TECHNICAL DESCRIPTION

MARCONI-E.M.I. SYSTEM OF TELEVISION

PART 8. THE TRANSMITTING AERIALS

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THE TRANSMITTING AERIALS

The Vision Aerial

The design of the aerial and feeder system is very complex. What is required is that the transmitter should feed its power into an impedance which is a pure resistance over the range comprising the carrier and both sidebands. In addition it is necessary that the aerial itself should not waste power by radiation in an upward direction or by induction into the mast, and furthermore that the radiation of power should be uniform in all directions. Very careful design is necessary to achieve all these results.

In consideration of the method adopted at the London Television Station, it will be best to start with the aerial. In order to get a uniform distribution of power in all directions, it was decided to have eight aerials uniformly spaced round the mast. In order to prevent upward radiation and induction into the mast, eight reflectors are provided between the aerials and the mast. Each aerial consists of a pair of push-pull end-fed dipoles. Push-pull design was adopted in order to obtain the best symmetry, and to prevent radiation through the short lengths of wire feeding the dipoles. Each dipole consists of three wires arranged in the form of a triangle on a 15 in. base, and this is done in order to simulate a dipole of considerably greater diameter than that of a wire, i.e. to form a cylinder. Although the dipole will be in tune at the carrier frequency, it will have reactance on the sideband frequencies, and the variation of this with frequency must be kept to a minimum if phase distortion of the picture is to be avoided. The reactance depends upon the product of the characteristic impedance of the dipole and the tangent of an angle, which angle is a function of the length of the dipole and of the frequency. For a minimum value of reactance, however, the tangent and the characteristic impedance should both be a minimum, and since the characteristic impedance of the cylindrical dipole is less than that of a wire dipole, the cylindrical construction is adopted. The length is also adjusted to be somewhat less than half the wavelength.

With regard to the reflectors the best compromise between their interference upon the aerials and the production of optimum field strength diagrams indicates that they should be somewhat greater than half the wavelength long.

The first transformation which is necessary is to proceed from the push-pull condition to the asymmetrical condition necessary to suit the concentric feeder. The eight push-pull aerials are, therefore, all joined in parallel and the push-pull reflectors are energised from the aerial feeders at a $\frac{1}{4}$ wavelength behind the aerial. One side of the push-pull aerial-reflector system is now joined to a $\frac{1}{2}$ wavelength section of concentric feeder, the other end of which is joined to the other side of the system. One end of the half wavelength section of concentric feeder thus becomes the common input to all the individual aerials and reflectors, since the insertion of the half wavelength section of concentric feeder into one side only of the push-pull aerial system creates the necessary phase difference of 180 . The push-pull aerial-reflector system can therefore now be fed from an asymmetric or concentric feeder. The impedance of this system so joined is complex, consisting of 20 ohms resistance plus some reactance.

Unfortunately, however, the value of 20 ohms only applies to the carrier and is a maximum at that frequency, falling off on either side. The characteristic impedance of the feeder is 78.5 ohms without any reactance, and that is what is shown to the transmitter. It is therefore necessary to transform the variable resistive impedance of 20 ohms plus a reactance into a fixed impedance of 78.5 ohms with no reactance. This is brought about by a number of transformers. The junction box for the aerials is termed the trunk, and the first operation is that a length of concentric feeder is connected to the trunk about 75° long and having an inner tube of 2-9/16 in. diameter. This constitutes a concentric transformer which changes the complex impedance of the aerials, consisting of 20 resistive ohms variable over the band width plus a reactance, into a resistive impedance of 78.5 ohms also variable over the band width plus no reactance. This new resistive impedance is inverted, being now a mimimum at the carrier frequency.

It is possible to calculate that at a certain distance from the point of commencement of the feeder proper in the direction of the transmitter there will be a point at which the nature of the impedance has changed. Instead of exhibiting the characteristics of a resistance variable over the required band width but devoid of reactance, the impedance at this point becomes a resistance constant over the band width but combined with a reactance. By breaking in at this point and introducing a parallel tuned circuit from the inner to the outer conductor it will be possible to remove this reactance leaving what is desired, an impedance composed of a resistance steady over the band width. The tuned circuit introduced does not, of course, consist of a coil and condenser, but of a certain length of short-circuited and also of open-circuited feeder fixed to the sides of the main feeder forming a cross.

In the case of the vision transmitter it was found advisable that the transmitter should look into an impedance of 50 ohms. Accordingly final transformation is effected from 78.5 ohms to 50 ohms in the last vertical section of the feeder where it enters the modulated amplifier in the Transmitter

Hall. A monitor is incorporated in this transformer so that the outgoing waveform may be observed on the control table oscillograph.

The above is concerned solely with the creation of the correct aerial impedance for presentation to the transmitter, but the feeder itself must be prevented from introducing irregularities, which it will naturally do if uncorrected. Examples of such irregularities are that when going round a corner the inductance of the feeder increases because the number of flux linkages of the magnetic field is greater. In addition, if it is necessary for mechanical considerations to put in additional internal supports at any point the capacity will increase. Then again the impedance of the feeder when horizontal may not be the same as when it is vertical, as in the latter case the inner conductor is truly central but in the former it sags. There is also the problem of the support of the inner conductor within the outer tube, as the supports must inevitably represent capacities. A solution to the latter problem has been found by spacing the supports at intervals of a $\frac{1}{4}$ wavelength, as the capacity produced by a support will appear a $\frac{1}{4}$ wavelength down the feeder as an inductance which will be tuned out by the similar capacity of an identical support placed at this point. In the feeders for this station the supports are spaced $\frac{1}{8}$ wavelength apart and every alternate support tunes out the inductance produced by the capaeity of the support next but one down the feeder.

A feeder of this kind, therefore, cannot be erected straightforwardly, but erection must be stopped frequently for measurement. As each section is added, and particularly when going round corners, it is necessary to measure the impedance-frequency characteristic, and if the inductance has been increased by a corner then it must be counteracted by the introduction of a small capacity at this point, or on the other hand if additional supports have raised the capacity then inductance must be added by reducing the size of the inner conductor. In practice both factors are present and the situation is met by fitting a large junction box at corners, in order to reduce the capacity at such points actually to less than the normal value, and by providing a small variable condenser by means of which the value of the total capacity can be adjusted as required in order to correct for the increased inductance. Lastly, a useful formula may be quoted: *If an irregularity is noticed in the impedance-frequency characteristic over the band width at a frequency F Mc/s, this will be caused by a feeder irregularity L feet along the feeder from the transmitter, where F and L are connected by* $F = \frac{492}{L}$

The Sound Aerial

In this case the problem is comparatively simple. The aerial system is similar to that provided for vision and, like it, is fitted with reflectors and with a transformation to the asymmetrical condition that enables the complete system to be fed from a common concentric feeder. The impedance then shown is a few ohms plus some reactance. In this case, since the band width to be covered is trifling, it suffices to tune out the reactance at the carrier frequency by means of a small length of feeder representing a condenser A transformation comparable to that employed in the vision aerial is effected to change the impedance to approximately 80 ohms, but the small correction to 78.5 ohms provided for the vision system is not required. No further transformers are provided and the impedance shown to the sound transmitter is approximately 80 ohms.