SECTION 5

HARMONIC ROUTINE TESTER FHP/3

The Harmonic Routine Tester FHP/3, when used in conjunction with a variable-frequency oscillator and an amplifier detector, permits the measurement of total harmonic content at the two fundamental frequencies of 100 c/s and 1 kc/s. The unit is essentially a high-pass filter, i.e., a filter which rejects low frequencies and allows high frequencies to be passed through it, the frequencies at which cut-off begins to take place being determined by the values of the constituent parts. In the FHP/3, these cut-off frequencies are fixed at 1·5 kc/s and 150 c/s approximately.

Circuit Description FHP/3 (Fig. 3)

Referring to the circuit diagram, it will be seen that the unit comprises an input jack, repeating coil, high-pass filter, terminating resistors, change-over key and output jack. The theorectical diagrams (Figs. 5.1, 5.2, 5.3) show the circuit arrangements for each position of the key.

(i) Central Position (Fundamental)

In the central position, the circuit is as shown in Fig. 5.1, R1 and R2 being connected in parallel and shunted across the secondary of the repeating coil; when the 30 kilohm input of the AD/4 is connected to the output of FHP/3, therefore, the repeating coil has a 600-ohm load.

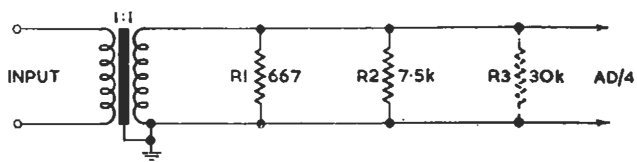


Fig. 5.1. Filter Circuit when Measuring Fundamental

Let R_3 = input impedance of $AD/4$ = 30 kΩ
We then have

$$\frac{R_2R_3}{R_2+R_3} = \frac{7{,}500 \times 30{,}000}{7{,}500 + 30{,}000} = 6\ \text{k}\Omega$$

This 6 kilohms is shunted by R1 = 667 Ω therefore, the repeating coil is loaded by

$$\frac{6{,}000 \times 667}{6{,}000 + 667} = 600\ \Omega$$

(ii) 1-kc/s Position

When the key is put to the 1-kc/s position (Fig. 5.2), the high-pass filter is introduced into the circuit. The output impedance of the filter is 6 kilohms and its termination is provided by R_2 and R_3 in parallel, i.e., 6 kilohms. The repeating coil is, therefore, terminated by 667 ohms shunted by 6 kilohms, i.e., 600 ohms.

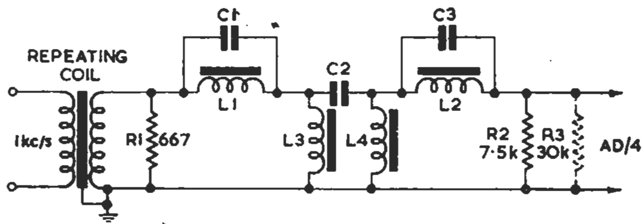


Fig. 5.2. Filter Circuit when Measuring Harmonics at 1 kc/s

The filter is designed to reject 1 kc/s and all frequencies below. It is a two-section filter, one of the sections being the simplest type of high-pass section, the *prototype*; the other section is one derived from the prototype by a process known as *M-deriving*, which will give resonant arms, and introduce very great loss over a narrow-band of frequencies. M-derived sections may be designed so that they have an impedance which, in nearly all the pass range, is a constant resistance; for this reason they are very suitable for putting at the ends of composite filters where they provide a better termination than would the ordinary prototype. For this reason the M-derived section is cut into two halves and the halves placed one at each end of the filter with the prototype in the middle. The total loss of the filter will then be, for about 95 per cent of the pass range, the sum of the attenuation of the individual sections. In the stop range, however, there may be serious impedance mismatches at the input and output of the filter, and for this reason, total losses introduced by the filter will be less than the sum of the attenuations of the individual sections.

The attenuations of the M-derived section, of the prototype section, and the approximate total loss of the filter, are shown in Fig. 5.3 curves *A*, *B* and *C* respectively. The resultant characteristics show that there is a high loss at all frequencies below 1·5 kc/s and a particularly high loss in the immediate neighbourhood of 1 kc/s. The loss at all harmonic frequencies is low.

In the 1 kc/s position of the key, the reading obtained on the amplifier detector will represent the total of the harmonic content at 1 kc/s, enabling the percentage distortion to be obtained by a simple calculation.

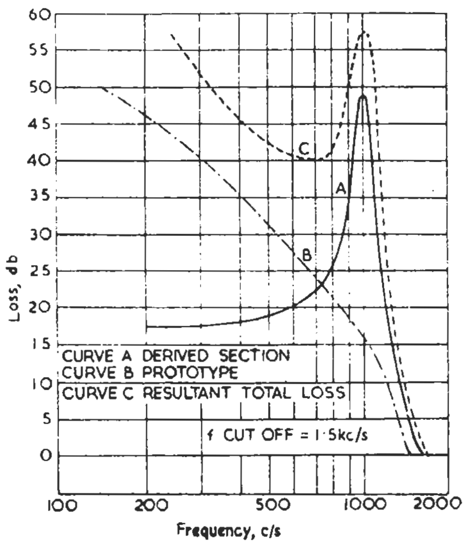


Fig. 5.3. Loss Curves for Filter, 1-kc/s Position

Thus, if the level of the fundamental = + 4 db and that of the total harmonic content = − 26 db, by finding the voltage ratio for − 30 db and multiplying this ratio by 100, the percentage harmonic content is obtained. In the example quoted the voltage ratio = ·0316. Hence the percentage harmonic content = 3·16.

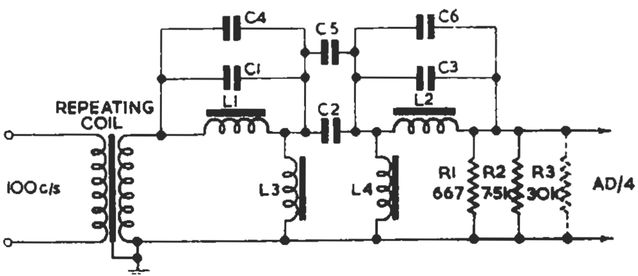


Fig. 5.4. Filter Circuit when Measuring Harmonics at 100 c/s

(iii) 100-c/s Position (Fig. 5.4)

In the 100-c/s position, similar conditions obtain as those indicated above, except that the capacitors C4, C5, C6 are paralleled across C1, C2, C3. The effect of this is to multiply the capacitance in each case by 100; the cut-off frequency, f_0 and the filter output impedance Z_0 are, therefore, both divided by 10. The filter is then terminated by 667, 7,500 and 30,000 ohms in parallel, and its termination impedance is 600 ohms.

Input Impedance

Figure 5.4 shows that in the 100-c/s position, the repeating coil is not directly shunted by R1; the input impedance is therefore high at the fundamental frequency. If, however, the apparatus under test is designed to work into a 600-ohm load, a 600-ohm 10-db attenuator should be connected between the output of the apparatus and the input to the FHP/3.

In the 1-kc/s position, the input impedance is limited by the inclusion of R1 across the repeating coil and the attenuator is not essential. Normally, however, tests at both frequencies are required and there is no object in switching the attenuator in and out of circuit. It is recommended, therefore, that the attenuator be used for all normal routine tests.

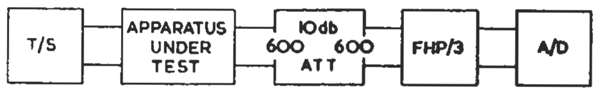


Fig. 5.5. Test Circuit: Block Schematic

Operation (Fig. 5.5)

(i) Switch on variable oscillator, amplifier detector and apparatus to be tested.
(The oscillator, Type PTS/9, is ***not suitable*** for use with the FHP/3, since its harmonic content is likely to be greater than that of the apparatus under test.)

(ii) Check oscillator for zero beat and calibrate amplifier detector in accordance with instructions given in Sections 9 and 1.

(iii) Plug the tone source to the apparatus or line input; insert a 600-ohm attenuator set for 10-db loss between apparatus or line output and FHP/3 input. Plug the output of FHP/3 to the high-impedance input of the AD/4.

(iv) With key in central position, measure the level of the fundamental with the apparatus under test set for normal output level.

(v) With key in 1-kc/s position, measure the level of the total harmonic content.

(vi) Repeat (iv) at 100 c/s, then (v) with the key in the 100-c/s position.

For normal routine tests, it is sufficient to enter the levels upon the appropriate forms. In cases where the results are to be expressed in terms of percentage distortion, the method of calculation described in the text of this Instruction should be used.

Checking Filter Characteristics

If, for any reason, it becomes necessary to check the filter characteristics, it is essential that precautions are taken to eliminate harmonics from the tone source.

The following table indicates typical loss frequency characteristics for both ranges.

100-c/s Filter		1-kc/s Filter	
f(c/s)	*Loss(db)*	*f(c/s)*	*Loss(db)*
50	44·6	500	42·5
70	41·2	700	41·4
90	48·8	900	51·6
Peak 99	55·0	Peak 980	63·0
100	54·5	1,000	58·6
110	30·5	1,100	37·9
130	12·9	1,300	10·2
150	6·2	1,500	0·3 Gain
200	1·3	2,000	0·5
300	0·8	3,000	0·5
400	0·5	4,000	1·0
500	0·5	5,000	1·2

FHP/3A and PFHP/3A

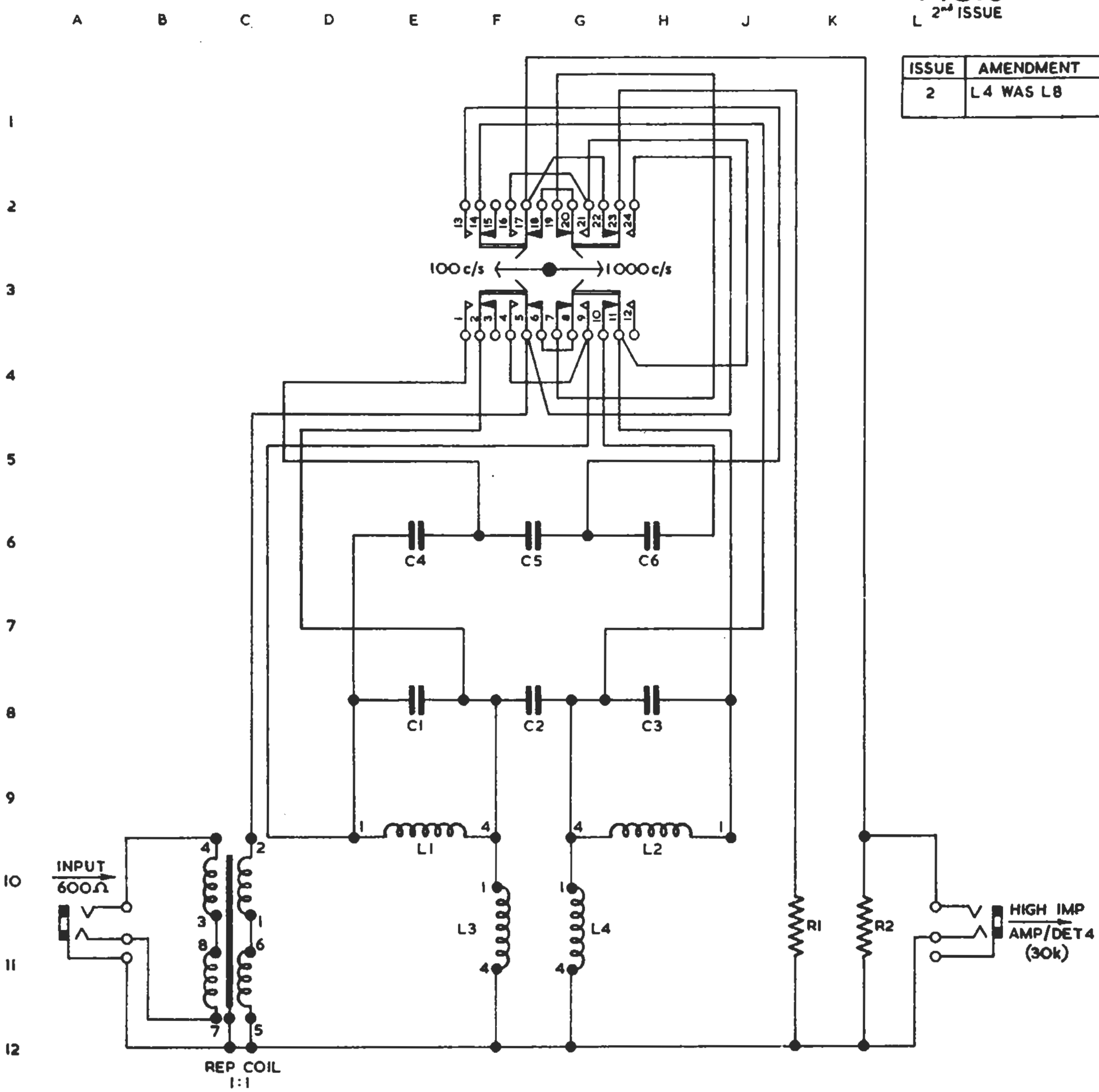
These units and the FHP/3 are identical electrically but the A versions are physically smaller. The PFHP/3A is a portable form which is mounted in a wooden carrying case.

FIG.3 S4

2nd ISSUE

ISSUE	AMENDMENT
2	L4 WAS L8

64099C/S4/AJDC



COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE
C1	E8	0·026 ±2%		L2	H9	0·92	DD4424-293
C2	G8	0·0092 ±2%		L3	F11	0·394	DD4424-292
C3	H8	0·026 ±2%		L4	G11	0·394	DD4424-292
C4	E6	2·62 ±2%					
C5	G6	0·92 ±2%		R1	K11	667	
C6	H6	2·62 ±2%		R2	L11	7·5k	
				REP COIL	C10		CD4102-3
L1	E9	0·92	DD4424-293				

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