FEEDER MATCHING

PRACTICAL TELEVISION

AND TELEVISION TIMES

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EDITOR
F. J. CAMM

A NEWNES PUBLICATION

Vol. 6 No. 62 JULY, 1955

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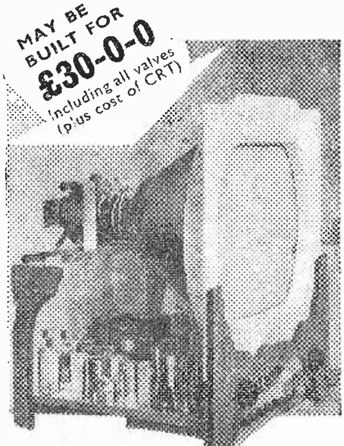

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& TELEVISION TIMES

Editor : F. J. CAMM

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Televiews

"SUNDAY EXPRESS" NONSENSE

IN a leading article in the *Sunday Express* an attack on the Order, which makes the fitting of suppressors to certain electrical apparatus compulsory on September 1st, was headed "Tear it up!" After reading the article the only conclusion one can come to is that the person who wrote it knows little of television and the chronic interference caused by vacuum-cleaners, hair-dryers, electric washing machines, safety razors and similar domestic electrical apparatus. Indeed, it is the article itself which should be torn up. The gravamen of this *Sunday Express* attack is that this electrical apparatus is bought to serve a useful purpose. "How fantastic that owners of such equipment should be compelled to spend money to protect gadgets whose only function is to amuse. How outrageous, too, that in a country where only a minority possess TV sets, the majority should be threatened with a £10 fine if they fail to fit suppressors for the benefit of the lucky few." The article concludes by stating that the Order should be completely scrapped. The writer of this ill-informed leader seems unaware that, apart from interference with television reception, such electrical apparatus seriously interferes with Air, Army, and Navy communications. The number of television receivers in use to-day is not an indication of the viewing public, which is probably at least three times as large as the number of TV licences. In five years it is likely that there will be at least eight million television sets serving a viewing public of at least 24 million people. Such a large viewing public can hardly be regarded as a minority. The State has been wise to introduce the Order now instead of waiting until the whole country is served with television programmes. Interference from power stations, electrically-powered factories and electric railways represents a larger problem which sooner or later will have to be tackled. It would seem from the *Sunday Express* that interference with legitimate amusement should not be anyone's concern.

The article was evidently written without reference to the evidence which resulted in the Order.

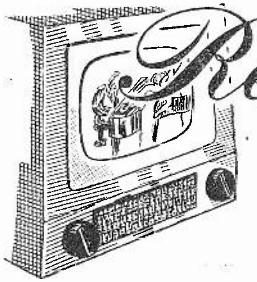
TV AND THE ELECTION

FAR more people watched the TV broadcasts, which, incidentally, were a model of BBC organisation, than listened to them on radio. The results were presented impartially and factually in a form which all could understand. Election night in the streets was comparatively quiet throughout the country, so TV served a useful purpose in stopping the brawling which formerly had taken place between those of rival political beliefs on election night!

COMMERCIAL TV

WITHOUT entering into any political issue, from the point of view of the viewing public it is a good thing that the Socialists lost the election, for they threatened if they were re-elected that they would do away with commercial television. No doubt this policy lost them a lot of votes. There are 4½ million people in this country owning television sets, and most of them eagerly await the day when they will have a programme alternative to that provided by the BBC. Commercial TV has proved highly successful in other parts of the world, including the Commonwealth. We shall run it in this country on lines vastly different from those current in America. The I.T.A. knows that if it does not devise programmes suited to English audiences the latter will switch back to the BBC. The Socialists talked airily, of course, and somewhat vaguely about an alternative programme free from advertising. They did not say that it would be free from political advertising! Certainly an alternative programme provided on their basis would mean an increase in the licence fee. Of course, it is part of that particular party's programme to wish to control everything, and in making this comment we are not attacking Socialism.

However, the election result means that if commercial television is a financial success it will be with us for at least five years. By that time, whichever party wins the next election, they would not dare to risk loss of votes by threatening to abolish it.—F. J. C.



Receiving the I.T.A.

THE FIRST IN A SHORT SERIES ON THE PROBLEMS INVOLVED IN THE RECEPTION OF COMMERCIAL PROGRAMMES ON BAND III

By Gordon J. King, A.M.I.P.R.E.

A SMALL but growing percentage of the total number of television receivers now in use in this country incorporate facilities for easily selecting two or more channels in Band III, together with a switching arrangement enabling a change-over from any one channel in Band I to a channel in Band III to be performed quickly and simply.

In order to enable the owners of the majority of receivers not possessing these features to tune in an I.T.A. broadcast their single-band receivers will need to be fitted with either a Band III adaptor or a Band III converter—we shall see later that there is quite a difference between these two modes of catering for Band III on a Band I receiver.

The Band III transmissions in this country are vertically polarised, as opposed to the horizontally polarised Band III TV transmissions in America ; we are, in fact, the instigators of vertically polarised TV transmissions in Band III. For this reason, therefore, the experience gained in America relating to Band III transmissions, although very helpful, cannot be taken as wholly typical of the conditions in our country.

In this series of articles we aim to embrace most of the practical factors associated with TV reception in Band III ; we shall consider the atmospheric influence, propagation problems, methods by which Band I receivers may be converted and adapted for the reception of the I.T.A. transmissions, and also the commercial aspect of band changing.

What is Band III?

Band III covers a frequency range, within the very high frequency spectrum, from 174 to 216 Mc/s—from 1.7 to 1.4 metres, and is sufficiently wide to cater for eight 5 Mc/s wide channels. A portion of this band is at present occupied by communication and aeronautical radio navigation services, but two 5 Mc/s channels are available for television, these being Channel 8 (186 to 191 Mc/s) and Channel 9 (191 to 196 Mc/s).

Channel 9 is assigned to London and Channel 8 to the Midlands ; when a station is eventually established in South Lancashire this will also operate in Channel 9.

The Range of Band III

Most of us are aware that Band I extends in range from 41 to 69 Mc/s—from 7.3 to 4.4 metres ; Band III thus being approximately four times higher in frequency than Band I. This fourfold increase in frequency imposes a limit on the distance at which consistent Band III reception may be obtained. Generally speaking, the service area where consistently good reception of any very-high-frequency (V.H.F.) transmission can be obtained—and let it be remembered that Band I is also in the V.H.F. spectrum—is almost confined to that area (the service area) where the receiving aerials are in line-of-sight with the transmitting aerial (see Fig. 1).

It is an established fact that even if a line-of-sight path does not exist it is still possible for signal energy to reach the receiving aerial. This is made possible by the earth's atmosphere (troposphere) acting as a form of reflector and refracting some of the signal energy around the curved earth (see Fig. 2). Such is representative of fringe area reception conditions, where, as is well known, the reliability of the communication path is considerably influenced by weather conditions.

As has been intimated, the fringe area becomes more sharply defined as the signal frequency is raised, and whereas reasonably good reception may be obtained from a Band I transmission at, say, 15 to 20 miles outside the line-of-sight distance a similar signal in Band III may be so severely attenuated over the same distance as to give rise to reception wholly unintelligible.

When we are considering line-of-sight distances we are really assuming a hypothetical smooth spherical earth possessing little in the way of earthly features. Nevertheless, such a basis for reasoning is quite permissible if we use it for comparing the signals in both bands and if we consider it only from tropospheric influence aspects.

When earthly features, such as irregularities of the ground, large buildings and towns, are introduced the comparison becomes more involved, and we find that such factors become much more dominant at the higher frequencies, and, as would be expected, have a far greater adverse effect on Band III than on Band I.

The Line-of-sight Factor

In the light of what we have already discussed it would appear that the line-of-sight distance (or even something less than this) will almost certainly correspond to the maximum distance from a transmitter at which reasonably consistent Band III reception will be possible. We will, of course, hear of freak reception in Band III over distances far greater than given by a line-of-sight, but it is extremely unlikely to represent good entertainment value as compared with reception at equal distance in Band I.

The line-of-sight distance between the radiators on a transmitting and receiver aerial is, of course, directly dependent on their height. For instance, the horizon distance from the top of a 100ft. aerial is approximately 12.2 miles. Therefore, the maximum line-of-sight distance—where the line-of-sight path just skims the horizon—between the top of two 100ft. aerials is twice the horizon distance, or 24.4 miles.

It has been shown that the horizon distance in miles is equal to 1.22 times the square root of the height of the aerial in feet. This is quite an interesting relationship which readily enables the maximum extent of the service area about a given transmitting aerial to be roughly estimated by knowing only the height of the transmitting and receiving aerials.

For example, let us suppose that our receiving aerial is situated 30ft. above sea level—giving a horizon distance of approximately 6.6 miles—and that the transmitting aerial (such as Sutton Coldfield) is some 1,300ft. above sea level—giving a horizon distance of approximately 43.4 miles. Now, if we add these two horizon distances together we shall obtain the maximum line-of-sight distance between the two aerials ; in this case approximately 50 miles.

Under ideal conditions such a distance could be considered as the line dividing the service area from the fringe area, but, unfortunately, owing to mineral content of the soil, surface irregularities of the ground, large buildings, towns and such like, the dividing line frequently falls at a distance less removed from the transmitting aerial.

The Tropospheric Factor

It has been mentioned that in fringe areas where a line-of-sight path between receiving and transmitting aerials does not exist the influence of the troposphere tends to bend the V.H.F. waves so that they follow the curvature of the earth.

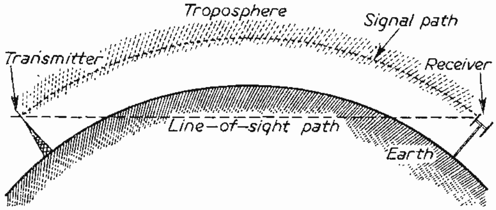


Fig. 2.—Illustrating the fringe area where a line-of-sight path does not exist and the signal is refracted around the curved earth by the influence of the troposphere.

The troposphere is the lowest layer of the earth's atmosphere, and should not be mistaken for the ionosphere, which occurs above the troposphere. It is the result of the variation of atmospheric pressure, temperature and moisture content with elevation above the surface of the earth within the troposphere which causes bending of the V.H.F.waves.

The amount of bending that takes place depends primarily on the weather conditions ; this being well in evidence in fringe areas during an unstable

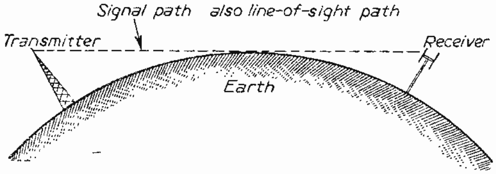


Fig. 1.—Illustrating the service area where the signal follows the line-of-sight path between transmitter and receiver.

spell of cyclonic conditions by very inconsistent reception and severe fading. During a spell of good conditions, however, quite strong signals are frequently received well beyond the line-of-sight distance.

At frequencies which rise towards Band III the refraction effect of the troposphere becomes considerably less efficient, and a larger portion of the Band III signals is lost in space.

Local Field Strength

The field strength at the vicinity of a receiving aerial which is situated within the line-of-sight distance of a transmitting aerial may be approximated by the following expression :

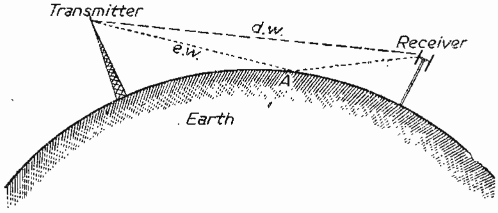


Fig. 3.—Illustrating the direct (dw) and indirect (ew) paths by which energy travels from transmitter to receiver.

$E=0.001\sqrt{W}.ht.hr.f/d^2$ . . . . (1)

where E is the field strength in microvolts per metre, W is the power in a half-wave transmitting aerial, ht is the height of the transmitting aerial in feet, hr is the height of the receiving aerial in feet, f is the frequency in Mc/s, and d is the distance between the two aerials in miles.

The fact that the field strength is inversely proportional to the square of the distance from the transmitting aerial (the inverse square law) is the result of the direct wave from the transmitting aerial being partly cancelled by an indirect earth wave.

The effect is shown at Fig. 3, where it may be seen that the receiving aerial is in receipt of two waves—the direct wave dw and the earth wave ew. Wave ew undergoes a phase shift as the result of reflection at point A, and thus the sum of the field strength at the receiving aerial is something less than would occur solely as the result of wave dw, which, if unhampered, would give rise to a field intensity inversely proportional to the distance from the transmitting aerial.

The expression at (1) clearly illustrates the desirability of employing lofty aerial installations, for leaving the other factors unaltered and simply doubling the height of one of the aerials has the effect of doubling the field strength !

Increasing the power in the transmitting aerial does not have such a marked effect—this would have to be multiplied by a factor of four to double the field strength.

Multiplying the frequency by a factor of four, such as the difference between Band I and Band III, increases the signal strength by the same factor. Unfortunately, this provides no apparent gain on Band III over Band I, because the E.M.F. induced across a correctly terminated half-wave receiving dipole, due to a given field strength, is inversely proportional to the tuned frequency. And this means that as the frequency is increased so the E.M.F. across the receiving aerial is reduced !

From the Aerial Point of View

A Band III aerial is about one quarter the size of a Band I aerial ; it is thus tuned to a frequency which is approximately four times that of Band I, and, as we have seen, has induced into it a correspondingly reduced E.M.F.

Moreover, losses in feeders increase considerably as the working frequency is raised ; with standard coaxial feeders the signal attenuation increases approximately to the square root of the frequency increase. Therefore, feeder which has an attenuation factor of, say, 3 db per 100 ft. at 50 Mc/s (Band I) has an attenuation factor of 6 db per 100 ft. at 200 Mc/s (Band III).

When considered from the length of feeder used on a normal installation this 2 to 1 increase in attenuation at Band III frequencies may not seem all that important. This is reasonably true so far as reception in the service area and open country is concerned, but it must be remembered that initially Band III is going to put many viewers who are in the service area of Band I in the fringe area where minus 1 or 2 db may make the difference between a viewable picture and a totally unviewable one.

It is interesting to note that manufacturers of feeder cables have now introduced a coaxial possessing an attenuation factor, in some cases as low as 2.6 db per 100 ft. at 200 Mc/s, and it is essential that such feeder be used in Band III fringe areas. It is hopeless expecting to raise a severely attenuated Band III feeder signal by adding on pre-amplifiers, for at 200 Mc/s a weak signal is soon lost beneath receiver noise.

Although some early specimens of two band receivers and adaptors are designed for 300 ohm balanced feeder, it is now the order of the day for 75-80 ohm coaxial feeder to be used for both bands. Three hundred ohm balanced feeder has less inherent attenuation at V.H.F. and U.H.F. (ultra high frequencs), but, unfortunately, its attenuation increases rapidly if the cable is routed adjacent to walls, pipes and other conducting and semi-conducting objects.

Three hundred ohm feeder is popular in America, where frequencies up to 884-890 Mc/s (Channel 83 !) are in use, but in order to avoid mismatch effects and considerable feeder losses it is common practice to carry the feeder on stand-off insulators. It is feasible to expect that such procedure will be adopted in this country when Band V becomes operational.

Signal Absorption

Most of us are aware that even at Band I frequencies the local signal strength is considerably affected by changes in ground height, surface irregularities, variations in ground conductivity, towns and large buildings. It would seem that at Band III frequencies these factors have an increased influence. For instance, the reports given by dealers of reception of the Belling and Lee low-power vision tests from the I.T.A.'s Croydon transmitter site indicated that while reasonable pictures were obtained in open country and urban districts difficulty was being experienced in obtaining any workable signal in built-up areas at distances of even 15 miles in some cases.

During these tests it was also noticed that the feeder signal could extensively be altered simply by changing the position of the aerial by a few feet; its orientation was also more critical than at Band I frequencies particularly in areas of "ghosting." Experiments showed, however, that in certain locations where appreciable Band I "ghosting" is experienced the Band III picture was not affected in this way.

Generally speaking, signal reflection and refraction occur more readily at Band III frequencies, and for this reason it is expected that "ghosting" and dead-spot areas will give more trouble on Band III than on Band I.

Weighing up the Factors

We are now in a position to weigh-up the factors governing V.H.F. transmissions in Band III and compare the result with transmission and reception as we know it in Band I.

We have seen that in both bands the limit of the service area is governed mainly by the line-of-sight factor when we consider a smooth spherical earth ; with the same assumption we find that the tropospheric factor is less efficient on Band III than on Band I, and due to this the field strength of a Band III transmitter falls rapidly outside the line-of-sight distance.

We have seen that the local field strength is relatively higher at Band III frequencies than at Band I frequencies, but this is counterbalanced owing to the smaller dimension of a Band III aerial, and that it might be easily overbalanced as the result of extra feeder attenuation at the higher frequency.

Also, and this is a most important factor, we have seen that as the frequency rises so losses due to signal absorption, surface irregularities of the ground, towns and large buildings increase. The higher frequency signal is also more liable to be reflected and in some cases stopped by buildings and hills.

We can conclude, then, that within the line-of-sight distance the signal strength at an aerial point is dependent mainly on the nature of the terrain and on whether the aerial is sited in a built-up area or in open country, and, as a comparison, it is interesting to note that at Band III frequencies the average field strength is some 5½ times (15 db) less in towns than at equal distance in open country. Although similar attenuation occurs at Band I frequencies the magnitude is considerably less.

This means that in a built-up area—within the line-of-sight distance—where an ordinary "H" aerial is being used on Band I it will almost certainly be necessary to use an aerial of more elaborate design (probably one with two or three directors and a reflector) to get a picture on Band III equal to that on Band I, assuming, of course, that the transmitters are co-sited and of equal power.

In fringe areas where three- and four-element arrays are demanded for Band I reception equal Band III reception will call for complex multi-element arrays. This problem is eased somewhat, however, by the relative reduction in element size, and no undue difficulty should be experienced in erecting arrays comprising eight or nine elements. In extreme Band III fringe areas two or more multi-element arrays correctly phased and coupled together will be most desirable.

The height of the aerial will also be of extreme importance, for, as we have seen, raising the height of an aerial puts it into a zone of higher signal strength and might well bring the receiving point within the line-of-sight distance of the transmitting aerial.

(To be continued)

FEEDER MATCHING

IMPROVING RECEPTION UNDER FRINGE CONDITIONS BY CORRECT MATCHING

By E. N. Bradley

IN the majority of television installations the feeder connecting the aerial to the receiver is regarded as being a "flat" or non-resonant line, one which is terminated at each end by an impedance which matches the characteristic impedance of the cable. A non-resonant feeder operates with low power losses since none of the signal is re-radiated from the line, whilst the feeder can be cut to any required length without the need for special matching arrangements or the maintaining of the length to a whole number of quarter wave-lengths. In addition, a perfect match at one end only of the feeder is sufficient to prevent reflections along the line and the setting up of "feeder ghosts."

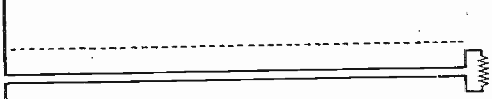


Fig. 1.—Current distribution along a "flat" line.

A "flat" line is so termed because the graph of the current along a non-resonant feeder is a flat or straight line (Fig. 1). If the terminating load is removed from one end of the feeder the current graph along the line is no longer flat but takes the form shown in Fig. 2. At the open end of the line the current must fall to zero, there being no conducting path, so that the voltage at the same point rises to a maximum. A set of magnetic fields is set up round the feeder in such a way that opposing currents and voltages are generated, these travelling back along the line to the aerial. These new signals act, therefore, as though they were "reflected" from the open end of the feeder, and are out of phase with the original signals. The reflections, on arrival at the aerial, are not absorbed by the load there, but are reflected again back towards the open end of the feeder, and these reflected signals continue moving to and fro until the various losses to which they are subjected absorb them completely. Since fresh signals are constantly being provided into the line from the aerial, giving rise to fresh reflections along the line, a "standing wave" is set up along the feeder.

If, instead of an open circuit at the end of the feeder, the line is terminated by an incorrect impedance, standing waves will still be set up. The accuracy of the matching can be measured as a "standing wave ratio" or S.W.R. This is the ratio of the maximum

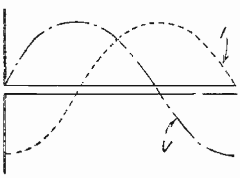


Fig. 2.—Current and voltage distribution along an unterminated line.

to minimum voltages or currents along the line and in a truly non-resonant feeder the S.W.R. must obviously be 1, the current being identical at all points along the cable. In open feeder lines such as those used in amateur transmitting techniques the measurement of the S.W.R. is a relatively simple matter, but it is practically impossible to measure the S.W.R. along a television coaxial feeder in an ordinary installation. Even if a quite serious mismatch has occurred there is little to show for it—a slightly less brilliant picture than was expected, perhaps, but no apparent ghosts due to reflections. In a fringe area the picture may be unexpectedly weak, but, on the other hand, conditions vary considerably in such reception positions so that even then there is no certain indication of a mismatch given by the picture.

Feeder and Ordinary Ghosts

It is sometimes forgotten that a "feeder ghost" will not show in the same manner as does the ordinary ghost due to split path reception. A ghost due to a reflection along the feeder is almost coincident with the original signal itself, due to the very short period of time taken by the reflection to return to the aerial and thence travel back to the set. In a 30-yards feeder run the reflection will appear at the receiver in approximately 0.15 microseconds, the ghost image on

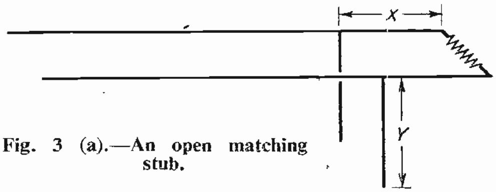


Fig. 3 (a).—An open matching stub.

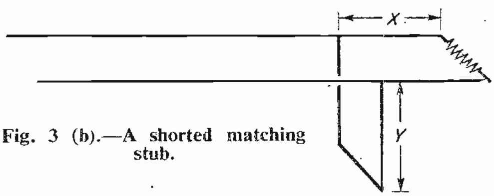


Fig. 3 (b).—A shorted matching stub.

a 14in. screen thus being shifted only about 0.04in. to the right of the true picture. Such a displacement would not make the ghost visible as a ghost, but it might well cause a loss of definition in the main image. A receiver in a good signal area which is apparently incapable of giving really first-class definition despite the most careful tuning may be operating under these conditions, and an investigation of the feeder matching may show that an improvement is possible.

In fringe areas the effect of a mismatch is more severe. Here the receiver is never able to give the best definition of which it is theoretically capable, since it must be run with full or almost full sensitivity and contrast. As these controls are advanced the linearity of the receiver's response curve is reduced, the lower frequencies being favoured, whilst "snow" due to amplified valve and circuit noise further breaks up the picture. A mismatch between the feeder and the receiver reduces the signal supplied

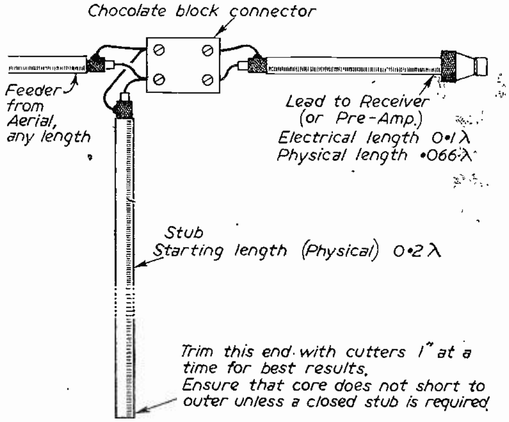


Fig. 5.—**A simple matching stub arrangement.**

to the set so that the contrast control must be even further advanced, whilst any "feeder ghost" which may be present will cause a still greater loss of definition. In any fringe area installation, therefore, a check should be made on the matching of the feeder to the receiver. It would also be an advantage to check, and correct if necessary, the matching of the feeder to the aerial, but as a general rule this must be left to the aerial manufacturers.

When a feeder is terminated in the correct impedance the load, to the feeder, "looks like" a pure resistance. If the terminating impedance is of an incorrect value the load, to the feeder, "looks like" resistance with reactance in series or parallel with it. If the terminating impedance (in this case the receiver's aerial input circuit) presents a smaller impedance than that required the reactance will be inductive, whilst if the terminating impedance is greater than that required the reactance will be capacitive. In either case the reactance can be "tuned out" by connecting across the feeder, at less than a quarter wavelength from the receiver, a reactance of equal value but opposite kind, these added reactances being most conveniently formed of "matching stubs."

Matching Stubs

Matching stubs are shown diagrammatically in Fig. 3. At *a* is shown an open stub, providing a capacitive reactance across the line, whilst at *b* a closed or shorted stub presents an inductive reactance.

The manner in which a stub or an incorrectly terminated feeder can behave as a capacitive or inductive reactance can be understood if the distribution of current and voltage along the stub or feeder is considered. In Fig. 4 a short-circuited and an open stub are shown. In the first case the current rises to a maximum across the closed end of the stub, the voltage therefore falling to a minimum at that point. The curves of current and voltage, drawn above the stub, show therefore that the voltage is leading the current by 90 deg. This, however, is also the effect of a pure inductance, where voltage again leads current by 90 deg. so that the closed stub can be regarded as having inductive reactance.

In the same way a feeder terminated by too low a load impedance is "tending towards being short-circuited." The reactive component of the load impedance will therefore also be inductive.

In the case of the open stub the current down the stub must fall to zero at the open end where there is no circuit. At the same point the voltage must rise to a maximum, the current thus leading the voltage by 90 deg. This, of course, is the effect of a pure capacitance, in which current also leads the voltage so that the open stub can be regarded as having capacitive reactance.

A feeder terminated by too high a load impedance is "tending towards being open-circuited." The reactive component of the load impedance will therefore also be capacitive.

If a suitable stub, either open or closed, is connected across a mismatched feeder at the correct point X from the load, the stub having the correct electrical length Y, it will reduce to unity the standing wave ratio between the point of connection and the aerial.

It is, unfortunately, necessary to know the standing wave ratio on the line in order to calculate X and Y accurately, besides which it is essential to recognise whether an inductive or capacitive reactance is required. In the ordinary installation neither fact can be ascertained easily so that recourse must be had to methods of cut-and-try.

Unless a serious error has occurred in the matching either at the aerial or the receiver, the S.W.R. along a television feeder should not be high—a S.W.R. of 2 would indicate quite large discrepancies. A compromise value for X at low values of S.W.R. is

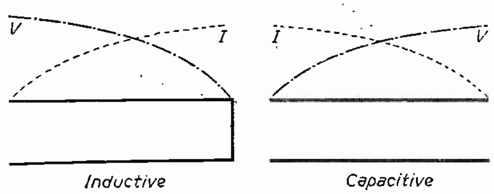


Fig. 4.—**Current and voltage relationships in closed and open stubs.**

0.1 wavelength, so that the stub should be connected to the feeder at one-tenth of a wavelength from the receiver input socket. It must be remembered that the velocity of propagation of the wave is reduced in a feeder line by a factor of about 0.66 for coaxial cable. When measuring off 0.1 wavelength along a feeder, therefore, the required fraction of a wavelength must be multiplied by 0.66 so that the final measurement is 0.066 wavelength.

As a general rule it will be found that an open stub is required and a compromise starting length Y is also 0.1 wavelength. For convenience it is as well to use a longer stub than this—say 0.2 wavelength—cutting back this length an inch or so at a time whilst watching the picture on the screen, and trimming the stub for best results.

A satisfactory arrangement for the simple connection of a stub to the feeder line is shown in Fig. 5. The aerial feeder is brought in to a "chocolate block" connector, into which the ends of the stub length of coaxial cable are also brought, inner to inner and sheathing to sheathing. From the other side of the block an 0.066 wavelength line is taken to the receiver (or preamplifier, if used).

Effect of Stubs

The first effect of connecting in the stub may well be to darken the picture on the screen. As the end is trimmed, an inch at a time, the picture should rapidly improve, if any mismatch was present on the original feeder line, and a stronger picture than before be obtained. If the improvement in the picture strength and quality is slow when the stub has been cut back to about 0.1 wavelength long (i.e. to a physical length of about 0.066 wavelength) try the effect of trimming back a half-inch or so of the stub sheath, thus exposing the inner conductor, and shorting this down to the outer. A jump in picture brilliance indicates that a shorted rather than an open stub is required.

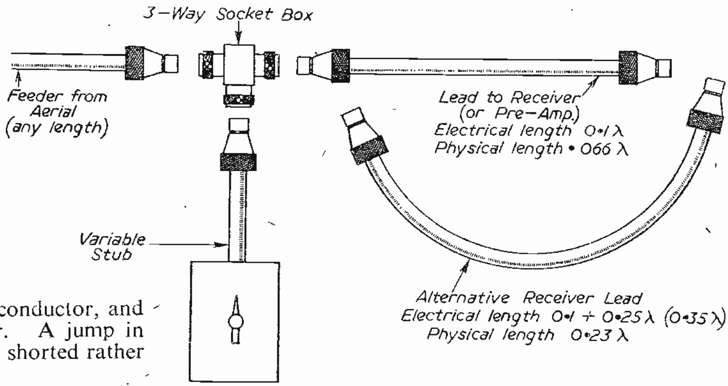


Fig. 7.—Coupling in the variable stub.

If neither the open nor the shorted stub, with still more trimming, gives an improvement on the original results it can be taken that the line was non-resonant and that the system was already satisfactorily matched.

Where the stub is found to give an improvement the trimming should continue, very small lengths being cut off, until no improvement on the screen can be observed from one cut to another. The trimming is then complete and the stub can be tapped along the main feeder, or along the short lead to the receiver. As the stub is bent along the feeder or lead an eye should be kept on the picture to ensure that no ill effects are introduced by bringing the stub and feeder into close proximity.

This is as far as the home experimenter, whose only concern is his own installation, will wish to go. The engineer, however, especially in fringe areas, may care to make an adjustable stub for plugging into any feeder run as it is made, and which can eventually be calibrated to show the type and length of stub to be fitted to any system to cure slight mismatching.

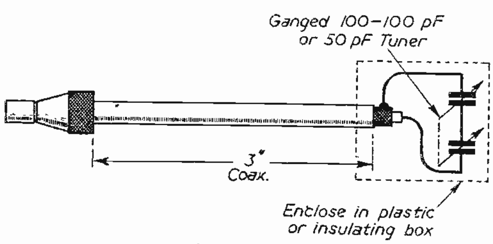


Fig. 6.—A variable capacity stub.

An inductive or capacitive stub can be replaced by a suitable inductance or capacitance connected directly across the line. A variable inductance of suitable range could be used in place of the closed stub, but a variable capacitive stub can, in fact, take the place of either an open or closed stub by correctly positioning it along the line. If an inductive stub is required at, say, 0.1 wavelength from the terminating load, the same effect can be obtained by placing a capacitive stub ¼ wavelength further up the feeder.

A variable capacitive stub can be made along the lines shown in Fig. 6. A capacitance of 50 pF is adequate for S.W.R.s up to two; a single 50pF component may be used or the value may be obtained by employing a split-stator or ganged 100-100 pF tuner. The capacitor may be enclosed in an insulating box and fitted with a pointer knob and scale.

Calibration

The stub can be calibrated, over a length of time, by comparing the settings of the control with the lengths of stubs cut by trial and error to give the same improvement in matching in a number of installations. The calibrations will, of course, be in inches of stub.

The aerial feeder, variable stub, and two receiver connectors, one of 0.1 and one of 0.35 wavelength, should be terminated in coaxial plugs and connected together in a three-way coaxial socket box as shown in Fig. 7.

Commence tests with the variable stub using the 0.1 wavelength receiver connector, and swing the tuner to give the best picture on the screen. With this point set, unplug the variable stub. The effect of the stub on the picture will be seen immediately—either the picture will improve, showing that the stub was not suitable or not required, or it will deteriorate, showing that the stub is of assistance. If the picture improves when the stub is removed, test the stub in the second line position by removing the 0.1 wavelength receiver connector and plugging in the 0.35 wavelength connector.

Again plug in the stub, swing the tuner for best results, then unplug the stub. If the picture again improves with the stub out of circuit, no stub is necessary or desirable. The three-way box and short receiver connector can be removed and the feeder plugged straight into the receiver.

TABLE 1.

Channel	Wavelength (Mid-channel figures)	Electrical 0.066λ (Receiver connectors)	Electrical 0.23λ (Receiver connectors)	Physical 0.2λ (Stub-starting Length)
Channel 1	6.94 metres	18in.	63in.	55in.
Channel 2	6 metres	15½in.	54½in.	47in.
Channel 3	5.45 metres	14¼in.	49½in.	43in.
Channel 4	5 metres	13in.	45¼in.	39in.
Channel 5	4.62 metres	12in.	42in.	36in.

Modifying the Type 223A Receiver

MAKING A TV CONVERTER FROM AN EX-GOVERNMENT UNIT

By F. J. Shipgood, A.M.I.P.R.E.

THE Air Ministry amplifier type 223A is a two-stage V.H.F. amplifier. The circuit is shown in Fig. 1. The layout above the chassis is shown in Fig. 3 and the underside with the three screening cans removed is shown in Fig. 4. To modify this amplifier to operate as a TV converter of the type shown in Fig. 2 is quite a simple matter and requires only a few additional components. In this converter the first valve performs its original function as a R.F. amplifier. This is followed by a tuned-grid, tuned-screen frequency changer the anode of which is resistance-capacity coupled to a circuit that is tuned to an intermediate frequency of the order of 12 Mc/s. Hence any existing receiver or I.F. strip designed to operate on this frequency will be capable of receiving the TV sound.

Figs. 3 and 4 (right) show the completed converter.

To modify the original amplifier proceed as follows: remove all components marked "X" in Figs. 3 (a) and 4 (a). This includes L1, which is a potted coil and is ideal for use as the oscillator coil. It is fitted in No. 3 compartment as shown in Fig. 4 (b). Coil L2 is removed and is connected in place of L1 to form the aerial coil LA. Rewind the coils as per Fig. 5. Connect LA primary between the input terminal and earth tag 15 and the secondary between V1 grid (pin 7) and tag 15. This completes the modification in compartment No. 1.

The coil LG has one winding only and is connected between tag 11 and tag 13 (coil LF does not require rewinding, neither does LO if it used on channel 5).

In compartment No. 2 check: that R7 is connected between V1 anode (pin 3) and tag 14; that C7 is between tag 14 and earth; that R6 is between tag 14 and through the chassis to the junction of R5 and C6, and that C3 is between V1 screen (pin 2) and earth. Connect: R3 between pin 2 of V1 and through the chassis to the junction of R2 and C2; C8 between V1 anode (pin 3) and tag 12; C9 between tag 12 and V2 grid (pin 7); R10 between pin 7 and earth; and finally check that V2 cathode (pin 6) is earthed.

In compartment No. 3 check: that C15 is connected between tag 9 and tag 10, and that R12 is between tag 9 and through the chassis to the junction of R11 and C14. Connect: one end of C16 to pin 3 of V2 and leave other end free; one end of LO and one end of C12 to the screen of V2 (pin 2); one end of C11 to earth. Connect the free ends of C11, C12 and LO together and to about 1½in. of wire and pass this through the chassis. Check that the secondary of LF is connected between tag 10 and the output socket. The primary of LF and one end of C17 are connected to pin 1 of V2, which is earthed; the other ends of LF primary and C17 are connected together and to the other end of C16. This completes the wiring in compartment No. 3.

Above the chassis check: that C5 and C13 are in position across the heater supply to V1 and V2 respectively; that C6 is connected between chassis and the junction of R6 and R5, the other end of the latter being connected to tag 4; that one end of C10 is earthed and that one end of R8 is connected to

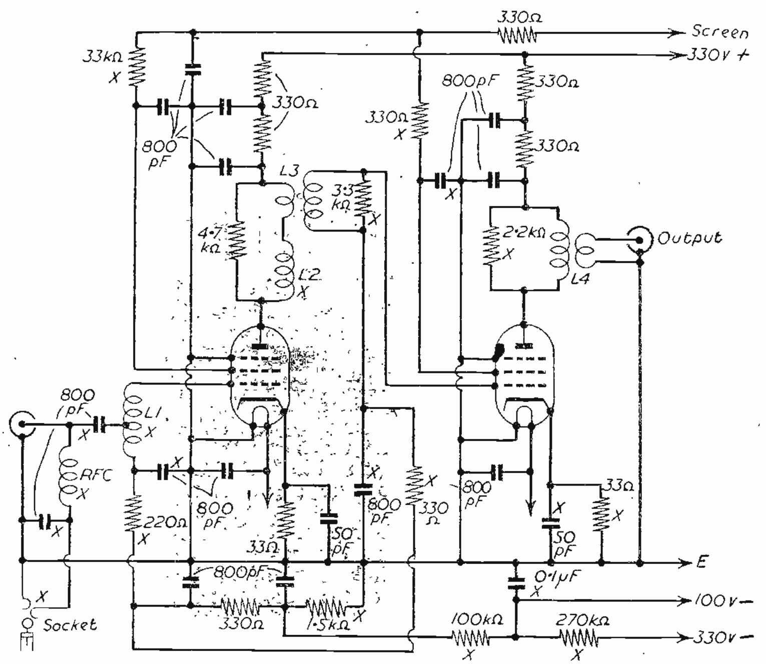


Fig. 1. — Circuit before modification.

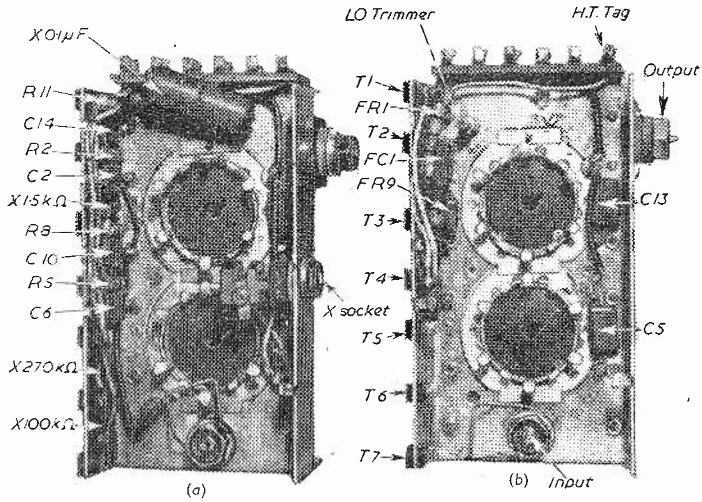


Fig. 3.—Details of the upper chassis. (Left, before modification; Right, after.)

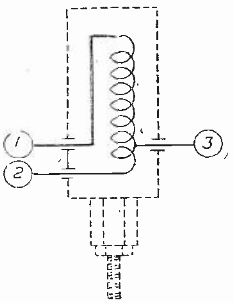


Fig. 5.—Coil Data. Coil LO: Insulate (3); use whole of coil, i.e., connections are (2) and (1).

COIL DATA

Channel	Coil LA		Coil LG	Coil LO	C12
	Primary	Secondary			
5	1	$4\frac{1}{2}$	$4\frac{1}{2}$	10	10 pF
4	1	5	5	11	12 pF
3	1	$5\frac{3}{4}$	$5\frac{3}{4}$	$12\frac{1}{2}$	14 pF
2	$1\frac{1}{2}$	$6\frac{3}{4}$	$6\frac{3}{4}$	14	18 pF
1	$1\frac{1}{2}$	8	8	16	24 pF

* With C12 fixed at 10 pF figures are given for the number of turns on LO.

Alternatively: To avoid rewinding LO, valves are given for C12 for the different channels. A 5-25 pF trimmer would cover all channels.

tag 3 Connect one end of R9 to the junction of R8 and C10 and the other end to the insulated wire coming through the chassis from the junction of C11, C12 and LO.

Check: that one end of C2 is connected to chassis and the other end to the junction of R2 and R3, the latter being in compartment No. 2; that one end of R2 is connected to tag 2; that C14 is between chassis and the junction of R11 and R12, and that the other end of R11 is connected to tag 1. Connect R1 between tag 1 and tag 2 and C1 between tag 2 and chassis With connecting wire join tags 3 and 4, tags 1 and 3 and tag 1 and the 330 v. + tag.

Check that all wires passing through the chassis are adequately insulated. This completes the modification.

Alignment

To align the converter short-circuit coil LO, inject into the input a signal from a test oscillator tuned to the TV sound, connect a valve voltmeter to the output and tune LA and LG for maximum output. Remove the short-circuit on LO and tune this coil for maximum output (tune also C12 if this is variable). If this test equipment is not available connect a 0.1 μF condenser, a crystal diode and a pair of high impedance headphones in series and connect these between V2 anode (pin 3) and chassis. Connect an aerial tuned to the TV sound to the input and adjust LA and LG for maximum sound, then adjust LO with the short circuit removed.

Note that the tuning slugs in the coils are sealed. Remove the sealing compound very carefully and do not attempt tuning until the slugs are free, since the slugs are very brittle and are liable to break up inside the coils. If this occurs the coils should be removed, $\frac{3}{8}$in. Aladdin formers fitted and the

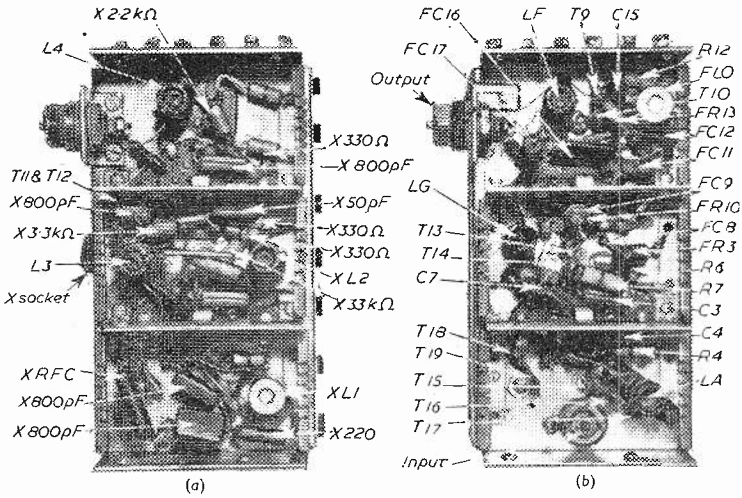


Fig. 4.—Details of the lower chassis. (Left, before modification; Right, after.)

coils rewound. The advantage of using Aladdin formers is that since the spacing of the turns of the coils can be varied a greater degree of tuning is obtained. Fig. 4 (b) shows Aladdin formers fitted in compartments No. 1 and No. 2. In this case giving interference from short-wave transmitters, retune the receiver for a quiet spot and retune coils LF and LO. When the TV sound is being received retune all the coils and the receiver for maximum output. When an I.F. strip is being utilised coils

LIST OF COMPONENTS

R1, 2, 5, 6, 8, 11, 12—330 Ω
R3—1.5 kΩ
R4—33 Ω
R7—4.7 kΩ
R9, 10—22 kΩ
R13—10 kΩ
C1, 2, 3, 5, 6, 7, 10, 11, 13, 14, 15—800 pF
C4, 9—50 pF
C8—100 pF
C12—10 pF
C16—300 pF
C17—250 pF
V1, V2—EF50

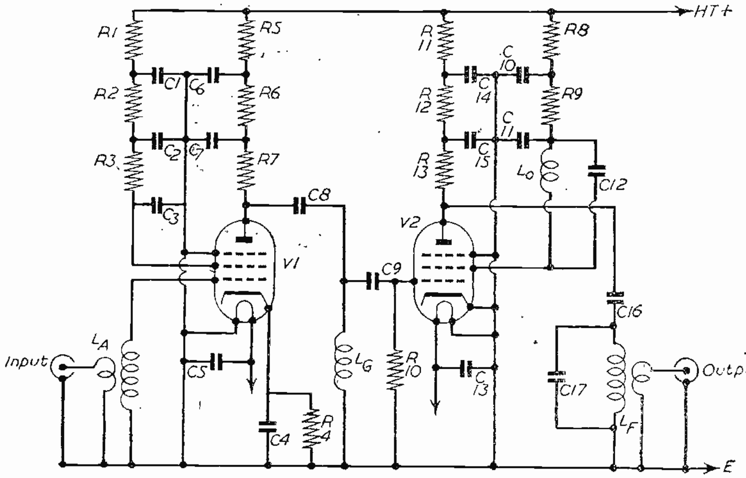


Fig. 2.—Circuit after modification.

the screen cans have been redrilled to provide access for tuning the coils, since they are in a slightly different position to the original ones.

Having tuned the converter, connect it to the receiver and tune the receiver on the short-wave band to the converter's intermediate frequency. If it is found that this frequency lies on a part of the band LO and LF must be adjusted until the converter's intermediate frequency is the same as that of the strip.

The leads coupling the converter to the receiver or I.F. strip must be as short as possible to minimise possibility of interference from short-wave transmitters.

North Regional Mobile Control Room

THE BBC's North Region has recently taken delivery, for its own exclusive use, of the latest Mobile Control Room for Television Outside Broadcasts. This vehicle, known as M.C.R.13, is mounted on a Bedford petrol-driven seven-ton chassis. It is the first mobile control room of post-war design to be mounted on a self-propelled chassis. By using this chassis it was found possible to reduce the overall length of the vehicle.

The bodywork of M.C.R.13 is of conventional double-skinned construction, having a hardwood frame covered with aluminium panels on the exterior surfaces. It is thermally insulated so as to maintain a comfortable working temperature inside the vehicle in spite of extremes outside. The internal panelling is of Formica, which provides a smooth, easily-cleaned surface and is of pleasing appearance. By making use of all the available space, including that over the cab roof, the overall length of the vehicle has been kept down to 24ft. It has an overall width of 7ft. 6in. The cab, which is also used when on location as an office, cloakroom and miscellaneous store, is fitted with windscreen washers, heater and fully adjustable driving seat.

The internal walls of the vehicle are cream; the upholstery, which is of leather for durability, is crimson, whilst the floor is covered with grey battleship grade linoleum. Table tops are of cigarette-proof Formica and all exposed metal work has a mid-grey rivel finish to match the technical equipment.

Technical Equipment

Three Marconi Mark III cameras and camera control units are associated with M.C.R.13 and the cameras are designed to use 4½in. image orthicon tubes which are expected to produce a noticeable improvement in picture quality. Until these become available, 3in. tubes are being employed. Considerable thought has been given to the mechanical design of these cameras; the sub-units can all be removed for maintenance, as can the components of the lens turret assemblies.

The lens turrets will accommodate lenses with focal lengths up to 40in., and in addition lenses of 2in. and 40in. focal length can be mounted simultaneously. This represents a considerable advance in design; with turrets previously available it has not been possible to mount a lens of greater focal length than 25in. simultaneously with one of 2in.

A pedestal waveform of variable amplitude can be inserted at the camera control unit; the waveform generators are an improved version of those in current use in other BBC outside broadcast vehicles.

The vision mixer will accept eight inputs, of which up to four may be either asynchronous or synchronous at will. Cutting, fading or mixing between any two cameras may be achieved, D.C. control of fading and mixing operations being employed. Signal processing is accomplished in a separate line clamp amplifier unit. Special emergency switching circuits are provided which allow for switching of pictures direct to line if the mixer or line clamp amplifier fails during transmission.

The Long-tailed Pair Circuit

ITS DESIGN AND APPLICATIONS

By Hugh Guy

Introduction

THIS curiously-named circuit is really an extension of the cathode follower, an account of which appeared in the March issue of PRACTICAL TELEVISION. It appears in a variety of forms and under several different names and is perhaps more accurately, though less picturesquely, described as a cathode-coupled amplifier.

The experimenter probably knows it best as a phase inverter used in, say, an audio amplifier to drive a push-pull output stage and the design procedure given below may well be adapted to fill this application, but it is also widely used in video and pulse work in amplifiers, switching and clipping circuits, comparators and in modified form in the "flip-flop" multivibrator.

Since the circuit is therefore a fundamental in the design of waveform generators and pulse equipment generally, it is described below and the associated design formulæ obtained and their application illustrated.

The Circuit

The basic circuit is shown in Fig. 1 where we see that two valves are used. Each has its own anode load, but both share a common cathode load. Furthermore, in this simple form, the grid of V2 is earthed to any A.C. signal. It would appear at first glance, therefore, that there is no coupling between the two valves whereby signal at V1 grid may appear at V2 anode.

However, as the cathode circuit is not decoupled, the signal at V1 grid appears across the common cathode load and is thereby introduced to the grid circuit of V2, for although V2 grid is earthed its cathode potential must vary and hence the relative grid to cathode potential must also vary. The anode current in V2 will change accordingly and an amplified signal will appear at V2 anode.

What about the relative phases of the signal?

Let us assume that we are applying a positive-going signal to the grid of V1 in the circuit of Fig. 1. The signal at the common cathodes will also be positive-going due to the cathode follower action of the circuit. With V2 grid earthed, however, the grid-cathode variation of V2 will be negative-going. A simple example may help to clarify this point: Imagine that the cathodes remove from +3 volts to +6 volts, V2 grid being earthed. Then, viewed from V2 grid, the grid-cathode change is from −3 volts to −6 volts, and the change is thus negative-going.

This negative-going excursion of V2 grid will produce a positive-going signal at the anode and the overall effect, therefore, is for V2 anode to follow the input to V1 grid, whilst this positive-going input to V1 produces a negative-going excursion at V1 anode. Thus we see that at the two anodes the signals are 180 degrees out of phase. This property of the long-tailed pair is utilised when the circuit is used as a phase inverter to drive push-pull output stages.

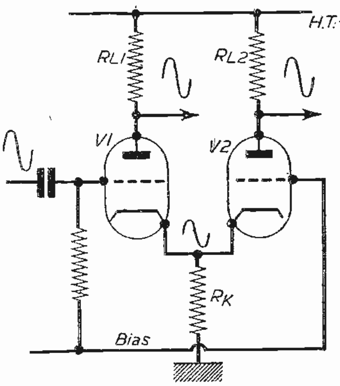
Perhaps the explanation appears rather complex but the process can be followed easily by reference to the circuit and a general rule to observe is that the signal at either anode follows that at the opposite grid. From this rule it is possible to visualise what will happen when we apply different signals to both grids simultaneously; the signals at both anodes will each consist of a composite signal comprising both the input signals, each anode signal being of opposite phase. Thus, if the output is taken from one rather than both anodes, we have a mixer or sampler valve. The anode we are not using in this case does not need a load resistance, and we can therefore return the anode directly to the H.T. line.

Having considered the function of the circuit, we can now consider its application to pulse and video techniques, after first establishing our design formulæ.

Equivalent Circuit

Of the several different approaches to the analysis of this circuit, probably the simplest is to examine it in terms of the common cathode coupling, making use of the properties of the cathode follower.

Fig. 2 shows how this is best achieved. In this circuit V1 is a cathode follower with an anode load



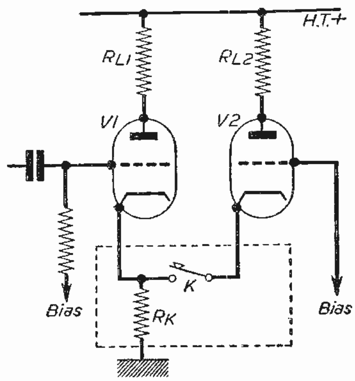


Fig. 1 (left).—Basic long-tailed pair circuit. Fig. 2 (right).—Development of the circuit.

R_{L1} and cathode load Rk. If the switch K is closed, then the grid circuit of V2 is connected in parallel with Rk and the cathodes of the two valves are joined. The circuit then becomes two valves coupled by a unit (shown inside the dotted outline), which attenuates the signal to a certain extent. If we examine the contents of this unit, we can see how much this attenuation is in terms of the valve constants and the values of the components in the circuit.

In Fig. 3, therefore, we see the development of the " contents " of the dotted outline. Diagram (a) shows the simplest equivalent circuit. The generator E represents the signal that is applied to V1 grid. The signal current flowing from this source must flow through the internal impedance of V1, represented by Z1 and then into the load Zk, across which appears the signal applied to the grid-cathode circuit of V2. This signal is given by

$$Ek = \frac{Zk}{Z1+Zk} \cdot E$$

Zk must consist of the parallel combination of the cathode resistor Rk and the input impedance to the cathode of V2. Also the internal impedance Z1 of V1 is really the output impedance of a cathode follower whose load is Zk. Now the cathode circuit impedance of a valve is approximately $\frac{1}{Gm}$ where Gm is the mutual conductance or slope of the valve. Thus Z1 may be written as $\frac{1}{Gm_1}$ and Zk becomes the parallel combination of Rk and $\frac{1}{Gm_2}$. The equivalent circuit then becomes that of Fig. 3b and the reader may easily verify that the signal appearing across the cathode load is given by

$$Ek = \frac{Gm_1 \; Rk}{1+(Gm_1+Gm_2)\; Rk} \cdot E$$

From this expression it can be seen that, if the slopes of the two valves are the same, and Rk is large, then the cathode signal is approximately half the input signal. This is an important point to remember, as it figures prominently in subsequent design procedure. Taking this a step further it is obvious that if half the input signal appears across the cathode load then only half the input signal appears between the grid and cathode of V1 to appear amplified at the anode.

This gives us another important result; the gain of one stage of a long-tailed pair is approximately half the gain that the same stage would have were it a straightforward amplifier with the same circuit values.

Step by step analysis of clipper operation.

Vg_2	Ik	Vk	Ia_2	Vak_2	Ia_1	Vg_1	Vin	Vin A.C.	Vout A.C.
−8	5.55	122	0	178	5.55	−4	118	+4.75	+42
−6	5.45	120	0.6	164	4.85	−4.2	115.8	+1.55	+28
−4	5.36	118	1.7	136	3.66	−4.75	113.25	0	0
−2	5.28	116	3.3	95	1.98	−5.6	110.4	−2.85	−43
0	5.2	114	5.2	46	0	−9	105	−8.25	−90

This simplification is perfectly justified if pentodes are being used in the long-tailed pair, provided that the value of Rk is large. It is this proviso which gives the circuit its name. The common cathode resistor may be likened to a tail—the drawing of the circuit presumably gave rise to this simile originally—and since it must be large or long, resistively, to fulfil this function, the name, long-tailed pair, is very apt. Other views favour the idea that the effective doubling of the grid base of the valves is what is really implied by the term " long-tail."

Whatever the origin, however, the important feature of the circuit is represented by this share of the input signal, half of which appears between the grid and cathode of the first stage and the other half of which appears across the cathode load and consequently between cathode and grid of the second valve. If each valve has the same value of anode load, then the signals at each anode will be of equal amplitude but of opposite phase.

This, then, is the phase inverter of audio amplifier fame, and if we could choose valves with a high μ and high Ra, then the formula of the circuit of Fig. 3b would suffice for all our design work. Unfortunately, it is only pentodes which possess these desirable characteristics, and to bring the triode into the picture necessitates a more rigorous approach.

Up to the present we have assumed that the equivalent circuit of a cathode follower may be represented by a signal source or generator of the same E.M.F. as that which we are applying to the grid of the cathode follower in question, and further that the output impedance is $\frac{1}{Gm}$. For most cases this is true enough, but for an accurate assessment of this particular circuit we must have the whole truth.

The circuit of Fig. 3c puts things in their right perspective. Here the signal source is shown to be E where

$$E = \frac{\mu_1}{\mu_1+1} \cdot Ein.$$

Ein is the signal we are applying between grid and earth of the first stage and μ_1 denotes the amplification factor of the first stage.

Further, the output impedance is no longer simply $\frac{1}{Gm}$, but is really $\frac{Ra_1+R_{L1}}{\mu_1+1}$ where Ra and R_L are the anode impedance and load respectively, the suffix denoting the first stage.

By the same argument the input impedance to the second stage will be $\frac{Ra_2+R_{L2}}{\mu_2+1}$ and will appear in parallel with Rk.

This gives a value for Ek, the signal appearing across the cathode load, which is shown by equation (1) at foot of page 63.

This may look a formidable result, but a little careful algebra will easily produce this answer from the circuit of Fig. 3c. Again, if μ and Rk are both large, this reduces to $Ek = \frac{Ein}{2}$ approximately, illustrating the validity of this result.

By adopting the equivalent circuit of the cathode follower for our analysis, the same reasoning that makes the generator E.M.F. not Ein, but $\frac{\mu_1}{\mu_1+1}$. Ein prevails when we consider the effect that the voltage Ek has on the second stage. This tells us that Ek is not the input voltage to the second stage, but that Ek is given by $Ek = \frac{\mu_2}{\mu_2+1} \cdot Eg_2$ where Eg_2 is the true grid-cathode variation of the second stage. Substituting Ek by its lengthy value given above, we can determine what Eg_2 is. (See equation (2) below.)

Now the gain of a triode stage is well known to be

$$G = \frac{Eo}{Eg} = \frac{\mu R_L}{Ra + R_L}$$

where Eo is the signal at the anode and Eg the input at the grid.

From which $Eo = \frac{\mu R_L}{Ra + R_L} \cdot Eg$

Thus in the case of V2

$$Eo = \frac{\mu_2 R_{L2}}{(Ra_2 + R_{L2})} \cdot Eg_2$$

and this gives the result shown by equation (3) below.

The gain of the long-tailed pair, from one grid to the opposite anode, is thus given by equation (4) below.

This is a lengthy expression as it stands and it is more conveniently dealt with as follows:

Let the gain of the basic cathode follower be G_1

Then $G_1 = \frac{\mu_1 Rk}{(\mu_1+1)Rk + Ra_1 + R_{L1}}$

Also let G_2 be the modified gain of V2 as a triode stage

$$G_2 = \frac{(\mu_2+1)R_{L2}}{Ra_2 + R_{L2}}$$

Finally, let m be a factor given by

$$m = \left(\frac{Ra_1 + R_{L1}}{Ra_2 + R_{L2}}\right) \cdot \frac{\mu_2 + 1}{\mu_1}$$

This now gives us three symbols which are more readily understood and remembered and, using these, the gain can be rewritten

$$G = \frac{G_1 \cdot G_2}{1 + mG_1}$$

In 90 per cent. of the practical cases encountered the values of R_{L1} and R_{L2} will be the same and so will be the two μ valves, or at least near enough to justify putting m equal to 1.

Again, if the value of Rk is large enough, the gain of the cathode follower approaches 1, and the overall gain of the long-tailed pair is then $\frac{G_2}{2}$.

Thus although the algebra associated with the equivalent circuit of Fig. 3c would appear to make the process of analysis rather complex, it yields a very useful result.

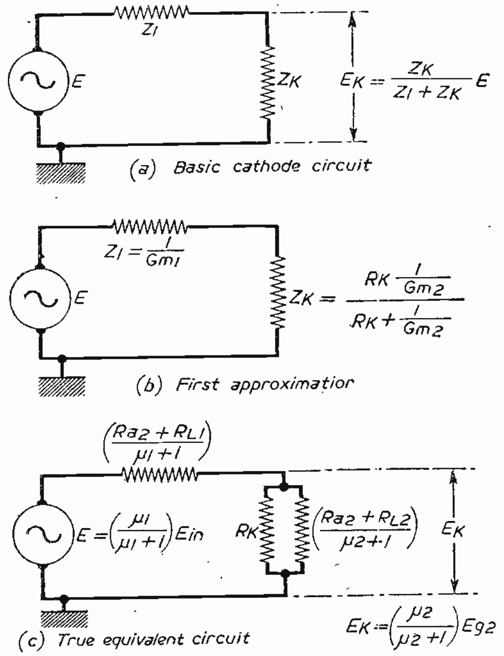


Fig. 3.—Development of the equivalent circuit of the long-tailed pair.

Paraphase Amplifier

We will consider the simplest application of the long-tailed pair first and show how a paraphase stage is designed.

The important factor to bear in mind the whole time is that provided the cathode resistor is large, then the input signal is divided into two nearly equal parts; half appears between grid and cathode of the first valve and the remaining half across the cathode load and, therefore, between grid and cathode of the second valve. To obtain equal amplitude signals of opposite polarity at the two anodes it merely remains to connect equal values of load in the anodes. The question is, how large is a large cathode resistor?

Let us illustrate the process by a simple, practical example. Imagine that we are designing a paraphase amplifier to feed, say, the Y-plates of a small cathode-ray tube. By using a paraphase amplifier the usual trapezium distortion associated with single-ended

$$\text{Equation (1)} = Ek = \frac{\mu_1(Ra_2 + R_{L2})Rk \ . \ Ein.}{[(\mu_1+1)(Ra_2+R_{L2}) + (\mu_2+1)(Ra_1+R_{L1})]Rk + (Ra_1+R_{L1})(Ra_2+R_{L2})}$$

$$\text{Equation (2)} = Eg_2 = \frac{(\mu_2+1)}{\mu 2} \cdot \frac{\mu_1(Ra_2 + R_{L2})Rk \ . \ Ein.}{[(\mu_2+1)(Ra_1+R_{L1}) + (\mu_1+1)(Ra_2+R_{L2})]Rk + (Ra_1+R_{L1})(Ra_2+R_{L2})}$$

$$\text{Equation (3)} = Eo = \frac{\mu_1 Rk(\mu_2+1)R_{L2} \ . \ Ein.}{[(\mu_2+1)(Ra_1+R_{L1}) + (\mu_1+1)(Ra_2+R_{L2})Rk + (Ra_1+R_{L1})(Ra_2+R_{L2})]}$$

$$\text{Equation (4)} = G = \frac{Eo}{Ein} = \frac{\mu_1 Rk(\mu_2+1)R_{L2}}{[(\mu_2+1)(Ra_1+R_{L1}) + (\mu_1+1)(Ra_2+R_{L2})]Rk + (Ra_1+R_{L1})(Ra_2+R_{L2})}$$

feeding of the plates is overcome. Let us say that we require a peak-to-peak voltage of 50 volts at the plates and that the H.T. voltage is 300 volts. Further, we will assume that the bandwidth of the amplifier is 1 Mc/s. Then the frequency response will be 3 dbs down at 1 Mc/s if the stray capacities between each anode and its associated Y plate are 35 pF and the anode loads each 4.7k. Ohm's Law tells us that a 50 volts swing will be produced across the 4.7k load when 10.65 mA flows through it. It remains merely to select a valve to perform this task and one readily available on the surplus market is the 6J6, or ECC91, or, in service notation, the CV858. This valve is a double triode with a common cathode, on a B7G base and the characteristics for it are shown in Fig. 4 where anode current is plotted against anode voltage for a family of grid voltages.

If we were designing a normal amplifier stage, we would draw the load line corresponding to 4.7k on the characteristics from the point Va=300 volts to Ia=64 mA, or since the latter point does not appear on the graph, through the point Va=250, Ia=10.65 mA. If we were to put this into practice, however, not only would the valve draw excessive current but we would not be allowing for the voltage to be dropped across the cathode load, whose value we have yet to determine. So we adopt a different approach to the drawing of a load line and work from the grid-bias characteristics.

We know that the positive excursion of the grid swing must not cause grid current to flow and, therefore, to allow a safe margin, we will assume that the positive swing causes the grid to rise to −1 volt. Similarly on the negative excursion, the grid swing must not cut off the anode current but must leave, say, 1 mA flowing. It is then a fairly simple matter to construct a 4.7k load line cutting the −1 volt grid characteristic and passing through the horizontal 1 mA line, in such a way that the anode voltage between these two limits is at least the 50 volts that we require. This load-line is shown in Fig. 4, and it can be seen that it is drawn as though we are working with an effective H.T. of 175 volts. This means that the remaining 125 volts of H.T. can be dropped across the cathode load. The final step, therefore, is to decide what the mean current will be and hence what value of cathode load is required. The necessary anode swing of 50 volts is obtained when the grid swings from −1 volt to −6 volts, these two points being the previously determined limits of the system, and the mean grid potential is, therefore, −3.5 volts when 4.5 mA flows through each valve. The total cathode current is thus 9 mA and to drop 125 volts, a resistance of 13.9k would be required. A 15k resistance would, therefore, be chosen as a practical compromise, such a value changing the working conditions slightly.

Having calculated the values from the curves, the formula developed above for the gain of a triode, long-tailed pair can be applied, knowing that μ for this valve is 30, and Ra is 9k for the mean operating conditions.

The gain may be verified as being 5.06 which suggests that 50 volts will be produced at the anode for an input of roughly 10 volts. It is interesting to note that with the same operating conditions, the gain of the stage with no cathode load would be 10.3, illustrating the way the gain is halved in this circuit.

This circuit is shown in Fig. 5. Note that the bias is obtained by a bleed chain across the H.T. supply, the bias resistors being connected to a point which is 3.5 volts negative with respect to the cathode, i.e., at +121.5 volts.

If the stage is directly coupled to the plates of the tube, then by including a potentiometer in the bias circuit, the trace on the tube may be shifted and this control becomes a D.C. shift control.

This practical example serves to show how the value of cathode resistor can be determined. It is not always possible to fix the value in this manner, but if the design arranges for the cathode current to remain as near constant as possible, then the "tail" will be long. This again can be demonstrated by an example.

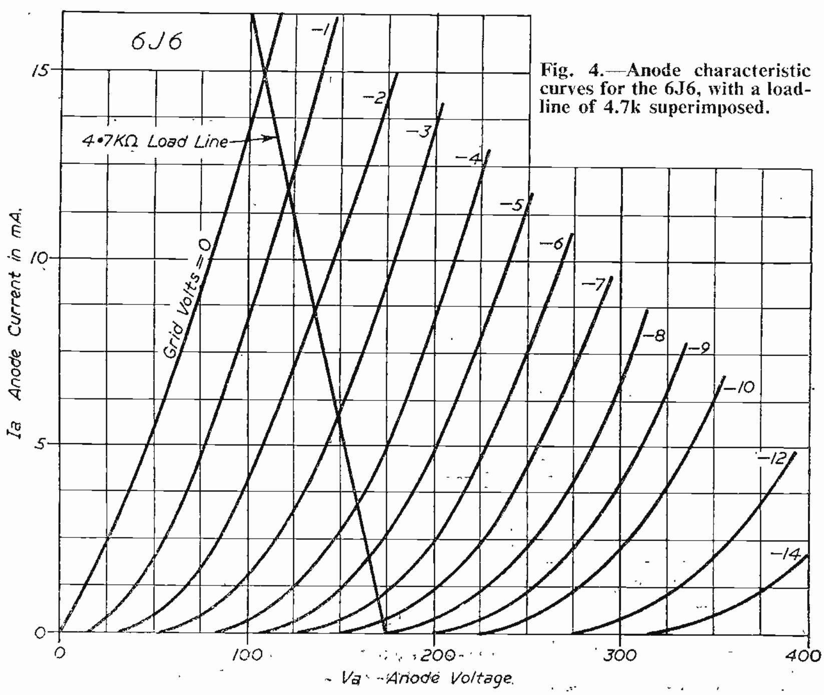


Fig. 4.—Anode characteristic curves for the 6J6, with a load-line of 4.7k superimposed.

Long-tailed Pair Clipper

The long-tailed pair is easily adapted to produce a square wave from a sine wave and, as such, forms the basis of a square-wave generator.

If a sine wave is applied to the grid of V1 in the circuit of Fig. 1, and the amplitude is large enough to cut the valve off, then the rapid change in cathode current can be made to produce a square wave at V2 anode. To do this, the anode current in V2 must be initially cut off. This is achieved by biasing the grids separately, that of V2 being more negative than V1 grid.

V1 will then act as a cathode follower and the cathode voltage will fall with the sine wave at the grid. When the cathode potential has fallen to within the grid base of V2 then the latter will start to conduct and the rapid fall of voltage at the anode produces the edge to the resulting square wave. The cathode will not fall so rapidly now due to the tendency of both valves to maintain the cathode current constant and the limit is reached when V1 is cut off and V2 is biased to zero volts. On the positive going excursion of the sine wave, V1 will suddenly cut on and the anode potential of V2 will rise precipitately to give the second sharp edge to the square wave. Further, the rising input signal will increase the total cathode current until the grid to cathode potential of V2 exceeds its cut-off value when V2 anode will remain at H.T. The intervals between the two steep edges are thus seen to correspond to the conditions when V2 is first just drawing grid current and, secondly, when V2 is cut off and hence the flat bottom and top to the square wave are created.

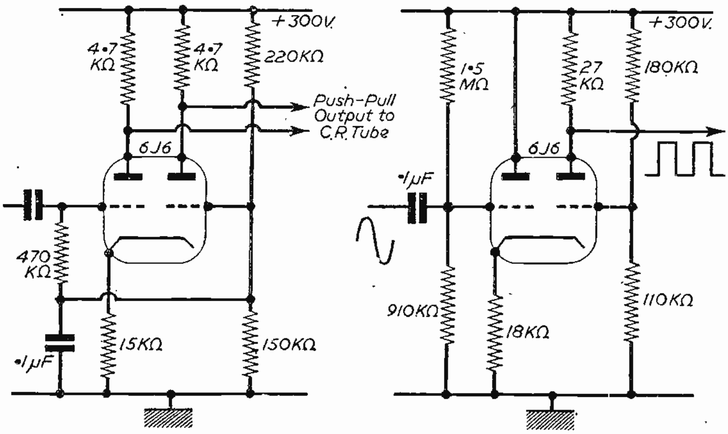


Fig. 5 (left).—Paraphase amplifier circuit for cathode ray tube. Fig. 6 (right).—Long-tailed pair clipper circuit.

This clipping action does not require grid current to flow in the input stage, and has the high input impedance associated with a cathode follower, facts which show an advantage over the customary limiters and clippers used for similar tasks. Furthermore, it provides voltage amplification and clipping without phase reversal of the signal.

Ideally a valve with a short grid base makes the best clipper, due to the fact that the amplitude of the input signal has to be well in excess of twice the grid base of stage—remember that the long-tailed pair effectively doubles the grid base by halving the input signal. However, the design is illustrated above using the data given for the 6J6.

We are going to produce a square wave of amplitude 140 volts, peak-to-peak, of mark-to-space ratio 1 : 1, and of 1,000 pulses per second. We have available a H.T. supply of 300 volts, and a sine wave of variable amplitude and frequency 1,000 c.p.s.

A quick glance at the curves suggests that working the second valve between Vg=0 and a cut-off bias in the 200 volts anode potential region will both allow 100 volts to be dropped across the cathode resistor and an anode variation of the required 140 volts approximately. To determine the value of V2 anode load, therefore, we draw a load line through Vg=0 at Va=50 to 60 volts and also through Vg=cut-off, at Va=200 volts. This gives a rough guide to the value of anode load required which is seen to be 27k, taking the most convenient value.

Now we are only interested in making V1 a cathode follower and we can, therefore, return its anode directly to H.T.

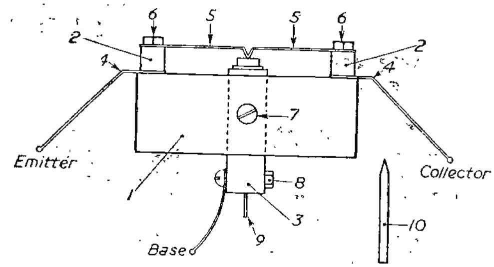
The cathode resistor is next determined : We have decided to drop 100 volts across it, approximately, and we know from the 27k loadline that when V2 is at zero grid volts and at Va=52 volts then Ia=5.5 mA. Furthermore V1 anode current is cut off under these conditions, so that the total cathode current is 5.5 mA. Ohm's Law, therefore, suggests the use of a cathode load of 18k.

From the characteristic curves of the 6J6 it is then possible to compile a table after the manner of that shown in which a detailed account of that part of the input signal reponsible for the square wave output is given. It is thus fairly obvious, as a graph plotted from these results would clearly show, that to produce a steep edge to the square wave a large amplitude input signal is required. About 50 volts peak to peak would produce a reasonable square wave.

In the circuit of Fig. 6, the long-tailed pair clipper is shown with the biasing components included and this circuit will operate satisfactorily at low frequencies for the production of square waves.

Compiling a table in the manner shown is invaluable when non-linear operation of the circuit is desired, since every step is clearly seen and if the information is obtained from the curves in the order that the columns are given then the process is straightforward. The same system can then be applied to the design of the cathode coupled multivibrator and the other circuits mentioned in the introduction.

A SIMPLE TRANSISTOR



An illustration of the transistor described.

A CONTRIBUTOR DESCRIBES A SIMPLE METHOD OF MAKING AN EFFICIENT TRANSISTOR AT LOW COST

By J. W. Hobley (G2V1)

As one who realises the important possibilities of transistors as regards radio and television I have carried out experiments with home-made transistors and was so pleased with my first results that I filed an application for a patent improved form of transistor, which lends itself very readily to experimental work and is certainly an advance on the present home-made designs.

However, I have decided not to proceed with the patent, but to give details for the information of other readers.

As will be seen, I have dropped the term "cat's whisker," which I regard as being out of date, and use instead what I call "contact springs." By using a circular insulating holder provision for three or four contact springs can be made, thus opening up yet another avenue for experiment.

If a number of even the best makes of germanium diodes are examined it will be found that, in some cases, the "cat's whisker" is merely laid across the surface of the crystal, yet they function satisfactorily as detectors. After trials I am convinced that it is not necessary to use chemically sharpened points and so long as they are needle sharp good results can be obtained with ordinary pointed springs. In my case they are finished off by relieving the underside of the point with a fine jeweller's file.

If the accompanying drawing is followed, a transistor which allows variations and quick change of crystals, thus facilitating experiments, can be made at a very low cost.

Construction

An essential feature of this transistor is that the pressure between the contact springs and the crystal can be varied, the crystal holder being a sliding fit in the body, and further the springs are adjustable vertically and horizontally by using a spring adjuster of suitable size.

For ordinary experiments good germanium diodes with glass bodies can be used. By carefully breaking away the glass in a vice the crystal is left in a cup with a connecting wire which passes through a hole in the holder. Both the holder and wire can be clamped into position by suitable screws and these form the base, a suitable connecting wire being soldered to the bottom of the holder opposite the lower clamping screw.

For a start it will suffice if a diode having a "forward" resistance of about 500 ohms and a "back" one of about 50,000 is used. After "flashing" an amplification of three or four can be obtained, which is enough to carry out ordinary experiments.

In connection with the drawing measurements are mostly in mm. for convenience. Fractional inch sizes are suitably indicated.

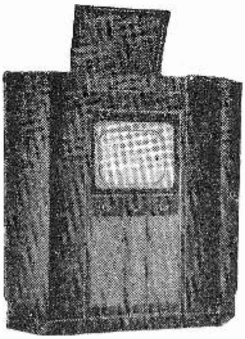
1. The body made from polystyrene, 15 × 7 × 8 wide.
2. The pillars from brass tubing, ⅛in. × ⅛in. long.
3. The crystal holder made from 5/32in. brass rod, 12 long with a 54 hole through, and countersunk 40 for ⅛in. to take the crystal cup. It is a sliding fit in the body.
4. The tags with connecting wires for the emitter and collector contact springs.
5. The contact springs made from 32 gauge hard-rolled phosphor bronze sheet. They are 9 overall with one end slotted to pass under the heads of the pillar screws. The other end is cut to a point and turned down for 2 mm.
6. Ten B.A. screws to hold the pillars and tags.
7 and 8. Ten B.A. locking screws for the crystal holder and crystal cup wire.
9. The crystal cup wire or tail passing through the holder.

To enable the contact spring points to be accurately and easily centred a pointed centring pin No. 10 is used. This slides into the body in place of the holder and enables the points to be properly located. The points are bent to a slight angle to enable them to be placed as closely as possible on the surface of the crystal.

The closer the points are together on the crystal the better the effect. A spacing of 1 thou. of an inch is possible, but 1½ thou. is easily obtainable by the use of a feeler gauge. The points should be at exactly the same height to ensure equal pressure seating on the crystal surface. The springs can easily be adjusted vertically by the use of a spring adjuster.

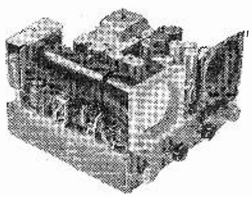
Very good results have been obtained by using transistors in receivers and transmitters, mostly in the 160 metres band, and two-way working has been successfully carried out at over 100 miles with very low H.T. But although the frequency range is at present very limited I am hopeful that it will before long be possible to raise it to a much higher degree.

—THIS MONTH'S SNIP—

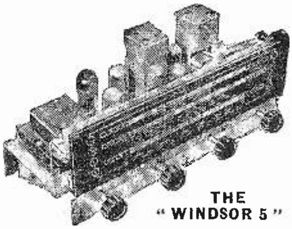


Corner Console. A massive cabinet but being corner fitted is not out of place even in a modern small living-room. Overall dimensions of this cabinet are 47in. wide x 31in. (deep to corner) x 50in. high. Made to house "15" Televisor. Radio Unit, Amplifier, Tape Deck, etc. Originally £18—our price, **£10**, plus 30/- carriage.

MINIATURE PORTABLE T.V.



The Elpreq Miniature Televisor employs a total of 13 valves and 2 crystal diodes. The tube used is a 2½in. The layout is clean and professional and the wiring, whilst naturally being more intricate due to miniaturisation, is nevertheless completely accessible. The total cost comes to **£16-£17**. Its size will be approximately 9½in. x 8in. x 6in.
Full construction data, layouts, diagrams, templates, etc., running into some 50 sheets is available, price 5/-, post free.



THE "WINDSOR 5"

This is a 5-valve A.C. superhet covering the usual long, medium and short wavebands. It has a particularly fine clear dial with an extra long pointer travel. The latest type loctal valves are used and the chassis is complete and ready to operate. Chassis size 15in. x 6in. x 6in. Price **£9/19/6** complete with 8in. speaker. Carriage and insurance 10/-. H.P. terms if required.

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TYPE 24

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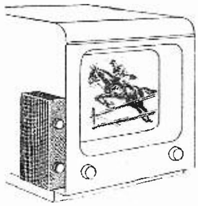
BAND III NEWS

ADD-ITA



This is a ready-to-work adaptor which fixes to the side or back of your T.V. and will give you the new commercial station by the flick of a switch. You do nothing to your set, just plug in mains and aerial leads. Suitable for any T.V. Price **£6/10/-** or **30/-** deposit and six payments of **£1**.

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THE "ELPREQ" Band III SIGNAL GENERATOR is very efficient and it :—
1. Will provide the signal for tuning to any Band III station.
2. Can be used as a grid-dip meter for checking the frequency of Band III T.V. aerials, Coils, etc.
3. Can be made to give a pattern on T.V. Receiver screen.

It can be accurately calibrated with included equipment. All the parts including valves, tuning condenser and metal chassis are available as a Kit at 25/- post free. Constructional data free with Kit or available separately price **2/6**.

BUILD YOUR OWN CONVERTER

The Elpreq Band III Converter has given very satisfactory results from the experimental Beulah Hill station. It uses 3 valves, is not at all difficult to make and can be lined up with the simple 25/- instrument described above. Price for all the components, including constructional data is **£3/10/-**—data available separately price **2/6**.

AERIALS & DOWNLEADS

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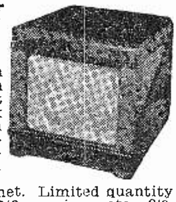
We have a limited quantity of ex-W.D. (new) aerials, ideal for the new I.T.A. station. These are single dipole type, very well made and suitable for internal or external use. Price, complete with adjustable fixing bracket, is only **15/-**, plus 2/6 post.

USEFUL TEST UNIT

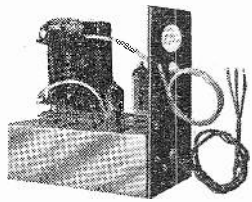
A very simple instrument for measuring E.H.T. and performing many tests is described in the May issue of this magazine. We will supply all the parts given in the parts list on Page 532 (except the item Box Panels, etc.) and the cost is **20/-**, post free. Paxolin panels available, **6d.** each.

CABINET 19/6

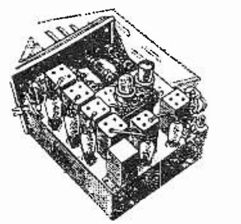


You can make an excellent bass reflex cabinet with this well-made veneered and polished walnut cabinet. Limited quantity offered at **19/6**, carriage, etc., 3/6.

THE ELPREQ E.H.T. GENERATOR



This is a made-up unit, power consumption (6.3 volt 8 amp. filament, and approx. 59 mA H.T.), contains three BVA valves. Output from 6 kV to 9 kV with normal H.T. rail input but somewhat higher outputs can be obtained with higher H.T. supply. Valve rectification is employed in the output stage. Dimensions are 6¼ x 4¾ x 7in. Price **69/6**, post, packing, etc., 5/-.



RESPONSER UNIT

Ideal for Commercial T.V. These contain 6 valves type SP61, and one each RL7, RL16 and EA50. Six IF transformers 12 Mc/s. band, and hundreds of other useful components. Price **59/6**, plus carriage and packing 7/6. These receivers are unused.

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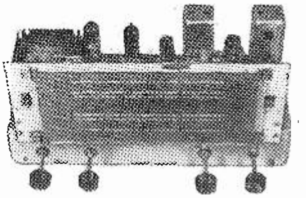

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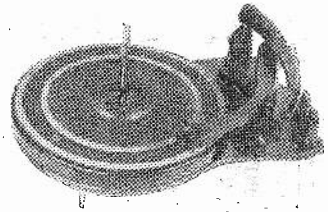

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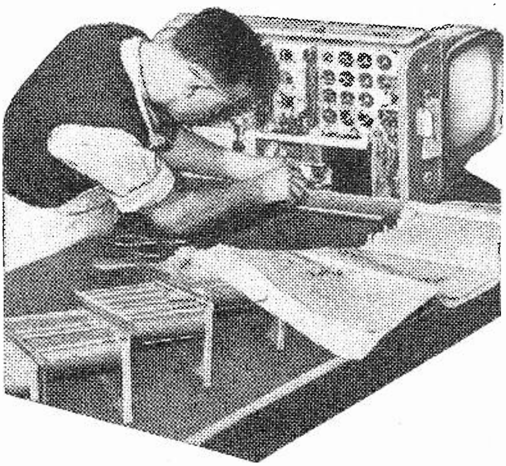


AERIALS FOR BAND III RECEPTION

AERIAL theory and design for Band III reception is exactly the same as that practised on Band I, but with the advantage of smaller overall physical dimensions resulting from the higher frequencies of operation involved. It is, therefore, possible to build up elaborate arrays without the corresponding mechanical difficulties of mounting and handling, and consequently very high gain and directivity can be achieved in fringe areas without any of the serious problems experienced at the lower frequencies.

Taking a frequency of 200 Mc/s as the band centre, the equivalent half-wavelength works out at 30in. compared with 120in. at 50 Mc/s. A simple half-wave dipole with reflector can therefore be constructed to the dimensions shown in Fig. 1, the rods being cut from the usual $\frac{3}{8}$in. diameter aluminium or dural tubing.

A director can be added to this basic array if desired, a rod of length 26in. spaced about 10in. from the active dipole being sufficient. The centre impedance of such an array is of the order of 70 ohms (actually depending on the proximity to earthed objects) and the usual 70 ohms coaxial or twin feeder is suitable for direct connection to the dipole. The directivity pattern is similar to that of like systems used on Band I, and the orientation with respect to the transmitter should be the same.

Yagi Arrays

The advantage of the higher frequencies used for Band III shows itself best in the design of elaborate arrays for fringe areas, an almost impossible undertaking at the lower frequencies on account of the cumbersome size of the finished system.

A very directive array of simple mechanical construction can be made in the Yagi form shown in Fig. 2. Here the dipole D is backed by a reflector element R, and fronted by three directors D_1, D_2 and D_3 respectively, the whole arrangement being supported from a horizontal metal bar. The directors and reflector do not require to be insulated from this supporting bar since the transmissions are vertically polarised, and so may be either soldered to it or tightly wedged in appropriately drilled holes. The dipole must, of course, be insulated at its centre point if the normal centre-fed single rod type is utilised, but by use of a folded dipole, as the figure depicts, this difficulty is further eased and direct fitting to the horizontal support is possible at the centre of the continuous arm.

The centre impedance of a single folded dipole is about 300 ohms, but in the presence of a reflector and a series of directors such as is used in a Yagi array this will fall to a figure much lower than this. By proper design, such as making the dipole up of elements of differing diameters (see No. 4 of this series, PRACTICAL TELEVISION, April, 1953), it is possible to match directly into a 70 ohms cable. The design shown in Fig. 2 will match reasonably well to 70 ohms cable and can be used with confidence in fringe areas.

Folded Vee

This sort of aerial is useful for ranges up to some 20 miles from the transmitter and takes up little space. It is essentially a go-between of the familiar X-array used on Band I and the folded dipole. Although a director is used in the X on Band I this is not necessary for the 200 Mc/s range and the system is unidirectional when mounted, as shown in Fig. 3. The actual arm length is about three-quarters wavelength overall, but is not critical, and a spacing of about 2in. between the rods is suitable. The angle θ may be between 100 and 110 deg., the theoretical optimum being 108 deg.

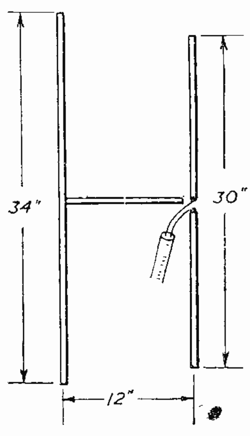


Fig. 1.—A simple half-wave dipole with reflector, showing dimensions.

Horn Aerials

For the experimentally minded a semi-horn type of aerial is feasible in the 200 Mc/s region, and Fig. 4(a) shows a practical arrangement seen from above. Actually, the "horn" is made up of two triangular plates only, these being positioned horizontally one above the other and flared out at the receiving end. The feeder connects to the plates at the narrow (apex) end, one conductor to each plate, and the plates are themselves insulated from each other by side spacers, not shown in the figure, of some suitable material. Fig. 4(b) gives the side view, where θ is the angle between the plates (the flare angle), a is

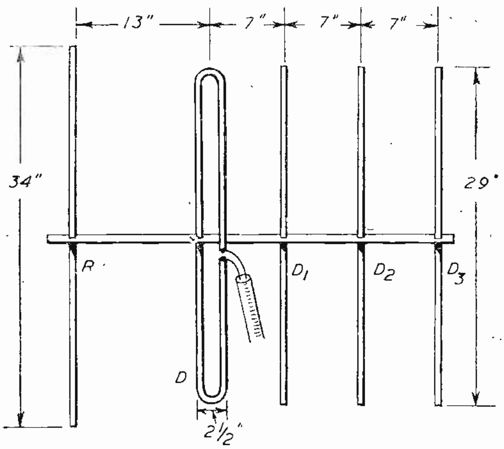


Fig. 2.—A Yagi array with folded dipole.

the length of one side, and b is the mouth width. The other dimension c (Fig 4(a)) is the width of the plates at the mouth of the horn.

Such a horn has a wavelength cut-off (λ_c) characteristic determined very roughly when dimension $b = \lambda_c/2$. This cut-off frequency must be kept well below the working band so that the reactive component of the system is small, and for Band III should not be above 100 Mc/s.

In order for the horn to be unidirectional, the

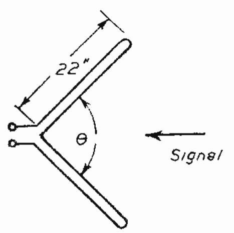


Fig. 3.—Details of a folded "Vee" aerial for Band III.

angle θ should be small, but this cannot be reduced much below 60 deg. without the arrangement becoming unduly long. Working to this angle then, we have from trigonometry:

$$b = 2a.\sin\frac{\theta}{2}$$

$$\therefore\ a = \frac{b}{2\sin\frac{\theta}{2}} = \frac{\lambda c}{4\sin 30^\circ}$$

which equals $\lambda_c/2$.

The height of the sector is made equal to a, so that $a = b = \lambda_c/2$. Taking also $a = c = \lambda_c/2$ and working to 100 Mc/s as the cut-off frequency ($\lambda_c = 3$ metres) the dimensions of a practical system are: $a = b = c = 58$in., $\theta = 60^\circ$.

It is true that this sort of aerial is not so simple to mount as the arrangements already discussed, but its power gain over a simple half-wave dipole at 200 Mc/s is nearly 10 dB, which is equivalent to a stacked dipole-reflector array of 10 elements. The side plates of the horn need not be solid sheet metal; very fine wire netting is quite suitable, ¼in. mesh being suggested. Better results are obtained as the flare angle is reduced and the cut-off frequency lowered, but the arrangement then becomes unwieldy; the dimensions can, however, be readily calculated from the example given.

The centre impedance of the horn under the above conditions is of the order of 350 to 400 ohms, and 300 ohm twin cable is best used as the feeder to the receiver.

Netting Reflectors,

Instead of the usual rod reflector as mentioned in connection with the simple and Yagi arrays earlier on, a netting reflector may be used, this giving slightly more gain for poor signal areas. The netting, which should be of small mesh, is fitted to a metal ring of diameter equal to the length of the equivalent rod element and placed behind the dipole in place of the rod, that is, the rod is replaced by a netting disc.

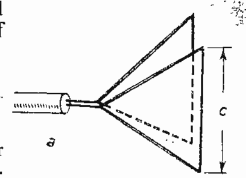
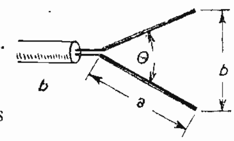


Fig. 4(a).—An arrangement for a semi-horn type of aerial. Fig. 4(b).—The side view.



The use of such an arrangement is only justified in areas of very poor signal strength which suffer from interfering signals from behind the array.

F.M. Aerials

It should perhaps be mentioned in passing that the arrays of Fig. 1 and 2 can be used for the F.M. transmissions from Wrotham by simply doubling all the dimensions as given, but they must be mounted horizontally.

Before the valve base is changed (if necessary) or the receiver used again, all the components marked with a star in Fig. 3 should be checked both for open-circuit or short-circuit condition.

The reason for the flashing or rather arcing over

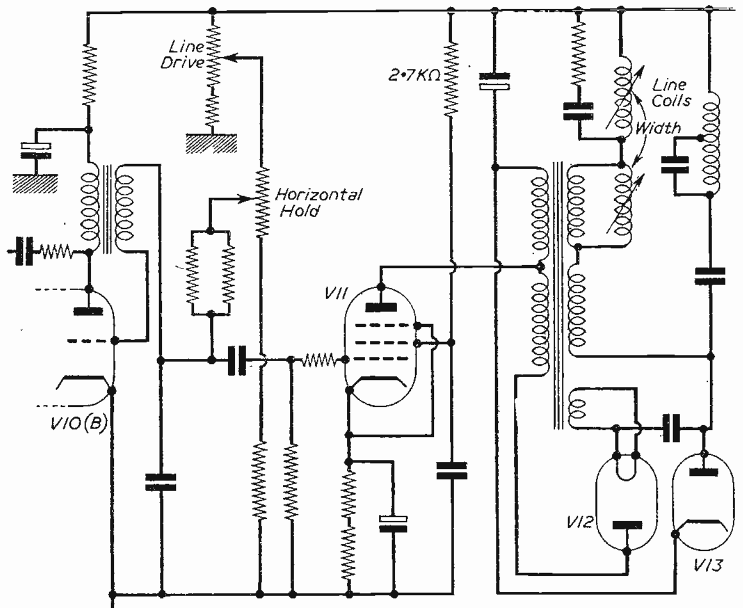


Fig. 1.—Line timebase circuit.

is the high voltages developed when the pentode section of the LN152 is allowed to oscillate on its own account. The damping negative feedback is rendered inoperative by the defective linearity component, and high voltages are developed.

Unsteady Line Sync

If the top of the picture persists in pulling when the hold control is in its optimum position, the cause should be looked for in the anode circuit of the video amplifier. It should be decoupled by a 4 μF electrolytic. In many models a 1 μF component may be found in this position. This is inadequate, and a 4 μF should be fitted in all cases. If this valve condenser is already fitted, its capacity should be checked to ensure its decoupling efficiency.

Hum on Sound and Vision

In the event of valves V1 to V4 (this being done to check change of valves V1 to V4 (this being done to check on heater-to-cathode leaks), the small .001 μF heater decoupling condenser fitted between the heaters of V2 and V3 should be replaced. These components are often overlooked as being a possible source of hum and many hours of searching for open circuit electrolytics and defective valves may be saved if these inexpensive items are replaced.

Distinct hum bars on the raster, so as to cause a large proportion of the tube face to be blacked out, should direct attention first to the V5 double diode and then to the tube itself. In the case of the 1814, the protruding ledge at the top rear of the cabinet provides a suitable place for an isolating transformer to be fitted. These may be obtained with a suitable 13-volt secondary, and the cathode should be strapped to one side of the heater to prevent variations. If the tube does not heat up sufficiently after this modification the shorting wire from the cathode should be replaced on to the other heater tag. If the tube short is in such a position as to render shorting of the cathode to heater impractical, the wire should be dispensed with and a .1 μF condenser fitted in its place. If the hum bars are not so pronounced, and an otherwise normal picture is being received, the earlier vision valves may be substituted in turn and the heater decoupling condensers replaced as previously described.

Vision on Sound

In the event of this fault occurring, first check that the oscillator is correctly tuned. This is an external adjustment (lower plastic knob), and may inadvertently be moved by a member of the family and should be tuned to maximum sound consistent with a good picture. On console models the volume control and brightness is mounted on a separate bracket on the front of the cabinet. Vision on sound may often be removed by bonding this bracket to the main chassis.

Vision Instability

Erratic vision reception, varying from loss of gain to oscillation of the video stages may be due to a number of usual defects, such as open-circuited decoupling condensers, misalignment, etc., but in several cases the first *sound* I.F. amplifier has been found to affect profoundly the video response, although the sound itself is apparently unaffected. This point should be borne in mind if the normal steps do not yield the desired result.

Varying Focus and Picture Size

This fault may be traced to various causes, depending upon whether the variation occurs with the

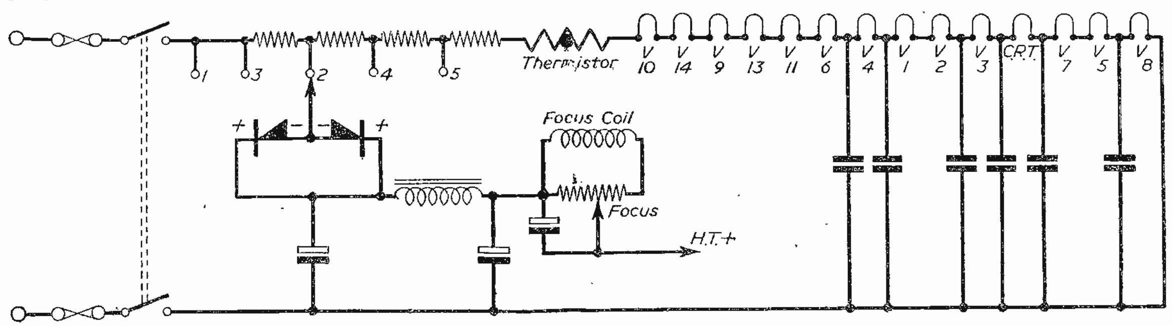


Fig. 2.—The power supply circuit.

operation of the controls. This point has been dealt with earlier when the effects of a failing N152 were discussed. However, should the picture focus and size vary, although the controls are not touched, the N152 may be blameless and if this proves to be so the following points should be checked.

The U151 (EY51) E.H.T. rectifier may be varying in emission; the series E.H.T. resistor may be intermittently changing in value (470 KΩ is the correct replacement should this be necessary.)

The E.H.T. smoothing condenser may be leaky (.001 μF 10 kV.). It is pointed out that none of these E.H.T. defects will cause lack of width. Lack of focus and a larger picture than normal is the symptom of reduced E.H.T. voltage.

Booster Diode

V13, which is a U152 (PY80), is the booster or efficiency diode and is reasonably trouble free. It contributes some 50-60 volts to the line timebase, or rather line output stage, and has a 2 μF electrolytic condenser wired from its cathode to the H.T. positive supply to smooth this extra voltage. The usual fault to occur with any valve in this position is for it to develop a heater-to-cathode short which, of course, completely upsets the operation of the line timebase.

On Low Voltage Mains

In some parts of the country difficulty is experienced in maintaining picture width due to the mains supply being below 200 volts. On A.C. mains the difficulty is overcome by the use of an auto-transformer which will provide a suitable step-up. However, on D.C. supplies this of course cannot be applied. The use of a .001 μF condenser wired directly across the line scan coils will provide extra width and the position of the focus magnet can be altered if necessary to give even focus with the control in the centre of its travel. The height is usually adequate in this respect.

Circuit Description

A superhet circuit, tunable to any of the BBC channels in Band I is used. V1 (Z152) is the common sound and vision R.F. amplifier. V2 (Z152) is the frequency changer, the screen grid of which behaves as the oscillator anode. L4 is its oscillator coil and

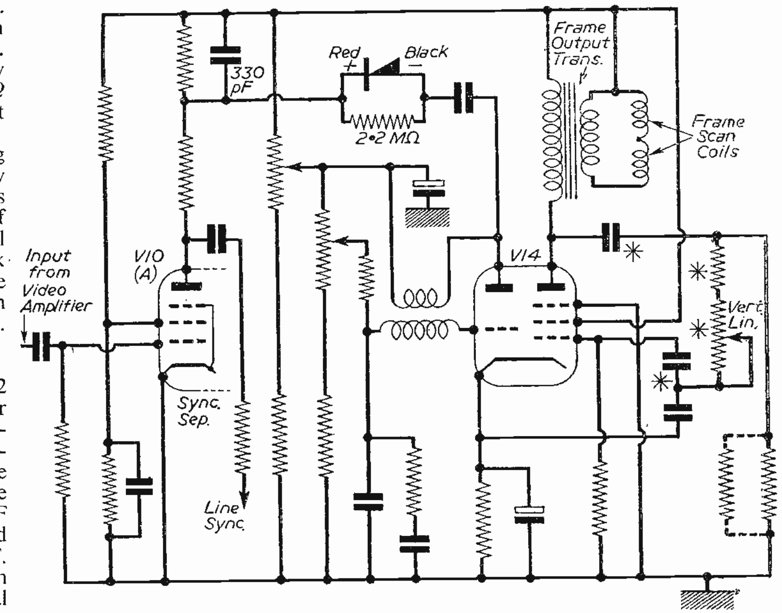


Fig. 3.—Sync separator and frame timebase circuit. (Note that the components marked with a star are linearity feedback components which can cause flashing or arcing at the valve base of V14 if faulty.

is tuned to a frequency *above* that of the R.F. input. The resulting I.F. at the anode, vision 34 Mc/s sound 37.5 Mc/s, is passed to the grid of V3 (Z152) which is the first I.F. amplifier. The contrast control is common to the cathodes of both V1 and V3. A resistance-capacity coupling to the grid of V4 is employed where the two I.F. signals are separated by L7, tuned to vision I.F., and L9, tuned to sound. L8, C16 is a tuned circuit adjusted to 41.5 Mc/s to prevent London sound signals from breaking through the I.F. stages. The vision I.F. at the anode of V4 (Z152) is then fed to the detector V5a (D152) L12 is tuned to sound I.F. to remove any remaining traces of signal at this frequency.

The cathode of V5a is loaded to chassis by a 6.8 k resistor, and the developed signal is passed via a choke to the grid of the video amplifier V6 (Z152). The anode of this valve is loaded by a resistor and two chokes, and decoupled from the H.T. line by a further resistor and an electrolytic condenser which, as previously mentioned, should be 4 μF. The video signal is passed to the tube by a resistance-capacity network, and is also applied to the cathode of V5b interference limiter. The anode of this limiter is tapped from a voltage divider network from H.T. to the cathode of the video amplifier. The tapping point is the slider of a variable resistor which forms the limiter control. The sync pulses are passed through a series resistor and capacitor to the grid of the pentode section of V10 (LN152), this acting as the sync separator. Fig. 3 shows the dividing circuit of the frame and line pulses. The horizontal drive VR4 control should be moved downward until the white line and the kink in the line scan just disappear ;

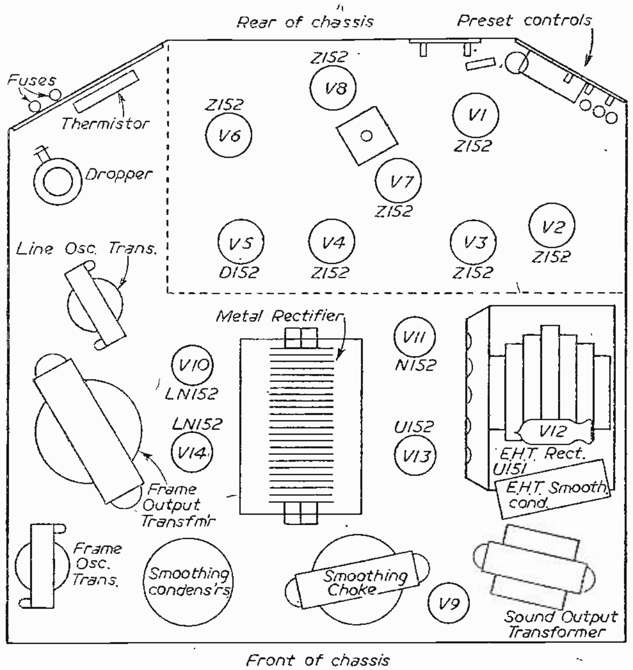


Fig. 4.—Top view of chassis which is mounted at an angle in console receivers.

the slider should not be adjusted beyond this point as V11, the line output valve, depends upon this control for its auto-bias. Thus the valve may be damaged by being over-run if this control is too far down. Always start the adjustment with the control at the top and then move downward as described. V10B, which is the triode section of the valve, functions as a conventional blocking oscillator. The frame pulses are fed via the small metal rectifier to the anode of the frame blocking oscillator which is the triode section of V14 (LN152). The pentode half serves as the frame output.

Sound Section

V7 (Z152) is the first sound I.F. amplifier. The grid of this valve is returned via a choke to an A.G.C. circuit from the sound detector load resistor. The second I.F. stage uses another Z152 and is of conventional type feeding the detector which is a crystal diode (XL1). The signal developed across its load resistor is fed through another diode, which is a small metal rectifier (W1). This forms a series noise limiter which cuts off during impulsive signals. The A.F. signals are then fed via the volume control to the sound output stage V9 (Z152). This valve is mounted on the power pack or main chassis. It will be noted that the vision and sound stages are mounted on an independent chassis bolted to the main unit.

Power Supplies

The heaters are connected in series with the mains resistor and Thermistor. A half-wave metal rectifier is used and is mounted in the centre of the chassis. The A.C. or D.C. mains are taken by a single wire to the centre plate, the D.C. supply being taken from the strapped end plates. Part of the H.T. current passes through the focus coil in the focus unit on the tube neck. The winding is shunted by the focus control variable resistor and most of the H.T. current passes through this control rather than through the focus winding.

Sound Circuit Variation

Early models in this series employ a ZD152 double diode pentode valve. This acts as the sound detector and audio amplifier, instead of the crystal diode and second I.F. amplifier.

Other Receivers

For the benefit of new readers we give below a list of all the receivers which we have so far dealt with in this series. We are unable to give information concerning future receivers which will be described in this series.

Bush models TV22 and T24 (November, 1954).

Ekco TS105 and series (May, 1955).

Ferranti 136-1145, 138-129, 1205 and series (December, 1954).

G.E.C. models BT2147, BT4541, BT5144 (February 1955) ; BT7092 and BT7094 (June, 1955).

H.M.V. 1803-4, 1805-6, 2806, etc. (January, 1955) ; H.M.V. and Marconi receivers with 1807 chassis (September, 1954).

Philips 1100W and 1100U series (April, 1955).

Pye model D18T and variants (October, 1954) ; FV1 and FV1c (March, 1955).

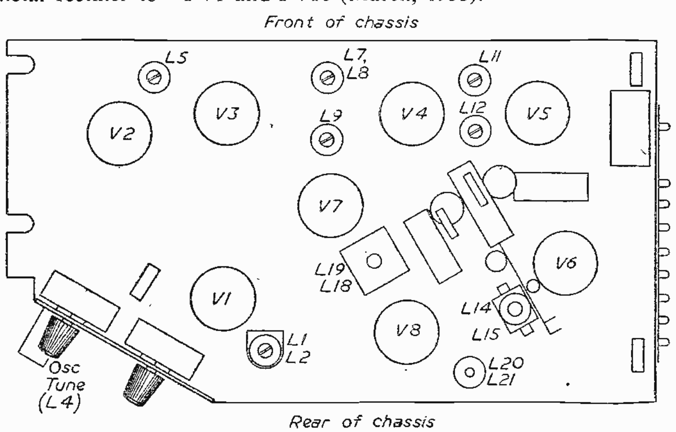


Fig. 5.—Top view of vision and sound unit as in Fig. 4, with coils and components shown.

Servicing Television Receivers

No. 11.—H.M.V. 1814, 1816, AND MARCONI VT59DA, VC60DA AND SERIES

By L. Lawry-Johns

All these models employ the same chassis with minor modifications. The major differences are in the cabinet, tube size and layout. However, the following notes may be used in conjunction with the diagrams, and differences in individual models as far as the circuit is concerned are only minor.

There are various " usual " faults, perhaps the most often encountered being lack of picture width with poor focus, frame bounce, unsteady sync and hum bars across the tube face.

Lack of width may be coupled with a number of other symptoms which enable the correct diagnosis to be made. A narrow picture which, when the brightness control is advanced, becomes a dull blur always indicates a faulty line timebase. This is usually due to a failing N152 (PL81) line output valve. This valve is marked V11 in Fig. 1.

An increase in line drive may improve matters, but this is not advised and will not affect a permanent cure. The line drive control is the extreme right-hand control which is not normally exposed. The correct position for this control will be explained later, when the operation of the line timebase is described. Assuming, however, that a new N152 has been fitted, the raster should present a normal appearance with the brightness control operating normally over its entire travel.

It would appear that the screen dropping resistor of the N152 has a profound effect upon the life of the valve. Should this component drop in value it will result in the working life of the valve being reduced. It is therefore worthwhile to check that the value of this resistor is 2.7 KΩ and not a great deal less. Also in connection with this fault it should be noted that if the N152 is not oscillating properly it will draw excessive current. This results in a drop of available H.T. voltage, giving the impression that the metal rectifier is failing.

A new metal rectifier should not be fitted until the line output valve has been proved up to standard. This applies, of course, to any receiver ; for example the KT36 in the 1807 often gives the same misleading symptom. It should not be assumed by these remarks that the line output stage is self oscillating. The line oscillator in the receiver being described is the triode section of V10, an LN152 (ECL80). From this it will rightly be assumed that failure of this valve will give the same condition as the failure of the N152. However, this valve should be suspected first, as it is far more often the cause of the trouble. The presence of a 25 μF 25-volt electrolytic bias condenser in the cathode circuit of the line output valve should be noted.

Frame Bounce

If the raster, although fully synchronised, persists in jittering or bouncing up and down, the trouble should be looked for in the anode circuit of the sync separator the pentode section of V10 (LN152)—. Fig. 3 shows the circuit of this stage, and the 330 pF condenser which is across the .15MΩ resistor is nearly always the culprit. This condenser can cause the loss of frame sync and the picture will then roll, but normally it will jitter as described, and sync will be maintained. If replacement of this condenser does not effect a cure the next component to be suspected is the small metal rectifier which can cause very similar symptoms. This again can cause the timebase to roll as well as jitter.

If the vertical movement of the picture is of a slower or more irregular nature, accompanied by varying height, the frame oscillator transformer should come under suspicion and a meter check made of the resistance of its windings. Prim. 290Ω, Sec. 295Ω.

Before any involved servicing is entertained, however, the valve in the circuit concerned should be replaced by a known good one. In the case of irregular height, especially if the lower half of the raster is practically unscanned, the trouble may well be the combined frame oscillator and output valve (LN152) V14. A heater-to-cathode leak will produce these or similar symptoms.

Inability to control the frame timebase is often due to the height and vertical hold control decoupling capacitor becoming open circuit. It is rated at 1 μF 350-volt working.

A rather alarming fault which can develop in the frame timebase is arcing or flashing between the valve-holder tags. This is not due to the valve-holder becoming defective as might be thought, but in almost every instance is due to an open-circuited component in the frame linearity feedback circuit. This may often be caused by the linearity slider itself, which may become fractured, or by an open-circuited condenser.

A Five-channel Tuner

ADAPTATION OF THE CYLDON TUNER FOR THE HOME CONSTRUCTOR

By B. L. Morley

THERE is available on the market a useful tuner unit which will switch to any of the five channels in Band I; it is inexpensive, genuine surplus stock and is easily adaptable for the amateur.

This unit comprises a small self-contained chassis with a high-gain pentode R.F. stage plus mixer and oscillator. The R.F. valve is one of the modern miniature types, an EF80. The mixer plus oscillator is a duo triode, one triode section being used for the oscillator and the other for the mixer.

The unit is equipped with a low-loss switch which can be turned to any of five positions, thus covering the five BBC channels.

It delivers vision at 13.5 Mc/s and sound at 10 Mc/s and the oscillator frequency can be adjusted to operate at a lower frequency, giving an I.F. of 22 Mc/s for vision and 15.5 Mc/s for sound.

The circuit diagram is given in Fig. 1.

The input is taken via the filter C14, C2, C13, L4 and L5 to the first tuned coil L1. This coil consists of a main section tuned by an iron-dust core and four incremental inductances, switched by the five-position switch.

The feed is taken directly to the grid of the pentode amplifier and the output of this valve is fed into the second coil, which is similar to the first. It consists of a certain fixed portion tuned by an iron-dust core and four further sections associated with the switch.

In the cathode circuit is a small resistor of 33 ohms and it is intended that the resistance should be extended to a variable resistance used as a sensitivity control.

The output is taken via C6 to the grid of the mixer valve. This is the first half of an ECC81 double triode. A 12AT7 could be employed in this position if desired.

A parallel fed Colpitts circuit is used for the oscillator, the oscillator coil L3 being arranged on the same principle as the two previous coils. There is one major difference. The switch is arranged so that the oscillator section is at the front of the chassis and a brass core is provided for each section of the incremental inductance. This enables each channel to be peaked separately.

A small coupling condenser C9 is used to transfer the oscillator frequency to the mixer.

The anode of the mixer valve is left free; it is intended to be connected directly to a coil tuned to the intermediate frequency.

The various connecting points are brought out to a tag strip at the side of the unit. These are labelled A, B, C, etc., from left to right. Figs. 2 and 3 show the layout.

As received, the unit is wired for series heater operation; it is a simple matter to alter it for parallel work. Connect a wire from pin 9 V2 to pin 4 V1 and from pin 4 V1 to chassis. Disconnect the wire from pin 9 V2 to tag A and in its place run a wire from pin 4 V2 to tag A. Tag A is now the connecting point for the "live" side of a heater circuit.

The input is for balanced twin cable, but can be easily modified for coaxial cable by winding two turns of about 28 s.w.g. insulated wire on L1 and earthing one side, taking the other to the centre conductor of the coaxial cable. The outer of the coaxial will go to the chassis.

Fitting a Sensitivity Control

There is insufficient room on the chassis for the fitting of a sensitivity control, but one can be fitted remotely, the control being fitted at any convenient point.

The control should be a 5K potentiometer inserted across terminal tags F and D. Fig. 4 shows the method, using a length of coaxial cable as the connecting link.

It is not necessary to fit a sensitivity control, and the gain of the unit can be left as a fixed item, the only modification being the insertion of a 150 ohm resistor between terminal tags "F" and "D."

Alignment

The output of the unit should be fed into a suitable

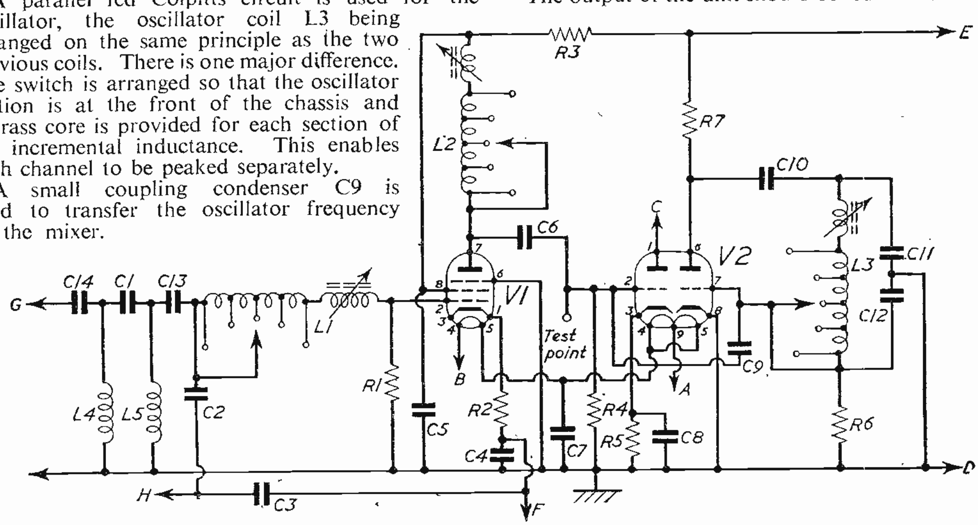


Fig. 1.—Complete circuit of the tuner.

I.F. coil rated at 13.5 Mc/s for vision and 10 Mc/s for sound.

The anode of V2 should therefore be connected in series with H.T. and the I.F. coil and the method of doing this is shown in Fig. 5. H.T. is fed via the 2.2 K decoupling resistor with the 820 pF condenser associated, to the primary of the I.F. coil. The secondary of the coil is connected to the grid circuit of the first I.F. valve.

To align the circuit the aerial should be connected and the output circuit arranged as explained above. It is assumed that the I.F. section of the receiver has been aligned previously.

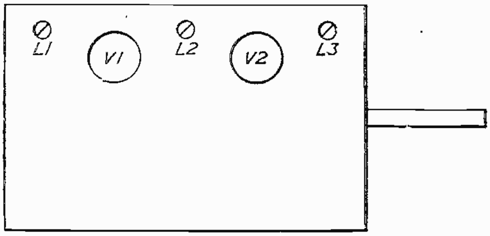


Fig. 2.—Top view of the tuner.

The switch is turned to the local channel and the oscillator coil adjusted by trimming the iron-dust core until the signal is heard at maximum. L2 and L3 can then be adjusted for maximum signal.

If the I.F. stages have been correctly aligned, then the oscillator should be adjusted for maximum volume on the sound channel and L2 and L1 adjusted to compromise between the best picture quality and volume of sound signal.

To trim the circuit to other channels the switch should be set to the channel it is desired to align but none of the trimming inductances L1 or L2 cores should be touched. To ensure that the signals peak the spacing between the turns of the coils laid across the contacts of the switch can be varied. The oscillator coil can be trimmed by adjusting the small brass trimmers associated with these coils.

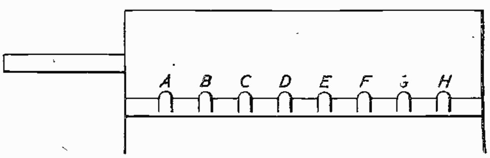


Fig. 3.—Side view, showing the tag strip.

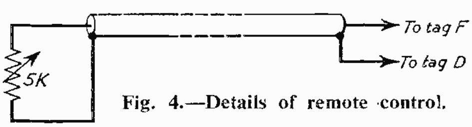


Fig. 4.—Details of remote control.

First adjust the oscillator trimmer for maximum sound and then adjust for picture quality and sound on L1 and L2 by altering the spacing between turns of the appropriate coils. This can be done with an insulated probe—the sharpened end of a wooden pen-holder will do the job.

Each channel can be adjusted in a similar fashion and where a signal generator is available the whole five channels can be accurately aligned. If no signal generator can be used then reliance must be laid on the actual transmissions.

The I.F. Strip

The unit can be used with any I.F. strip operating at 13.5 Mc/s for vision and 10 Mc/s for sound. There are several ex-Government I.F. strips available on the market and there is no reason why they could not be modified as a vision and/or sound receiver provided the I.F. is suitable. It is also possible to modify the existing sound and vision sections of a straight receiver so that superhet working is obtained.

Several methods of doing this are available but the two simplest ones are either to modify the existing coils for the intermediate frequency, or to use new coils especially wound for the required intermediate frequency.

The conversion of a straight receiver in this manner is a very good preliminary for operation on Band III. One of the difficulties likely to be associated with the new Band is that a convertor for the Band will use the existing Band I set up as an intermediate frequency. This intermediate frequency will be tuned to the local transmitter and the possibilities of break-through of the local stations is a very real one.

A simple answer is to fit a five-channel tuner so that when changing over to a Band III convertor the televisor tuning can be switched from the local station to another channel which is not local, and the possibility of break-through is thereby eliminated.

As an example, supposing the televisor is tuned to the local station on channel 2, then the five-channel tuner could be switched to channel 4 or 5, and then the Band III convertor operated on this channel. No break-through should then be experienced from channel 2.

Altering Tuning Coils

It is not possible to state how many turns of wire will be required on a particular coil in order to operate it at 13.5 Mc/s, as each television receiving circuit has the coil turns necessary to provide a suitable inductance value which, together with associated stray wiring capacitances and input capacitances of the valve, etc., will enable the coil to tune to the desired frequency.

Where a signal generator is available then extra turns can be added until the desired frequency is reached, but the possession of such a generator is not a common occurrence with the average home constructor.

If the constructor has plenty of patience and is prepared to experiment then, as a rough guide, we can say that about 20 turns of 34 s.w.g. wire close wound on a former ⅜in. diameter should, under average conditions, come within the range of the tuner.

(*Continued on page 79*)

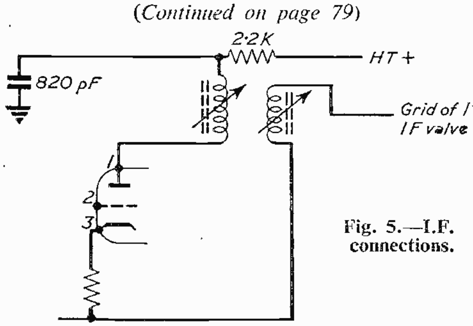
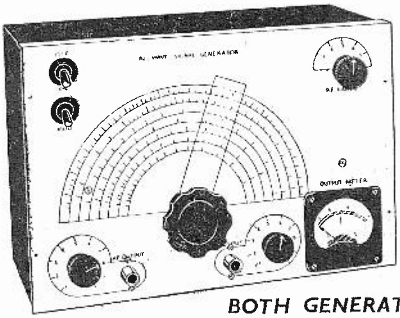


Fig. 5.—I.F. connections.



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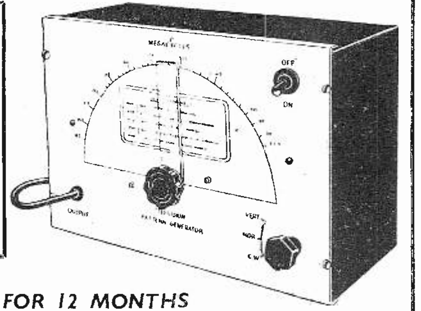

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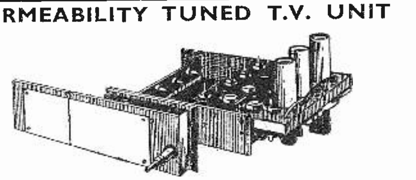
COMPLETELY BUILT SIGNAL GENERATOR

Coverage 120 Kc/s-320 Kc/s, 300 Kc/s-900 Kc/s, 900 Kc/s-2.75 Mc/s, 2.75 Mc/s-8.5 Mc/s, 8.5 Mc/s-25 Mc/s, 17 Mc/s-50 Mc/s, 25.5 Mc/s-75 Mc/s. Metal case 10 x 6¾ x 4¾in. Size of scale 6¼ x 3¼in., 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated, R.F. output continuously variable 100 milli volts. C.W. and mod. switch, variable A.F. output and moving coil output meter. Black crackle finished case and white panel. Accuracy plus or minus 2%. **£4/19/6**, or **34/-** deposit and 3 monthly payments **25/-**. P. & P. 4/- extra.

PATTERN GENERATOR

40-70 Mc/s direct calibration, checks frame and line time base, frequency and linearity, vision channel alignment, sound channel and sound rejection circuits and vision channel band width. Silver plated coils, black crackle finished case 10 x 6¾ x 4¾in. and white front panel. A.C. mains 200/250 volts. This instrument will align any T.V. receiver, accuracy plus or minus 1%. Cash price **£3.19.6** or **29/-** deposit and 3 monthly payments of **£1**. P. & P. 4/- extra.

PERMEABILITY TUNED T.V. UNIT



Input 300 ohm balanced line, coverage 54 Mc/s—89 Mc/s and 174 Mc/s—217 Mc/s. Vision I.F. :—45 Mc/s, sound 40.5 Mc/s. Uses 6AK5 RF valve, 6AK5 as mixer, and 6C4 oscillator. Provision for auto-gain control. Dimensions 9in. wide, 6½in. deep, 4in. high, 9in. blank-scale. Width including scale-overlap 14in. Four stages permeability tuned Complete with 3 valves. P. & P. 3/-. **£2.19.6.**

Used Mazda C.R.M. 123 Cathode heater short aluminised. Complete with rubber mask. Elac P.M. focus unit, scan coils, low line, low frame and frame O/P trans., **£5.10.0.** P. & P. 7/6.
USED 9in. TUBE 22/14C with ion burn, **17/6**. Post paid.
USED Mullard 12in. with ion burn, **50/-**. P. & P. 7/6.
T.V. Convertor for the new commercial stations complete with 2 valves. Frequency : can be set to any channel within the 186-196 Mc/s band. I.F. : will work into any existing T.V. receiver designed to work between 42-68 Mc/s. Sensitivity 10 Mu/v with any normal T.V. set. Input : arranged for 80 ohm feeder. Circuit EF80 as local oscillator. ECC81 as R.F. amplifier and mixer. The gain of the first stage, grounded grid R.F. amplifier 10 db. Required power supply of 200 v. D.C. at 25 mA., 6.3 v. A.C. at 0.6 amp. Input filter ensuring complete freedom from unwanted signals. 2 simple adjustments only. P. & P. 2/6. **£2.19.6.**
Line and E.H.T. Transformer. 9kV. Ferrocart core. EY51 heater winding, complete with scan coils and frame output transformer and line and width control. **£2.5.0.** P. & P. 3/-.
As above but complete with line and frame blocking transformers, 5 henry 250 mA. choke, 100 mfd. and 150 mfd. 350 wkg., 380 mA. A.C. ripple. **£2.19.6.** P. & P. 3/-.
Standard wave-change Switches, 4-pole 3-way, **1/9** ; 5-pole 3-way, **1/9** ; 3-pole 3-way, **1/9** ; 9-pole 3-way, **3/6** ; Miniature type, long spindle 3-pole 4-way, 4-pole 3-way and 4-pole 2-way. **2/6** each. 2-pole 11-way twin wafer, **5/-** ; 1-pole 12-way single wafer, **5/-**. P. & P. 3d.
Senter Cell RM4B 300 mA. 250 v. **15/-.**
USED metal rectifier, 250 v. 150 mA. **6/6.**
R. and A.T.V. energised 6½in. Speaker with O/P frans., field coil 175 ohms. Requires minimum 150 mA. to energise maximum current 250 mA. **9/6.** P. & P. 2/6.
R. and A.M.E. 6½in. with O/P Trans., 440 ohms field, **10/6** plus 2/6 P. & P.
Combined 12in. Mask and Escutcheon in lightly tinted perspex. New aspect, edged in brown. Fits on front of cabinet. **12/6.** As above for 15in. tube, **17/6.**
Line or Frame Oscillator Blocking Transformers, 4/6 each.
Smoothing Choke, 250 mA., 5 henry, **8/6**; 250 mA., 10 henry, **10/6**;
Wide Angle P.M. Focus Unit, Vernier adj., state tube, **25/-.**

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T.V. Coils, moulded former, iron cored, wound for rewinding purposes only. Ali-can 1⅜in. x ⅞in., **1/-** each ; 2 iron-cores Ali-can, 2⅜in. x ⅞in., **1/6** each.
Dubilier .001 10kV. working, **3/6.**
Primary, 200-250 v. P. & P. 2/-.
300-0-300, 100 mA., 6 v. 3 amp., 5 v. 2 amp., **22/6.**
Drop thro' 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., **14/6.**
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250-0-250 80 mA., 6 v. 4 amp., **14/-.**
Drop thro' 270-0-270 80 mA., 6 v. 3 amp., 4 v. 1.5 amp., **13/6.**
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250 v. 350 mA., 6.3 v. 4 a., twice 2 v. 2 a., **19/6.**
Semi-shrouded drop-through 380-0-380 120 mA., 6.3 v. 3 amp., 5 v. 2 amp., **25/-.**
Auto-trans. Input 200/250, H.T. 500 v., 250 mA., 6 v. 4 a., twice 2 v. 2 a., **19/6.**
250-0-250, 60 mA., 6.3 v. 1.5 a., 0-5-6.3 v. 1.5 a., **10/6.**
Auto Trans. Input 200/250. H.T. 350 v. 350 mA. Separate L.T. 6.3 v. 7 a., 6.3 v. 1½ amp., 5 v. 3 amp., **25/-**. P. & P. 3/-.
Heater Transformer. Pri 230/250 v. 6v. 1½ amp., **6/-**; 2v. 2½amp., **5/-.**
Pri. 230 v. Sec. 500-0-500 and 500-0-500 250 mA., both windings. 4 v. 3 amp., 4 v. 3 amp., **39/6.** P. & P. 5/-.
Fully-shrouded screened primary 13 v. 1 amp., **7/6.**
Input 210, 220, 230, 240. Sec. 350-0-350 100 mA., with separate heater transformer. Pri. 210, 220, 230, 240. Sec. 6.3 v. 2 amp., 6.3 v. 3 amp., 4 v. 6 amp., and 5 v. 2 amp., **30/-**. P. & P. 5/-.
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R.F. E.H.T. Oscillator Coil. 6-9 Kv. with EY51 rectifier winding. and circuit diagram, **15/-.**
As above, but complete with 6V6, EY51 and associated resistors and condensers. Circuit diagram, **37/6.**
As above, but complete with line O.P. transformer, scan coils and frame O.P. transformer, **£2.19.6.** P. & P. 3/-.
Polishing Attachment for electric drills. ¼in. spindle, chromium plated 5in. brush, 3 polishing cloths and one sheepskin mop mounted on a 3in. rubber cup. Post & pkg. 1/6. **12/6.** Spare sheepskin mops, **2/6** each.
Used AC mains 200/250 volts, 4 valve plus metal rectifier, medium wave superhet in polished walnut cabinet, size 14 x 9½ x 7½in., complete with valves 6K8, 6K7, 6Q7 and 6F6. 6½in. PM speaker. Fully guaranteed. P. & P. 7/6. **£3.15.0.**

Valve Holders, moulded octal Mazda and loctal, **7d.** each. Paxolin, octal Mazda and loctal, **4d.** each. Moulded B7G, B8A and B9A, **7d.** each. B7G moulded with screening can, **1/6** each.

32 mfd., 350 wkg.	2/-
16 x 24, 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
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16 x 8 mfd., 500 wkg.	4/6
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16 mfd., 500 wkg., wire ends	3/3
8 mfd., 500v. wkg., wire ends	2/6
8 mfd., 350 v. wkg., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
100 mfd., 350 wkg.	4/-
100 mfd., 450 v., wkg., 280 mA., A.C. ripple	3/11
150 mfd., 350 v. wkg., 280 mA., A.C. ripple	4/6
100 + 200 mfd., 350 wkg.	9/6
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50 mfd., 12 wkg.	11d
32+32 mfd. min. 275 wkg.	4/-
50 mfd., 50 wkg.	1/9
Miniature wire ends moulded, 100 pf., 500 pf., and .001. ea.	7d.

Where cost and packing charge is not stated, please add 1/6 up to 10/- 2/- up to £1 and 2/6 up to £2. All enquiries S.A.E. Lists 5d. each.

R. AND T.V. COMPONENTS (ACTON) LTD.

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Winding New Coils

Perhaps the most satisfactory method of tackling the problem is to wind new coils, and for this purpose the Haynes coil kits are an ideal solution.

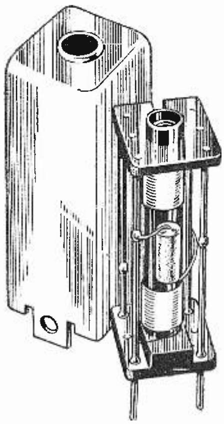

Fig. 6.—A completed coil unit.

For those not familiar with these coil kits a few words of description would not be out of place.

Each coil unit consists of a bakelite coil former 0.3in. diameter and 2½in. long, threaded internally to take iron dust or brass cores. A top plate is provided and four side wires, the whole being enclosed in an aluminium can. The complete coil assembly makes a neat, efficient and attractive unit which gives a receiver a polished professional finish. (See Fig. 6.)

Each coil kit is provided with sufficient D.S.C. wire for all the coils and also has a small bottle of coil dope of the polythene variety.

The new I.F. coils can be constructed on the coupled coil principle, one winding being inserted in anode circuit of the preceding valve and the other in the grid circuit of the next valve. Fig. 7 shows the basic principles of the scheme.

Of course it is not necessary to employ coupled coils but single coils anode connected (Fig. 8a) or grid connected (Fig. 8b) can be employed.

Single Coils

The winding can be made at either end of the coil form whichever is the most convenient.

It is not possible to state accurately the number of turns required as stray circuit capacitances, etc., come into play and these will depend upon the televisor design itself. Taking average conditions then, about 30 turns of 40 s.w.g., all turns lying next to one another, should give about a 13.5 Mc/s tuning position.

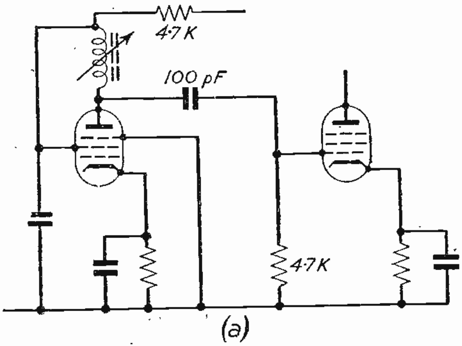

Fig. 8.—Single coils.

Coupled Coils

The best method of winding these coils is first to anchor the wire at the bottom and then to wind on the first coil ; the total number of turns, less two, should be put on, and for the primary coil in the anode circuit 46 turns will be required.

The first coil should, therefore, have 44 turns wound on ; now spiral the wire up the former to almost the centre and wind on four turns closewound as the main coil. Now spiral the wire farther up the coil form and then wind on 37 turns which is suitable for the secondary.

When the side wires are inserted the bottom wire is soldered in position and then the top wire. The small coil in the centre of the coil form is cut and two ends taken to the nearest side wires. The result should be as shown in Fig. 9.

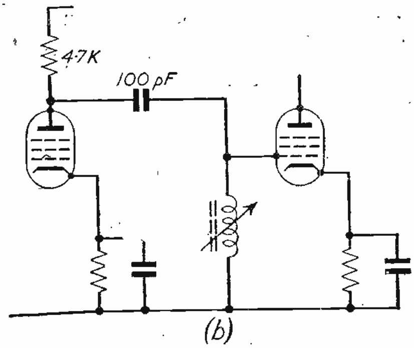

Fig. 8.—Single coils.

The top end of the primary winding should go to the anode of the preceding valve and the bottom end of the secondary winding to the grid of the next valve. The subsidiary turns in the centre effect the coupling between the two coils, yet each coil is far enough apart for them to be tuned separately.

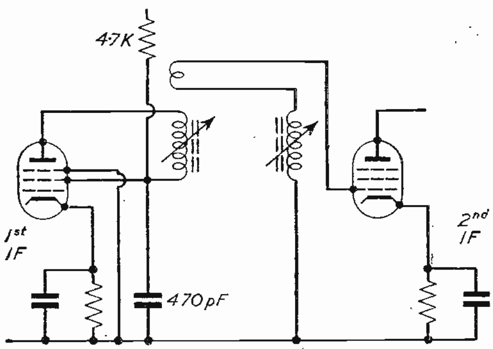

Fig. 7.—The coupled coil.

Sound Coils

The coils for the sound section of the I.F. strip should be made in a similar manner, but a small condenser of about 15 pF should be connected across the winding. In the case of the single coils this will mean one condenser, and in the case of the coupled coils, two condensers, one across each coil.

The condensers can be conveniently mounted within the coil casing (screen).

Alignment

Where a signal generator is possessed then the alignment will prove fairly easy. The sound coils should all be peaked to the sound I.F. of 10 Mc/s and, in the first instance, the vision coils to 13.5 Mc/s.

It is not possible to give alignment details for all cases as the number of stages varies according to the design of the receiver. The only rational procedure to follow would be to cover the bandwidth with the signal generator and to aim at an even response. The circuits can be stagger-tuned, but where coupled coils are used bandpass working can be aimed at for each pair.

In the case of coupled coils it may be found that the one coil is pulled by the other. In this case a resistance of 470 ohms should be temporarily connected across the one coil when the other is being tuned, and transferred to that coil in its turn.

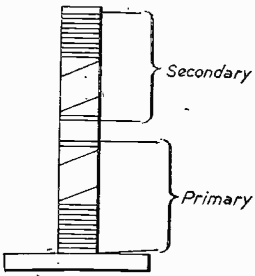

Fig. 9.—A coupled coil.

Where no signal generator is available then good alignment can be obtained, but greater patience is required.

In the first instance the oscillator of the Cyldon unit should be tuned for maximum sound, and an endeavour should be made to arrange that the sound coils peak when the core is about level with the top of the coil form.

The oscillator should then be trimmed for maximum vision and the vision I.F. coils for maximum response.

Now trim the oscillator again towards the sound channel so that the "volume" of the vision signal is reduced by half its previous figure. This should bring in maximum sound, but the sound I.F.'s can be retrimmed so that this *is* the position of maximum sound.

COMPONENTS

Resistors	Condensers
R1—10K	C1—47pF
R2—33 Ω	C2—47pF
R3—1.5K	C9—5pF
R4—15K	C10—47pF
R5—680 Ω	C11, 12—75pF
R6—10K	C13, 14—75pF
R7—10K	C3, 4, 5, 6, 7 and 8—820 pF

From this point the oscillator need not be touched and all that is necessary is to adjust the trimming of the vision I.F.'s for maximum quality of picture. This is best done on Test Card "C."

Rejector Coils

It may be found necessary to fit rejector coils and the constructor should be guided by the number and type of rejectors fitted in the existing televisor. All that is necessary is to fit similar rejector coils tuned for the new intermediate frequency and to adjust them for minimum response of sound on vision.

Conclusion

Provided the instructions given in the preceding paragraphs are followed carefully, there should be no difficulty in getting the unit working. It is a worthwhile proposition, especially for the fringe viewer where the superhet shows its superiority over the normal straight receiver.

I.T.A. News

Northern Station

AT the end of May the Lancashire Council announced that they had granted the I.T.A. planning permission to construct its Band III television station for Lancashire on Winter Hill, some five miles to the north-west of Bolton. The site is 1,450ft. above sea level on Rivington Moor, which runs north and west from Bolton towards Darwen, Blackburn and Preston, and it is undoubtedly the best possible one for providing the people of Lancashire, Cheshire and parts of North Wales with a first-class service. The overall design of the station has been completed by the I.T.A. engineers, and much of the transmitting equipment, aerial system and 450ft. lattice steel tower is now under construction at the works of Messrs. Marconi's Wireless Telegraph Company.

Messrs. E. R. Collister and Associates are the authority's architects for the station buildings, which will be of modern appearance and construction. Construction work on the site will start very shortly, but while the authority and the contractors will spare no effort to complete the station by the end of this year no promise can be made to get on the air until the spring of 1956. The station will transmit at first with an effective radiated power of 100 kW., but this may be increased later to about 200 kW. Because of the hilly nature of the surrounding country the radius of reception will inevitably vary somewhat, but here the Lancashire County Council's agreement to the use of Winter Hill has been of considerable help. To the north coverage will extend roughly to Barrow-in-Furness, Lancaster and Settle; to the south, to Stoke-on-Trent, Crewe and Wrexham; and to the west to Liverpool and as far as Colwyn Bay (nearly 60 miles away). To the east towards Yorkshire effective coverage will be curtailed by the ridge of the Pennines and is not likely to extend much beyond Rochdale. The estimated total population which will obtain satisfactory reception from the new station is about 7 millions.

Plans for Yorkshire

The station at Winter Hill is specifically intended to be a Lancashire station, and is not intended to be receivable in Yorkshire on the east side of the Pennines. This, however, does not mean that Yorkshire has been forgotten in the authority's plans. In fact, the authority is at this moment actively considering its plans for a Yorkshire station, and much of the engineering design for the station is already in progress. A consideration of the possibilities of about a dozen different sites for the Yorkshire station has been completed, and interest now centres on a site at Ovenden Moor near Halifax, which it is thought should give the best reception conditions within the whole of the county. The Halifax Borough Council and its planning authorities have been most helpful to the authority, which will be starting site test transmissions, using an R.A.F. balloon about the beginning of June. The use of two separate stations for the North of England, one on each side of the Pennines, instead of a single central station will enable the authority to give greater coverage and far better reception generally on Band III to a potential viewing public totalling about 11 million people.

BUILDING THE "SIMPLEX"?

Thousands of enthusiasts are building the "Simplex" Televisor, now being featured in "Practical Television." WHY NOT YOU? **CONSTRUCTOR'S ENVELOPE** containing full constructional details and Blue Print, additional notes and suggestions, and Query Service form, sent for ONLY **5/-**. All components available ex stock as follows :

ALUMINIUM CHASSIS. — 18 s.w.g. DRILLED, for VCR97 version with screens and tube holder bracket, **22/6.**

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VALVES.—EF50 **6/6**, SP61 **4/-**, 6SN7 **9/-**, 6J5 **5/6**, EB34 **3/6**, EA50 **3/6**.

VALVEHOLDERS.—B9G/(EF50) **10d.**, I.O. and M.O. **6d.**, Diode (EA50) **6d.**, VCR97 **2/6.**

VCR97 TUBE.—Tested full screen, **42/6.**

CONDENSERS.—Electrolytics 25 mfd. 25 v. **1/10**; 16 x 8 mfd. 450 v. **5/6**, 32 x 32 mfd. 450 v. **6/-**. Mica, silver mica, and tubulars, 350 v. **6d.** each.

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2B7	8/6	12J5	6/-	ECH35	12/6
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6AG5	7/6	12SK7	8/6	EB34	3/6
6AK7	9/6	12SR7	7/6	EF36	6/6
6B4	7/6	28D7	7/6	EF39	6/6
6B8	7/6	32	7/6	EF50	6/6
6C8	8/-	36	7/6	,, Red Sylvania	8/6
6G8	6/6	50Y6	8/6	EF91	12/6
6H6	5/-	58	8/6	EY51	15/-
6K6	9/-	1622	11/-	EK32	6/6
6L7	7/6	1626	4/-	EL32	7/6
6N7	7/6	1299A	7/6	SP61	4/-
6R6	8/6	VR150/30	8/6	MU14	10/6
6U5	8/6	VR137	5/9	RL37	6/-
6V6	8/6	KT44	8/6	VS70	7/6
6V6GT	7/6	KT2	5/-	954	6/-
6SA7	8/6	VP23	6/6	955	6/-
6SG7	7/6	HL23DD	6/6	9003	6/-
6SH7	7/6	TP25	8/-	9004	6/-
6SJ7	8/6	1S5	8/-	931A	50/-
6SK7	7/6	1T4	8/-		
6SL7	9/-	1R5	8/-		
6SS7	7/6				

PYE 45 mc/s I.F. STRIPS.—The strip that is ready made for the London Vision Channel. Complete with 6 valves EF50 and 1 of EA50. BRAND NEW. **ONLY 59/6.**

R.F. UNITS TYPE 26 and 27. For use with the R.1355 or any receiver with a 6.3 v. supply. These are the variable tuning units which use 2 valves EF54 and 1 of EC52. Type 26 covers 65-50 Mc/s (5-6 metres), and Type 27 covers 85-65 Mc/s (3.5-5.0 metres). Complete with valves, and BRAND NEW IN MAKER'S CARTONS. ONLY **29/6** each.

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TRANSFORMERS.—Manufactured to our specifications and fully guaranteed. Normal Primaries. 425-0-425 v. 200 ma. 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a., **ONLY 65/-**; 350 v.-0-350 v. 160 ma., 6.3 v. 5 a., 6.3 v. 3 a., 5 v. 3 a., **ONLY 47/6**; 250 v.-0-250 v. 100 ma., 6.3 v. 6 a., 5 v. 3 a., **ONLY 37/6.** 350 v.-0-350 v., 150 ma., 6.3 v. 5 a., 5 v. 3 a., **ONLY 37/6.** 250-0-250 v. 60 ma., 6.3 v. 3 a., 5 v. 2 a., **ONLY 21/-.** The above are fully shrouded, upright mounting. 5.5 kV. E.H.T. with 2 windings of 2 v. 1 a., **ONLY 79/6**; 7 kV. E.H.T. with 4 v. 1 a., **ONLY 89/6.** PLEASE ADD 2/- POSTAGE FOR EACH TRANSFORMER.

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G. G. GOURIET, A.M.I.E.E.

72 pages. 21 diagrams and 7 colour plates. Cloth. 8/6

This monograph contains the substance of a series of lectures delivered in 1954 to the Television Society. It explains the development and theory of the present American colour television system with a comment on future development in this country.

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72 pages. *75 diagrams.* 5/-

Designs and complete constructional notes for 25 different pre-amplifiers for both Band I and Band III, which include models for use with a communal aerial. The basic principles underlying the design of preamplifiers are clearly explained, and the reasons for the marked difference between Band I and Band III circuits are given in detail.

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Describes almost every type of TV aerial of practical use with full details for their construction and erection. The theory of the transmission and reception of electromagnetic waves is given in a clear and non-mathematical manner. Deals with the latest developments in Band III aerials and the construction of tested and tried types.

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Length 9ins. 25 Watts.

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12-50 **24/-** each
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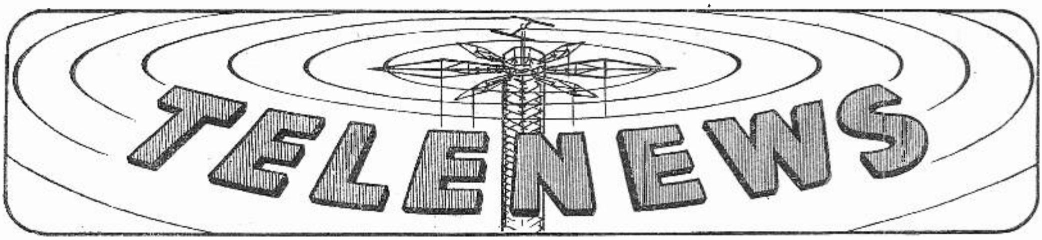


Northern Radio Show Success

THE aggregate attendance for the 10 days that the Northern Radio Show was open to the public was 90,385. Mr. F. W. Perks, chairman of the exhibition organising committee of the Radio Industry Council, has stated: "Our return to Manchester has been fully justified, both by public attendance and business done with the retailers and wholesalers who have come from every part of the country."

Television Licences

THE following statement shows the approximate number of television licences in force at the end of April, 1955. The grand total of sound and television licences was 14,017,447.

Region	*Number*
London Postal ...	1,135,681
Home Counties	497,658
Midland	836,293
North Eastern ...	666,291
North Western	665,783
South Western ...	254,038
Wales and Border Counties	249,982
Total England and Wales	4,305,726
Scotland	250,498
Northern Ireland	24,501
Grand Total	4,580,725

Transmitters for Second Service

THE BBC has ordered two pairs of television transmitters from Marconi's Wireless Telegraph Co., Ltd., for its proposed alternative programme service and in anticipation of the allocation of frequencies by the Postmaster-General.

The vision transmitters are rated at 7½/10 kW output power, while their sound counterparts are of 2/2½ kW output. Delivery is expected to be made late next year.

ITA Midland Station

PERMISSION has been received by the ITA to build its Band III Midland television station on a site some five miles south-east of Lichfield, Staffordshire. It will be situated at Common Barn Farm, Hints, 500ft. above sea level, and the station buildings will cover about 11,000 sq. ft.

First War Distress Message

THE torpedoing of the Donaldson liner *Athenia* on the outbreak of war in September, 1939, was the "link" that brought Mr. David Don and Mr. Robert M. Gibson together in "Find the Link" recently and they defeated the panel.

Mr. Don, as radio officer of the *Athenia* when she was torpedoed, transmitted the first "enemy action" distress message of the war from a British merchant ship, while Mr. Gibson, on the receiving end at the G.P.O. coast station at Portpatrick Radio, took part in directing the distress traffic and rescue operations by radio. Until the TV programme the two had never met.

Fall in Sales

THE B.R.E.M.A. Monthly Retail Market Survey reveals that the normal seasonal decline in sales has continued and that April sales of television receivers amounted to 14,000 units less than in the previous month. This represents a fall of some 16 per cent., which is not particularly serious considering that the Budget and the Easter holiday fell in the middle of the period under review.

Radio receiver sales followed the same general pattern, falling by 16,000 units—a decline of about 17 per cent.

New Mayor of Southgate

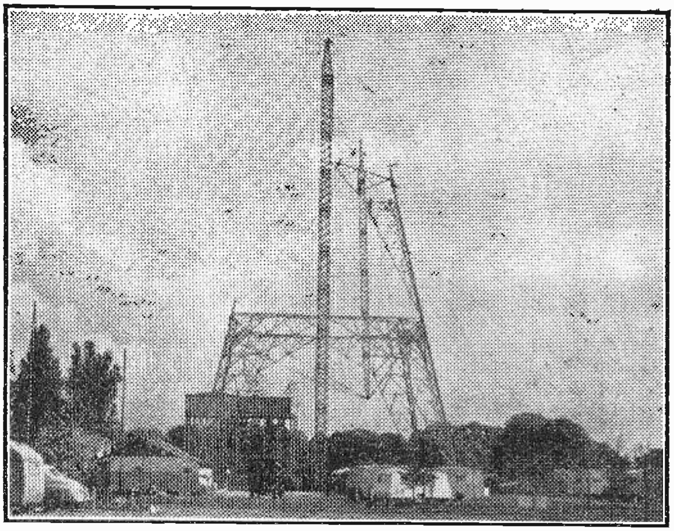
THE new Mayor of the Borough of Southgate is Alderman John Clarricoats, O.B.E., general secretary of the Radio Society of Great Britain.

Alderman Clarricoats has operated his own amateur radio station —call-sign G6CL—since 1926.

Highest TV Tower

BELGIUM is to build the highest television tower in the world on the site of the 1958 Brussels International Exhibition. This was announced by Mr. Edouard Anseele, Belgian Minister of Com-

A view of our stand at the recent Northern Radio Show which attracted many visitors.



The BBC's new London transmitting station being constructed on the Crystal Palace site.

munications, during his recent visit to London.

It will be made of concrete and will be twice as tall as the Eiffel Tower.

Downlead Cables

BRITISH INSULATED CALLENDER'S CABLES, LTD., have recently introduced a new range of television downlead cables incorporating cellular polythene insulation.

They have been developed as an answer to the problem of the increased cable attenuation which occurs at the higher frequencies at which commercial television will be operating.

Delivery Completed

AN order for six V.H.F. experimental transmitters placed with Mullard, Ltd., by the BBC has just been completed. The order was finalised by the delivery of a transmitter for use on frequencies in Band V.

Two transmitters in each of the Bands III, IV and V were supplied and are being employed for experiments which the BBC are conducting in connection with propagation and field strength surveys. These will provide information on which to base plans for the possible use of these frequencies for television at some future date.

London Offices for Telerection

WE are informed by Telerection of Cheltenham that they have now opened London offices at Lennox House, Norfolk Street, Strand, W.C.2.

Mr. K. W. Harbridge, who was previously Midland Area representative, has been appointed London area manager. Wholesale stocks are being held in London for immediate delivery to the trade.

America Honours BBC Woman

MISS MARY SOMERVILLE, O.B.E., the first and only woman Controller in the BBC, has been presented with a Twenty-fifth Anniversary Award made by the Institute for Education by Radio-Television in America for an outstanding contribution to the development of educational broadcasting during the past quarter of a century.

Miss Somerville's award was received in New York, on her behalf, by Mr. Basil Thornton, the BBC's North American representative.

TV for American Railways

TWO television cameras have been installed in a railway shed in the Potomac Yard at Alexandria, Virginia, to keep a constant watch on all freight trains that arrive from the Southern States. As the trains pass through the shed, their number and initials are picked up by the television cameras and transmitted to a record office two miles away. This system is always in operation, day and night and in all kinds of weather, as the shed is well illuminated by floodlights.

This is the first permanent installation of this nature in the United States.

Double Vision

A POLICE highway patrolman in Wickenburg, Arizona, recently arrested a motorist for having a television set in his car.

The driver had built a seven-inch screen into the dashboard of his car and this, it was considered, was too great an attraction for any motorist who must give his entire concentration to the road ahead.

Distinguishing Cancer Cells

AN optical electronic instrument known as the Cytoanalyzer is being developed by the Airborne Instruments Laboratory in co-operation with the American Cancer Society and the United States Public Health Service.

The object of the device is to distinguish cancer cells from normal cells using basic television techniques, the television camera viewing slide specimens through a microscope and changing the picture into an electric signal. A computer then distinguishes between normal and cancer cells.

The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Television." Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed to: The Editor, "Practical Television," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

Owing to the rapid progress in the design of radio apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

CORRESPONDENCE

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

INEXPENSIVE INDOOR AERIAL

SIR,—I cannot agree with Mr. Austin in his article upon an inexpensive indoor aerial. The paragraph which deals with preparing the co-axial cable for connection to the aerial elements is where I find it difficult to see the point. If the braiding of co-axial cable is slit and peeled back as Mr. Austin advises, it will surely result in every strand being severed, and if the braiding is then soldered into a solid lump, the point where the solder ends will still be liable to come apart. I find that the only practical method is to unpick the strands individually and then twist them together to form a pigtail, the tip only of which needs to be soldered. This requires more patience but results in an infinitely more flexible and stronger job.—L. LAWRY-JOHNS (Gravesend).

RAI-TEL-ADE

SIR,—It was with great interest that we read the letters from Messrs. G. R. Jones and B. Montagu. It is apparent that they did not read the extensive note on the Rai-Tel-Ade which you so kindly published.

We acknowledge that the basic idea is not new, and also that there are other instruments on the market purporting to serve a similar purpose. These, however, cover but a *part* of the scope of the Rai-Tel-Ade as indicated by the following brief details.

1. It does not require extra external attachments in order to ensure complete safety in its use.

2. It is the only instrument of its type, giving the user the facility in operation, of switch control for varying and selecting the different tones of speech and music.

3. Any number of wireless receiving sets can be used in the same room, and, provided they have the attachment, the users can enjoy full-tone listening, with complete freedom from interference between each other, or disturbing any other persons who may be occupying the same room, i.e., a hospital ward, etc.

We trust that the additional brief emphasis on these points will indicate that while some of the basic principles are well known their combination in this specific instance is new. It is the intelligent selection, adaption and application which makes such a variation in the quality and versatility in instruments purporting to carry out similar functions.—W. J. L. LONGLAND (p.p. Electric Ades).

TV ON A CRYSTAL RECEIVER

SIR,—I wonder if you would be interested to know that the TV signal can be received on a crystal receiver using a germanium diode, with a two-valve amplifier.

The tuner does not make much noticeable difference but a .0005 μF appears to give slightly better results. The aerial is 50ft. but is indoors (in loft). No earth is needed. The coil consists of four-and-a-half turns of 21 s.w.g. enamelled wire on a 1½in. diameter former wound ¼in. apart. I give details of the coil in case some of your readers would like to try the experiment in their particular part of England. I think it speaks very well of a germanium diode when the signal can be received. The crystal set was, of course, amplified by a two-valve four-watt amplifier.—B. KEEDY (Leeds).

RADIO AND TELEVISION INTERFERENCE

SIR,—The whole question of interference caused to and by radio and television receivers and other electrical equipment is the cause of much concern at the moment and should be thoroughly tackled from all angles.

It is totally unfair that one section of the public should be threatened by fines when causing interference to television receivers when, at the same time, the majority of those instruments are also guilty of interference to sound radio. All owners of television sets which cause such interference are breaking the law as well as others, and if the Post Office cannot (or will not) enforce their own licence conditions, then the relevant condition regarding interference should be taken out altogether. The Post Office could then sort that one out.

So far the whole matter has been tackled from one side only. If a vacuum cleaner is causing trouble, then the Post Office quite rightly sorts out the offending equipment. If, however, the offender is a television receiver, then that is the last place the Post Office will consider. Instead, the person complaining is told to acquire an efficient aerial/earth system which has nothing whatever to do with the fact that the television set is breaking the law.

It is to be hoped that a lot of publicity can be given to this matter. Perhaps then the responsibile authorities will awake from their lethargy and become quite fair about it.—J. RAYNER (Basford, Notts).

"SHARED AERIALS"

SIR,—The article in your June issue, "Shared Aerials," by "Serviceman," expresses certain opinions which are hardly justified and possibly misleading to the average reader.

On what ground could one possibly conceive that the predominance of "X" or "H" type aerials in any locality is due to their gain over the simple dipole, as "Serviceman" suggests? Has "Serviceman" considered that the installation of these aerials in his locality may be due to severe ghosting from some near object in the area or that interference generally is at such a level that the dipole with its omni-directional characteristic is very susceptible. Whilst the "X" type is highly directional, its relative gain over the dipole is not worth considering, and the "H" type aerial is essentially uni-directional. The installation of these aerials, therefore, would make a considerable improvement to the sig./noise ratio, particularly if sited in the clear, i.e., above the roof level, and the reduction or elimination of ghost images a very much simpler matter.

"Serviceman" advocates indoor aerials wherever the signal is adequate. This may be good policy in areas very close to the transmitter, but logically, though the signal may be "adequate," the noise level from domestic appliances will undoubtedly be greater, especially where the receiver gain is necessarily high. An indoor aerial installation can only give inferior results, and in addition is very prone to interference from a nearby amateur transmitter.

The use of receiver H.T. for operating a pre-amplifier remotely may be a good idea, but it is hardly a practical one. The average viewer is, as a rule, very independent and could not be expected to co-operate where his television set is to be connected up with the people's next door.—FREDERICK J. CRISP (S.E.23).

RECEIVER DESIGN

SIR,—Now that the commercial wavelengths are in the offing is it not time that the design of receivers underwent some change from the stereotyped present-day arrangement? At one time everything was crowded on to one chassis, and any modifications could not be carried out. During recent years one or two firms have separated the R.F. units (or vision and sound strips), and these may now be replaced to cover the commercials. Other firms are having to supply a most intricate array of bits and pieces, and one has to remove a valve, insert a plug, take out another plug and put in another plug, and so on, and then add an adaptor to the front to get the new station. What is going to happen should colour come along? Will this mean another set of plugs and bits and pieces? I think a modern television set could most easily be split into its separate component sections, i.e., vision strip, sound strip, frame timebase, line timebase, power section, etc. Then, servicing would be simplified, as should a frame fault be present, one would simply unplug the frame unit and put in a replacement, servicing the "dud" at a convenient time. Whilst the cost of the replacement would be higher than that of any one component in that section, the labour and time charge would be considerably reduced, and the bill would therefore probably be less. Furthermore, any circuit improvements which came along could more easily be introduced, and I should be glad to see some designer attack this problem, but, and this is a point which I should stress, the tube must not be part of the set, but mounted in the cabinet and kept quite separate. A chassis, even with power pack, is much more easily handled than a chassis with a 14in. or 16in. tube mounted on it.—G. HARMON (Edgware).

AERIAL CALCULATIONS

SIR,—Recently I have been interested in differences in aerials and used the article in your August, 1951, issue, where you deal on page 106 with the gain of so many db of one against another type. The formula is given. Laidlaw in his recent book gives the same formula.

On this basis I worked out from Polar diagrams the figures, and found that they were half those given by a well-known firm in their latest catalogue. So I wrote them and am told that the formula given should not be used. They say that as signal strength is given for any particular district in microvolts per metre, one should use *voltage* in comparison of aerial gains and not *power*.

The formula to use is:

$$\text{db} = 20 \log \left\{ \frac{\text{Signal voltage from given aerial}}{\text{Signal voltage from dipole}} \right.$$

I now see that this is exactly like Sound, with similar use of formula for *power* at 10 log and *pressure* at 20 log.

I think somebody should write up this matter, and make it clear, as at present odd figures are quoted for db gain without any reference to which way it is calculated. Or, in fact, is it well known that the formula you gave was not correct for this comparison? Possibly "Erg" could do it for us, and also say whether there is any other way to do this which is plain to see at a glance as to effects. Possibly to replace this silly db by percentages, or other scale which can be visualised. The db scale is unequal and does not give an easy idea.—Y. ARRAY (Sheffield).

FOREIGN TRANSMISSIONS

SIR,—During the month of May a period of interference arose in which the BBC had to apologise for patterns on viewers' screens. It was later stated that these emanated from the French television stations. Has anyone successfully resolved pictures from these interferences, as surely, if the signal was strong enough to form patterns, it should only have been a question of adjusting the necessary timebases to make these into a picture? I thought I heard sound backgrounds during the period, but when speech did become distinguishable it turned out to be the London transmitter, and I wondered if the interference did not, in fact, come from the Wrotham F.M. transmitters.—G. LITTLE (N.W.5).

AMERICAN INTERVIEWS

SIR,—During the recent election we saw an American interview conducted by the now popular Ed Murrow, and I was impressed by the vast difference between this and similar interviews conducted by the BBC.

It is difficult to define the actual difference but one was left with the feeling that we had been given all the information and trimmings that the producer and editor had wished us to have, whereas BBC programmes of this type tend to spend twice as long telling us only half as much. Also, American television interviews always appear to be spontaneous, and questions and answers are posed and given in a natural manner. The English interviewer and interviewee, however, seem to give the impression of having rehearsed every minute detail beforehand, and we are far from convinced that the interview has been a sincere one because of this.—F. K. RANDALL (Peckham).

VIEWING IN THE DARK

SIR,—Although we have been told time and again by doctors and opticians that the best viewing conditions are when a room is illuminated by a dim but "warm" light to prevent eye strain, I can never resist sitting in front of my receiver with all lights out.

This may not be very good for my eyes, or at least that is what I am told, although I am never conscious of my eyes becoming tired, but this is certainly the best way of viewing television. The picture appears brighter, clearer and crisper.—N. GUNN (Orpington).

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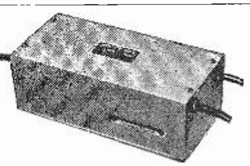

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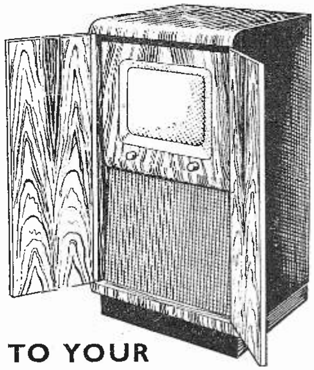

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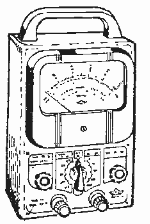

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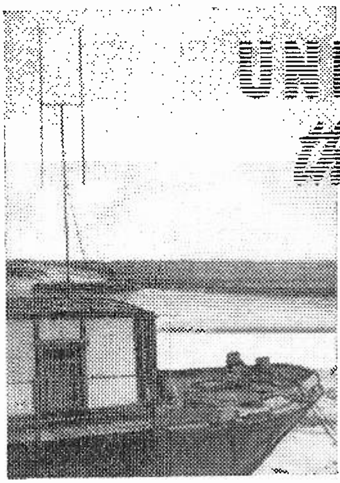

UNDERNEATH the DIPOLE

TELEVISION PICK-UPS AND REFLECTIONS

By Iconos

THE music-hall is supposed to be utterly finished, dead and gone. And, if one were to judge its present state by the number of variety theatres which have closed their doors during the last few years, such an assertion might seem to be correct. Television usually gets the blame, but the fact is, unable to compete with the comfort of the modern cinema, with its luxurious seating, air conditioning, heating and wide screen gimmicks, the music-hall has failed to hold its audiences. Lower attendances have led to poorer variety bills, cheap revues of vulgar pattern and the almost complete disappearance of the "family" audience which was so catered for in the days of the late Sir Oswald Stoll.

MUSIC-HALL REVIVAL?

DOZENS of the closed theatres in smaller towns have been converted into factories, furniture stores or garages but a few have remained in show business by turning over to cinemas or TV studios. Fortunately the spirit of the old robust variety show lives on in some of the cinemas which stage periodic variety shows, and in mechanised form it is welcomed by a large "popular" public on radio and TV. The growing popularity and star value of a number of variety comedians such as Harry Secombe, Max Wall, Benny Hill, Frankie Howerd, Terry Thomas, Jimmy James, Arthur Askey and others does indicate a measure of revival in music-hall. Sometimes even these performers are hampered by poor material and it is never safe to assess them by viewing just one TV appearance. Max Wall and Jimmy James have not always "clicked" on this account, and yet on many occasions they have scored a great hit. Harry Secombe's own show—*Secombe Here*—was full of production numbers with extreme long shots of ballet and chorus routines, but the terrific personality of this great little Welsh comic won through. Harry now goes into the top line of music-hall comics, and tempers his special "goon" brand of foolery with serious excerpts from opera with his fine tenor voice. Apart from the over-emphasis on long shots, the production of *Secombe Here*, by W. Lyon Shaw, was first rate and the hilarious finale, with Harry Secombe fencing and fighting his way out of the Television Theatre in the manner of the Scarlet Pimpernel, was crazy variety at its best.

VERA LYNN

VERA LYNN is a star who shone brightly again in the VE-Day programme. The appealing tones of her remarkable voice seem to register particularly well on TV sound and she put over her act very strongly to an invited audience of members of the British Legion and the three Services. In the same show other stars gave first-class performances, including Jack Warner, Murdoch, Horne, Costa, Charlie Chester and Eric Barker. The production included film flashbacks of VE-Day and scenes at the Merchant Navy Hotel, with Doris Hare recalling her wartime "shipmates" series. The idea and presentation of this programme was carried out by Robin Scott and Derek Burrel Davis. One slight complaint, however: the tab curtains at the Television Theatre are too light and dazzling. Could we not return to the traditional red-velvety curtains of the Shepherd's Bush Empire?

BLUE FOR DANGER

UNFORTUNATELY there has been an inclination lately to allow comedians too much latitude in putting over broad patter. Some of the dialogue has had a distinct "blue" flavour of the type which drove the family audiences away from the live music-halls. This tendency may have crept in the scripts when the writers have exhausted their inspiration for genuine humour. The temptation to score cheap laughs in this manner must be resisted. The Ted Ray show was, surprisingly, not free from blemishes in this respect. Another pitfall to be avoided is the repetition of material which has been heard and seen many times over a period of years, such as Terry Thomas's disc jockey who has lost his records and has to imitate such artistes as Noel Coward, Paul Robeson, Ronnie Ronalde and Josef Locke.

THIS WAS YESTERDAY

THE question of film speed arises in respect of very old silent pictures, such as those included in the special scrapbook-like feature, *This Was Yesterday*, which was compiled for the BBC by Pathé from 36 years of weekly Pathé Pictorials. The early excerpts showing scenes from London stage plays and musical comedies of the 'twenties suffered from jerkiness arising from 16 frame per second photography being projected by the BBC TV at 25 frames per second. The dancing routines looked quite absurd speeded up and the dramatic scenes became decidedly undramatic! Nevertheless, this feature, produced by Howard Thomas, was a highly absorbing series of pictorial milestones. Another point which rather marred the reproduction of the old silent pictures was the off-centre effect of the TV pick-up, resulting from the sound track area (which used to be occupied with a portion of picture) being cut off. Both the left-hand side and top of the picture were cropped by the modern aspect ratio, cutting the tops of heads and clipping the wording of titles. The value of these very old silent pictures should justify the provision by the BBC of special TV equipment for dealing with them. We viewers should at least be able to see them looking at least as good as they originally did, uncropped and at their correct speed.

Your problems solved

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from p. 95 must be attached to all Queries, and if a postal reply is required a stamped and addressed envelope must be enclosed.

BAIRD T29 EVERYMAN RECEIVER

Could you please give me some advice on the above TV receiver. I should mention that I possess the theoretical circuit diagram.

The set developed a fault, whereby the height and the width were reduced, i.e., a picture of half the normal size. I diagnosed this as faulty Sen-Ter-Cell rectifiers and changed them. This has restored the picture size, but I still have not got correct width, due to bad trapezium distortion on the right-hand side of the raster.

A second-hand 20PI valve was tried, but with no improvement and a check made on R33, the 5,000Ω screen resistor of this valve. Checks have also been made on the focus control and I have come to the conclusion that the H.T. line feed to the 20PI valve is O.K.

The scan coils do appear to get rather warm and I am wondering if this is the solution.—J. Poole (Ware).

Trapezium distortion is nearly always caused by shorted turns in the scanning coils and, as in your case, the symptom is generally accompanied by a reduction in scan. The temperature rise of the coils is an additional pointer to this fault.

VIEWMASTER

The height of the picture gradually decreases to approximately 7in. after a few minutes and remains at that point without decreasing any further. This means that the screen is under-scanned, over ½in. at the top and bottom of the raster with no cramping or stretching in evidence. I assume that I can obtain correct linearity.

I should add here that I can gain approximately a ¼in. either way by adjustment of the height and linearity controls but this only causes the picture to become non-linear with severe distortion at both the top and bottom of the raster.

I have also noted that by increasing the brilliance control (with the aerial disconnected) I can reach a point when I can overscan the 12in. tube with the scanning lines sharply focused, the frame flyback lines are also very bright.

This is well above the normal setting. If the control is left turned towards maximum with the aerial connected in, the scanning lines are almost obliterated by the brightness with the result that the picture is hardly discernible, until the control is reduced to the point when the scanning lines reappear with the normal clear picture, but at reduced scan as I stated earlier. I am utilizing the boosted E.H.T. circuit as described in the Viewmaster booklet (edition No. 6).—D. Smith (W.12).

A short frame scan of the type you describe may be due to V12 being faulty or unsuitable or to either the frame transformer or scanning coils being faulty or unsuitable. We suggest in the first place that you carry out voltage measurements making certain that these are exactly as specified; if, for example, the volts are low it may be necessary to replace MR4. At the same time we suggest you make the following modifications which should also assist you:

Delete R67, break the connection between the top of R60 and the junction of R57 and C48 and connect a 1μF condenser across these points. Connect a 220-ohm resistor in place of R66, connect a 1,000-ohm resistor in parallel with R65 then readjust R64 and R65.

£9 TV SET

I have been reading your book, "Practical Television Circuits."

I decided to construct the £9 television set. On buying the indicator unit I find it contains a VCR517B cathode-ray tube. I would be very grateful if you could help me in any way. If you cannot recommend me any television circuit using this tube, an oscilloscope or any piece of equipment will do.—A. Beech (Corby).

The VCR517B tube can be used in place of a VCR97 tube if desired. One of the best circuits for the beginner is the "Simplex" televisor and full constructional details with blueprint are available from this office.

COSSOR 916

The line output transformer in my Cossor Model 916 has broken down. I have seen advertised in your journal an L.O.T. 6.9 Kv E.H.T. and 4.3 v. winding. Do you think this would work in the 916 receiver?—B. Wells (Trowell).

It is essential to use the correct replacement type line scan transformer in your Cossor—these are readily available through a Cossor agent. The installation of a different kind of transformer is bound to impare severely the operation of the line timebase and E.H.T. circuits.

LACK OF CONTRAST

I shall be most grateful if you will advise me on a fault I have found on my home constructed set.

The fault is when I turn up the contrast control the whites lose all definition, whilst the blacks are still

(Continued on p. 95)

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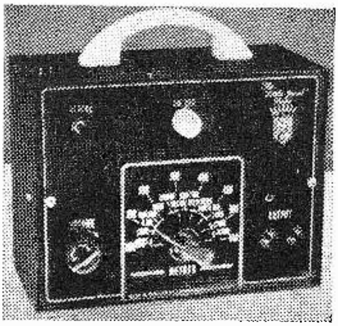

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fairly well defined, also the scanning coils seem to run very warm.

The tube I am using is a Mazda CRM 121B 12in.—S. Foster (Liverpool).

This symptom is quite normal if excessive contrast is used in an endeavour to obtain a picture brighter than that which the tube is capable of delivering. If it is considered that the picture is not bright enough, however, you should check the circuits appertaining to the video amplifier valve and the vision noise limiter. You should also bear in mind that low E.H.T. voltage or a faulty picture-tube are other factors that frequently cause this symptom.

ULTRA VA7216

Recently the vision interference suppression circuit went u/s, and following this the picture developed a watery band about an inch wide covering completely the width of the trace and coming at different heights across the frame. Sometimes the watery effect would spread all over the tube giving a fuzzy "double image" effect. I discovered that switching off and then on again would often cure this, but not always. Sometimes the effect was completely absent for the whole evening. I sent the set to my radio servicer and explained the whole effect. He replaced the 100,000Ω control in the vision interference suppression circuit and also the 1 μF condenser and soak tested the set for two hours, when the "water" effect did not appear. The set has now been returned to me. The vision suppression circuit now works again but the other effect has returned.

Can you advise me, please, of the probable cause of this? Line and frame both lock solid. Also can you tell me an up-to-date replacement for the CRM121A when eventually this becomes necessary?—C. B. Proudlore, B.Sc. (Bristol).

We feel that this symptom is the result of an intermittent heater to cathode short in the picture-tube. You can prove this possibility by gently tapping the neck of the tube when the trouble starts. If this results in clearing the fault temporarily, then you can be practically certain that the tube is defective.

There is no up-to-date substitute for the tube in your receiver, but you need not worry as the original type is still readily available for replacement purposes.

REGENTONE "BIG 15/5"

I find I am unable to "peak" the focus of the raster, due to the lever on the back of the set coming up against the stop at the lowest position.

Also the raster is only in focus on the middle third of the screen gradually fading out of focus at either side. Perhaps this fault ties up with the first.

My last query, is regarding interlace. This is entirely lacking except for what appears to be a narrow band of interlaced raster running down the screen from top to bottom. This narrow band is about ¾in. wide and is only just noticeable on examining the screen very carefully. The band stretches across the screen and travels from top to bottom in about three seconds.

The manufacturers instruction sheet states that interlacing is produced by very critical adjustment of the frame hold control. Although I have tried this adjustment as directed, interlace cannot be obtained. The frame hold control works in all other respects.

I might add that the set works perfectly in all other respects, also that the set is working on a private supply from a small alternator which runs at approximately 60 cycles per second. The voltage is set correctly and has been checked by several good quality meters.

Would interlace be in any way affected by a poor sine wave response from the A.C. generator?

I believe that the above faults have always been present but have only recently observed them due to my lack of experience, also one gradually becomes more critical of the picture as one learns the technical side of the subject.—L. Ling (Kent).

The answer to the narrow band of interlace which travels slowly down the screen is probably that the 60 c/s alternator beats with the frame frequency to produce a 10 c/s band. The lack of interlace on the whole is probably bound up with this. To alter the focusing carry out the following proceedure. Slacken the four fixing screws and the 4 BA bolts holding the scanning coil straps to the bracket. Move the bracket to the rear if the focus lever should be moved to the right, and move it forward if the lever should be moved to the left. The total focus lever movement is equal to about ½in. movement of the bracket. Switch on and check that the scanning coils have not been accidentally moved during adjustment.

GHOSTS

I receive a ghost signal on my set which, I may add, shows on all sets in this district. I remember reading in an early "Practical Television" about finding out the distance the reflecting object lies. The tube is a 15in. with a correct ratio picture. Could you please give me an idea of the distance from me of reflecting object?—W. Mawdsley (Liverpool 5).

In order to compute the distance of the reflecting object from the receiver you will need to make two measurements; one, the width of your picture, and two, the distance, on the screen, between the ghost and the main image. After having found these, the distance of the reflecting object from the aerial is equal to: 15.4 x d/W, where d is ghost displacement and W is the width of the picture.

EKCO T161

I wrote and asked you about reduced height and width on my ECKO type T161 and you told me to test U801 and the two 50Ω resistors coupled to the anodes. I have replaced the U801 and the two resistors are O.K., and I now get full width of picture but height is about 1½in. short at top and about 1in. short at bottom. Could you please help me in this matter.—A. Todd (Withensea).

Limited frame scan is frequently caused by low emission of the 6L18 frame amplifier valve. This is situated to the right of the line scan transformer, as viewing from the rear of the cabinet.

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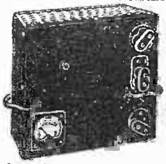

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DD620	7/-	EL42	13/6	PCF82	12/6	UU6	10/-	220VSG	6/9	6BA6	8/-	6K8GT	9/6	7S7	8/6	12J5	8/-
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DH73M	10/-	EL91	8/-	PEN46	8/6	VP23	8/-	2X2	5/-	6BG6G	14/6	6L19	12/6	75	10/-	12K8GT	9/-
DH81	10/-	EM31	9/-	PL81	14/6	VR105/30	5/6	3A4	8/-	6BR7	9/6	6L6G	9/-	77	8/-	12Q7GT	9/-
EA50	2/-	EY51	14/6	PL82	10/-	VR116	4/-	3D6	5/-	6BW6	8/6	6L7M	7/6	80	8/6	12SC7	7/6
EB34	2/-	EY91	7/6	PL83	12/-	VR150/30	9/-	3Q4	9/-	6BX6	14/6	6N7	7/6	84	9/-	12SH7	5/6
EB41	11/-	EZ40	10/-	PM12M	10/-	VT52 (EL32)	8/-	3Q5	10/-	6C4	8/-	6Q7G	9/-	807	7/6	12SJ7	8/6
EBC33	7/6	EZ41	11/-	PY80	9/6	VT501 (TT11)	6/-	3S4	8/6	6C5GT	7/6	6Q7GT	9/-	866A	7/6	12SK7	6/6
EBC41	11/-	E1148	2/-	PY81	10/6	VU39 (MU12/14)	8/6	3V4	8/-	6C6	6/6	6R7G	8/-	8D2	2/9	12SL7	9/-
EBF80	11/6	GZ34	12/6	S130	8/6	VU111	3/6	4D1	3/-	6C9	8/-	6SA7GT	8/-	9001	5/6	12SQ7	8/6
EC52	6/3	H30	5/-	SP220	6/9	VU120A	3/-	42	8/-	6CD6G	13/6	6SG7	7/6	9002	5/6	12SR7	7/6
EC91	7/6	H63	7/9	SP61	3/9	W61	9/-	43	10/-	6D3	6/-	6SH7	6/-	9003	5/6	20D1	9/-
ECC33	8/6	HL1320	3/9	SP41	3/6	W61M	10/6	5U4 (U52)	8/6	6D6	7/3	6SJ7GT	8/-	9004	5/6	20F2	12/6
ECC35	8/6	HL23DD	7/6	TH233	7/9	W76	9/6	5Y3GT	8/6	6F6G	7/6	6SK7	6/3	9006	6/-	20L1	10/-
ECH35	13/-	HP210	6/9	TP26	9/-	W77	8/6	5Z3	8/6	6F6M	8/6	6SL7	8/-	954	2/-	30L1	11/-
ECH42	10/6	HP210C	7/6	U10	9/-	W81	10/-	5Z4G	8/6	6F8G	7/-	6SN7GT	9/-	955	4/9	20P1	15/-
ECL80	14/6	HR210	6/9	U17	10/-	OZ4	6/-	6A7	10/6	6F13	13/6	6SQ7	9/-	956	3/6	20P3	11/6
EF8	6/6	KT2	5/-	U22	8/-	1A3	9/-	6A8G	10/6	6F14	12/6	6SS7	6/-	10C2	13/6	20P4	11/-
EF36	6/-	KT32	10/-	U25	14/6	1A5GT	6/8	6AC7	6/6	6G6G	6/6	6U5G	8/6	10F1	10/-	25A6G	9/-
EF39	6/6	KT33C	11/6	U37	15/-	1A7	11/6	6AG5	7/6	6H6	3/6	6V6G	7/6	10F9	13/-	25L6GT	8/6
EF41	10/-	KT66	11/6	U281	10/6	1C5GT	8/-	6AJ5	9/-	6J5G	5/-	6V6GT	7/6	10LD11	11/-	25U4GT	12/-
EF50Syl	8/-	KT74	8/-	U301	12/6	1L4	7/6	6AK5	7/-	6J6GT	5/6	6W2	15/-	10P13	11/6	25Z4G	9/-
EF50	6/-	KTW61	7/9	U403	10/-	1LD5	6/9	6AL5	7/-	6J5M	6/6	6X4	8/-	10P14	11/6	25Z5	7/9
EF54	7/-	KTW63	7/9	U404	10/-	1R5	7/6	6AM5	5/6	6J6	8/-	6X5GT	7/9	11D5	10/-	35L6GT	8/9
EF80	11/6	KTZ41	6/9	UAF42	12/-	1S5	7/6	6AM6	7/6	6J7G	6/6	7B6	9/6	12A6	6/9	35W4	10/-
EK32	8/-	LD210	6/9	UB41	9/-			6AQ5	8/6	6K6GT	6/6	7B7	8/6	12AH8	11/6	35Z4GT	8/6
		LP220	6/9	UBC41	11/-					6K7G	6/-	7C6	8/6	12AT7	9/-	50L6GT	8/6
		MS/PEN	5/-											12AU7	9/-		

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For conversion of Acoustic Gramophone to Electric reproduction. Fitted with Universal Adaptor for any type of tone arm. For use with Standard Size Needles. Highly polished plastic, brown finish. Type 112, 2,000-ohm resistance. Output 0.3 volts. Special Price 17/6 ea.

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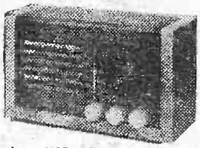

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