Wireless World

RADIO, TELEVISION AND ELECTRONICS

VOLUME LVI

JANUARY - DECEMBER 1950

Published from the Offices of "WIRELESS WORLD"
ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD ST., LONDON, S.E.1.

Wireless World

VOL. LVI. No. 1. JANUARY, 1950

Planning Television Extensions

AS soon as data has been collected on the working of the new Birmingham television station the last remaining excuse will have disappeared for delay in formulating—if not for putting into execution—clear-cut plans for developing the British television service to a stage where it will provide a signal for the majority of the population. True, a plan does exist (we publish a summary of it elsewhere in this issue), but many of the details are incomplete and, in particular, there is as yet no precise information as to when the various stations will come into operation. Without this knowledge, the industry cannot, in its turn, make long-term plans for producing receivers, the demand for which is closely linked with the number of homes served by available transmissions.

Apart from these questions of delay, the basis on which coverage of the major part of the country has been planned seems in general to represent the best possible compromise between the many factors that must obviously be taken into account. Clearly, the general idea was to provide the largest possible proportion of the population with a signal, subject to certain economic and technical limitations.

The location of stations in any large-scale system of distribution is always interesting, and it is rather surprising that the details have not been more widely discussed in technical circles. In general, the distribution of the stations is very much what one would anticipate, though at first sight it would seem that the Tyneside station could have been better sited on a vantage point at the northern end of the Pennine chain. By increasing at the same time the power of the station, it would appear that one of the more obvious gaps in our national coverage could have been filled in at relatively low extra cost, as the counties on the western side of the Pennines would stand a chance of enjoying a fair signal. Admittedly, however, the additional area that would then be served is one of low population density.

THE problems of providing for East Anglia and Wales are, as a glance at our map on page 14 will show, much less simple, though it is to be expected that the more densely populated parts of South Wales will come well within the service area of the Bristol station, presumably on the Mendip Hills. It should be stressed that part at least of the plan is tentative, and so may be revised in the light of experience gained from the Midlands.

No doubt there will be protests from sections of the country that stand to be poorly served. While sympathizing with them, we hope they will derive some comfort in the thought that our distribution system is organized on a rational and equitable basis, and they suffer merely from the accident of geography. We hope the B.B.C., in its turn, will not allow the action of energetic "pressure groups" to deflect it from sound principles. Whatever the merits and demerits of our system of broadcast distribution may be, it does at least make orderly development possible. Difficulties of the post-war years have tended to offset our initial advantage of an early start in television, but there is no real reason why we should not now make up for the ground that has been lost.

THOUGH the delays that have arisen in extending the service are to be deplored, there is nothing to make us think that British television will fail to develop in a steady and healthy manner. The public has accepted it; that view is confirmed by recent licence figures, which show for the first time that the monthly increase in the number of viewers exceeds the number of newly licensed listeners to sound broadcasting. We are more than ever convinced that our moderate-definition standards represent the best possible compromise, allowing both cheap receivers and a transmission service that can be extended at reasonable cost.

American Hearing Aids

Current Practice in Design and Fitting

By A. DINSDALE

American "Acousticon" hearing aid, Model A-120.

IN dealing with this subject, I must of necessity confine myself to a discussion of the hearing aids with which I am most familiar; that is, American hearing aids in general, and more particularly those manufactured by Acousticon International of New York.

Essentially, a hearing aid consists of a microphone, amplifier, receiver and power supply. The overall performance of the hearing aid can be adjusted or altered by varying one or more of these essential components.

The most important consideration is that the final evaluation of a hearing aid must be based upon the total performance of the entire instrument as judged by a deaf person. It has been found that out of two or more instruments which perform identically so far as quantitative measurements are concerned, a hard-of-hearing person can frequently express a very definite preference for one instrument over the others.

Looking for pointers for research into this problem, Acousticon turned to a series of reports issued by the U.S. Public Health Service in 1938 on the results of a nation-wide survey of deafness, supplemented by several articles published in 1940 by Dr. Willis C. Beasley, the director of this survey. In passing, it is interesting to note that the survey uncovered the fact that 10 per cent of the population of the United States suffered from loss of hearing in some form.

Based on audiometric measurements, the survey established three stages of partial deafness.

Stage 1. Can understand direct conversation without difficulty, but has difficulty in hearing properly in church, theatre, and in groups.

Stage 2. Has difficulty in hearing ordinary conversation unless voice is raised, but can hear on the telephone.

Stage 3. Cannot hear direct conversation unless shouted directly into the ear, but can hear with hearing aid or amplified telephone.

The survey also revealed three general types of hearing loss:—

(1) Relatively greater loss for frequencies above 1,500 c/s in varying degrees of intensity. (Nerve deafness.)

(2) Relatively greater loss for frequencies below 1,500 c/s. (Conductive deafness.)

(3) Approximately uniform loss for all frequencies. (Mixed deafness.)

Dr. Beasley recommended various patterns of acoustic gain, in varying degree, to compensate for these various types of losses. The essential principle brought out is that all speech sounds, of whatever frequency, appear to a person with normal hearing to have equal loudness. But to a person with a hearing loss, some speech frequencies are heard normally, others faintly or not at all. A person with normal hearing has *balanced hearing*. A person with a hearing loss is most likely to have *unbalanced* hearing.

Accurately to rebalance hearing in a wide range of hearing losses, it is held that a variety of hearing aids with a wide range of characteristics should be made available, and provision must be made in the fitting procedure for an accurate diagnosis of a particular loss, and for the selection of equipment with the proper characteristic to compensate accurately for that loss and thus restore the balance. Acousticon maintain a policy of providing a wide variety of hearing-aid responses to meet the essential requirements of the hard-of-hearing public. Specifically, the current Acousticon "Constellation" models provide 36 different combinations. There are three "transmitters" (microphone-amplifier-power supply) of various powers, to which may be connected

Though the views expressed in this article are often at variance with conclusions arrived at in this country (see, for example, Medical Research Council Special Report No. 261, "Hearing Aids and Audiometers," published by H.M. Stationery Office) we publish it as an indication of present trends in the development of hearing aids on the other side of the Atlantic.

12 receivers (earphones) of different characteristics

The three transmitters are known as A-120, A-130 and A-140, which are designed for Stage 1, Stage 2, and Stage 3 degrees of deafness, respectively. Maximum peak acoustic outputs, as suggested by the model numbers, are 120 db, 130 db, and 140 db relative to the threshold of hearing. The first two are self-contained instruments; the A-140 requires outside batteries.

The A-120 (illustrated) measures 4in × 2$\frac{5}{16}$in × $\frac{7}{8}$in, and weighs six ounces, complete with batteries. The "A" (l.t.) battery, a Mallory mercury cell, will give 80-90 hours of service. The service life of the 15-volt "B" (h.t.) battery depends upon the volume control setting and with a drain of 220 to 300μA will vary between 250 and 450 hours.

The A-130 is slightly longer, to accommodate a 22½-volt "B" battery. "A" battery life is the same. The "B" battery drain varies from 500 to 800μA, giving a life of 150-300 hours.

The A-140 is a much smaller and lighter instrument, because the battery compartment has been omitted. The external 1½-volt zinc-type "A" battery will give 70-75 hours' service. The 30-volt "B" battery drain ranges between 850 and 1,350μA, giving a battery life of 150-300 hours.

As stated above, the choice of transmitter is governed by the degree of loss, and the amount of power required to make the patient hear properly. The percentage of instruments in use is as follows: A-120, 65% ; A-130, 32% ; A-140, 3%.

Individual Characteristics

To compensate for the characteristics of individual hearing, there are nine air receivers and three bone conductors of various characteristics. These are listed below by type number, peak frequency response, and percentage ratio of use :—

Type	Peak Frequency (c/s)	Per Cent In Use
M4	400	2.5
M6	600	1.7
N	900	3.1
E	1100	8.7
S	1600	14.9
T	2000	19.5
L	1100-2400	12.7
P	3000	11.0
U	Uniform 400-3000	10.3

To peak these receivers at any desired frequency, the diaphragms are mechanically loaded to achieve the requisite damping. The manufacturing process is difficult and expensive, because the percentage of rejects is high. Each receiver is individually checked, and must conform closely to specifications. Thus, there is a temptation to reduce the number of receivers. But the demands of the hard of hearing, as indicated by percentage figures of use, do not permit of any reduction. Response curves obtained from six Type S receivers of each type, chosen at random and superimposed, are shown.

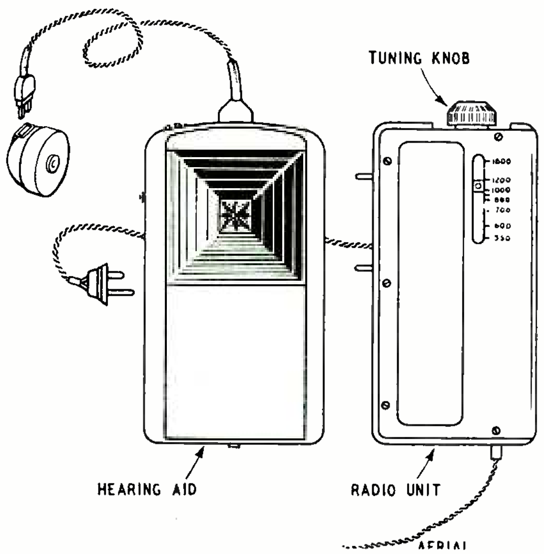
The three bone conductors are classified as low, medium and high and the percentages in use are 8.2, 5.2 and 2.2 respectively. It has not so far been possible to devise suitable equipment to measure the response of a bone conductor accurately. A bone conductor is applied to the mastoid bone behind the ear, under considerable pressure supplied by a headband. Where conductive deafness (due to middle ear disease) is indicated, the patient can often hear better with a bone conductor than with an air receiver, and in severe cases of conductive deafness, it may be the only way to make him hear.

The performance of any given "transmitter" can be varied slightly by means of a 4-position tone control. The first position provides no alteration of basic response. The second position attenuates low frequencies. The third position attenuates high frequencies. In the fourth position, uniform attenuation is introduced *before* the signal enters the second amplifier tube. This suppresses high-level background noise which would otherwise mask reception of desired speech. This feature is extremely helpful when in a noisy place, such as a restaurant, city street, or while riding in an automobile.

The Analytic Speech Test

For a number of years it has been (and still is) customary in America to use an audiometer as an aid to the fitting of hearing aids. An audiometer is an excellent diagnostic tool in the hands of an ear specialist, but there is considerable doubt, even among those who use it, as to its efficacy for the purpose of fitting a hearing aid properly. After all, the ultimate criterion of an effective hearing aid is how well it will permit the wearer to hear *and understand* speech.

Acousticon therefore devoted many years of research into the problem of devising an effective method of testing with speech. The extensive experimental work done by the Bell Telephone Laboratories provided much useful information to start with. However, the various standard word tests, composed of random assortments of all speech



Showing inter-connections between hearing aid "transmitter" and auxiliary radio receiver unit.

sounds, failed to reveal the hearing unbalances which Acousticon sought to identify. What was needed was a test which would reveal the relative ability of a hard-of-hearing person to perceive speech sounds having predominantly low-frequency and high-frequency content.

As finally developed, the Acousticon speech test consists of two lists of monosyllabic words, one in the low-frequency range, and one in the high-frequency range. In the l.f. range there are words like *roar, war, home;* in the h.f. range, words like *patch, cease, chief.* Thus, instead of one average score, as in previous tests, the Acousticon test provides two scores, one in each frequency range.

For example, a phonetically balanced (PB) word list may provide a score of 50% at a given intensity, as shown in Fig. 1(a). The same subject, when given the Acousticon test, might come up with a score of 75% in the low-frequency range, and 25% in the high-frequency range, as shown in Fig. 1(b). This averages out at 50%, as with the PB list, but it reveals clearly the nature of the hearing loss, and the steps which must be taken to correct it and restore balanced hearing.

From the indications given in Fig. 1(a), it would appear that all that is needed is a universal type of hearing aid with enough acoustical gain to drive the score up to 100%. This is the brute-force method. When Fig. 1(b) is studied, it becomes clear that enough brute force will drive the weak h.f. score up to 100%. But what of the l.f. end? At that end of the scale, sufficient power to correct the h.f. deficiency will overpower the patient and cause acute distress.

If the patient persists in wearing a hearing aid which is misfitted in this way, he will eventually become a nervous wreck, and the strain on the nervous system, in turn, is likely to produce various more-or-less serious physical disabilities.

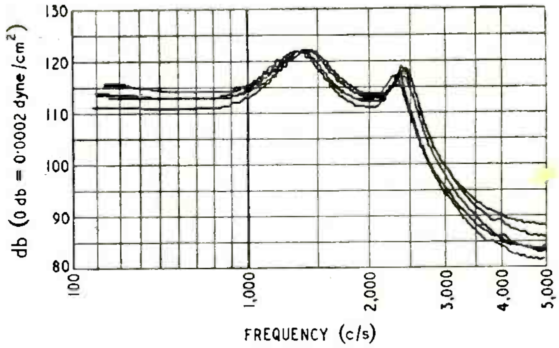
Further study of Fig. 1(b) will suggest that the commonsense procedure, before applying power indiscriminately, is to apply correction to the h.f. end to restore the balance. The ideal correction would raise the h.f. score to 75%. This having been accomplished, it is then safe to apply just sufficient power to overcome the *degree* of loss.

Fitting Procedure

The Acousticon fitting procedure is designed to achieve the results described in the preceding paragraph, by enabling the examiner to determine exactly the nature and extent of the loss, and select the proper fitting (receiver) and transmitter which, in combination, will restore the patient's hearing to as nearly normal as the age and severity of his disability will permit.

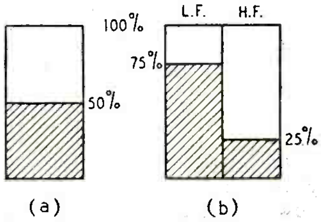
The equipment employed consists of a hearing aid transmitter, a "coupler," and a pair of headphones.

The characteristic curve of the amplifier in the transmitter rises slightly from the l.f. to the h.f. end. The coupler contains a filter which flattens this curve to a uniformly flat response at all frequencies. Thus, when testing, the gain is the same at all frequencies. Also included in the coupler is a switch by means of which the operator can direct his speech into either or both of the patient's ears.



Response curves of six Type S receivers taken at random. Measured on an artificial ear of 2 c.c. volumetric capacity with a constant electrical input of 100 mV.

Fig. 1. (a) Results of normal phonetically balanced (PB) test; (b) Acousticon word test.



In preparation for the test, the operator talks to the patient (both ears), using adequate power to be heard easily. Then he switches first to one ear and then the other, to determine whether one ear may be totally deaf, and to measure by the volume control setting the degree of power required for each ear. The two ears are very seldom alike, either in degree or nature of loss.

Having selected one ear to start on, the operator then slowly reduces power until the patient can just barely understand him and no more. In cases of very light loss, this may involve moving several feet away from the transmitter. Then, using a silken lip mask to prevent the patient from reading his lips, the operator reads over the word lists, waiting for the patient to call back each word—if he can identify it. Each correctly repeated word is scored. The process is repeated for the other ear. Then the scores are added up and reduced to percentages.

Wherever possible, Acousticon prefers to fit the "bad" ear. The reason for trying to do so is to leave the "good" ear open to hear what it can, and thus reinforce the assisted "bad" ear, to provide better overall hearing, and some degree of directional sense. However, in extreme cases, it is not always possible to provide understanding of speech through the "bad" ear, due to irretrievable damage In such cases, the "good" ear must be fitted.

Having studied the patient's scores and evaluated them with respect to high- and low-frequency loss, plus consideration of the degree of loss in each ear, the operator decides which ear to fit. To find the correct fitting (receiver), he transfers the score figures on to a special slide rule, which indicates the preferred fitting and an alternative. The preferred and alternative fittings are tried and the patient is asked to say which seems best to him. In cases of conductive deafness (low l.f. score), the operator will also try a bone conductor to determine whether the patient can hear better with an air receiver or a bone conductor.

There is a weakness at this point which has caused much trouble in the past. The patient is not always a reliable witness as to how well he hears. If he has been hearing badly or not at all for some years, any sort of improvement seems wonderful to him. But his judgment as to how well he hears may be seriously impaired. Or he may be the incoherent type, who cannot express intelligently just what he hears, or how well.

So the patient's opinion is used only as a rough guide. When it seems that the best fitting has been selected, the word test is applied again, this time through the medium of the complete hearing aid and the correction thereby supplied. If the fitting is correct, the l.f. and h.f. scores will balance. If they don't balance, then another receiver is chosen, higher or lower in pitch as indicated by the score. The test is applied again, and if the operator is an expert he will usually hit it this time.

The important point is that when he has finished, the operator does not rely on the doubtful judgment of the patient as to how well he hears. As a result of his scientific check-back, he *knows* for certain. Next come sentence tests and distance tests, to prove to the patient that he is properly fitted, and demonstrate how well he can hear.

All this seems simple enough but, as with all things, there is danger in over-simplification. Many factors caused by the psychological condition of the patient enter into the picture, but this is no place to discuss such problems. Suffice it to say that the psychological problems are very real, and must be taken into consideration. They call for expert handling and sound judgment by an experienced operator.

There is one other physical factor which must be taken into consideration. When a patient begins to wear a hearing aid for the first time, using an air receiver (this does not apply with bone conduction), changes gradually take place in his hearing. Thus, after the first few weeks, the original fitting becomes unsuitable, and it must be changed for another, which a re-check with word tests reveals as now correct. If the patient will wear this instrument steadily, day after day, his hearing will usually stabilize within two or three months. During that period, one or two changes of fitting may be necessary—in extreme cases, four or five changes.

The exact cause of this change is a subject of medical controversy in the United States. But it seems apparent that the stimulation provided by the direct application of properly-corrected sound into the ear canal does produce changes of some sort in the hearing mechanism. The important fact is that *changes do take place*, and they must be compensated for. Otherwise, the hearing aid is discarded in disgust, or worn in spite of its inadequacy, to the ultimate detriment of the patient's nervous and physical health.

That is why it is Acousticon's policy to sell *and maintain* good hearing, rather than just another hearing aid. There is no charge for changing fittings during the initial period.

Various attachments and accessories are available to hearing aid users. Of interest to *Wireless World* readers is Acousticon's "Super-Radion." This is a miniature radio which can be plugged into any of Acousticon's current models. As can be seen from the illustration, it is smaller than the smallest of the hearing aids (A-120). It consists essentially of a two-valve circuit—one stage of r.f. amplification and detector—powered by the hearing aid batteries. The output goes into the three-valve a.f. amplifier of the hearing aid itself, so that the combination is the equivalent of a five-valve set.

Two aerials are provided, both plug-in. One is a 4ft length of flexible insulated wire; the other, a 15ft length. In the average home at night, especially if the aerial wire is draped over the telephone, or an electric lamp, it is possible to pick up stations all over the United States.

The inspiration for this idea came from the miniature radios, made up to look like hearing aids, which were employed by European underground movements during the war.

Many hard-of-hearing persons complain that they cannot hear the radio properly, with or without a hearing aid. This is due, in part, to the fact that many American radio announcers and speakers tear along like a rocket, and do not always enunciate properly. In part, it is due to the losses and distortions which occur: (1) in the radio; (2) in room acoustics; and (3) losses in pick-up by the hearing aid. All these losses are eliminated by using the "Super-Radion."

The set can also serve a very valuable function in rehabilitation. Many people who have been severely deafened for many years suffer a sound-memory loss. Certain words, not heard for years, are forgotten, and by listening attentively to the radio for a certain period every day, the ability to hear and recognize words is improved.

Future Trends

There are several new developments in the way of design or components. One of these is a new receiver just placed in the market which has a diameter no greater than a sixpence. This is smaller than anything yet produced. The advantage claimed for it is that it can be seated further into the ear and thus made less conspicuous. Receivers now available must (except with very large ears) be held outside of the ear by building up the earmould appropriately. In the new receiver, the attachment to the earmould can be offset to fit the ear, and the amount of moulded material reduced to permit snug seating of the receiver within the outer ear.

One or two American hearing-aid manufacturers have already incorporated printed circuits and/or automatic volume control, but some manufacturers with very high standards are not yet satisfied that these developments can be incorporated in their instruments to advantage.

Another development being worked on is the rechargeable "A" battery. The idea here, of course, is to reduce the cost of operation.

A leading contender in this field is a silver oxide-zinc cell, being pioneered by André and Yardeny. While two American hearing aid manufacturers have "jumped the gun" with batteries of this type, it is felt by conservative engineers that this battery has not yet reached the stage where it can safely be entrusted into the hands of the public.

T-Match Television Aerial

Built Inexpensively with Simple Tools

By B. MAYSON *(Marconi's Wireless Telegraph Company)*

IN the field of v.h.f. communications the T-match type of aerial has been in use for some years, although for television purposes it appears to have been entirely neglected in favour of the split dipole. It is not clear why this should be so because the T-match type has three basic points which should make it attractive to the home constructor, if not to the manufacturer.

First, the use of a continuous rod for the receiving element, reinforced by the matching section, gives mechanical strength and electrical efficiency with ease of construction. Secondly, close aerial-feeder matching can be achieved. Thirdly, the whole metallic structure can be earthed to provide not only a lightning conductor but a drain for static charges, with a consequent reduction in receiver noise.

Having decided on the type of aerial to be made, the next step was to fix its measurements. Not an easy matter this, especially as regards the T-match, for design is influenced by many factors, some opposing others, and by differences in expert opinion. The measurements decided on are shown in Fig. 1. In general, the T dimensions were determined from data obtained experimentally.

Great care was taken in selecting materials, especially when it came to the vertical rods. One can see the sorry results of false economy in this respect all too often.

Half-inch duralumin tubing with a wall thickness of $\frac{1}{16}$in was chosen for the vertical rods. A lesser gauge is risky. Aluminium tubing is quite unsuitable for the purpose, not having the necessary mechanical strength, otherwise many metals and alloys will meet the requirements. Whatever material is used, the rods should be obtained each in one piece, if possible In the writer's case 6-ft lengths only were available, necessitating a joint at the centre of each rod, which was done by getting some round duralumin rod, just oversize to the bore of the tubing, rubbing it down, and making a force fit. Care was taken during this, and subsequent operations, not to damage the tubing.

Three-quarter-inch gas tubing was used for the assembly shown in Fig. 2 (a), the threads being cut by a local tradesman. This resulted in an extremely strong but rather heavy job. Where weight is an important consideration half-inch gas tubing would be preferable and would no doubt be quite strong enough.

In Fig. 2 (a), B is a hole drilled in the underside of the horizontal member nearest the receiving rod. It is fitted with a rubber bush. Through this hole the feeder is passed from the matching section and thence down the mast section C, which, like the horizontal part of the H, consists of three-quarter-inch gas tubing having a wall thickness of $\frac{5}{32}$in. A mast section length of 10ft was used, attached to a wooden pole, as described later. A similar length would be just right for a chimney mounting. Alternatively, where a lighter assembly is required, half-inch gas tubing having a similar wall thickness would do very well, with a horizontal part to match.

The receiver and reflector rods were fitted with the aid of reducing adaptors, A in Fig. 2. When purchased, of course, these adaptors had threaded bores, fortunately about $\frac{1}{8}$in less in diameter than the duralumin rod. Accordingly, after being softened in a gas flame, the adaptor bores were filed to take the rods. Next, two rounded grooves were filed in each adaptor as shown in Fig. 2 (b). Then, with the adaptors screwed into the T-pieces, the duralumin rods were positioned and finally secured by means of pins driven into the adaptor grooves. Small oval nails, minus heads, were used as pins.

Fig. 3 gives details of the matching section, duralumin tubing as specified above being used for the rods. The porcelain insulator has metal end bushes, tapped 2 B.A. On to each of these ends was screwed an inch of ebonite tubing, to which the matching rods were secured by pushing them over the ebonite. The brass supporting strips C were secured to the duralumin rods by 6-B.A. screws and nuts. These strips were fixed at right-angles to the horizontal part of the H, but the positioning is in no way critical.

The 80-ohm co-axial feeder was terminated with a co-axial

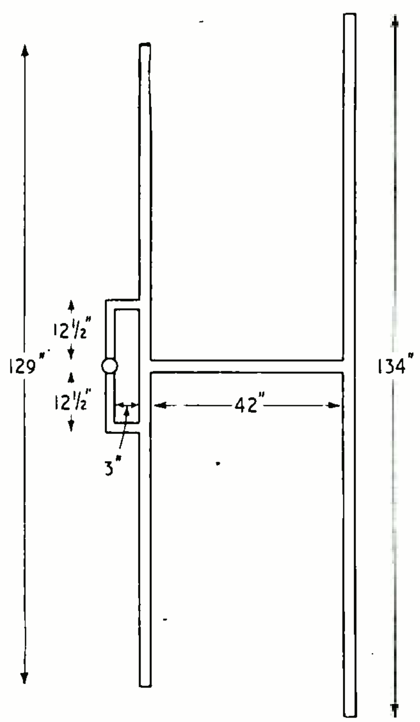


Fig. 1. General form of T-match aerial

plug, fitted into a socket. The socket (feeder inner conductor) was connected to the upper matching rod clip by means of a 16-s.w.g. Telcothene-covered wire. The plug (braid) was connected to the lower matching rod clip in a similar manner. The soldering was very carefully done; readers who are not used to working with light co-axial cables should note that it is only too easy, when soldering the outer part of the plug to the feeder braid, to run the solder through on to the inner conductor. A simple way of avoiding this fault is to slip a tube of brown paper between the insulation and braid.

Considerable attention was given to weather-proofing the completed aerial, bearing in mind that duralumin is particularly liable to corrosion and that dissimilar metals joined together are subject to electrolytic action.

To begin, all metallic parts were thoroughly prepared in the normal manner and then roughened with a wire brush to provide a good base for the paint. If the reader can get his parts sand-blasted, so much the better. All electrical connections in the matching section were well cleaned before being screwed up. Joints and connections were sealed with Bostik B Compound, which was also used for plugging the ends of the tubes. The feeder connection was wrapped in insulating tape and tied with fishing line. Finally, the assembly was given a coat of red lead followed by two coats of good aluminium paint.

Mounting the Aerial

How the aerial is mounted will naturally depend on the reader's circumstances. The writer's choice was a 30-ft spruce pole, erected in the garden about 40ft from the house. The mast section, C in Fig. 2, was clamped to the pole by means of shaped metal bands $\frac{1}{8}$in thick, made with some difficulty without the aid of an anvil. A 16-s.w.g. earthing wire was run from C down the pole to a buried copper plate. Two sets of stays were fitted to the pole, three stays to a set. These were considered necessary owing to the weight of the aerial assembly, and because the pole diameter at the top was 2in only. The stays were made of 14-s.w.g. galvanized iron-wire sections connected by egg-type insulators spaced 7ft apart. Whether insulators are really necessary in the case of a receiving aerial of this kind is a matter of opinion; the writer considers it good practice to fit them.

The measurements given in Fig. 1 were based on the London vision frequency, 45 Mc/s. Suggested measurements for Sutton Coldfield, 61.75 Mc/s, are:—

Reflector rod	97.5in
Receiving rod	93.5in
H spacing	31.0in
Matching rods, each	9.0in
T spacing	3.0in
Insulator spacing on stays	5.0ft

(Reflector rod = 0.51 wavelength. Receiving rod = 0.49 wavelength. H spacing = 0.16 wavelength. Insulator spacing on stays = $\frac{1}{4}$ wavelength. Wavelength = vision wavelength of station required.)

As explained above, the remaining dimensions were determined from experimental data.

The aerial described was built at a cost of £3 10s, including the pole and feeder. It is located on low-level ground 30 miles from the London transmitter and has been in use for some months, the performance being completely satisfactory.

In conclusion, readers who have not yet been at close quarters with a television array are reminded that the finished assembly is a very awkward thing to handle where space is limited; a little thought given to this point before construction is started may well save trouble later on.

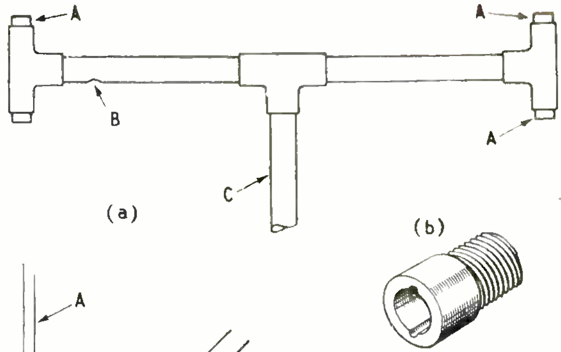


Fig. 2. The detail of the horizontal member is shown at (a) with a "close-up" sketch at (b) of one of the modified reducing adaptors.

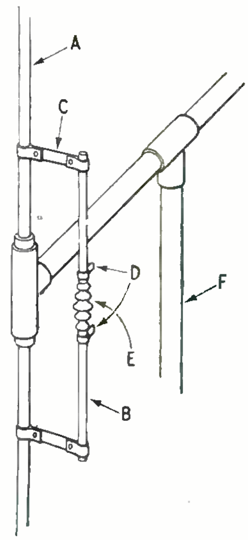


Fig. 3. Perspective sketch of the T-matching section; A = aerial rod, B = matching rods, C = brass supporting strips, D = cable-connecting clips, E = insulator, F = upper part of mast section.

RADIO TAXI

Although many private-hire cars have been fitted with two-way radio, the first London taxi to be so equipped has now been approved by the Commissioner of Police. The Marconi 10-W v.h.f. transmitter-receiver (Type H16) is installed under the driver's seat and, as can be seen in the photograph, the microphone is fitted above the windscreen and the combined control unit and loudspeaker below the dashboard.

New Bridge Technique

Square-wave Excitation Instead of Sine Waves for Measuring Complex Impedances

By THOMAS RODDAM

A LETTER to *Nature** recently described a new bridge technique which appears to be of considerable interest. Bridge circuits, as generally used, operate at a single frequency and give an answer which is valid at that frequency alone. Often this does not matter: if the impedance which is being measured is a good resistor, or a good capacitor, the value of resistance or capacitance is the same at 50 c/s as it is at 5,000 c/s. If the impedance which is being measured is not a simple one, it is necessary to know what form it has if the results of a measurement at a single frequency are to be properly interpreted.

Let us, for example, consider a circuit consisting of a resistance and capacitance in parallel. The admittance of such a circuit is $(1/R + j\omega C)$, so that the impedance is $R/(1 + j\omega CR)$. This can be written as

$$\frac{R}{1 + \omega^2C^2R^2} + \frac{1}{j}\,\frac{CR^2}{1 + \omega^2C^2R^2}$$

This is the impedance of a resistance $\dfrac{R}{1 + \omega^2C^2R^2}$ in series with a capacitance $\dfrac{1 + \omega^2C^2R^2}{CR^2}$. If, therefore, we balance the unknown circuit by using a resistance and capacitance in series in the bridge arm, we shall obtain values which depend upon frequency and shall have great difficulty in discovering just what the unknown network is.

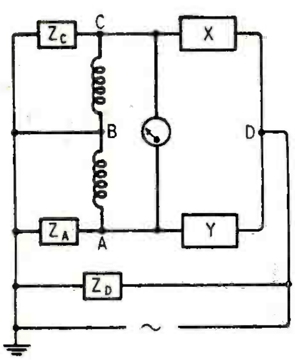
The new bridge technique gets round this difficulty very easily by demanding that the bridge should be balanced simultaneously at all frequencies. This is not as complicated as it sounds, because the frequencies are applied together in the form of a square wave. The bridge output is viewed on a cathode-ray oscilloscope, and the bridge components adjusted until the balance is obtained.

The actual bridge circuit used is one first suggested by Blumlein. It has the particular advantage that it is almost immune from earth capacitance effects. Fig. 1 shows the basic circuit, which differs somewhat from that given in *Nature* in a way to be discussed later. The bridge will be balanced if the currents entering A and C and leaving the tapped coil at B produce no voltage difference between A and C. For tightly-coupled windings of low resistance this means that the products of current and number of turns must be equal for the two windings. The flux in the core will then be zero, so that the potential difference between A, C and B will be very small, being produced by the drop in the resistance and leakage inductance only. This means that the voltage across the capacitances shown as Z_A and Z_C will be very small, so that these capacitances can have little effect on the balance of the bridge. Z_D, being across the generator, cannot affect the balance of the bridge. The bridge is therefore practically immune from the effects of capacitances to earth.

The two impedances X and Y shown in the circuit are, of course, the unknown and the measuring arm. The output from the bridge is easily determined. Suppose that a current 2I is produced by the generator. If the inductance of the ratio arm system is very great, the current will divide equally at B, and the drop across the two external arms will be IX and IY, giving a voltage of I (X–Y) across the detector. If we interchange the generator and the detector, and assume that the detector has a low impedance, the current through the detector becomes $V(1/X - 1/Y)$. It is this interchange of detector and generator which characterizes the circuit described in *Nature*. In Fig. 2 the circuit is shown in this revised form, using a third winding to inject the alternating-current input.

* *Nature*, Vol. 163, p. 132, Jan. 22nd, 1949 (Yates), and p. 571, April 9th, 1949 (Prowse and Laverick).

Fig. 1. Simple form of bridge with inductive ratio arms, showing stray capacitances Z_A, Z_C, Z_D.



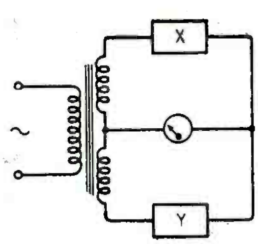


Fig. 2. Circuit with generator and detector connections interchanged.

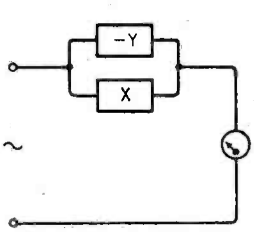


Fig. 3. Equivalent circuit of bridge shown in Fig. 2.

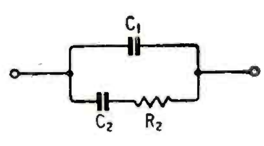


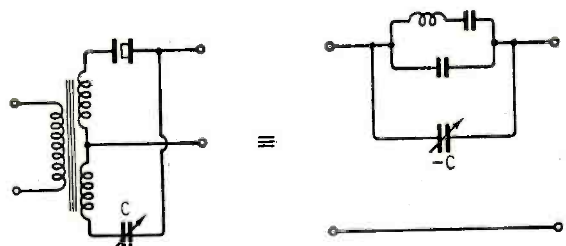
Fig. 4. Typical circuit for which the bridge is particularly well suited.

This last expression is a very interesting one. The output current is proportional to the difference of the admittances, so that the circuit is equivalent to the circuit shown in Fig. 3. In the application for which the bridge is intended, this equivalent is particularly useful. Suppose that X consists of a parallel pair of circuits, as shown in Fig. 4. By adjusting one component of Y, the capacitance C_1 can be completely balanced out, leaving only the circuit consisting of C_2 and R.

A special application of this is already well known. It is the crystal filter used in communication receivers. By adjusting the variable capacitance the value of capacitance in parallel with the series resonant circuit can be varied over a range which includes negative values. In this way the anti-resonant frequency of the combination, at which the filter has a high rejection peak, can be put above or below the narrow pass-band.

The bridge circuit, of course, can be used as an ordinary a.c. bridge, and a number of commercial audio- and radio-frequency bridges have been produced using the inductance ratio arms. Let us now see what happens if we put in a square wave. Consider first the circuit of Fig. 3, with Y equal to zero. If we have a resistance at X, we shall get a square wave of current through the detector, which is now, of course, the input to a cathode-ray oscilloscope amplifier. If we have a capacitance, we shall get a sudden peak of current, dying away as the capacitance charges up. Five typical waveforms are shown in Fig. 6. By looking at the waveform on the oscilloscope, which is, of course, synchronized with the square wave, we can make a pretty good guess at the type of impedance which we have at X. Suppose that we obtain a response like that shown in Fig. 6 (4). We can connect a capacitor at Y in the bridge circuit, and adjust its value until we get a square wave, like the one shown in Fig. 6 (1). Then we add a parallel resistance, adjusting this until we get no deflection at all on the cathode-ray oscilloscope. In Fig. 7 the various waveforms obtained are shown, and it will be seen how easily the two components can be balanced separately. When the bridge has been balanced for

Fig. 5. Circuit of crystal filter used in some communication receivers and its equivalent network.



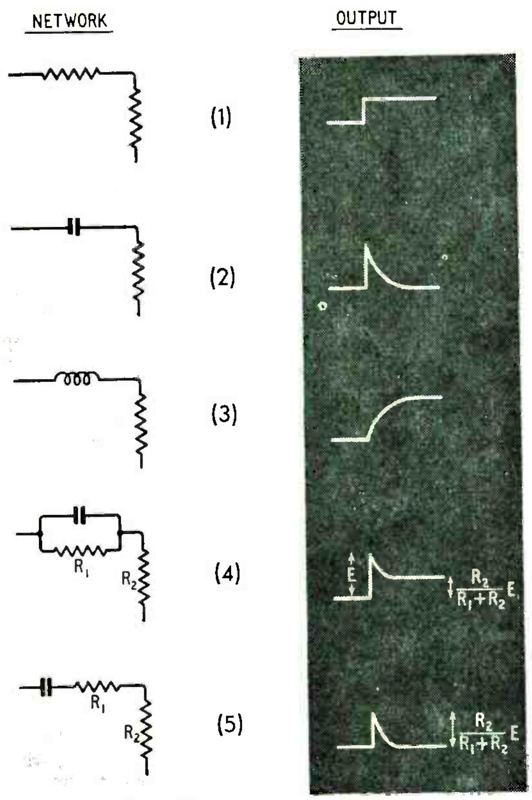
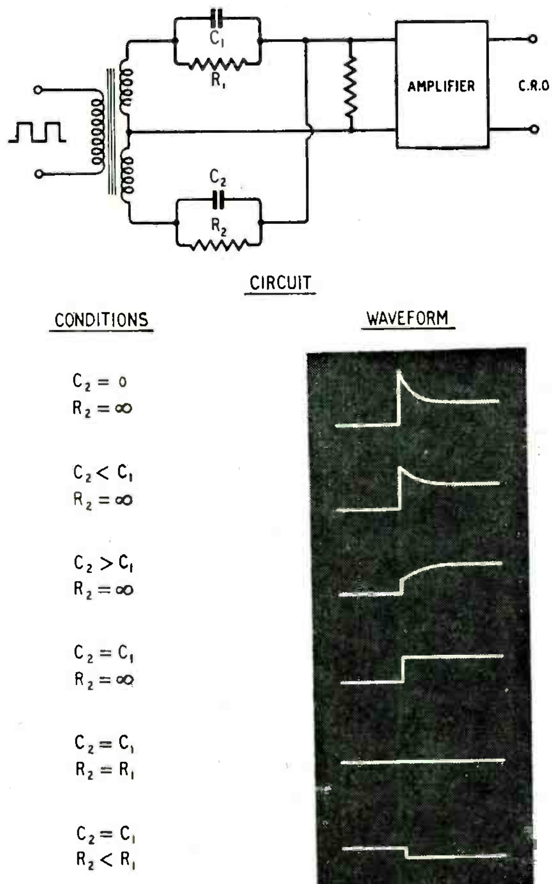


Fig. 6. Typical responses to square-wave inputs.



(Right) Fig. 7. Typical circuit and waveform using square waves for balancing bridge.

square waves, the Y network is exactly equivalent to the unknown. No calculation is needed.

A special application, which is actually that for which the bridge was designed, is the study of dielectrics. An ordinary paper capacitor, the sort used for filtering in power packs and other odd jobbery, has an equivalent circuit which is shown in Fig. 8. In this circuit C is just the usual capacitance, and R the leakage: all capacitors lose their charge ultimately, and usually the product CR is of the order of some thousands of megohm-microfarads. The extra components, *c*, *r*, represent a feature of capacitors which can be both dangerous and annoying.

If a capacitor is kept charged for some time, and then discharged, it will be found that after say 30 seconds it has apparently become recharged. This means that if you short-circuit the capacitors in the television power pack with a screwdriver before you start work on it, you may still get quite a sharp blow when you put your hand on a hot spot a couple of minutes later. That's the dangerous end. The annoying end is that in some circuits operating down to d.c. and using feedback through capacitors, and circuits of this kind are common in servo devices,

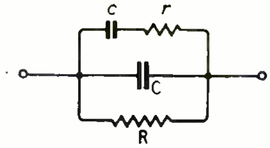


Fig. 8. Complete equivalent circuit diagram of a typical filter capacitor.

there will be a drift due to this secondary charging and discharging. This phenomenon has been called "dielectric hysterics," though I suspect a typist was to blame: another term, which I prefer, is "soaking"; the charge soaks into the dielectric like butter into hot toast. I refuse to pursue the analogy. In circuit terms, the capacitance *c* is charged slowly through *r*, and if C is discharged, the charge on *c* leaks back slowly to recharge C. The way in which this effect varies with temperature is considered to provide a clue to the molecular effects in the dielectric which cause soaking. The bridge is used with C and R balanced out, so that the response is due to the *cr* circuit alone. Changes in this circuit then produce changes in the waveform on the cathode-ray oscilloscope which are not lost in the effects due to C and R.

NEW BOOK

Radio Engineering (Volume 2). By E. K. Sandeman, Ph.D., M.I.E.E. Pp. 579+xxi, Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 40s.

THIS volume completes the work of which Vol. 1 was reviewed in the April, 1948, issue. It deals mainly with interference and noise, receivers, measuring equipment, response adjustment and equalizer design, feedback, network theory, and filters.

The chapter on network theory is the longest and most fully developed. The novices, for whom, among others, the whole book is intended, would probably welcome a few numerical examples to help them through this chapter.

In the chapter on feedback, the aspects of stability and input impedance are treated exceptionally fully.

The chapter on measuring equipment is of interest chiefly for its fairly detailed descriptions of instruments used mainly in broadcasting. All else is very perfunctory except for r.f. bridges and frequency comparison by Lissajous figures. The latter method, which is made to appear far more difficult and confusing than it is in practice, is one of very few applications of the c.r.t. included. The only c.r.t. shown is a diode type; brilliance control is not mentioned. The treatment of a.f. capacity bridges includes measurement of leakage but ignores other losses. Even though this chapter apparently does not attempt more than a B.B.C.'s-eye view of the subject, one would have expected that intermodulation would have been recognized as a form of distortion worth mentioning, if not actually measuring.

The chapter on receivers is even more disappointing, in that it is not only unbalanced but actually misleading. Obsolete practice is given prominence and a number of important considerations unmentioned. The latter part of the chapter is devoted to B.B.C. instructions on receiver measurements. They have to be read in conjunction with the specification tentatively introduced by the now extinct R.M.A. in 1936. Incidentally, the statement that an inductance of 0.5H "may be constituted conveniently by a 50-000-μH Bulgin H.F. choke" seems to suggest a regrettably wide manufacturing tolerance!

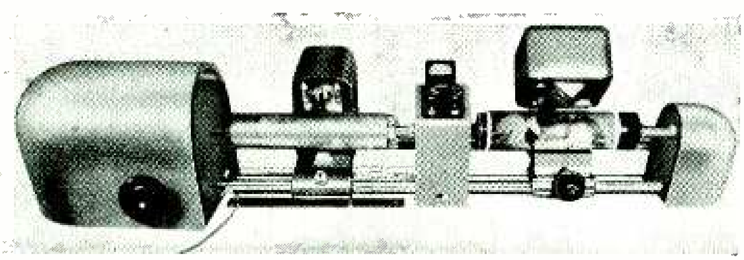
The chapter on interference and noise is, on the whole, a good survey of the subject. But i.f. harmonic interference should certainly have been included among those to which the superhet is subject.

Introducing the 75-page bibliography, the author admits that it is incomplete and unsystematic, and that inclusion of a reference does not guarantee that it is useful even in its own sphere. If this is so—and it obviously is—one wonders why so much space was devoted to it.

It is a pity that among the many authorities to whom the author acknowledges help in providing the material for this book—much of it very sound and hitherto unpublished—he had not included any to advise on balance and presentation.

M. G. S.

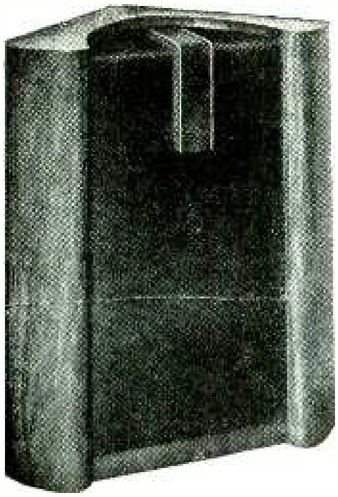
Electronic Photo-engraver

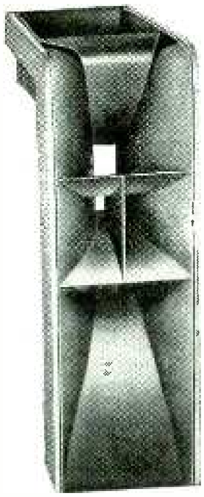


Designed for the rapid production of half-tone blocks, this machine by the American Fairchild Corp. scans the original print (right) by means of a photoelectric cell, and engraves a plastic sheet on the roller (left) with the equivalent half-tone dots through the medium of an amplifier and a current-heated stylus. Average time for the production of a column block is six minutes, and the maximum size available is 8in × 10in.

Corner Ribbon Loudspeaker

Realistic Sound Distribution





Dimensions of the Corner Ribbon loudspeaker are: height, 34in.; maximum radius, 24in. The high-frequency horn is segmented to give improved sound distribution.

THE development of this high-quality reproducer, which is made by the Acoustical Manufacturing Company, of Huntingdon, has been carried out against a background of measurement and subjective listening tests involving comparison between the original and the reproduced sound. In deciding on the final design, considerations of naturalness and "presence," for which methods of measurement have not yet been evolved, were given due weight.

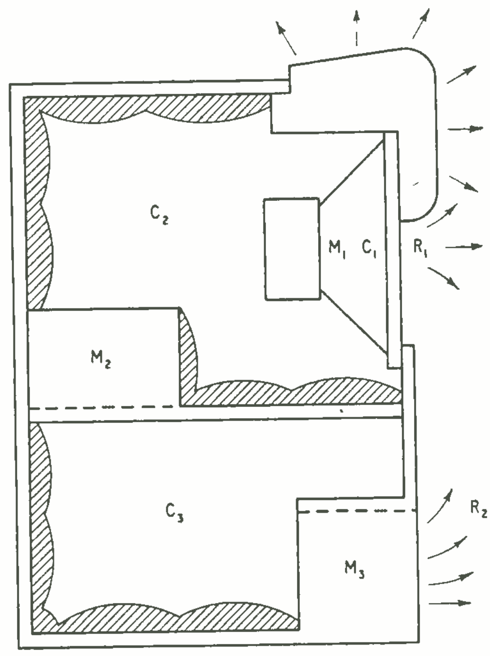
Essentially, the unit comprises a twin cone diaphragm loudspeaker for low frequencies and a horn-loaded ribbon diaphragm for frequencies above 2,000 c/s. The back radiation from the l.f. unit is modified by a two-stage acoustic filter and emanates from a vent at the bottom of the cabinet. Two stages are used to give a smooth downward extension of the low-frequency response without introducing complications in the region of 150-200 c/s.

The 0.00025in-thick aluminium ribbon diaphragm of the h.f. unit is loaded at the front by a multiple horn designed to give the optimum distribution both vertically and horizontally. The back radiation is directed towards the corner walls of the room and provides further extension of the sound source to enhance the realism of orchestra music. On speech the residual directional properties of the main cone predominate and give the appropriate effect of a point source.

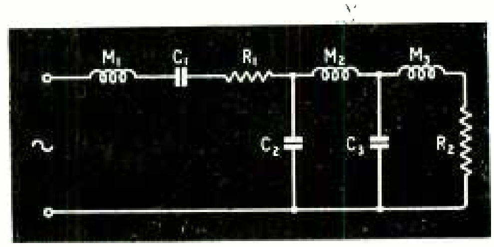
We have had an opportunity of listening to this loudspeaker on a variety of programmes, and the manner in which the apparent source adapts itself automatically to the frequency content of the original is strikingly effective. Another outstanding quality of the performance is the transient response. One does not need to wait for loud and dramatic passages in the music to demonstrate this. It is there all the time, in the bowing attack of strings in pianissimo passages and in other subtle ways that will be appreciated by those that have ears to hear. For instance, the difference in quality between a spherical and an elliptical reproducing point on high-quality recordings is at once apparent.

The bass response is smooth, and judging from some organ recordings, effective down to frequencies of the order of 20 to 30 c/s. In the top register the character of surface noise is much less objectionable than usual, due no doubt to the effective damping of the ribbon and the absence of resonant coloration. The response has not been measured by the makers above 18 kc/s, but is believed to extend to 30 kc/s.

A cross-over network is included and the input impedance is 15 ohms. It is important that sustained single-tone inputs to the h.f. unit should not exceed a power of 1.5 watts, but on speech and music the power input to the loudspeaker as a whole can be raised to 12 watts. Normally, the Corner Ribbon loudspeaker will be installed by the manufacturers, and the price is £83.



Section of bass acoustic filter, with equivalent circuit. R_1 and R_2 represent radiation resistance of the front of the cone and the cabinet vent.



Amateur Exhibition

Third Annual Show Held by the R.S.G.B.

THE visitor seeking advice on any of the products displayed at this year's amateur exhibition rarely found difficulty in obtaining the kind of information he required, as among the staffs of the various firms present could usually be found one or more wearing the familiar R.S.G.B. button hole badge of the licenced amateur.

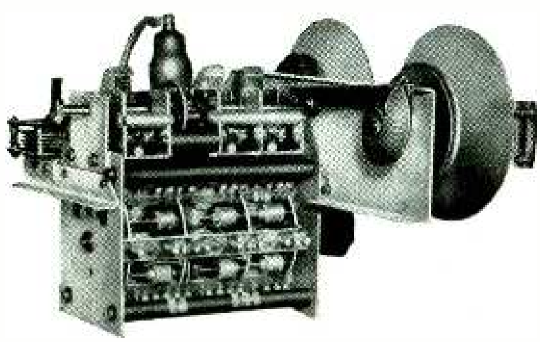
Keen interest was taken in the latest equipment for the higher radio frequencies, especially for 460 Mc/s (70 cm). A particularly impressive and well-executed corner reflector aerial system was shown by G.S.V., which being constructed of light alloy, weighs 12 lb only and, curiously enough, gives a gain of 12 db over a half-wave dipole.

Any new valves, especially of the v.h.f. variety, were bound to attract attention. G.E.C., for example, had a miniature version of the KT61 output tetrode, the N78, with an anode dissipation of 9 watts and giving 4 watts audio output. It has several applications in small transmitters, such as for crystal oscillator and frequency doubler and tripler up to about 100 Mc/s.

A miniature L63, in the form of the L77, is new and in addition to its use as an a.f. voltage amplifier it finds many applications in transmitting circuits up to 250 Mc/s. Disc-seal triodes cater for the higher frequencies, the DET22 being one that can be used as an oscillator up to 3,000 Mc/s (10 cm). As amateur activities now extend into the 1,215 Mc/s region such valves are of definite interest.

Other new G.E.C. valves were the TT17, an equivalent to the American 829B but with a 19-volt heater, the TT16, which closely resembles the Eimac 4-125A triode. There was also a range of germanium and silicon crystals.

Some of the new miniature valves shown by Standard Telephones have dual personalities in that whilst they appear to be receiving types they can also be used in transmitting circuits. The 12AT7, which is a double triode on the B9A or "Noval" base, makes an efficient frequency changer for v.h.f. superhets, one triode being the oscillator, the other the mixer. It can be used in this way up to 300 Mc/s.



Denco rotary coil turret, Type CT4C, fitted with r.f. and f.c. valves. Mechanical bandspread is incorporated.

Also on the Noval base is a miniature r.f. beam power tetrode, the 5763, having an anode dissipation of 12 watts, which finds application as frequency doubler and tripler up to 175 Mc/s and as the output valve in small transmitters.

For still higher frequencies Standard Telephones have a range of disc-seal triodes, one of which, the 3A/147J, or CV82, has already proved its worth in 460 Mc/s amateur equipments. It functions well on quite low voltages and should prove useful in low-power v.h.f. transmitters for radio control of models.

Miniature quartz crystals as used in commercial v.h.f. equipments for some time past are now becoming available to amateurs. The new type F shown by the Quartz Crystal Company has pin spacing to fit an international octal valveholder, two units being easily accommodated in one socket. These have gold plated quartz plates with the crystal suspended in the holder by its connecting wires, a form of shock-proof mounting that renders the crystal practically immune to damage by rough handling.

Examples of miniature plated crystals were shown also by Salford, one type measuring $\frac{3}{4}$ x $\frac{3}{4}$ x $\frac{3}{8}$in only is fitted with pins to plug into an octal valveholder.

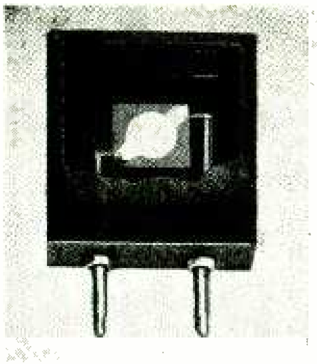
Another method of mounting oscillator and resonant-type crystals is in small glass envelopes with base pins resembling the new miniature valves. This type were shown by Quartz Crystals, Salford and Standard.

The paucity of communications receivers was a matter of some surprise as this kind of set forms the backbone of all amateur stations. Webb's Radio had a fairly comprehensive range of Eddystone sets including the latest model 710, also described as the "All World Six," and designed primarily for overseas use as it takes all power from a 6-volt accumulator. The price is £37 10s.

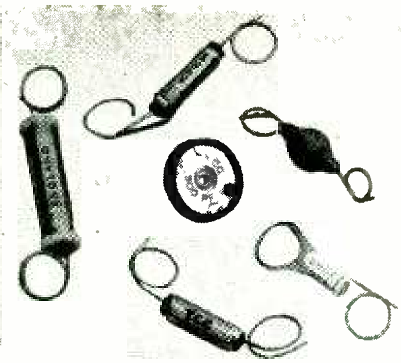
Several improvements have been made in the Denco DCR19 communications receiver, this set being notable for its unusually high intermediate frequency of 1.6 Mc/s. It has an r.f. and three i.f. stages with eight tuned circuits, and additional selectivity is afforded by a crystal filter and also an audio filter, all individually switchable. The coverage is 36 Mc/s to 175 kc/s and the price is £49 10s.

Redesigned coil turrets with shortened contacts and made largely of polystyrene, some incorporating r.f. and f.c. stages, were shown by Denco, which firm had also a range of television parts, one being a combined line output transformer and e.h.t. unit But in general components were not over plentiful although Webb's Radio had a range of Eddystone parts and Southern Radio showed examples of Labgear, Q-Max, Raymart and Wearite products.

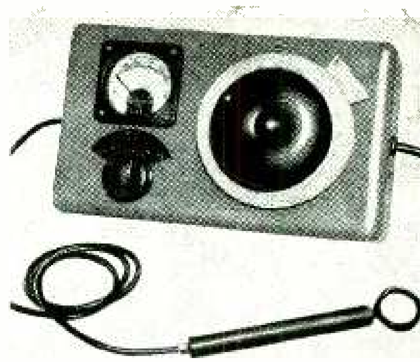
The extent to which T.C.C. capacitors cater for all amateur needs was well exemplified by this firm's exhibit, and as befitted the occasion, emphasis was



Shock-proof mounting of crystal plate adopted by Quartz Crystal Company.



Group of T.C.C. miniature capacitors including a Micadisc, Plastapack, Metalicon and various ceramic types.



E.M.I. absorption wavemeter covering 1.6 to 30 Mc/s. There is another model covering the v.h.f. range 100 to 160 Mc/s.

placed on the latest miniature ranges such as Micropacks, Picopacks, Plastopacks (which are noted for extremely high insulation resistance) and a wide selection of small silvered ceramic capacitors employing the new "High-k" material.

Mains, audio and modulation transformers of various designs and characteristics constituted the Woden exhibit and an opportunity was offered here to examine at first hand the various transformers and chokes needed for the *Wireless World* "Williamson" amplifier.

A.F. components were a feature of the Varley exhibit and these shared space with a range of heavy-duty variable resistors and e.h.t. transformers.

A number of useful pieces of test apparatus, designed especially for amateur stations, were shown by E.M.I. There was an absorption wavemeter, with a germanium crystal and micro-ammeter as the indicator covering 1.6 to 30 Mc/s and a companion model, for the v.h.f. worker, with a range of 100 to 160 Mc/s. Others comprised a grid-dip oscillator, a spot frequency meter with a 1-Mc/s crystal giving detectable harmonics up to the 146th, and a cathode-ray tube modulation indicator.

Taylor Electrical had a comprehensive display of their various items of test gear including a new television signal generator giving a pattern and covering the London and Birmingham frequencies. There were also pointer instruments and instrument parts on this stand while AVO showed a range of Avometers extending back over 25 years for historical interest and supported this with most of their latest products in the test instrument class.

For the discriminating amateur, who likes his station neat, tidy and safe at high voltages, Imhof had a wide range of metal cabinets and associated items, such as panels, chassis and panel fittings. To select one item only, the Model 1022DR cabinet typifies a style that should prove popular, as it accommodates three chassis 17½in x 10in with panels 19 x 10½ and it is totally enclosed.

If non-standard cabinets are required the demand can be met by Philpotts Metal works, which firm showed a number of "tailor-made" cabinets.

It may be interesting to record that S. G. Brown's adjustable-reed headphones—much sought after even before World War I—are still made and the latest pattern, Type "A" closely resemble the early ones in appearance, but the magnet system is greatly improved. They cost £3 17s 6d a pair.

Rola and Celestion loudspeakers, ranging in size from 2½in to 18in, were shown by Cyril French in company with a comprehensive selection of McMurdo valveholders, including all the newest miniatures.

Finally, mention must be made of the apparatus displayed by the General Post Office. By a neat arrangement of "trafficator" lamps, the current distribution on correctly and incorrectly terminated twin-wire and co-axial feeders was convincingly demonstrated. Another demonstration showed the latest development in aerial lenses for centimeter wavelengths.

Group of Osram valves including the TT17, L77, N78, DET20 and a Germanium crystal.

The 12AT7, 5763, 2C26A, and 3A/147J valves shown by S.T.C.

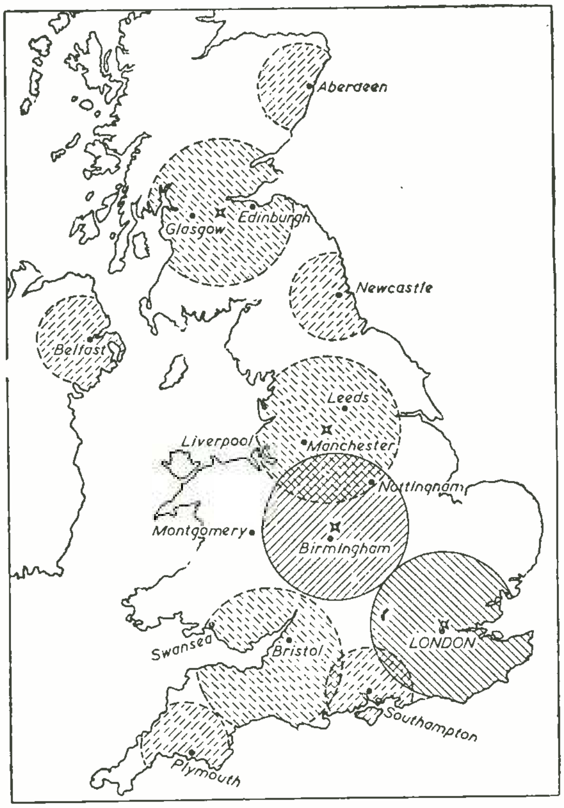
Extending Television

Second Link in Proposed Chain

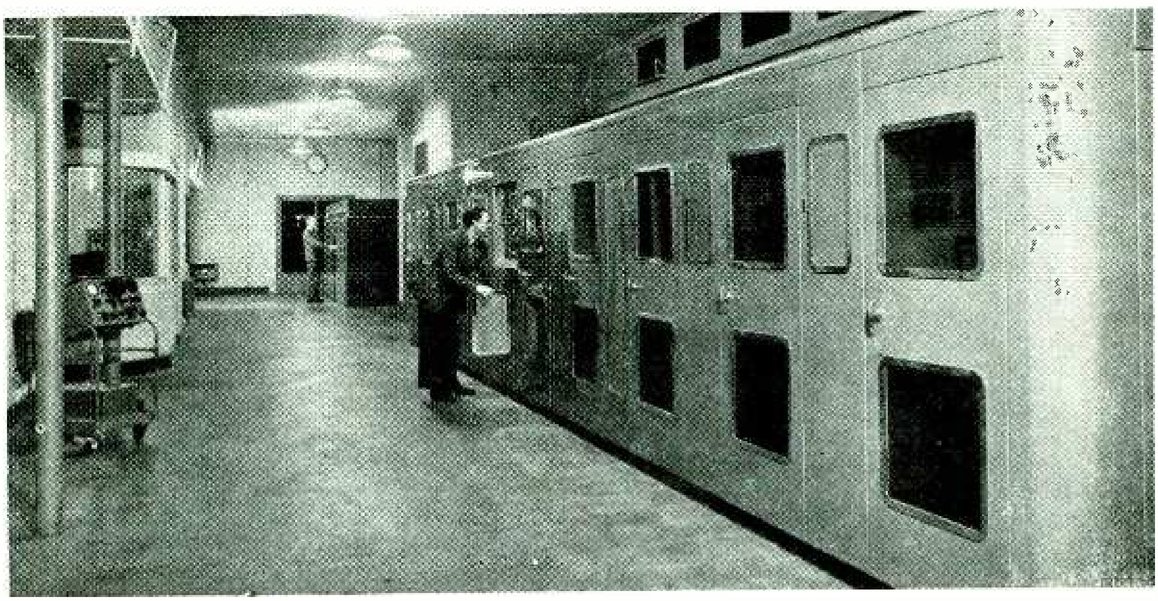
WITH the opening of the Midland television station at Sutton Coldfield, some 10 miles north of Birmingham, on December 17th, the second link in the proposed chain of transmitters in the United Kingdom was completed. Although data giving the service area of the Midland station has not yet been completed, Sir Noel Ashbridge has stated that while the average range will be about 50 miles—as shown on the accompanying map—"it will be greater to the east than to the west, where the Welsh hills will constitute a formidable obstacle." During tests reception at two or three times the distance has been recorded.

The vision transmitter, which, together with the control equipment, has been supplied by E.M.I., is operating on 61.75 Mc/s with a power of 35 kW—more than twice the power of Alexandra Palace. The crystal drives for both the vision and sound transmitters have been provided by Marconi's, whilst the vision r.f. amplifiers came from Metrovick. The Marconi 12-kW, Class "B," amplitude-modulated sound transmitter is operating on 58.25 Mc/s.

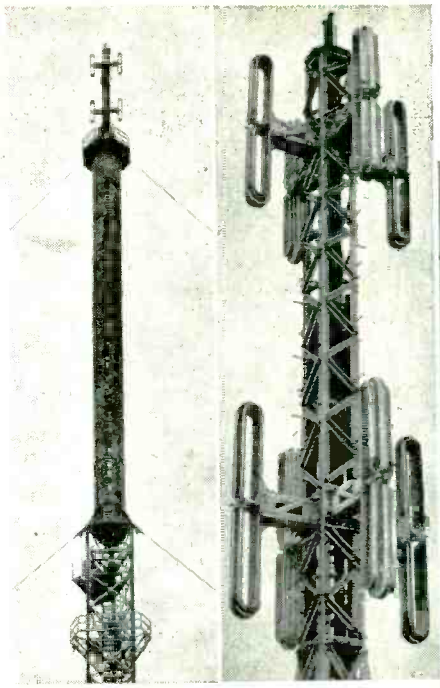
The single wide-band aerial, which will radiate both sound and vision and consists of two tiers of four vertical folded dipoles arranged in cruciform, was designed by the B.B.C. Research Department in



This map gives some idea of the anticipated coverage of the proposed chain of ten stations. Sites for the Bristol and low-power stations are not yet chosen.



The transmitter hall at Sutton Coldfield with the E.M.I. 35-kW vision transmitter in the foreground and, beyond, the Marconi 12-kW sound transmitter.



Combined sound and vision aerial array (centre) at the top of the 750-ft mast—constructed by B.I. Callender's Cables—is some 1,300 feet above sea level. The cylindrical structure below the television array (left) includes slot aerials for the proposed e.h.f. broadcasting experiments.

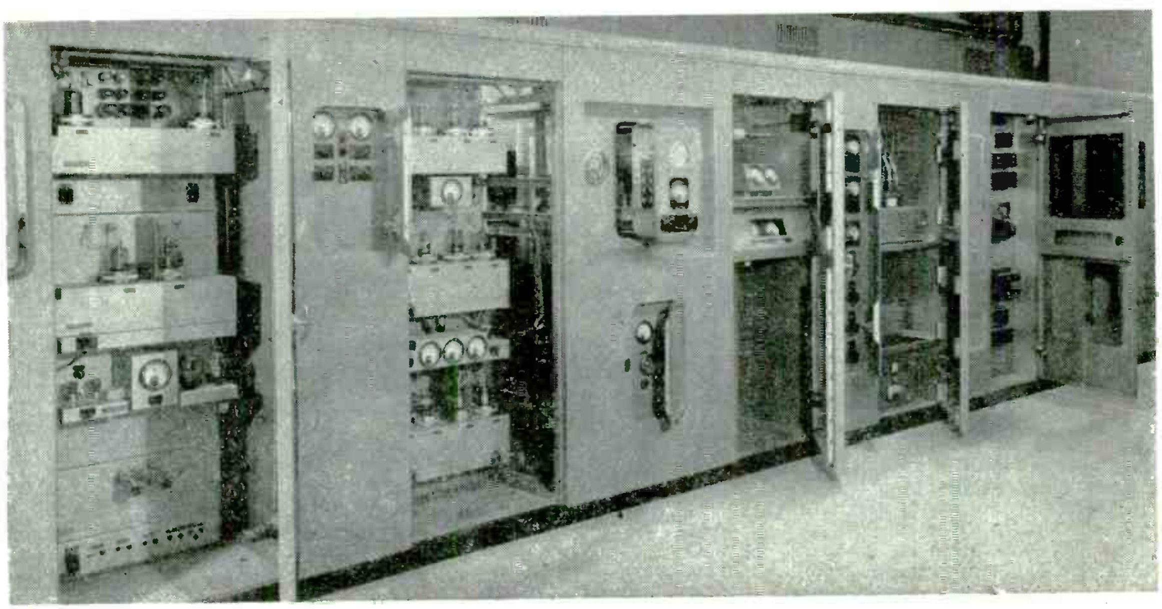
Control desk for the sound and vision transmitters is shown below.

collaboration with Marconi's, the manufacturers. Sound and vision signals are fed from the respective transmitters to a Marconi "Diplexer," or combining unit, from which the combined transmission is fed to the eight dipoles. We hope later to include a technical description of the station.

The plans for extending the television service to half the population of the United Kingdom within two years and to some 80 per cent by the end of 1954, provide for ten transmitters—five high-power and five low-power. The site for the third main transmitter has already been chosen at Holme Moss in the West Riding of Yorkshire.

The site for the Scottish station has not yet been announced, although negotiations are said to be proceeding for the purchase of ground near Harthill, Lanarkshire, which is some 10 miles south of Falkirk and equi-distant from Edinburgh and Glasgow. The fifth main station is to be in the Bristol Channel area. The service area of the five low-power stations is of course still a matter of conjecture and they are shown on the map with a 30-mile radius.

Modulator stages of the Sutton Coldfield vision transmitter are on the left and the r.f. stages on the right.



WORLD OF WIRELESS

Television Progress ✦ Radar Film ✦ Remotely-Controlled Transmitter ✦ Receiver Production

Receiving Licences

FOR the first time the monthly increase in television licences exceeded that of "sound" licences.

Of the 12,124,250 broadcast receiving licences current in Great Britain and Northern Ireland at the end of October, 188,350 were for television sets. Increases of 15,300 "sound" and 17,350 television licences were recorded during the month. The record television increase was almost double that in September. One wonders how much the increase in television licences is due to Radiolympia, to the extension of the television service to the Midlands, or to both.

Ionosphere Disturbances

ADDITIONAL information on ionosphere disturbances is now being radiated by the United States Bureau of Standards transmitter WWV at Washington.

At 19 and 49 minutes past the hour the station now radiates on the standard radio frequencies one of three letters, N, W or U, in morse, to indicate conditions of the ionosphere. N indicates normal conditions; W that disturbed conditions are present or are expected within twelve hours; and U—the additional classification — that conditions are unstable.

Marine Radar

A DOCUMENTARY film, "In All Weathers," showing the background against which the pre-eminence of British radar for merchant ships has been achieved, was given a press preview in London recently. It has been made under the auspices of the Central Office of Information and is for showing overseas to stimulate interest in British commercial marine radar.

The film includes some interesting shots of s.s. *Manchester City* berthing at St. John, New Brunswick, at night and in thick weather. It also traces the development of the Ministry of Transport prototype marine radar from Admiralty designs and emphasizes the rigorous performance tests which commercial sets must pass before being granted a Ministry of Transport Certificate of Type-Testing.

Eight types of set made by four manufacturers—Cossor, Metrovick, Kelvin-Hughes and Marconi—have so far passed these tests which are undertaken by the Admiralty Signal and Radar Establishment on behalf of the M.o.T. British merchant ships are now being fitted with commercial radar sets at the rate of 15 a month. Some 400 U.K. ships and over 200 foreign vessels have so far been equipped with British gear.

Multiple-unit Transmitter

A TRANSMITTER has been designed by Wayne Kerr for unattended operation at remotely controlled stations and is being used by the B.B.C. at the Brighton Third Programme station. It has duplicate low-power radio-frequency and modulator units, and ten identical modulated amplifier units, each of which comprises a r.f. amplifier, series modulator and power supply.

Each unit is provided with an automatic protection circuit which, in the event of a fault, isolates the unit from the remainder of the transmitter. Any five of the ten modulated amplifier units can fail before the transmitter shuts down. With all ten units operating in parallel, as they normally do, the r.f. carrier power output is 1.5 kW.

The series modulator employs an unconventional circuit, in which the modulator valve acts as a cathode-follower with the modulated amplifier valve as cathode load. Thus all the advantages of a cathode follower are obtained, particularly low distortion.

Television Sales

RECORD sales of approximately 36,500 television receivers by manufacturers to dealers in October is announced by the British Radio Equipment Manufacturers' Association. The total is a 75 per cent increase on the sales during the whole of the first three years of the television service (1936-1939) and 10,000 more than that for the whole of 1947. The previous highest monthly sales figure was 21,000 in September. Sales in October exceeded production by nearly 10,000.

According to figures issued by B.R.E.M.A. the industry has manufactured 300,000 television receivers since the war. Manufacturers' home sales of broadcast receivers during September reached 100,000—nearly twice the August figure—and radio-gramophones 8,000.

American production figures show that in October nearly 305,000 television sets were made. The total for the year ending October 31st was 1,707,600.

Airport V.H.F. Radio

DEMONSTRATIONS showing how time and effort can be saved and the working efficiency improved by the use of mobile v.h.f. radio telephones were given recently at London Airport by Marconi.

A section of the Wayne Kerr multiple-unit transmitter is shown withdrawn from its housing on the trolley provided for maintenance.

Marconi walkie-talkie (Type H19) as used by one of the airport staff.

Although weather conditions hampered movements of aircraft and vehicles, reports and ground control instructions were rapidly passed between a temporary headquarters station, members of the staff at distant points equipped with Marconi walkie-talkies and aircraft tenders fitted with the mobile Type H18 two-watt transmitter-receiver. The headquarters station used the 10-watt equipment (Type 16A).

PERSONALITIES

Air Comdre. W. E. G. Mann, C.B.E., M.I.E.E., R.A.F. (Ret.), has been appointed Director-General of Navigational Services in the Ministry of Civil Aviation in succession to Air Comdre. W. G. P. Pretty, O.B.E., who was seconded from the R.A.F. to the M.C.A. During the war Air Comdre. Mann was Chief Signals Officer, R.A.F. Middle East, and since joining the M.C.A. has held several administrative telecommunications posts. Since August 1948 he has been Director of Navigational Services (Telecommunications).

R. W. J. Sullivan, B.Sc., who succeeds Air Comdre. Mann as Director of Navigational Services (Telecommunications) at the M.C.A., began his radio carreer as a student apprentice at Siemens and was subsequently in the Technical Service Department of Radio Transmission Equipment, Ltd., a subsidiary of Mullards. During the war he was at Fighter Command headquarters. He was appointed Assistant Director of Telecommunications at the M.C.A. in 1947 and Deputy Director of Telecommunications in 1948.

Hugh Townsend, C.B., is retiring from the position of Director of Telecommunications, G.P.O., to take up the post of Assistant General Secretary of the International Telecommunications Union. He will commence work in Geneva in January. He has been a member of the present Government Television Advisory Committee since it was formed in 1945.

B. J. Edwards, M.B.E., **technical** director of Pye, Ltd., is leading the team of eight technicians who are demonstrating the company's television transmitting and receiving equipment in the U.S.A. The first demonstration was in Washington on November 21st.

Peter E. M. Sharp, B.Sc. (Eng.), who has been appointed Industrial Officer (electronic equipment) with the Council of Industrial Design, was, until recently, with Standard Telephones and Cables, where he was responsible for the production of technical publications. He will be responsible for liaison between manufacturers of electronic gear and the Festival of Britain, and for that part of the 1951 Stock List —from which exhibits will be selected —dealing with domestic radio and television, industrial electronics, radar and communications equipment.

Leslie Hotine, who, as recorded last month, was recently placed in charge of one of the two sections of the reorganized Operations and Maintenance Departments of the Engineering Division of the B.B.C., is leaving the Corporation after more than 26 years' service. He was successively engineer-in-charge of the Glasgow, Daventry and Brookman's Park stations and, since 1943, has been Senior Superintendent Engineer.

J. P. Jeffcock, O.B.E., M.I.E.E., has joined Mullard Electronic Products, Ltd., as commercial manager of the Equipment Division, and has been appointed a director of Mullard Equipment, Ltd. From 1929 to 1936 he was with the Western Electric Co., engaged in the design of sound-on-film equipment. He joined the Air Ministry in 1936 and the Ministry of Aircraft Production in 1941. He was appointed a member of the Civil Aviation Radio Advisory Committee in 1942, and organized the Central Radio Bureau, which has continued in peacetime to promote the exchange of information between the U.S.A. and the British Commonwealth.

J. P. Jeffcock joins Mullards.

IN BRIEF

Wrotham.—It is understood that the Marconi f.m. transmitter which has been installed at Wrotham, Kent, for the B.B.C. has passed the initial tests and has been accepted by the Corporation. It will be recalled that this 25-kW transmitter will be used initially for experimental work preparatory to the erection of a chain of some 30 e.h.f. stations to cover the whole of the country.

F.M. Criticized.—C. O. Stanley, director of Pye, Ltd., has criticized the B.B.C. expenditure on f.m. in an address to the members of the Brit. I.R.E. in these terms:—"At the time when every penny of capital was wanted to establish television they [the B.B.C.] started on this Wrotham station. It may be a very interesting scientific investigation. The fact that it has been investigated elsewhere in the world and most things are known about it does not seem to have had much weight with the B.B.C. . . . To-day in America broadcasting time on f.m. transmission is very nearly unsaleable . . . I am sure that if the energy and money that have gone into f.m. broadcasting had been available for television we would have been much better off."

American Praise for the Williamson amplifier is voiced in an article in *Audio Engineering*, November 1949. The authors (David Sarser and Melvin C. Sprinkle) of "Musician's Amplifier—an adaptation of a famous English circuit" add this peroration: "To a couple of fiddlers—one who fiddles all day on a Stradivarius, the other who fiddles all day with amplifiers, *this* amplifier is the best we have heard."

Amateur V.H.F. Achievement.—What is believed to be the first amateur two-way telephony communication in this country in the 1215-1300Mc/s band (24cms) was made by stations G8DD/P and G6CW on November 17th. Conditions were far from ideal as owing to rain one transmitter-receiver was located indoors with the aerial behind a closed window, while the other operated—complete with aerial—from inside a car. Despite these adverse conditions signals were S9 in both directions over a distance of 4½ miles.

Faraday Lecture. — This year's Faraday lecturer is Dr. R. A. Smith, M.A., superintendent of the Research Department of the Telecommunications Research Establishment, Great Malvern. His subject is radar. The lecture was first given at Birmingham on December 5th and, as will be seen from "Meetings," is being repeated at other I.E.E. centres. The London lecture, which will be given at the Central Hall, Westminster, on January 18th at 6.30, is open to the public.

Television Fund.—Admiral Dorling, director of the R.I.C., is a member of the committee of the National Television Fund which has been established to "create resources from which grants may be made to provide sets in places where, for example, sick or crippled children or aged people may otherwise be without hope of enjoying the facilities of television." The fund is operating under the ægis of the British Charities Association. Donations should be sent to 12, Whitehall, London, S.W.1.

Index to "W.E." Abstracts.—A monthly feature of our sister journal, *Wireless Engineer* is the section devoted to abstracts from and references to articles appearing in the world's technical journals. Throughout the year some 3,600 abstracts and references are published and an index to these is issued by our Publishers. Copies of the 1949 index, price 2s 6d plus 2d postage, should be available in February.

Fleming Centenary.—To mark the centenary of the birth of Sir Ambrose Fleming—November 29th—the Science Museum, South Kensington, exhibited the original "oscillation valve," which was invented in 1904, in a place of honour for two weeks.

"Television Explained."—A third (fully revised) edition of this popular book by W. E. Miller, Editor of our associated journal, *The Wireless Trader*, has now been issued. The television receiver circuit is split up into self-contained units and a chapter devoted to each. Aerials and the nature of the television signal are also covered, and there are some useful screen photographs showing how various faults reveal themselves. The book is distributed by our Publishers and costs 5s (by post 5s 4d).

Distress Signals.—An additional v.h.f. radio-telephone channel is now being used by the R.A.F. for the location of lost aircraft. This is the International Aeronautical Distress Channel of 121.5 Mc/s which is in addition to those given in our September issue.

Electronics Exhibition.—An exhibition of industrial electronics is being organized by the Midlands Branch of the Institution of Electronics to be held at the Exhibition Floor, Lewis's, Ltd., Bull Street, Birmingham, 4, on January 5th, 6th and 7th. Further particulars are available from Dr. W. Summer, 31 Beech Road, Bournville, Birmingham, 30.

Canadian Television.—Commenting on the recent announcement that American rather than British equipment will be used in the C.B.C. television stations at Toronto and Montreal, the Director of Television at the Academy of Radio Arts said ". . . after a great deal of study and comparison, I am fully convinced that it [British equipment] is every bit as good [as American] and that the old country product possesses many operational characteristics and innovations that are truly unique. It is perhaps not as well styled as the American counterpart, but it is a great deal more functional.

G.E.C. in Singapore.—The sound reproducing equipment installed in the Victoria Memorial Hall, Singapore, for the recent United Nations conferences was supplied by the G.E.C. It included 29 microphones with a separate line amplifier for each channel. The G.E.C. has also installed in the Singapore area v.h.f. radio-telephone equipment providing inter-island communication for the oil depots of the Shell Oil Co. and the Standard Vacuum Oil Co.

Egypt.—Two high-power short-wave broadcasting transmitters have been ordered by the Egyptian Government from Standard Telephones and Cables for installation at a new station under construction at Abu Zabal, about 12 miles from Cairo.

Car Radio.—The current price of the Ekco Model CR61 car radio receiver, reviewed in our December issue, is now £31 10s, inclusive of all accessories except the aerial. The home sales purchase tax is £6 16s 6d.

NEW ADDRESSES

Allen Components, Ltd., of Tower Road, London, N.W.10, manufacturers of radio and television coils and transformers, etc., have moved to 1 Shrewsbury Road, Stonebridge, London, N.W.10. (Tel.: Willesden 3675.)

International Aeradio, Ltd.—A typographical error appeared in the note in our last issue announcing the company's change of address. The new head office is 40 Park Street, London, W.1,—not Parker Street.

Speaker Services, Ltd., have moved to new premises at Central Road, West Hoe, Plymouth, and are now able to undertake repairs to Rola Types F, 5Z, 6Z, 8Z, 10Z and pre-war G12 loudspeakers.

Sinclair Speakers.—The head office of Electrical Sound and Television Patents, Ltd., manufacturers of Sinclair loudspeakers, has been transferred from Pembroke Street, London, N.1, to the factory at 3 and 4, Manor Way, Boreham Wood, Herts.

Willesden Transformer Co. has moved from 28, Balmoral Road, London, N.W.2, to 781, Harrow Road, London, N.W.10 (Tel.: Ladbroke 2846).

Engineering Appointments. — The offices of the Professional Engineers' Appointments Bureau have been moved from 13 to 9, Victoria Street, London, S.W.1 (Tel.: Abbey 1737).

MEETINGS

Institution of Electrical Engineers

"Radar Echoes from Precipitation," by J. E. N. Hooper, B.Sc., and A. A. Kippax, B.Sc.Tech., at 5.30 on January 12th.

Faraday lecture on "Radar," by R. A. Smith, M.A., Ph.D., at 6.30 on January 18th, at the Central Hall, Westminster, London, S.W.1.

Radio Section. — "The Relative Merits of Presentation of Bearings by Aural-Null and Twin-Channel Cathode-Ray Direction-Finders," by S. de Walden, Dipl. Ing., and J. C. Swallow, M.A.; and "Some Experiments on the Accuracy of Bearings Taken on an Aural-Null Direction-Finder," by F. Horner, M.Sc., at 5.30 on January 11th.

"Factors Influencing the Design of a Rubber Model," by G. B. Walker, M.A.; and other demonstrations of apparatus for solving the Laplace equation by E. Colin Cherry, M.Sc. (Eng.), and E. E. Hutchings, B.Sc. (Eng.), at 5.30 on January 17th.

"Electronic Components — Government and Industrial Relations and Co-operation; Commercial, Professional and Service Standards," discussion opened by D. H. Black, Ph.D., and N. F. S. Hecht, at 5.30 on January 23rd.

Unless otherwise stated, the above meetings will be held at the I.E.E., Savoy Place, London, W.C.2.

Cambridge Radio Group. — "The Application of Differential Analyzers with Electrolytic Tanks for Tracing Electron Trajectories," by K. F. Sander, M.A., at 8.15 on January 17th, at the Cavendish Laboratory.

Mersey and N. Wales Centre.—"Hot-Cathode Thyratons: Practical Studies of Characteristics," by H. de B. Knight, M.Sc., at 6.30 on January 2nd at the Liverpool Royal Institution, Colquitt Street, Liverpool.

North - Western Centre.—"Radar Echoes from Precipitation," by J. E. N. Hooper, B.Sc., and A. A. Kippax, B.Sc. Tech., at 6.15 on January 3rd at the Engineers' Club, Albert Square, Manchester.

North - Western Radio Group.—"Some Considerations in the Design of Negative-Feedback Amplifiers," by W. T. Duerdoth, B.Sc. (Eng.), at 6.30 on January 18th, at the Engineers' Club, Albert Square, Manchester.

Southern Centre.—Faraday lecture on "Radar," by R. A. Smith, M.A., Ph.D., at 6.30 on January 20th at the Guildhall, Southampton.

Western Centre.—"The Application of Frequency Modulation to v.h.f. Multi-channel Radiotelephony," by J. H. H. Merriman, M.Sc., and R. W. White, B.Sc., at 6.0 on January 2nd at the South Wales Institute of Engineers, Park Place, Cardiff.

Faraday lecture on "Radar," by R. A. Smith, M.A., Ph.D., at 6.30 on January 13th at the Brangwyn Hall, Swansea.

British Institution of Radio Engineers

London Section.—"The Performance and Stability of Permanent Magnets," by A. J. Tyrrell, at 6.30 on January 19th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

South Midlands Section.—"Commercial Marine Radar," by M. J. Millane, B.Sc., at 7.0 on January 26th, in Room A5, The Technical College, Coventry.

Scottish Section.—"Ultrasonics," by B. E. Noltingk, Ph.D., at 6.45 on January 5th at the Heriot-Watt College, Edinburgh.

West Midlands Section.—"The Performance and Stability of Permanent Magnets," by A. J. Tyrrell at 7.0 on January 25th, at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

North-Eastern Section.—"Activities and Equipment of an Industrial Electronic Laboratory," by G. H. Hickling, at 6.0 on January 18th at Neville Hall, Westgate Road, Newcastle-on-Tyne.

Television Society

London Meeting.—"High-Frequency Cables in Television," by R. C. Mildner (Telcon), at 7.0 on January 27th at the Cinema Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Constructors' Group. — "Some Aspects of Single-Sideband Receiver Design," by W. M. Lloyd, B.Sc. (Bush Radio), at 7.0 on January 12th at the Cinema Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Midlands Centre.—"Some Problems Associated with Synchronizing Signals," by C. E. Horner (Philips Electrical), at 7.0 on January 2nd at the Lecture Hall, The Crown Restaurant, Corporation Street, Birmingham.

British Sound Recording Association

London Meeting.—"Magnetic Tape; Its Properties and Measurement," by G. F. Dutton, Ph.D., at 7.0 on January 27th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Radio Society of Great Britain

"The Use of v.h.f. for Radiotelephone Services," by J. Neale, B.Sc (Eng.), (Post Office Engineering Department), at 6.30 on January 27th at the I.E.E., Savoy Place, London, W.C.2.

Easing Impedance Calculations

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

Rearranging the Expression for Continuous Slide-Rule Operation

THE fact that one is so often obliged to evaluate expressions of the form $x = \sqrt{a^2 \pm b^2}$ is an irritating feature of a.c. calculations. Finding the value of Z, R or X (given two of them) is the commonest example of this type of work, but of course there are others, such as adding currents or voltages having 90° phase displacement or different frequencies. It can be dodged to some extent by the use of j, but sooner or later one is bound to want the modulus (or magnitude). To find a^2 and b^2 with the slide-rule necessitates two operations; pencil and paper are then usually needed to add them together before performing the final operation of taking the square root. During this sequence of four separate operations it is only too easy to go wrong with the decimal place.

By a slight rearrangement of the expression it can be evaluated in one continuous slide-rule operation in about half the time, and with less likelihood of making a slip. Assuming for the moment that the positive sign applies, as in calculating Z from R and X, and that a stands for the larger of the two knowns, the rearranged form is

$$x = b\sqrt{\left(\frac{a}{b}\right)^2 + 1}$$

Adopting the convention of referring to the four basic scales of a slide-rule by the letters A, B, C and D (reading from top to bottom), divide a by b in the usual way by bringing b on C over a on D. $(a/b)^2$ is then indicated on scale A by the end of B. Next, move the slider to the right to increase this figure by 1. The end of scale C will then point to $\sqrt{(a/b)^2 + 1}$ on scale D, while b on scale C points out the answer, x. It may, of course, be necessary to shift the slider a distance equal to the length of scale C in order to get the final reading. The whole business takes less time to do than to describe, and the saving of time and mental effort is very considerable, especially in work involving a succession of values of R and X.

As an example, suppose $a = R = 15.4\,k\Omega$ and $b = X = 8.75\,k\Omega$. With the rule set to divide 15.4 by 8.75, the 100 end of the B scale marks 3.10 on A. When it is shifted up to 4.10, 8.75 on the C scale marks 17.7 on D, which is the answer, Z, in kΩ. There is no uncertainty about the decimal place, because the answer is bound to be between a and $\sqrt{2}a$.

Provided that a is not more than nearly 10 times b, there is also no room for doubt about how much of the A scale represents 1 when performing the addition, because the scale markings, 1 to 100, hold good as they are. If a does exceed $10b$ there is seldom much point in doing any calculation at all, for the error in regarding x as equal to a does not then exceed 0.5%. However, if the method is used when $a > 10b$, the A scale must be reckoned as running from 100 to 10,000, and of course this makes the shift of 1 look very small.

An alternative method, by which small differences between x and a can be calculated very accurately, will be described in a moment or two; but in the meantime the procedure for calculating R or X, given Z and X or R, should be noted. Since the formula is

$$R = X\sqrt{\left(\frac{Z}{X}\right)^2 - 1}$$

(or the corresponding one with R and X interchanged), the only difference is to subtract 1 instead of adding it. Try it by working the above example backward. Finding R by dividing 17.7 by 8.75, and then shifting the slider from 4.1 to 3.1 on the A scale, reading R = 15.4, calls for no comment. But if X is the unknown, dividing 17.7 by 15.4 indicates 1.32 on the A scale. Deducting 1 gives 0.32, which necessitates moving the slider to the right so that 1 on B corresponds with 32 on A. Unless one does this carefully with a large slide-rule, the answer is likely to look more like 8.70 than 8.75, because it is difficult to read scale A accurately enough to see that the original figure should be 1.322+. (Calculating the smaller of the two components of impedance is liable to result in relatively large errors whatever method is adopted.) Although examples such as the last involve a shift of decimal place on scale A, they should cause no confusion, since it is a logical consequence of following the general method.

It may be interjected here that the trick of transforming a sum or difference of two quantities into (a ratio ± 1) is widely useful, and often leads to a clearer picture of the situation. "Cathode Ray" has recently given some examples.*

It is not always realized how rapidly x approaches a as a/b increases. The difference when a/b is 10 is, as already stated, only 0.5%. Figures worth noting are:

$\frac{a}{b}$	Difference between x and a
7	1%
10	0.5%
22.4	0.1%

* "Generalized Graphs," Sept. 1949; "Smoothing Circuits," Oct. and Nov. 1949.

Easing Impedance Calculations

If for any reason one wants to know with some accuracy how much larger x is than a when a is considerably larger than b, this can be done very simply by an alternative method. The first two terms in the binomial expansion of $(a^2 + b^2)^{\frac{1}{2}}$ are a and $b^2/2a$. The latter is, of course, easily computed by marking the smaller quantity, b, with the cursor on scale D, giving b^2 on scale A. The latter is then divided by $2a$ by movements of scale B.

For example, suppose the reactance of a circuit is known to be 245 Ω and its series resistance 15 Ω. What is its impedance? Computing $15^2/(2 \times 245)$ gives 0.46, so Z is 245.46 Ω. Note that by this method the answer can (assuming sufficient accuracy of data) be given correct to more significant figures than a slide-rule is capable of when used straightforwardly. Reckoning in differences, when they are relatively small, is another trick with a wide range of application.

The third term in the binomial expansion, representing the major part of the error here is negative. Even when b is as much as $a/3$, it is only $-$ 0.1% of x, so for large values of a/b it is extremely small.

Transforming resistances and reactances in series into their parallel equivalents, or vice versa, invariably brings in $R^2 + X^2$. The larger of the two quantities being denoted, as before, by a, the form of expression can be altered for purposes of slide-rule calculation to $b^2 [(a/b)^2 + 1]$. The advantages are not quite so pronounced as in the first method described here, but are worth considering. The procedure is identical except that the answer is read on scale A instead of D. And the decimal point can usually be located without difficulty, remembering that the answer must be between a^2 and $2a^2$.

NEW TELEVISION RECEIVER

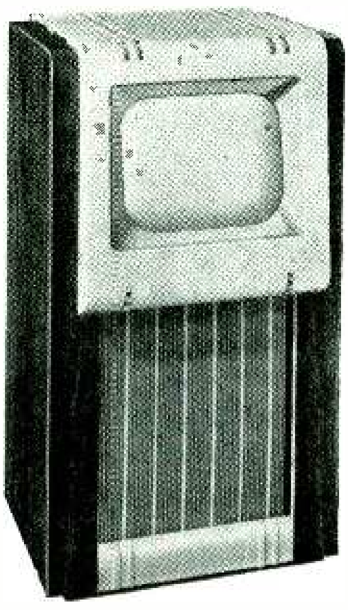
Two-Unit Design to Simplify Maintenance

THE English Electric Co. has entered the television field with a receiver, Model 1550, having some unusual features. Designed in conjunction with Marconi's W. T. Co., an associate of English Electric, the receiver is of the console type with a 15-in c.r. tube and in addition to television, provision is made for reception of the B.B.C. experimental f.m. transmissions.

The set is of the superheterodyne type with one r.f. stage. On the sound side there are three i.f. stages followed by a diode detector for a.m. or a discriminator and double-diode detector for f.m. A triode audio stage and a tetrode output valve with negative feedback are fitted. On vision there are four i.f. stages with single-circuit couplings and traps for sound-channel rejection, a diode detector, a diode sync separator and one v.f. stage.

The 15-in tube is operated at 9 kV which is obtained from a ringing choke circuit and rectifier; this is pulsed at line frequency through a tetrode valve. The tube has an ion trap with permanent magnets and a permanent magnet is also used for focusing. A fine adjustment of focus is obtained by varying the e.h.t. supply by a control which adjusts the screen potential of the "ringing-choke" valve.

Magnetic deflection is used with a high-inductance frame coil. The h.t. supply is taken straight from the mains through a metal rectifier and smoothing circuit and an auto-transformer is used for the heater supplies. For use in areas subject to interference a special sync circuit can be provided. This takes the form of a transformer and additional valves which can be plugged into sockets provided and which then give a fly-wheel effect to the line-scanning circuit and enable it to run regularly upon the mutilated sync pulses which are likely in areas of poor field strength. The system is termed synchrophase, and is arranged as a plug-in unit because it is an unnecessary refinement in the normal good-reception areas.



English Electric Model 1550 console television receiver with 15-in tube.

Mechanically, the main chassis carries all parts but the power supply and is removable from the cabinet in a matter of seconds. All inter-unit connections are by plug and socket and two thumb screws hold the chassis to the cabinet. This chassis is actually in two halves—a time-base unit and the receiver proper. They can be separated without removing the tube by undoing a few screws and, again, the connections are by plug and socket.

For work on the chassis a metal frame is available which plugs into holes provided and which enables the chassis to be turned upside down for servicing without any risk of damaging the tube.

It is intended that servicing shall be carried out by means of a unit replacement scheme by which method it is hoped to put any receiver into service again in a maximum of 48 hours.

The makers are English Electric Co. of Queen's House, Kingsway, London, W.C.2, and the set is priced at 90 guineas, plus purchase tax.

Electronic Circuitry

Selections from a Designer's Notebook

By J. McG. SOWERBY (Cinema-Television, Ltd.)

COUPLINGS IN D.C. AMPLIFIERS

DIRECT coupled amplifiers are used in a variety of applications ranging from amplifiers for oscilloscopes to industrial electronic equipment of various types. The design of such amplifiers is often quite specialized, and to those unfamiliar with these devices one of the commonest sources of difficulty is the question of the coupling between successive stages.

In ordinary amplifiers for audio signals, say, the coupling presents no difficulty and the ordinary RC coupling is commonly used. Such a coupling does not transmit zero frequency however, and as soon as extension to zero frequency is required, difficulties begin to arise. The simplest coupling in d.c. amplifiers is that shown in Fig. 1, which is really not a coupling at all inasmuch as the grid of the second stage is directly connected to the anode of the first. Unfortunately the anode of V_1 is positive to earth by the voltage V_a and this is equally true of the grid of V_2. For this reason the cathode of V_2 must be held at a positive voltage $V = (V_a + V_k)$, where V_k is the bias voltage for V_2.

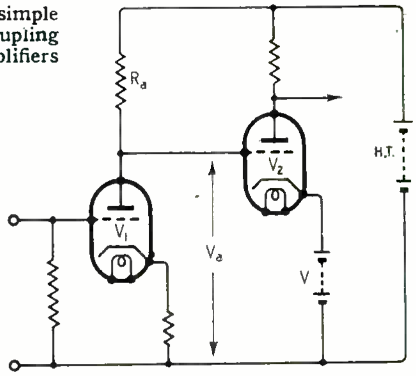


Fig. 1. A simple anode-grid coupling in d.c. amplifiers

In practice it is inconvenient to use a battery to supply V, so that the cathode of V_2 is either tapped into a bleeder network across the h.t. supply, or, better, held at the required voltage by a cathode follower as in Fig. 2. If V_2 and V_3 are similar valves, then if the grid of V_3 is held at a positive potential equal—or nearly so—to V_a, suitable working conditions will be obtained for V_2. The standing current in V_2 will be approximately $V_a/2R_k$, and the same will be true of V_3. It is obvious from the circuit that V_2 and V_3 form a cathode coupled pair with an anode load on one valve only (R_{a2} on V_2). If V_2 is a triode, then the usual Miller effect will throw a relatively large capacitance across R_{a1}. This may be avoided by short-circuiting R_{a2}, and placing an equal load (R_{a3}) in the anode circuit of V_3, as shown dotted. The gain of the V_2, V_3, circuit from the grid of V_2 to the anode of V_3 is given by:

$$A_{2,3} = \frac{\mu R_{a3}}{R_{a3} + 2r_a + \dfrac{r_a (R_{a3} + r_a)}{(\mu + 1) R_k}} \quad \cdots \quad (1)$$

where μ = amplification factor, r_a = anode resistance } of V_2 and V_3

The disadvantage of this method of coupling is the high value of h.t. supply potential (V_b) required. Provided the grid-cathode bias of V_2 and V_3 is small compared with V_a, the effective supply potential for V_2 and V_3 is only ($V_b - V_a$), and this must be sufficient to supply the voltage drop across R_{a3} (or R_{a2}), and the anode potentials of V_2 and V_3. It would be more convenient if we could arrange to operate the cathode of V_2 at earth potential; this may be done with the circuit of Fig. 3.

In Fig. 3 a negative supply of V_c volts is used. If V_2 is to be operated at zero bias, it turns out that ($V_c R_1 = V_a R_2$) is the condition which must be satisfied. In fact the grid of V_2 will nearly always be

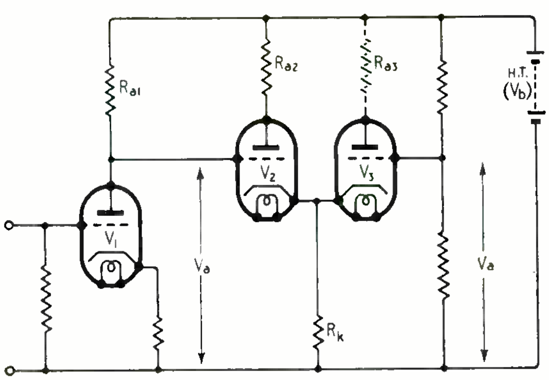


Fig. 2. Direct coupling on to cathode-coupled pair, with cathode of V_2 held at required voltage by V_3

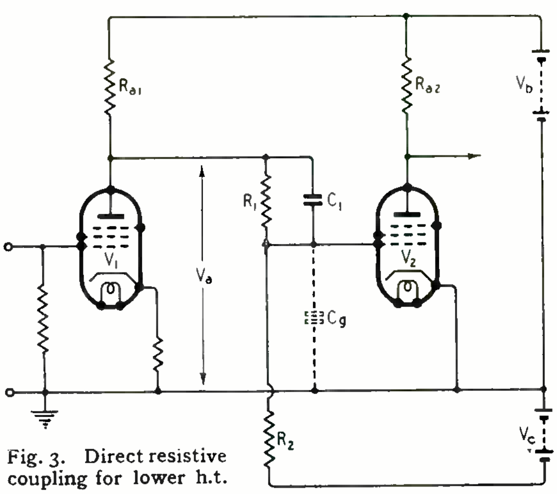
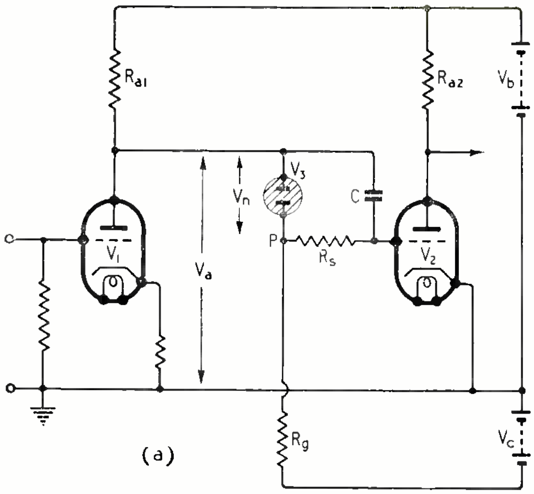


Fig. 3. Direct resistive coupling for lower h.t.



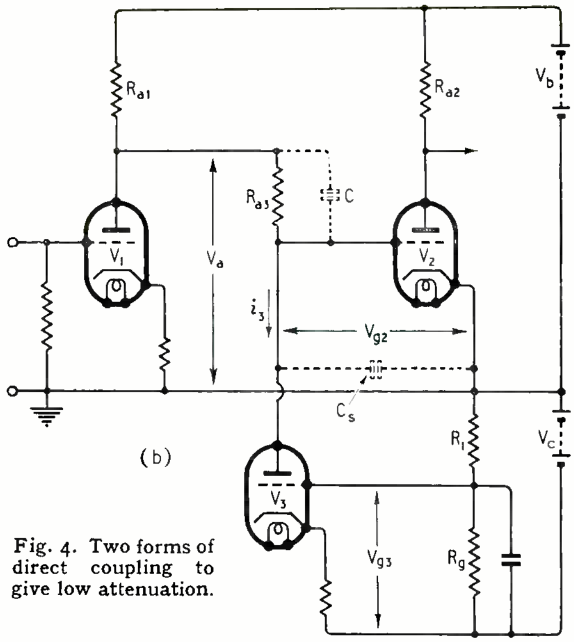


Fig. 4. Two forms of direct coupling to give low attenuation.

operated negative to earth, so that this simple expression is only an approximation. However if V_c is large compared with the grid base of V_2, the bias of V_2 may be neglected in the calculation of V_c. The disadvantage of this method is obviously the fact that an attenuation of $R_2/(R_1 + R_2)$ is inserted between the two stages, and if $V_a = V_c$ the loss will be one half. A virtue may be made of this disadvantage if high frequencies are important, as R_1 may be shunted by a condenser C_1 to make the time constant $R_1C_1 = R_2C_g$, where C_g is the input capacitance of V_2. The attenuation of the R_1, R_2 network is then independent of frequency, and the capacitance loading on the anode of V_1 by the grid circuit of V_2 is reduced from C_g to $C_g/(1 + C_g/C_1)$.

Low Attenuation Couplings

In purely low frequency applications, the loss of gain introduced by the coupling may be important and two means have been found for overcoming this disadvantage; these are shown in Fig. 4(a)[1] and (b)[2]. At (a) a gas discharge stabilizer tube has been substituted for R_1 of Fig. 3. As such a tube has the property of maintaining a nearly constant potential across its terminals, it follows that any changes at the anode of V_1 will be transferred without alteration in amplitude to the point P. As the point P will have to be negative to earth by the bias of V_2, (V_g), a series resistor, R_g, to a negative supply, V_c, is needed to maintain sufficient current in the stabilizer to maintain the discharge. It is not difficult to see that the minimum safe value of V_c is given by:

$$V_{c\,min} = V_s + V_g$$

where V_s is the striking voltage of V_3.

In order to maintain V_2 at the required bias (V_g) it is also not difficult to see that

$$V_n = V_a + V_g$$

where V_n is the running voltage of V_3.

The resistance R_s and the condenser C are included because stabilizer tubes often have an impedance varying with frequency.

If R_s is made large compared with the nominal internal resistance of V_3 (R_n = 500 Ω or so) and the time constant CR_s made sufficiently long (1/10 to 1/100 second), variations of R_n with frequency become unimportant at the higher frequencies, as C progressively approximates to a short circuit as the frequency increases.

Because of these difficulties with stabilizer tubes the alternative circuit of Fig. 4(b) is sometimes used. In this arrangement the valve V_3, and its anode and cathode loads R_{a3} and R_k, form the coupling network. As readers are well aware, the use of negative current feedback introduced by a cathode resistor leads to a very high effective anode resistance, r_{ao}. In fact

$$r_{ao} = (\mu_3 + 1)R_k + r_{a3} \quad \ldots \quad (2)$$

where r_{a3} = anode resistance of V_3. So that the transmission of the coupling is

$$T = \frac{(\mu_3 + 1)R_k + r_{a3}}{(\mu_3 + 1)R_k + r_{a3} + R_{a3}} \quad \ldots \quad (3)$$

If V_3 is a high-μ valve this transmission is generally not far short of unity.

The circuit is easy to design if V_3 is a high-μ valve, for then the current, i_3, in V_3 is nearly V_{g3}/R_k, and the voltage drop across R_{a3} is $i_3R_{a3} = \frac{R_{a3}}{R_k}V_{g3}$.

In practice low current high-μ valves like the 6Q7G, or 6F5G, are very suitable for the V_3 position, and the coupling transmission then approaches unity. Taking a practical example let us make V_a = 145 volts, V_{g3} = 50 volts, R_k = 100 kΩ, so that $i_3 = \frac{1}{2}$mA approx. If the required bias on V_2 (V_{g2}) is 5 volts, R_{a3} must drop 145 + 5 = 150 volts at $\frac{1}{2}$mA. Thus R_{a3} = 300k Ω. If μ_3 = 50 and r_{a3} = 70k Ω (for a 6Q7G) the transmission turns out to be

$$T = \frac{51 \times 100 + 70}{51 \times 100 + 370} = 0.945$$

If good high frequency performance is required—when V_1 and V_2 will usually be pentodes—R_{a3} may be shunted by a condenser C so that $CR_{a3} = C_s r_{ao}$ and

[1] Miller, S., *Electronics*, Nov. 1941.
[2] Valley and Wallman, "Vacuum Tube Amplifiers," p. 486.

then the value of T will become independent of frequency. In our example above r_{aa} was 5.17MΩ, and if we assume C_g = 20pF, a likely value, C = 5.17 ×20/0.3 = 345pF. In the circuit of Fig. 4(b), the bias of V_2 may be adjusted over a small range by variation of R_k or R_g with but little change in the transmission of the coupling.

One other[3] rather interesting coupling is very useful for wideband direct coupled amplifiers. This is a variant on the ordinary resistive coupling of Fig. 3, and is shown in Fig. 5. It is applicable only when V_1 is a pentode as shown. In wideband amplifiers it is essential to use a low value of anode load, in order that the inevitable stray shunting capacitance shall produce the usual droop in the high frequency response at some conveniently high frequency. If R_{a1} in any of the previous circuits is made small, then V_a would assume a value approximating to the full h.t. potential. This involves a greater loss in the coupling than is the case with Fig. 5.

Consider now the circuit of Fig. 5 at some high frequency, but not so high that the stray capacitance has produced noticeable loss of gain. At such a frequency C_d is a virtual short-circuit, and so is C_1. Thus the load on V_1 is R_a, and all the signal voltage across R_a is transmitted to the grid of V_2 through C_1. Now consider the circuit at zero frequency. The total load on V_1 is $(R_a + R_{ad})$ so that V_a may be made relatively low compared with V_b. At the same time any zero frequency signal is transmitted to V_2 with a loss of $R_2/(R_1 + R_2)$. If $(R_a + R_{ad})$ is small compared with r_a of V_1, the gain of V_1 will be proportional to the anode load. If the gain times the coupling loss can be made constant at all frequencies where loss of gain due to stray capacitance is negligible, a very advantageous result will have been secured. In the arrangement shown we may take the signal current (I_a) in V_1 to be constant with constant input (v), and in passing we see that

$$I_a = \frac{g_{m1}v}{1 + g_{m1}R_k} \qquad \cdots \quad (4)$$

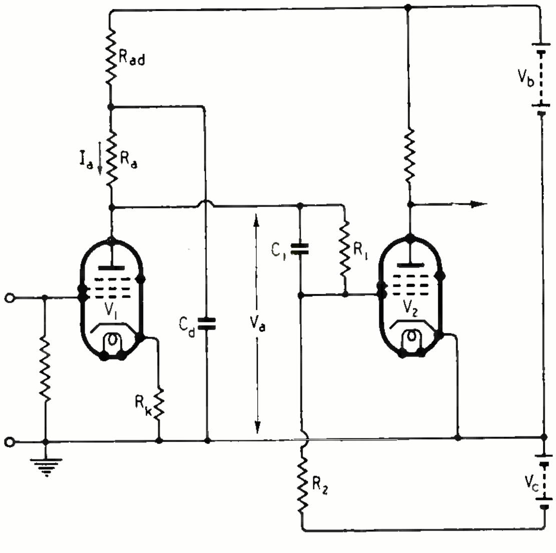


Fig. 5. A direct coupling used in wideband amplifiers.

[3] Edwards and Cherry, *J.I.E.E.*, Vol. 87, p. 178 (1940).

It turns out on analysis that if
$R_2 = nR_a$ and
$R_1 = nR_{ad}$
and $R_1C_1 = R_{ad}C_d$
} Where n is any convenient numerical ratio, e.g. 20 or 50,
the output signal voltage is simply

$$V_g = \frac{n}{n+1} \cdot I_aR_a$$

at all frequencies where stray capacitances are unimportant.

Consequently the gain of V_1 from the grid of V_1 to the grid of V_2 is

$$A = \frac{g_{m1}R_a}{1 + g_{m1}R_k} \cdot \frac{n}{n+1} \qquad \cdots \quad (5)$$

which is the usual expression for the gain of a pentode with an un-bypassed cathode bias resistor, except for the factor including n which may be made to approach unity by making n large.

The circuit of Fig. 5 is in fairly wide use now, and one of its main advantages is that R_{ad}, C_d, form a decoupling network which reduces the injection into the h.t. supply of the higher frequency components of the signal current in V_1. This is very useful in preventing instability and undesired feedback from one stage to an earlier one via a common impedance in the h.t. supply.

At low frequencies approaching zero, decoupling networks cease to be effective, so that in multi-stage direct coupled amplifiers a very low impedance h.t. supply—preferably stabilized—has to be used. The same is true of the negative supplies shown in various coupling circuits, although here it is usually stability rather than low impedance that is the prime consideration, since the currents taken from the negative supply are usually quite small.

No mention has been made of drift in d.c. amplifiers in the foregoing, but as any changes in the anode voltage of the first valve due to changes in the valve itself with changing temperature or other electrode potentials, are transmitted more or less completely to the next stage, a steady undesired drift in the anode potential of the output stage occurs only too frequently. There are various means of combating this, which can be found in the extensive literature of the subject.

TELEVISION RECORDING

A SYSTEM of television recording has been developed by B.B.C. engineers. It is a combination of cinematographic and television apparatus and enables programmes to be "telefilmed"—as it is called—so that they can be re-transmitted at some future time with little loss of the original picture quality. The Service of Remembrance and the Lord Mayor's Show were among the first O.B.s to be telefilmed for a second transmission in the evening programmes.

The recording system uses a continuous-motion film camera in which the movement of the film is chased by an optical image of the television screen picture reflected from a rotating mirror drum. By this means all the 405 interlaced lines of the picture are recorded on the film and the difficulties of relating the television frame frequency to the picture repetition frequency on the film are overcome.

The method was proposed by H. W. Baker, Engineer-in-Charge at Alexandra Palace, and H. G. Whiting, now Engineer-in-Charge of Sutton Coldfield, in collaboration with D. R. Campbell, a senior engineer at Alexandra Palace, and was perfected by W. D. Kemp, of the B.B.C. Planning and Installation Department.

Further Notes on the

High-Quality Amplifier

Replies to Queries Frequently Raised by Constructors and Other Correspondents

By D. T. N. WILLIAMSON

THE series of articles recently published on the High-Quality Amplifier has aroused considerable interest and given rise to correspondence. It is hoped that these notes, which deal with matters of general interest arising from the correspondence, may be of assistance to readers who have similar difficulties.

Valves.—There is no exact equivalent for the Osram type KT66, and its use is recommended where possible. When the equipment is to be used overseas, the KT66 may be difficult to obtain, and 6L6 glass and metal types may be regarded as direct replacements, with the proviso that the total anode and screen dissipation should be reduced from 25 W to 21.5 W by reducing the total current from 125 mA to 110 mA by adjustment of R_{21}. The use of these valves with reduced rating entails a slight reduction of the maximum output. The 807 may be used at the full rating of 25 W, with modifications to the valve connections.

Since the articles were written, a modification of the EF37 has appeared under the number EF37A. This has improved heater construction giving greater freedom from hum, and its use may be advantageous for V_8 and V_{13}.

No other changes in valve types can be recommended, as their use would involve radical redesign.

Output Transformer.—When assembling the core of the transformer, care should be taken to ensure that the edges of the T and U laminations butt together. The magnetic properties of the core are dependent upon careful assembly and tight clamping.

Static Balancing.—The method of balancing the standing currents in the output valves, which was suggested in the article in the August issue, is dependent for its success on close matching of the d.c. resistances of the halves of the output transformer primary. Nominally the sections are identical, and when carefully machine-wound from the same reel of wire, the resistances should not differ materially. It is possible, however, due to variations in wire diameter and insulation thickness, for the resistances to differ by up to 5 per cent and even, in extreme cases, 10 per cent. Should this occur, a compensating resistor should be added in series with the low-resistance side in order to equalize the resistances, and the meter connected across the equalized sections.

Other more direct methods may, of course, be used to adjust the anode currents to equality, but unless the transformer has a split primary winding they are inconvenient, and great care should be taken to ensure that the insertion of instruments does not cause oscillation which could give misleading readings.

Construction.—There is little to add to the constructional data on the main amplifier given in the August issue, except perhaps to explain that the purpose of the sub-chassis screen, shown in Fig. 3, is to prevent feedback from the anode connections of the output valves to the input of the amplifier. It should extend downwards to the full depth of the chassis.

The method of construction of the preamplifier and tone-compensation units will usually be adapted to individual circumstances. One suggested method of construction for the preamplifier circuit of Fig. 15 is to use a shallow chassis about 9in × 3in × 1in. The valves and electrolytic capacitors are mounted in a group along the centre of this chassis, and the other components mounted vertically above the chassis on tag strips arranged on each side of the central group. The connections to the valveholders are taken through slots cut in the top of the chassis. The input transformer should be mounted on the top of the chassis at one end. With the sizes given, there is ample room for a screened component of dimensions up to 3in × 3in × 2in. The whole unit should be fitted with screening covers, and mounted on the underside of the motorboard as close as possible to the pickup.

The tone compensation unit of Fig. 19 may be constructed on orthodox lines, the only essential being to provide sufficient frontal area to accommodate seven controls. Grid leads should be kept short to avoid hum pick-up. The blank valveholder terminals (pin 6) should *not* be used as anchors for the leads to the top-cap grids. The power supply components can, with advantage, be assembled on a separate chassis.

Conclusion.—The circuits published in the series have been evolved over a considerable period of time and are capable of giving a very high standard of performance. Requests have been received for data on modifications, but as it is rarely possible to determine the full effect of these without carrying out tests, in general, no such data can be supplied by the writer.* It is regretted that due to the volume of correspondence received, it has not been possible to reply to all letters.

* Or, for that matter, by *Wireless World*.—ED.

FILTERS

1. *The Importance of Z_0, the "Characteristic Impedance"*

By "CATHODE RAY"

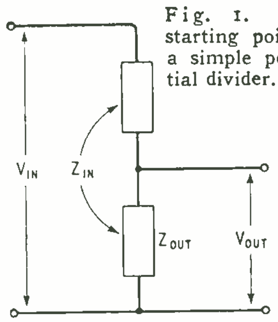


Fig. 1. The starting point—a simple potential divider.

As I said two months ago, I had to think, not twice, but several times before being lured on to the subject of filters. One difficulty is that a mere outline of it takes up the space of a whole book. Another is that it bristles with mathematics and especially with hyperbolics. Not that there is any difficulty in *using* hyperbolics—it is in fact easier than looking up a log table—but if one doesn't know what they mean they are not much help towards *understanding* filters.

Anybody who expects to master filters completely in one short easy lesson will be disappointed. But I hope to show how they are related to the ordinary familiar circuits (such as tuning circuits and smoothers), how they work and how their theory and design are tackled. In other words, the sort of introductory things that the textbooks evidently consider too obvious to explain, but which may be quite puzzling to those not in the know. And I am not going to assume any knowledge of hyperbolic functions, but will try to show why they are so often used. All this I hope may make more detailed study easier to start and to follow.

To anybody who understands reactance and how it is related to inductance and capacitance, the last two sessions (on smoothing circuits) should have been quite easy. That was because we assumed that the impedance of the output circuit or load was too high to make much difference to the results. Doing that, we could treat each section of a smoother as a simple potentiometer (Fig. 1). If the output terminals are tapped across one quarter of the whole impedance between the input terminals, then the output voltage is one quarter of the input voltage; and so on. In general terms, $V_{IN}/V_{OUT} = Z_{OUT/IN}$.

If the whole thing is made up of resistance, then it can be used as a voltage reducer (or attenuator), the attenuation being the same at all frequencies. The object of filters (including smoothers), however, is to discriminate between different frequencies, so at least one arm must have reactance. (Arms are the impedances represented by oblongs in Fig. 1). If, for example, the lower arm in Fig. 1 consists of a capacitive reactance, while the upper is a resistance, the attenuation increases steadily with frequency. If the upper arm is also a reactance, it must be inductive—another capacitive arm would just give a constant attenuation at all frequencies above zero.

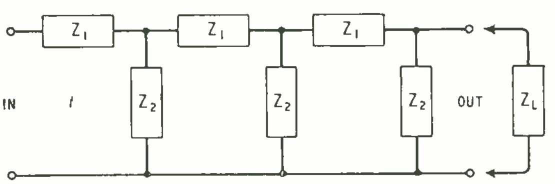


Fig. 2. Three potential-dividers (or ┐ sections) in cascade. The influence of the load impedance, Z_L, complicates matters considerably.

Number of Sections

There is an important difference in principle between attenuators and filters that may not be so obvious. It is, of course, possible to connect two or more potentiometers in cascade—one feeding into another. But except for dodging stray reactance or for convenience in switching or some other incidental reason, there is no point in doing this. Any attenuation one likes can be obtained with the simple Fig. 1 arrangement, by tapping the output off at the right place. It is quite different with filters—but don't imagine that the fact that we spent a large part of the last two instalments in finding the best number of smoother sections has anything to do with it. The motive there was economy in components; a single section to reduce 100 c/s hum to $\frac{1}{100{,}000}$ would need, say 1000H and 250 μF, whereas it could be done much more economically with several sections. We won't get as far as the question of economy with filters; the matter in mind now is the performance, as judged by the frequency characteristic. This matter was rather obscured when we were considering smoothers, because the requirements were comparatively simple—the only frequency to be passed was zero, and so long as all the ripple frequencies were attenuated as much as necessary it didn't matter two hoots what the smoother did with frequencies between zero and the lowest of them. But filters in the more general sense are liable to be faced with problems such as passing all frequencies completely up to, say, 1000 c/s, and heavily attenuating all those above 1200 c/s; or vice versa. Or, more tricky still, attenuating all frequencies above one frequency and below another (higher) one.

These sudden transitions from go to no-go just can't be organized by any single section, no matter what the kind and values of the components. One must be prepared to use several sections. These could simply be repetitions of the Fig. 1 potential-divider cascade, such as Fig. 2 where three are shown. We used this sort of thing quite satisfactorily as a smoother; but there we were lucky, because we found that in practice the shunting effect could be neglected, so that the attenuation (at any frequency) of the whole system was approximately equal to the product of the attenuations (at that frequency) of the separate sections. If each of them reduced the input voltage by 20 to 1 three would reduce it by 20^3 to 1. Or if the attenuations were expressed in decibels, one just added them. Even so, we noticed errors of 30% or more, but that didn't matter much with smoothers. Filter-users are not always so tolerant; and, anyway, it is rarely safe to assume that the load impedance is too high to matter, or that the input impedance of one filter section is too high for the section in front to notice it.

The moment we are forced to abandon this shunting assumption we get into difficulties. Starting at the input end of Fig. 2 and trying to calculate the voltage drop in the first section we can't do it until we know the impedance of the second section, and we can't find that until we know the impedance of the third section, and to find that we have to take into account the impedance of the load. Evidently we started at the wrong end.

Meaning of Characteristic Impedance

Starting at the back, we can find the impedance of Z_2 and Z_L in parallel, and thereby see that the attenuation of the last section is $\frac{Z_1 + Z_2Z_L/(Z_2 + Z_L)}{Z_2Z_L/(Z_2 + Z_L)}$. Considering that the Z's have to be worked out in detail according to what they consist of, taking account of phase, this is already beginning to look rather tiresome; but it is nothing to what emerges when we get to work on the middle section; and that in turn looks simple by the side of the full expression for the first section. Given unlimited time, paper and patience, it can be done, no doubt; but, as mathematicians say, it lacks elegance.

Yet that is a very easy case, consisting of only three sections, all identical, and containing only two different impedances besides the load. If you consider it, you will see that it is this load impedance that is the cause of most of the trouble. Suppose, for example, that it is low compared with Z_2; then it affects the last section considerably. But it won't affect the middle section so much, because Z_1 stands between and may be quite a high impedance. The front section may be hardly affected at all. If the Z_1's are very low, however, it will be. In general, every section will be working under different conditions, and will have a different attenuation. Obviously that makes things very complicated. If we could arrange matters so that every section were shunted to the same extent by the next section, then each would be working under the same conditions and it would be practically as easy to calculate n sections as 1. What this amounts to is finding a particular value of Z_L that makes it true. That is the most important idea in the whole subject of filters.

Imagine we had a filter consisting of an infinitely large number of identical sections. If that is too difficult, imagine we had a thousand million. The attenuation would be so great that whatever was connected to the far end would make no noticeable difference to the input end. Reckoned between the input terminals, that filter would have a certain impedance, regardless of the load impedance. Suppose for example, measurement showed it to be 500Ω resistance (Fig. 3(a)). If the first section or two, or even a dozen, were removed, the total number left would still, to a high degree of approximation, be a thousand million, so their input impedance would be 500Ω. Therefore a 500Ω resistor could be substituted for them at the output of the few front sections without making any difference at the input of those few (Fig. 3(b)). They would in every way be the same as if the nearly-a-thousand-million were still there. If, then, we make the load 500Ω resistance, the filter calculation is quite easy. Alternatively, if we are given a certain load impedance (not necessarily a pure resistance) it is advisable to design the filter so that that is its *characteristic impedance*†—i.e. the input impedance of an infinitely long chain; symbol Z_0, or (if resistive) R_0.

The beauty of the idea is that it didn't matter in

† Sometimes called *iterative impedance.*

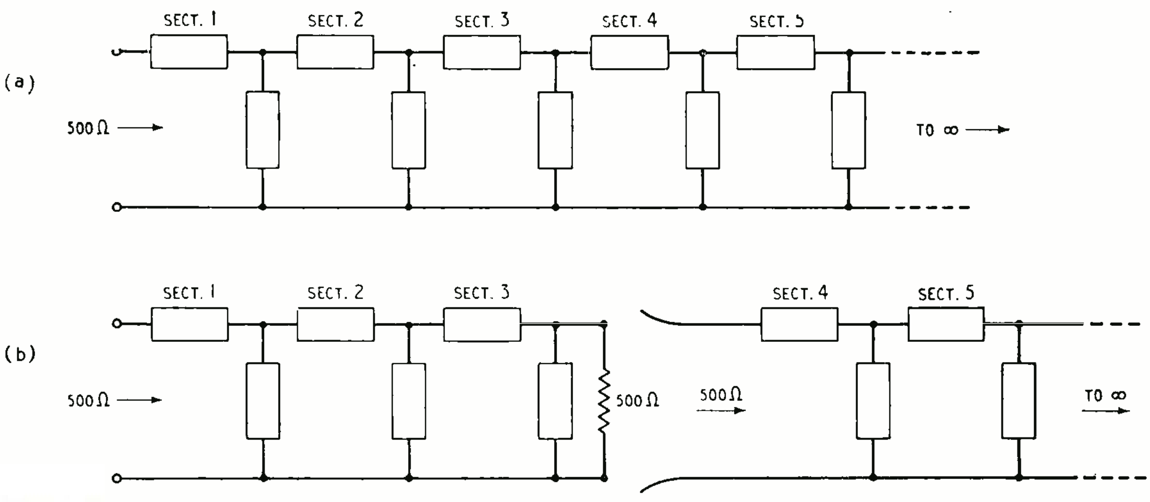


Fig. 3. If the filter chain is infinitely long, its impedance measured at the input terminals depends on itself only (a). An impedance of this value (called Z_0) can therefore be used to simulate an infinite chain (b) and the impedance will be the same as this at the input to every section.

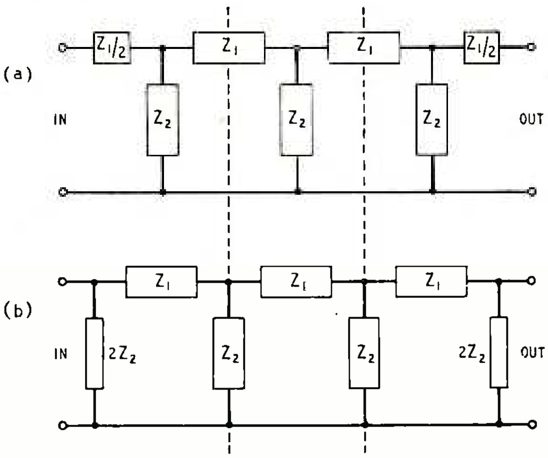


Fig. 4. By transferring half a section in Fig. 2 from one end to the other, the filter can be made to look the same from both ends. Splitting a series arm across gives T sections (a), and splitting a shunt arm lengthwise gives π sections (b).

Fig. 5. How to calculate Z_0 for one (or any number of) T sections.

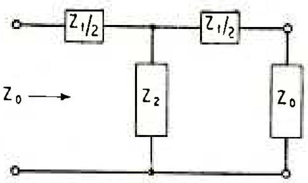


Fig. 3 whether we knocked off one, two, three, four, or any practical number of sections; so long as we terminated them with Z_0 the input still looked like Z_0.

The next question is, what decides Z_0? It would be awkward and expensive to construct a filter comprising an infinitely large number of sections, or even a thousand million, in order to find out. Fortunately it isn't necessary. A single section will do. You might terminate it with a variable impedance and vary it until the impedance measured at the input to the section was the same. That is very troublesome in practice, because you have to be able to vary not only the ohms but also the phase angle from $-90°$ to $+90°$ at any frequency. There is a more convenient way, by making two input measurements, one with the output shorted and the other with it open. It is an important method theoretically as well as practically, and the books discuss it fully.

It is also quite an easy exercise in quadratic equations to work out Z_0 on paper, either for the general case of a filter section consisting of two or more impedances, Z_1, Z_2, etc., or for particular cases (e.g., $Z_1 = \omega L$; $Z_2 = 1/\omega C$; etc., or even particular numerical values in ohms resistive and reactive). The result depends on the form of the filter; i.e. how the arms are arranged in each section. So far we have been thinking exclusively in terms of the inverted-L form. It has the great merit of simplicity, requiring only two arms, and it can be made to have any desired Z_0 at its input terminals; but the more critical kinds of filter users turn it down because it doesn't look the same from both ends. They insist that not only shall the impedance at the input be Z_0 when a load equal to Z_0 is connected at the back, but also that its impedance measured from the back, when a generator with an impedance Z_0 is connected to the input, shall also be Z_0. The point is this: inserting the filter between a generator and a load must not upset the matching conditions.

Sometimes—as with a rectifier power unit—impedance matching doesn't come into it, and there is no reason for not using the simple ┐ type. But in the general calculation of filters it would add considerably to the difficulties if one were faced from the start with all possible varieties of load mismatching. So it is actually easier to take a rather more complicated form of filter that is capable of matching Z_0 in both directions; then, when the principles of that have been fully grasped, one can start finding out what happens when there is a mismatch due to the load not being equal to Z_0. Before expending effort on calculating Z_0 for the unsymmetrical ┐-type, then, we had better see what forms are more generally useful.

To make the 3-section ┐ filter of Fig. 2 symmetrical, all we need do is chop the first Z_1 in half and stick it on at the back, as shown in Fig. 4(a). To divide this filter up again into three identical sections, the cuts have now to be made midway along the original Z_1 arms, as shown by the dotted lines. So each section of this type of filter (known for obvious reasons as the T) consists of one shunt arm, impedance usually denoted by Z_1, and two series arms, each $Z_1/2$.

An alternative method of dealing with Fig. 2 is as it were, to split the last Z_2 lengthwise, into two parallel impedances each equal to $2Z_2$. One of these is then moved to the front (Fig. 4(b). When this filter has been divided into its sections, each consists of one series arm Z_1 and two parallel arms each $2Z_2$. We have to go to the Greeks for a letter—π—appropriate to this type.

Now we can start finding how Z_0 is related to Z_1 and Z_2. Taking one T section terminated with Z_0, as in Fig. 5, we can write down an equation connecting them, thus: Z_0 equals $Z_1/2$ plus Z_2 and $Z_1/2 + Z_0$ in parallel. One way of writing the solution to this (when you have solved it) is

$$Z_0 = \sqrt{Z_1 Z_0} \cdot \sqrt{1 + \frac{Z_1}{4Z_2}} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

That is not quite the tidiest form, but the reason for preferring it will appear soon.

The solution for a π section is the same except that the first factor ($\sqrt{Z_1 Z_2}$) is *divided* by the second. These are two really important formulae.

How Z_0 Varies with Frequency

Next, it is time to open the sealed Z boxes and reveal the contents. They vary according to what the filters are for. The one bit in the whole filter story that never gives anybody any trouble is the classification of the main types, so I just show these as Fig. 6 and leave it at that. There are of course plenty of other types, but these are the ones everybody is expected to know about.

Seeing that the Editor is obliged to leave some room for other writers, I won't be able to go into detail about all these. I propose to concentrate (as an example) mainly on the low-pass T type.

Filters

Unless one is much too bright to be reading this, one begins by assuming that the arms are perfectly free from resistance. They never can be in practice, of course, but the results deduced comparatively simply on this basis are a good guide to the general behaviour of reasonably low-loss filters; and, moreover, the effects of unavoidable resistance(like those of mismatching) can best be studied at a later stage when the main outline is clear.

Getting down to our low-pass T, shown on a larger scale in Fig. 7, we have $Z_1 = j\omega L$ and $Z_2 = 1/j\omega C$. Before substituting these in equation (1) you should take note of a custom that is no doubt all for the best but is apt to trip up beginners. Because each of the series arms is *half* Z_1, the inductance of each is half L. That is quite reasonable when you remember how we derived the T from the ⌐, but it is easy to forget when working out values. In the same way the two shunt arms in a π section are each *twice* Z_2, so if they are capacitive they consist of—and here is another catch —*half* C.

Substituting in equation (1):

$$Z_0 = \sqrt{\frac{L}{C}}\sqrt{1 - \frac{\omega^2 LC}{4}} \quad .. \quad .. \quad .. \quad (2)$$

By meditating on this result it is possible to learn a lot about low-pass T sections, in spite of the fact that we seem to be no nearer discovering what their frequency-attenuation curve is than when we started. But let us see.

It consists of two factors, the first of which is $\sqrt{L/C}$. Anybody who knows the first thing about transmission lines will recognize this at once as the characteristic impedance—a remarkable coincidence! If $\omega^2 LC$ is equal to zero—which of course it is at zero frequency—the second factor becomes equal to 1, so the first interesting discovery is that at zero frequency the characteristic impedance is $\sqrt{L/C}$, the same as that of a loss-free transmission line. If L and C are both made very small indeed, $\omega^2 LC/4$ may be much smaller than 1 (and Z_0 therefore is approximately equal to $\sqrt{L/C}$) even at fairly high frequencies. A transmission line can be considered as a low-pass filter with an infinitely large number of sections in each of which L and C are infinitesimally small, so that $\omega^2 LC/4$ never amounts to anything significant at any finite frequency, and $Z_0 = \sqrt{L/C}$ over the whole range.

So here, incidentally, we have a link with something that might have been considered quite a different subject. Z_0 begins as $\sqrt{L/C}$ at zero frequency, and gets less as the frequency is raised; but the smaller L and C are, the higher the frequency before the lessening is substantial, until, when L and C are infinitesimal, as in a uniform line, Z_0 remains constant at all frequencies.

The next thing to do is to find out more exactly how Z_0 varies with frequency, and the most helpful method is to draw a graph. If the principle of generalized graphs (see September issue) appeals to you, you will take as the unit of Z_0 the quantity $\sqrt{L/C}$. And when you expand the term $\omega^2 LC/4$ to bring out f, the frequency, you get.

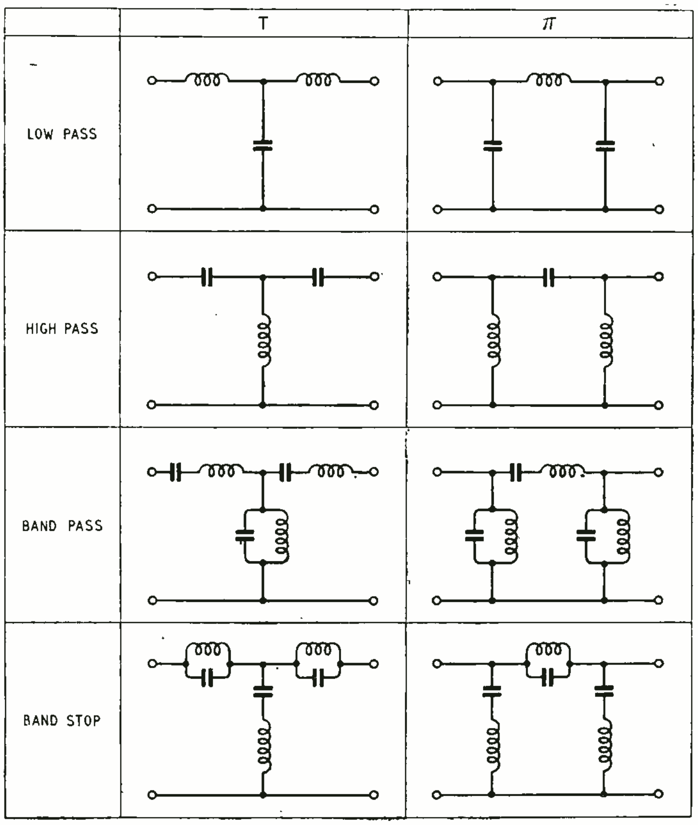
$$\frac{\omega^2 LC}{4} = \frac{(2\pi f)^2 LC}{4} = (\pi\sqrt{LC}f)^2$$

So on the same principle you will choose $\pi\sqrt{LC}$ as the unit of frequency, and plot

$$Z_0^* = \sqrt{1 - f^{*2}}$$

where Z_0^* is Z_0 in units of $\sqrt{L/C}$ and f^* is f in units of $\pi\sqrt{LC}$. If you find generalized graphs confusing, you will have to fill in some values for L and C and plot the graph in the ordinary way, but of course the actual figures will apply only to a filter section with those particular values of L and C. Still, the shape will be the same, and that is the main thing.

It is obvious that as f increases from zero (where $Z = \sqrt{L/C}$), Z_0 decreases; and the decrease gets faster until $f^* = 1$ (or $f = 1/\pi\sqrt{LC}$), when Z_0 becomes zero (Fig. 8(a)). (The nimbler mathematicians may have noticed that the relationship between Z_0^* and f^* is the same as



(Left) Fig. 6. Classification of ladder filters.

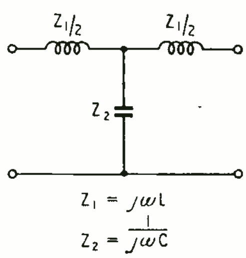


Fig. 7. How the low-pass T section is composed. In the π section, Z_1 and Z_2 have the same values but they are distributed differently (see Fig. 4b).

that between the sin and cos of an angle, so it may be no surprise to them that this part of the curve is a quadrant).

Up to this point, j has been entirely absent, so we conclude that Z_0 is a pure resistance. But when f^* exceeds 1, we are faced with the square root of a negative number, and have to bring in j. Multiplying outside the root sign by j and inside by j^2 ($= -1$), we have

$$Z_0^* = j\sqrt{f^{*2} - 1}$$

and so continue plotting the curve. This part of it, being covered by j, must represent a pure reactance.

So we find that if the load impedance is going to meet the requirements at all frequencies it must be a pretty versatile sort of fellow—a pure resistance varying in a quarter-circle from $\sqrt{L/C}$ ohms at zero frequency to zero at $1/\pi\sqrt{LC}$ cycles per second, and then suddenly changing into a pure inductive reactance, increasing steadily without limit. The advantages of meeting this involved requirement, let us remember, are both theoretical and practical—theoretical because it enables any number of sections to be used without complicating the calculations; and practical, because it avoids mismatching and consequent divergence from scheduled performance.

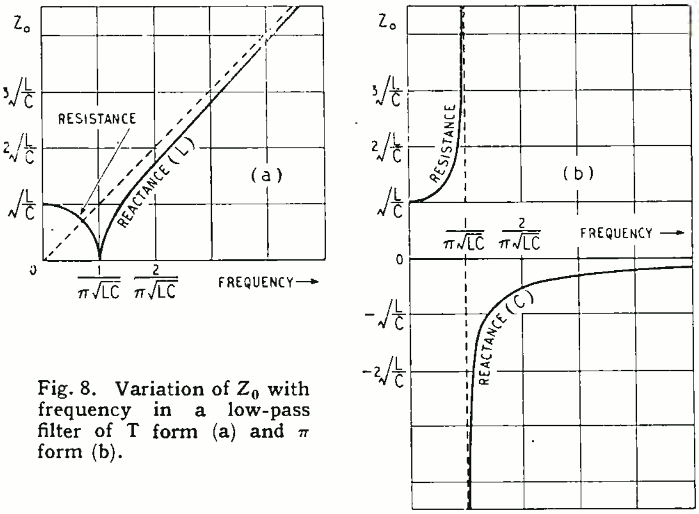


Fig. 8. Variation of Z_0 with frequency in a low-pass filter of T form (a) and π form (b).

We do know a simple circuit that has a critical frequency and an increasing inductive reactance above that frequency—a simple series resonance circuit. But below the critical frequency it is a capacitive reactance, not a resistance. So that won't fit. Actually, nothing will. Thus the low-pass T filter is awkward at the start; its Z_0, without which both theory and practice are unsatisfactory, is impracticable. In spite of this, it is quite a commonly used type of filter. What, then, about the Z_0 difficulty?

If you remember that the Z_0 formula for the π section is the same as for the T except that the second factor is a divisor instead of a multiplier, you will see that it is the reciprocal of the Z_0 for the T. So instead of coming down to zero at the critical frequency it soars up to the sky (Fig. 8(b)). And the reciprocal of an inductive reactance is a capacitive reactance. The high-pass filters are similar, but turned left to right (i.e., reciprocal as regards frequency). And the band filters have two critical frequencies. But all of them have the first factor in common, namely, $\sqrt{L/C}$. The normal practice is to regard $\sqrt{L/C}$ as the impedance of the load (and generator), unless there is any special reason for not doing so. The filter will then be correctly matched only at one frequency (zero in Fig. 8), but it will be nearly right over what might be an important range of frequency. Even though it is hopelessly out near the critical frequency, the assumption that $R_L = \sqrt{L/C}$ is at least a definite condition, for which it is possible (though not very easy) to calculate the departures from simple ideal theory.

It is time to end, and we still haven't found what the attenuation is doing, but we have laid a good foundation on which we can build next month. In the meantime I strongly recommend you to consolidate that foundation by working out for yourself the Z_0 curves for various values of L and C—try some of last November's smoother sections, for instance. You might also see how nearly the shapes of the curves fit what you would expect from the various sections by looking at them. (In Fig. 7, for example, if the input frequency were enormously high Z_2 would be practically a short circuit and the impedance would consist almost entirely of $Z_1/2$, which would be a high inductive reactance.) But especially consider the critical frequency, and what it signifies, and whether it has any connection with any other sort of critical frequency you know of, and why. A whole lot of very instructive and interesting thought can be generated by these innocent-looking little circuits. Some of the answers will come next month.

LOUDSPEAKER CABINET DESIGN

AT a meeting of the British Sound Recording Association on November 25th last, G. A. Briggs gave a lecture on "Some Aspects of L.F. Performance of Loudspeakers" in which he emphasized the importance of the loudspeaker mounting. After demonstrating the modification of the speaking voice by talking into a number of "megaphones" of various shapes—including a conventional extension loudspeaker cabinet—he went on to discuss the baffle systems available for preventing short-circuiting of front and back radiation from the loudspeaker cone at low frequencies.

Comparative tests were then made with an open-backed cabinet, vented cabinets with and without matching to the loudspeaker resonance, a tapered pipe with variable point of entry for the loudspeaker aperture, and a heavily-built "reflex" corner chamber of brick and concrete. Both on speech and music, and with random noise input having a continuous frequency spectrum from 15 c/s to 20 kc/s, the differences in coloration were clearly demonstrated.

Mr. Briggs stressed the point that coloration in some degree was inevitable, but expressed no preference for any one method of mounting. The choice of the individual would be governed by psychological as well as objective factors and would depend as much upon what was listened for as upon what was being listened to.

UNBIASED

By FREE GRID

Houyhnhnms and Yahoos

WHELKS and wireless have not much in common but having recently seen the proprietor of a Southend whelk stall lunching in one of the most Lucullan of West End restaurants and apparently enjoying it by the gusto with which, mouth-organ fashion, he was attacking a leg of chicken, I wondered whether manufacturers of radio receivers consumed their own products or preferred those of their rivals.

Accordingly I visited the house of one of them who is no mean musician. I found him enjoying himself with a mixture of radio and records, assisted by the very latest thing in quality amplifiers made by a rival firm, complete with bass boost, treble turn-up and all the other what-nots which one finds on these instruments. As his own firm makes both radio sets and radiograms, I naturally asked him for an explanation.

He excused himself on the ground that results from such an instrument as he was using could only be appreciated by a handful of musical Houyhnhnms like himself. He felt that it would be a wicked waste of materials and skilled technical labour to cast super-quality amplifiers before Yahoos—in which class he evidently included the majority of listeners who, as he explained, only demanded of a wireless set that it be capable of producing a reasonable row.

Undoubtedly there is a certain amount of truth in what he said and I don't suppose that the general public would be prepared to pay for extra valves solely for juggling with bass and treble balance. In any case they would make a hopeless hash of the juggling and then blame the instrument. But I do think that it is time the manufacturers of what I will call "ordinary" sets, to distinguish them from the super-quality push-pull jobs, provided an outlet to which those of us who think ourselves musical highbrows could couple our own or somebody else's version of a quality amplifier.

It is true that most manufacturers of quality amplifiers sell excellent r.f. units to go with them, but the few that I have seen, while they would look thoroughly at home in a ship's wireless room, just wouldn't blend with a Louis Quinze drawing-room, and they can't be shoved under the sofa like an a.f. amplifier. No woman would permit them to be installed permanently in a reception room, and as such refusal forms no valid ground for divorce, most of us are compelled to temper the joys of the ear with those of the eye. I hope, therefore, to see quality output sockets on all "ordinary" sets at the next Radiolympia, and shall take their absence on any set as a tacit admission on the part of its manufacturer that quality is too mangled in the pre-a.f. section for there to be any hope of its resuscitation.

Push-pull in Action.

A Ticklish Question

A KINDLY reader writing to me from the watery wastes of Westmorland draws my attention to some investigations he has been making into a peculiar form of interference occurring about 11 p.m. and lasting only a couple of seconds. Eventually he found the trouble to be caused by the bedtime removal of what he, with an appropriate sense of delicacy, calls "certain feminine undergarments." While publicly thanking my correspondent for the report on his research work, I must inform him that it is by no means original, as I carried out some researches into this matter nigh on twenty years ago and published my findings in these columns in 1931.

In those far-off days I was merely a voice crying in the wilderness, but things are vastly different nowadays, as I have the full weight of the law behind me in my endeavour to stop this interference; at least I have in theory, but so far the Post Office authorities have been singularly loath to investigate this source of interference. As for the manufacturers of anti-interference devices, they do not, so far as I am aware, make a single suppressor for dealing with this particular form of man-made, or rather woman-made, interference at the source. I firmly believe that their laboratories haven't done any practical research work in the matter whatever, due, I suppose, to the dearth of properly qualified women engineers.

It is, however, high time that something was done about it, and I hope that before long one of the more go-ahead firms will market

Silk-stocking Static.

suppressors together with the necessary instructions for connecting them up and that they will at the same time not be afraid to submit a specimen to the Editor for a test report.

If anybody doubts the seriousness of this kind of interference, let him do what I have been doing recently—attempting to receive television at a spot by the silvery sea hard by one of our most famous girls' public schools. So far the only thing I have learned as a result of my investigations is the girls' bedtime, which produces a most appalling snowstorm on the screen. Very much later in the evening a snowstorm of less intensity appears, due, I presume, to the retirement of the mistresses. This additional snowstorm is, however, sufficiently heavy to make it obvious that the mistresses are no bluestockings.

If it is found that a suitable suppressor unit cannot be designed I trust that the Editor will not hesitate to attack those at the head of the women's underclothing trade and smite them hip and thigh with a stern demand for a return to the days of flannelette and wool on which foundations England's greatness was built. It is not too much to say that had radio been in existence in Queen Victoria's time the force of public opinion would have rendered underwear suppressors unnecessary, as the offending kind of underwear would itself have been suppressed.

A.C./D.C.-Battery Power Supplies

Design Considerations for Maximum Economy

By L. MILLER

THE design of a combined a.c., d.c. and dry-battery operated receiver calls for departure from the orthodox only in so far as the power supply is concerned. It should be apparent that the power supply for a "three-way" receiver will be called upon to give a smoothed d.c. supply for the valve filaments as well as the normal h.t., as, of course, directly-heated valves will be used for the receiver in order to keep down the heater watts when the set is to be run on the self-contained dry batteries. The obvious choice will be the "all-dry" 0.05-A valves.

Next comes the question of series or parallel wiring of the filaments. Parallel operation for both mains and battery supplies is ruled out by the high losses which would be incurred in the voltage-dropping resistor, and the extra space which would be needed to provide adequate ventilation. Series-parallel switching is one method of overcoming this difficulty, but a really reliable switch is necessary and when this is found will inevitably add to the cost of the set.

We will therefore assume that series operation is to be used on all supplies. In the usual four-valve superheterodyne circuit, three 1.5-V and one 3.0-V valves will require a filament current of 50 mA at 7.5 V.

Choice of Rectifier

If the same output valve is to be used on a.c., d.c. and batteries, then the metal rectifier will almost certainly be chosen, as it takes up no more room than a valve rectifier and requires no heater current. Some commercial three-way receivers incorporate an auxiliary mains-type output valve which is automatically switched in circuit when mains operation is used. With this type of set it is quite a practical proposition to use a valve rectifier, as its heater will be wired in series with the mains output valve heater and will only be consuming current which normally would be wasted.

As 90 V is the maximum voltage that will be required, it may appear obvious at first thought to drop the surplus 100 or so volts *before* rectification, and indeed in almost all of the American-made sets this procedure is adopted, but only for the reason that 110 V is the standard pressure in the U.S.A. and the extra pre-rectification dropping resistor has been added to enable the receiver to be operated on mains in the region of 200-230 volts.

In England 100 V mains are comparatively rare, and unless the designer contemplates ever being located in a 100-V district there is nothing gained in dropping the surplus volts before rectification except, perhaps, that a slightly smaller rectifier could be employed.

One economical method of "losing" the extra volts is to dispense with the reservoir condenser. As half-wave rectification will be employed, the d.c. output from the rectifier will be very nearly half the input, which will give a value closely approximating to that which we require.

This also has the very important advantage of providing good voltage regulation, since the average voltage appearing across a reservoir condenser is dependent upon the current being drawn from it during the non-conducting half-cycle, and is liable to vary appreciably with quite small changes in load.

With no reservoir condenser the only factor affecting voltage output is the resistance of the rectifier itself, and as this factor is also present with both systems, and we do not need the extra volts which a reservoir condenser will supply, it is obvious to our advantage to dispense with it, as voltage regulation is a very important point when dealing with the filament supply, which needs 7.5 V—not just "about 7.5 V."

Smoothing

In order to keep the filament regulation good, it may be considered advantageous to split the smoothing into two sections, as shown in Fig. 1. Assuming that a mains supply of 200 V is the minimum we are likely to encounter, and that a small dropping resistor is used before rectification for mains adjustment as shown, the d.c. output from the rectifier will be 100 V less the drop across the rectifier. This voltage drop due to the rectifier will have to be determined by experiment unless the resistance of the rectifier under working conditions is known. Probably the best plan would be to construct the entire power pack using a small 300-ohm

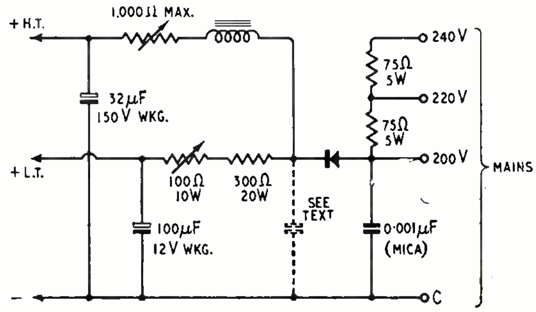


Fig. 1. Supply circuit using metal rectifier.

smoothing choke for the h.t. section and place loads across the two outputs equivalent to the h.t. and l.t. requirements. If the h.t. is too high an extra small value of resistor may be placed in series with the choke, while if the h.t. is too low a *small* value of reservoir condenser should be placed across the output from the rectifier. Usually a 0.25 or 0.5 μF will be sufficient to compensate for the drop lost across the rectifier, and such a small value will not materially affect the regulation of the supply.

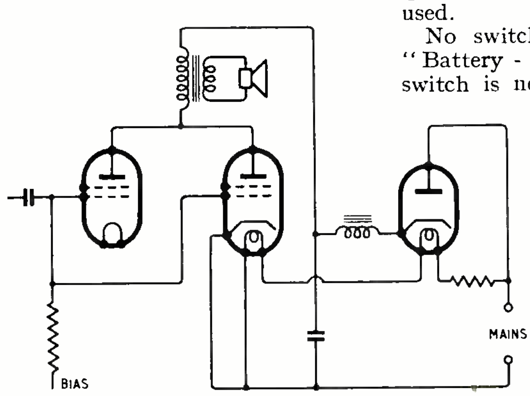
On the l.t. side we have to drop the 90 or so volts to the required 7.5 V, and the resistor needed can also conveniently serve for smoothing purposes. A really large filter condenser can be employed, as the voltage will never rise above the 7.5 V, and a very low working voltage, bias-type condenser, say 100 or even 200 μF, can be used.

Voltage Adjustment

For really accurate adjustment it is a good plan to make up the l.t. dropping resistor with one fixed and one variable, as shown in Fig. 1 and connect a temporary resistor of 150 ohms (one-watt type will suffice) across the l.t. output, and one 8,000- to 9,000-ohm across the h.t. output, then make the h.t. and l.t. adjustments as described.

Upon removing these temporary resistors the power pack is ready for operation and should require no further adjustment. Any change of h.t. current, say between 5-10 mA, will have a negligible effect on the l.t. output, as the only resistance common to both l.t. and h.t. circuits is that of the rectifier itself, which is normally quite low; should it tend to increase the l.t. voltage the filaments will consume more current, which will to a large extent offset the increase, but in any case the deviation from 7.5 V will be very slight.

Fig. 2. A valve rectifier can conveniently be used when separate output valves are provided for battery and mains operation.



It was mentioned earlier in this article that some commercial firms incorporate an auxiliary mains output valve for use on a.c. and d.c. mains. Obviously the idea lying behind this is to get "mains quality" and better volume when current economy is of no importance and, if this refinement is required, a valve rectifier can be used.

No switching other than the "Battery - Mains" changeover switch is necessary, both valves being connected in parallel as shown in Fig. 2. as the "Battery - Mains" switch ensures that h.t. is applied only to *one* of the output valves.

An interesting point arises here. The 50L6 is very suitable as an output valve for this type of receiver when using the mains supply, as the heater current is only 0.15 A. It consumes 53 mA of h.t. with a supply voltage of 110 V and requires 7.5 V grid bias.

Cathode-current Heating

It is a comparatively simple matter to adjust the anode voltage of the 50L6 so that exactly 50 mA flows, and to wire our four battery valves between cathode and earth, as shown in Fig. 3. As the 50 mA will obviously be flowing through the valve filaments and as we know that when 50 mA is flowing through the valve filaments the combine voltage across them will be exactly 7.5 V, which is the bias required by the 50L6, it will at once be realized that we have here a very convenient means of heating our battery valve filaments without taking any additional current from the rectifier. The 50L6 acts as the smoothing and voltage-dropping "resistor," and the 100 μF capacitor serves the dual purpose of filter and bias condenser for the valve.

If this method is adopted it will be necessary to add a further two-way switch (which should be ganged to the "Battery - Mains" switch) as shown, to cut the h.t. supply off the battery output valve when the mains output valve is used.

The writer claims no originality for this type of circuit which is believed to be used by many commercial manufacturers in the U.S.A.

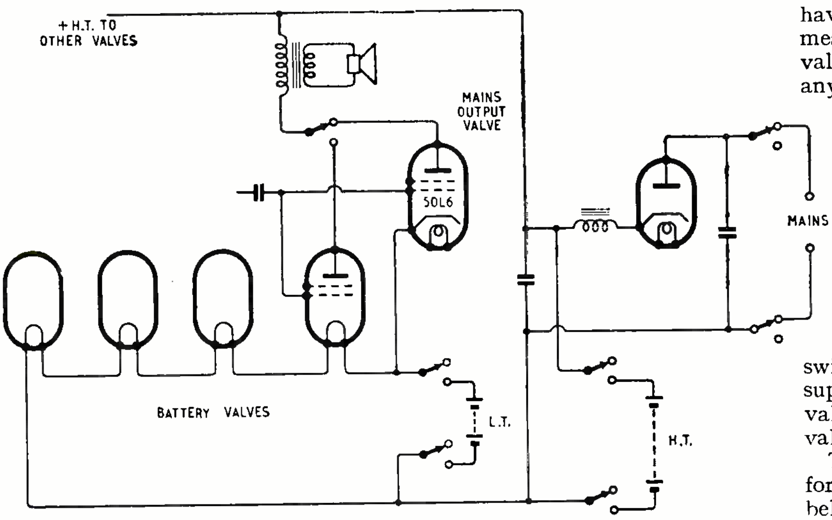


Fig. 3. Filament heating of early valves by anode current of "mains" output valve. All switch elements are, of course, ganged together.

Manufacturers' Products

New Equipment and Accessories for Radio and Electronics

Miniature Standard Cell

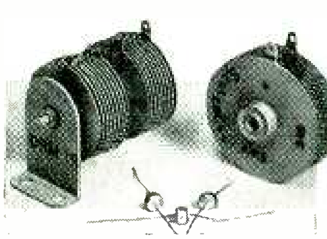
A STANDARD Weston cell (1.01859V abs. at 20°C) has been developed by Muirhead, Elmers End, Beckenham, Kent, and is contained in a square-section vertical moulded case measuring only $\frac{7}{8} \times \frac{7}{8} \times 3\frac{1}{2}$in. A single tube has been adopted in place of the conventional H construction and the electrodes, which lie side by side, are separated by a glass web. One advantage of this form of construction is that there is less risk of temperature differences arising between the mercury and cadmium amalgam half-cells.

Miniature Rectifiers

FOLLOWING the general trend of miniaturization, Standard Telephones and Cables, Connaught House, Aldwych, London, W.C.2, have introduced some miniature "Centercel" rectifiers for h.t. and r.f. use. They are the selenium type, the h.t. models being known as the RM1, RM2 and RM3, their d.c. outputs being 60, 100 and 120 mA respectively. The maximum r.m.s. input to a single rectifier is 125 volts, but two or more can be joined in series for higher voltages. Likewise they can be employed as voltage doublers or triplers, or bridge-connected for full-wave rectification. Their small size (the RM1 measures $1\frac{3}{8}$in in diameter and $\frac{1}{2}$in thick), enables combinations of this kind to be accommodated in a small space.

A miniature r.f. rectifier for use up to 5 Mc/s is also included. Its size is $\frac{1}{8}$in × $\frac{1}{4}$in × $\frac{1}{4}$in and it is so light it can be suspended in the wiring; it weighs 0.015oz only. Among its many applications are those of second detector in superhets, a.g.c. rectifier, noise limiter and d.c. restorer. It is the type M1.

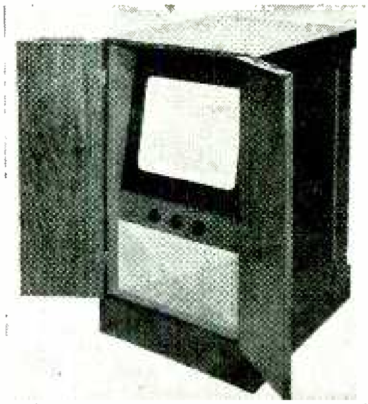
Its principal characteristics are: Self-capacitance, 20 pF; forward resistance, 12 kΩ; reverse resistance, 20 MΩ; and maximum peak inverse voltage, 50. For satisfactory rectification a minimum voltage of 0.5 is needed.



Some of the new S.T.C. miniature rectifiers for h.t. and r.f. use. The dual assembly consists of two RM1 rectifiers. Type M1 shown in front.

Big-tube Television

A PICTURE size of $12\frac{1}{2} \times 10$in on a 15-in aluminized tube is provided in the new V176C Murphy television receiver. The superhet circuit, which is available for either the London or Birmingham transmissions, includes interference suppression on both sound and vision. Focusing is effected by a combination of permanent and electro-magnets and is stabilized against mains fluctuations. The makers are Murphy Radio, Welwyn Garden City, Herts, and the price, including tax, is £176.



Murphy television receiver, type V176C, with aluminized screen.

Precision-drawn Waveguide Tubing

WAVEGUIDE tubing in long lengths (10ft), having close dimensional tolerances, small radii of internal corners and a very high internal finish, is now being made by Johnson, Matthey and Co., 73-83, Hatton Garden, London, E.C.1.

This guide is available not only in brass and copper but also in silver-lined brass or copper, silver-copper alloy and aluminium. A range of sizes is available from 2.0 × 0.667in, including the normal service requirements, down to 0.180 × 0.09in internal dimensions.

A technical service has been made available to assist in establishing satisfactory service to the consumer both in choice of guide and subsequent processing, and tubes having non-standard dimensions can be manufactured to specification providing the quantities involved justify the production of special tools.

Portable Recorder

A SELF-CONTAINED recording machine has just been introduced by Electrosound Supplies, 99, Belgrave Road, London, S.W.1. It makes use of the "Technifon" Type TG2 traverse gear which is a development of the Type TG1 described in the July, 1947 issue of this journal; it has a moving-iron type cutter head with a response of 50 to 6,000 c/s. The lead screw is friction-driven from the centre of the record and the traverse gear as a whole is hinged and can be lifted clear of the record.

"Technifon" portable disc recorder.

The turntable is an aluminium alloy casting running in oil-retaining bearings and is belt-driven by a motor developing a torque of 400 gm/cm.

A three-stage amplifier with an output of 5 watts is built on the underside of the motor board, and a monitoring loudspeaker is fitted in the lid of the carrying case. A high-grade moving coil microphone is included.

The light-alloy carrying case, which is finished in durable enamel, measures 14in × 15in × 10½in. The cost of the complete equipment is £85.

Moving-iron Meters

REPULSION-TYPE movements giving a substantially linear scale from 20 per cent to full-scale deflection are a feature of a new range of moving-iron panel-mounting meters recently introduced by Taylor Electrical Instruments, 419-424, Montrose Avenue, Slough, Bucks.

The Series 400 and Series 500 with 4in and 5in scale lengths in rectangular cases are already available and a circular type with 3½in scale is in course of development.

New R.F. Cables

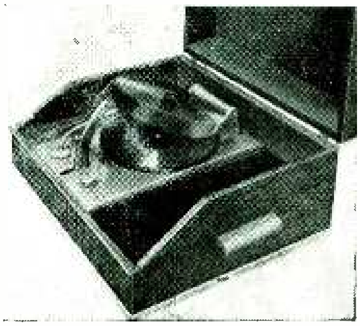
THE following new types have been added to the range of "Co-Ax" air-spaced articulated cables made by Transradio, Ltd., 138A, Cromwell Road, London, S.W.7: *Type C34, low-capacitance cables*; outside diameter 0.85in, capacitance 4.8 μμF/ft; impedance 231 ohms. *Type C344, very-low-capacitance cable*; o.d. 0.85in, capacitance 4.3 μμF/ft; impedance 259 ohms. *Type A34, highly flexible medium-power transmission line*; o.d. 0.85in, impedance 73 ohms. At 100 Mc/s attenuation 0.65 db/100ft and loading 1.5 kW. Bending radius 3in. *Type A344, flexible 51.5-ohm medium-power transmission line*; o.d. 0.85in, nominal impedance 51.5 ohms, bending radius 4in. Loading 2.3 kW and attenuation 0.78 db at 100 Mc/s.

Photo-Electronic Relay

THE Model 71 photo-electronic relay made by Electronic Instruments, Paradise Road, Richmond, Surrey, is sensitive to changes of input of the order of 2 μA over a range from zero to 2 amps.

The input is backed off by a potentiometer which can be graduated directly in the units to be measured (e.g., temperature, pH), and applied to a conventional moving-coil meter which is normally operated at zero. A small lamp below the dial illuminates a vacuum photo-cell through a narrow slot which is obscured when the pointer of the meter is deflected. The current from the photo-cell passes through a d.c. amplifier to operate a mechanical relay with on-off, change-over contacts rated at 3 A, 250 V a.c. or d.c.

The operating point is continuously variable and the backing-off potential is derived from a neon-stabilized source. By reversing the input connections the relay can be made to function on either a rise or fall of input.



"K.F." automatic record changer for sixteen 10in or 12in discs.

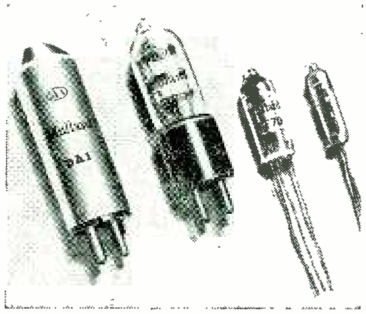
Miniature Hearing Aid

WEIGHING only 5 oz with batteries, and contained in an engraved gold-finished case, this hearing aid employs a three-valve circuit drawing only 0.4 mA from a 15-V sub-miniature h.t. battery. The h.t. life is approximately 350 hours, and the l.t. 8 hours from a standard "pen" cell, or 30-35 hours if a Kalium U7 cell is employed.

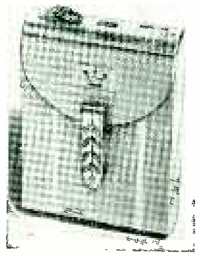
The crystal microphone is concealed behind the coronet motif on the front of the case, and either a magnetic or crystal insert earpiece is supplied. In addition to the volume control, two stages of tone control for top or bass cut are provided. The circuit incorporates automatic volume limitation.

Plug-in type valves are used and the chassis is removable after withdrawing two screws.

Made by Bonochord, Ltd., 48, Wigmore Street, London, W.1, the "Micropak" hearing aid costs 27 guineas.



The DF66 (extreme right) with earlier Mullard sub-miniatures.



(Left) Model 71, photo-electric relay made by Electronic Instruments.

Bonochord "Micropak" miniature hearing aid.

Record Changer

UP to sixteen 10in or 12in records can be accommodated in the "K.F." record changer sold by Brooks and Bohm, 90, Victoria Street, London, S.W.1. Only one record at a time is on the turntable, and after playing the record is removed to a hopper at the side. Records can be added to or removed from the stack while playing, so that a continuous programme can be arranged. The change cycle occupies less than 2½ seconds.

The trigger mechanism which operates when the pickup enters the run-off groove has a light action and will function with needle pressures down to ¼oz. A ruby stylus is fitted to the pickup and the needle pressure is adjustable.

The single-knob control includes a "delay" position which raises the pickup and returns it to the record at the same point. This feature is useful for interjecting announcements, and for musical games.

A constant-speed rim drive motor for a.c. supply is fitted and the weight of the complete instrument is 12 lb. The price, including tax, is £16 5s.

New Hearing Aid Valves

MULLARD ELECTRONIC PRODUCTS, LTD., have announced two flat-type sub-miniature valves of extremely small size. The DF66, a voltage amplifier pentode, is 1.1in long, and the DL66, an output pentode, is 1.38in long; both are 0.33in wide and 0.24in thick.

An important feature is economy in filament battery drain. The DF66 filament is rated at 0.625 V and the DL66 at 1.25 V, but each consumes only 15 mA, as compared with 25 mA for previous Mullard valves and 30 and 45 mA for similar American types. Using a 22.5 V h.t. battery, the DF66 will give a voltage gain of 30 db per stage whilst the DL66 will give a power output of 2.5 mW at less than 10 per cent distortion.

Academic Qualifications

ALTHOUGH sympathizing with your correspondent, "Unemployed A.M.Brit.I.R.E.," I feel that he, like many others, fails to appreciate the proper interpretation of academical and professional qualifications.

The Higher School Certificate should be regarded as proof that the holder has the power to assimilate the theory of certain basic sciences. It is no proof that he is capable of putting those theories into practice. The same could be said of C. & G. Telecommunications, except that it is almost impossible to obtain the full certificate without the aid of considerable practical experience.

On the other hand, professional qualifications such as Corporate Membership of the Brit.I.R.E. are proof of sound theoretical knowledge combined with at least five years of practical experience in a responsible position.

An intelligent employer appreciates these facts, and should he require staff which he intends to train and mould to suit his own particular specialized class of work, he accepts those who have the Higher School Certificate.

However, should he desire staff who can take over a job of work almost immediately with the minimum of guidance or supervision, he looks for those with technical and professional qualifications.

From my knowledge of the Royal Aircraft Establishment, Farnborough, with its departmental groups and specialized divisions of labour, the advertisement referred to by your correspondent is not as anomalous as he would have us believe, nor would any applicant be turned down simply because he had C. & G. Radio-Comm. plus Tech. Elec. II, or A.M.Brit.I.R.E. instead of Higher National Certificate.

I am not conversant with the inner workings of the Technical and Scientific Register, nevertheless I would advise him to take heart rather than umbrage, and not to take such advertisements too literally. H. WILLAN CRITCHLEY.

Scarborough.

MAY I as a regular reader of *The Wireless World* encroach upon your space to support the views of "Unemployed, A.M.Brit.I.R.E." in the November issue?

I, also, have City and Guilds Radio-Communication I, II and III and Technical Electricity II and am employed by the Admiralty as an Assistant Scientific Officer on radar. I find that my colleagues who obtain Higher National Certificates are usually rewarded with promotion to A.E.O. (two grades higher) but City and Guilds certificates receive no recognition at all, although the latter are much more closely related to our daily work.

I feel it is time that Government departments assessed the value of other qualifications and gave the holders due recognition.

"BUNNY."

London, S.E.1.

Valve Types

THE valve position in this country has always been notable for its confusion and we all had hopes that with the benefit of octal based valves we should have a standard which would serve for the majority of purposes.

It appears that new sets are being made in which rectifiers and output valves are of the all-glass type. It is generally agreed that this construction makes for much better tubes at v.h.f., but has it any advantages at audio and power frequencies?

It has three disadvantages:—

1. The pins generally do not make such good contact with the holder.
2. The bases are liable to crack round the pins.
3. The price is usually considerably higher.

If there is a good reason for the change I should like to know it; otherwise I hope that, in the majority of cases when replacements fall due, someone will change the valve holders for octal type.

H. O. BRADSHAW.

Birmingham, 31.

Beacon Interference

I AM very glad that the matter of these medium-wave beacons has been raised again. I feel, though, that "Mikerobe" (your November issue) is either considerably less critical or more long-suffering than I am.

My letter to my M.P. on this subject produced a reply from the Assistant P.M.G., dated 20th October, 1947, to which I called your attention at the time.

In particular, we have a very fine local phenomenon, in the shape of a 2nd harmonic from Croydon Airport beacon on 400kc/s, though this has never bothered me, as it appears to be crystal controlled, unlike the others, and keeps off the B.B.C.

I hope that it will not be necessary for the Post Office to take action against these offenders, and that they will quietly disappear.

South Croydon. J. B. ROSCOE.

Photomicrography

YOUR report on C. E. Watt's address to the B.S.R.A. (December, 1949 issue) on his valuable work in the photographic examination of record grooves, styli, etc., refers throughout to this technique as "microphotography."

This is incorrect, as this term relates to the production of miniature transparencies or prints from normal negatives or objects of ordinary dimensions, e.g., letters, documents. The proper description for the preparation of these greatly enlarged negatives or prints of objects of microscopic dimensions is "photomicrography," which word was used in the title of the lecture.

In the same issue another term that interests me is in the opening paragraph of E. W. Berth-Jones's article on measuring turntable speed fluctuations, where erratic non-cyclic speed changes are said to be frequently called "watering"; surely this is a misprint for "wavering"? DONALD W. ALDOUS.

Torquay, Devon.

[No, this was not a misprint. We understand the term "watering" is widely used, particularly in film recording.—ED.]

"*Pick-up Design*"

I READ with horror the last paragraph of the article by T. S. Marshall in the November issue. His suggestion that a jewelled point be used on old and valuable records will surely be ridiculed by the serious collector, because in the olden days there was little consistency in any one make of record, let alone different makes. The tip-radius would depend on the make of record, the factory it came from, the year it was made, and the amount of wear it has already had; indeed, it would become difficult to single out the correct tip to use.

Imagine the plight of an old disc after having (n-1) ill-fitting hard tips ploughing their way along its inconsistent groove and ruining once and for all its already poor and equally inconsistent surface, in an effort to find the best size. One need glimpse only once the bushy mass of swarf around the tip of a decent sapphire after playing even a modern record under as nearly ideal conditions as possible.

Any enthusiast knows that the only way to play an old record with a minimum of surface noise and wear is to use a soft point. Now let me make it perfectly clear that I am not advocating a triangular needle in a sound-box which one can hardly lift (these gave easily the best results of their day, and I have yet to see a record appreciably worn under these conditions), because even we "Soft-Point-Men" have advanced a little.

I, like many others, use a miniature thorn in a light-weight pickup of reputable make. If thorn needles are used intelligently (which includes keeping them dry and crisp) one sharpening will last enough sides for all but the idealist. Furthermore, they do not pick up dust to chew up the groove, at least, not as far as my eye can see with the aid of a biological microscope. As proof of this, I have a collection of over 500 selected recordings which, though very much played, are all in that immaculate fibred condition which high-class dealers demand.

But back to Mr. Marshall's theme of noise reduction by large tip-radius. A thorn soon wears to the optimum size and stays there, however old the record, hence the correct top-cut is quite automatically brought into operation.

I fully appreciate the age of this controversy, which has gone on since the gramophone needle was invented, and most emphatically I do not wish to restart it. All I ask is that collectors of old records pick one that does not matter if they wish to use a sapphire—or any other hard point—since these are all we possess to remind us of the lost artistry of olden days.

JAMES A. MacHARG.

Gosforth.

REFERRING to the first point in Mr. Lowden's letter in your December issue, I introduced the term "pinch effect" because I thought it would convey very clearly to readers the conception of the included angle of the groove walls not being constant but varying continuously throughout the modulation cycle. What I did, and still do, intend to state is the fact that where the groove is too large for the stylus it will, in the course of the cycle, penetrate the groove so deeply as to come in contact with the bottom thereof and be compelled to lose contact with one of the groove walls. No amount of theoretical argument as to what groove dimensions records are supposed to be cut, will get over the fact that *in practice* a large number of commercial pressings will not play with a 0.0025in stylus, and that one has to go up to a 0.0035in stylus, and sometimes even beyond, before a satisfactory signal-noise ratio can be achieved.

Second, the groove depicted in Fig. 3 was found by shadow-graphing the unmodulated groove on a well known standard frequency record. Whether or not it has the dimensions intended by the makers, I do not know, but I think it can be assumed to be fairly typical of pre-war pressings. As to fitting the groove, the fit is to be regarded from the engineering viewpoint, and was never intended to be taken as satisfactory from the reproducing standpoint.

It must be remembered that in developing this new pick-up we were not concerned solely with providing one that would do full justice to the latest recordings but also one that would give acceptable results with recordings that are normally regarded as unplayable on modern equipment. I have had the pleasure of personally helping several very disheartened record collectors in this respect, and it was primarily for such folk that the article was written.

T. S. MARSHALL.

London, E.18.

CLUB NEWS

Basingstoke.—At the next meeting of the Basingstoke-District Amateur Radio Society on January 6th at 7.45 at the British Workmen's Restaurant, Basingstoke, the design and construction of communication receivers will be discussed. Sec.: L. S. Adams, 16, Bramblys Drive, Basingstoke, Hants.

Cleckheaton.—L. Butterworth, of R. N. Fitton (Ambassador) will deal with radiogramophones at the meeting of the Spen Valley Radio and Television Society at 7.30 on January 18th at the Temperance Hall, Cleckheaton. Sec.: N. Pride, 100, Raikes Lane, Birstall, Nr. Leeds, Yorks.

Croydon.—Members of the British Television Viewers' Society will be addressed by D. F. Wolfe-Murray (B.B.C. Television Liaison Officer) and Harold Cox (B.B.C. Newsreel Manager) at their next monthly meeting on January 16th at 8.0 at Kennard's Restaurant, Croydon. Sec.: F. E. Gearing, 58, Woodland Way, Mitcham, Surrey.

Manchester.—Monthly meetings of the Manchester Area Group of the Radio Controlled Models Society are held alternately on Saturdays and Sundays. The next meeting will be on January 15th. Sec.: L. Witcombe, 12, The Crescent, Prestwich, near Manchester, Lancs.

Sunderland.—A series of lectures on valve manufacture by members of the staff of the Edison Swan Electric Co. has been arranged for the Sunderland Radio Society (G3CSR). The third of the series — on "Grids," by R. Matthews — will be given on January 18th. At the meeting on January 11th A. E. Coghlan will talk on "Design of R.F. Components for Superhets." Meetings are held at 8.0 at the Club Room, Prospect House, Prospect Row, Sunderland. Sec.: C. A. Chester, 38, Westfield Grove, High Barnes, Sunderland, Co. Durham.

SHORT-WAVE CONDITIONS

November in Retrospect : Forecast for January

By T. W. BENNINGTON (*Engineering Division, B.B.C.*)

DURING November the average maximum usable frequencies for these latitudes increased considerably during the daytime, and decreased considerably by night. This was in accordance with the normal seasonal trend. Daytime working frequencies were, in fact, rather higher than had been expected. 28Mc/s, for example, was regularly usable over most circuits from this country at the appropriate time of day, and American police signals on 42Mc/s were often receivable here. The London television signals were received in South Africa on very many occasions during the month. At night the highest regularly usable frequencies were about 6 or 7 Mc/s.

Sunspot activity during the month was, on the average, only slightly lower than during the previous month, and now stands at a value much higher than was expected a year ago. This high solar activity accounts, no doubt, for the particularly high values of the daytime working frequencies.

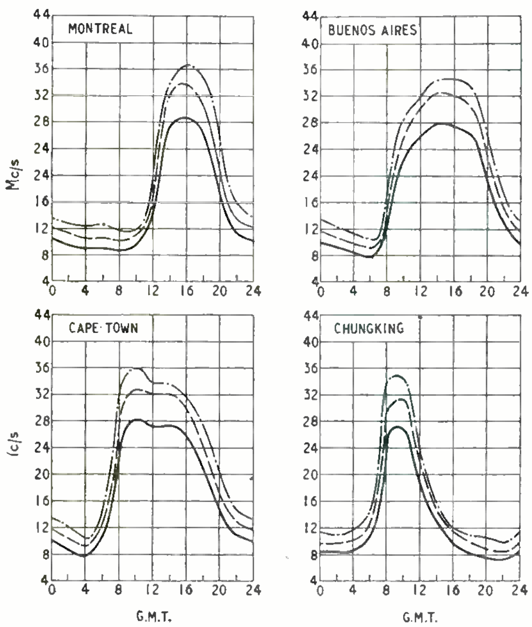
Ionospheric storms occurred during the periods 1st-5th, 11th-12th, 19th-22nd and 29th-30th, and on 6 nights during the month, within each of these periods, the storms were accompanied by displays of the Aurora Borealis visible in this country. Dellinger fadeouts were reported as occurring at 1158 on 5th, 0940 and 1133 on 17th and 1030 on 19th.

Forecast.—There should be little change in either day-time or night-time m.u.fs. between December and January, the former remaining relatively high (though not so high as in November) and the latter being, on the average, near the lowest values for the present winter season.

Long-distance working frequencies should thus be high by day and low by night. The period during which the higher frequencies should be usable will, of course, be relatively short, and that for the lower frequencies relatively long. Frequencies as high as 28Mc/s should be frequently usable over most circuits at the appropriate time of day (*regularly* usable to the eastern part of North America), whilst at night those as low as 7 or 6Mc/s will be really necessary over most paths.

Ionospheric storms are likely to be troublesome after dark in January, although this is not usually a bad month. Long-term prediction here is, of necessity, effected at present solely on the basis of the 27-day recurrence tendency in ionospheric and magnetic disturbances. As a rule this gives good results at certain periods in the sunspot cycle, but has not been doing so lately. Until either the 27-day recurrence tendency begins to give better prediction results, or other data becomes available on which to base long-term predictions, we shall not, therefore, in this column, attempt to specify the days on which ionospheric storms may occur.

The curves indicate the highest frequencies likely to be usable over four long-distance circuits from this country during January.



——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS
– – – – PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
—·—·— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

RANDOM RADIATIONS

By "DIALLIST"

Take Off the Brakes!

As the days go by, I read of television development programmes in other countries and become, by turns, more depressed and more wrathful over the slow *tempo* and the general inadequacy of what is being done here. That's one reason why I make no apology for returning to the subject. We were first in the field of television. We have adopted a system which makes good reception possible with domestic apparatus priced considerably lower than that manufactured in other countries. The interest shown by our people in television is enormous. Home sales of television receivers could be many times what they are if we had a scheme for completing a country-wide transmitting system within, say, two years from now. Nor can there be any doubt that we should have a fine chance of building up important overseas markets for transmitting and receiving gear. The B.B.C.'s plans for a country-wide system are cut and dried, so that something like a complete service could be in operation within a couple of years. Nothing is needed but permission to go ahead from the "Powers that Be." Let's hope that they'll have vision enough to realize the importance of the matter and to take off the brakes.

Interfering Fluorescent Lamps

A letter from a Netherlands reader has raised a very interesting point. Briefly, he told me that though the firm with which he is associated uses fluorescent lamps in its workshops, it has had to return to lamps of the incandescent type in rooms where wireless apparatus is demonstrated to customers, on account of the interference which fluorescents were found to cause. Could I, he asked, tell him of any successful suppressor for these lamps? I knew from experience that some tubes (though only a small percentage) cause interference with short-wave radio and with television. My own practice has long been, like that of my Dutch friend, to change over from fluorescent to incandescent lighting when any sort of s.w. or u.s.w. reception is in progress. When I recalled that at Radiolympia there had been hundreds of fluorescent lamps without any apparent interference with television reception, I realized that something must have been done about it.

Oscillation Problem

Drawing a bow not so much at a venture as with a fair feeling of certainty that my arrow was aimed at the right direction, I sent a line to E. M. Lee of the firm which makes the prevention of interference one of its special studies. His reply told me several things about fluorescent tubes that I didn't know, and I am sure that some of them will be news to most readers. About 6 per cent of new tubes give rise to interference, which, as a rule, does not start until about a quarter of an hour after they have been switched on. At the end of this time an interference-producing tube suddenly starts to oscillate. Some tubes, however, which are blameless when new, develop interference-producing properties with age. An oscillating (and therefore interfering) tube can often be stabilized by tapping the glass; but it falls back into oscillation in a matter of minutes. So far, tube manufacturers know of no means of controlling or preventing this oscillation, or of predicting whether or not a given tube will be liable to it.

Heater "Poisoning"

Next time you find that a fluorescent tube is causing interference take a look at the heater at either end through the clear glass near the caps. On one of them you will see a noticeably bright spot. Tap the glass and it disappears at once; so does the interference. But both return simultaneously within from three to 15 minutes. The trouble is believed to be due to a form of "poisoning" of the heater coating. Belling and Lee have produced a neat little suppressor, easily fitted to any existing fluorescent tube mounting. How effective it is was proved by conditions at Olympia. The Radio Industry Council laid down that every fluorescent tube in the building should be fitted with this suppressor. This was duly carried out—but on the opening day there was some interference with television. The source was found to be a particular stand on which one or two tubes were oscillating. Suppressors had been provided, but the electricians who fitted them had connected them incorrectly. The connections having been put right, there was no more interference.

Television and Broadcasting

Forecasts by writers on the other side of the Atlantic that "sound" broadcasting will soon be ousted by television have been echoed by some writers in this country. Nothing of the sort is likely to happen for a great many years—if it ever does happen! Gloomy predictions of that kind are made about most new things; they are going to kill this or that. Such prophecies come true only when a new system offers a better and cheaper way of doing something that was previously costly and inefficient. The steamship was bound to render the merchant sailing ship obsolete because it could run to a time-table and was less dependent on weather; but it will be a very long time—if it ever does come about—before the steamship is ousted by the 'plane as the most economical way of conveying passengers and goods over the sea. Like radio and television, steamship and 'plane are complementary; each does something that the other can't. Unless basic changes come about in television methods, there can be no near vision equivalent of the three-valve radio set, and certainly not of the crystal set. Vision programmes, again, are far more costly to provide than those for "sound" broadcasting, and that is reason enough for feeling pretty sure that television is likely to remain for a long time a provider of entertainment for only a few hours each day.

MANUFACTURERS' LITERATURE

Catalogue of receiving aerials and accessories, from Aerialite, Ltd., Castle Works, Stalybridge, Cheshire.

The following new leaflets have been received from the Baldwin Instrument Co., Brooklands Works, Dartford, Kent:—No. 113, Decade Resistance Boxes; No. 114, Visual Null Indicator; No. 116, Farmer Electrometer-Voltmeter; No. 120, Gamma Radiation Detector (Type PP); No. 1001, Scientific and Industrial Measuring Instruments; No. 1002, Scientific Measuring Instruments for X-rays and other Ionizing Radiations; No. 1003, Scientific Measuring Instruments for Photometry.

List of r.f. coils and transformers, from the British Distributing Co., 66, High Street, London, N.8.

Supplement No. 1 to literature describing the Type NMT industrial noise measuring equipment made by A. E. Cawkell, 7, Victory Arcade, The Broadway, Southall, Middlesex.

Illustrated leaflets describing amplifying and intercomm. equipment made

MANUFACTURERS' LITERATURE

by Easco Electrical, Brighton Terrace, London, S.W.9.

Descriptive leaflet of "Kling" protective cellulose lacquers, from the East Anglia Lacquer Co., Street One, Aycliffe, Darlington.

Abridged leaflet listing rotary convertors for radio, television and p.a. equipment, from the Electro Dynamic Construction Co., St. Mary Cray, Kent.

Illustrated list (EST2) of miniaturized hermetically sealed transformers, from Ferranti, Ltd., Hollinwood, Lancashire.

Illustrated catalogue of standard electronic instrument cases, including a new range of enclosed racks, from Alfred Imhof, 112-116, New Oxford Street, London, W.C.1.

Catalogue "Special Valves and Electronic Devices for Industry and Research," including the new type 57CV photometric cell, from Mullard Electronic Products, Century House, Shaftesbury Avenue, London, W.C.2.

Reference card of useful data and tables for radio technicians, and a new leaflet, "Hints on Soldering," from Multicore Solders, Mellier House, Albemarle Street, London, W.1.

Brochure "Methyl Bromide Extinguishers for Electrical Fire Risks" (including applications to radio transmitters), from the National Fire Protection Co., Argosy Works, Kingston Road, Leatherhead, Surrey.

Illustrated leaflet dealing with synthetic sapphire inserted gramophone needles, from Salford Electrical Instruments, Silk Street, Salford, 3, Lancashire.

Bulletin F/SRT5 (Edition 2), "Low Current Tubular Rectifiers," and Bulletin F/SRT6 (Edition 3), "Single Phase Medium Current Rectifiers," from Standard Telephones and Cables, Rectifier Division, Warwick Road, Boreham Wood, Herts.

Illustrated leaflet describing "Trixette" portable electric gramophones and record players, from Phonodisc, Ltd., 1-5, Maple Place, London, W.1.

RECENT INVENTIONS

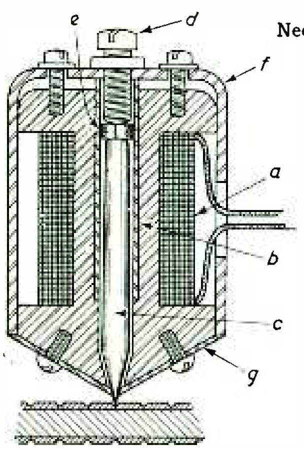
A Selection of the More Interesting Radio Developments

Magnetic Recording

THIS relates to the use of a magnetizable grooved disc record instead of the conventional type.

Sound recording and reproducing heads which are essentially similar but may differ in detail, comprise an elongated spool *a* lined with a thin tube *b* of Permalloy or like material. The end of the bore is tapered and the bore accommodates a similarly shaped needle *c* of material of high electrical resistance and low coercive force (e.g., 6 per cent silicon alloy). The needle is held in place by set screw *d* through resilient washer *e*. The whole is surrounded by a magnetizable frame *f*. The reproducing head may have a magnetic shield *g*, while a recording head may have a separate d.c. winding to give a unidirectional magnetic bias.

The British Thomson-Houston Co., Ltd. Convention date (U.S.A.) January 9, 1945. No. 625,563.

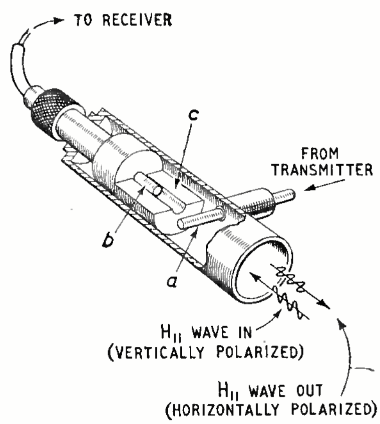


Needle-type magnetic recording head.

T—R Aerial System

COMMON T—R aerial systems have various advantages for duplex working from the point of view of space, ease of alignment and so on. A system of this character relying on cross polarization of the waves operating in the two directions and utilizing a waveguide system is shown on the sketch; this comprises a radially positioned transmitting probe *a* and an axially placed receiving probe *b*, the two being spaced by a block *c* of polystyrene of semicircular section which may be grooved to receive the receiving probe *b*. This block is of such length that an H_{11} mode wave which is vertically polarized will be transformed into an E_0 mode wave and *vice versa* but will have no effect on a horizontally polarized H_{11} mode wave. With the probes arranged as shown, the transmitting probe will not excite the receiving probe. The aerial system of the other station will, of course, have the transmitting probe vertically arranged with the flat face of the block parallel thereto so that duplex working is possible. Local oscillator signals of the receiver may set up an E mode wave in the guide which will be transformed by the block *c* into a vertically polarized H_{11} mode wave which, however, is not receivable by the remote aerial system and thus cannot interfere with reception.

E. Coop. Application date, November 21st, 1946. No. 623,770.



Junction for duplex working on a common T-R aerial system.

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

Crystal Mountings

PIEZO crystals of rectangular or disc form, cut to oscillate in a thickness shear mode, many tend to vibrate only at their centre, hence they are clamped at their corners or around their periphery.

The mounting described is relatively simple and cheap and permits a small frequency adjustment. Three or more silver "spots" are deposited towards the edges of the crystal, which are then lapped down so that when mounted between plates, which function as energizing electrodes, but are not in physical contact with the crystal.

The General Electric Co., Ltd., G. M. Wells and L. Rollin. Application date, March 3rd, 1947. No. 625,188.