

GRAPHICAL DETERMINATION OF INPUT IMPEDANCE OF REPEATING COIL WITH ANY TERMINATING IMPEDANCE 120E COIL

1. GENERAL

1.01 This section contains transmission characteristics of 120E repeating coils, and charts for graphically adding the effect of a 120E coil to, or subtracting it from, a given positive impedance. The charts are computed from the equivalent T network impedances and image parameters given for dc currents up to 100 ma.

1.02 The 120E repeating coil has an impedance ratio of 1.5 to 1 which is equivalent to a unity ratio coil plus an ideal 1.5:1 ratio transformer, as shown in Fig. 1. This makes it possible to obtain the input impedance of the 120E coil from charts similar to those for the 1:1 ratio coils. For a general discussion of the method of using the charts, refer to Section 304-200-100.

1.03 The input impedance Z_x looking into the high side of the 120E coil, as indicated in Fig. 2, is found by entering the appropriate chart with the value of terminating impedance $Z_T = 1.5 (Z_T + \text{cap.})$. The input impedance looking into the low side, as indicated in Fig. 3, is given by $Z_x = 2/3 Z'_x$, where Z'_x is the value of input impedance obtained from the chart for a terminating impedance Z_T plus its associated capacitor.

1.04 Figs. 1, 2, and 3 show, for computation purposes, the equivalent location of capacitors normally associated with the repeating coil, and for convenience a table of reactances of 1 mf and 4 mf at several frequencies is given below. The average value of Western Electric capacitors is usually 8 to 10% (and may be as much as 25%) higher than the nominal, with proportionately lower values of reactance.

FREQ. cps	1 mf CAPACITOR		4 mf CAPACITOR	
	NOMINAL	AVG. 1.1 mf	NOMINAL	AVG. 4.4 mf
200	-j 796	-j 723	-j 199	-j 181
300	-j 531	-j 482	-j 133	-j 121
500	-j 318	-j 289	-j 80	-j 72
1000	-j 159	-j 145	-j 40	-j 36
2000	-j 80	-j 72	-j 20	-j 18
3000	-j 53	-j 48	-j 13	-j 12

1.05 The following examples illustrate the computations for two conditions. Determine the impedance at 1000 cps looking into (1) the high side of a 120E repeating coil terminated in $600\omega + 2$ mf, with a 1 mf capacitor on the 600ω side and a 4 mf capacitor on the drop side, and (2) the low side of a 120E coil terminated in half section 22-gauge H88 cable with a 4 mf capacitor on the line side and a 1 mf capacitor on the drop side.

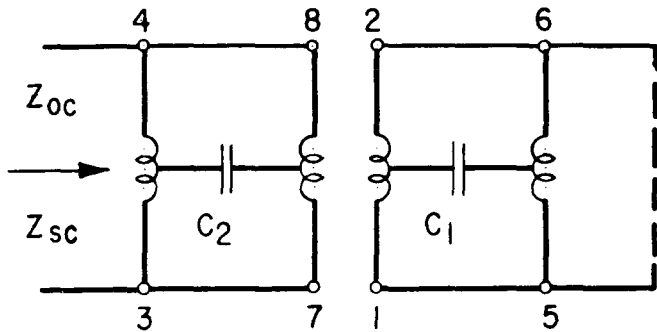
Example (1): Looking into high side of 120E coil. (See Fig. 2)

600 ω + 2 mf, Z_T	600 -j 80
1 mf capacitor	-j 159
Terminating impedance, $Z_T + \text{cap.}$	600 -j 239
$Z'_T = 1.5 (Z_T + \text{cap.})$	900 -j 359
From Chart 4,	N = 0.1
+ 1 unit,	N = 1.1
Input impedance of coil, Z_x	1020 -j 120
4 mf capacitor	-j 40
Required impedance	1020 -j 160

Example (2): Looking into low side of 120E coil. (See Fig. 3)

Midsection impedance 22 H88, Z_T	1035 -j 177
4 mf capacitor	-j 40
Terminating impedance, $Z_T + \text{cap.}$	1035 -j 217
From Chart 4,	N = 0.75
+ 1 unit,	N = 1.75
Input impedance of coil, Z'_x	1080 +j 80
$Z_x = 2/3 Z'_x$	720 +j 53
1 mf capacitor	-j 159
Required impedance	720 -j 106

2. BASIC IMPEDANCE MEASUREMENTS



Z_{oc} = open circuit impedance
 Z_{sc} = short circuit impedance
 $= 6.5 + j \omega 0.001125$
 $C_1 = 0.0060 \mu f$
 $C_2 = 0.0116 \mu f$

FREQ. cps	Z_{oc} (0.05 to 3.5 V ac)		
	0-200 ma dc	280 ma dc	360 ma dc
200	10 + j 217	6 + j 195	5 + j 184
300	13 + j 306	9 + j 280	7 + j 259
500	20 + j 495	15 + j 452	12 + j 416
1000	56 + j 974	48 + j 895	43 + j 817
1500	109 + j 1470	90 + j 1380	65 + j 1230
2000	175 + j 1917	145 + j 1740	118 + j 1610
2500	250 + j 2370	200 + j 2160	165 + j 2000
3000	338 + j 2830	255 + j 2570	215 + j 2370

3. LIST OF CHARTS

	CHART
200 Cycles per Second	1
300 " " "	2
500 " " "	3
1000 " " "	4
2000 " " "	5
3000 " " "	6

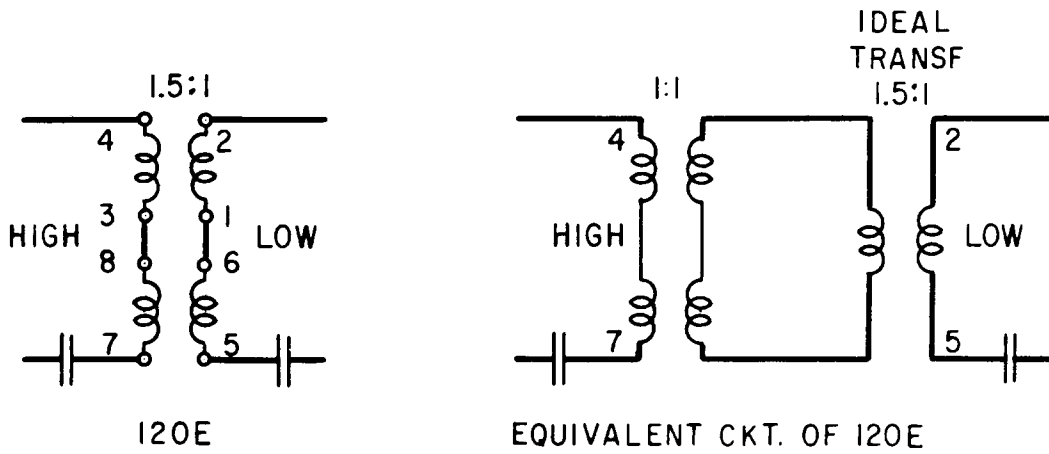


FIG. 1

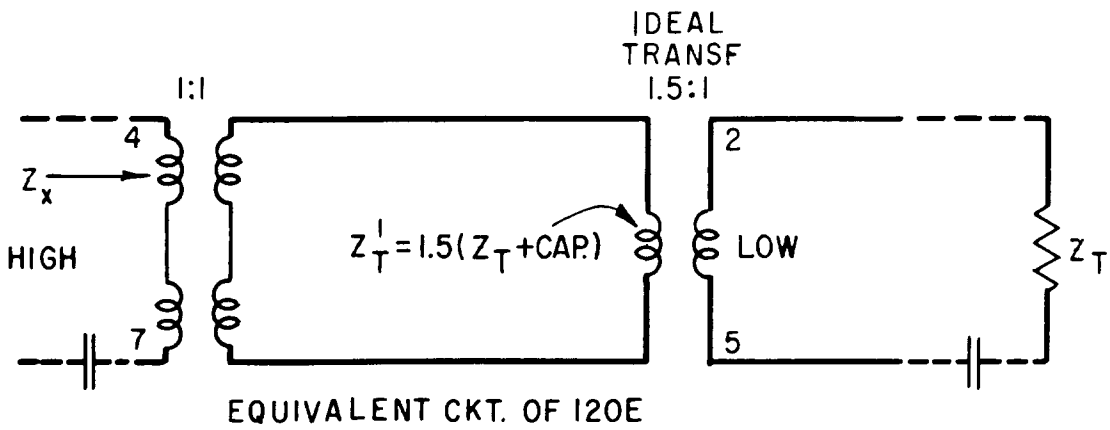


FIG. 2

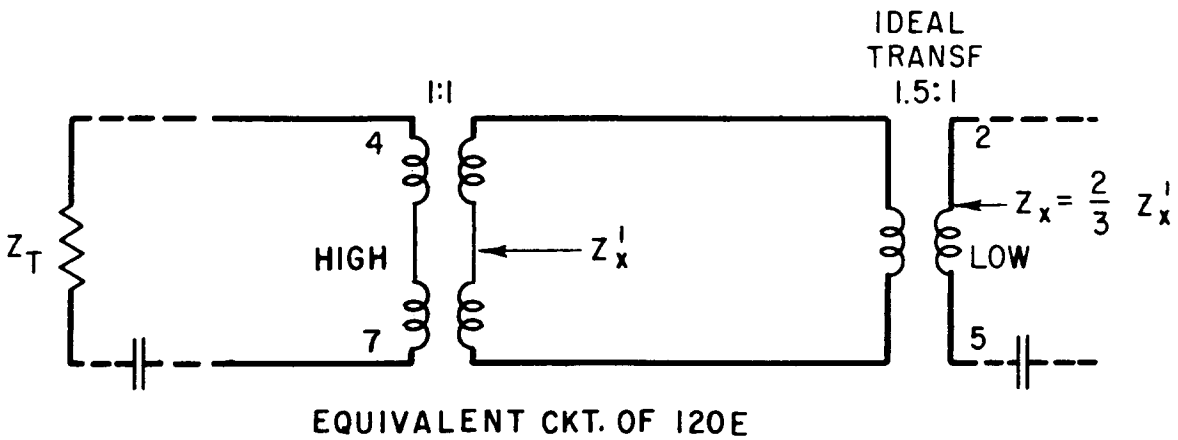


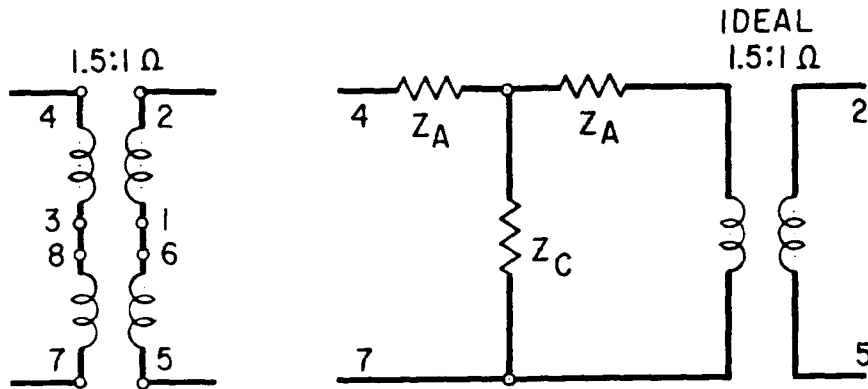
FIG. 3

TRANSMISSION CHARACTERISTICS OF 120E REPEATING COIL

Miscellaneous Data

Inner windings (2-1) and (6-5), parallel wound, each 380 turns #27ES, $5.0\Omega \pm 15\%$.
 Outer windings (4-3) and (8-7), parallel wound, each 465 turns #25ES, $5.5\Omega \pm 15\%$.
 Permalloy core with 8 mil equivalent series air gap.
 Impedance ratio (4-3) (8-7) to (2-1) (6-5) = 1.5:1 ($\pm 4\%$).
 Inductance of (4-3) (8-7) at 900 cps, 3V, = 0.55 hen. min., 0.90 hen. max.
 Effective resistance of (4-3) (8-7) at 900 cps, 3V, = 450Ω max.
 Impedance of (2-1) (6-5) at 20 cps, 5V, = 130Ω max.
 Inductance unbalance: (2-1) and (6-5) = 0.3% max; (4-3) and (8-7) = 0.3% max.

Equivalent Networks and Parameters



0.1-7V ac, 0-100 ma dc in (4-3) (8-7)

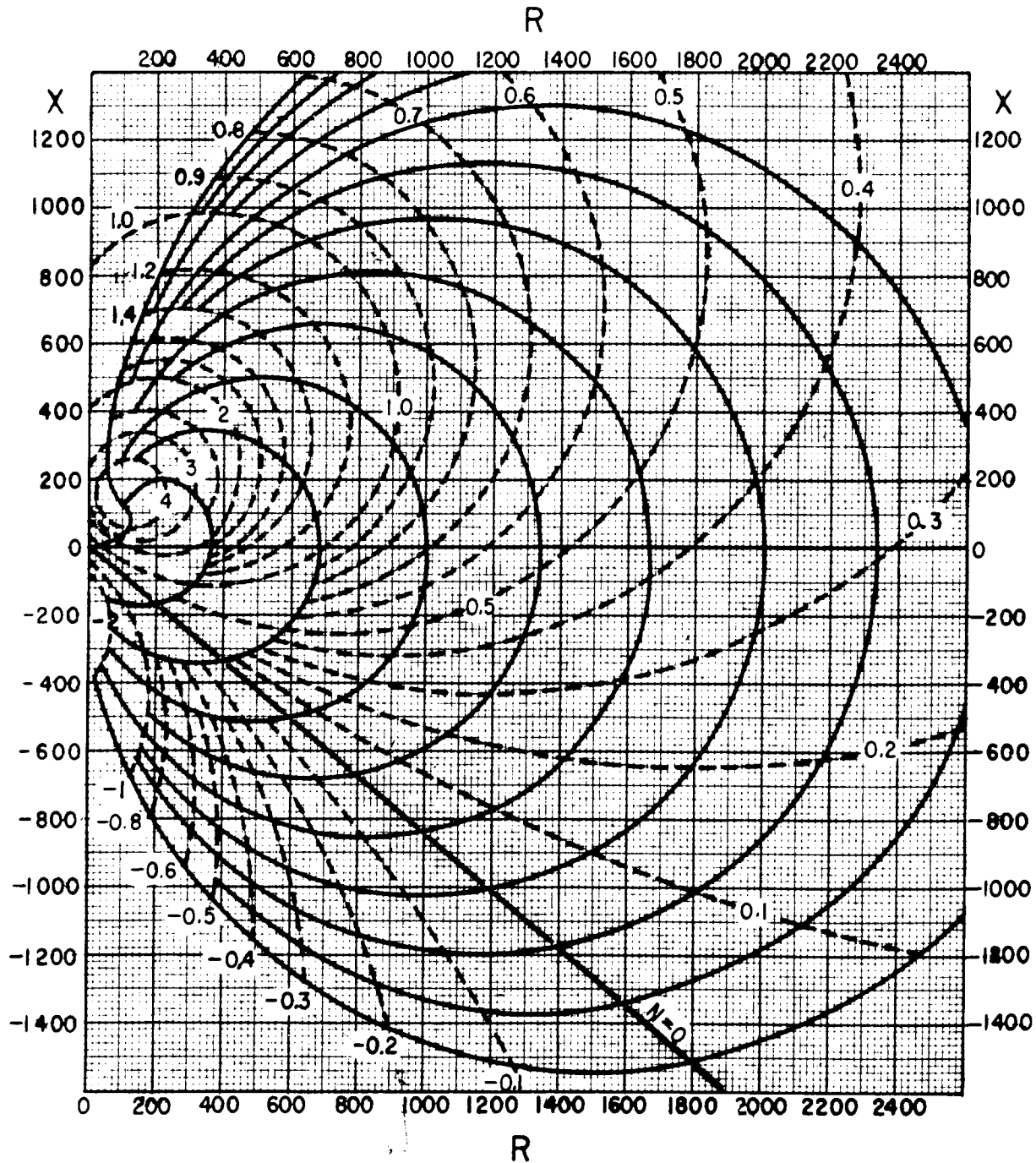
Freq. cps	Equivalent Unity Ratio T Network		Transfer Constant A +j B		IMAGE PARAMETERS	
	Z_A	Z_C	Nep.	Rad.	A db	Image Impedance Z_1
200	13 +j 3	27 +j 869	.1387 -j .1078	1.20	97 +j 117	
300	13 +j 4	39 +j 1230	.1210 -j .0862	1.05	111 +j 145	
500	13 +j 7	67 +j 2020	.1049 -j .0602	0.91	129 +j 208	
1000	13 +j 14	255 +j 4290	.0887 -j .0318	0.77	160 +j 373	
1500	13 +j 21	673 +j 7120	.0809 -j .0190	0.70	190 +j 564	
2000	13 +j 28	1745 +j 12100	.0703 -j .0104	0.61	248 +j 834	
2500	13 +j 35	5499 +j 21700	.0576 -j .0031	0.50	384 +j 1235	
3000	13 +j 42	34226 +j 46100	.0386 +j .0066	0.34	1017 +j 2005	

0.1-7V ac, 180 ma dc in (4-3) (8-7)

Freq. cps	Equivalent Unity Ratio T Network		Transfer Constant A +j B		IMAGE PARAMETERS	
	Z_A	Z_C	Nep.	Rad.	A db	Image Impedance Z_1
200	13 +j 3	8 +j 736	.1496 -j .1172	1.30	88 +j 109	
300	13 +j 4	13 +j 1040	.1307 -j .0952	1.14	101 +j 135	
500	13 +j 7	27 +j 1690	.1140 -j .0668	0.99	117 +j 191	
1000	13 +j 14	192 +j 3530	.0977 -j .0354	0.85	144 +j 339	
1500	13 +j 21	365 +j 5970	.0881 -j .0222	0.77	165 +j 518	
2000	13 +j 28	977 +j 9300	.0802 -j .0134	0.70	203 +j 733	
2500	13 +j 35	2441 +j 15400	.0688 -j .0068	0.60	274 +j 1044	
3000	13 +j 42	13675 +j 27300	.0535 +j .0044	0.46	612 +j 1522	

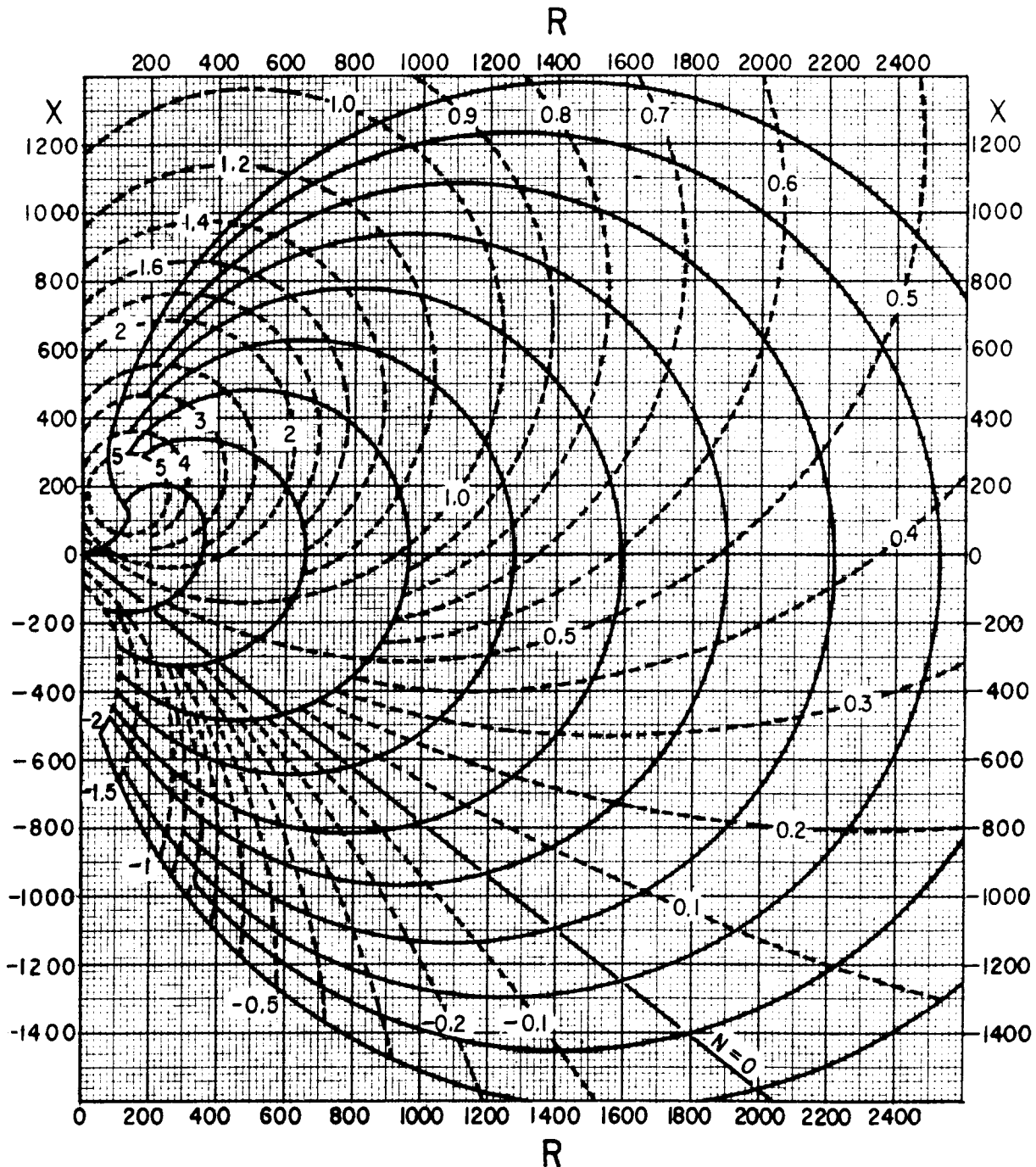
INPUT IMPEDANCE OF 120E REPEATING COIL WITH ANY TERMINATION

200 CPS



FOR EXPLANATION OF USE OF CHARTS SEE SECTION 304-200-100

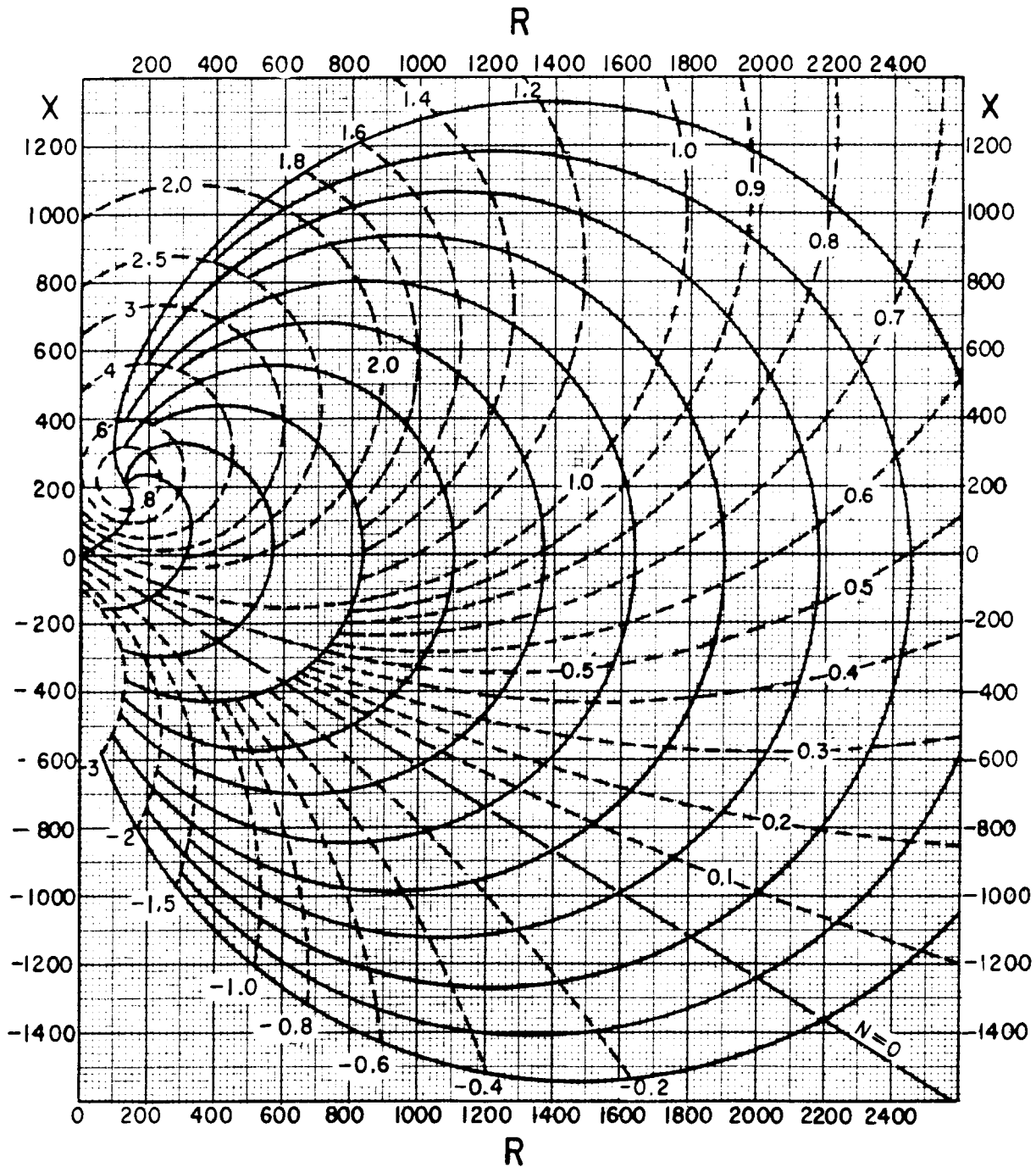
INPUT IMPEDANCE OF 120E REPEATING COIL WITH ANY TERMINATION 300 CPS



FOR EXPLANATION OF USE OF CHARTS SEE SECTION 304-200-100

INPUT IMPEDANCE OF 120E REPEATING COIL WITH ANY TERMINATION

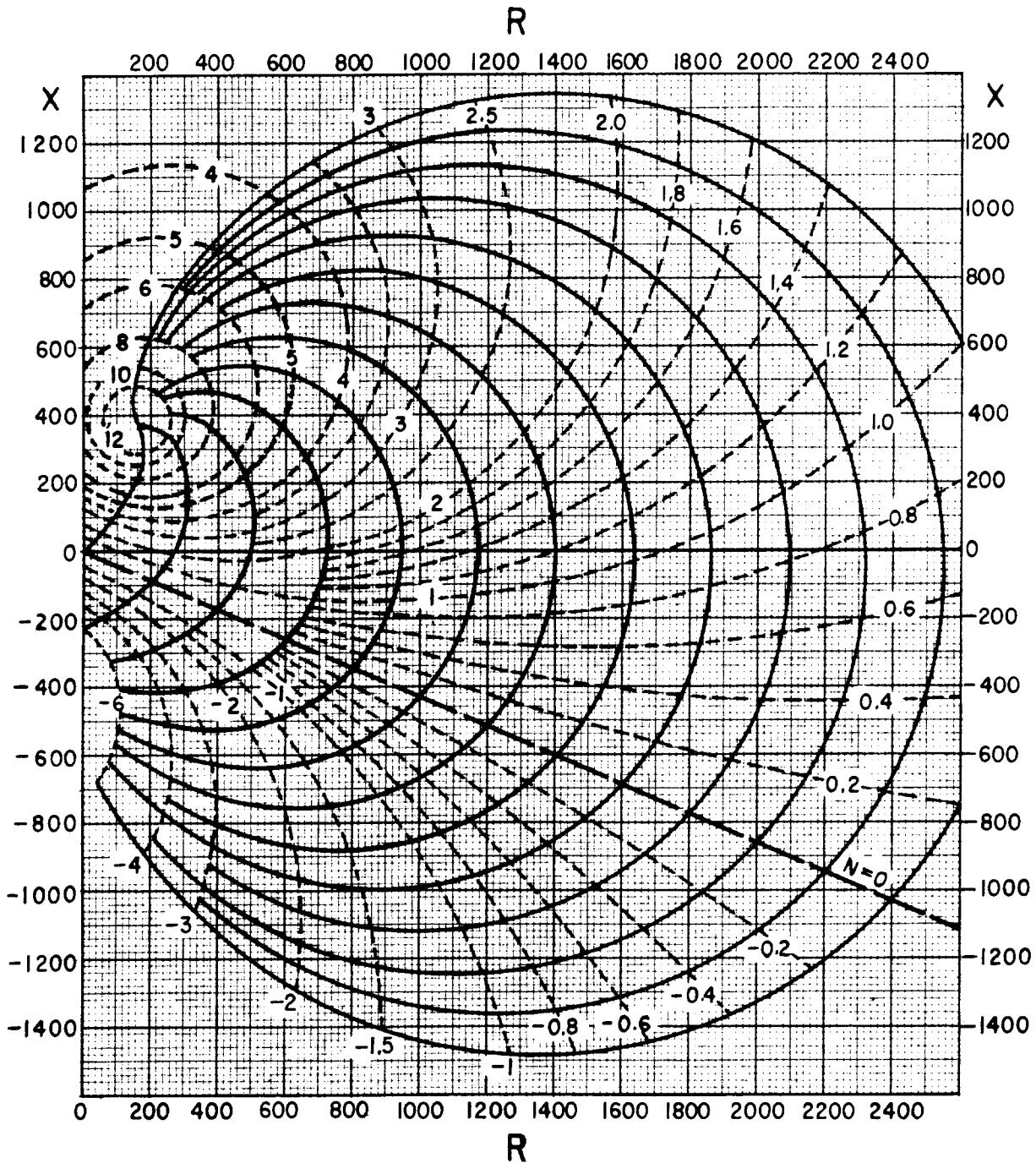
500 CPS



FOR EXPLANATION OF USE OF CHARTS SEE SECTION 304-200-100

INPUT IMPEDANCE OF 120E REPEATING COIL WITH ANY TERMINATION

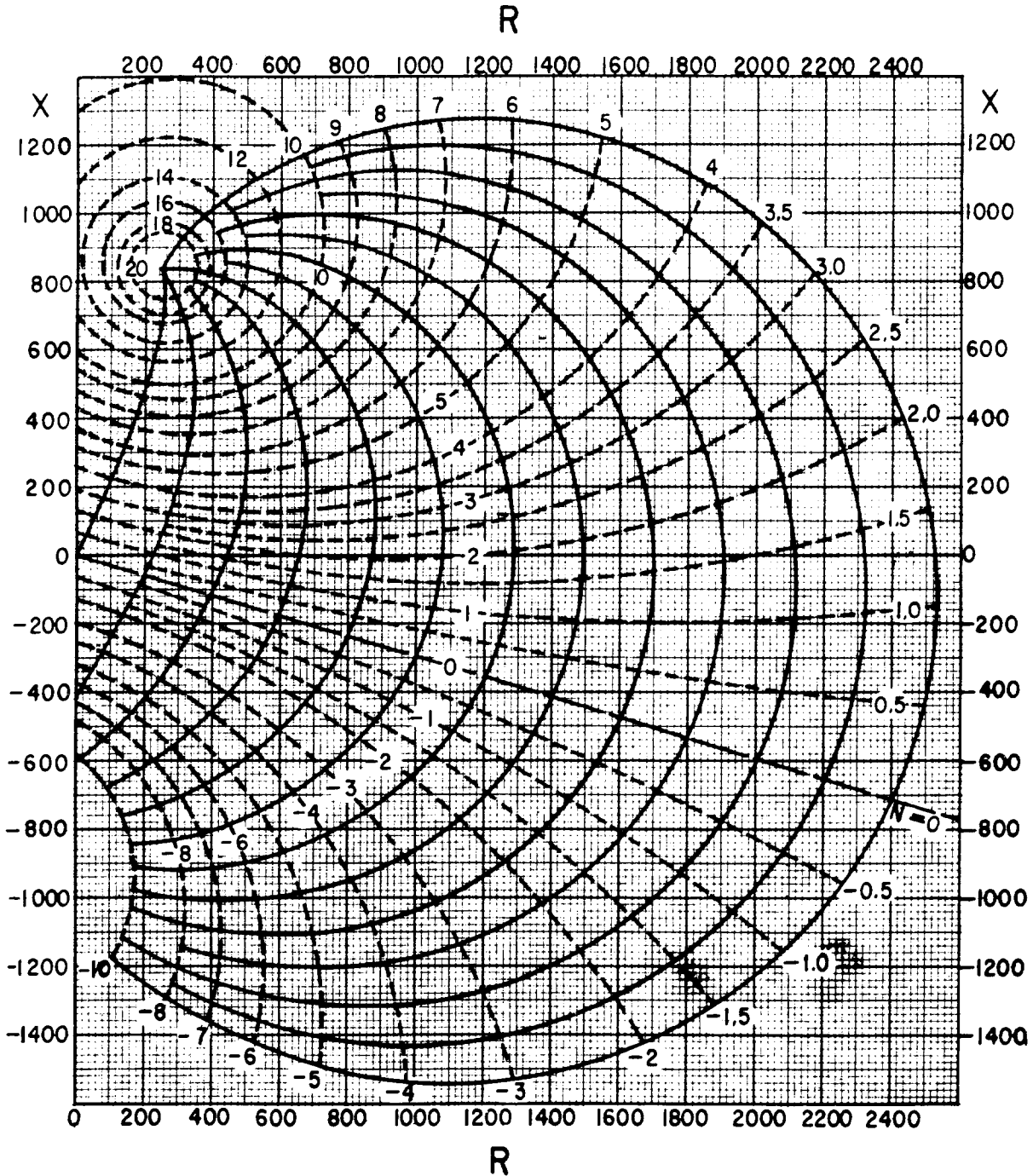
1000 CPS



FOR EXPLANATION OF USE OF CHARTS SEE SECTION 304-200-100

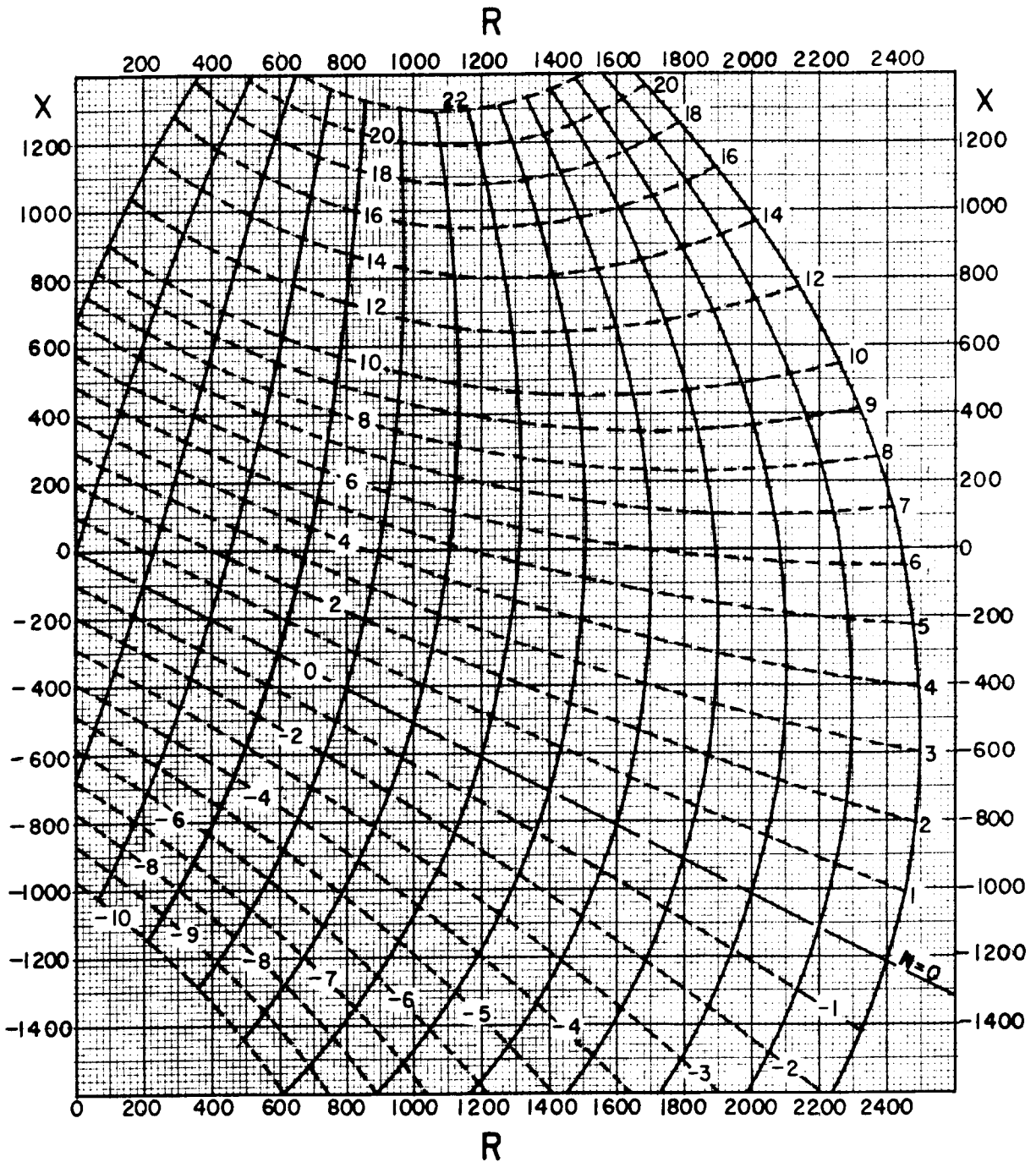
INPUT IMPEDANCE OF 120E REPEATING COIL WITH ANY TERMINATION

2000 CPS



FOR EXPLANATION OF USE OF CHARTS SEE SECTION 304-200-100

INPUT IMPEDANCE OF 120E REPEATING COIL WITH ANY TERMINATION 3000 CPS



FOR EXPLANATION OF USE OF CHARTS SEE SECTION 304-200-100