SECTION 5

TELEVISION EQUALISERS TV/EQ/7, TV/EQ/8, TV/EQ/17

Introduction

The Television Equalisers Types TV/EQ/7, 8 and 17 form part of the equalising apparatus used with balanced cable employed for the transmission of television signals. The apparatus is described in general in Section 3 of this Instruction. This section deals with the first two equalisers of the apparatus, TV/EQ/7 or TV/EQ/17 followed by TV/EQ/8. These provide coarse equalisation according to the length of cable employed; for the 1-inch balanced cable, correction for a maximum length of seven miles of cable is obtainable. All three equalisers are mounted in 19-inch panels, and are bay mounted.

The basic difference between Types TV/EQ/7 and TV/EQ/17 (shown in Fig. 2) is the impedance level; Type TV/EQ/7 is designed to work between 186-ohm terminations and Type TV/EQ/17 between 100-ohm terminations. The type employed in a given installation is dependent upon the class of incoming cable most usually encountered. Type TV/EQ/17 is most suitable for use with a telephone pair, the characteristic impedance of which is approximately 100 ohms whilst Type TV/EQ/7 is used with the 186-ohm balanced cable. If STC 140-ohm cable is used, there is a smaller overall loss if the TV/EQ/17 is employed.

The equalisers TV/EQ/7 and TV/EQ/17 incorporate repeating coils used to terminate the cable, and these repeating coils require correction at high and low frequencies. High-frequency correction is provided in the parent equaliser. Low-frequency correction is provided in the second equaliser TV/EQ/8. Part of this latter correction is by means of a non-constant resistance section; the remainder of the equaliser, is however, designed to work between 75-ohm terminations.

Because of their similarity, equalisers TV/EQ/7 and 17 are described together. The equaliser TV/EQ/8 is described separately later. All three equalisers make extensive use of constant-resistance sections, and these are discussed in general below.

Constant-Resistance Equalising Sections

A constant-resistance equalising section is a network the input impedance of which is constant, and which has an insertion loss varying with frequency. In the balanced-cable equalisation equipment, these sections are of the form of bridged-T sections of the type shown in Fig. 5.1(a). The theory of this type of equaliser is discussed in detail in Technical Instruction V.1, Section G, but a brief summary is given below. The bridged-T equaliser can be derived from the bridge circuit of Fig. 5.1(b) where the terminating resistance of Fig. 5.1(a) is shown explicitly between points C and D. It can be shown that the condition for the input impedance to be constant, and equal to R_0, is that $R_0^2 = Z_1 . Z_2$. This is also the condition that the bridge is balanced, i.e. that there is no e.m.f. across points C and E. In fact, the resistance R_0 connected between these points could be omitted, or of any value. The value selected, R_0, ensures that the output impedance is constant, and

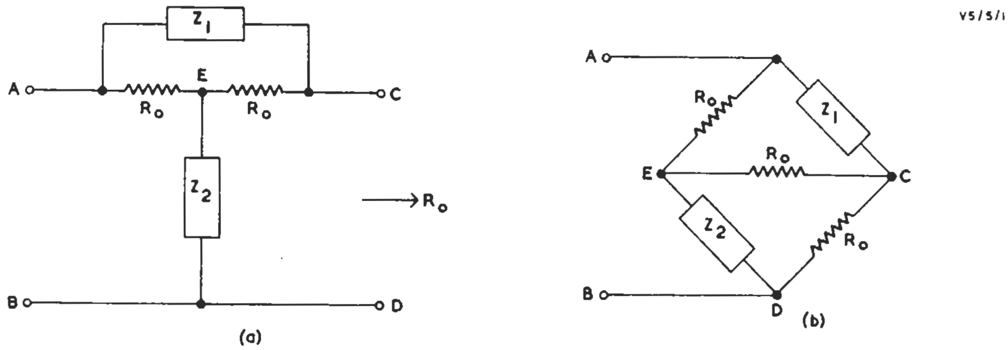

Fig. 5.1. (a) Circuit of Bridged-T Network (b) Network of (a) re-drawn in Bridge Form

equal to R_0 when the source impedance is R_0. By inspection, the output voltage, E_0, is related to the input voltage, E_{in}, by the expression

$$E_0 = E_{in} . R_0/(R_0 + Z_1).$$

Since Z_1 can be a complex impedance, the gain can be made to vary with frequency.

In the circuits employed in the cable equalisers under consideration, Z_1 is a resistor in parallel with either a capacitor or a capacitor and inductor in series (' resonant ' section). The inverse impedance Z_2 then comprises a resistor in series with an inductor or a resistor in series with a parallel-tuned circuit. The shape of the frequency response of the former type is shown in Fig. 5.2(a). This curve is determined entirely if two parameters are known, and those usually quoted are the loss at zero frequency, and the ' half-loss ' frequency, i.e. the frequency at which the attenuation is half that at zero frequency. From inspection of Fig. 5.2(a), it is obvious that zero loss occurs only at infinite frequency. This type of equaliser is however, used almost entirely with half-loss frequencies below 1 Mc/s, with the effect that there is very little residual attenuation at 3 Mc/s.

With the ' resonant ' type of section, the parameters usually quoted are the zero-frequency loss, the resonant frequency of the series inductance and capacitance (this frequency is also the resonant frequency of the parallel-tuned circuit in the impedance Z_2) and the ratio of the inductors, which is also equal to the inverse ratio of the capacitors. Variation of the latter ratio alters the shape of the curve, as shown in the nest of curves of Fig. 5.2(b). This type of section is employed to give high-frequency correction, since it provides the required steepness of characteristic. The resonant frequency is usually well outside the passband, in the region of 4 to 5 Mc/s.

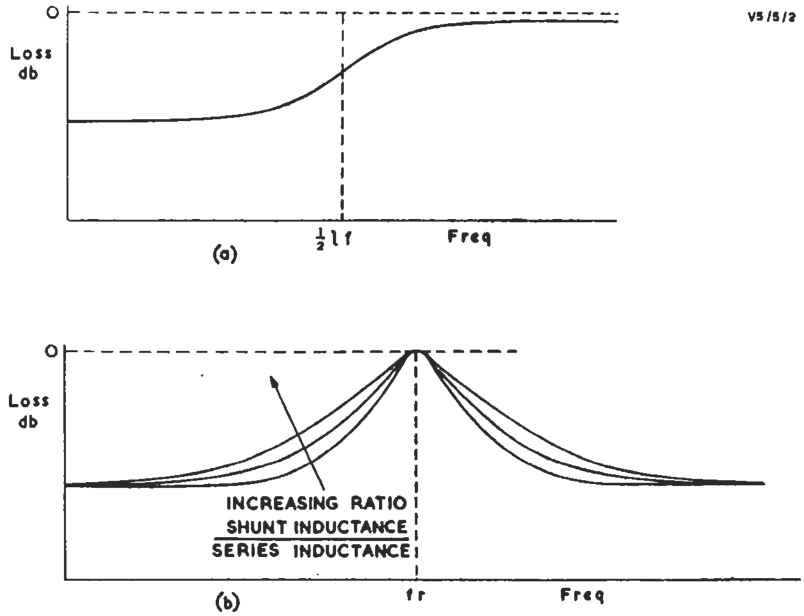

Fig. 5.2. (a) Response of Bridged-T Network of Fig. 5.1 (a) with Z_1 comprising a Resistor and Capacitor in Parallel (b) as (a) but with Z_1 comprising a Resistor in Parallel with a Series-resonant Circuit

Circuit Description

TV/EQ/7 and TV/EQ/17

These equalisers are identical in performance, differing only in that Type TV/EQ/7 works between 186-ohm terminations and type TV/EQ/17 between 100-ohm terminations. When used with the balanced-cable equipment, they are designated BAL. CABLE EQUALISER NO. 1. The circuit diagrams are given in Fig. 2. The following description applies to both:

The input signal is fed via two coaxial leads, operated as a balanced pair, to two Musa plugs. From these, the signal is fed to the repeating coil

TR.1 which provides an unbalanced output from the balanced input. The coil is preceded by a network of elements, which are chosen to ensure that the input impedance is substantially resistive and constant at all frequencies in the working range. The elements required vary with each individual repeating coil, and are selected on test. Thus if a repeating coil is to be changed, the associated input impedance correcting network must be changed also. In the TV/EQ/17, these elements are omitted.

Following the repeating-coil is a constant-resistance ' resonant ' section, which provides correction for the h.f. losses associated with the repeating coil. This section is adjusted according to the requirements of the repeating coil, and must be changed with its associated repeating coil.

The remainder of the equaliser comprises cable equalisers which can be switched into circuit when required. The operating keys project through the front panel; the input and output keys are separated physically and are operated together by a bar linking the handles. When not in circuit, the equalisers are replaced by attenuator pads having the same low-frequency insertion loss.

The second constant-resistance equaliser comprises four separate constant-resistance sections. One of these is of the ' resonant ' type, and provides high-frequency correction; this is identical with the single resonant section mentioned above. The other three sections provide medium-frequency correction. The parameters of these sections are

(1) zero-frequency loss 1 db, half-loss frequency 28 kc/s,
(2) zero-frequency loss 2 db, half-loss frequency 157 kc/s and
(3) zero-frequency loss 2 db, half-loss frequency 470 kc/s.

Three response curves of the four sections together provide a smoothly rising characteristic providing the equalisation required. This equaliser is designated ' 2-mile equaliser '.

TV/EQ/8

This equaliser comprises three separate equalisers, providing equalisation for the repeating-coil low-frequency characteristic and for 1-mile and 2-mile section of average 1-inch balanced cable. The three equalisers are terminated on Musa plugs, to provide

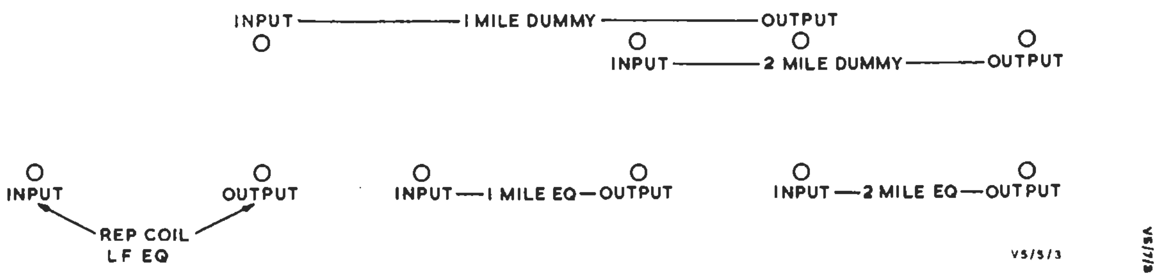

Fig. 5.3. Layout of Musa Plugs at Rear of TV/EQ/8

Each equaliser is designed to correct for the frequency characteristic of two miles of average 1-inch cable. The two equalisers are not, however, identical. The first equaliser has a single ' resonant ' section providing high-frequency correction only. This equaliser is designated ' 2-mile resonant equaliser '. The zero-frequency loss is 12·7 db, and the resonant frequency is 4·2 Mc/s. When this equaliser is employed, low- and medium-frequency correction has to be inserted by means of the ' fine control ' Bode equalisers situated later in the equalising chain. This is a desirable feature, since it permits of fine adjustment of the low- and medium-frequency response of the overall characteristic. The point is discussed in some detail in Section 3.

flexibility in setting-up. Additionally, attenuator pads are provided to replace the 1- and 2-mile equalisers. The arrangement of Musa plugs, at the rear of the unit, is shown in Fig. 5.3. When used with the balanced-cable equipment, the equaliser is designated BAL. CABLE EQUALISER NO. 2.

The first equaliser (' Repeating Coil L.F. Equaliser ') is a non-constant-resistance network which provides the low-frequency correction for the repeating coil of the TV/EQ/7 or TV/EQ/17. This equaliser is designed to work from a 75-ohm source. The combination of R1, R2, C1 provides a variable low-frequency correction in the region of field frequency. The variation is accomplished by R_2, which is provided with a control knob moving over a graduated scale on the front panel. The network also embodies a constant-resistance section (75 ohms) having a nominal half-loss frequency of 600 c/s. The high-frequency loss is variable in 0·1 db steps from 0·5 db to 1·5 db. The variation is accomplished by switch SA, which projects through the front panel. This alters simultaneously the resistance in parallel with L_1 and the resistance in series with C_2 to maintain the constant-resistance conditions.

The second equaliser (' 1-mile Equaliser ') comprises four constant-resistance sections of 75-ohms impedance providing equalisation for the characteristics of 1 mile of average 1-inch balanced cable. High-frequency correction is provided by a single resonant section having a zero-frequency loss of 6·3 db and a resonant frequency of 4·5 Mc/s. The three preceding sections provide medium frequency correction and have parameters

(1) zero-frequency loss 0·5 db, half-loss frequency 69·5 kc/s,
(2) zero-frequency loss 1·0 db, half-loss frequency 270 kc/s and
(3) zero-frequency loss 1·0 db, half-loss frequency 478 kc/s.

The total zero-frequency loss is thus 8·8 db, and an attenuator pad of this value is provided, to be placed in circuit if this equaliser is to be removed from circuit at a time when it is not convenient to alter amplifier gains. If time permits of re-setting the amplifier gains, then it is preferable that the pad should not be used in order to achieve the highest signal-to-noise ratio.

The third equaliser (' 2-mile Equaliser ') comprises four constant-resistance sections of 75-ohms impedance providing equalisation for the characteristics of 2 miles of average 1-inch balanced cable. High-frequency correction is provided by a single resonant section, having a zero frequency loss of 12·7 db and a resonant frequency of 4·2 Mc/s. The three preceding sections provide medium-frequency correction and have parameters

(1) zero-frequency loss 1·0 db, half-loss frequency 28 kc/s,
(2) zero-frequency loss 2·0 db, half-loss frequency 157 kc/s and
(3) zero-frequency loss 2·0 db, half-loss frequency 420 kc/s.

The total zero-frequency loss is thus 17·7 db and an attenuator pad of this value is provided to enable rapid changes to be made between equaliser in circuit and out of circuit without alteration to amplifier gain settings.

TEST SPECIFICATIONS

TV/EQ/7

(1) With the output terminated in 186 ± 1 ohms, the dummy loss pads in circuit, and using a source of 186-ohms output impedance balanced with respect to earth, the overall response should be flat within 0·25 db from 10 kc/s to 3 Mc/s. A suitable source of test signal is a sending amplifier TV/SA/1 or TV/PSA/1. Allowance should be made for any deficiencies of the frequency response of this amplifier.

(2) With the ' 2-mile Resonant Equaliser ' terminated in 186 ± 1 ohms, and fed from a source of 186-ohms output impedance, the response of this equaliser at the test frequencies listed below should be within 0·1 db of the figures quoted.

2-mile Resonant Equaliser

Frequency	*Insertion loss (db)*
10 kc/s	12·7
50 ,,	12·7
100 ,,	12·65
200 ,,	12·5
300 ,,	12·35
500 ,,	11·75
700 ,,	10·9
1 Mc/s	9·6
1·5 ,,	7·3
2·0 ,,	5·2
2·5 ,,	3·25
3·0 ,,	1·65

(3) With the ' 2-mile Equaliser ' terminated in 186 ± 1 ohms, and fed from a source of 186-ohms output impedance, the response of this equaliser at the test frequencies listed below should be within 0·1 db of the figures quoted.

2-mile Equaliser

Frequency	*Insertion loss (db)*
10 kc/s	17·57
20 ,,	17·35
30 ,,	17·07
50 ,,	16·68
70 ,,	16·43
100 ,,	16·05
200 ,,	14·95

2-mile Equaliser (continued)

Frequency	Insertion loss (db)
300 ,,	14·07
500 ,,	12·7
700 ,,	11·5
1 Mc/s	9·9
1·5 ,,	7·5
2·0 ,,	5·25
2·5 ,,	3·3
3·0 ,,	1·7

TV/EQ/17

As for TV/EQ/7 above, except that where 186 ohms occurs in the above, read 100 ohms.

TV/EQ/8

(1) With a terminating resistance of 75 ± 1 ohms, connected to the output of the ' 2-mile Equaliser ', and fed from a source of 75-ohms output impedance, the response of this equaliser at the test frequencies listed below should be within 0·1 db of the figures quoted.

2-mile Equaliser

Frequency	Insertion loss (db)
10 kc/s	17·5
20 ,,	17·2
30 ,,	17·0
50 ,,	16·63
70 ,,	16·35
100 ,,	16·0
200 ,,	14·85
300 ,,	14·05
500 ,,	12·68
700 ,,	11·48
1 Mc/s	9·92
1·5 ,,	7·38
2·0 ,,	5·18
2·5 ,,	3·24
3·0 ,,	1·7

(2) With a terminating resistor of 75 ± 1 ohms, connected to the output of the ' 1-mile Equaliser ' and fed from a source of 75 ohms, the response of this equaliser at the test frequencies listed below should be within 0·1 db of the figures quoted.

1-mile Equaliser

Frequency	Insertion loss (db)
10 kc/s	8·66
20 ,,	8·62
30 ,,	8·59
50 ,,	8·45
70 ,,	8·34
100 ,,	8·19
200 ,,	7·71
300 ,,	7·26
500 ,,	6·59
700 ,,	6·05
1 Mc/s	5·26
1·5 ,,	4·05
2·0 ,,	2·94
2·5 ,,	1·83
3·0 ,,	1·03

Transient Response of TV/EQ/7 or TV/EQ/17 with TV/EQ/8

Under working conditions, the transient response of the first two equalisers of the balanced-cable equalisation equipment should be checked as follows:

(1) The input equaliser should be fed from a source having an output impedance of 100 or 186 ohms balanced with respect to earth, according as to whether the equaliser is Type TV/EQ/17 or TV/EQ/7. The first equaliser (TV/EQ/7 or TV/EQ/17) should feed into an amplifier TV/A/1, the input impedance of which is selected to match that of the equaliser. The equaliser controls should be set to DUMMY. The gain of the amplifier should be set to 30 db approximately, being set to give an output of 1 volt d.a.p. into a 75-ohm load. The output of the repeating-coil l.f. equaliser of the TV/EQ/8 should be terminated in 75 ohms, and the output should be displayed on a waveform monitor. The sending amplifier should be fed from a test generator TV/TG/1.

(2) With a field-bar waveform from the test generator, the l.f. equalisation control of the TV/EQ/8 should be adjusted for best waveform.

(3) With a 2-microsecond line bar from the generator, the rise and fall times of the displayed output pulse should be less than 0·14 microseconds. (Note: The rise and fall times of the generator pulse should be less than 0·1 microseconds). The overshoot of the pulse should be less than 10 per cent, and the ringing frequency should be greater than 4 Mc/s.

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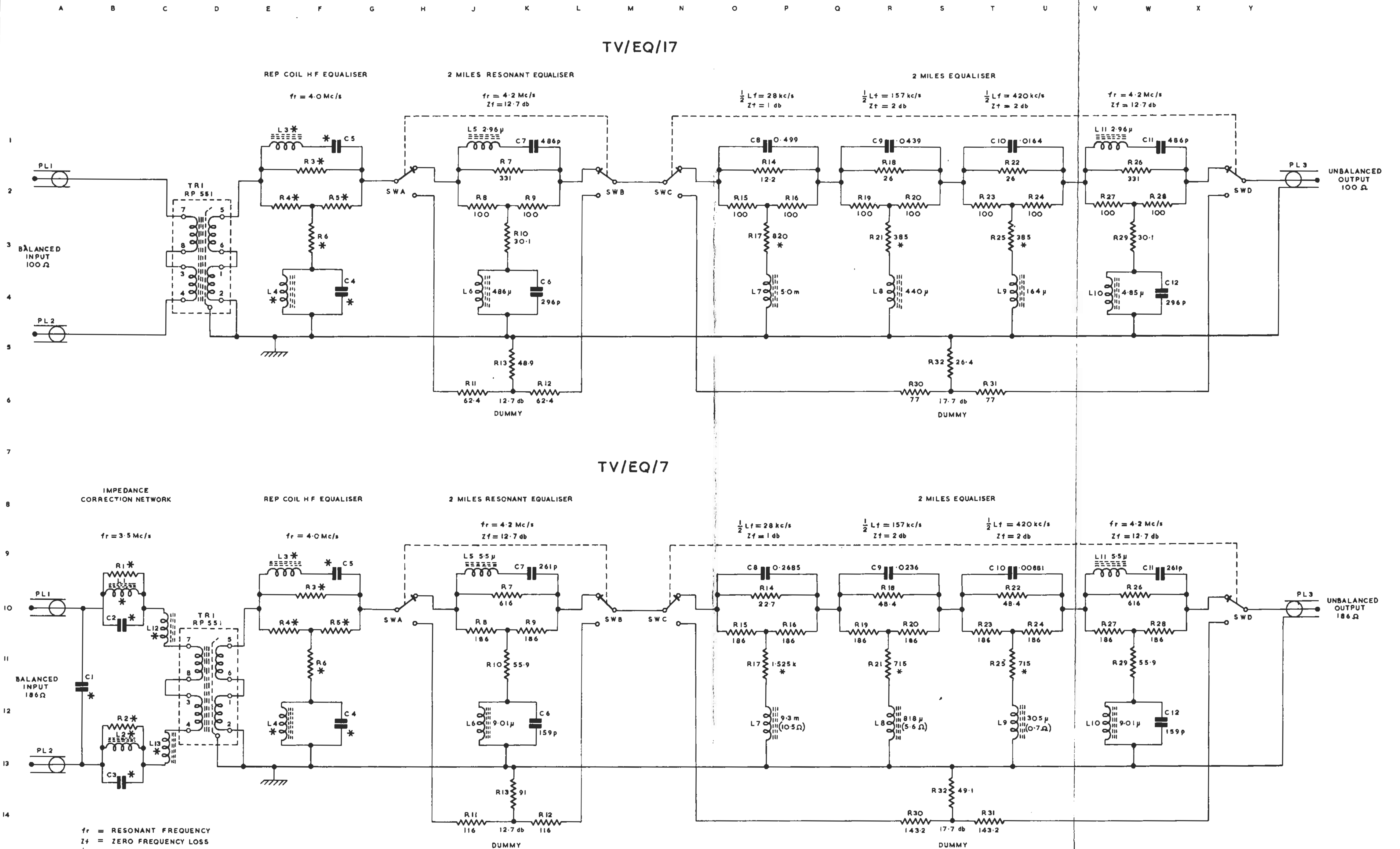
FIG 2 V5



fr = RESONANT FREQUENCY
Zf = ZERO FREQUENCY LOSS
½ Lf = HALF LOSS FREQUENCY
* ADJUSTED ON TEST

TELEVISION EQUALISER TV/EQ/17, TV/EQ/7

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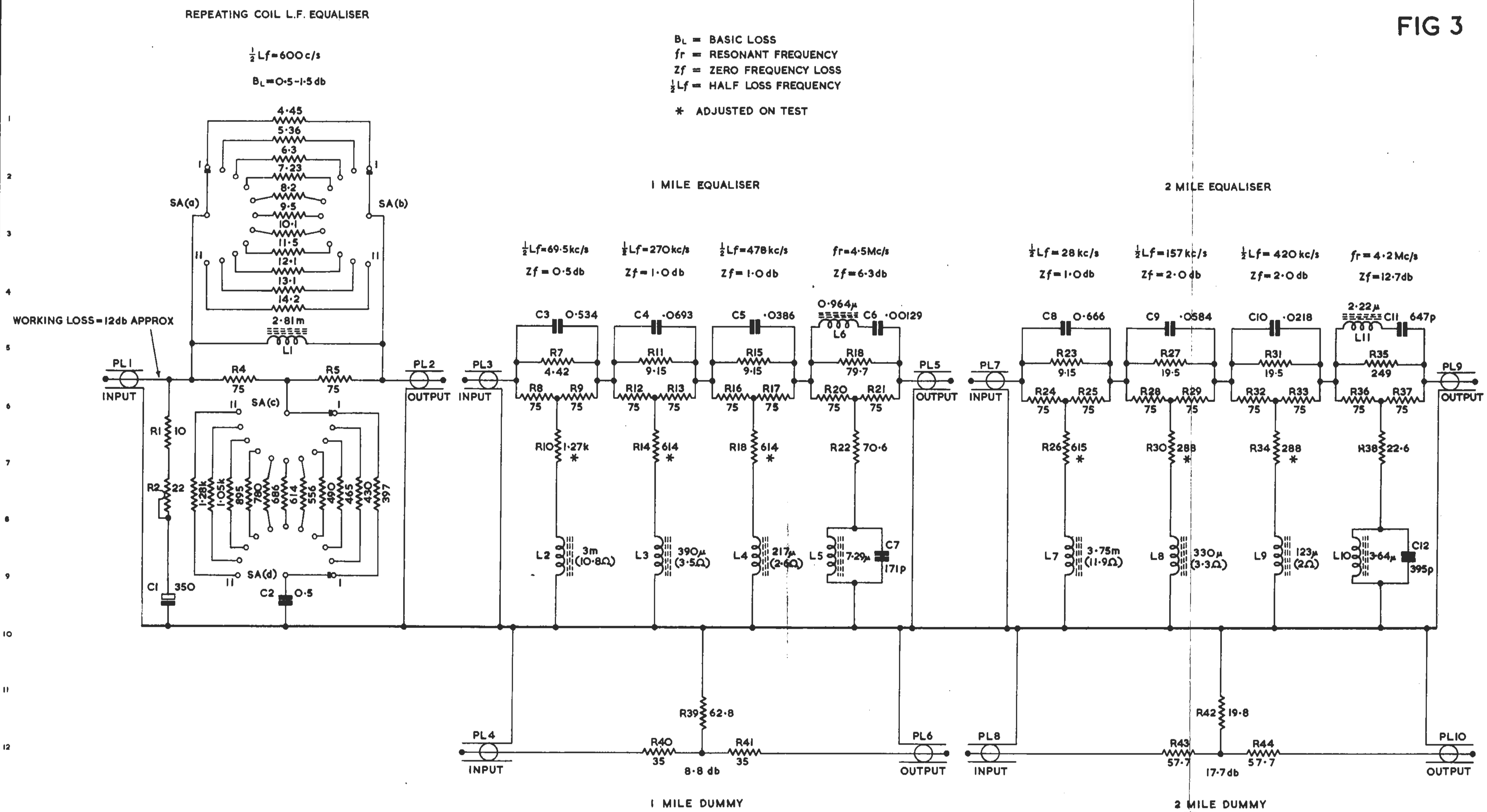
FIG 3



TELEVISION EQUALISER TV/EQ/8

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