of the sixpence or so necessary to secure an evening's entertainment at the local hothouse, are compelled to listen night after night to the B.B.C.'s programmes.

One of the most ingenious of these devices is the comfortable leg-rest made by one well-known firm of wireless cabinet makers; but they now have, as competitors, a big firm of HT battery makers, who have produced a quite different article for this same purpose of enhancing the comfort of listeners.

I refer to a miniature electric fan resembling in almost every detail an ordinary electric torch and designed to be driven from a torch battery. This device has, I am secretly informed, been produced especially to cool the fevered brows of wireless journalists and others who, as I have already mentioned, are compelled for one reason or another, to listen to everything that the B.B.C. churns out.

Compelled to listen.

There are other uses which I could suggest for the fan such as that of a pocket autogyro or helicopter to enable exhibition visitors to make their escape from ground floor to gallery, or vice versa, when hard pressed by the throng. There is a great doubt in my mind, however, as to whether the exhibition authorities will allow the firm to exhibit this product at Olympia, even though it appears to have been especially designed for radio listeners.

A couple of years ago electric clocks were banished from several stands on the grounds that they were not wireless, in spite of the ingenious plea that they were intended for the purpose of enabling listeners to tell whether it was a fault at the power station or merely another valve failure, or breakdown of the set, which had caused the programme to cease abruptly.

By

FREE GRID

Most probably it was the nasty innuendo conveyed in this raison d'être which led to their being banished by the R.M.A., for it was noteworthy that the leg-rests, which surely must be considered still less as "wireless," were allowed to remain.

A Boring Business

IT is well known that wireless is of the same nature as heat and light waves, the only difference being one of wavelength. The tendency of late years has been steadily in a downward direction, and the cross-Channel telephony service using a wavelength of seventeen or eighteen centimetres is the lowest yet achieved in commercial work. Low as it is, this is a far cry from heat waves, which start at something about a tenth of a millimetre, I believe.

Nevertheless, many earnest experimenters have for long been endeavouring to bridge the gap between the two, and at last somebody in Canada claims to have succeeded in producing heat waves by means of wireless technique. He states that he has built a small portable beam transmitter which, while having a range of only a few yards, does, nevertheless, represent an unparalleled achievement.

In his home town there is being held a large exhibition with all the fatuous exhibits common to such affairs, including statues executed in butter. Our hero has been mingling with the crowd and amusing himself and the spectators by directing his beam against the statues, boring holes in them, and finally destroying them altogether, to the complete mystification of the officials.

Unfortunately for him, in an over-excess of zeal he accidentally directed his little beam against the back of the neck of a burly Canadian farmer. Still more unfortunately, the burly one, with that astonishing luck and complete lack of logic often associated with the technically ignorant, spotted the transmitter, and immediately connected it with his sore neck. The sequel is now waiting the attention of the Canadian Courts.

Design of Output Chokes

The Use of Gapped Cores for Windings Carrying Both AC and DC

A FULL treatment of the behaviour of the magnetic core material of coils when carrying both AC and DC simultaneously. It is shown that, while the prejudicial effect of the polarising DC may be easily overcome in intervalve transformers, special design is necessary in the case of output chokes.

THERE are a number of important practical instances in transformer operation where a direct current is superposed upon the alternating components, and it is this class of problem which we propose to treat now. We commence by a short outline of the methods used in the laboratory to obtain experimental data regarding the influence of DC superposed upon AC magnetisation. Although much data is available concerning either of these states individually, there has been little information published upon them collectively.

Suppose we have a number of ring stampings of the type illustrated in Fig. 1 (*a*) over which are wound (1) an inner coil of short length, (2) an outer coil covering the whole length. If an alternating current of sine wave form is passed through the outer winding and a sensitive voltmeter—with amplifying apparatus, if necessary—is connected across the inner one, it will register a reading corresponding to the current from the alternator of Fig. 1 (*b*).

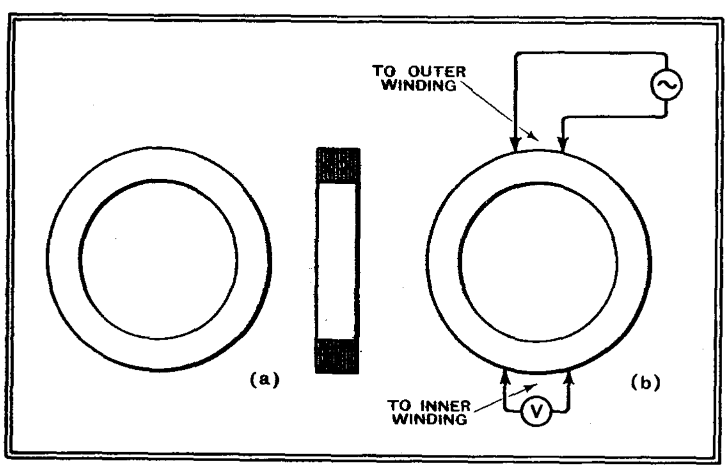


Fig. 1.—Annular core stampings, and connections for investigating magnetic condition of the core under AC magnetisation.

The magnetic state of the iron can be represented by a hysteresis loop of the form shown in Fig. 2. The loop is a symmetrical one, the two parts corresponding to the positive and negative half-waves of the current being identical—except, of course, as regards relative position to the vertical axis. These are shown by the thick and dotted lines respectively. To obtain the effect of superposed direct-current magnetisation, a number of cells can be connected in series with the alternator. The cells are short-circuited to alternating current by means of condensers as shown in Fig. 3.

The effect of the direct current magnetisation is to cause a steady magnetic flux in the iron circuit. Its influence will be to polarise the core, and, therefore, to reduce the freedom with which the tiny magnets, of which we imagine the core to be composed, turn round during each cycle of the current. In virtue of this constraining force we should expect the magnetic response, or variation in flux density with alternating currents, to be less than that without polarisation. Unfortunately, for practical work our belief is justified, and the variation in flux density for a given alternating current steadily falls with increase in the direct-current polarisation.

To illustrate this effect we make reference to Fig. 4. The loop ABCDEF is that which is obtained by a pure alternating current of large magnitude, whilst the loop HK is obtained with a small value of AC. In the latter case the variation in the flux density is ON and the variation in magnetising force due to the AC is OG. The ratio of these two "quantities," namely, ON/OG, is known as the magnetic permeability with pure AC. Now we imagine the large AC to be switched on and suddenly stopped at X, the value thereafter being maintained constant by a battery. Then the small AC of the same value as that required to give the loop HK is applied, the complete circuit being that shown in Fig. 3. The hysteresis loop is now that indicated at XY (Fig. 4). Its total horizontal width is identical with that of HK, i.e., LG, but the depth XM is a good deal less than ON = GK. Since the depth is a measure of the flux variation, it follows that the response of the iron at X is less than it was with pure AC round the point O. Since there is a steady flux in the iron, that due to the AC is relatively an increment or a decrement. Thus the ratio XM/YM is known as the incremental permeability ($\mu\delta$).

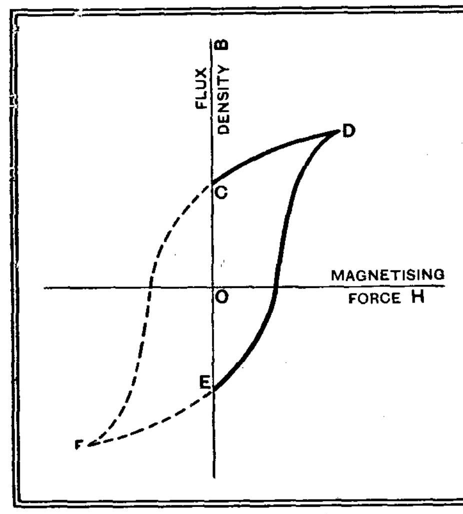


Fig. 2.—A hysteresis loop representing magnetic condition of the closed iron core shown in Fig. 1 (a).

The influence of the polarising force on the incremental permeability is shown very clearly in the curves of Fig. 5. These curves apply to the special alloy known by the trade name "Radiometal," which is used very extensively for iron-cored apparatus incorporated in radio receivers. The lower curve is for a low degree of alternating current magnetisation and the upper for eight times the value. The units are given as "gauss," this being the name of the great applied mathematician, K. F. Gauss, of Brunswick (1777-1855). Calculation of the magnetising force is effected by using the formula $H = \frac{1.257nI}{l}$ gauss, where n is the number of coil turns evenly wound on the iron ring, I is the current in the coil in amperes, and l is the mean length of the iron core. The polarising magnetisation due to direct current is calculated from the same formula.

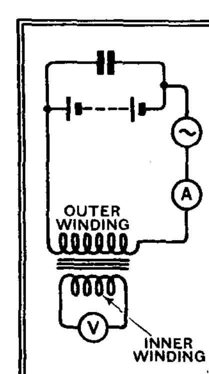


Fig. 3.—Circuit for investigating magnetic properties when both AC and DC currents are passed through the windings.

From Fig. 5 we see that when the alternating current magnetisation is held constant at 0.05 gauss, the incremental permeability steadily falls from 1,900 at zero polarisation to only 480 at 2.0 gauss. For a larger AC magnetisation, namely, 0.4 gauss, the corresponding

Design of Output Chokes—

values of the incremental permeability are 4,500 and 500, this being a ratio of 9 : 1. In fact, the incremental permeability in both cases is substantially the same for large DC polarisation.

It follows from this experimental data that if we designed a transformer to work with an AC magnetisation of 0.05 gauss, but no DC, i.e., a parallel-feed type, the inductance with a polarising current (due to an anode feed) would fall.

As a concrete example, suppose that the inductance of a parallel-feed transformer with an AC magnetisation of 0.05 gauss at 50 c/s is 80 henrys, what is its value when the anode-feed current is passed through the primary winding, thereby causing a steady uni-directional magnetisation of 1.0 gauss? From Fig. 5 we find that the incremental permeability with zero DC is 1,900, whereas with DC

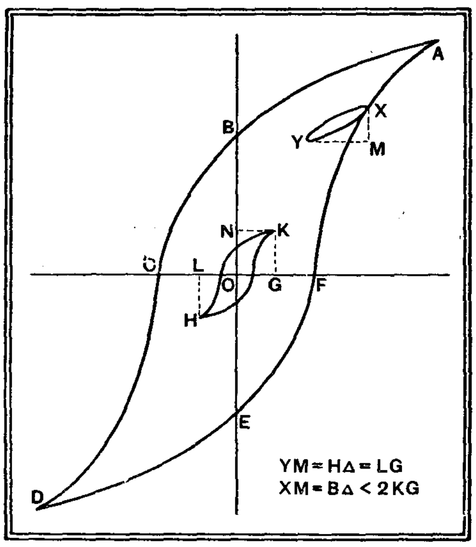


Fig. 4.—Hysteresis loops for small and large values of alternating current.

it is 940. Hence the inductance is now $\frac{80 \times 940}{1,900} = 40$ henrys approximately, which is one-half the value for the parallel-feed transformer arrangement.

This illustrates very forcibly the necessity for employing a parallel-feed circuit with transformers using Radiometal. When the higher permeability alloys (Mumetal and the like) are used, the reduction in incremental permeability with DC polarisation is more striking still. Whereas, at a pinch, Stalloy and Radiometal-cored transformers can be connected directly in the anode circuit of a valve, it is not possible to do so with transformers having Mumetal or Permalloy cores.

The parallel-feed circuit for inter-valve transformers is illustrated in Fig. 6 (*a*). As we have seen above, the use of the resistance R and condenser C enables a comparatively small transformer with a core of high-permeability alloy to be used. But we cannot treat the output transformer from the power valve to the loud speaker in quite the same way. Here it is imperative to get as many volts across the anode-filament space of the valve as the high-tension source can supply. If a resistance of 30,000, or even 10,000, ohms were connected, as shown in Fig. 6 (*a*), the volt drop with a power valve would be much too large. It is essential, therefore, to replace the resistance by something which drops volts when the current alternates, but does not do so when the current is uni-directional. Also, the said something must pass the steady anode-feed current of the power valve. Obviously, a low-resistance choke is called for, and this well-known accessory is used in practice. For the present we can assume that a choke of about 20 to 30 henrys will be sufficient for average purposes (Fig. 6 (*b*)). It will offer sufficient impedance over the range 80 to 5,000 c/s to divert the major part of the alternating current through the loud speaker.

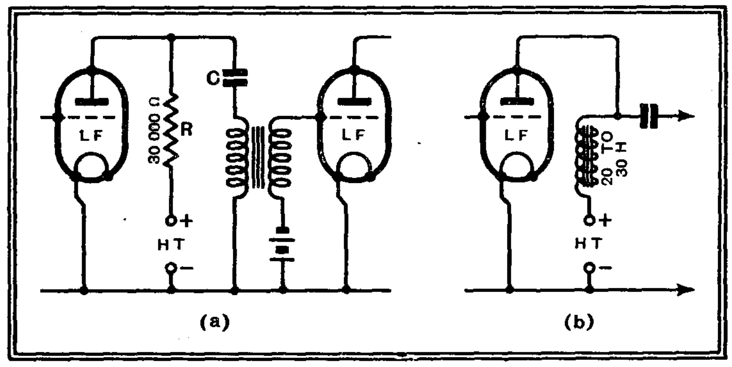


Fig. 6.—Circuits for resistance-fed transformers and choke-fed loud speakers.

We have already seen that the influence of polarisation due to a steady current is to reduce the inductance. Since the choke will have a large number of turns and the anode feed current is large (especially if the valve is operated on 400 volts) the inductance will fall considerably. This necessitates a bulky choke unless some way can be found to obviate the difficulty. The way out is obtained by inserting a short air-gap in the magnetic circuit of the core. The reason for this is not very

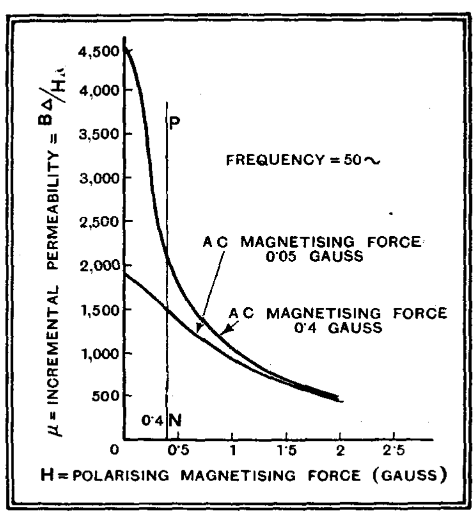


Fig. 5.—Incremental permeability for Radiometal strip, 0.015in. thick.

obvious, so we now proceed to elucidate the matter.

If we have a magnetic circuit, whose cross-sectional area can be considered uniform (for the sake of simplicity), it can be likened to an electrical one. The latter has resistance, and an electromotive force is needed to send a current through the resistance. Similarly, a magnetic circuit is said to have reluctance, and a magnetomotive force is required to send the magnetic flux round the circuit. When a magnetic material is very permeable it offers little reluctance, so a large flux is obtained in the core. With magnetic materials like iron, steel, Mumetal and Permalloy, the flux is very large compared with wood or other non-magnetic substances. These, in common with air, have a permeability of unity, whereas Mumetal has a permeability reaching tens of thousands.

It follows that the reluctance of a magnetic circuit of, say, Radiometal, would be materially increased by putting an air-gap in it. For if the permeability of the metal were 4,000, whilst that of the air is 1, the reluctance of 1 cm. of air would be 4,000 times that of 1 cm. of the metal.

Length of Air Gap

Consequently, to avoid increasing the reluctance of the complete magnetic circuit too much, the length of an air-gap in it must be quite small. When the magnetic circuit has an air gap it is easy to see that the reluctance to variations in flux due to an alternating current also increases. From Figs. 5 and 7 we see that, except near the origin, where H is small, the DC permeability exceeds the incremental permeability appreciably. Hence, the effect of an air-gap on the former will be greater than it is on the latter. An approximate numerical example will make the position clearer.

Suppose we have a magnetic circuit of the type illustrated in Fig. 1 (*a*), there being no air-gap, and that there is a direct current in the outer winding which causes a steady magnetising force H = 0.4 gauss. Turning to Fig. 7, we find that the permeability of the core, which we assume to be the special alloy Radiometal, is

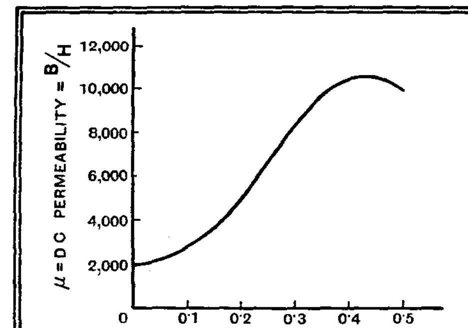


Fig. 7.—Direct-current permeability curve of Radiometal.

Design of Output Chokes—

approximately $\mu = 10{,}000$ when $H = 0.4$. We now require the formula $\mu = B/H$ or $B = \mu H$, where B is the number of lines of magnetic flux passing through every square centimetre of the core, i.e., the flux density per square cm. Thus, $B = \mu H = 10{,}000 \times 0.4 = 4{,}000$ lines per sq. cm.

If an air gap is inserted in the core a certain proportion of the available magnetising force H will be utilised in overcoming its reluctance. For simplicity, let us assume that the reluctance of the gap claims 0.35 gauss, whilst the Radiometal takes 0.05. The flux density in the core is now much less than before, and its value can be obtained from Fig. 7 if we assume that all the flux passes through the air gap and does not leak out at the edges. In practice leakage would occur, but we need not complicate matters by taking it into consideration now.

From Fig. 7 when $H = 0.05$ the permeability is $\mu = 2{,}000$, and since $B = \mu H$ its value is only 100 lines per sq. cm., or 1/40th the value in the absence of the air gap. This large reduction in flux is due to the high value of the permeability of radio metal compared with that of air (in the gap).

We have now to consider what happens in the case of superposed alternating current magnetisation. When there is no air gap the AC value of H can be taken as 0.4 gauss to correspond with the curve of Fig. 5. The incremental permeability as read off the curve is 2,000, which gives a flux density $B = \mu H = 2{,}000 \times 0.4 = 800$ lines per sq. cm., this being only one-fifth the value for DC magnetisation or for alternating magnetisation in the absence of the latter. In this case, therefore, the effect of polarisation is to reduce the flux in the ratio 5 : 1. With an air gap the proportion of available H dropped thereon is different from the DC case, because the DC and incremental permeabilities are unequal. The incremental permeability is less than the DC value, so the value of H available for the metal will not be exactly 0.05 gauss, but it will be some value of this order of magnitude. This can easily be shown from the incremental permeability curve of Fig. 5. The value of the AC flux density is, therefore, about 100 lines per sq. cm. Thus, the influence of the air gap is to reduce the DC flux density in the ratio 40 : 1, but the AC flux density only in the ratio 5 : 1. In other words, the influence of the gap in reducing B is much more marked for the polarisation than for the alternating current superimposed thereon.

Thus, when the proportionate value of H dropped on the gap exceeds that required for the core, the influence of the gap is to reduce the effect of polarisation in a marked degree. Under this condition the inductance of the choke to AC will not vary a great deal, and the polarising current, provided, of course, the limits of variation are not too wide. In practice, it is necessary to design a choke whose inductance shall not fall below a certain limit when a specified polarising current passes through the winding.

It may be of interest to calculate the *effective* permeability of the core in the above case of DC magnetisation. Although the permeability of the Radiometal itself is 2,000, the influence of the air gap is such that the complete magnetic circuit behaves as though it were uniform throughout, but of much lower permeability than that of the Radiometal and higher than that of air (unity). The total H is 0.5 gauss, and the flux density throughout the circuit is $B = 100$ lines per sq. cm. Now we define the effective permeability as $\mu e = B/H$ (under the above conditions), so $\mu e = 100/0.5 = 200$, this being ten per cent. of the value without the gap. Thus the gap reduces the ordinary permeability by 90 per cent.

(To be concluded.)

Short-wave Broadcasting

RECENT remarks upon the subject of short-wave programme-value have brought forth a few interesting letters from readers, most of whom state emphatically that they *do* often switch on at a given time to hear a given item. With some, in fact, it is quite a habit.

The one and only obstacle in the way of an extension of this desirable habit is the absence of reliable advance information about programmes. Empire listeners to Daventry, of course, are excellently served in this way; British listeners to America, for instance, are not looked after at all.

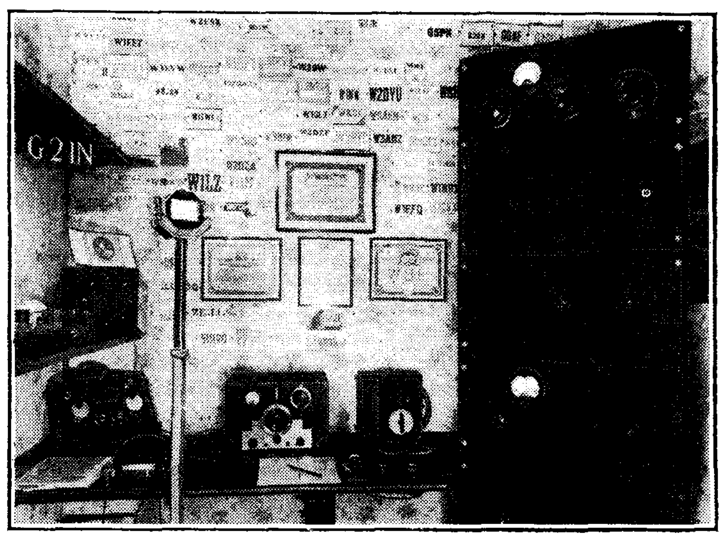
Actually, of course, the average short-wave listener is making use of programmes that are not really meant for him at all; and he may consider himself lucky to have them available, without worrying about what is coming next!

The result, of course, has been something very near to chaos. The 49- and 31-metre bands have occasionally sounded like the medium-wave broadcast band at its worst. The amateur bands on an "all-wave" set are practically hopeless, too, but most amateurs, in this year of grace, use something fairly selective in the way of receivers, and are not unduly perturbed.

"Unusual" Stations

Among the more unusual broadcast stations logged during the past fortnight are the following: HPF, Panama City, on 20.7 metres—presumably a commercial station doing some test relays of broadcast; HJ4ABA, Colombia, on 25.6 metres; CMHB, Cuba, on 29.5 metres; VLK, Sydney, on 30.75 metres.

Above the 31-metre band, and below the 49, the following have been logged: COH, Havana, 31.8; HAT, Budapest, 32.9; HC2AT, Ecuador, 35.8; JVP, Japan, 40.0; CR7AA, Angola, 41.8 (in the amateur band); and TIEP, a Costa Rica station on 44.71 metres.



STATION G2IN, owned and operated by Mr. W. Johnson, 6, Denmark Road, Southport, works on 5, 20, 40, 80 and 160 metres. The W.A.C. and W.B.E. certificates are held and the station carries on regular two-way telephony tests with the U.S.A. Special 5-metre transmissions will be carried out on Sunday next from 10 a.m. to 5 p.m.

It is good to see that others have been taking up the whole question of Morse interference with short-wave broadcasting; many, however, overlook the fact that fully 30 per cent. of the broadcast stations work on wavelengths to which they are not really entitled, and that any interference from which they suffer is really their own fault.

A short-wave receiver, really carefully designed with band-spread to cover just the 49-, 31-, 25- and 19-metre bands would hardly pick up a single Morse signal. Unfortunately, quite a number of interesting broadcasting stations would also be lost to it.

The same sun-spot that is being blamed for our unflaming June this year is also said to be responsible for the abnormally good short-wave conditions, which show no sign of abating. We really have had a taste of "1928" conditions once more, but, this time, all the transmitters are more powerful and the receivers more sensitive. (With regard to selectivity it is better to maintain a discreet silence.)

One needs two receivers and four ears to keep pace with all the stations that suddenly appear on the most unlikely wavelengths and sink back into oblivion; but the catching of them is one of the most fascinating aspects of short-wave reception as a hobby.

A calibrated receiver is an absolute necessity these days. Fortunately there are so many "known" stations on which one can work that accurate calibration is quite an easy matter, provided that a band of reasonable width is covered on each coil. One receiver recently encountered was said to tune from 6 to 60 metres on one coil with a 0.00035 condenser. In view of the fact that the minimum capacity of the latter proved to be about 45 mfd., that "six metres" (with a three-turn coil!) seems a little doubtful.

MEGACYCLE.

★ Listeners' Guide for the

Outstanding Broadcasts at Home and Abroad

"THE IMPORTANCE OF BEING EARNEST," Oscar Wilde's delightful comedy, has already proved to be an ideal microphone play. It will be repeated on July 2nd and 3rd. This photograph recalls the "Old Vic" production of the play and shows (left to right) Dr. Chasuble (Charles Laughton), Ernest, Cicely, Jack, and Miss Prism.

MAN-HUNT TO MUSIC

LAST week we tasted the *hors d'œuvres* in the "Mystery of the Seven Cafés," Sydney Horler's secret service story with music. To-night we begin the real feast, and, if we are not misled, will find ourselves in a certain café in Paris in company with Tiger Standish and some less pleasant characters.

Although this is a serial, it is emphasised that listeners will obtain entertainment from the music, specially orchestrated by Walford Hyden, while ignoring the man-hunt in this background.

Perhaps the B.B.C. will soon graft man-hunts on to the "Prom" concerts and so please two audiences at once.

SLAVONIC MASS

Wireless World readers who take an interest in the acoustic environment of an orchestra may like to know that the big Maida Vale studio is being used to-night (Friday) for the performance of Janacek's Slavonic Festival Mass by the B.B.C. Orchestra conducted by Sir Henry Wood. The principals include Laelia Finneberg and Walter Widdop.

CREATIVE ARTISTS

IT is sometimes debated whether the creative artist is the best exponent of his own work. Two interesting opportunities to judge the question occur on Sunday evening in the Regional programme. At 6 p.m. there will be a recital by Percy Manchester (tenor) of songs by Teresa del Riego, with the composer at the piano; at 9.45 a short story, "Miss Ambrose Reviews Her Enmity," will be read by its author, V. C. Clinton-Baddeley.

SIR THOMAS BEECHAM

WITH all its faults, Sir Thomas Beecham loves broadcasting still, to judge from his readiness to conduct before the microphone. On Sunday evening Sir Thomas will be in Brussels directing the concert by the London Philharmonic Orchestra in the Palais des Beaux Arts. The concert will not be broadcast in Belgium, but two items, Arnold Bax's "The Garden of Fand" and Elgar's "Enigma Variations," will be relayed by the B.B.C.

STAG PARTY

STANELLI'S "Stag Party" on July 4th, as its name implies, will have a cast of men only, and among the well-known variety stars brightening the atmosphere in Stanelli's "flat" will be Norman Long, Denis O'Neill, Leslie Sarony and Leslie Holmes, Sydney Jerome and, naturally, Stanelli.

There is only one answer to this sort of thing: a "Hen Party," and this may be expected soon.

CARROLL GIBBONS

IT will come as a surprise to many to learn that Carroll Gibbons and His Boy Friends will broadcast for the first time on Monday evening, July 1st. They are a well-known gramophone combination featuring pianoforte arrangements of what might be called high-class dance tunes, but they have never appeared together in a broadcasting studio. The programme at 8 p.m. will be presented by Austen Croom-Johnson.

ERNIE LOTINGA

HALF an hour later will come Ernie Lotinga's "Ladies' Outing." Many attempts have been made to persuade the famous comedian to broadcast, but only now has he acceded to the requests of the B.B.C. programme sleuths.

MODERN OPERA

ONE of the most distinguished casts of singers ever collected by the B.B.C. is to take part in Serge Prokofief's opera, "The Love for Their Oranges," to be broadcast at 8 p.m. on Thursday next (National). Arthur Fear appears as the King of Clubs, Heddle Nash as the Prince, and Constance Willis as Clarisse, and other soloists include Walter Widdop, Samuel Worthington, Oda Slobodskaya and Ina Souez.

THE DOLMETSCH FAMILY, famous as performers on old musical instruments, will be represented in the National programme on Wednesday at 10.15. Rudolf Dolmetsch will play the harpsichord and recorder, Millicent Dolmetsch the viola da gamba and recorder, and Carl Dolmetsch the recorder. Diana Poulton will play the lute.

Week

OSCAR WILDE COMEDY

FEW drawing-room comedies have worn so well as Oscar Wilde's "The Importance of Being Earnest," and its excellence as a broadcasting play has never been doubted since it was first adapted for the microphone in 1930. The play depends largely on its verbal wit, which is of shimmering brilliance, and less on the plot. The cast collected for the two performances next week (National, July 2nd; Regional, July 3rd) will include Jack Melford, who should be an admirable Algernon, while the important parts of Cicely and Gwendoline will be played by Joan Duan and Agatha Carroll respectively.

MASCAGNI AS CONDUCTOR

A SPEAKING CHOIR will be heard in Breslau's broadcast of "Tobias Wunderlich," a dramatic legend by Orther and Paqué, which figures in tonight's programme at 8.45. The station orchestra and soloists will be conducted by Koschinsky.

Mascagni, the famous composer, will conduct his own three-act opera, "Lodoletta," to be broadcast from Rome tomorrow evening (Saturday) at 8.40.

On the same evening at 8.45 Radio-Paris offers "Le Hulla," a lyrical tale in four acts. This is a modern opera composed by Marcel Samuel Rousseau, who won the Prix de Rome in 1905, and is now Professor of Harmony at the Conservatoire, Paris.

LIGHT OPERA

OPERETTAS during the next few days include Millar's "The Gallant Brigands" which Hilversum is giving tomorrow night (Saturday) at 7.55. On Thursday, July 4th, at 8.30 Paris PTT broadcasts "L'amour mouillé," an opéra comique in three acts by Varney; and on the same evening Poste-Parisien gives "Peauffin," words by Baugé, music by Mazellier. The orchestra will be conducted by the librettist.

THE BELGIAN KING

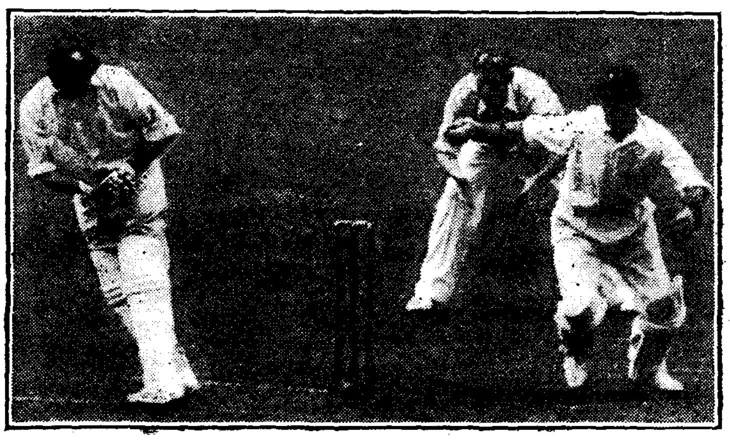
A DESCRIPTION of the arrival of H.M. the King of the Belgians at Mass on Sunday morning will be relayed from Brussels No. 1 at 11 a.m. Preceding this will be a relay of the Pontifical High Mass at 9.15.

"HAPPY WEEK-END"

THE week abroad is singularly rich in concerts. Tomorrow (Saturday) between 10.30 p.m. to 1.0 a.m. Berlin (Funkstunde) gives another "Happy Week-end Concert" provided by the Arno Berger Band and soloists. On the same evening Cologne relays a concert from the Terrace of the Royal Palace, Brühl, at 7 o'clock. At 9.30 Rome relays a concert from the Basilica of Maxentius, the conductor being Signor Bellezza, just returned from the Covent Garden opera season.

A Debussy Festival will be relayed by Paris PTT on July 2nd on the occasion of the ceremony at the Debussy Monument at St. Germain. The Félix Raugel Choir and National Orchestra will be conducted by Inghelbrecht.

ERNIE LOTINGA, wearing a characteristic expression. He makes his microphone debut on Monday and Tuesday.



ENGLAND v. SOUTH AFRICA Test Match commentaries are being given daily by Captain H. B. T. Wakelam. The above picture, showing Hammond being beaten by a ball from B. Mitchell, was taken during the first test at Trent Bridge.

STUDIO OPERA

As most of Germany's well-known opera houses are closed down during the height of the summer, the stations of the Fatherland are giving studio performances of operas. An example is "The Tailors of Schönau," a three-act comic opera by Jan Brands-Boys, to be broadcast at 8.20 on Sunday evening from Munich. The same evening at 8 p.m. Berlin gives Floto's opera, "Alessandro Stradella."

"ALL OUR OWN MAKE"

THE feud between the German broadcasting organisation and the gramophone firms has forced the broadcasters to make their own records. Listeners who wish to judge the quality of these records should tune in a special concert of Northern music from Stuttgart and Frankfurt at midnight on Wednesday next, continuing until 2 a.m., which will consist exclusively of the company's own records.

THE AUDITOR.

30-LINE TELEVISION

Baird Process Transmissions.
Vision, 261.1 m.; Sound, 296.6 m.

MONDAY, JULY 1st.
11.15–12.0 p.m.

Harry Hemsley showing Winnie a picture book; Kenneth Blain, the intelligent fool; Pinello and Viviani, comedy dancers; Joan Fred Emney, comedienne; Morgan Davies, songs, Sydney Jerome's Quintet.

WEDNESDAY, JULY 3rd.
11.0–11.45 p.m.

Ballet Carnival arranged by Lydia Sokolova, directed by Eustace Robb. Music by Schumann. Lydia Sokolova, Columbine; Idzikovsky, Harlequin; Algeranoff, Pantalon; Diana Gardiner, Papillon.

HIGHLIGHTS OF THE WEEK

FRIDAY, JUNE 28th.

Nat., 7.30, B.B.C. Military Band. 8.10, "Mystery of the Seven Cafés. 10.15, Janacek's Festival Mass by B.B.C. Chorus and Orchestra. Conductor: Sir Henry Wood.

Reg., 8, Organ Recital by Sir Walter Alcock. 9, B.B.C. Theatre Orchestra.

Abroad.

Berlin (Deutschlandsender) 8.45, Fairy Opera: "Das kalte Herz" (Lothar).

SATURDAY, JUNE 29th.

Nat., Test Match Commentaries from Lord's. ¶Songs by Haydn Wood. ¶"Out of Town Tonight." ¶B.B.C. Theatre Orchestra.

Reg., American Half-Hour. ¶B.B.C. Orchestra (Section C). ¶Ambrose and His Embassy Club Orchestra.

Abroad.

Hilversum, 7.55, Operetta: "The Gallant Brigands" (Millar).

SUNDAY, JUNE 30th.

Nat., Reginald King and His Orchestra. ¶Chopin Recital by Niedzielski. ¶Albert Sandler and Park Lane Hotel Orchestra. 9.30, Brussels relay: Sir Thomas Beecham and Philharmonic Orchestra.

Reg., 9, Part II of "The Messiah."

Abroad.

Paris (PTT), 8.30, Planquette Festival Concert with the French National Orchestra.

MONDAY, JULY 1st.

Nat., Test Match and Wimbledon Tennis Commentaries throughout day. ¶Carroll Gibbons and His Boy Friends. 8.30, Ernie Lotinga Revue.

Reg., Concert by B.B.C. Choral Society. ¶"The Number Seven" by Lord Ponsonby.

Abroad.

Munich, 8.10, Choral concert with 1,500 voices relayed from Augsburg Municipal Singing School.

TUESDAY, JULY 2nd.

Nat., Wimbledon Tennis Commentaries. 8, "The Importance of Being Earnest." ¶B.B.C. Orchestra (E).

Reg., 8, Ernie Lotinga Revue. ¶B.B.C. Theatre Orchestra.

Abroad.

Brussels I, 8, Orchestral Concert. Songs by Rachel Piette.

WEDNESDAY, JULY 3rd.

Nat., Wimbledon Tennis Commentaries. ¶"From One Dance Band to Another" (George Scott Wood and Mantovani). 10.15, Dolmetsch Chamber Music Recital.

Reg., 8, "The Importance of Being Earnest." ¶Pianoforte Recital by Max Pirani.

Abroad.

Strasbourg, 8.45, Symphony Concert from the Orangerie.

THURSDAY, JULY 4th.

Nat., Wimbledon Tennis Commentaries. ¶Henry Hall and B.B.C. Dance Band. 8, "For the Love of Their Oranges." ¶B.B.C. Theatre Orchestra.

Reg., Stanelli's Stag Party. ¶B.B.C. Military Band.

Abroad.

Radio-Paris, 8.45, Gala Concert of French Music by National Orchestra and Raugel Choir.

New Apparatus Reviewed

Recent Products of the Manufacturers

Multi-range Test-all Meter for DC measurements.

TEST-ALL METER

THIS is a comprehensive DC test instrument covering a range of voltage and current most commonly met with in battery-operated receivers. The two voltage ranges are 0-6 and 0-150 respectively, and the current range 0-30 mA. Valve sockets are fitted on the case for inserting a valve, should it be suspected of a faulty filament, while two sockets are provided for the leads to enable the instrument to be used as an ohmmeter or for continuity testing of circuits or of components. The small battery required for valve and continuity testing is housed in the case, so that the instrument is entirely self-contained.

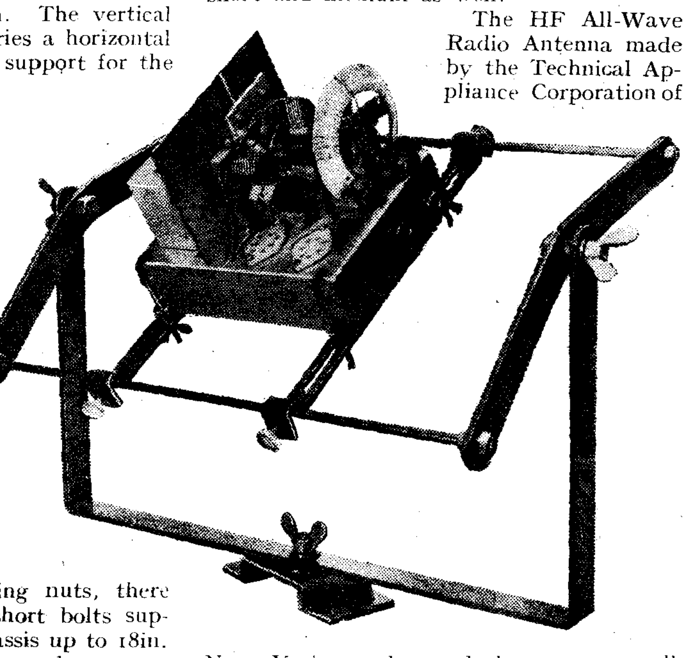
The instrument has a moving iron meter, and on test was found to be quite accurate on both voltage and current ranges. The resistance measurements were not quite so reliable, but as the scale is small and no provision is made to compensate for any change in the battery voltage this must be regarded as giving approximate values only. It is, nevertheless, a very useful range.

The Test-All Meter is obtainable from "Jack's," 120, Chatsworth Road, Clapton, London, E.5, and the price is 15s.

LYSTAN CHASSIS CRADLE

THIS useful accessory is a strongly made cradle for holding wireless chassis undergoing repair or overhaul. It consists of a U-shaped bent-iron frame mounted on a cast-iron base plate which is drilled for screwing to the workbench. The vertical frame is rotatable, and carries a horizontal frame which serves as the support for the chassis. This frame is rotatable also, thus the cradle enables repair work to be carried out with the chassis tilted to the most convenient angle for every operation.

In order to accommodate different sized chassis, the top frame is provided with adjustable rails, each having two long slots for the holding-down bolts. These are L-shaped and fitted with wing nuts, there being four long and four short bolts supplied with each cradle. Chassis up to 18in. long and about 12in. wide can be accommodated.



Lystan repair cradle showing a small chassis in position.

It will readily be seen that the use of this cradle avoids the necessity to pack wood blocks under the chassis whenever it is removed from its cabinet and reversed for access to the underside. Fragile and projecting parts cannot therefore be damaged, and, furthermore, the chassis is held rigidly in any position desired.

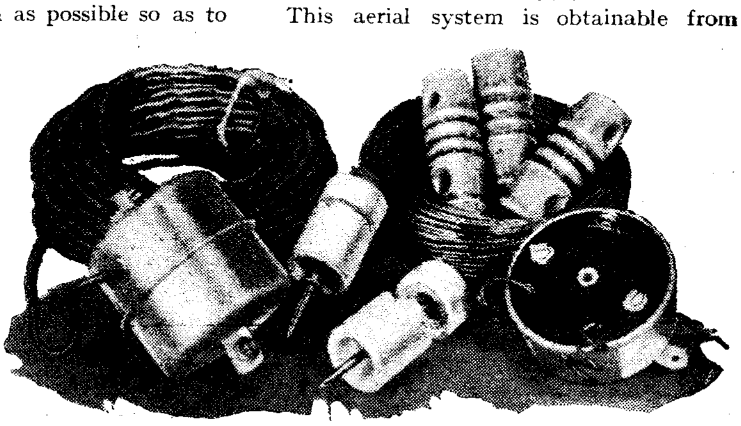
It is a most useful accessory for the service engineer, and the price complete is 24s. 6d.

The makers are Lystan Products, Ltd., 33, St. Andrew's Road North, Lytham St. Annes, Lancs.

NEW ALL-WAVE AERIAL

IN the U.S.A. where all-wave receivers have been in use for some considerable time, much progress has been made in the design of special aerial systems for minimising the effect on reception of local electrical interference. In all such schemes the aerial is raised as high as possible so as to bring it above the interference zone and the signals are conveyed to the receiver by a feeder system that does not form an integral part of the aerial, but serves only as a link between aerial and set.

Such arrangements as a rule are limited in the wave-range over which they are effective. Normally they cover the short-wave range only or in another form the medium-wave band, but few embrace short and medium as well.



Kit of parts for the HF All-Wave Radio Antenna.

The HF All-Wave Radio Antenna made by the Technical Appliance Corporation of New York can be used, however, on all broadcast wavelengths and consists of two aerial spans each 40 to 50 feet long joined in the centre by a special coupling unit from which a twisted pair of wires, forming the feeder, is brought down to the receiver. This cable terminates in another coupling unit that must be located close to the receiver. On it is a switch for matching the impedance of the feeders to the set. It has three positions, one and two give coupling ratios, whilst the third converts the system into a normal "T" type aerial which will be found best for long-wave reception.

The two halves of the aerial span need not be in line if space does not allow, and they may be arranged at right angles; the length of each is important and the dimensions given in the instructions must be adopted. The down-lead cable can be any length, and should be brought down as near as possible at a right-angle to the horizontal span; the aerial proper may be located well away from buildings or raised above the interference zone.

This aerial system is obtainable from R. A. Rothermel, Ltd., Rothermel House, Canterbury Road, Kilburn, London, N.W.6, and the price is 37s. 6d.

The Thyratron

IN connection with the article in our issue of May 31st, entitled "The Thyratron Inverter," our attention has been drawn to the fact that the word "Thyratron" was registered by the British Thomson-Houston Co., Ltd., some years ago as a trade mark in respect of electric discharge tubes. The name should not, therefore, be used to describe discharge tubes other than those manufactured by this company.

"Glorious Adventure At Home," published by Philco Radio and Television Corporation of Great Britain, Ltd., Aintree Road, Perivale, Greenford, Middlesex, whilst announcing the new Philco 1936 "Empire Receiver," an all-wave superhet covering a range of 17 to 2,068 metres, is more in the nature of a beginner's guide to short-wave reception. It deals briefly with the history of short waves, describes why they are received over such vast distances, and concludes with a comprehensive list of the world's short-wave stations with times of working, and there is a useful world map showing their location.

"Glorious Adventure At Home" describes in easy-to-follow non-technical language many points that often puzzle the beginner and so gives an added interest to short-wave listening. Copies cost 2d. each.

BROADCAST BREVITIES

By Our Special Correspondent

How Many Schools?

SIR JOHN REITH'S recent complaint anent the apathy of educationists to the B.B.C.'s own efforts in the teaching line prompts one to ask just how many schools are taking the transmissions.

The same old tantalising question dogs all departments of the B.B.C.; no one knows the size of his broadcast audience, but the school broadcasting service has, perhaps, obtained fairly reliable figures. These are given in the new pamphlet, "Broadcasts to Schools," covering the period September, 1935, to June, 1936.

Unknown Multitude?

It is known that at least 1,200 schools have been listening to the travel talks. Three hundred infant schools enrolled last autumn in order to listen to the course on "Music and Movement." Altogether 4,700 annual-report forms relating to the various courses were received from schools, but there is little doubt that very many schoolmasters making use of the transmissions do not establish contact with the B.B.C.

Loud Speaker Sense

In the case of many private schools the teacher's own apparatus is employed, and in not a few cases school reception comes from a line from the teacher's private receiver next door. Sometimes reception is good and sometimes . . . well, the B.B.C. touring technicians have some sad tales to tell.

Fortunately (or, perhaps, unfortunately), many children are accustomed to poor reception at home and their little ears are acclimatised to, and can make sense of, the most woofy and boomy educational (*sic*) talk.

Programme Cutting

THE recent pother on the cutting of broadcast programmes to suit the clock has not been smoothed out by B.B.C. explanations that the cutting is done "artistically." Even murder can be artistic.

But there is an important point of view which the public may overlook.

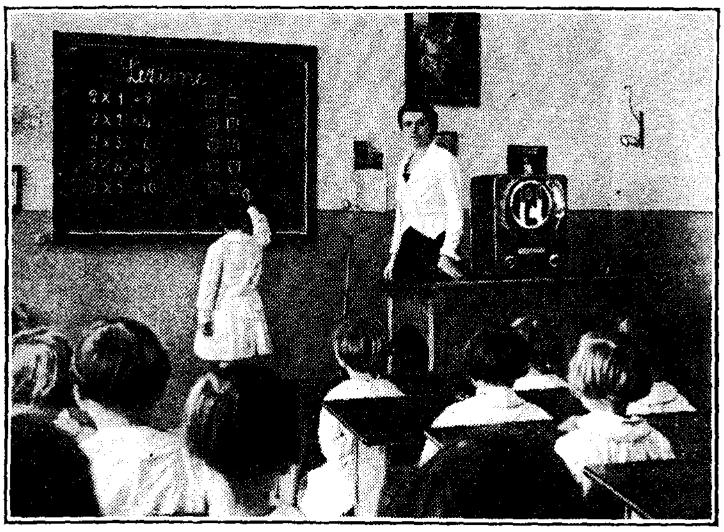
"We have," a B.B.C. official told me, "to consider *two* audiences—those listening at the moment and those who are waiting for the next item. We want to please both.

Under-Timing

"As a rule programmes of about an hour are under-timed. In a musical programme we allow five minutes in the hour to permit of the vagaries of the conductor's interpretation. Musical broadcasts in the studio often *are* cut; it is when we are dealing with an outside broadcast, such as opera, that we are not in a position to fade out the performance when the programme time is exceeded."

From Tape to Disc

RE-RECORDING is saving space and money in the B.B.C.'s new Recording Branch at the converted skating rink in Maida Vale. Magnetised steel tape, although it probably gives the most faithful sound record, is expensive to buy and bulky to keep. Discs are relatively efficient, cheap and easy to store on shelves. So the engineers are now transferring speeches by eminent people, commentaries, and important ceremonies from tape to disc. The discs are put away, while the tapes are demagnetised for future use.



SCHOOL RADIO. Broadcast lessons are warmly encouraged by the Italian Government. In this classroom scene the set is a special "Radiorurale" model—a 5-valve superhet—distributed to schools at a reduced price.

New Studios

Before the end of the summer four additional studios will be ready at Maida Vale. Two of them are for concerts by large orchestras. One is being constructed especially for Henry Hall and the B.B.C. Dance Orchestra, and another, rather smaller, for general purposes.

Spoilt Records

DANISH "O.B." engineers had the bright idea recently of recording a version of Shakespeare's "Hamlet" from Kronborg Castle, near Elsinore. So a party of players and engineers set off from Copenhagen one afternoon. When night came microphone leads hung from windows and doors, while the torches of the engineers flickered about the echoing corridors. On the bastion Hamlet was ready to meet his father's ghost.

The start signal flickered on the control panel. Came Hamlet's question: "What time is it?" and Horatio's "About midnight." All was still as the record revolved, but bursting into the mediæval silence came the bark of a racing motor-boat, and the ghost, lighting a thick, black cigar, declared with a sigh that he was ready to start all over again.

It was not until dawn that, after many attempts, the scene was recorded in a manner which would not have shocked the author of the play.

Do You Know?

MANY an honest man does not know in which B.B.C. region he lives, moves and has his being. The lines of demarcation have recently been redrawn with meticulous care. Take, for instance, the North Region. This includes the Isle of Man, Northumberland, Cumberland, Westmorland, Durham, Yorkshire, Lincolnshire, Cheshire, Lancashire, as well as Derbyshire north of a line drawn from the Notts border just north of Heanor to the Staffordshire border just south of Ashbourne.

Yet I am told that there are bad men in Heanor who snap their fingers at the boundary and tune in North Region just as if it were their own.

An Extensive Region

Who would dream that Norfolk was in the London region? The official list of counties under London's jurisdiction is South Oxfordshire, Berks, Beds, Herts, Cambridge and the Isle of Ely, Norfolk, Suffolk, Essex, Kent, Middlesex, London, Sussex, Surrey, Hants, Bucks and Isle of Wight.

The Empire Orchestra

CAN the Empire listener determine whether the music coming to him on the short waves is real or recorded?

Listeners who have doubted the genuineness of the B.B.C. Empire Orchestra may be glad to know that its actual composition is now as follows: Three first violins, two second violins, two violas, two violoncellos, one double bass, one flute (doubling piccolo), one oboe, two clarinets, one bassoon, first and second horns, first and second trumpets, one trombone, drums, and pianoforte.

The Ceremony of the Keys

ON July 23rd listeners will again hear the Ceremony of the Keys relayed from the Tower of London.

The ceremony opens when the Chief Warder meets his Escort at the Bloody Tower, whence they proceed to the Visitors' Entrance Gate. On reaching the Bloody Tower they are challenged with the historic words: "Halt! Who goes there?" "The Keys." "Whose Keys?" "King George's Keys." They then proceed to the Main Guard. The Main Guard salutes the Keys and the Chief Warder, raising his hat, calls out: "God Preserve King George." The Guard answers: "Amen."

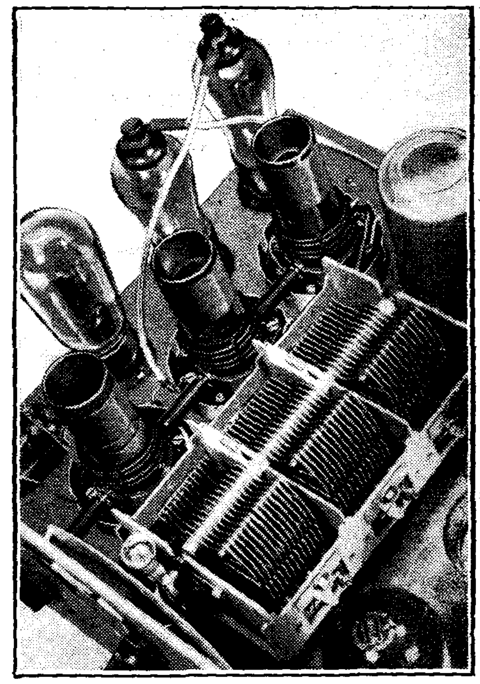
The relay finishes at 10 o'clock with the Last Post.

GANGING: *A Possible Compromise*

Provision of External Means of Alignment

By D. A. BELL, B.A., B.Sc.

THE author of this article does not suggest that the tuning arrangements of commercial receivers should be made more complicated. He points out, however, that errors of alignment must inevitably arise in a fully-ganged set, and shows in what directions the knowledgeable amateur might best improve performance by using a more flexible system of tuning.



A RECENT article in *The Wireless World*[1] pointed out some of the objections to the ganging of a number of tuned circuits—added cost and the probability of loss of performance due to small discrepancies in the matching of components. Apart from errors in initial matching, there is the difficulty of securing sufficient permanence of the tuned circuits. For example, the split end vanes of gang condensers have to be of specially tempered metal, so as to eliminate as far as possible any tendency for the plate to creep back to its original form after it has been bent in the process of matching up sections; then again a mains-driven receiver may attain a fairly high temperature when running, and repeated heating and cooling will tend to cause distortion of coil formers and possibly of trimming condensers. In reckoning the cost of ganging, therefore, one must include an allowance for the more exacting constructional requirements of components as well as for matching of coils and condensers.

This suggests that the difficulty would be eased if frequent re-trimming were permissible, but mounting the trimmers as controls on the panel would destroy both the necessity and the utility of matched circuits, and increase the complication of control. However, observation suggests there are a number of non-technical listeners who cannot accurately tune a single-control receiver without instruction (faith in the accuracy of station-marked tuning scales rather than in the evidence of their own ears is a usual source of trouble), if then it be granted that the listener must in any case *learn* how to tune his receiver, the argument in favour of over-simplification of control is largely invalidated. In the previous article it was mentioned that a frame aerial is particularly difficult to gang to other tuned circuits, and, therefore, possibly deserving of a separate control; in fact, a number of mains transportable receivers have employed the compromise whose more general use is suggested, namely, single-dial control of all tuning condensers with a separate trimmer on the panel for the frame circuit.

Coupled condensers[2] with variable trimmers are no novelty, and a particularly attractive form is the condenser assembly which has all moving plates rigidly mounted on a common shaft, but each set of "fixed" plates capable of moving through a small angle; there is then no separate trimmer with its associated wiring to add to the minimum capacity of the circuit. This method has been used in certain ship receivers having a number of tuned signal-frequency amplifying stages; a so-called "gang" condenser of this type also appeared commercially a year or two ago. (The latter was, I suspect, produced mainly from the point of view of low cost.) There is, however, one feature of modern design which is usually considered to *necessitate* permanently matched ganging, and that is the "band-pass filter." Since the tuning here is double-humped, or at least flat-topped, it is practically impossible to tune to the required setting by varying each circuit independently. The enthusiast might feel tempted to fit a tune-receive switch to reduce coupling of the filter circuits below the critical value for tuning, but this would not be satisfactory for any but the mutual inductance and "link" types of coupling. For, as shown in Fig. 1, the resonance curve of the latter two types is symmetrical about the resonance frequency *fo* of either of the two tuned circuits alone; but with any form of capacity or common inductance coupling (Fig. 2) the filter curve is not symmetrical about the single-circuit resonance frequency. These curves can, of course, be deduced mathematically, but a more general argument is, perhaps, easier to follow.

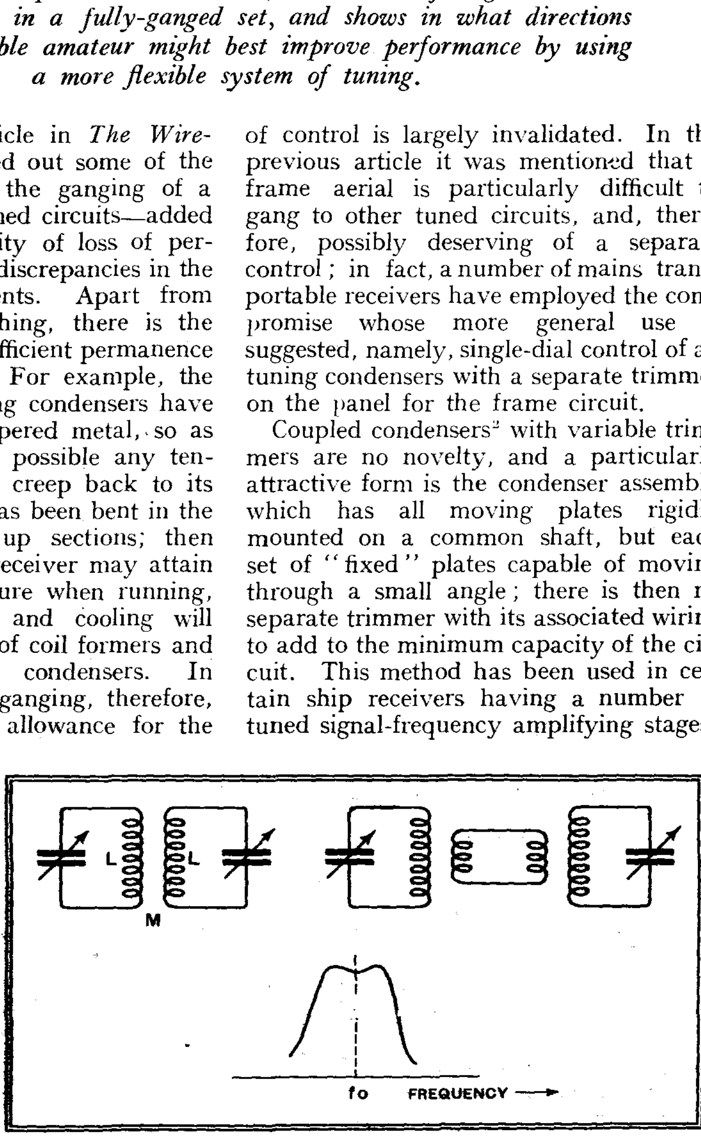


Fig. 1.—Band-pass filters with inductive or "link" coupling show a symmetrical resonance curve.

Effect of Filter Coupling

With mutual inductance coupling (illustrated in Fig. 1) the two frequencies of the band-pass response curve arise because the effective inductance of either coil may be either L + M or L − M (L is the inductance of either coil and M the mutual inductance between them) according as the currents flow in the same or in opposite directions in the two coils; there is thus one higher frequency (for L − M), and one lower (for L + M) than that corresponding to the inductance L of either coil alone. But in the common-capacity-coupled filter (Fig. 2), one possibility is for the current to flow through the two coils and two tuning condensers in series, without passing through *Co*; the frequency is then the same as for one coil and condenser alone. Alternatively the current may flow round each circuit separately via *Co*; in that case the tuning condenser is effectively in series with *Co*, giving a smaller resultant capacity and higher frequency. Consequently with this type of filter it would not be satisfactory to tune each of the two circuits to the desired fre-

[1] "Ganging—Is it Worth While?" — *Wireless World*, March 15th, 1935.

[2] To avoid confusion it is suggested that the term "gang" might be restricted to condensers with accurately matched sections, assemblies of unmatched condensers on a common drive being described as "coupled condensers."

Ganging : A Possible Compromise—
quency and then increase coupling to produce the band-pass effect, since the response would be spread entirely on one side. It is therefore essential that such circuits should be correctly and permanently ganged, and, incidentally, the most satisfactory method of observing the accuracy of adjustment is to use cathode-ray equipment (such as was exhibited by Plessey and the G.E.C. at the Physical Society's Exhibition in January of this year).

Circuits Out of Step

At this stage the argument might well be raised that since it is necessary to provide a pair of accurately ganged circuits for the band-pass filter (if one is fitted in the signal-frequency stages) the other one, or possibly two, tuned circuits might just

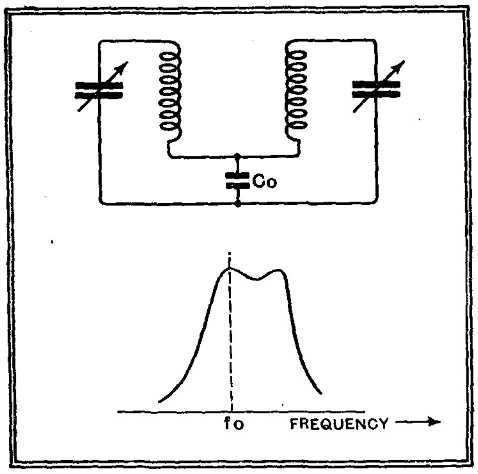


Fig. 2.—Capacity-coupled filters have an asymetrical resonance curve, and so it is virtually essential that they should be gang-tuned.

as well be ganged on at the same time. But we have already seen that a frame aerial particularly deserves a separate control, and another circuit where this might produce a noticeable improvement is the oscillator circuit of a superheterodyne. Since the oscillator circuit virtually carries with it the whole of the selectivity of the IF stages, gang control results in the receiver being largely tuned by this circuit; consequently any tracking error here may result in all the signal-frequency circuits being correspondingly detuned in a common direction. An entirely separate tuning control for the oscillator would meet this difficulty; but there would be no point in fitting a trimmer to this circuit while leaving all the tuning condensers on a common shaft, since we have already seen that it is the oscillator circuit which will be correctly ganged, while the others may be slightly out. If, then, we are not prepared to go the whole way and fit an entirely separate control for the oscillator tuning, the only useful measure is to fit a trimmer to any signal-frequency circuits other than band-pass filters which there may be.

It is not suggested that commercial receivers are likely to be built with more elaborate tuning arrangements; but for the amateur who is prepared to sacrifice extreme simplicity of control in favour of better performance and possibly a substantial saving in cost, the following may serve as guiding principles:—

(1) Band-pass filters should always be made up of a pair of accurately matched and permanently ganged circuits.

(2) If two separate controls are to be used, the order of preference for the circuit which is to have an independent control to itself is (a) frame aerial, if used; (b) oscillator tuning if the receiver is a superheterodyne; (c) detector grid circuit in a "straight" set, if reaction is applied to it; (d) aerial circuit when using an open aerial.

(3) *Except for the superheterodyne oscillator circuit,* the two independent controls may be replaced by a gang condenser together with a trimmer on the least easily ganged circuit (the one specified in (2)).

(4) If the number of controls may be as large as the number of circuits, then apart from band-pass filters it is possible to use a system of coupled condensers with a separate trimmer for each circuit other than the oscillator of a superheterodyne.

Random Radiations

By "DIALLIST"

A Wonderful Factory

THE Ultra people have good reason to be proud of their new factory at Acton which was opened recently. To the opening ceremony they sportingly invited the heads of many competing firms, and it was more than interesting to hear the comments made by these as they passed from department to department. Without exception, they agreed that the factory was designed upon the soundest and most up-to-date lines. "Nothing like it in the world," one of them remarked admiringly.

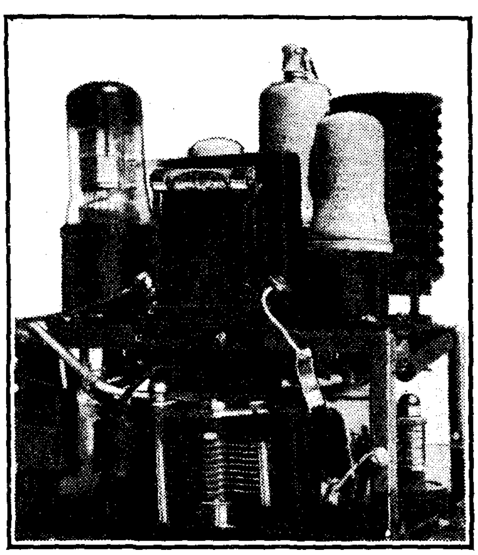
Particularly impressive is the thoroughness of the arrangements for testing receiving sets before they are passed out for sale. By means of oscillators or miniature transmitters, most firms test each set on two or three different wavelengths. In the new factory there will be not less than five tests on as many wavelengths for sensitiveness and selectivity.

Finland and Car Radio

THE Finnish police authorities found themselves on the horns of a dilemma when taxis fitted with car radio equipment made their appearance in the streets. On the one hand these were the last word in up-to-date taxis; on the other a campaign against unnecessary noise had just been launched. After long consultation the authorities agreed that taxi radio came under the heading of unnecessary noise and, as such, must be suppressed.

I admit that any kind of car radio set, if allowed to bellow at full blast, is a most unnecessary noise; but I can't see any objection to the set which reproduces quietly in either private car or taxi.

HOME-MADE CAR SET



This midget set was designed by a reader of *The Wireless World*, Mr. W. D. Horniman, to fit into the dashboard of a Riley car. The circuit consists of HF; Det; and 2 LF. Overall dimensions are 6 ins. × 4 ins. × 6½ ins. deep. LT is provided by one cell of the starter battery. Plug-in coils are used, allowing for reception on all wavebands.

Useful for Set Testing

SOME years ago, in the course of talks on broadcast reproduction, the London station sent out a series of notes on various frequencies from about 50 to 6,000. I remember that I was engaged in testing out a new set at the time, and I found this series of notes of the greatest value in judging its overall response. *The Wireless World* has repeatedly asked for a service of this kind. Couldn't we have a half-hour once a month devoted to such transmissions and others useful to the wireless experimenter? These half-hours could be conducted if necessary in such a way that they wouldn't interfere in the least with ordinary programmes. Here's my suggestion. Every evening from 10.45 to 11.15 all B.B.C. stations, whether Regional or National, are sending out the same programme. Now there can't be anybody within range of a medium-wave National transmitter who cannot receive his local Regional at least equally well. If therefore this half-hour were occasionally devoted to transmissions of the kind outlined nobody would lose anything though many would gain a great deal. Actually, there must be few people who use the medium-wave Nationals during the period mentioned, for in most instances the same programme can be received very much better from the Regionals.

B.B.C. Decentralisation

IT was good to hear from the lips of no less an authority than Major Gladstone Murray that the policy of centralisation on London, which has been tried out, is now as dead as the proverbial mutton. He gave this information when opening the enlarged studios at the Manchester station, and I am sure that it will be warmly welcomed by listeners. The National programmes must, of course, be a centralised business; but you can't cope with demands of local patriotism from London. After all, what Lancashire thinks to-day, London thinks to-morrow! In every country in the world there's a big gulf fixed between North and South, and East and West. North regards South as effeminate; South looks on North as efficient but not culchahed. East and West don't think much of one another, though they are united in regarding North and South as "foreigners."

In other words, programmes of a strongly Regional character are quite definitely required if everybody is to be satisfied. This change of policy on the B.B.C.'s part means that Regional stations will preserve their individuality, which is the best thing that could happen to them and their listeners.

A Relay Problem

SPEAKING the other day at a meeting of newspaper proprietors, Lord Iliffe called attention to a point about the relay services that has perhaps not been fully realised. Unless they are controlled in some way, there is nothing to prevent them from supplying their subscribers with programmes from foreign stations staged specially for the benefit (or otherwise) of British listeners. In this way it will be quite possible to upset, as Lord Iliffe said, the balance of broadcasting opinion on controversial matters, which is so carefully held by the B.B.C. to-day.

Wireless Less Seasonal

AT one time there was quite a marked wireless season which began with the Olympia Exhibition, then held in September, and ended with the coming of British Summer Time in April. Manufacturers kept their new lines up their sleeves until the Exhibition opened; factories worked overtime during the winter months in an endeavour to cope with demands; the public ceased to buy new sets shortly after the beginning of the new year, deciding to wait for the new models; comparatively little listening was done, except by genuine long-distance enthusiasts, during the summer months. The wide adoption of high power for broadcasting stations has brought about a vast and very beneficial change. Many firms now bring out new sets, new valves or new components in the spring and the early summer. Listeners have found that they can receive both home and foreign stations well all the year round, and quite apart from general entertainment, which is always available, they know now that summer brings such thrills as the running commentaries on the Derby, the Test matches and Wimbledon tennis. Summer time, too, has some of the best outside broadcasts of the year. The effect of all this upon the wireless industry is thoroughly good. No longer is there the same marked and deplorable contrast between winter overtime and summer unemployment.

Radio Pilots for Planes

THE Air Ministry, I see, is to find the money for a three-years experimental campaign by the National Physical Laboratory for the purpose of improving wireless methods of guiding aeroplanes flying in the dark, in foggy weather, or in falling snow. A great deal has already been done in this way, though we are still a long way from perfection. One great difficulty is to make direction-finding instruments completely accurate at all times, and this is, no doubt, one of the special objects of the N.P.L.'s new campaign.

Radio Data Charts—V.

The Self-inductance of Single-layer Coils for Short Waves

By R. T. BEATTY, M.A., B.E., D.Sc.

HERE is another data chart which will be found of particular value in designing coils for short-wave receivers suitable for the wave range 5 to 20 metres. The inclusion of a practical example makes the method of using the chart quite clear.

THE accompanying chart enables us to design coils of inductance lying between 0.5 and 10 microhenrys, a range which is useful in dealing with short waves comprised in the region from 5 to 20 metres. Such coils may have diameters ranging from 0.5 to 1 inch, and their lengths also usually lie between these limits.

The chart may be regarded as an extension to short waves of the chart given in *The Wireless World* of August 12th, 1932, for medium and long waves, and the same method of construction has been adopted. The formula for self-inductance is

$$L = SD^3n^2$$

where L = microhenrys.
D = diameter of coil in inches.*
n = turns per inch.
S = shape factor depending on ratio of length to diameter of coil.

The method of procedure is shown by the inset on the chart. If we choose values of L and D and join the corresponding points by a line we have performed the operation of dividing L by D^3. Next we return from right to left through the point corresponding to the number of turns per inch length: this operation divides by n^2, and we have now L/D^3n^2, which the formula shows to be equal to the shape factor S. Actually no scale of S appears on the chart, but it was placed there temporarily when the chart was being constructed, and by joining corresponding values of S and length/diameter a set of lines was obtained from which a curve was drawn to touch all the lines. Accordingly the third operation is to draw a line touching this curve and giving the required value of length/diameter. Their total turns = turns per inch × diameter × length/diameter.

* Diameter of coil = diameter of former + diameter of wire.

TABLE A.

Standard Wire Gauge.	Turns per inch (Close Wound). Enamel.	Double Cotton.	Single Silk.	Double Silk.
20	26.1	21.7	26.3	25.3
21	29.4	23.8	29.4	28.2
22	33.3	26.3	33.3	31.8
23	38.8	29.4	38.5	36.4
24	42.1	31.3	42.1	40.0
25	46.0	33.3	46.0	43.5
26	50.6	35.7	50.6	47.6
27	55.9	37.9	55.1	51.6
28	61.4	40.2	60.4	56.2
29	66.2	42.4	65.2	60.2
30	73.3	44.7	72.0	67.1
31	77.8	46.3	76.3	70.9
32	83.0	50.5	81.3	75.2
33	88.9	52.6	87.0	80.0
34	98.0	54.9	93.4	85.5
35	106	61.0	101	91.8
36	116	64.1	110	102
37	128	67.6	121	110
38	143	71.4	133	121
39	168	75.8	149	134
40	180	78.1	159	142

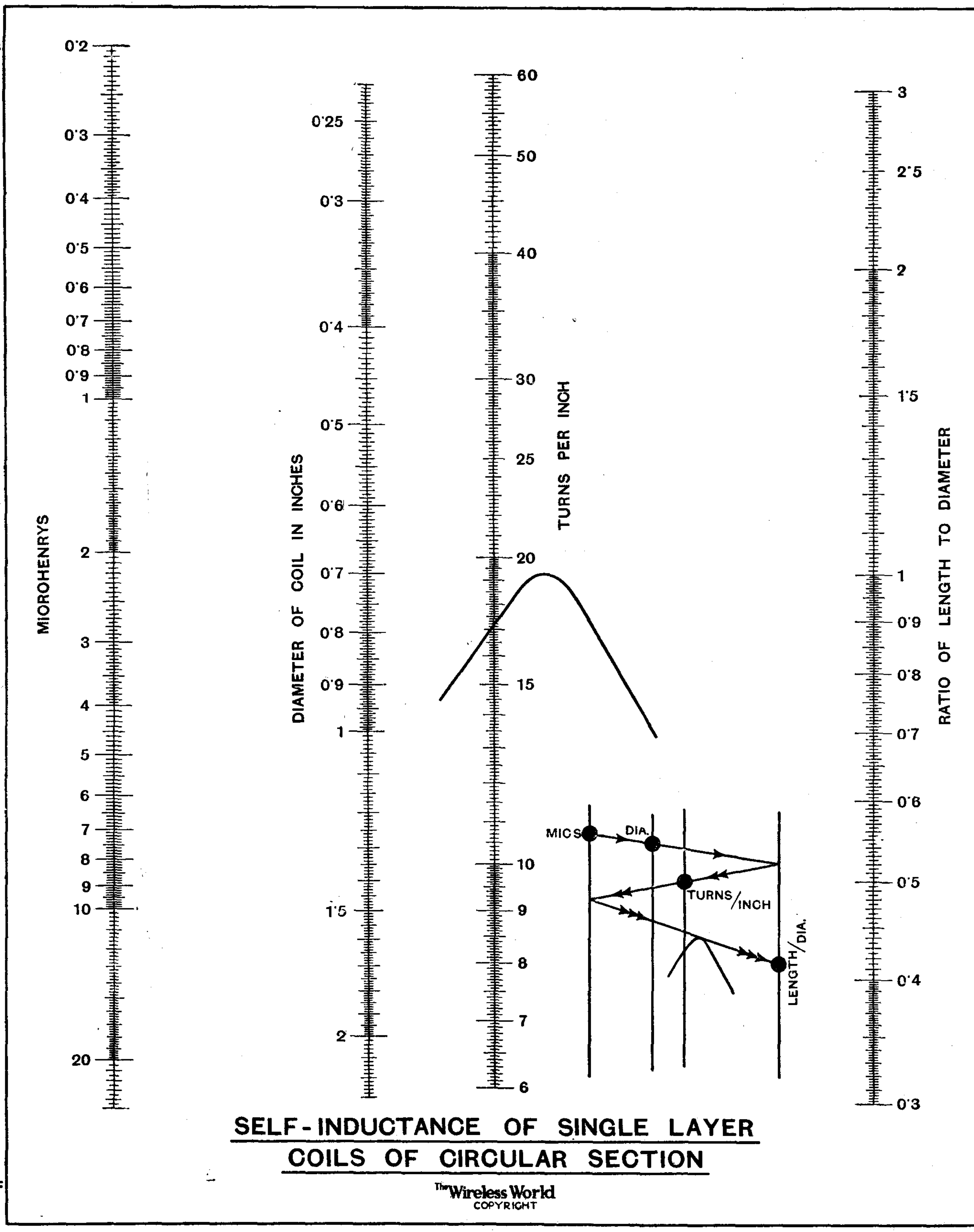
TABLE B.

Standard Wire Gauge.	Diameter in thousandths of an inch. Enamel.	Double Cotton.	Single Silk.	Double Silk.
20	38	46	38	39
21	34	42	34	35
22	30	38	30	31
23	26	34	26	27
24	24	32	24	25
25	22	30	22	23
26	20	28	20	21
27	18	26	18	19
28	16	25	17	18
29	15	24	15	17
30	14	22	14	15
31	13	22	13	14
32	12	20	12	13
33	11	19	11	12
34	10	18	11	12
35	9	16	10	11
36	9	16	9	10
37	8	15	8	9
38	7	14	7	8
39	6	13	7	7
40	6	13	6	7

Spaced Windings

In tuning a circuit to short wavelengths it is important to keep the self-capacity of the coil low. Thus at 5 metres the relation between self-inductance in microhenrys and tuning capacity in micro-microfarads is LC=7.036. Hence with a coil of 2

DATA CHART FOR THE DESIGN OF SHORT-WAVE COILS



microhenrys the self-capacity must be kept below 3.5 mmfd.; since otherwise the circuit cannot be tuned down to as low as 5 metres.

The self-capacity of a close-wound coil diminishes rapidly at first, as the turns are spaced farther and farther apart, and then more slowly, and it is sufficient to space the turns so that there is room for another turn between two consecutive turns of the coil. This is easily achieved by close-winding the coil with two wires in parallel and then unwinding one of the wires.

Example

A former of 0.8in. diameter is available, and a reel of 24 S.W.G. enamelled wire. How many turns are required to produce a coil of inductance 1.5 microhenrys?

Table B shows that the diameter of this wire is 0.024 in., while Table A gives 42.1 turns per inch, corresponding to close winding. Hence if the winding is spaced by one wire diameter we have 21.05 turns per inch. Accordingly

Inductance = 1.5 microhenrys.
Coil diameter, 0.824in.
Turns per inch, 21.05.

Hence we find from the chart that length/diameter = 0.470.

Hence total turns = 21.05 × 0.824 × 0.47 = 8.15.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Noise

ON page 595 of June 14th issue of your journal, in the decibel ladder illustrating the article "Noise," I notice that airscrew appears next to the threshold of feeling, and would like to suggest that the noise associated with an airscrew is usually caused by the motor driving it, being unsilenced exhaust noise.

While writing, it would seem that Richard Tauber (on page 597) would enjoy his own recording better if he closed the lid of the H.M.V. radiogram, as per instructions, which, I believe, are usually transferred on to the inside of the lid. R. F. COOKE.

Olton, Warwickshire.

Foreign Market for Receivers

I HAVE been a keen follower of *The Wireless World* for many years and read with great interest your Editorial Comments each week. This week I find it particularly interesting, and back up every word you have printed and the information given by your correspondents.

I am an Englishman resident in Gibraltar actively engaged in the radio trade, and am working with one of the leading makes of American radio receivers, but am very sorry to say that there is not an English receiver to compare with the Americans, who hold complete sway of the market. My reasons for making this statement are as follow:—

(1) Price. The average 6-valve all-wave receiver sells at £12 to £15. Leaving a good margin of profit. These are really efficient receivers.

(2) Spares. Complete catalogue of spare parts for all models manufactured. Showing part number, price, and full description of article. Immense saving of time when ordering spare parts by cable or letter.

(3) Co-operation between dealer and factory.

(4) Advance information. Sales helps.

(5) Sharing of expenses in organised sales campaigns.

(6) Prices of valves. This is very important in my estimation, as the purchaser of a radio receiver (American) knows that the replacement of valves is not going to cost him much even though he has to replace the whole set.

(7) *Complete service instructions supplied with every receiver, schematic and wiring diagrams.* The Americans are not afraid to supply this information, as they know it is in their interest to do it.

I have never seen one English receiver despatched in this manner, and to obtain diagrams, spare parts, etc., for them is practically out of the question. I can assure you that I do not relish the job when an English receiver comes in for service as I know that if anything has gone west that cannot be replaced by American components it is as well to put the set on one side for a rest of two or three months until means can be found of obtaining the spares.

As regards service, everything is done by the manufacturer to help the service man. Weekly issues of service notes, circular letters, etc., and the supply of efficient test equipment. I would like to sell English made receivers, but it is impossible and not worth the gamble because the dealer is unable to give service, they are not as efficient as the American receiver and do not give satisfaction in general. My advice to anybody leaving England for abroad is to buy American receivers and rest content as to performance and service.

I would like to give you just one instance of the methods of the American manufacturer. We encountered a certain amount of trouble in a particular model with the volume controls; this matter was reported to America; immediately they rushed a supply of new type volume controls sufficient to cover the sets sold, in stock and in transit. The sets were drawn in, the new volume controls fitted, and returned again to their respective owners without expense to anybody. Would an English manufacturer have done the same?

I am enclosing a copy of the service instructions for one of the models and also a copy of the service news, and I am sure, after you have looked these over, you will agree with me that the English manufacturers have got to get up a little earlier in the morning before they can even think about putting English made radio receivers on the foreign market, whether they be all-wave or only medium and long, and they have got to take the service man into consideration. S. R. C. ALLEN.

36, Main Street, Gibraltar.

The Cardiograph

WE have been interested in the correspondence appearing in your columns regarding the cardiograph, and, although we do not propose to enter into controversy on the respective merits of the various types, we should be glad if you would allow us the courtesy of your columns to correct statements which might give rise to an erroneous impression.

We were gratified to read the entirely unsolicited testimonial of Mr. R. J. Parris, in which he related his experience with the string instrument. In the reply by "One of the Designers," in your issue of June 7th, it is inferred that Mr. Parris's experience is exceptional and the result of expert handling. This is not the case. It is more a rule than an exception that string galvanometer fibres last for some years; there are some, supplied on the first portable cardiographs, that are working after seven years' use. In fact, the construction of the Cambridge instrument is such that it is almost impossible for a fibre to be broken, and although over one thousand string galvanometer cardiographs are in regular use we rarely find a string broken. Sometimes they may lose electrical conductivity through a fracture in the plating or an imperfect soldered joint, but this has become increasingly rare since improved methods of plating fibres by a cathode bombardment process have been developed.

Damage due to overload voltage is negligible since the resistance of the fibre is not less than 3,000 ohms, and it is capable of carrying currents over two hundred times as great as those met with in cardiograph examinations.

The fact that the fibre is of such a fine diameter has led to a mistaken impression of its frailty, so it should be remembered that the tensile strength of the material is high and, since it is straight and subject to no strains, and possesses little mass, while its movements are strongly damped by the surrounding air, it is probably less subject to damage due to jolts (such as occur in motor transit) than many apparently stronger or thicker but less well-supported filaments.

In short, fibre trouble in the portable cardiograph has been, and is, a myth, and where difficulty has been encountered it has generally been due to other causes and circumstances, although the "fibre," as the indicating (and therefore the obvious) part of the equipment, has usually been blamed. The behaviour or lack of movement of the fibre indicates when something is wrong, but it should not be assumed that the fibre is at fault.

It is not a fact that strings supplied with and for cardiographs made by this company vary in their characteristics sufficiently to affect the electro-cardiogram; they are selected to conform to certain limits which makes them interchangeable.

The other points raised are matters of preference in technique, and all manufacturers estimate to the best of their ability the need of the profession for which they cater.

ROBERT S. WHIPPLE,
Joint Managing Director,
For Cambridge Instrument Co., Ltd.
London, S.W.1.

Improving the Gramophone Record

I HAVE wondered for some little time why two separate recordings aren't made and issued of the same record; the normal one, and the other for the users of radio-gramophones and pick-ups.

Surely the requirements of acoustical and electrical gramophones are quite different? On many discs the loud passages *seem* to be over-recorded, and naturally after a few playings these parts are the first to show signs of wear and give distorted reproduction. For pick-up owners records could well be recorded with an overall reduction of volume, this being compensated for by slightly turning up the volume control of the reproducer. Not only would that nasty "juddering" so often experienced on loud passages of partly worn records be practically eliminated, but the whole useful life of the record would be lengthened; and then why not some "volume-expanded" records?

The only trouble may be that of surface scratch coming into greater evidence during soft passages, but I don't think it would be unbearable, especially on the better makes of records. G. L. SIDGREAVES.

Heidelberg, Germany.

I READ with much interest Mr. N. Mackechnie's suggestion on p. 554 of *The Wireless World* for May 31st.

Mr. Mackechnie may be interested to know that I well remember having been invited to a "recital" of gramophone cylinders in 1903. These cylinders had some sort of announcement recorded on them, but I must admit that one was not much the wiser for it! *Nil nove sub sole?*

I heartily agree with Mr. R. W. Taylor's opinion on fuses: *adequate* fuses should be fitted to every set—with a possible exception of our old friend the crystal set!

Watermael, Belgium. E. J.