Wireless World

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Show Survey

IN the following pages the technical staff of *Wireless World* presents a broad survey of the trend of design in radio equipment generally as exemplified at the National Radio Exhibition, held recently at Castle Bromwich. In reading this report it should be borne in mind that, in many fields, the Show was not fully representative. True, as we said in our last issue, few aspects were entirely unrepresented, but in some branches very small cross-sections of the British industry's productions were on view. That, incidentally, seems to us to be a pity; there is a great deal to be said in favour of a comprehensive exhibition which serves as a focal point of the radio year in all its aspects.

As was to be expected, television was the star feature and clearly it appealed most to the majority of visitors. It becomes more evident than ever that the public insists, rightly or wrongly, on the largest possible picture it can get for its money. Wisely enough, the industry has done all it can to meet this demand, both by producing large-tube direct-viewing sets and projection models. Further, some designers now make the maximum possible use of the available area of existing tubes by "cutting corners" in the mask; this trick will probably prove acceptable, as very little is generally lost by eliminating the corners of the picture.

As the television service is extended more widely over the country, more attention is naturally given to station selection. Though the fully tunable set is still rare, there were several examples at the exhibition. A more usual plan, which will probably satisfy the needs of most potential viewers, is to provide interchangeable tuning units for the various channels.

There is a growing tendency to cater for the fringe areas, and special long-range television receivers, sometimes with an extra r.f. stage, have been produced. Many designers wisely face the fact that some deterioration of picture quality must be expected where signal strength is low, and various means—including the reduction of band-width—are adopted to give the most acceptable picture under difficult conditions. High-gain aerials for the fringe areas are being produced in great variety. With regard to television aerials generally, real progress seems to have been made in improving both their mechanical and electrical properties, particularly in the direction of better weatherproofing. In the future we should see fewer of the "lopsided H aerials" cited recently by a contributor to our pages as responsible for some of the æsthetic prejudice against television.

It was evident that visitors to the Castle Bromwich show greatly appreciated the facilities for side-by-side comparisons of television receivers in operation. Indeed, it is difficult to call to mind any other exhibition where the public can make similar comparative evaluations of performance of the products of practically all competing manufacturers. The success of this section of the exhibition makes us wonder whether the same kind of thing could not be done for high-quality sound reproducing equipment. Unfortunately, the ear is much less selective than the eye, but possibly the difficulties might be overcome.

In one respect, however, the show was inferior to some of those conducted by comparable industries. There were very few attempts to demonstrate to the lay visitor any technical points in sound or vision receivers, and still fewer exhibits designed to inculcate in him any intelligent interest in the working of his set. Does the radio industry face with complacency a situation where receivers are bought only on the "eye appeal" of the cabinet? Admittedly it is not easy to explain to the layman what is happening electrically inside a radio receiver. But, by the help of mechanical analogies and visual aids, it should be possible to capture the interest of at least the younger generation.

Radio Exhibition Review

Trends in Design — and Some Highlights

We present here reports from the Wireless World *Technical Staff on the things that most impressed them at the recent 17th National Radio Exhibition at Castle Bromwich.*

TELEVISION

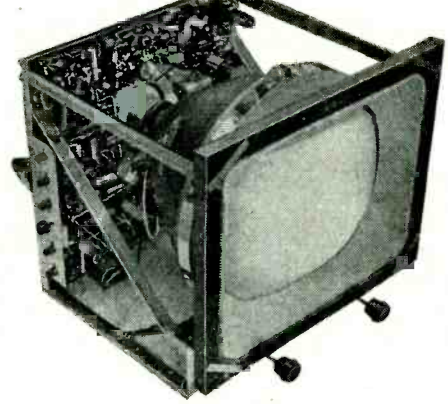
THERE is still no evidence of any approach to finality in television receiver design, either externally or internally. Externally, the most obvious tendency is towards the use of large tubes. There were more 12-in models exhibited than smaller ones and 15-in sets were not at all uncommon. The second notable feature is the number of sets having a tinted protective cover plate for the tube. The majority are clear but at least six firms showed sets with tinted plates, ranging from the pale grey of Ultra to the "near black" of Ferguson, Invicta and Pye. The object is to improve the picture contrast when the set is used in a lighted room. The blackest black that can be obtained is the colour of the tube face and while this is a true black when viewing in darkness, it is nearly white in daylight. The tinted screen darkens the blacks because the ambient light has to pass through it twice and the picture only once. It requires, of course, an initially brighter picture.

The third obvious trend is less general, but quite a few sets are designed to provide a larger picture by "cutting corners." The tube mask is provided with nearly semi-circular, instead of straight, sides, the top and bottom edges being straight. The picture width is made nearly equal to the tube diameter and so the corners of the picture are cut off. Little if any of the useful picture is lost. Mask shapes vary between the two extremes of this nearly circular-side type and the nearly rectangular. Probably the majority exhibit a very slight curvature.

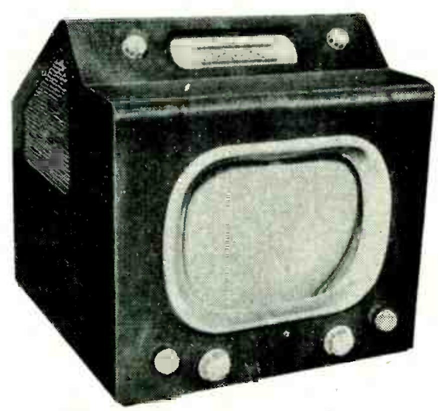
Table models are common now even for 12-in tubes, but very many console types were shown. Combined television and broadcast sets are not nearly as common although most firms had one model of this type. Some ingenuity has been expended in combining the two, for the arrangement of the tuning scale of the broadcast set without unduly increasing the size of the cabinet has its problems.

In the Masteradio T851 the scale is carried in a projection at the top of the cabinet while in the Cossor 920 the scale and control knobs are in a movable flap which can be folded down flush with the top.

There is no more internal uniformity than there is external. There is definitely a trend towards the use of higher voltages on the c.r. tube and 9 kV is fairly common. Few sets use less than 6 kV. As a result, scanning power requirements have increased. At the same time the widespread adoption of the



McMichael Model 512 television set with continuous tuning.



Masteradio Model T851 table model with long- and medium-wave broadcast receiver.

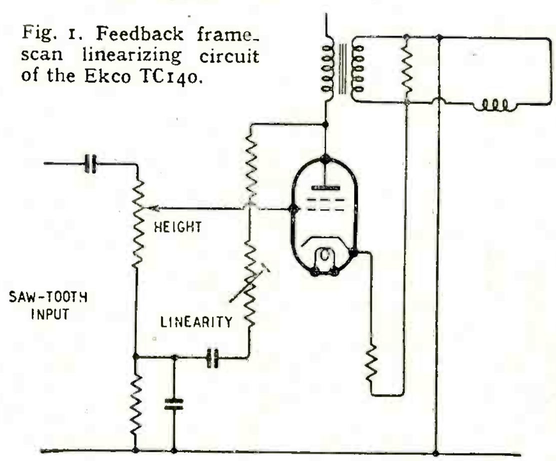


Fig. 1. Feedback frame-scan linearizing circuit of the Ekco TC140.

transformerless set to reduce size and weight has increased the difficulties of scanning.

It has, therefore, become a very common practice to use an economy circuit with a so-called "efficiency" diode to provide h.t. boost. In practically all the smaller sets the e.h.t. supply is taken from the line fly-back. Usually a single rectifier valve is employed, its filament being supplied by a winding on the line-scan transformer. A few sets, however, have two such valves in a voltage-doubling circuit—the R.G.D. 1700 is one.

In their bigger sets, however, R.G.D. use an h.f. oscillator supply and this course is also adopted by Dynatron who obtain 8 kV in this way. English Electric, however, adopt the ringing choke method.

Low-inductance frame deflector coils are now almost universal. Because it is impracticable to obtain a high enough inductance in the coupling transformer to maintain linearity, correction circuits are needed. There are two main types with many minor variations. One involves negative feedback from the anode of the output valve and is used in various forms in the Ekco (see Fig. 1), H.M.V. and Marconiphone sets—to mention only three. The other does not depend on feedback but consists in integrating the saw-tooth output of the scanning oscillator and adding a suitable amplitude to the original wave. One system, used in the R.G.D. 1700, has a double integrator and is shown in Fig. 2.

Blocking oscillators are widely used as saw-tooth generators but the thyratron is still employed by some designers. Single-valve self-oscillating current generators for the line scan are tending to increase, although they are hardly common as yet. Murphy adopt this sytem and Pye have one in which the control and screen grids of a pentode are used for the oscillating action so that the anode is left free for a more-or-less normal circuit. This arrangement was described in detail in the August *Wireless World.*

On the signal side there appears to be a definite trend towards the superheterodyne. This is not surprising in view of the way in which it simplifies station selection. The straight set is not dead, however. As it is almost impracticable to provide for several channels in this type of set, the usual procedure is to make the r.f. side a sub-chassis which can be changed by the dealer as a unit to suit the required station.

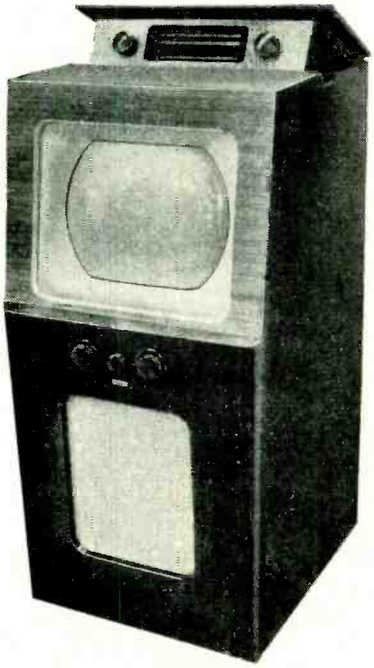
In the superheterodyne various methods of station selection are adopted. In some a change of coil connections with re-trimming (Philips) is needed; in others plug-in coils are used, and in still others only re-trimming is required.

Bush adopt continuous tuning in the TV22 (9-in) and TV24 (12-in) with a composite dust-iron metal-slug core. The oscillator has a knob control for user adjustment while the two signal circuits are screw-driver controls. All three are accessible from the rear. The McMichael Model 512 also has knobs moving close-fitting metal sleeves outside the coils.

For couplings in both superheterodyne and straight sets stagger-tuned single circuits and coupled pairs are widely used. In their straight set, however, Pye employ two sets of four coupled circuits arranged as shown in Fig. 3. On account of the greater selectivity obtainable only one sound-channel rejector is needed.

While most makers can provide a pre-amplifier for fringe area reception, some firms offer special models. In some cases these include an extra r.f. stage, in others the long-range set is the normal model with the circuits differently damped and aligned to give higher gain with a smaller bandwidth. This reduction of bandwidth is not necessarily the disadvantage which it may at first appear, for it reduces noise and under long-range conditions may well provide a more acceptable picture.

The use of ignition-interference limiters is now general on both vision and sound channels. A simple



Cossor Model 920 with broadcast receiver having disappearing tuning scale.

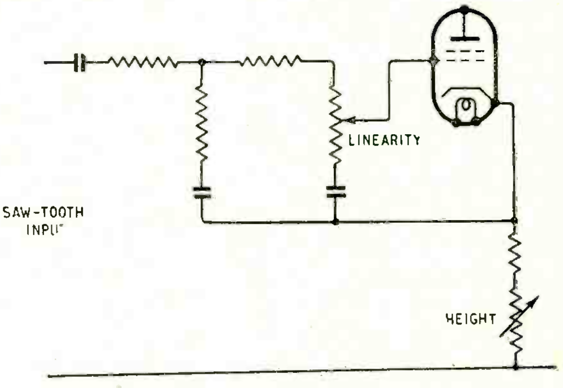
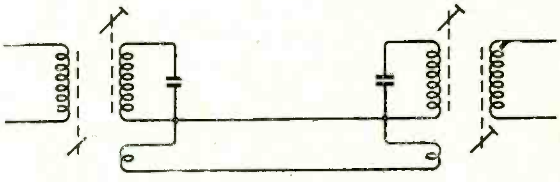


Fig. 2. Double integrator used for linearizing the frame scan in the R.G.D. Model 1700.

Fig. 3. Pye four-stage wideband i.f. coupling network.

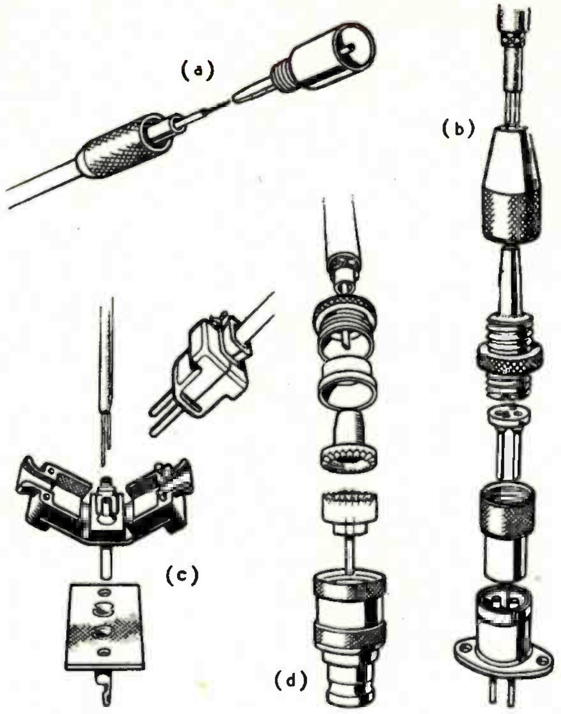


series-diode limiter on sound is usual and no adjustment is provided. On vision there is more variety. A shunt diode with a threshold adjustment is common. A diode-controlled feedback circuit is also widely used, however, and is sometimes made automatic. This user simplicity is paid for, however, by some effect on the picture quality since the circuit is likely to operate on the picture highlights under conditions of no interference.

The permanent magnet has nearly displaced the electromagnet for focusing and picture centring is nearly always accomplished by tilting the magnet. An unusual feature of some of the G.E.C. models, however, is the provision of electrical centring by means of a subsidiary deflector-coil system.

Turning now to projection receivers, the differences are quite small for the requirements of the projection tube differ but little from those of the directly-viewed variety. The scanning requirements are much the same, the input signal needed is somewhat greater, but not vastly so. The only major difference on the receiver side is the provision of tube safety devices to black out the tube in the event of a time-base failure. The e.h.t. supply is invariably 25 kV taken from a pulsed-choke supply through a voltage tripler.

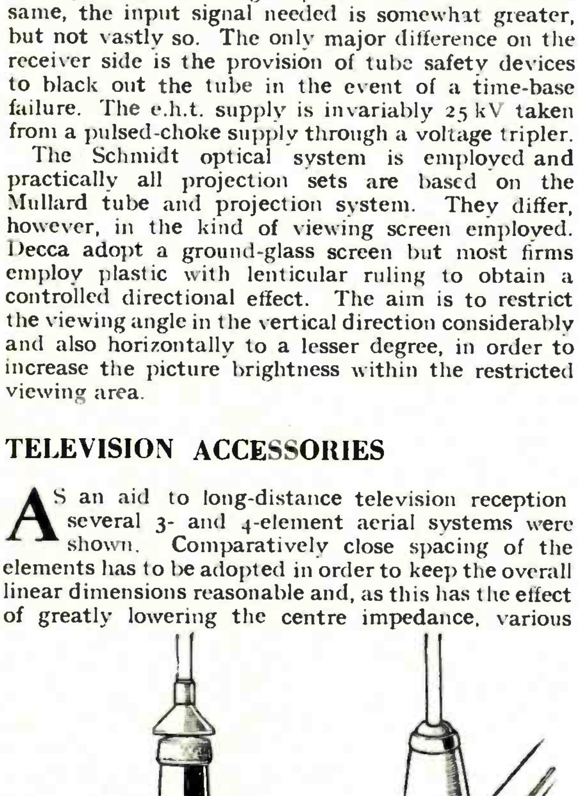
The Schmidt optical system is employed and practically all projection sets are based on the Mullard tube and projection system. They differ, however, in the kind of viewing screen employed. Decca adopt a ground-glass screen but most firms employ plastic with lenticular ruling to obtain a controlled directional effect. The aim is to restrict the viewing angle in the vertical direction considerably and also horizontally to a lesser degree, in order to increase the picture brightness within the restricted viewing area.



Some examples of the new cable plugs and sockets (a) Aerialite two-piece co-axial plug and the twin-screened at (b). The Belling-Lee new twin plug and socket is shown at (c) and the co-axial for semi-air-spaced cables at (d).

TELEVISION ACCESSORIES

As an aid to long-distance television reception several 3- and 4-element aerial systems were shown. Comparatively close spacing of the elements has to be adopted in order to keep the overall linear dimensions reasonable and, as this has the effect of greatly lowering the centre impedance, various methods of restoring it to a figure suitable for connecting a low-impedance feeder are being adopted.



Two of the several methods used to ensure a weather-proof junction box for television aerials : (left) Wolsey and (right) Antiference.

Telerection use a 'T' match on one of their 4-element aerials and a line transformer on another. The 'T' match avoids the need for a centre insulator in the main dipole and possibly leads to greater strength at this point.

Other makers, such as Belling and Lee, Aerialite and Wolsey, favour folded dipoles, which again make for stronger centre elements, since one rod can be continuous and securely clamped to the main boom. Antiference obtain their matching by using a short stub.

Aerial development has not stopped at the 3- and 4-element systems but investigation is being made into the possibilities of more elaborate arrays for the extreme limit of range. For example, Wolsey have a 6-element system arranged as two side-by-side assemblies of 3 elements, while Aerialite have introduced an 8-element system, arranged as two 4-element sections side by side.

The centre insulation of most dipoles is a weak point and accordingly has been receiving some attention recently. Fairly massive insulated mouldings ensure adequate strength but moisture seeping in can play havoc with the efficiency of an aerial. In fringe areas semi air-spaced feeders are often used and the slightest trace of water in the air cells of the feeder will completely change its characteristics.

Weather-proofing and sealing the essential openings, such as the channels in which the rods fit, the fitting for the cross arm and the inspection cover giving access to the dipole terminals for connecting the feeder, have all come in for serious attention and rubber seals, rings and washers are used quite lavishly to keep the inside dry.

Plugs and sockets for aerial feeders have also come in for some attention. Simplification of the loading of the cable is the main aim and the new plugs in co-axial, screened-twin and unscreened-twin types made by Belling and Lee and by Aerialite exemplify the work done in this field.

BROADCAST RECEIVERS

ALTHOUGH some consolidation in the ranges of the more prolific manufacturers was evident, the choice of types offered by the industry as a whole was wider than ever and a number of out-of-the-way needs are catered for. As an example, Eddystone make a yachtsman's receiver with a dial calibrated for time signals, navigational aids, etc., and a battery-operated receiver with pressure-drive horn loudspeaker for communal listening outdoors under tropical conditions. Pye offer a battery receiver (Model P47B) with bandspread tuning.

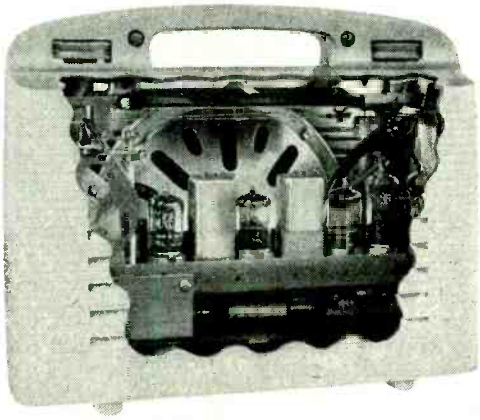
Numerically, the most significant growth since last year has been in a.c./d.c./battery sets, with "all-dry" battery portables and a.c./d.c. transportables close runners-up. Built-in frame aerials have in general increased in size and efficiency, and separate h.t. and l.t. batteries are now fitted in preference to the combined block batteries of a few years ago. The general tendency is to provide capacity for much larger batteries.

An increase in the number of sets fitted with "magic eye" tuning indicators was noted, and many features, such as variable selectivity, which were omitted during the immediate post-war austerity period, are showing signs of returning in moderately priced sets (e.g., Murphy A170).

Circuit design in the r.f. and i.f. stages has, in general, followed established practice, but a notable exception is to be found in the H.M.V. Model 5213 ("European" version of the Model 1121) which makes use of an earthed-grid r.f. amplifier before the frequency changer. Designers seem to have found the a.f. stages a more flexible medium for the exercise of ingenuity; variations of design are wider in feedback and tone control circuits than in any other part of the circuit. Fig. 4 shows the essentials of some typical examples.

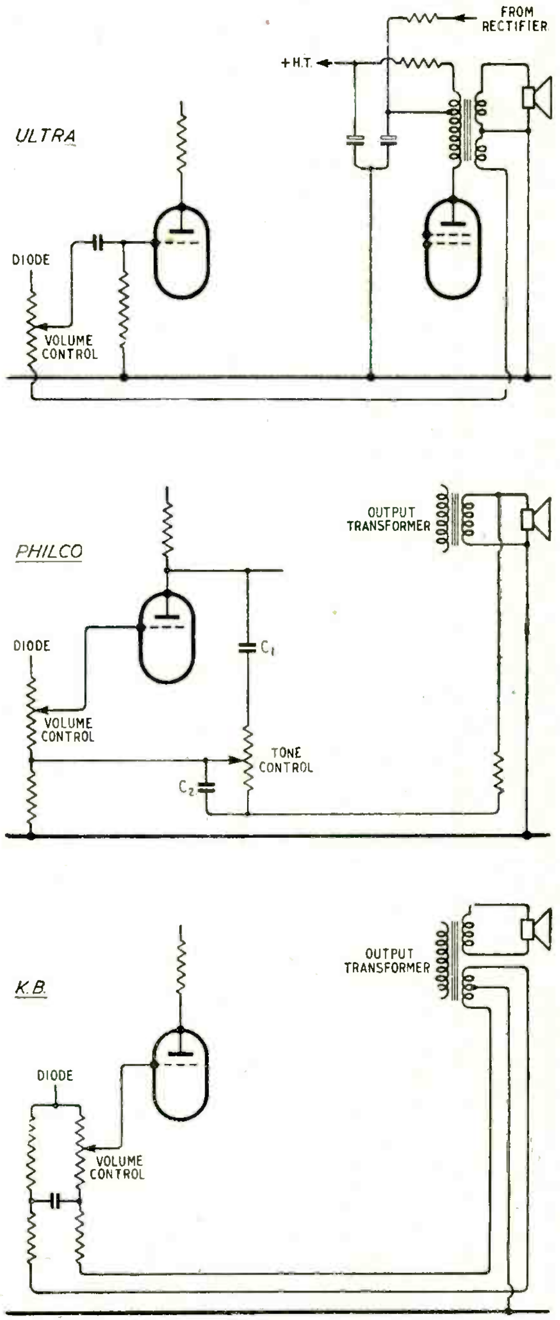
In the Ultra "Leader," negative feedback is increased as the volume control is moved towards minimum and the frequency response has been designed to give good balance as well as low non-linearity distortion at medium and low volume levels. This circuit also shows the tapped output transformer primary for hum neutralization in the h.t. supply, an economical method of smoothing which is also used in Kolster Brandes sets.

The Philco tone control gives a progressive top cut and bass boost by virtue of the small series



Cutaway view of Murphy A144 portable.

Fig. 4. Examples of feedback and tone control circuits in current broadcast receivers.

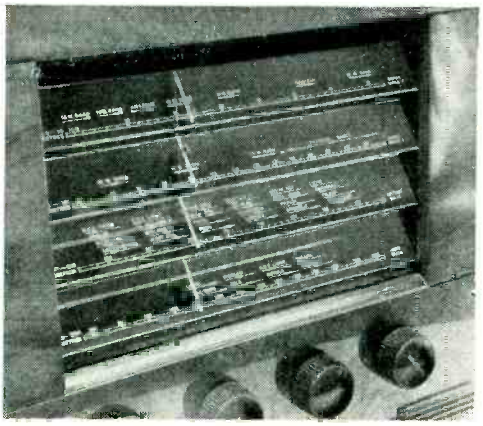


capacitance C_1 and the larger shunt capacitance C_2, the latter having the effect of reducing feedback at low frequencies.

A balanced circuit providing both positive and negative feedback from a separate tapped winding on the output transformer is used in several of the Kolster Brandes receivers. On weak stations feedback is slightly positive and gives a more favourable a.c./d.c. ratio in the diode load, as well as maximum sensitivity. On strong stations negative feedback is increased as volume is reduced, but a small bypass condenser ensures less feedback at high frequencies and a consequent top boost to offset i.f. sideband cutting.

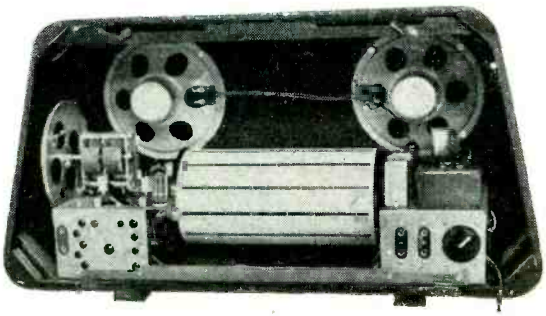
The influence of miniature valves in reducing the size of small transportables was everywhere apparent and the cutaway model A144 shown by Murphy exemplified the kind of layout which is possible. In some cases there was evidence of local modifications to cabinet lines in the interest of ventilation, which suggests that some designers have overlooked the fact that the valve makers, for all their skill, have not yet succeeded in miniaturizing the watt.

Among larger sets the interior layout of the Kolster Brandes export model FR20T is noteworthy. A large drum tuning scale with eight bandspread ranges occupies the middle of the cabinet, and the chassis is divided into two sections with r.f. and frequency changer on the left and i.f. and a.f. stages on the right. In the H.M.V. Model 1121, four transparent horizontal tuning scales are arranged as louvres to the loudspeaker grille, giving a good scale length without increasing the frontal area of the cabinet.



Louvred tuning scales are mounted in the loudspeaker aperture of the H.M.V. Model 1121.

Division of chassis to accommodate tuning scale drum in the K.B. export model FR20T



Radio-gramophones, with very few exceptions, were fitted with three-speed gramophone turntables, to play long-playing as well as 78-r.p.m. standard records. This development is discussed in more detail under the heading of Sound Reproduction.

Special broadcast receivers shown included a comprehensive range of schools equipment by Ekco. A compact portable radio-gramophone for use in rural schools has been added to this range and weighs only 30 lbs., with dimensions of $16\frac{1}{2} \times 14\frac{1}{2} \times 10$ inches.

Two new H.M.V. car radio receivers were shown by S. Smith & Sons (Radiomobile), a basic five-valve superhet (Model 4100) and an eight-valve (Model 4200) with r.f. stage and push-pull output giving 5–7 watts. Both sets make use of permeability tuning with push-button mechanical pre-set tuning as well as continuously variable control.

SOUND REPRODUCTION

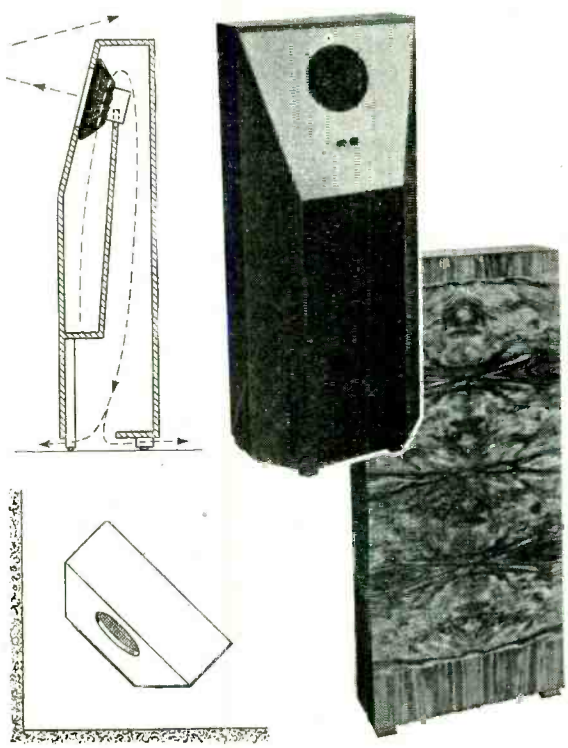
THE most important activity in this field centred around the advent of long-playing records, and the reaction of designers to the various methods of reproduction available. Record changers with speeds of $33\frac{1}{3}$, 45 and 78 r.p.m. are being fitted to most radio-gramophones, and, to cope with the different stylus sizes and needle pressures required by standard and microgroove records, most manufacturers are fitting interchangeable plug-in pickup heads. Turnover heads with a 0.001-inch radius stylus on one side and 0.0025-inch on the other are available with magnetic or crystal movements, and have been adopted by a few firms; Ferguson, on the other hand, have fitted a single fixed head with the compromise stylus tip radius of 0.0017 inch.

Long-playing records have a pronounced rising characteristic towards high frequencies compared with standard shellac records, and a different reproducing response curve is required in each case. Most makers seem to have left this to the existing tone controls in their sets and to the ear of the customer, but there are one or two notable exceptions. Decca fit their pickup heads with three-pin plugs, the connections of which are arranged to select automatically the appropriate correction circuit in the amplifier; a similar arrangement is adopted in K.B. radio-gramophones. In their model A172R, Murphy, who use a moving coil for 78 r.p.m. and a lightweight moving-iron pickup with higher sensitivity for $33\frac{1}{3}$ r.p.m. records, have taken advantage of the spindle extension on the speed-change control of the Garrard RC72 record changer to switch-in appropriate alternative correction networks via a Bowden wire control.

The Show was not really representative of loudspeaker manufacturers, but the few new models shown were of more than usual interest. Decca have introduced a corner cabinet loudspeaker of modest size and price with surprisingly good bass response and spatial distribution of high frequencies. An 8-inch unit is mounted at the "back" of the cabinet (Fig. 5) and the forward radiation is reflected and scattered by the corner of two walls from which the cabinet is spaced by a few inches. At the back the diaphragm feeds a quarter-wavelength closed pipe resonator and is introduced about $\frac{1}{4}$ the length from the closed end in order to excite the fundamental but not the 3rd and other odd harmonics. The pipe is tapered with the open end about twice the cross-sectional area of the closed end; this damps and broadens the fundamental resonance by virtue of the increased radiation resistance and at the same time increases the electro-acoustic efficiency. A smooth response down to 50 c/s is obtained with very small excursions of the speech coil, and the response is largely independent of the diaphragm fundamental resonance frequency. It is claimed that the overall efficiency is further increased by the fact that the general sound source from the corner of the room is a solid angle of $\pi/2$ compared with 2π for a plane baffle.

R.G.D. type RC5 professional mobile tape recorder.

Fig. 5. Illustrating the principle of the Decca corner cabinet loudspeaker.



Whiteley Electrical have introduced a 12-inch version of their 10-inch concentric duplex loudspeaker with a new graded long-fibre pulp material for the main diaphragm, and all-aluminium construction for the h.f. horn drive unit. Both moving coils now have an impedance of 15 ohms which simplifies the design of the cross-over network. Loudspeakers of this type with the h.f. horn passing through the centre pole of the magnet system now have many adherents, and Decca were showing sectional models and response characteristics of the duo-centric unit now fitted in the Decola radio-gramophone.

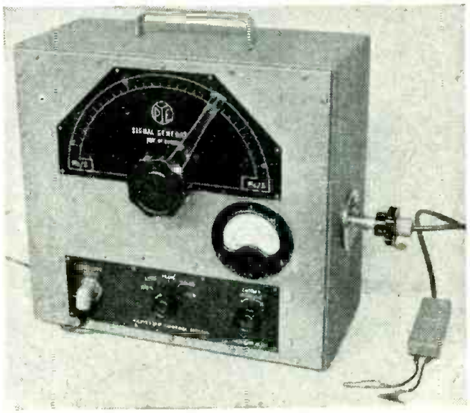
The new Goodmans concentric diffuser is a loudspeaker designed for 360-degree distribution of sound for public address, and consists of a flattened spherical Helmholtz resonator to load the 10-inch moving-coil unit down to 50 c/s, and a cone diffuser to spread the higher frequencies in a horizontal plane.

A wide range of public address equipment was shown by Trix, one of the most interesting of their new products being a very compact portable 12-watt a.c./d.c. amplifier (Type U86) using miniature valves, with two 8-inch speakers, moving-coil microphone and stand, and measuring $14\frac{1}{4} \times 11\frac{1}{4} \times 13\frac{1}{4}$ inches.

Magnetic recording equipment for both domestic and professional use was shown by R.G.D. The new type RC5 mobile tape recorder has a frequency response of 40–10,000 c/s $\pm$ 2db and has provision for a wide range of input and output conditions to comply with current broadcasting and recording requirements. Another new tape recorder shown was the Scophony Baird "Home Recorder," a self-contained portable for domestic use with built-in 6-inch loudspeaker.

TEST AND MEASURING GEAR

EQUIPMENT for testing television receivers in the absence of an external signal was shown by several firms this year. The test pattern provided takes the form of a series of broad bands which can be switched to appear either vertical or horizontal



Pye Television Pattern Signal Generator.

for checking the linearity of the time bases. From the width, spacing and general clarity of the bands a very good indication of the performance of the set can be deduced, but if a more detailed investigation is needed, test sets designed for use with an external oscilloscope have to be employed.

A typical test set of this latter kind is the Pye television pattern generator which has a built-in r.f. oscillator covering 40 to 70 Mc/s, a sweep generator, modulator providing 4 vertical bands or 8 horizontal and a calibrated piston attenuator. The sweep generator frequency-modulates the applied r.f. signal and produces a visual indication of response of the r.f. and i.f. circuits on a c.r. oscilloscope. Wide-band and over-coupled circuits, and also rejectors, are easily aligned by noting the effect of adjustments on the response.

The Cossor "Telecheck" is intended for use in a similar manner but it has a slightly wider frequency coverage, namely 7 to 70 Mc/s and so takes in the usual i.fs as well as the signal frequencies. Both can be used without oscilloscopes as self-contained test sets.

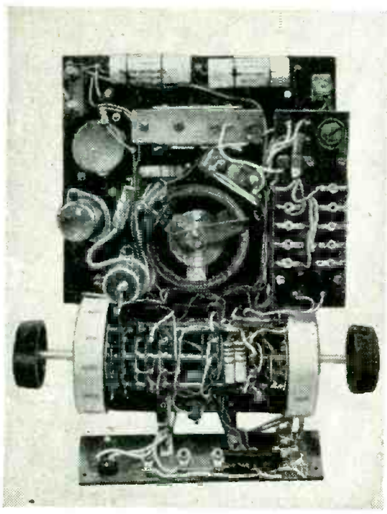
Insulation testing at high voltage is not generally practicable or safe, with simple equipment, but all the attendant difficulties appear to have been surmounted in the new high-voltage insulation test set developed by English Electric. It enables measurements to be carried out safely at voltages up to 10,000 d.c. by using the rectified output from an r.f. oscillator; the short-circuit current does not exceed 0.5 mA under any condition. The threshold voltage of breakdown can be determined by utilizing the ionization method, audible warning of impending collapse being given by the built-in amplifier and loudspeaker.

Developments in general-purpose test gear continue, and Mullard have introduced a new valve bridge with switching for valve-holder connections and voltage selection actuated by inserting a perforated card in a slot and pressing a lever. Cards covering comprehensive tests on some 600 valves are available.

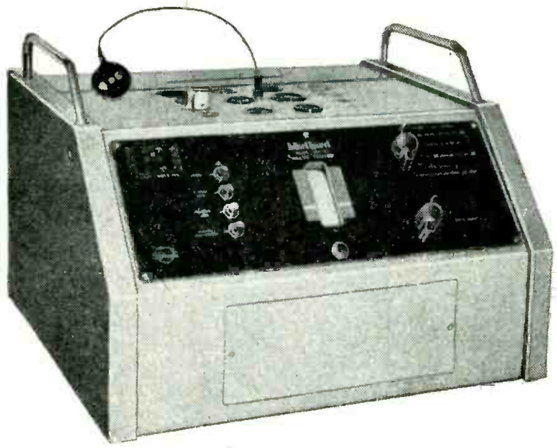
The Avo contribution to this category is a new universal bridge to extend the scope of their test gear, while Taylor have two high-resistance, 20-kΩ/V, multi-range meters, the types 72A and 77A respectively. One covers 3 kV d.c.

OTHER EXHIBITS

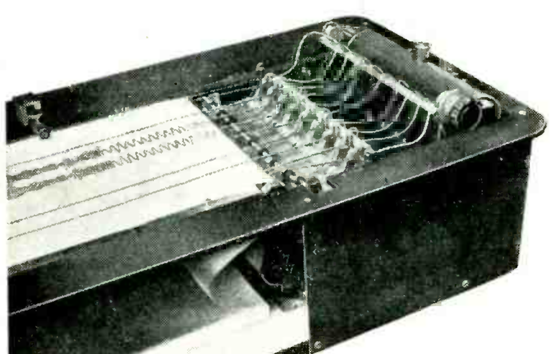
THE continued popularity of the germanium crystal was evident from the fact that three brand-new types were on view in an exhibition which was not, on the whole, remarkable for new components and accessories. The B.T.H. CG5/M and CG6/M, shown by Ediswan, have been developed mainly to replace thermionic diodes in television circuits, whilst the GEX66 is an addition to the GEX



Above : Well laid-out chassis of the Avo Universal Bridge.



Above : Mullard High-speed Valve Tester.



Above : Ediswan high-speed moving-coil multiple pen recorder. Left : High-voltage insulation test set made by English Electric.

range shown by G.E.C. and is notable for a more linear characteristic at the lower voltages. This general tendency to oust thermionic diodes from television receivers was further exemplified by Westinghouse and S.T.C., who showed tubular rectifiers with high-voltage plates suitable for obtaining e.h.t. from the line flyback. S.T.C. also had a new miniature metal rectifier, the RM4, designed chiefly for television-receiver h.t. supplies.

The modern criterion of smallness was noticeable as a common factor in several different fields of activity. For instance, the latest "Convette" battery eliminator shown by Amplion measured only $2\frac{5}{8}$in × $3\frac{1}{2}$in × $4\frac{1}{8}$in and weighed $1\frac{1}{2}$ lb, although their model PR 1 was actually the smallest on the stand. Turning to r.f. components, the same trend was well illustrated by the new Eddystone range of miniature tuning coils, giving a frequency coverage of 3 to 33 Mc/s, for these were obviously the result of a straightforward reduction in size from the plug-in ribbed-former pattern for which the firm is already well known. The lower-frequency coils had been kept within the same small dimensions by using dust-iron cores to obtain the necessary greater inductance. Exceptionally small mechanical movements and pressures also came into the picture with the new Bulgin microswitch, which has an ingeniously simple s.p.d.t. action. Models of this are available for currents from 5 to 10 amps at 250 volts and for different degrees of mechanical operation.

There were no outstanding new developments in materials, but one or two well-known commodities were being applied in different ways. For example a new and simple method of insulation was put forward by Telcon, who pointed out that metal components can be given a coating of Telcothene simply by heating them, plunging them into Telcothene powder and then applying more heat until the adhering powder melts into an even layer. Various coated specimens were shown by way of illustration. Then in another field, Multicore Solders revealed that there is now a tendency in the industry to use finer gauges of solder and that, as a result of the present high price of tin, many firms are changing from 60/40 alloy to the cheaper 50/50 alloy.

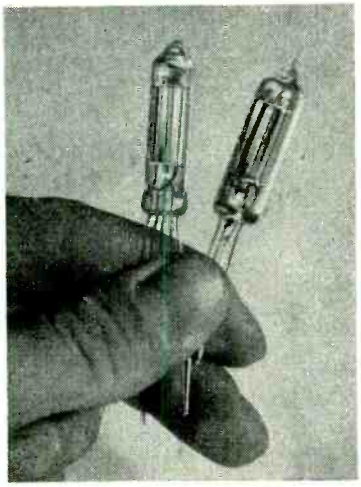
Miniaturization and television were the twin keynotes of the valve displays this year. The Mullard Noval-based valves for television are now well-known, but Ediswan had two new efficiency diodes, U281 and U801, and a new e.h.t. rectifier U24. Subminiature valves for hearing-aids were shown by Mullard and by Hivac, who had an interesting flat sub-miniature beam tetrode, the XFY23, which has been designed as an output valve for the modern hearing-aids using only 15-V h.t. batteries. Hivac also had a sub-miniature electrometer valve, the XE2, in which the grid connection was brought out at the top of the silicone-treated bulb, thereby obtaining the exceptionally high leakage resistance of 10^{16} ohms between it and the other electrodes.

Aluminization was a common feature of many of the television picture tubes on show, although there is still some disagreement on its merits and it has certainly not been adopted to the exclusion of the plain-backed picture tube. Amongst the oscilloscope cathode-ray tubes shown by Cossor, the 89J was interesting for its new beam-trap device intended for use between shots when photographing the screen. This consists of a cup-shaped anode into which the beam can be directed by the X-shift control so that no stray electrons will accidentally irradiate the screen and fog the film.

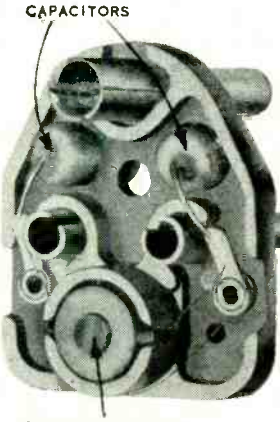
Much prominence was given to the problem of interference and several aerial manufacturers gave weight to the old adage that prevention is better than cure by exhibiting interference suppressors along with their anti-interference aerials. Of particular interest was a handy type of mains suppressor by Aerialite, consisting of an LC filter enclosed in a standard three-pin 5-amp plug socket.

Business radio was well represented by various makes of mobile radiotelephones working on crystal-controlled spot frequencies. Typical examples were shown by Pye, who had a new 12-15 watt equipment with extra facilities for selective calling and loud-hailing, and by Wolsey, who are distributing the small Hudson 5-watt mobile set which is all housed in one unit so that it can easily be fitted under the dashboard of a car.

Working demonstrations of the few electronic equipments on show made up, to some extent, for their small number. An interesting high-speed pen recorder with eight pens operated by moving coils was shown by Ediswan, having a flat frequency response ±5 per cent from zero to 90 c/s. Another visual demonstration came from the A.T.M. regenerative repeater, which was shown in the process of reconstituting distorted teleprinter signals.



Left: Hivac subminiature valves; XFY23 beam tetrode on the left and XE2 electrometer valve on the right. Below: Bulgin microswitch with the moulded case cut away to show the s.p.d.t. action. Right: Aerialite three-pin mains suppressor with case removed, showing how the filter components are incorporated in the moulding.



ELECTRONIC CIRCUITRY

SELECTIONS FROM A DESIGNER'S NOTEBOOK

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

Reducing Drift in D.C. Amplifiers—2

IN the first part of this article (August issue) we saw how drift arising from fluctuations in the cathode emission of a valve could be balanced out by the use of an extra valve to form a bridge circuit. A double-valve circuit (Fig. 3) was then described in which the effects of heater fluctuations were reduced to negligible proportions even when a single-ended output was taken—an advantage over the simple bridge circuit. To continue from there, similar results to those given by the circuit of Fig. 3 can be obtained by the use of a diode triode[3] with a genuinely common cathode. Such a valve is the 6Q7G, and the circuit is shown in Fig. 4. Here the diode is arranged always to draw more current than the peak current required by the triode. As before, if $v = v'$, then v merely adds to E_2 to change the current in R_k only by a very small percentage and the common cathode potential by a similarly small amount. Using a valve type with a genuinely common cathode, a discrimination of 20 to 1 against heater fluctuations can usually be obtained. If v and v' are unequal it is as if a voltage of $(v - v')$ were applied to the input. The amplification of the stage of Fig. 4 is reduced by the resistance in the cathode circuit, and this is—when R_k is large—effectively the diode anode resistance R_d. The amplification is given by:

$$A = \frac{\mu R_a}{(\mu + 1) R_d + R_a + r_a}$$

and it has been stated[3] that

$$R_d = \frac{0.09}{I_d} \text{ approx.}$$

where I_d = diode anode current, when an oxide-coated cathode type is used at low currents of a milliampere or so. At a diode current of 1mA, R_d will thus be about 90 ohms.

Series-Valve Circuits

The foregoing circuits depend for their operation on equality between v and v' and no provision has been made for their inequality. A circuit has been devised, however, where such provision can be made and is shown in Fig. 5. Here section (a) forms an amplifier and (b) forms a control section which maintains the anode current in (a) constant in the absence of any input. The resistance R_1 provides bias for section (b) and R_2 is adjusted so that constant current is maintained in section (a) with slightly varying heater supply voltage. It can be shown analytically that if $v = v'$, $R_2 = 1/gm_b$ for perfect control, when gm_b is the mutual conductance of the (b) section. If v and v' are unequal R_2 will have to be slightly modified and this is best done by experiment. The amplification of the stage is given by:

$$A = \frac{\mu R_a}{R_a + 2r_a}$$

As this circuit has already been described in this journal [1,4] we may pass on to another rather interesting arrangement.

The circuit of Fig. 6 [5] is analogous to that of Fig. 2 inasmuch as it is a bridge in which the valves are arranged in two adjacent arms. In this case the valves are in series and for that reason it has the disadvantage that a valve with a common cathode cannot be used. A double triode with the valves in the same envelope

[3] "Vacuum Tube Amplifiers," Valley and Wallman, 1st Ed. McGraw-Hill, p. 458 *et seq.*

[4] *Wireless World*, Vol. 48, p.111 (May 1942).

[5] Artzt, M. U.S. Patent No. 2,310,342.

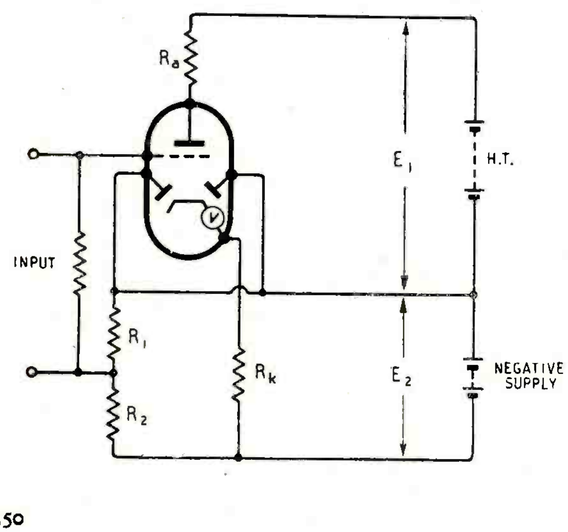


Fig. 4. Diode compensation circuit; R_1 and R_2 provide the triode grid bias.

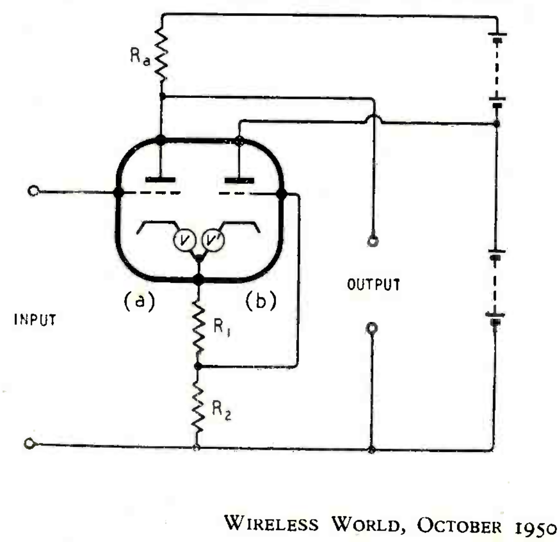


Fig. 5. Cathode control circuit

can be used however, and if $v = v'$ then the condition for independence of heater-supply voltage is simply $R_{k1} = R_{k2}$. Under these conditions the potential at terminal 1 is half the h.t. supply potential, so that if the h.t. supply is centre-tapped, as shown, zero p.d. appears across 1, 2 for zero input. The amplification is found, on analysis, to be simply $\mu/2$, where μ is the amplification factor of one valve. If v is not equal to v' adjustment of R_{k1} (or R_{k2}) can be made to achieve the required independence of heater supply voltage, but then the potential at 1 is not necessarily half the h.t. potential. This circuit has been widely used in the U.S.A. with success and forms the first stage of the amplifier of a popular oscilloscope.

Apart from the impossibility of using a common-cathode valve type, the main disadvantage of the circuit is the relatively large input capacitance due to the Miller effect. This disadvantage is shared by the previous circuits except in the case of Fig. 3 when $R_{a1} = 0$, and Fig. 4 when a diode pentode can be used. This difficulty can be overcome in the case of Fig. 6 by the cascode[6] connection of Fig. 7. Here V_1 is a double triode and the series connection is as before except that another triode is interposed between the two sections, as shown. As before, if the cathode behaviour of V_1(a) and V_1(b) are the same, $R_{k1} = R_{k2}$ for balance; and, if not, then adjustment of one cathode resistance or the other achieves the required independence of heater supply fluctuations. The amplification is increased to μ approximately (the amplification factor of one section of V_1) and if V_2 is a type similar to one section of V_1, the input Miller effect is very small, and the input capacitance is increased from the static value only by the addition of C_{ag}, where C_{ag} is the grid-anode capacitance of V_1(a).

H.T. Fluctuations

Throughout these notes, drift has been referred to as if it were solely a function of heater supply voltage. This is unfortunately not so, and drift can also arise from differential cathode ageing, changes in the resistive components of the amplifier (it is essential to use wire-wound resistors for the best results, and at the least high-stability carbons, much under-run), grid emission due to deposition of cathodic material on the grid in manufacture, expansion and shift of parts of the valve structure with temperature and mechanical shock, cooling due to draughts on the valve envelope, and so on. From this incomplete catalogue, it can be seen that the construction, ventilation and arrangement of the components is of paramount importance in d.c. amplifiers, and considerable care is often necessary to obtain really good results. In a good design the overall drift can be reduced with care to as little as one mV/hour equivalent input signal, and a figure of 10mV/hour is not difficult to attain using the foregoing circuits. In each case a "warm-up" period of at least 10 to 15 minutes is assumed. In medium-gain d.c. amplifiers a "constant-voltage" transformer in

[6] Electronic Circuitry, *W.W.*, Feb. 1949, p. 50.

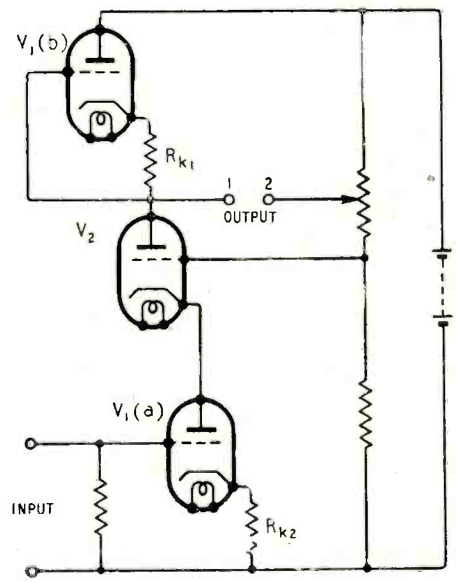


Fig. 7. Cascode version of the series-balance circuit.

Fig. 6. Series-balance circuit with bias resistors R_{k1} and R_{k2}.

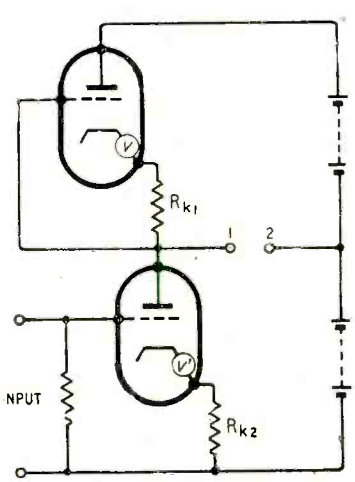
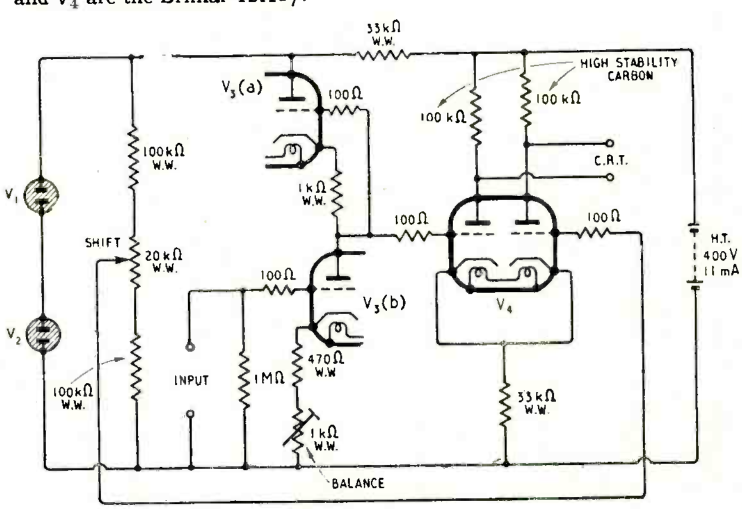


Fig. 8. A simple d.c. amplifier. V_1 and V_2 are the Mullard 7475, and V_3 and V_4 are the Brimar 12AT7.



conjunction with one of the foregoing circuits will often be sufficient. In the best apparatus an electronic stabilizer can be substituted for the "constant-voltage" transformer.

Another point which should not be overlooked is that the circuits of Fig. 2, Fig. 3 (push-pull connection), and Fig. 6 are also balanced to fluctuations of h.t. potential, so that the performance of stabilizers used here may justifiably be relaxed somewhat. The circuit of Fig. 3 is particularly useful not only as a first stage (where the drift is subject to the maximum amplification) but as subsequent stages. By way of example, Fig. 8 shows the circuit of Fig. 7 as an input stage, and the circuit of Fig. 3 as a push-pull output stage for driving a cathode ray tube. Using the new 12AT7 double triodes an amplification of approximately 1,000 is obtained. On an experimental model the h.t. supply was derived from a conventional full-wave rectifier connected to the a.c. mains, and the heaters were operated from a transformer winding in the usual way, so that no stabilization was introduced in the power pack. It was found that on varying the mains supply ± 10V about a nominal 230V, the drift did not exceed an equivalent input signal of about 10mV—provided violent surges in the mains supply were absent. No doubt an improved result could be obtained by the use of a "constant-voltage" transformer. When connected to a typical six-inch c.r. tube the frequency response was found to be 3db down at about 20kc/s.

SHORT-WAVE CONDITIONS

August in Retrospect : Forecast for October

By T. W. BENNINGTON

(*Engineering Division, B.B.C.*)

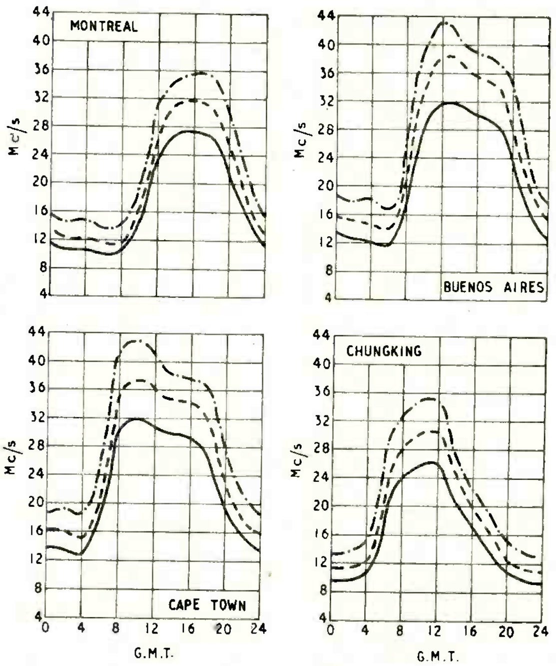
THE average day-time maximum usable frequencies for these latitudes were about the same during August as during the previous month, whilst those for night-time were considerably lower.

Day-time working frequencies for long-distance communications were, on the average, rather low, and the 28-Mc/s amateur band, for example, usually appeared to be particularly "dead," both for long-distance and medium-distance working. Occasionally, however, it was below the m.u.f. for north-south paths and was reported as "opening up" on one occasion for communication to the U.S.A. Frequencies of the order of 24 Mc/s were generally usable at the appropriate time of day, and 15 Mc/s was often usable till after midnight.

Sporadic E remained very prevalent, and on one or two occasions Continental stations on frequencies of the order of 40 Mc/s were audible here, though, as has been said, there seemed to be less medium-distance activity in the 28-Mc/s band.

Sunspot activity was, on the average, somewhat higher than during the previous month.

There were some very severe ionospheric disturbances during the month, occurring during the periods 8th-13th and 19th-22nd, whilst minor disturbances took place from 1st-3rd and 29th-30th. During the first two periods mentioned, widespread displays of *aurora borealis* were seen in this country, whilst reports from New Zealand show that the *aurora australis* was visible there. Interruptions to radio communication services were, in both cases, severe. No Dellinger fadeouts have, as yet, been reported for August.



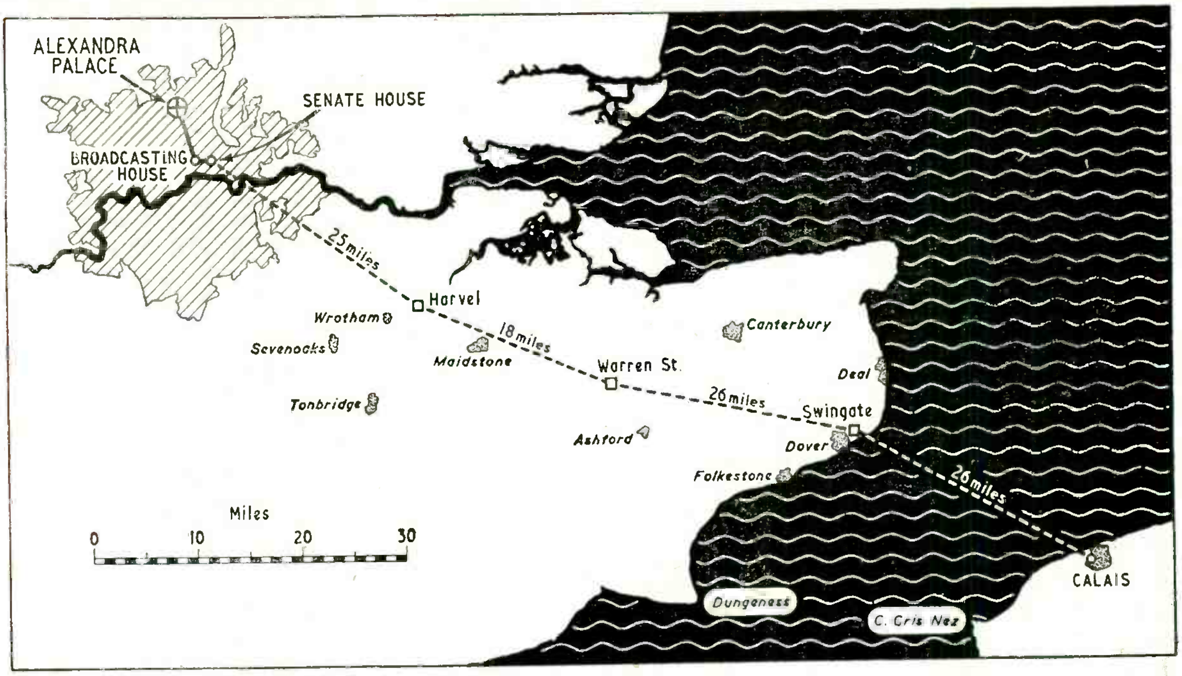
——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS
– – – – PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
–·–·– FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

Forecast.—There should be a very considerable increase in the day-time m.u.fs during October, whilst the night-time m.u.fs should continue to decrease.

Day-time working frequencies should, therefore, be high, and may, in fact, reach their highest seasonal values towards the end of the month. Frequencies as high as 28 Mc/s should be regularly usable over north-south paths at the appropriate times of day, and over east-west paths this frequency should become almost regularly usable. Due to the decrease in the hours of daylight the lower short-wave frequencies will have to be used for a greater proportion of the total time, and frequencies lower than 9 Mc/s will be necessary in order to maintain night-time communication over high-latitude transmission paths.

It is unlikely that the E or F_1 layers will control medium-distance transmission from this country at any time of day, and over such distances the day-time m.u.fs should be considerably higher than during September. It is also unlikely that there will be much medium-distance communication on high frequencies by way of Sporadic E, for this phenomenon should not be very much in evidence. Ionospheric storms are often prevalent during October and periods of bad conditions are, therefore, to be expected.

The curves indicate the highest frequencies likely to be usable over four long-distance circuits during the month.



Television from France

Metre- and Centimetre-Wave Radio Links Between London and Calais

By M. J. L. PULLING, M.A., M.I.E.E. (B.B.C. Television Service)

IT was not very long ago that the use of the B.B.C.'s television O.B. units was limited to an area within about 25 miles' radius of the receiving point at Highgate, this being the limiting range of the only two mobile vision transmitters then available. These transmitters have a radiated power of 1 kW and work on a frequency of about 65 Mc/s. Their chief drawback is size and weight and the considerable demands which they make on man-power. More recently experimental work has been undertaken with transmitters of much lighter weight and lower power and working on much higher frequencies, with the object of using two or more in tandem and so extending the outside broadcast "catchment area." The particular frequencies used have been in the neighbourhood of 200 Mc/s and in bands near 5,000 Mc/s and 7,000 Mc/s. Some success was achieved earlier this year in the use of these bands for outside broadcasts from more distant points; notably from Southend on May 26th and 29th, and from Trent Bridge, Nottingham, from July 20th to 25th.

It was decided to mark the centenary of the laying of the first cable across the Straits of Dover by a television programme from French soil. Calais was an obvious choice both from the point of view of a programme as well as from its nearness to England, and the date decided on for the programme was August 27th. (A second programme was also taken from Calais on August 30th.) This project was clearly more ambitious than any of the previous ones, and in practice it turned out that four radio links in tandem were needed for the first programme, and a fifth was added for the second programme. As the map indicates, the first link was from Calais to Swingate, on the cliffs near Dover. At Calais, a microwave transmitter with its paraboloid was installed at the top of the tower of the Hotel de Ville, operating on a frequency of 4,700 Mc/s. At the first relay point at Swingate, the receiving paraboloid was set up on

THE FIRST RELAY. Paraboloid for the microwave transmitter mounted on the upper platform of one of the masts at the R.A.F. radar station near Dover. The transmitter, working on 6,800 Mc/s, is housed in the canister at the back of the reflector.

one of the masts of the R.A.F. radar station at a height of 350 feet above sea level.

The output from this was fed in turn to another microwave transmitter, immediately adjacent, working on 6,800 Mc/s. The second relay point was established at Warren Street, near Lenham, where the receiving paraboloid was mounted on the top of a water-tower. For the third link it had been intended to use a transmitter working on 187 Mc/s, but trouble developed on this link a day or two before the first programme and at the last moment one of the higher power 65-Mc/s transmitters had to be sent down to take over this particular link. This was a disappointment, because it had been hoped to demonstrate how a range of this kind (Calais to London) could be spanned by a series of lightweight transmitters and receivers in tandem.

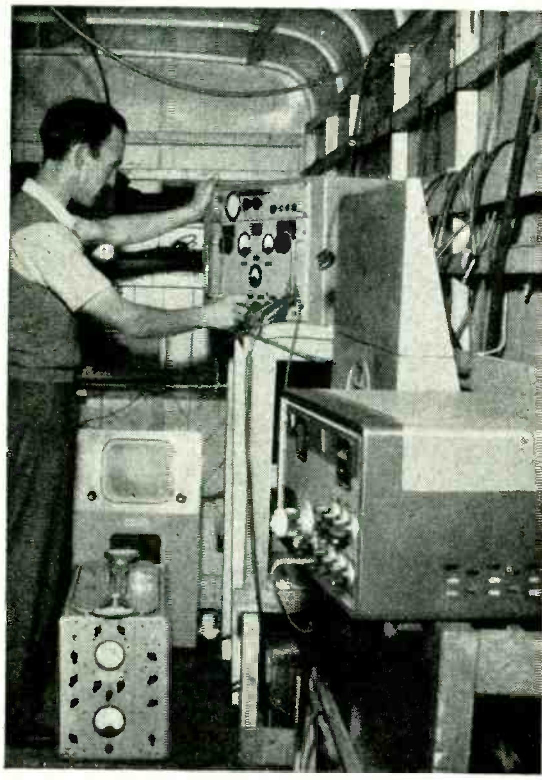
The third relay point was established at Harvel, near Wrotham, and here again the top of a water-tower proved a most convenient location for a receiving aerial and for the 4,750-Mc/s transmitter which was to cover the final link to London.

The receiving point in London was on the top of the tower of the London University, Senate House, in Bloomsbury. This receiving point had been used for previous tests and had been found to be very satisfactory: so it proved also on this occasion. At this point the picture signals were fed to the G.P.O. Museum Exchange, little more than half a mile away; a normal telephone circuit being used. At Museum Exchange the signals were fed over the normal route to Broadcasting House and thence to Alexandra Palace. Over the whole of this part of the route a 1-in diameter coaxial cable is used.

The chief novelty and technical interest in these two programmes lies in the linkage by which the picture signals were transmitted from the mobile control room in Calais to the central control room at Alexandra Palace. The total distance is about 100 miles and, at various stages on their journey the signals were conveyed by almost every means at present known in the television art—coaxial cable, a normal telephone pair, a radio link using a frequency near the television broadcast band, and, of course, microwaves. To this already impressive list was added a further local link in Calais for the second programme on a frequency of 187 Mc/s.

A complete television O.B. unit and its staff were sent over to Calais and good pictures were obtained with Marconi camera equipment using image orthicon pickup tubes. The television radio link equipment was supplied by three British companies—Standard Telephones and Cables, Marconi's, and Pye. The communication transmitter-receivers, which are indispensable for maintaining communication between adjacent stations, were supplied by Mullard Electronic Products. They were frequency modulated and operated on 72 Mc/s. The sound signals were carried by Post Office lines from Calais to London.

The success which attended this enterprise was in large measure due to the quite remarkable degree of help and co-operation which was received. In France, the civic authorities in Calais, and officials of the French P.T.T. and of the French Television Service went out of their way to put at the B.B.C.'s disposal every facility that was needed. On this side of the Channel, the same can be said of the Post Office and the radio industry, on many members of which abnormal demands were made, often at short notice.



Interior of the transmitting van used at Harvel, near Wrotham. The technician is shown adjusting the gear associated with the S.T.C. microwave transmitter.

Unretouched end-of-tube picture taken during the first television transmission from the Continent.
(Courtesy Marconi's W.T. Co.)

PUBLICATION DELAYS

We apologize to our readers for the delay in publication of recent issues, caused by a dispute in the printing industry. It is now hoped that "Wireless World" will in future appear regularly on the last Thursday of each month.

Variable Filter Tuning

1.— Comparison of Tuned Circuit and Variable-Filter Response Characteristics

By A. B. SHONE, B.Eng., A.M.I.E.E.

A good argument can be made out for the use of filters, in certain cases, in preference to the more conventional tuned circuits of a radio receiver. This article, which discusses the alternative circuits available for obtaining the required compromise between selectivity and quality, will be followed by design details for a receiver incorporating variable filter tuning.

BEFORE comparing the response curves obtainable with tuned circuits, coupled tuned circuits, staggered tuned circuits and filters in a high-quality receiver, it is necessary to stipulate an optimum characteristic which can be used as a standard of comparison.

For those fortunate listeners who happen to live close enough to the wanted transmitter for adjacent-station field strength to be innocuous, a straight receiver with heavily-damped tuned circuits is the ideal solution. For those of us who are less fortunate a compromise must be made between quality and interference.

As a basis we may start from a typical amplitude-frequency distribution of voltage for a typical programme. The curve given in Fig. 1 is taken from a paper by L. J. Sivian, H. K. Dunn and S. D. White,* and shows the average and peak distribution of sound for an orchestra of 75 players. There is a big difference at high frequencies between the mean energy and the peak energy. Curves for piano, organ, voice, etc., show a similar disparity between mean and peak energy.

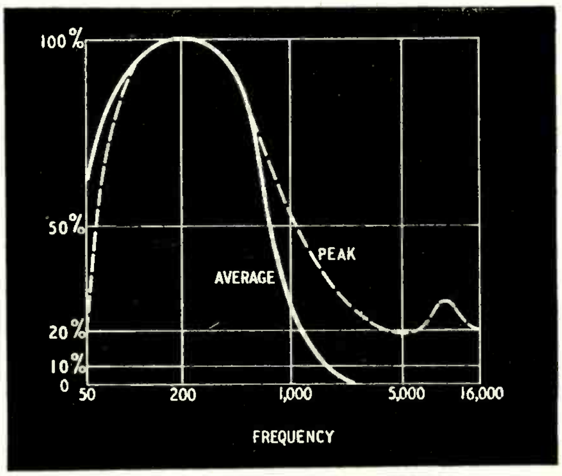
If one is aiming at removing all the adjacent-station crosstalk, the curves of peak energy should be used, but this would clearly so restrict the bandwidth as to ruin completely the quality of the wanted station. Alternatively, one can use the average curves, in which case by far the greatest proportion of the crosstalk is removed with the minimum deterioration of the quality of the wanted station. Admittedly there will still be some splash-over from the adjacent stations, but the energy content is very low, occurs only for short intervals of time and only causes annoyance if the volume of the wanted programme at such instants is too low to camouflage it.

It is the nature of the problem that a compromise must be accepted and the second alternative seems the more rational compromise.

The curves of Fig. 1 would of course be modified if high-frequency pre-emphasis were used by the adjacent-station transmitters. As far as B.B.C. transmitters are concerned there is no pre-emphasis and programmes are radiated with a flat characteristic. In the case of other European transmitters the degree of high-frequency pre-emphasis, if any, is not known with sufficient accuracy for account to be taken of it in the present calculations.

Nor is the use of automatic volume compression likely to require any modification to the curves of Fig. 1. In the case of the B.B.C., automatic volume compression is never used on domestic programmes: nor is it likely to be used by the European stations that endeavour to provide high-quality programme material. It is therefore perhaps fair to say that any adjacent station that is using automatic volume compression is unlikely to be radiating sidebands much above 5 or 6 kc/s. In any case it can be argued that even if automatic volume compression were used by an adjacent station radiating sidebands up to 9 kc/s it still would not materially alter the shape of Fig. 1, as in general there is unlikely to be any very great high-frequency energy above the top note of the piano (say 3.5 kc/s) without considerably greater energy at lower frequencies. It is therefore the lower

Fig. 1. Peak and average energy/frequency distribution for an orchestra of 75 players.



* *Journal of the Acoustical Society of America*, January, 1931.

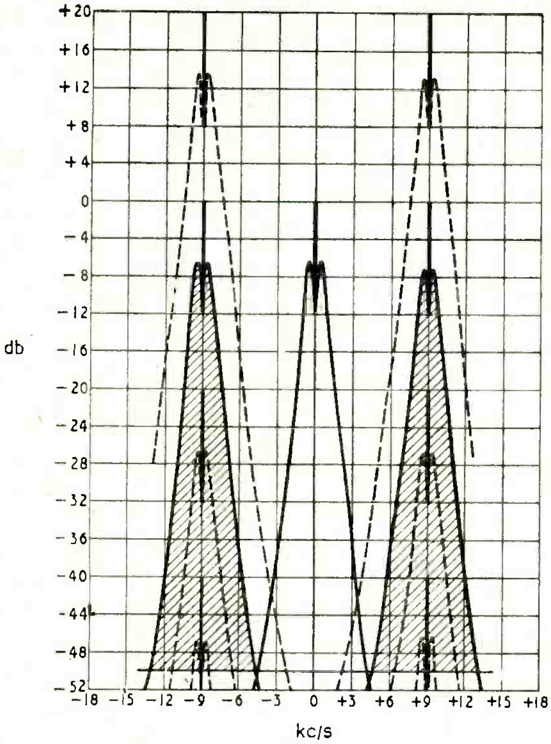
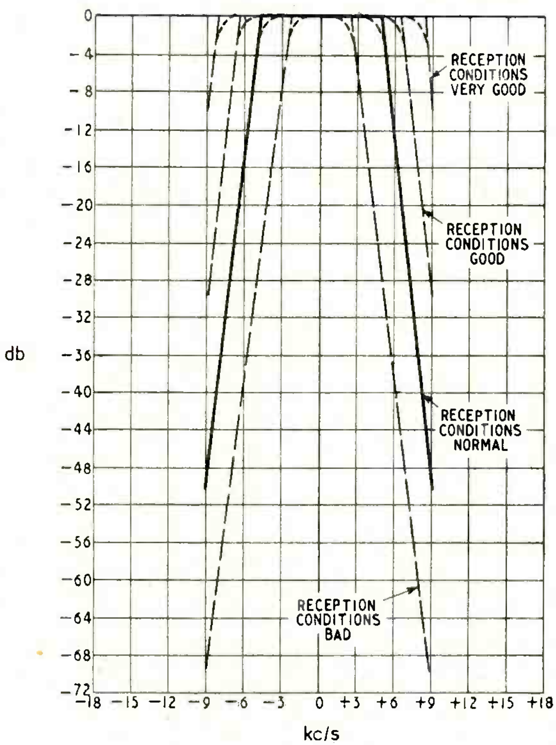


Fig. 2. Average energy/frequency distribution of adjacent station transmission. The cross-hatching represents the carrier and sidebands of equal adjacent station transmissions which it would be necessary to filter out if a noise level of −50 db is to be obtained.

Fig. 3. Deduced optimum receiver characteristic



frequencies which tend to operate the compressor, and presumably in so doing reduce the level of low- and high-frequency terms equally.

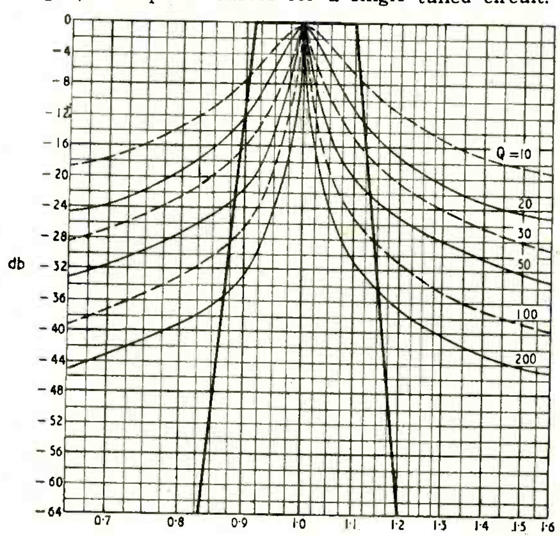
We can now establish the response characteristic that will give us the best compromise between adjacent-station crosstalk and programme quality by replotting the curve of average energy in Fig. 1 as in Fig. 2, which shows the distribution of carrier and sidebands for the wanted channel and a similar distribution on the two adjacent channels 9 kc/s above and below. The latter are shown of equal magnitude to the wanted transmission, 20 db weaker and 40 db weaker. They are also shown 20 db stronger though reception under such severe conditions is hardly likely to be required.

If we further stipulate that crosstalk is to be kept below − 50 db we can now plot the desired characteristic as in Fig. 3, which will ensure that the carrier and all sidebands of the adjacent stations are kept below the 50-db line. The full curve is the characteristic required if the adjacent stations are of comparable magnitude to the wanted transmission and is the characteristic taken as the optimum in the following paragraphs. The dotted curves are the alternative characteristics which would be desirable if it were possible to adjust the bandwidth of the receiver for reception under various conditions ranging from the adjacent transmission being 20 db above to 40 db below the wanted transmission. The slight rounding off of the curves shown in Fig. 3 is desirable, as too sharp a cut-off is liable to produce unpleasant results on the wanted transmission.

The stipulation of a crosstalk level of − 50 db is open to question, as this depends largely on the type of interference and its position in the frequency spectrum, but considering a receiver as one link in a communication chain it seems reasonable to apply the same standards as one would to noise on a music line. Most engineers would regard a music line as good if the noise were less than − 60 db, but would reject it if it were worse than about − 45 db; so − 50 db seemed a reasonable compromise figure to aim at.

In Figs. 4 to 8 the characteristics of tuned circuits, coupled tuned circuits, staggered tuned

Fig. 4. Response curves for a single tuned circuit.



circuits and filters are compared and in each case the curves associated with the networks have been plotted against a logarithmic scale expressing frequency ratio in order that the tuned circuits shall appear symmetrical. In each case the desired characteristic of Fig. 3 has been superimposed in order that a comparison may be made between the various alternatives.

Fig. 4 gives the general shape of a single tuned circuit for various values of "Q" (damping). It will be seen that for no value of "Q" is it possible to obtain a good approximation to the desired characteristic.

Fig. 5 shows the effect of using coupled tuned circuits. These circuits can give a variety of characteristics, but for simplicity the curves shown are those for two identical resonant circuits with equal damping. The various curves illustrate the effect of increasing the mutual coupling. Fig. 6 shows the characteristic when three and five pairs of coupled circuits are used, from which it appears that we do not approach the desired characteristic until several pairs of coupled circuits are employed.

Fig. 7 illustrates the characteristics obtainable with staggered tuned circuits. The resonant frequencies and coefficients of damping being as set out in Appendix I. It will again be seen that we do not approach to the desired characteristic until several tuned circuits are employed.

Fig. 8 gives the characteristics of a filter designed to approximate to the desired characteristics. The full-line curve is for a 3-section filter built in the form of high- or low-pass filters (for reasons which will appear later) while the dotted curve shows the effect of adding a fourth section (prototype). The chain-dotted curves show the alternative characteristics if the cut-off frequencies of the high- and low-pass sections of the filter are moved further apart or closer together.

It will be seen from Figs. 6, 7 and 8 that characteristics approaching the desired characteristic can be obtained with either 8 staggered tuned circuits, or 4 pairs of mutually-coupled resonant circuits, or a

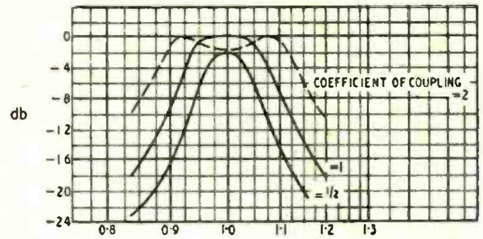


Fig. 5. Response curves for a pair of mutually-coupled circuits.

Fig. 6. Response curves for three pairs of coupled circuits in tandem (two with coupling coefficient of 2, and one with coefficient of 1), and for five pairs (four with coefficient of 2, and one with coefficient of ½).

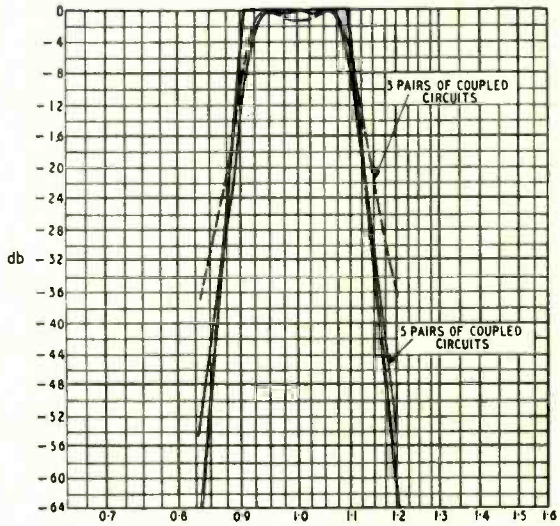


Fig. 7. Response curves obtainable with staggered tuned circuits.

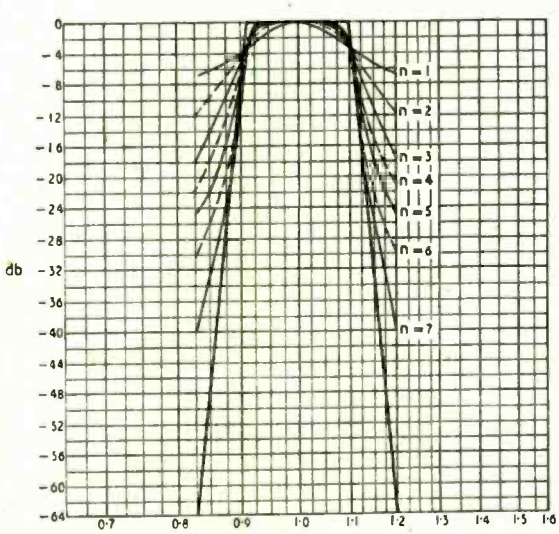
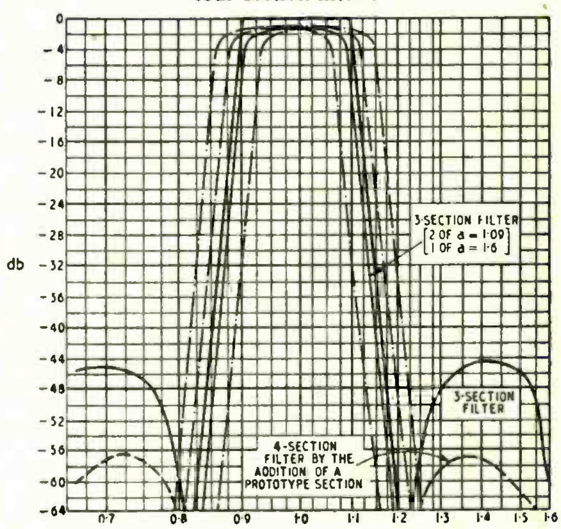


Fig. 8. Response curves obtainable with three- or four-section filters.



4-section bandpass filter. In Fig. 9 the circuit elements of these three alternatives are shown.

A comparison of the alternatives presented in Fig. 9 shows that the actual number of condensers and inductances required is about the same in each of the three cases. Perhaps we might have anticipated some such result as this, and no doubt the pure mathematicians, had we only taken the problem to them, could have told us straight away.

It therefore appears that for any given standard of excellence there is no short cut to the solution, and for the optimum characteristic we must be prepared to face the fact that all the solutions require careful design. However, though all the solutions require approximately the same number of reactances there are a few other practical differences which are worth consideration.

In both the tuned-circuit cases there are ten damping resistances to be adjusted which do not appear in the filter. Further, in the tuned-circuit cases, one (the staggered-tuned) require seven buffer valves, while the other, (the mutual-coupled), requires three buffer valves and four adjustable mutual couplings—the latter being more difficult to adjust than is often supposed.

There is therefore a case for using filters in receiver design if only because, for any given characteristic, it requires slightly fewer components and adjustments. If, however, we add in the facts that in the filter case the pass band is made very narrow before the signal reaches the first valve with a consequent very material reduction in receiver noise, and that by adjusting the relative cut-off frequencies of the high- and low-pass sections of the filter, we can obtain bands of various widths (Fig. 8) comparing very favourably with the desired variable widths shown in Fig. 3, then the case for the use of filters becomes quite strong.

The reduction in receiver noise obtained in the filter case by restricting the band of frequencies reaching the first valve is probably due to the elimination of two effects which give rise to noise in normal superheterodyne receivers. First, the filter tends to eliminate more effectively those r.f. noise terms which would mix with the various harmonics of the local oscillator to give noise terms in the i.f. band, and, second, it greatly reduces the risk of a signal, other than the wanted one, being of such a magnitude as to drive the grid of the r.f. and mixer valves to non-linear portions of their curves.

This reduction in noise is very apparent when such a receiver is tuned to very weak signals, e.g., receiving the Northern programme in London. On such signals the i.f. bandwidth has to be reduced to a minimum owing to adjacent channel interference, so that the quality is no better than on any other normal communication receiver, but the improvement in noise compared with a normal receiver is quite marked.

The signal reaching the first grid is not appreciably less than in the tuned-circuit case, as at signal frequency there is practically no loss in the filter; with a well-designed transformer between the filter and the first grid it could possibly even be greater than in the tuned-circuit case, which must have a fairly loose coupling to obtain selectivity.

(To be concluded.)

APPENDIX I

Approximate case: arithmetic symmetry

Band centre $= f_0$; overall bandwidth $=$ B; B/f_0 small.

2. Staggered-pair:
   Two stages staggered at $f_0 \pm 0.35B$ of bandwidth 0.71B.
3. Staggered-triple:
   Two stages staggered at $f_0 \pm 0.43B$ of bandwidth 0.5B.
   One stage centred at f_0 of bandwidth B.
4. Staggered-quadruple:
   Two stages staggered at $f_0 \pm 0.46B$ of bandwidth 0.38B.
   Two stages staggered at $f_0 \pm 0.19B$ of bandwidth 0.92B.
5. Staggered-quintuple:
   Two stages staggered at $f_0 \pm 0.48B$ of bandwidth 0.31B.
   Two stages staggered at $f_0 \pm 0.29B$ of bandwidth 0.81B.
   One stage centred at f_0 of bandwidth B.
6. Staggered-sextuple:
   Two stages staggered at $f_0 \pm 0.48B$ of bandwidth 0.26B.
   Two stages staggered at $f_0 \pm 0.35B$ of bandwidth 0.71B.
   Two stages staggered at $f_0 \pm 0.13B$ of bandwidth 0.97B.
7. Staggered-septuple:
   Two stages staggered at $f_0 \pm 0.49B$ of bandwidth 0.22B.
   Two stages staggered at $f_0 \pm 0.39B$ of bandwidth 0.62B.
   Two stages staggered at $f_0 \pm 0.22B$ of bandwidth 0.90B.
   One stage centred at f_0 of bandwidth B.

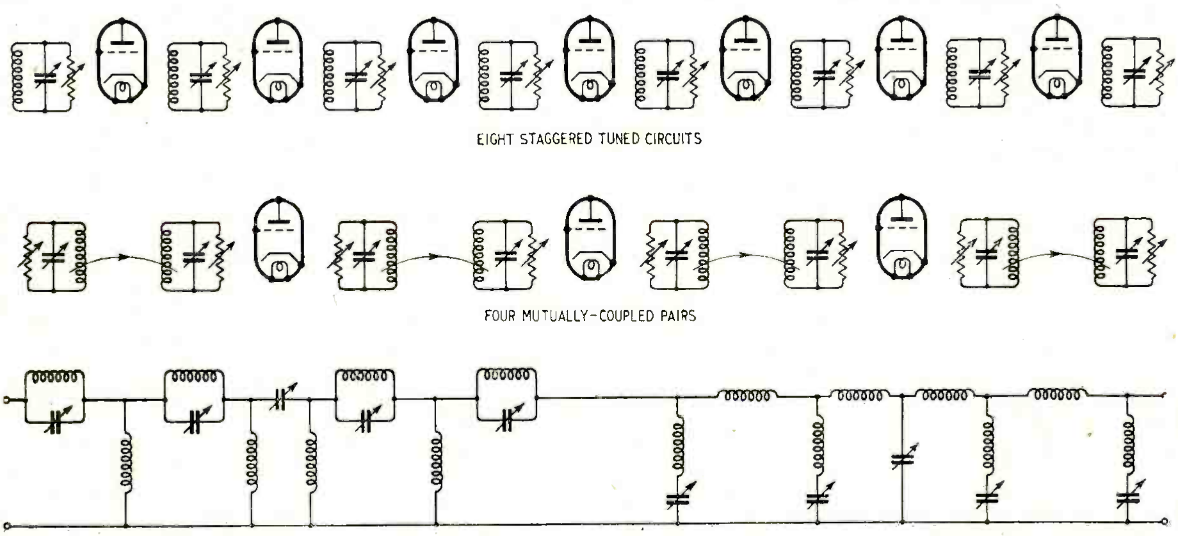


Fig. 9. Comparison of the elements required by coupled tuned circuits, staggered tuned circuits and filters to produce comparable characteristics.

WORLD OF WIRELESS

Notes and News : Personalities : Industry : Organizations

Scottish Television

AS already stated in *Wireless World*, the extension of the television service to Scotland will be by radio relay. Although the sites for the proposed seven unattended repeater stations have not yet been finally decided upon by the Post Office, whose responsibility it is to provide the necessary links between the television transmitters, it has been announced by Standard Telephones and Cables that they have received the contract to supply the necessary equipment.

The two-way radio link, which will be over a distance of 245 miles, will be from Manchester—through which the coaxial cable linking Sutton Coldfield and Holme Moss passes—to the Scottish station at Kirk O'Shotts, which lies midway between Edinburgh and Glasgow. The proposed route is on the east side of the Pennine Chain.

The equipment at each station includes duplicate transmitters and receivers and four paraboloid reflectors mounted on steel towers.

Television from Wrotham?

THE B.B.C. has issued a statement following the launching of the campaign by the South Coast Televiewers' Association for the installation of a high-power television transmitter at Wrotham to which reference was made in our August issue. The statement reads: "The B.B.C. is aware that the site of the experimental v.h.f. station at Wrotham might prove suitable for television transmissions, but extensive tests will be necessary before a final decision can be made. It is not possible to say when a television transmitter could be installed at Wrotham, if the site proved suitable, because the total amount of money that the B.B.C. is allowed to spend each year on capital development is limited by Government restrictions on capital expenditure."

New Valve Prices

THE British Radio Valve Manufacturers' Association has announced a general revision of receiving valve prices to bring them into line with current production costs. Mainly this affects obsolete and obsolescent types, which have been increased in price because they are expensive to produce in small numbers. From a very rough survey, the average increase could be placed at about 2s 6d, although in some cases there have actually been reductions in price. The changes took effect on September 1st, but will not affect stocks already in the hands of traders.

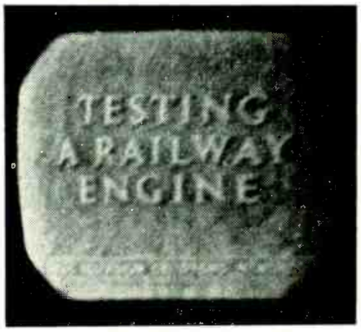
"*Wireless World*" *Diary*

NOW in its 33rd year of publication, the 1951 edition of the Diary will be available later this month. In addition to the usual diary pages of a week to an opening, it includes an 80-page reference section giving technical as well as general information. Copies will be obtainable, price 5s 6d in morocco leather or 3s 8d in Rexine covers (including Purchase Tax), from booksellers and stationers. As supplies are limited orders should be placed immediately.

IN BRIEF

Broadcast Receiving Licences current in Great Britain and Northern Ireland at the end of July totalled 12,260,600, including 423,550 television licences.

V.O.R., the abbreviated title for v.h.f. omnidirectional range equipment, has been installed at London Airport and initially will be used experimentally. Operating on a frequency of 113.1 Mc/s, the call sign, MVA, is transmitted approximately ten times a minute.



TELEVISION AT 800 MILES. A correspondent sends this unretouched end-of-tube picture of an Alexandra Palace transmission received in Falconara, Italy, on a home-built 23-valve receiver.

Colour Television transmissions in both the 70- and 500-Mc/s bands, after the signals had been relayed from Washington to New York—some 200 miles—by coaxial cable, were recently demonstrated by R.C.A. The versatility of the colour scheme was evidenced in that viewers using standard monochrome sets received the programme satisfactorily.

Cable & Wireless are to send a wireless telegraph unit to Korea for handling war correspondents' messages and personal messages to and from British Forces. During the 1939-45 war C. & W. operated mobile Telcom units, as they were called, in various theatres of war.

Telcon Celebrations.—To coincide with the centenary of the laying of the first submarine cable, mentioned in our last issue, the Telegraph Construction and Maintenance Company commemorated its own centenary with a week's celebrations from August 28th. The old Gutta Percha Company, which made the first cable and was the nucleus of the existing company, was actually formed in 1845, but the celebrations could not be held at the correct time in 1945 owing to unsettled conditions, so it was decided to postpone them until this year as the next most fitting occasion.

Training Facilities provided by the British Thomson-Houston Co. are described in the third edition of "Engineering Training for the Craftsman and the Professional Engineer," issued by the company. This 68-page book is not for general circulation but pamphlets dealing with specific courses, such as the graduate radar course, available at the company's various establishments, are obtainable from Rugby by prospective trainees.

Pulse Technique.—Among the evening courses in specialized branches of engineering arranged by the Manchester and District Advisory Council for Further Education is one, of 13 lectures, on the theory and application of pulse technique. The course opens at the Royal Technical College, Salford, on October 5th and the fee is one and a half guineas.

Swedish Television.—A sum equivalent to £157,000 has been requested by the Swedish Telegraph Board to build an experimental television station.

Generic Terms.—The R.C.A. announces that it has voluntarily surrendered its registration of the trade names Iconoscope, Orthicon, Kinescope and Acorn which may, therefore, now be employed as generic terms.

Radio Premiums.—The I.E.E. has awarded nine premiums for papers read before the Radio Section, or accepted for publication, during the 1949-50 session. The Duddell premium is awarded to Dr. F. E. Jones and E. C. Cornford for their paper "The Measurement of the Velocity of Propagation of Centimetre Radio Waves as a Function of Height Above the Ground." The Ambrose Fleming premium is awarded to Dr. L. G. H. Huxley and J. A. Ratcliffe for their paper "A Survey of Ionospheric Cross-Modulation." Premiums have also been awarded to the following for the papers shown in parentheses:—Dr. E. L. C. White and M. G. Harker

("The Design of a Television Camera Channel for Use With the C.P.S. Emitron"); Dr. J. L. Pawsey ("Solar Radio-Frequency Radiation"); B. Y. Mills ("A Million-Volt Resonant-Cavity X-Ray Tube"); W. T. Duerdoth ("Some Considerations in the Design of Negative-Feedback Amplifiers"); J. E N. Hooper and A. A. Kippax ("Radar Echoes from Precipitation"); S. de Walden and J. C. Swallow ("The Relative Merits of Presentation of Bearings by Aural-Null and Twin-Channel C.R. Direction-Finders"); and G. Millington and G. A. Isted ("Ground-Wave Propagation over an Inhomogeneous Smooth Earth").

Evening Courses at the South-East London Technical College during the coming session include one of twenty-four lectures on communication networks, commencing on October 16th, another of twelve lectures on modulation, commencing on November 14th, as well as shorter courses on magnetic amplifiers and servo mechanism. Syllabi and enrolment forms are obtainable from the Electrical Engineering Department of the College, Lewisham Way, London, S.E.4.

Exhibition Attendance.—During the ten days of the 17th National Radio Exhibition at Castle Bromwich the attendance totalled 128,260 and included visitors from forty-eight overseas countries. The attendance at last year's show at Olympia, London, was 395,465.

Belgium's Minister of Communication has announced that the Government has decided to adopt the 625-line standard for the country's television service.

EARL Services, which provide a consulting service including the preparation of critical test reports and the design of specialized electronic apparatus, have moved to King Street, Exeter (Tel.: 2132), and, having acquired the stock and plant of R.T.S. Electronics, Ltd., will also manufacture the R.T.S. transformer.

Peter Armstrong.—With reference to the note in the last issue of *Wireless World* regarding the supply of Brans' "Vade Mecum" it is regretted that Peter Armstrong has since died. Communications should no longer be sent to the address given.

E.I.B.A.—The annual ball organized in aid of the funds of the Electrical Industries Benevolent Association will be held at Grosvenor House, Park Lane, London, W.1, on November 10th.

Filmstrips.—The two Tartan filmstrips on television, which, as stated in the July issue, are produced by the Mullard Co., are distributed by Diascopic Films, Ltd., of Newton House, Twickenham Road, Teddington, Middx.

BUSINESS NOTES

Radiomobile, Ltd., the company responsible for the manufacture and distribution of H.M.V. car-radio, has changed its name to S. Smith & Sons (Radiomobile), Ltd., to overcome certain trade mark and company registration difficulties in overseas markets. The company is jointly owned by the Gramophone Co. and Smith's Motor Accessories.

Greek Telecommunications.—Equipment valued at £80,000 has been ordered by the Greek authorities from Standard Telephones and Cables as part of the reconstruction of the country's telecommunication system. The equipment, which will provide the main overseas radio-telephone link, includes two 4-kW single side-band transmitters for simultaneous working to London and New York, with a 40-kW power amplifier for use when transmitting conditions are poor, two single side-band receivers and aerials, power plant, etc.

Decca Marine Radar, Type 159, is to be fitted in 25 vessels operated by the Fred Olsen line of Oslo, Norway.

Caribbean Air Radio.—International Aeradio, Ltd., has formed a separate company, International Aeradio (Caribbean), Ltd., with headquarters in Port of Spain, Trinidad, which will co-ordinate the aeronautical radio facilities in Jamaica, Barbados and British Guiana.

Murphy Radio, in collaboration with its associated medical equipment companies, General Radiological and Solus Schall, has produced an ultrasonic generator for medical treatment. It produces mechanical vibrations at a frequency around 1,000 kc/s and these are applied to the patient by means of a specially designed water-cooled quartz crystal.

Southern Trade Services, Ltd., of 297, High Street, Croydon, have closed down their transformer rewinding section in order to concentrate on the production of transformers. Arrangements have been made that Dawsons, of Seamoor Road, Bournemouth, undertake the rewinding previously handled by S.T.S.

Mullard's announce that C. L. G. Fairfield, M.A., A.M.I.E.E., who joined the company in 1948 as technical assistant to the directors, has been made a director of Mullard Equipment, Ltd.

Antiference.—Norman S. Beebe has resigned his directorship of Antiference, Ltd., and is going to Australia. He will be concerned with promoting the sale of Antiference products in the Commonwealth, but in view of the time which will elapse before television is introduced, he will be glad to hear from those interested in marketing their equipment in Australia. His address will be 8, Pindari Road, Dover Heights, Sydney.

Avo Valve Data Manual.—It was erroneously stated in the advertisement of the Automatic Coil Winder Co. on page 1 of the September issue that this 15s book is supplied free with the Avo Electronic Testmeter. It is, however, supplied with the Valve Characteristic Meter.

MEETINGS

Institution of Electrical Engineers

Inaugural address of Sir Archibald Gill, B.Sc. (Eng.), as President on October 5th.

Radio Section.—Address by C. F. Booth, O.B.E., chairman, on October 18th.

Discussion on "Projection- versus Direct-viewing Television in the Home" opened by W. T. Cocking on October 30th.

Informal Meeting. — Discussion on "Radio Interference and the New Wireless Telegraphy Act," opened by the President on October 23rd.

The above meetings will be held at 5.30 at the I.E.E., Savoy Place, London, W.C.2.

East Midland Centre.—"The Operation and Maintenance of Television O.B. Equipment," by T. H. Bridgewater at 6.30 on October 17th at Loughborough College.

Cambridge Radio Group.—Address by F. H. Townsend, chairman, at 6.0, on October 17th, at the Cambridgeshire Technical College.

N.E. Radio Group.—Address by Prof. J. C. Prescott, D.Eng., chairman, at 6.15, on October 16th, at King's College, Newcastle-on-Tyne.

N.W. Radio Group. — Address by A. G. S. Smith, chairman, at 6.30 on October 25th, at the Engineers' Club, Albert Square, Manchester.

South Midland Radio Group.—"Economies in the Planning, Design and Operation of a Sound Broadcasting System," by R. T. B. Wynn, C.B.E., M.A., at 6.0 on October 2nd, at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Discussion on "Achievement of Reliability in Radio Equipment," opened by G. W. Sutton, Ph.D., B.Sc., and F. E. McGinnety M.Sc., at 6.0 on October 23rd, at the James Watt Memorial Institute, Birmingham, and at 7.0 on October 24th, at the Warwick House Restaurant, Malvern.

N. Staffordshire Sub-Centre.—"Some Electromagnetic Problems," by Prof. G. W. O. Howe, D.Sc., LL.D., at 7.0 on October 27th, at the Crown Hotel, Stone.

Oxford District. — "Present Problems in Television," by G. H. Watson, at 7.0 on October 11th, at the Electricity Showrooms, 37, George Street, Oxford.

London Students' Section.—"Television—An Introduction to the Generation and Transmission of Television Signals," by I. J. Shelley, chairman, at 7.0 on October 9th, at the I.E.E., Savoy Place, London, W.C.2.

British Institution of Radio Engineers

London Section.—"Signal Sources for Television Testing," by D. W. Thomasson at 6.30 on October 18th, at the London School of Hygiene and Tropical Medicine, Gower Street, London, W.C.1.

N. Eastern Section.—"High Fidelity Reproduction," by H. J. Leak at 6.0, on October 11th, at Neville Hall, Westgate Road, Newcastle-on-Tyne.

N. Western Section.—"Education in Industry," by Dr. P. F. R. Venables at 6.45 on October 5th at the College of Technology, Manchester.

West Midland Section. — "Loudspeaker Design," by A. E. Falkus at 7.30 on October 25th, at the R.G.D. Factory, Bridgnorth, Shropshire.

Hull Electronic Engineering Society

"Broadcasting Under Tropical Conditions," by A. Cross, M.Brit.I.R.E. (Rediffusion), at 7.30 on October 13th at the Y.E.B. Showrooms, Ferensway, Hull

British Sound Recording Association

"Elements of Photographic Sound Recording," by Norman Leevers, B.Sc., at 7.0 on October 27th at the Royal Society of Arts, John Adam Street, London, W.C.2.

The Coupling Condenser

Several Ways of Looking at It

By "CATHODE RAY"

OFTEN it seems that the best-known things are the least understood. That is my apology for devoting a whole article to the coupling condenser—or capacitor. Many people who are supposed to know how it works turn out to have very curious ideas on the subject. And no wonder, for books and teachers themselves are not always as helpful as they might be. Some have been known to explain the action in terms of charging and discharging, whereas in fact a coupling capacitor works by virtue of *not* charging. In so far as it does become charged by the signal, it is failing in its duty.

Another fact that may perhaps account for some of the confusion is that several apparently different explanations exist. This does not necessarily mean that all but one are wrong; there are various correct ways of looking at the same thing. A workshop drawing must generally show at least three different views of an article to enable it to be manufactured correctly: and a thing like coupling capacitor action is more likely to be understood after seeing it from several points of view. But most necessary of all is a knowledge of basic principles, and in this particular case "The 'Ohm's Law' of Electrostatics" (May, 1950) may refresh the memory.

Potential-divider Approach

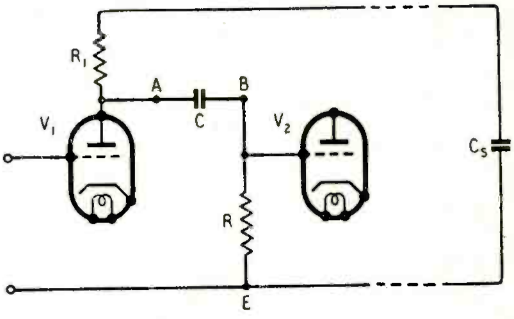
In Fig. 1, point A represents the output terminal of one stage of a valve amplifier, and point B the input of the next valve. The object of the coupling capacitor C is, of course, to join A to B for signal voltages while keeping them apart for steady supply voltages. If A were simply connected to B by a wire it would serve the first purpose perfectly, but would not allow the anode of the first valve and the grid of the second to be held at the different voltages that are usually necessary for efficient operation. The capacitor connected between A and B serves this second purpose perfectly (assuming no leakage) because it does not conduct: its d.c. resistance is practically infinite. That is easy enough to understand. The questions arise in connection with the first purpose—how and to what extent it passes on the signal voltage.

This is where we have to take account of R, the "grid leak." Its purpose is to apply the appropriate steady bias voltage to the grid of V2. Provided that it does this, the higher its resistance the better. If it is made too high—many megohms, say, with most ordinary types of valve—there is a risk that the small amount of grid current that flows even when the grid is kept negative may cause an appreciable voltage drop which would alter the intended bias voltage. So the maker of the valve V2 specifies the highest value of R with which he cares to guarantee a reasonable life for the valve. If, on the other hand, one were to choose an R well below this top limit, it would probably reduce the signal voltage seriously. To go to extremes, making R = 0 would be ideal as regards grid bias, but would prevent any signal voltage at all from being developed across it. And, as we shall see, another reason for keeping R as high as is allowable is to avoid having to make the capacitance C any larger than necessary.

It may be as well to answer two beginners' questions before going on. First: it doesn't look as if R were applying any grid bias; it is just connected to the common negative or "earth" wire, E. True, but grid bias is reckoned relative to the cathode of the valve, and is most often provided by the voltage drop in a resistor (not shown in Fig. 1) connected between cathode and this same earth wire. Second: R is regarded (for signal currents) as being in parallel with the coupling impedance (R_1 in Fig. 1), but it doesn't look like it. Well, in the first place the B end of R_1 is, or should be, as good as joined to the A end of R by C. And the E end of R is joined to the top end of R by a low impedance battery or by a large smoothing capacitance C_s. So R_1 and R really are in parallel—to a.c.

Now we come to consider exactly how C passes the signal voltages at A on to B and whether it does the job properly. One way of looking at it, assuming some knowledge of a.c. theory, is to regard C and R as forming a potential divider across R_1 (We have already agreed to assume that the top end of R_1 is kept at a perfectly steady voltage by C_s or other means, so as regards signals it is as good as connected to E.) Looking at it in this way, we see that the signal voltage reaching B is bound to be less than the signal voltage at A; but the difference can be made very small by making the impedance of C very small compared with R. For example, if R were 1 megohm, making C one hundredth of 1 megohm (= 10 kΩ) would result in more than 99% of the

Fig. 1. The parts of an amplifier circuit needed for discussing the action of the coupling capacitor C. R_1 represents any sort of coupling impedance, tuned or untuned.



voltage at A reaching B. It is not quite as simple as if C were a 10-kΩ resistance, because the voltage across C is 90° out of phase with that across R. As a result, the voltage transfer is improved, but there is a phase shift.

Fig. 2(a) shows the coupling part of Fig. 1, with V denoting the r.m.s. signal voltage at the anode of the first valve. This causes current (call it I) to flow through C and R, and the separate voltages across C and R, denoted by V_C and V_R respectively, are of course proportional to their impedances. But whereas V_R is in phase with I, V_C is 90° behind ("current in a capacitance leads the voltage by 90°"), so the vector diagram is as in Fig. 2(b). V is equal to V_R added to V_C in the usual vectorial manner, indicated by the dotted lines. It is easy to see that even if V_C is quite a sizeable fraction of V_R, V_R is still nearly as large as V. Suppose V_C is as much as a quarter of V_R. Then V_R is barely 3% less than V—for most purposes a negligible loss of signal. If C had been a resistance of the same magnitude, the loss would have been 20%.

The impedance of C is its reactance, $1/2\pi fC$. Obviously it is at its largest when the frequency, f, is least. At zero frequency (d.c.) it is infinitely large, completely cutting off B from A, as is required. In choosing the capacitance of C to pass a signal without more than a certain loss, it is clearly necessary to consider the *lowest* signal frequency. If that is made negligible, the loss at all higher frequencies will be even more negligible. Suppose, for example, that 50 c/s is the lowest frequency to bother about, and that 10% loss can be tolerated. Drawing a vector diagram with V_R 10% shorter than V, one finds that V_C is 48.5% of R, so $1/(2\pi \times 50\ C)$ should be 0.485 R, which works out to make $C = 0.00655/R$: so if R is 1 MΩ then C should be at least 0.00655 μF, say 0.01 μF. The phase shift, incidentally, is nearly 26°.

One thing to remember about this is that, although a given loss at a particular frequency may be tolerable, the combined loss due to several couplings might not be. A 10% loss, for example, is the same thing as a 90% *pass*; and the net effect of three such couplings would be $0.9 \times 0.9 \times 0.9 = 0.73$ or 73% pass. Even this might well be tolerable, but if the amplifier has negative feedback, or is to be used for television, there is the phase shift to think about. If the combined effect of all the phase shifts in the amplifier is sufficient to turn negative feedback into positive feedback at any frequency at which the amplifier amplifies—whether or not it is a frequency that one wants—it may cause oscillation or distortion. And in television a phase shift at low frequencies causes visible distortion, even though there is no audible distortion in sound amplification.

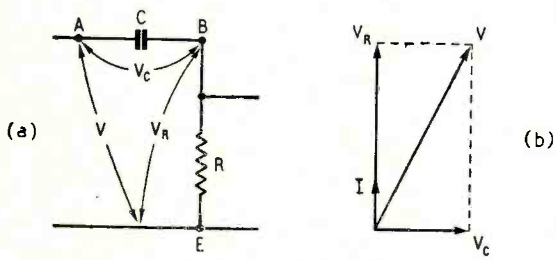


Fig. 2. (a) The coupling capacitor C and grid leak R regarded as an a.c. potential divider across the output of the first valve, and (b) the corresponding vector diagram.

So far we have been taking it for granted that the signal has a sine waveform; in other words, that it has only one frequency at a time. Mention of television reminds one that all sorts of waveforms have to be amplified. How does a coupling capacitor cope with a square wave, for example? There are at least two ways of tackling such a question. One way is to make use of Fourier's famous principle; that all periodic waves, whatever their form, can be analysed into sine waves of appropriate amplitudes, harmonic frequencies, and phase relationship. These can be treated as separate signals, each in the manner already considered, and the results can then be put together to give the complete signal at B. Unfortunately a perfect square wave consists of an infinitely large number of harmonics, so in that case the job is tedious, to say the least. But as the harmonics become steadily smaller as their frequency rises, there is no need to go beyond a certain point. Even taking only the first few of them gives a pretty good idea of what the full result would be; as was shown in a *Wireless World* article some time ago (December 1945, p. 358). But at best it is a laborious method, and it may be simpler to get right down to first principles.

Charge and Discharge Aspect

That is the second approach to the coupling capacitor problem. It looks at C as something that becomes charged when current flows into it. The guiding principle, which I tried to bring out in "The 'Ohm's Law' of Electrostatics," is that the voltage across the terminals of a capacitor is directly proportional to the charge and inversely proportional to the capacitance; or in symbols

$$V = \frac{Q}{C}$$

where V is in volts, Q is the charge in coulombs, and C is in farads. And of course this can be turned round into $Q = VC$ and $C = Q/V$.

In dealing with the coupling on this basis it is actually much easier to assume a square-wave signal than a sine wave. And to make it simpler still we can for this purpose ignore the steady voltages necessary for the valves to function, and assume that at the start C is completely uncharged, the voltages at A and B both being zero. No current is flowing through R, so there is no voltage across it.

Next, suppose the square-wave signal begins, by point A going instantaneously from zero volts to 100 volts, as represented by ab in Fig. 3. So we now have 100 V existing between points A and E; that is to say, across C and R in series. The only way that C can acquire a voltage is by its becoming charged, and the only way it can become charged is for a current to flow into it for a period of time (a coulomb is really an ampere-second). At the point marked b in Fig. 3 no time has elapsed since the signal voltage was applied, so no charge can have entered C, and so the voltage across it must still be zero. Therefore (because at every instant the voltages across C and R must add up to equal the applied voltage, which at this moment is 100) the voltage across R must be 100. *The fact that C has not charged means that it has passed on the whole of the applied signal voltage instantaneously to B.* So far the coupling is doing very well—but admittedly it isn't very far!

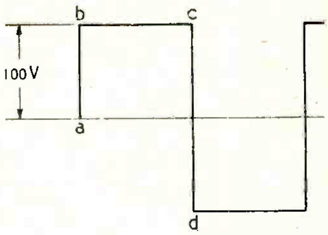


Fig. 3. The first cycle of a 100-V square-wave signal at the anode of V_1 in Fig. 1.

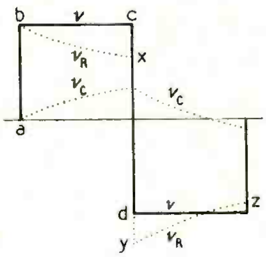


Fig. 4. How the voltage v in Fig. 3 divides between C and R during the first cycle.

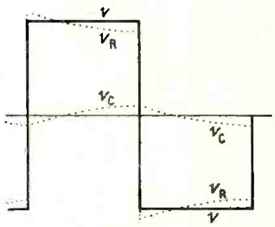


Fig. 5. Voltage graph for a cycle after the signal has been running long enough to settle down into a symmetrical condition.

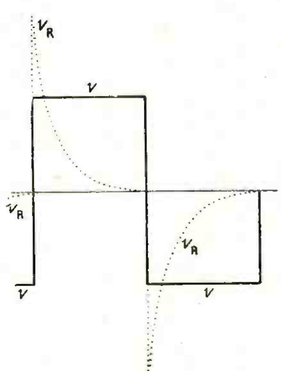


Fig. 6. Same as Fig. 5 except that C × R is much smaller so that C receives practically a full charge during each half-cycle.

Clearly the condition for maintaining this ideal state of affairs is to prevent C from ever becoming charged at all. Such an ideal is unattainable, for the existence of 100 V across R means that current must be flowing through it, and the only place such current can go is into C. So during the period marked bc, when the applied voltage is a steady 100, C is acquiring a charge, and a voltage across it is steadily growing. Since the applied voltage continues to be the same, the voltage across C can only be at the expense of that across R, which must decline. But this means that the current must decline too, so the rate of charge must fall off in proportion. This is shown in Fig. 4, where all three voltages are graphed. Note how at all times $v_C + v_R = v$. (The small letters mean instantaneous voltages, to distinguish them from the r.m.s. voltages in Fig. 2.) Note, too, that the waveform of v_R is different from that of v, so the coupling capacitor is causing distortion.

The curvature in the growth of v_C (and in the falling-off of v_R) complicates the calculation of the distortion. The particular kind of curve is known (for reasons it would take too long to explain just now) as *exponential*; but without going into the mathematics of the thing there is one fact that is useful to remember, namely that the period of time required for v_C to grow to about 37% of v is equal to RC in ohm-farads—or more conveniently in megohm-microfarads. And up to that point one will not go wildly wrong in ignoring the curvature and assuming a steady growth.

For example, let us suppose that a 10% fall in v_R is tolerable, and that the lowest frequency is again 50 c/s, or 100 half-cycles per sec. Then the period of one half-cycle at that frequency is 0.01 sec., so if a 10% fall occurs in that time a 37% fall will (according to our approximation) take about 0.037 sec. It will therefore be necessary to make RC = 0.037 megohm-microfarads; so if R is 1 MΩ, then C must be at least 0.037μF. So this 10% requirement is a rather more exacting one than the 10% loss in 50-c/s sine-wave signal, which suffered no waveform distortion but only a phase shift. But of course the *average* loss during this first half-cycle is only about 5%, and if we go on to consider subsequent events we shall find that there will be very little average loss in amplitude, because the instantaneous voltage rise and fall in a perfect square-wave input is always passed on in full.

Consider what happens when V suddenly changes 200V negatively, from c to d. The starting point for v_R is not c, but x; so on the negative swing it actually becomes more negative than v (point y). Current now flows through R in the opposite direction, so one may reckon that C is discharging. But it is necessary to be careful here, not to talk at cross purposes. Remember that neither terminal of C is earthed, so that the voltage changes at terminal B are quite different from those across C.

The fact that v_R goes more negative than v leads to a complication, because the current at the start of the second half-cycle must be greater than it was at the start of the first. Consequently C will discharge rather more rapidly than it charged, with the result that it charges slightly negative, as shown at z in Fig. 4. This tends to even out the inequality between the first and second half-cycles; and after a sufficient number of cycles for this tendency to have its full effect the waveforms are symmetrical, as shown in Fig. 5. Thus the effect of C on the signal is mainly to cause the flats of the waveform to become slopes.

If we carry this effect to extremes, by making RC small in relation to the time of a cycle or half-cycle, so that C charges practically fully every time, we get the waveform shown in Fig. 6. Here the peak value of the output voltage is actually twice that of the input, but the average value is less. It may be hard to believe that the same peaky waveform is obtained by analysing the square wave into its component sine waves, calculating them all separately as in Fig. 2 (b), and adding the results together; but it is true, as demonstrated in the 1945 article previously mentioned. Although a coupling capacitor cannot alter a sine waveform, the unequal phase shifts and losses imposed on the component sine waves of a composite signal have the effect of altering the waveform of the composite signal.

Either method of calculation leads to the conclusion that the larger the product RC the better, as regards distortion, signal loss and phase shift. Given a definite input signal, it would not matter whether, say, 0.01 megohm-microfarad were made up of 1 MΩ and 0.01 μF or 0.5 MΩ and 0.02 μF or 0.1 MΩ and 0.1 μF or any other combination giving the same product; but it must be remembered that R and C form a shunt across R_1 and cause some loss in that way too. So, as we saw at the start, it is usually better (as well as cheaper!) to make R as large as is allowable and then choose C to make R×C right. The only limit to R mentioned so far is determined by the valve biasing arrangements; but if one wants to handle very high frequencies it is necessary to take into account the input capacitance and conductance of the valve. That is quite a subject in itself, however.

Instead of going off into that lengthy by-way, let us end by considering the coupling from a still more fundamental point of view. One reader, endeavouring to do so, reached some rather unorthodox conclusions. But he was right to make the attempt, because although it is much harder to think things out basically than to make a glib use of memorized results, it is the only way to a thorough understanding.

Electrostatic Viewpoint

Since a square wave is much less difficult to handle in this way than a sine wave, we start by assuming that the A plate of C in Fig. 1 is suddenly made positive. This does not mean that a large number of electrons have to be suddenly removed from it. If the other plate were to be made equally and simultaneously positive, the capacitor could not charge at all, so no electrons would move off or on to either plate. But since the B plate is earthed, there will certainly be a tendency for C to charge. A positive charge cannot be established on the A plate, however (by electrons moving away from it), unless an equal number of electrons move on to the B plate; and such a movement of electrons is severely restricted by the high resistance R. Their efforts to get through at first absorb all the applied voltage; and only gradually, as electrons move away from A and towards B, does any voltage build up across C. The fact that one plate of C gives up electrons while the other receives them does not mean that a positive signal voltage at the anode results in a negative signal voltage on the grid. Until the electrons have had time to move, no voltage at all can arise actually across C; and the voltage appearing at B is of the same polarity and magnitude as that applied at A, and is not due to the capacitor but to resistance R. True, when C has had time to acquire a charge, terminal B becomes negative relative to A; but the effect of that is merely to reduce to some extent the positive voltage that B has relative to E (which is what counts with the second valve). Even if the positive half-cycle lasts long enough for C to become fully charged, the most the negative voltage of B relative to A can do is to offset the signal voltage entirely, so that none appears across R. But except for deliberately distorting the signal waveform, as in Fig. 6, that is not a result that would be sought in practice.

There are still other ways of explaining the affair; for example, by taking account of the supply voltages along with the signal voltages, in which case what I have referred to as charging might be called discharging, and so on. Personally I think it is much less muddling to consider signal voltages and supply voltages separately, and it is quite allowable to do so as long as no non-linear items like rectifiers are involved. Dressed up in more formal language, that is what is called the Superposition Theorem.

DANISH EXHIBITION

(From a Correspondent)

TO celebrate the twenty-fifth anniversary of broadcasting in Denmark a Jubilee Radio Exhibition was held in August at the Forum opposite the "Radiohus," the modern headquarters of Denmark's State Radio Service, in central Copenhagen.

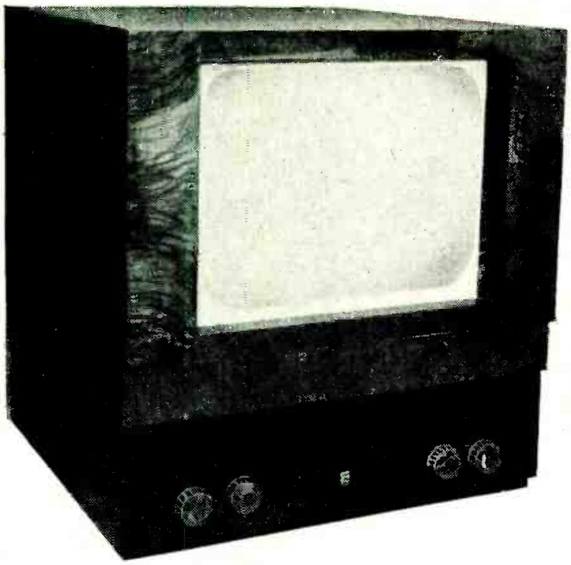
As in most radio exhibitions these days, the emphasis was on television, although Denmark has not a television service. An experimental low-power (about 100 watts) vision transmitter (Philips), with f.m. sound, has been in operation for some months at the Radiohus, the aerials being at the top of that building. It was this 625-line transmitter, working in the region of 67 Mc/s, which provided the signal for the dozen or so makes of receiver demonstrated at the exhibition. The transmitter can, incidentally, be rapidly switched from negative to positive modulation.

To a British visitor, used to the comparatively high standards of the B.B.C. television service, the general impression was that most of the receivers were not capable of responding to the transmitted definition. The received definition was generally well below that seen on the average English receiver. It was admitted that, due to the temporary and experimental nature of the equipment, the transmission characteristics were not of as high a standard as desirable but nevertheless it appeared that most deficiencies were in the receivers.

While the policy was not definitely settled, it seemed, on enquiry of competent engineers, that Denmark is in favour of the 625-line standard. On being challenged that they were obtaining definition barely as good as that provided by the British 405-line system, the answer given was that initially, achievement of the full possible definition of a 625-line system was not expected, but it was felt better to commence with this higher standard rather than change to it in five or ten years' time. On the question of modulation polarity there was a less decided view.

There was a large selection of domestic receivers and radiograms on the 65 stands and it was noted that most of the receivers used the Philips "U" series valves (B8A base). The radiograms largely conformed to a style vaguely reminiscent of the roll-top desk, with gramophone turntable, etc., side-by-side with the radio section. General performance of the sets was of a high standard.

Whilst no British-made domestic receivers were seen, most of the well-known component manufacturers appeared to be well represented and there was an interesting show of British communication equipment.



Front view ; from left to right the controls are : Brightness, Focus, Volume and Contrast.

TEST REPORT

Philips Projection Television

Table Model:

Philips Type 600 A

IT is obvious that the great merit of projection television is the large size of the picture which is obtainable from apparatus of relatively small dimensions. Equally obviously, it has the advantage over many directly-viewed systems of providing a flat picture.

In the Philips Type 600 A the picture obtained measures $13\frac{1}{2}$ in by 10 in. This is about the size obtainable on a 16-in tube but it appears on a flat surface whereas the face of a 16-in tube would almost inevitably have a considerable curvature. As shown in the photographs the viewing screen is fixed to the cabinet and the picture is projected on to its back by an optical system. The tube is of some $2\frac{1}{2}$ in diameter and operates with a final-anode supply of 25 kV.

The picture obtained is bright enough for daylight viewing and, when viewed on the centre line, the screen is fairly evenly illuminated. The screen has directional characteristics in both planes in order to increase the efficiency and this has the inevitable result of restricting the viewing angle. As one moves away from the centre line not only does the picture as a whole lose brightness but it becomes unevenly illuminated and the parts of the screen nearer to one are brighter than those farther away.

The effect is not marked for deviations up to about $\pm 30°$ from the centre line and the viewing angle is thus adequate for most purposes. It is, however, undoubtedly smaller than with a directly viewed tube and this does remove some of the advantage of the flat screen.

The minimum satisfactory viewing distance appears to be relatively greater than with direct viewing.

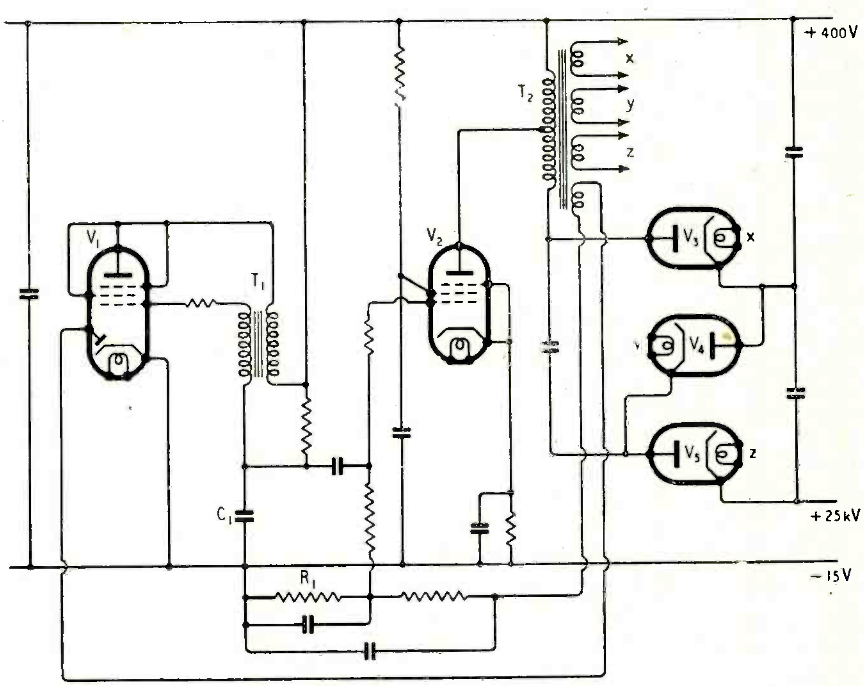


Fig. 1. Circuit diagram of 25-kV e.h.t. supply.

It is, of course, very much a matter of personal preference, but in some tests most observers placed it at 8-10 ft—the optimum distance being about 12-15 ft. Since the picture height is 10 in this makes the ratio viewing - distance / picture - height around 12 : 1, which is about double that for direct viewing.

It is not easy to see why this preferred distance is greater. It is not because the line structure is more prominent; in fact, the lines are much less noticeable than one would expect, even on close inspection. It is not because of any lack of detail, for careful examination reveals that the detail is not inferior to that with direct viewing.

It is probably connected with the entirely different character of the picture which, in itself, is almost certainly due to the viewing screen. The picture quality may be likened to that of a photographic print on matt or rough paper whereas the quality with a directly viewed tube is nearer that of a glossy print. Which is considered the better is a matter of personal preference and depends very much also upon the subject matter of the picture.

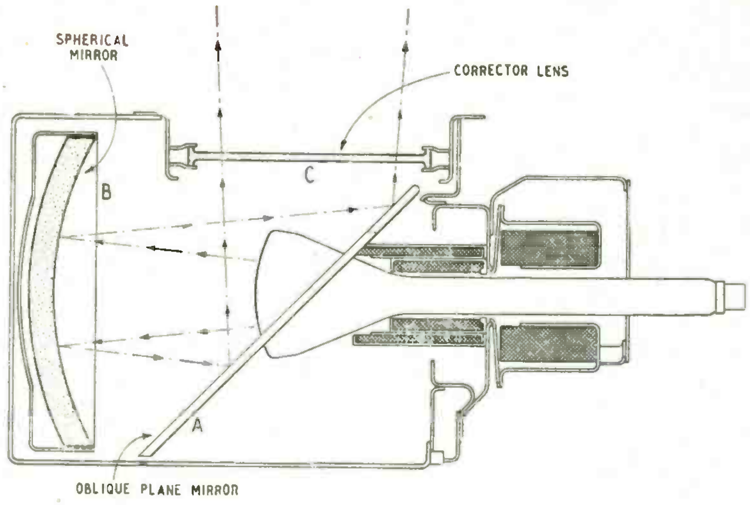
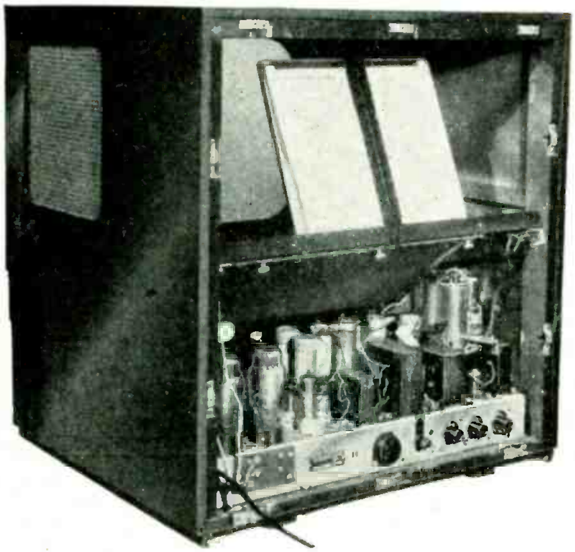


Fig. 2. Layout of the optical unit which includes the tube and its associated coils.

The somewhat restricted viewing angle and the rather large optimum viewing distance limit the domestic application of the set to those possessing large rooms. The size of the picture is undoubtedly too great for a small room.

On the electrical side the adoption of projection has only a small effect on the design and the receiver is in most respects conventional. It is a superheterodyne and can be adapted for London or Birmingham reception by changing the r.f. and oscillator coils and certain resistors. In spite of the high operating voltage of the tube the scanning requirements are little different from normal because the tube is relatively longer than its big brothers. A single pentode with a "damping diode," providing h.t. boost, is adequate for the line scan.


Rear view of the receiver showing the inclined mirror in the upper part.

The 25-kV e.h.t. supply is obtained through a voltage-tripler rectifier from a 9-kV damped sine wave developed in a ringing transformer which is connected in the anode circuit of a pentode. The circuit is shown in Fig. 1, the ringing transformer being T_2 and the rectifiers V_3, V_4 and V_5. A blocking oscillator V_1 with transformer T_1 develops a saw-tooth wave of repetition frequency 1 kc/s across C_1. This is applied to the pentode V_2. It is cut off on the fly-back of the saw-tooth wave and for a period thereafter but is brought up gradually to full conduction during the intervals between successive fly-backs. It is the sudden interruption of current on fly-back which shock-excites T_2 to develop a damped sine wave.

A winding on T_2 supplies a portion of the voltage wave to the diode in V_1 which rectifies it and develops a steady voltage across R_1. This is applied as bias to V_2 and acts rather like an a.g.c. system to reduce the peak current in V_2 if the output voltage increases. It tends, therefore, to maintain the output constant and so provides a regulated e.h.t. supply.

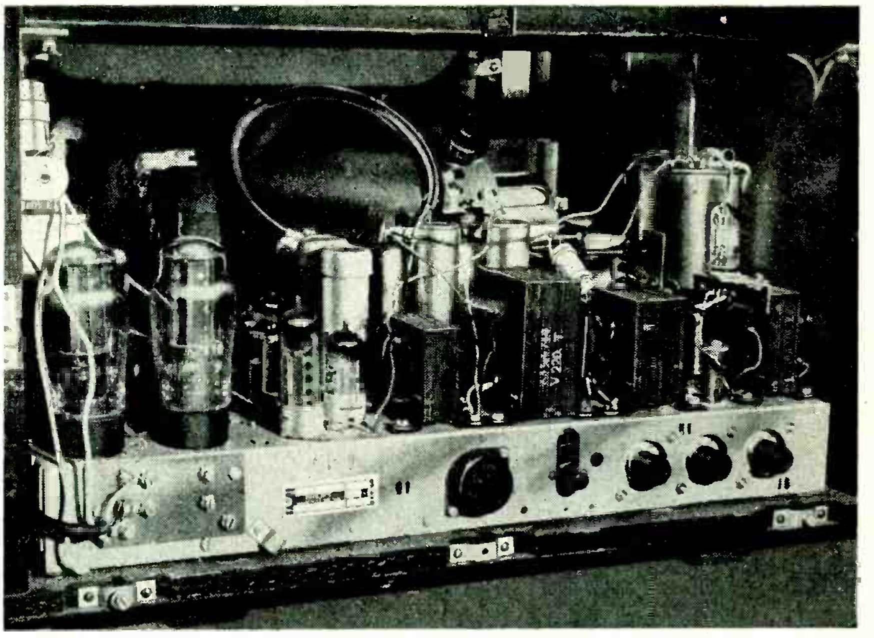
The whole of the e.h.t. circuit, including the rectifiers, but not the other valves, is housed in a metal container and is so adequately protected from accidental contact.

Safeguards against time-base failure, which would otherwise prove disastrous to the tube, are provided. The tube is normally heavily over-biased. Diode circuits develop a counter-bias from the outputs of both line and frame time bases and unless both are operating the tube remains blacked out.

There are four panel controls: Brightness, Contrast, Focus and Volume with which is combined the on-off switch. At the rear there are controls for Line and Frame Hold, Height and Interference Suppression. There is no width control.

The adjustment of the panel controls is more difficult than usual because it is not possible to get far enough from the screen to observe their effect accurately. They would be much easier to adjust if they were fitted to a 10-ft flexible cable instead of on the set itself.

The optical system is of the Schmidt type and is folded to occupy a minimum of space as shown in Fig. 2. The tube faces a spherical mirror B which reflects the light on to an inclined mirror A and thence through a correcting plate C to a second inclined mirror mounted in the back of the top part of the cabinet. This mirror passes the light to the viewing screen and its angle is adjustable for positioning the picture in the vertical direction. The first mirror has a central hole through which the tube passes.



Close-up of the receiver chassis with separating plate removed to show the optical unit. The " porthole " is the corrector plate.

The tube-mounting with its focus and deflector coils, the spherical mirror, first plane mirror and corrector plate form a unit which can be removed as a whole. The tube base and the mechanical adjustments are reached through a removable panel in the side of the cabinet. The receiver chassis can be removed without disturbing the optical system. The cabinet is of wood and measures 21 in wide by 22¼ in high by 18½ in deep. The set is for a.c. operation only and costs £88 14s 6d including purchase tax. A stand is available at £2 15s 2d extra. The makers are Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

On test the receiver gave an excellent picture. The linearity was good and the synchronizing excellent. As already mentioned the picture detail was as good as with a directly viewed tube but the quality of the picture was of a different character.

In spite of the use of a regulated e.h.t. supply, changes of picture size and focus with large changes of picture brightness were noticed. The contrast and brightness controls were rather fierce and it would be better if the panel controls had a more restricted range and were supplemented by pre-set controls.

COLOUR TELEVISION IN U.S.A.

New-type C.R. Tube

THE R.C.A. colour-television system[1] operated by a sampling process. The three-colour pictures are broken up into a series of dots by sampling them at appropriate intervals. They are then mixed and the combined signal is a form of time-division pulse modulation. At the receiving end the three groups of pulses are sorted out by gating circuits and so allocated to three separate colour channels.

In the apparatus previously described the three signals were applied to three separate c.r. tubes to produce pictures in the three colours, which were then superimposed optically to give the full colour picture. This presents considerable difficulty and special single tubes are now being developed.[2]

In the first of these there are three separate guns to which the colour signals are applied, but a common deflection system operates to deflect all three beams together. The screen is made up of a mosaic of fluorescent material in the three colours, arranged as groups of three dots—red, green and blue. At the back of this there is a perforated disc with as many holes as there are groups of three dots on the screen.

In order to reach the screen each electron beam must pass through a hole and the disc and screen are so aligned that each beam can land only on the dot of its own beam. Thus, a blue-signal beam passes through a hole to land on a blue dot. The red-signal beam will pass through the same hole to land on the red dot because it approaches at a different angle. Similarly, with the green beam.

A second type of tube has a single gun only but the same form of colour dot fluorescent screen and perforated disc. Here it is not necessary to separate the colour signals and the receiver output can be applied directly to the tube to modulate its electron beam. The sorting out process is done by so deflecting the beam that, at the appropriate times, it is directed on to the correctly coloured dots of the screen. This is done by a small circular deflection of the beam additional to the normal scanning deflection. This circular deflection produces at the appropriate times a change in the angle by which the beam approaches the perforated disc and so simulates with one gun the effect obtained by three in the other.

[1] *Wireless World*, November 1949, p. 459.
[2] *Tele-Tech*, May 1950, p. 20

Civil Aviation Radio

New Radar Aids and Multi-channel V.H.F. Radio Telephones

THE wide-coverage v.h.f. radio-telephone system which, under the operation of the Ministry of Civil Aviation, will soon be in operation for the control of all civil aircraft in the U.K., is very likely responsible for the large amount of v.h.f. equipment shown at this year's display and exhibition held at Farnborough by the Society of British Aircraft Constructors.

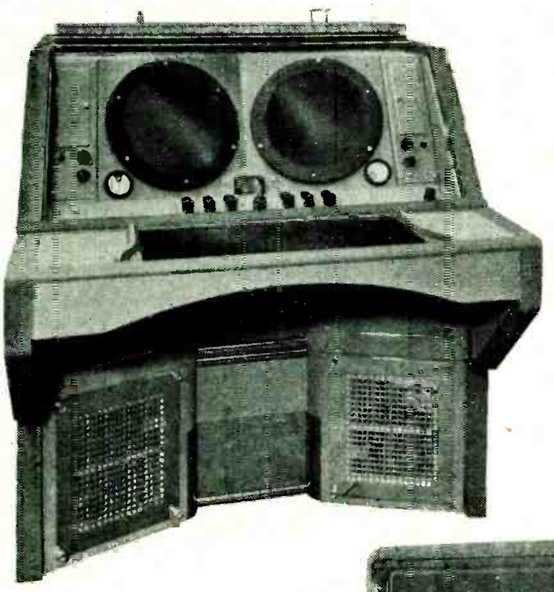
There can be as many as eight operating channels in any one geographical area, and aircraft flying even within the confines of the U.K. may need the use of a dozen channels, or more if going abroad.

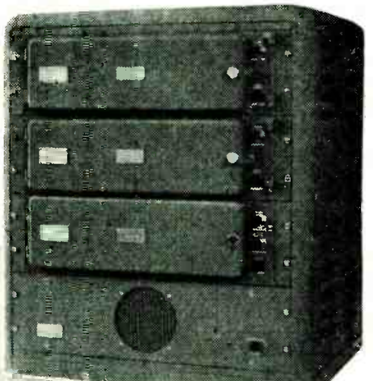
The total number of channels in the civil aircraft band of 118 to 132 Mc/s, with 100 kc/s separation, is 140 and some makers of v.h.f. aircraft equipment allow the whole 140 and provide for simple channel selecting by remote control. Others provide a limited number of channels only for immediate use and make available a whole new series by changing crystals.

As all operating frequencies must be highly stabilized, crystal control of transmitters, and also of receiver oscillators, is now customary practice, but as it would be hardly practicable to control 140 channels by separate crystals, if for no other reason than that the size of the equipment would preclude it, ways are being evolved to give crystal control throughout, but using a few crystals only. Marconi in their A115 transmitter-receiver use two crystal oscillators and mix the outputs in such a way as to provide selection of the final working frequency in 100-kc/s steps. The remote control unit has two frequency-selecting switches, one giving a change in 1-Mc/s and the other in 0.1 Mc/s steps.

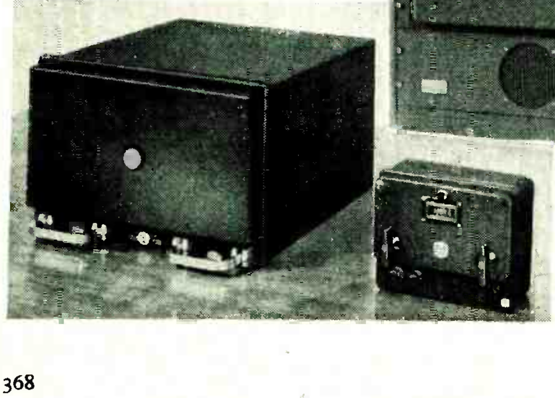
About 20 crystals are used in the Standard Telephones STR12C 140-channel set which was also shown as a 70-channel set with 200 kc/s spacing. It has a motorized form of channel selection for both transmitter and receiver. Another 140-channel set, using very few crystals, was shown by Murphy, and this firm included also a 23-channel model (MR80) having separate crystals for every channel and Ekco had an 11-channel set (CE40) with provision for changing to a whole new set of channels in the air.

Communications equipment did not stop with v.h.f. sets, for Plessey was showing a completely new series of miniature units for h.f. operation designed to fit the modern type of aircraft-racking, also a diversity receiver for ground stations.





(Above) Console of S.T.C. Precision Approach Radar, (right) dual-diversity receiver made by Plessey, (below) Marconi 140-channel v.h.f. aircraft equipment.



Several interesting radar devices were seen this year. In addition to the Ekco Cloud and Collision Warning set, which operates on 3 cm and gives warning of heavy cloud formations and potential storm centres up to 30 or 40 miles, there was a new Precision Approach Radar, also operating on 3 cm, shown by Standard Telephones. It has two c.r. tubes for elevation and azimuth display respectively and provision for using remote viewing consoles in the airport control tower. "Talk-down" facilities for "blind" landing are available also.

Much development work has gone into the Rebecca-Eureka type of responder beacons; Ferranti has developed one for the 1,000-Mc/s band (Distance Measuring Equipment) while the Murphy beacon is for 190- to 240-Mc/s operation and is coded for identifying individual ground beacons.

Other new equipment included high power ground transmitters made by Redifon and a Marconi v.h.f. direction finder.

Design for a Wobbulator

Frequency Modulated Oscillator for the "Simple C.R. Oscilloscope"

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

SINCE the publication in the March 1950 issue of a design for an inexpensive cathode-ray oscilloscope there have been requests for a "wobbulator" to go with it. The term "wobbulator" does not appear in BS.204 (British Standard *Glossary of Terms used in Telecommunication*) so for the benefit of any who do not associate with the lower strata of technical society it may be defined as a frequency-modulated r.f. generator designed to enable receiver amplitude/frequency response curves to be displayed on an oscilloscope in order to facilitate the alignment of the i.f. transformers. Although hardly a beautiful word, wobbulator has something to be said for it on the ground of brevity.

Fig. 1 is a simple functional diagram showing how a wobbulator fits into the scheme of things. If the time-base generator and its connections are ignored, the oscilloscope can be regarded as a d.c. voltmeter for measuring the rectified output at the detector resulting from an unmodulated r.f. signal. If the frequency control knob of the r.f. generator is turned steadily, the vertical deflection of the spot on the c.r. tube increases as the frequency approaches that to which the receiver is tuned, and then decreases when resonance is past. It would be possible by this means to trace out amplitude/frequency or resonance curves point by point. But a great deal of time and trouble can be saved by continuously sweeping over the range of frequency containing the resonance, in synchronism with horizontal deflection of the spot. In this way the response curve as a whole is displayed on the oscilloscope, and the results of adjustments made on the receiver can be seen instantaneously. Assuming that one has a suitable oscilloscope, the additional apparatus required is a r.f. generator designed so that over a sufficient range the frequency is proportional to a voltage ; in brief, a wobbulator.

Voltage-variable Reactance

There are various ways in which voltage can be made to control frequency. The one generally accepted for wobbulating purposes is the so-called reactance valve, in which a phase shift is introduced between anode current and anode voltage, so that the valve behaves as a reactance which can be varied by means of the grid voltage. This voltage-varied reactance can be connected in parallel with the tuned circuit of a suitable oscillator, and is effective on all frequency ranges. Although the extent of the frequency modulation is very limited, it is usually sufficient to cover the interesting part of the response of a receiver designed for sound reception.

Another system, described by K. C. Johnson in the April and May, 1949 issues has the advantages of giving up to 30 per cent f.m.—sufficient for vision receivers—and of not necessitating a valve additional to the oscillator. On the other hand, it is inconvenient for working over more than one frequency band. In superhet receivers the response is controlled almost entirely by the i.f. tuning, so it is usually sufficient to see the curve at any one frequency. This being so, the Johnson system was adopted for the wobbulator to be described. It has been developed largely from information supplied in the articles referred to. These should be read in order to understand the principle on which the system works, for it is not easily explained in a few words. For one thing, the type of oscillator circuit employed is rather out of the usual. Instead of the customary parallel tuned circuit, L and C are in series with one another and the valve, as in Fig. 2. In order to maintain oscillation it is necessary to have a voltage at the grid proportional to the oscillatory current and in phase opposition to that at the anode. It is

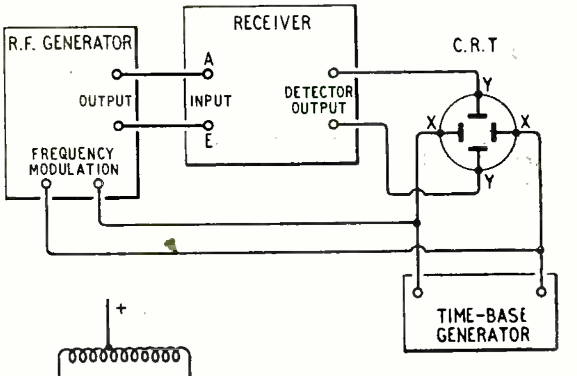


Fig. 1. Method of using a r.f. generator with provision for frequency modulation (a wobbulator) in conjunction with an oscilloscope in order to observe the frequency response curves of a receiver.

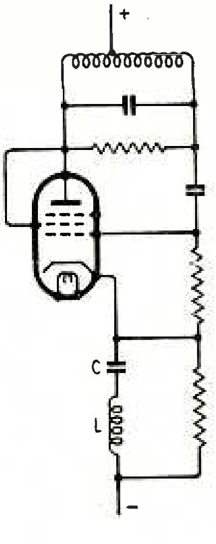


Fig. 2. Series-tuned oscillator circuit on which wobbulator here described is based. The coil between anode and grid is a phase-inverting transformer for providing current-controlled positive feedback

C1

provided by the auto-transformer shown; which is very flatly tuned so as to cover the whole of the operating band of frequency.

Applying negative bias to the suppressor grid has little effect on the total space current, but it diverts current from anode to second grid. If the anode current is made to pass through a coil tightly coupled to L, then the mutual inductance will either increase or decrease the effective inductance in series with the valve. The amount of such increase or decrease—and hence the frequency of oscillation—will depend on the proportion of space current flowing via the anode, which is controlled by the suppressor-grid voltage.

Johnson recommends that this frequency-modulating voltage be derived from the 50 c/s supply, which is simultaneously used as the time-base source. If no sawtooth generator is available this scheme

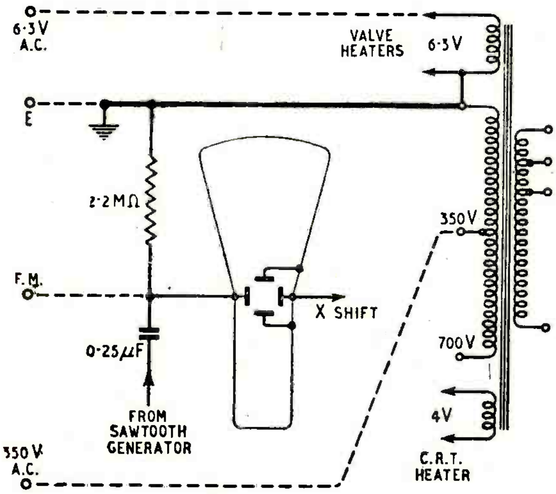


Fig. 3. Four connections, shown here in dotted line, are required to be made between wobbulator and oscilloscope.

obviously has a strong economic advantage. A minor disadvantage is that the slowest and therefore brightest parts of the trace are just those that are not used—the ends. And in testing highly selective circuits the rate of change of frequency at resonance may be sufficient to distort the resonance curve. It is true that warning of the existence of such distortion is given by a difference between the backward and forward traces; but if a variable-frequency time-base generator is available it might as well be used, and then the frequency can be reduced until further reduction causes no change in the form of the trace.

Connecting the Wobbulator

The oscilloscope to which this is the sequel does contain a sawtooth generator, and before going into the details of the wobbulator circuit it will be as well to recall the features of that oscilloscope so as to see how the wobbulator can be most economically adapted to it. (There should be little difficulty, however, in modifying the wobbulator to suit other types of oscilloscope.) The full circuit of the oscilloscope is on page 83 of the March 1950 issue; it comprises a VCR138 or similar c.r. tube with its power supplies, adjustments, shifts, etc.; a gas triode sawtooth generator; and a single-stage deflection amplifier. Any ordinary receiver transformer, as recommended for supplying the power to all these circuits, would have ample reserve for providing the wobbulator with its low and high voltage a.c. The only other interconnection required is to the X plate, for the sawtooth modulating voltage. Fig. 3 shows the relevant parts of the oscilloscope circuit, with the connections to the wobbulator in dotted line.

Fig. 4 is the full circuit of the wobbulator. L_1 and C_5 constitute the series tuned circuit, carrying both anode and second-grid oscillatory current via the cathode. L_2, closely coupled, carries the anode part of the current only, so its eff ct depends on the third-grid voltage. L_3 is the phase-inverting transformer, tuned by C_3 to the centre of the working

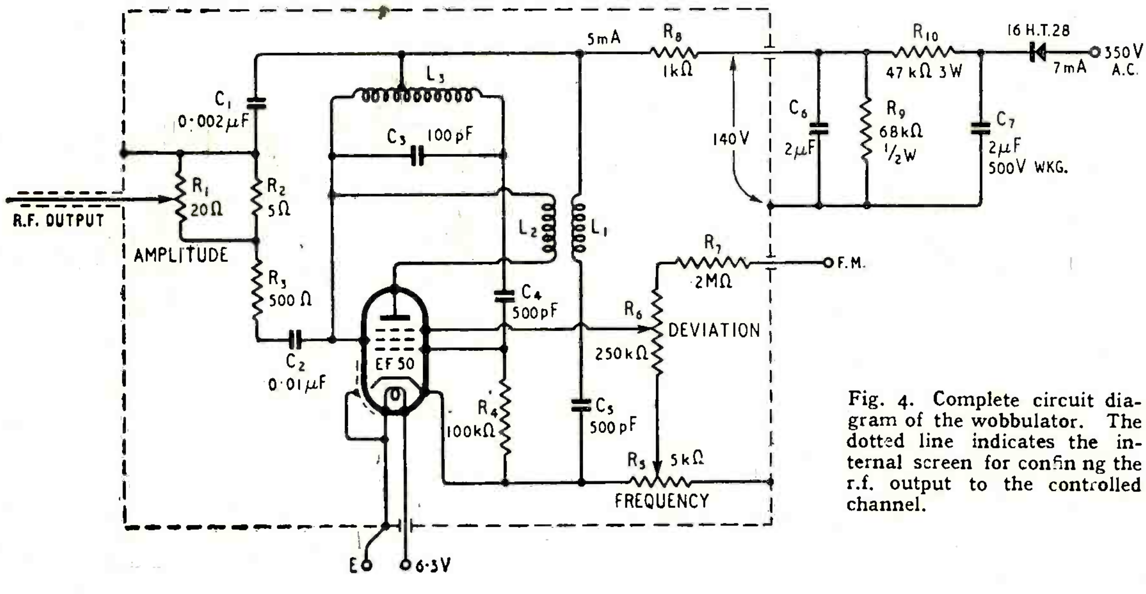


Fig. 4. Complete circuit diagram of the wobbulator. The dotted line indicates the internal screen for confin ng the r.f. output to the controlled channel.

frequency band, and heavily damped by R_3 (via C_1, R_2 and C_2) so as to be nearly flat over the whole of that band. A small fraction of the r.f. voltage set up across this circuit is tapped off by R_1, which is a low-impedance output control. The initial or centre frequency is adjustable by means of R_5, which controls the bias voltage for the third grid. In series with it is the sawtooth voltage, a controllable amount of which is obtained from R_6.

Outside the screen is a simple rectifier and smoother system. The Westinghouse 16HT28 rectifier is rated for a maximum open-circuit r.m.s. input voltage of 420, so allows a safety margin with a nominal 350-V supply. The maximum current rating (temperate climate) is 8 mA, and 2μF is the maximum allowable reservoir capacitance. The minimum power on which the EF50 wobbulator valve gives reliable results is about 5 mA at 140 V; these figures should be used as the basis of any modification to the power circuit to suit a different supply voltage.

For the widest frequency deviation, iron-dust-cored coils are advised, and Johnson recommends a wave-wound type for L_3; but as readers might have difficulty in duplicating coils to such specifications, simple single-layer coils on 1-in paxolin tubing were tried and found quite satisfactory. It was considered that a frequency band in the region of 1 Mc/s would be suitable for testing broadcast receivers. The range covered by R_5 turned out to be 860-1040 kc/s; a variability of just over 20 per cent. Operation of R_5 has a slight X-shifting effect, but this is unlikely to be objectionable, because it is normally left set somewhere near the middle of its range, where it allows reasonably linear deviation over the maximum band. Some slight adjustment may be required to dodge breakthrough from a local transmitter. If removal of the X-shift effect is considered to be worth an extra component, it can be obtained by inserting 0.25μF or more in the "F.M." lead.

Construction

L_1 consists of 50 turns of 34 s.w.g. enamel-covered wire, wound closely in a single layer on 1-in diameter tubing. L_2 is a similar layer wound straight on top of L_1, in the same direction. The anode and cathode connections to the coils are together as shown in Fig. 4. L_1 is connected to + h.t. (instead of − h.t. as in Fig. 2) to reduce risk of short-circuit to L_2. L_3 has 100 turns of the same wire on the same kind of tubing, and the best tapping position was found to be about 40 turns from the g_2 end.

To enable the r.f. signal to be controlled down to a low level for testing fairly sensitive receivers, it is necessary to screen the generator carefully. There are various ways in which the requirements could be met; the photograph shows one layout that proved satisfactory. The panel is a sheet of 0.03-in tin plate on which was soldered a strip about ½-in wide to fit the inside of a tin box forming a screening cover. If the lid of this box had been available it could have been used instead; but an inside strip is slightly neater, being invisible when the cover is on; and also it lends itself better to forming grooves, shown in Fig. 5, for bringing out the leads in a manner that does not much impair the overlap of screening. An alternative could be the use of "feed-through" capacitors, bringing the leads through the front panel.

If the screening is found to be inadequate, a simple method of locating the r.f. leakage is to connect a foot or two of screened lead to the aerial and earth terminals of a receiver—aerial to inner conductor and earth to screening—with about an inch of the inner wire projecting from the screening. This projection is used as a probe, care being taken of course not to short-circuit any power leads. In this way a leakage via + h.t. was discovered, and stopped by inserting R_8. The other emerging leads were arranged so as

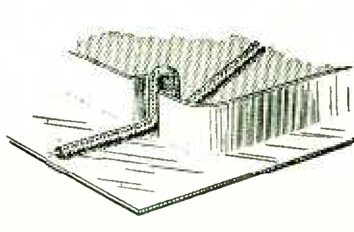


Fig. 5. Method of looping leads emerging from the screened compartment over the cover-retaining flange, so as to provide an overlap of screening when the cover is in position.

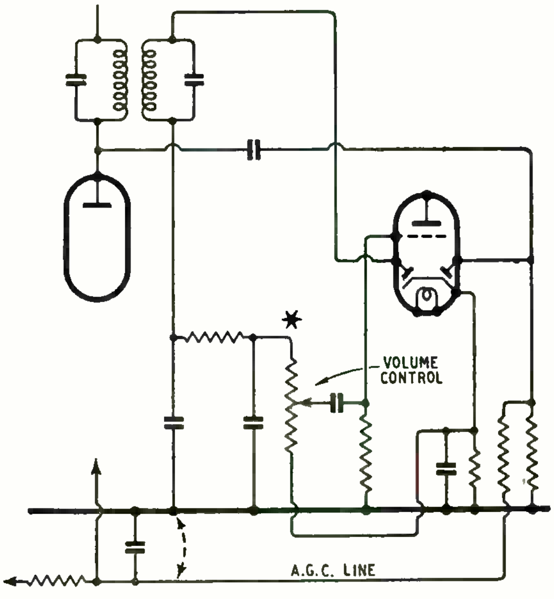
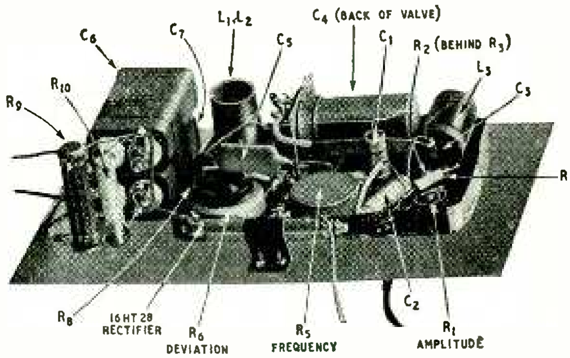


Fig. 6. Detector circuits of typical broadcast receiver, showing point (*) at which to connect the Y plate of the oscilloscope. In this type of circuit the a.g.c. can be put out of action by a short-circuit as indicated by the dotted line.

Layout of Wobbulator with screening box removed Parts can be identified by reference to Fig. 4.



to minimize r.f. pick-up, and no additional filtering was found necessary. The earth and 6.3 V leads should consist of twin flex, and the modulating lead should not be run alongside as it is a high-impedance circuit and sensitive to stray capacitance and hum.

Note that L_1, L_2 and L_3 are mounted at right angles to one another, with the valve in between, to minimize coupling.

There is scope for variation in the r.f. output circuit to suit requirements and availability of components. The resistance of the amplitude control, R_1, is not at all critical. R_2 was used to reduce the signal amplitude to about 12 mV maximum (which was found ample) and also to minimize the effect on L_3 of adjusting R_1 when the output is more or less short-circuited. The output can either be applied direct to the grid of the frequency-changer, for example, or through a dummy aerial to the aerial terminal of the receiver. The latter gives an overall picture, and avoids possible disturbance of capacitance at the first i.f. primary.

The Y input to the oscilloscope is connected to the high-potential end of the detector load resistance —in most present-day receivers, the "top end" of the volume control (Fig. 6). The a.g.c. must be put out of action. In some sets this can be done simply by short-circuiting the first a.g.c. filter capacitor, but the circuit diagram of the particular set should be studied to make sure that doing so does not affect the damping of the i.f. transformer. In most receivers there is sufficient output to give an adequate picture without using the deflection amplifier; this is just as well, for it is difficult to avoid picking up hum if the high-impedance detector circuit is connected to the amplifier input. In the oscilloscope previously described, about 30 V is optimum for a good picture, but anything from 10 to 40 is satisfactory. Fig. 8 shows the type of picture obtained from a well-adjusted receiver.

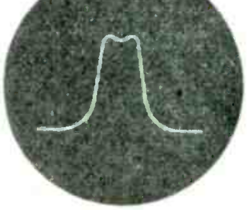


Fig. 8. Typical receiver response curve obtained with the wobbulator.

If it is desired to measure the width of the curve in terms of frequency, in the absence of a multivibrator or other calibrator it can be done by tuning in two or more identifiable stations on the receiver and noting the horizontal shift in the wobbulator signal corresponding to the frequency difference between them, say 9 or 18 kc/s.

QUALITY AMPLIFIER

High-grade Instrument with Separate Control Unit

THE new "QUAD" equipment introduced by the Acoustical Manufacturing Company, Huntingdon, comprises a high grade, low-distortion amplifier similar to the earlier type QA12, and a separate quality control unit with a well-thought out system of frequency compensation designed to give the best available performance with all types of input and under varying listening conditions.

The control unit comprises a master volume control, bass and treble balance controls giving both rise and fall, variable-slope low-pass filters for the suppression of high-order background and interference frequencies and a master control selector switch with facilities for quick reference to "straight-line" amplification without disturbing any other control settings. Alternative "cut-off" frequencies centred on 6,000 and 8,000 c/s are available and the rate of attenuation above these frequencies is continuously variable from 10db/octave to 100db/octave.

Acoustical manufacturing "Quad" 12-watt amplifier and quality control unit.

From tests we have made it is evident that these characteristics have been well chosen to cope with all types and conditions of record and radio programmes. The best modern recordings can be played "neat" without correction, when in absolutely new condition, but after a score or so of playings even "vintage" records, from the point of view of frequency range and low intermodulation and tracing distortion, benefit from a moderate filter slope above 8 kc/s.

With a separate low-pass filter to deal with deficiencies in the input signal, the conventional bass and treble control can be applied to the correction of room acoustics or loudspeaker deficiencies and once set need no further adjustment. This is a distinct advantage, as was proved by a comparative test in which a programme with over-emphasized sibilants was subdued by the two alternatives available: the variable-slope filter went straight to the heart of the trouble, whereas the conventional top-cut control alone made appreciable incursions into middle frequencies before satisfactory suppression was achieved.

The QUAD amplifier and control unit can be confidently recommended to those who have discovered the inadequacy of the simpler tune controls; the wider scope extends the useful life of records, and the settings of the various controls can be used as a criterion of the quality of the input.

Frequency response in the basic amplifier is 20 to 20,000 c/s $\pm$ 0.3 db, and at 12 watts output the total distortion is not more than 0.25 per cent. Response is independent of volume control within 1 db.

The price of the QUAD equipment—amplifier, control unit and connecting cable—is £33.

Band-Pass Converters

"Tailor-Made" Units to Provide New Wavebands or to Expand Existing Ones

By H. B. DENT

THE unit described here was intended originally to extend the range of the R.A.F. receiver R1155 to take in the 10-metre amateur band, but it has since been used in a slightly modified form to fill in part of the gap in the tuning range of the set that lies between 1.5 Mc/s and 3.5 Mc/s. The inability to tune over the top amateur band covering 1.7 to 2 Mc/s has always been a cause of irritation to the writer and possibly to other users of this receiver also. No doubt a single unit could be made to cover both wavebands but switching r.f. circuits is best avoided whenever possible and although separate units entail duplication of parts they often prove better in the end. Moreover, alterations can be made to one without upsetting the performance of the other.

As the initial requirement was for a unit to cover 28 to 30 Mc/s only, it was decided to be a little unorthodox and employ wide-band circuits in the r.f. and mixer stages and by so doing reduce the controls to a single small oscillator capacitor. Later on an r.f. gain control was added to avoid overloading the early valves when receiving strong local signals. It takes the usual form of a variable cathode resistor, but no compensation has been made for the effect it may have on the input impedance and capacitance of the valve and this will, of course, lead to a small change in tuning of the grid circuit, but it has not been detrimental for ordinary communications work.

Whilst some emphasis has been placed on the use of the converters with the R1155 receiver, the circuit arrangement and form of construction are equally applicable to a converter for any type of receiver provided a relatively small coverage is acceptable. They can be employed to fill in missing bands or even to band-spread a portion of an existing range for greater ease of tuning. So far the units have been used with rather high first intermediate frequencies —none lower than 5 Mc/s—and it is therefore difficult to say how they would behave if one were limited to, say, an i.f. of 1.5 Mc/s. With the low i.f. a coverage of 0.5 to 0.75 Mc/s should be attainable, but anything wider might let in a considerable amount of second channel interference, as the selectivity of wide-band circuits is not usually good on the immediate boundaries and, moreover, the second channel region must not fall within the working band.

From the circuit (Fig. 1), it will be seen that the converter consists of an r.f. stage, a mixer and a separate oscillator. The first two positions are filled by Mullard EF50 valves and the last by an EC52. Signals enter the converter by a co-axial socket on the left rear top of the chassis and reach the grid of the r.f. valve via the transformer T_1. Coils L_1 and L_2 are wound on a ⅜-in diameter bakelized paper tube about 1¼in long and the grid circuit is tuned

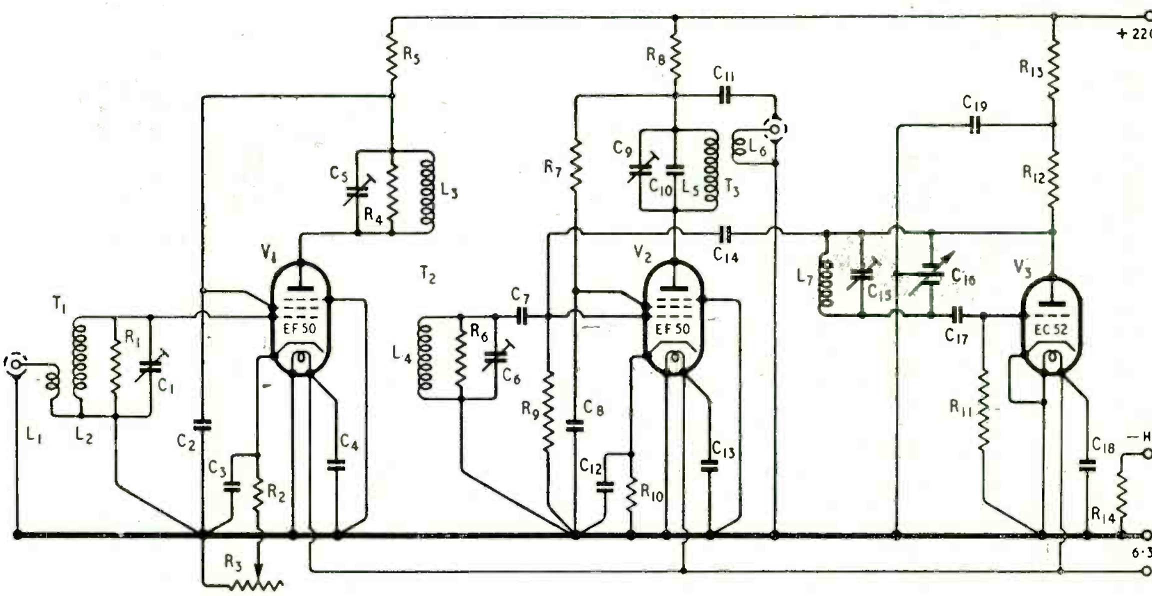


Fig. 1. Circuit of the 10-m converter, component values are :—C_2, C_3, C_4, C_{18}, C_{19} = 0.001μF ; C_8, C_{11}, C_{12}, C_{13} = 0.01μF ; C_7, C_{17} = 22pF; C_{14} = 5pF ; C_{15} = 30pF (Max). R_2, = 150Ω, R_3 = 10KΩ(Var), R_5, R_8, R_{13}, R_{14} = 2.2KΩ, R7 = 68KΩ, R_{10} = 470Ω, R_{11}, R_{12} = 33KΩ, R_9 = 2.2MΩ. All ½W except R_{12} = 1W.

by a midget air-spaced trimmer C_1 (Cyldon 184/10) with a maximum capacitance of 10pF and the circuit is damped by a 10-kΩ resistor R_1.

A pair of tuned circuits, C_5L_3 and C_6L_4, couple the r.f. stage to the mixer, the capacitors C_5 and C_6 being pre-set air-spaced trimmers similar to C_1. The coils L_3 and L_4 are wound on a common former of ⅜in diameter and the windings are spaced ⅜in apart measured from the end turn of one of the first turn of the other and, unlike most couplings of this kind, the high potential ends of the coils "look" at each other. Both circuits are damped by 10-kΩ resistors, R_4 and R_6 respectively. Winding details of these and the other coils in the converter are given in the coil table, while the dimensions and other constructional details can be found in Fig. 2.

No attempt can be made to design the i.f. output transformer T_3 or the oscillator circuit, $L_7C_{15}C_{16}$, until the first intermediate frequency has been chosen. As previously mentioned, a comparatively high i.f. is desirable in the interests of second channel rejection, but it should not be so high that it precludes the use of the higher of the two oscillator frequencies without recourse to special circuit arrangements.

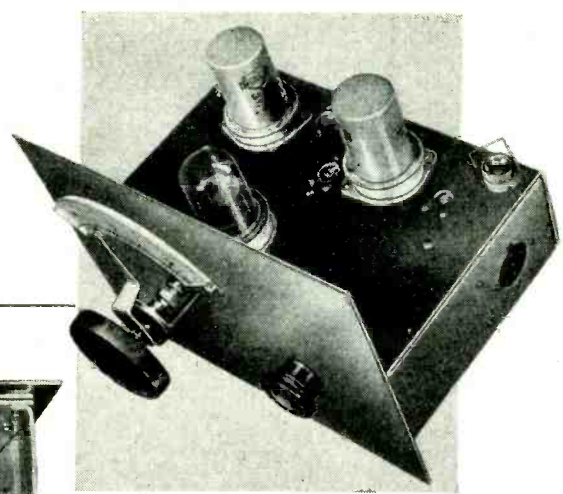
The above two requirements are actually closely related, especially in the present case as the use of the higher oscillator frequency brings the second channel zone well into the v.h.f. band. On the other hand, if the lower setting is used the second channel region falls in the h.f. band and any part of this band from about 16 metres upward will be a potential source of second channel interference.

Using a first i.f. of, say, 5.6 Mc/s, and the upper of the two oscillator settings, the second channel region when tuning over 28 to 30 Mc/s falls between 39.2 and 41.2 Mc/s. If the i.f. is exactly 6 Mc/s there might be some risk of interference from the A.P. television sound transmitter in the London area, but 6 Mc/s has been used on the south coast, some 60 miles away, without experiencing trouble of this kind.

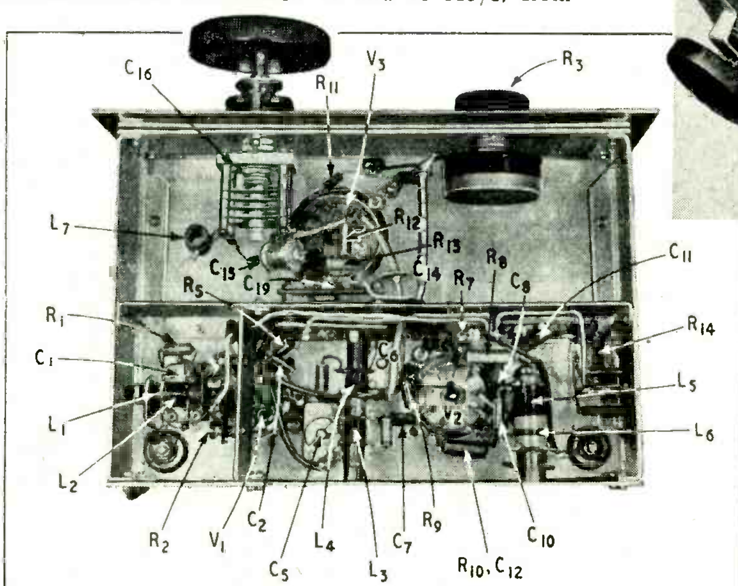
The lower oscillator frequency would place the second channel at between 16 and 18 Mc/s, from which region the probability of interference will be far greater. In that band of 2 Mc/s there are no fewer than 37 broadcast stations using 50 kW or more. One other likely cause of interference must be borne in mind when choosing the first i.f. That is heterodyne between a harmonic of the frequency changer's oscillator in the receiver and either the fundamental or a harmonic of the converter's oscillator. This will produce a phantom signal having all the characteristics of the genuine article. It may be caused either by direct radiation from the oscillators or by impedance coupling in the h.t. and l.t. leads. These possibilities are effectively countered

COIL TABLE FOR 10m CONVERTER

Coils	Sizes of Former	Wire s.w.g.	Turns	W.nding length	Approximate Inductance
T_1 L_2	⅜in × 1¼in	No. 24EN	15	0 38in	1.5 μH
T_1 L_1		No. 24EN	5	(see text)	
T_2 L_3	⅜in × 2½in	No. 24EN	16	0.4in	1.6 μH
T_2 L_4	(see text)	No. 24EN	14	0.35in	1.4 μH
T_3 L_5	½in × 1¾in	No. 26EN	48	1.0in	12.0 μH
T_3 L_6	(see text)	No. 26EN	5	(see text)	
L_7	⅜in × 1in	No. 24EN	13	0.33in	1.3 μH



General view of the 10-metre converter showing the layout of the top of the chassis and of the front panel.



The use of single-ended valves enables all the components to be accommodated below the chassis and, incidentally, shortens the wiring.

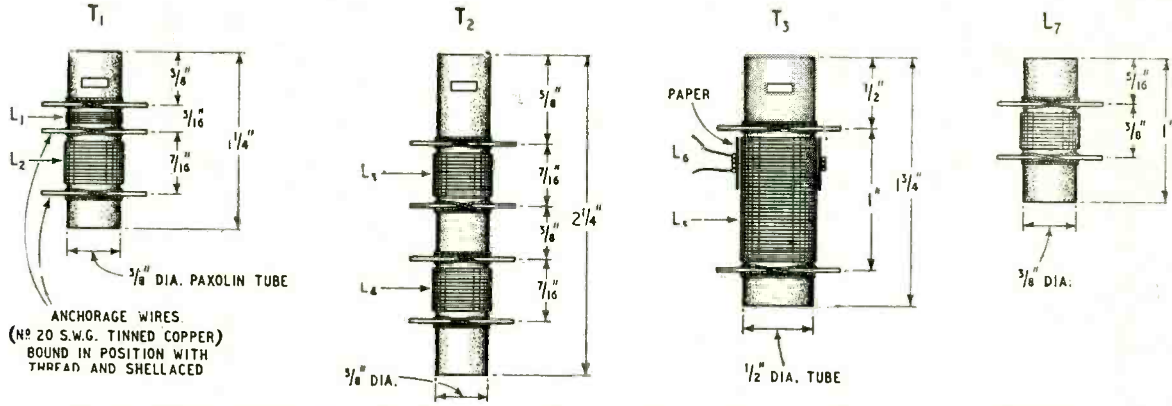


Fig. 2. Details of the formers used for the r.f. and i.f. transformers T_1, T_2 and T_3 and the oscillator coil L_7.

by the generous r.f. filtering in the converter; capacitors C_4, C_{13} and C_{18} being in the heater line and C_2R_5, $C_{11}R_8$ and $C_{19}R_{13}$ in the h.t. circuit.

As the frequencies concerned are in the 28-30 Mc/s region all by-pass capacitors must be non-inductive at these frequencies. The mica types, silvered and stacked varieties, generally comply with this requirement and it is also possible to use some of the latest miniature tubular paper type. All the likely makes have not been tried but Hunt's new "Mouldseal" midgets have proved quite satisfactory. Like any other double superheterodyne, good screening of the oscillators is essential but when reasonable care is taken very little trouble arises from inter-oscillator heterodyne.

Taking 6 Mc/s as the i.f. for the converter, winding data can be prepared for T_3 and the coverage of the oscillator circuit also determined. Assuming C_{10} has a capacitance of 22pF and C_9 30pF maximum (Cyldon 184/30), L_5 of T_3 will require an inductance of 12μH. The i.f. output is taken from the coupling coil L_6 wound over the "earthy," or h.t. end, of L_5 to a coaxial socket located at the right rear of the chassis. The sockets shown in the illustration may not be very familiar, but the writer's station is cabled up with this pattern and the converters have to fit into the general scheme. Without ties of this kind the latest Belling-Lee sockets could have been used. As a well-screened lead is necessary to take the i.f. output to the receiver, a co-axial cable seems the obvious choice and the receiver itself must be adequately screened against direct pick-up of signals otherwise a great deal of interference may be experienced.

The photographs illustrate the form of construction adopted. The chassis, which is made of aluminium, measures 8½in × 6in × 2½in deep with a front panel measuring 9in × 7in. It raises the chassis 1¼in and so brings the oscillator tuning knob (the oscillator tuning capacitor is below the chassis) to a convenient height above the table.

An Eddystone butterfly capacitor (Cat. No. 739) of 8+8pF and having an effective maximum capacitance of 4pF, tunes L_7. With this type of capacitor the rotor vanes cover 90° only and it was found more convenient to use an epicyclic friction drive and a small quadrant scale rather than fit an orthodox pattern drive. The oscillator's coverage is 33.5 to 36.3 Mc/s.

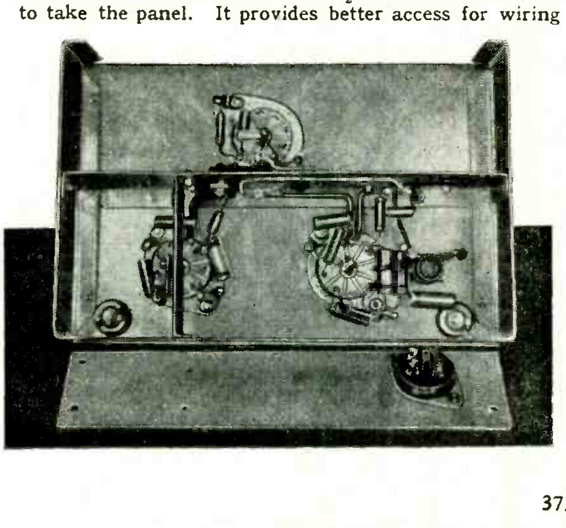
A lengthwise partition divides the underside of the chassis into two equal compartments, the back accommodating the r.f. and mixer stages, and the front the oscillator. There is a small cross-screen dividing grid and anode circuits of the r.f. stage.

During the construction of the unit it was seen that a number of improvements could be made without departing from the general design. They were embodied in another model of which a photograph, when partially finished, is shown and it will be seen that the rear compartment can be made much more accessible for wiring if part of the back of the chassis is removable. The power input socket has been transferred also to this side.

Other changes also to be embodied in this unit, which will cover 1.6 to 2.2 Mc/s, is that T_1, T_2 and T_3 will be wound on Denco ½-in diameter formers with variable dust cores and the oscillator tuning capacitor C_{16} may have to be replaced by a slightly larger one and all by-pass capacitors will be 0.01 μF.

The resistor R_{14} in Fig. 1 is included because, as mentioned earlier, the converters were intended for use with the R1155 receiver. Power is taken from the receiver and as the h.t. negative line is about 35 volts below the chassis the two chassis could not be connected without short-circuiting this supply which is needed for r.f. gain control and other purposes. As the consumption of the converter is 15 mA at 220 volts a 2.2-kΩ resistor suffices.

In a subsequent model (1.6-2Mc/s) the chassis was modified and has a loose back and a ½-in turn-over at front to take the panel. It provides better access for wiring



UNBIASED | By FREE GRID

Applied Telearchics

A FEW weeks ago the Editor of our leading motoring journal came down with a heavy hand on the frills and furbelows of modern motoring. In particular he objects to over-simplification of car controls. (*The Autocar*, 25.8.50.) Thank heaven both he and I live in a country where we can have our own individual opinions and be free to

A guilty feeling.

voice them without being liquidated. As a token of my respect for his views, although they are diametrically opposed to my own, I am thinking of sending him a five-gallon drum of paraffin for his car lamps in the hope that he will reciprocate by letting me have his electric starter which is, I suppose, one of the least essential pieces of equipment in a car and coveted only by sybaritic souls like myself.

His words, when I read them, gave me a guilty feeling as I have lately put into use a radio-operated device whereby I can, while still a mile or so from the goal of home, open the garage doors, switch on the radio, the house lights and heaters, my electric blanket and also the electric griller over my previously prepared evening kipper. I can thus return tired and weary to my residence with all my home comforts ready for me instead of a cold, dark, cheerless and silent house with the added insult of having to get out and open the garage doors myself.

Of course the opening of garage doors has been done by many people previously by simply flashing the car headlights on to a suitably sited photocell, but kippers take a little time to grill and electric fires to warm up and, of course, the photocell won't work until the car is within a few yards of home. There has, however, for a long while been no *technical* reason why the whole operation should not be accomplished from a distance by radio but there have been obvious legal snags. However, as a result of a visit last August to the Model Engineering Exhibition I have managed to overcome them.

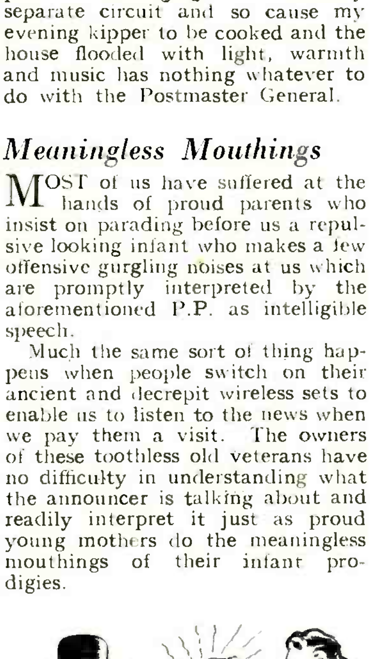
At that exhibition there were available several telearchic transmitters for controlling models of all types. Provided that their power is limited to five watts and they work on certain frequencies specified by the P.M.G. and are only used for controlling models no transmitting licence or other red tapery is required.

The range claimed by most manufacturers is a modest half-mile or so but, as I was told and have since proved, this is a very conservative estimate. I find that with the transmitter with its attached vertical rod aerial stretching through the roof of my car I can cause the doors of a *model* garage to swing open when, like the returning prodigal, I am "yet a great way off." The fact that when the doors of the model swing open they interrupt a photocell belonging to an entirely separate circuit and so cause my evening kipper to be cooked and the house flooded with light, warmth and music has nothing whatever to do with the Postmaster General.

Meaningless Mouthings

MOST of us have suffered at the hands of proud parents who insist on parading before us a repulsive looking infant who makes a few offensive gurgling noises at us which are promptly interpreted by the aforementioned P.P. as intelligible speech.

Much the same sort of thing happens when people switch on their ancient and decrepit wireless sets to enable us to listen to the news when we pay them a visit. The owners of these toothless old veterans have no difficulty in understanding what the announcer is talking about and readily interpret it just as proud young mothers do the meaningless mouthings of their infant prodigies.



A mellow bellow.

This ability to get used to the distortion and travesty of reproduction produced by an old set which is in constant use has some very strange repercussions. Recently I had a few friends in on a night when an important political broadcast was being given. I switched on my latest creation which, I flatter myself, is as free from distortion as it is possible for a set to be in our present state of knowledge. To my amazement my friends found the words of the speaker almost unintelligible and my reputation was in grave danger until I hastily dragged out an old set which I built thirty years ago on the occasion of Melba's famous broadcast from Chelmsford in June, 1920; instantly my friends' faces were wreathed in smiles of enjoyment as they listened to the sort of quality to which they were accustomed.

The set, like myself, was completely unbiased.

Stereovision

IT is my firm opinion that no matter what we do we should not get a great deal nearer to the distant goal of perfection in television while we stick to the old-fashioned Cyclopian system we now use and refuse to change over to stereovision.

One of the arguments against stereovision which obstructionists will probably put forward is that in bygone years when stereo film experiments have been made in cinemas the public objected to wearing the special spectacles with differently coloured or polarized lenses with which they were provided. But the far-seeing Mr. Bevan has abolished all that by making the wearing of spectacles second nature to everybody. In any case, however, as has been recently pointed out in the learned columns of the *Amateur Photographer*, stereoscopic vision without glasses or other paraphernalia only needs a little perserverance to acquire. Those lacking the patience to persevere could still enjoy a cyclopovision programme as at present by simply switching off one of the pair of screens which, of course, would be incorporated in each receiver.

There remains the problem of etheric *lebensraum*. Possibly this will be solved by using one channel only for the two transmissions, sending one by vertically and the other by horizontally polarized waves. The problem has certainly got to be solved somehow if television is to be made as realistic as a stage show which is, after all, the only goal worth aiming at.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents.

"Airmet"

YOUR campaign for the restoration of Airmet and its invaluable weather service is the finest thing you have ever undertaken.

Although the majority of broadcast receivers could get this station and at least one make of receiver had it specially marked on the dial, very few of the general public knew of its existence. It was never advertised except by word of mouth.

Whenever I have called attention to it and its very complete and up-to-the-minute weather reports I have always been subsequently thanked for what was considered about the most useful broadcast of all.

When weather conditions have been in doubt and the activities of the day have been dependent on an accurate knowledge of the weather during the next few hours I have always turned to Airmet—convenient on a push-button—for last-minute guidance.

In areas like Cornwall, where conditions frequently differ from the main forecast, Airmet would always reveal whether a dull, rainy-looking sky was as bad as it looked or masked a fine day. When rain was falling, the broadcasts always indicated the likelihood or otherwise of its early cessation.

If the scope of the new Airmet service is to be widened, the question arises as to who should undertake its distribution. There is little doubt in my mind that it should be regarded as an auxiliary B.B.C. service.

B. S. T. WALLACE.
London, S.W.16.

V.H.F. Mobile Communications

IN the July issue of the American journal *Tele-Tech*, Major Edwin Armstrong, the f.m. pioneer, has taken space to review the progress of frequency modulation as he sees it.

On the subject of mobile communication he makes the following statement: "In communications the mobile services are still expanding rapidly. Here the use of f.m. is universal. No one would even attempt to sell a Chief of Police a.m. equipment." In making this statement, Major Armstrong is either unaware of or is ignoring the following facts:—

1. 86 British police forces use a.m. Four use f.m.

2. While it is true that one of the four f.m. users is the London Metropolitan Police, it is also true that the London Fire Service is a well-satisfied a.m. user.

3. British ambulance services, with only one exception so far, have adopted a.m.

4. All aeronautical v.h.f. throughout the world is a.m. All attempts to persuade aeronautical users to change to f.m. have been unsuccessful.

5. The British Post Office have recently adopted a.m. as standard for all maritime applications.

6. In the commercial v.h.f. mobile field in Britain, between 80 per cent and 90 per cent of all licensees use a.m. In many cases a.m. has been chosen after competitive demonstrations with f.m. equipment.

7. My company exports every month increasing quantities of a.m. radio-telephony equipment. This business is obtained in many cases after direct competitive trials with British and American f.m. equipment.

These are but seven examples of many which could be quoted in evidence of the rapid and successful expansion of mobile a.m.

Major Armstrong's statement that the use of f.m. is universal is incorrect, and in police and in all other mobile applications my company offers a.m. equipment with complete confidence and success.

J. R. BRINKLEY.
Pye, Ltd., Cambridge.

Wrotham A.M./F.M. Schedules

YOUR editorial plea for a regular schedule of a.m./f.m. e.h.f. transmissions from Wrotham will, I am sure, be endorsed by many designers and experimenters, both professional and amateur. The present tests, which have been going on since May, are most unsatisfactory in many respects, and the following points are worth mentioning.

1. The transmitters are seldom on the air before 11 a.m., thereby wasting half the morning.

2. Modulation is removed for periods of 30 mins. or 1 hour in the already scanty daytime schedule.

3. The unpredictable night-to-night change from Home to Third Programme is annoying when demonstrations are planned.

4. The interruption every hour of music or speech for the "Wrotham Testing" record is infuriating and could best be included at programme junctions.

5. Lastly, and most important,

there is no daytime transmission on Saturdays, and no transmission whatever on Sundays.

No doubt the station is primarily for the benefit of the B.B.C. research branch, but e.h.f. tests have been going on since 1945 and many enthusiasts have spent time and money on receiving equipment and deserve some consideration. These enthusiasts can do much to secure the eventual popularity of an e.h.f. service and in the meantime are gaining valuable experience in the stability of receivers and other problems which you mention. Of necessity much of their work is carried out on week-ends, and an all-day Saturday and Sunday schedule should be instituted at once.

Is this another example of the secrecy in which the B.B.C. shroud many of its engineering activities, and which Mr. Bishop sought to deny existed in your columns earlier in the year? Incidentally, he then promised an early statement on the Wrotham tests.

In connection with my earlier correspondence on medium and long wave beacon interference, and your plea for a channel for "Airmet," it is interesting to note that even after the Copenhagen Plan the Bovingdon Airport Radio Range (BO) is operating on 223 kc/s, where it effectively prevents reception of Oslo in London.

"MIKEROBE."

Valve Heaters

PHILIP MORRIS, in your August issue, raises the question of the "evil" of the long warm-up time in a.c. receivers. The solution which immediately suggests itself is that the heaters of mains receivers should be left permanently on. I do not know whether there are any theoretical objections to such a practice, but the only practical objection seems to me to be the wastage of power entailed, amounting to about twenty watts when the receiver is "off"—that is, with no h.t. applied to the valves—for an average "four-plus-one." Since this amounts to about a halfpeny a day at a penny per kWh, many listeners will not begrudge the expense.

It seems worth mentioning that valve heater failure very rarely occurs at times other than during the warm-up period, the strains occurring during heating being sufficient to cause fracture of the heater of an old but otherwise good valve. It might be added that the designers of ENIAC, which has eighteen thousand valves, found it economical to supply something in the region of 50 kW for the valve heaters *continuously* because, after a while, every time the computor was switched on about fifteen heaters failed. After the valves were replaced and the equipment was again turned on, fifteen more "went"!—and so on. After this had happened a few times, they just left the heaters permanently on.

Another point is that, if the mains transformer is left permanently connected to the mains, there is no possibility of heavy switch-on surges due to the instant of switch-off occurring when the transformer iron was at the wrong point on the B-H loop. I have it on unimpeachable authority that the surge can be large enough to blow heavy fuses, although I have never found the effect so bad as that.

I myself use a receiver rather larger than the normal four-plus-one and, while a mains switch is of course provided, I normally switch off by disconnecting the h.t. *at the reservoir capacitor*. It is important that it should be done at that point, for the regulation of capacitor input filters is notoriously poor, and if the reservoir can stand the rise in mean d.c. level the filter capacitor quite likely will go down.

A.c.-d.c. sets require even longer to warm up than a.c. sets, and if means can be found to switch off the h.t. supply alone the benefit would be very real. The heavy current during warm-up appreciably reduces the life of series-connected valves, and the thermistors I have used have shown a distinct tendency to short life when they are used as heater current limiters. Where no dropping resistor is used it is a simple matter to disconnect the h.t. line from the rectifier cathode; where dropping resistors are essential it might be worth while providing separate h.t. and heater droppers.

C. F. K. GAULDER.
Feltham, Middx.

Beauty and the Beholder

I READ "Radiophare's" letter in your July issue with interest and with enjoyment, but not, I am afraid, with any conviction that town and country planners, borough surveyors and architects, etc., would be moved by his argument.

No doubt, once neat and tidy television aerials have been erected, we will grow accustomed to them and accept the situation whether it be a thing of beauty or otherwise.

Unfortunately the aforementioned dictators of town and country beauty are not likely to permit that situation to arise. And, before they have a change of heart many things may happen, such as the considerable extension of relay and re-diffusion services. In fact, in areas where the T. and C. planning boys are particularly "sticky," this may become the sole means of having television for those who are not near enough to the transmitter to be able to use indoor aerials.

It is a bit early to criticize the B.B.C. television policy, but why did they not decide on a policy which would provide a chain of low-power transmitters sited in such a manner that television would be available to any viewer with a moderately good receiver and an indoor aerial?

I appreciate that the expense would be greater from the B.B.C.

point of view, but the prospective viewer would find it cheaper. And as it is public money both ways I do not see any reasonable grounds for argument against such a policy.

H. WILLAN CRITCHLEY.

Scalby, Scarborough.

Superhet Radiation

IT is not only listeners in the North of England or to the North-East Regional wavelength that suffer in the manner H. R. McDermott complains of in your August issue. When listening to the Third Programme on 464 m (647 kc/s) I frequently hear none-too-steady heterodynes which I believe to come from the local oscillators of superhets tuned to the Light Programme on 200 kc/s. I wonder if these unfortunate possibilities were considered when the new wavelengths were agreed.

E. F. GOOD.

Malvern, Worcs.

MANUFACTURERS' LITERATURE

"Asbestos Textiles and the Electrical Industry," a well-illustrated booklet on the various forms and uses of asbestos, from Turner Brothers Asbestos Co. Ltd., Rochdale.

Industrial Battery Chargers described in an illustrated catalogue from G.E.C., Magnet House, Kingsway, London, W.C.2.

Television Pre-amplifier; a technical specification from Rainbow Radio Manufacturing Co. Ltd., Mincing Lane and Mill Lane, Blackburn, Lancs.

Communication Receiver Type CC150 described in a technical specification from Hamtune Communication Receivers, 10 Elm Street, Wellingborough, Northants.

"The Home Constructor's Handbook," containing eleven circuit diagrams, price lists and a catalogue, can be obtained from Roding Laboratories (Electronics), 70 Lord Avenue, Ilford, Essex, price 1s 6d.

Williamson Amplifier and other products described in a brochure from Radio Trades Manufacturing Co. (Ealing) Ltd., 141 Little Ealing Lane, London, W.5.

Capacitor Price List, issued in May, 1950, by Claude Lyons Ltd., 180-182 Tottenham Court Road, W.1, cancels all previous lists.

"Mermaid" Radiotelephone described briefly in a leaflet from Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

Receivers; the complete range by Ferranti Ltd., Hollinwood, Lancs, covered in a set of technical specifications.

RANDOM RADIATIONS

By "DIALLIST"

A Difficult Question

A FRIEND asked me the other day: "Can you tell me why it is that ships equipped with radar still run into one another or on to rocks when the weather is thick?" As I told him, this is a question which puzzles me as well. The answer is certainly not that marine radar is unreliable. With 3-centimetre gear "sea-clutter," caused by reflections from the surface of choppy water, can be a nuisance at times; but all good equipments have a device which minimizes its effects—and, in any event, the combination of fog and a water surface whipped up by wind is one that must be of very rare occurrence. Neither sea-clutter nor clutter due to other causes (heavy showers of rain or snow, for example) was mentioned in any of the proceedings following a disaster at sea in which I have been directly concerned, or those which I've studied with the utmost care. In every one of such cases it appeared that the radar set was in operation and indicating "targets" correctly on the P.P.I. screen Yet collisions or wrecks occurred. Why?

The Radar Picture

Any reader who has had practical experience of radar in general, and in particular of the P.P.I. varieties, knows that quite a bit of constant, regular use of the apparatus is needed before one's mind's eye forms accurate and clear pictures of what is happening from the information set out on the screen. What, so far as my experience goes, appears to happen far too often with marine radar gear is this: When visibility is reduced to but a cable's length, "Sparks" is summoned to switch on the radar and work it. The radio officer is not as a rule versed in the niceties of navigation; the navigating officer, for lack of practice, may fail entirely to realize the import of the information which he gleans from his occasional glances at the screen or from the reports received from the radio officer. Hence the "blip" representing another ship or a rock, as the case may be, is allowed to drift into the small blind area at the middle of the screen, the central point of which represents the position of the navigator's own ship. The target is then lost and radar can do nothing to prevent a collision between ships, or the piling up of a ship on a rock. The only way that I can see of enabling navigating officers to interpret the radar picture correctly, and to realize how completely reliable it is, is this: In the clearest of clear weather the radar screen should be used as a matter of routine and its picture compared with what the eye sees whenever another vessel or a coastline is sighted, or when the ship is entering or leaving harbour. Will some of *Wireless World's* marine readers give us their views and their experiences?

Good, Clean Fun

WHEN you come to think of it, most of the things that give you a really good laugh are funny because some fellow human being gets hurt in one way or another. If it isn't his carcase that takes a physical knock, there's usually a blow of some kind to his pride (or, maybe, his conceit!), to his dignity, to his self-respect, or to his moral outlook. Fate, I think, has a peculiarly human sense of humour; she loves to see a campaign undertaken wholeheartedly against some anti-social action—and then to produce out of the blue convincing proof that the campaigners are themselves guilty, all unbeknownst, of something just as reprehensible. She must have had a grand laugh over the business of man-made interference with television reception. Champions arose on every side to battle for the right of the owner of a television set to receive the programmes free from interference.

Foreground Noise

Fate must have held her sides when the discovery was made that some television sets can be generators of the most powerful and devastating interference with the reception in nearby homes of the medium-wave radio programmes. I have had some. A near neighbour of mine had a television receiver installed on trial. I didn't know that he had done so, but found that at certain times my radio reception was just about blotted out by what was much more like foreground than background noise. Luckily, he is a good and co-operative neighbour. We arranged some tests, in which the switching-on and switching-off of the television set were reported by telephone. Results? As soon as the television receiver had warmed up, my radio set was pretty well swamped; when it was switched-off reception was normal. That particular receiver went back; my neighbour has now installed one which does not interfere.

American Television

A MONTH OR TWO AGO, when taken to task by a corespondent for having written that the quality of our television was, generally speaking, better than that of the services in the U.S.A., I promised to record the opinions expressed by friends, then in America, when they came back to this country. I've consulted three of them and here is the gist of what they report. (None of them, by the way, is connected with television manufacture or with the B.B.C., so there are no axes to be ground.) First of all, it has to be remembered that America has over 100 transmitters. A few are in the fairly high-powered class; but the vast majority are low-powered—some of them very low indeed. In television reception the signal-to-noise ratio is of vast importance. It will obviously be better if your viewing is done well within the service area of a station of respectable output power than if you have tuned in a small station some distance away. Again, some stations are first-rate engineering productions and beyond reproach as regards maintenance. Others are not so good in either respect. Hence there appears to be a considerable variation from place to place in the quality obtained. Only one of my trio thought that the quality was as good as ours; his viewing was done in New York only. The other two, who had used television receivers in a good many places, felt that, though reception from the best transmitters by means of high-quality sets was nearly up to our own standard, the average images that they saw there were not so good as average images in this country. All were impressed by the number of alternative programmes available in some of the big towns and by the ease with which a change from one station to another could be made.