

# RADIO MANUAL CALLING MEN AT WAR RADIO OPERATORS AND CIVILIAN RADIO ENGINEERS

A BROADCAST OF  
USEFUL  DATA

TUNE IN FOR  
FORMULAS, CODES, DATA,  
LAWS, FACTS, TABLES,  
CHARTS, ETC.



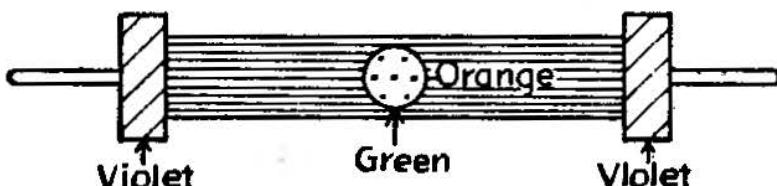
BERNARDS, 77. THE GRAMPIANS, WESTERN GATE, LONDON. W.6.

## BRITISH COLOUR CODES

### Resistances.

The colour of the body represents the first figure of the resistance value, and the colour of the tip or end band the second figure. The colour of the spot on the centre band denotes the number of cyphers that follow the first two figures.

Colour	Figure	Colour	Figure
Black	0	Green	5
Brown	1	Blue	6
Red	2	Violet	7
Orange	3	Grey	8
Yellow	4	White	9



Example:-Orange body, Violet Tip and Green spot  
= 3,700,000 ohms resistance

### WANDER PLUGS

<u>Value</u>	<u>Colour</u>
Highest + H.T.	Red
2 <sup>nd</sup> highest + H.T.	Yellow
3 <sup>rd</sup> highest + H.T.	Green
4 <sup>th</sup> highest + H.T.	Blue
L.T. Positive	Pink
Negative(L.T.-,H.T.-,G.B.+)	Black
Highest G.B.-	Brown
2 <sup>nd</sup> highest G.B.-	Grey
3 <sup>rd</sup> highest G.B.-	White
Any additional battery lead is Violet, and any centre tap is white.	

### FUSES

<u>Value</u>	<u>Colour</u>	<u>Value</u>	<u>Colour</u>
60 mA	Black	1 Amp	Dark Blue
100 mA	Grey	1.5 Amp	Light Blue
150 mA	Red	2 Amp	Purple
250 mA	Brown	3 Amp	White
500 mA	Yellow	5 Amp	Black&White
750 mA	Green		

## FIXED CONDENSER LEADS

<u>Value</u>	<u>Colour</u>
Highest Capacity +'	Red
2nd highest Capacity +	Yellow
3rd " " +	Green
4th " " +	Blue
5th " " +	Violet
Principal Negative Lead	Black
2nd Negative "	Brown
3rd " "	Grey
Centre lead of Voltage doubler Condensers	White

When 2 capacities are of the same value,  
the one of the higher voltage rating has the  
higher colour in the table.

Common Positive junctions are marked	+
" Negative " " "	-
Series connections are marked	±
Unconnected sections are marked	&

### Examples:—

- 8+8= Two 8 $\mu$ F condensers with common positive lead
- 8-8= " " " " " negative "
- 8±8= A series voltage doubler connection
- 8&8= Two isolated 8 $\mu$ F condensers.

## MAINS TRANSFORMER LEADS

<u>Primary Value</u>	<u>Colour</u>
10 volt tapping	Black and Green
210 "	Black and Yellow
230 "	Black and Red
250 "	Black and Brown
Zero "	Black

<u>Secondaries Value</u>	<u>Colour</u>
High tension ends	Red
" " centre tap	Red and Yellow
Rectifier heater ends	Green
" centre tap	Green and Yellow
Valve heater ends	Brown
" " centre tap	Brown and Yellow
Additional L.T winding ends	Blue
" " centre tap	Blue and Yellow
Earthing Lead	Bare Wire

## FIXED CONDENSERS

### COLOUR CODE FOR CAPACITY IN mmf

First Dot   Second Dot   Third Dot

Black - 0	Black - 0	
Brown - 1	Brown - 1	Brown - 0
Red - 2	Red - 2	Red - 00
Orange - 3	Orange - 3	Orange - 000
Yellow - 4	Yellow - 4	Yellow - 0000
Green - 5	Green - 5	Green - 00000
Blue - 6	Blue - 6	Blue - 000000
Purple - 7	Purple - 7	Purple - 0000000
Grey - 8	Grey - 8	Grey - 00000000
White - 9	White - 9	White - 000000000

Example :- 1<sup>st</sup> dot Green, 2<sup>nd</sup> dot Red, and 3<sup>rd</sup> dot Brown = 520mmf capacity.

### WAVELENGTH OF A TUNED CIRCUIT.

$\lambda = 1884 \cdot 96 \sqrt{L.C.}$  where L = inductance in microhenries, and C = capacity in microfarads.

### FREQUENCY OF A TUNED CIRCUIT.

$f = \frac{10^6}{2\pi\sqrt{LC}}$  where f = frequency in cycles per second and, h and C have values as shown in the previous formula.

### INDUCTANCE OF A COIL

$L = \pi^2 d^2 n^2 TK$  where L = inductance in microhenries, d = diameter of coil in cms, n = number of turn per cm, T = length of coil in cms, and K = a constant depending on ratio of diameter to length of coil.

Value for K given below.

$\frac{d}{T}$	K	$\frac{d}{T}$	K	$\frac{d}{T}$	K
.00	1.00	.8	.735	4.0	.365
.1	.959	.9	.711	5.0	.320
.2	.920	1.0	.688	6.0	.285
.3	.884	1.5	.595	7.0	.258
.4	.850	2.0	.526	8.0	.237
.5	.818	2.5	.472	9.0	.218
.6	.788	3.0	.429	10.0	.203
.7	.761				

## VARIABLE CONDENSER CAPACITY

$C = \frac{0.0885 \text{ NS}}{10^6 d}$  Where N = number of moving vanes  
S = area of one moving vane in  
sq cms, and d = thickness of air  
gap between fixed and moving vanes in cms.

## REACTANCE OF A COIL

$R = 2\pi f h$  where f = frequency in c.p.s.  
and h = inductance in henrys.

## REACTANCE OF A CONDENSER

$R = \frac{1}{2\pi f C}$  where f = frequency in c.p.s.  
and C = capacity in farads.

## WAVELENGTH

$W = 1884 \sqrt{LC}$  where W = metres, L =  
inductance in microhenries, C = capacity  
in microfarads. Also  $W \times f = 3 \times 10^8$

## LOW FREQUENCY AMPLIFICATION

The voltage stage gain of a L.F. transformer  
coupled-amplifier is approximately as follows

$$A = \mu \frac{N_2}{N_1} \times \frac{P}{\sqrt{P^2 + R^2}}$$

Where  $\mu$  = voltage gain of valve,  $N_2$  = number  
of secondary turns of transformer,  $N_1$  = number of  
primary turns of transformer,  $R$  = A.C. resistance of  
valve, and  $P$  = reactance of primary coil in ohms.

## RESISTANCE COUPLED. L.F. AMPLIFICATION

Voltage stage gain of a resistance coupled  
L.F. amplifier is as follows.

$A = \mu \times \frac{R}{R+T}$  where  $\mu$  = amplification  
factor of valve,  $R$  = external  
coupling resistance in Ohms. and  $T$  = A.C.  
resistance (impedance) of valve.

## JELLY ELECTROLYTE FOR ACCUMULATORS

A fast setting mixture which jellifies in  
10 minutes is prepared as follows:-

1 part pure sodium silicate of specific  
gravity 1.200 mixed with 3 parts of cold  
sulphuric acid of 1.400 specific gravity.

## EUREKA RESISTANCE WIRE

S.W.G.	O.D. in INCHES	URNS per INCH D.S.C.	LENGTH per Ohm in inches	Ohms per yard.	Wt per 1000yds in lbs
16	.064	14.7	173.8	.21	37.2
18	.048	19.6	96.8	.37	20.93
20	.036	25.6	54.4	.66	11.77
22	.028	32.2	32.9	1.10	7.12
24	.022	40.0	20.3	1.77	4.392
26	.018	48.8	13.7	2.64	2.942
28	.014	57.8	9.2	3.91	1.989
30	.012	67	6.5	5.57	1.399
32	.010	75	4.9	7.35	1.059
34	.009	85	3.6	10.12	.768
36	.007	90	2.4	14.84	.525
38	.006	11.8	1.5	23.80	.327

### BIAS RESISTANCE

#### Grid Leak Bias

$$V_g = I_g \times R_g \quad R_g = \frac{V_g}{I_g} \quad R_g = \frac{V_g - E}{I_g}$$

Where  $R_g$  = grid leak resistance,  $V_g$  = bias voltage,  
 $I_g$  = d.c. grid current, and  $E$  = voltage of series battery

#### Cathode Bias

$R_g = \frac{V_g}{A_g + A_s + A_a}$  where  $V_g$  &  $R_g$  are as  
 $A_g$ ,  $A_s$  &  $A_a$  above, and  $A_g$ ,  $A_s$ , and  
 $A_a$  are grid, screen, and anode currents respectively.

### METER CONVERSIONS

#### To Extend Range of a Milliammeter

$$\text{Shunt resistance } R_s = \frac{R_M}{n-1}$$

#### To Extend Range of a Voltmeter

$$\text{Series resistance } R_T = R_M \times (n-1)$$

#### To use a Milliammeter as a Voltmeter

$$\text{Series resistance } R_T = \frac{E}{I_M} - R_M$$

Where  $n$  = factor by which it is desired to  
 multiply the range of meter,  $R_M$  = resistance of meter,  
 $E$  = required voltage reading, and  $I_M$  = reading of  
 current meter at full scale deflection.

# SPECIFIC RESISTANCE

$$R = \frac{TP}{A}$$

Where T = specific resistance of a centimetre cube, P = length of wire in cm, A = cross sectional area of wire in sq cms, and R = the resistance of the wire at  $0^{\circ}\text{C}$ . If T is in Microhms R is in microhms; if T is in ohms, R is in ohms.

## SPECIFIC RESISTANCES OF MATERIALS.

Material	Resistance in Microhms per cm cube.	Material	Resistance in Microhms per cm cube
Silver	1.47	Mercury	94.07
Copper	1.588	Manganin	46.7
Aluminium	2.665	Eureka	51.0
Iron	9.07	Nichrome	95.0
Platinum	10.92	Water	$7 \times 10^{16}$
Tin	13.05	Mica	$5 \times 10^{22}$
Lead	20.4	Glass	$5 \times 10^{24}$

1 micrahm = .000001 of an ohm

## DECIBELS AND POWER RATIO

The Decibel is the comparative unit of sound strength. 1 decibel = the sound that can just be discerned by the human ear.

## DECIBELS CONVERSION TABLE

DECIBELS	POWER RATIO	DECIBELS	POWER RATIO
1	1.25	-1	.8
2	1.6	-2	.625
3	2.0	-3	.5
4	2.5	-4	.4
5	3.2	-5	.3125
6	4.0	-6	.25
7	5.0	-7	.2
8	6.0	-8	.166
9	8.0	-9	.125
10	10.0	-10	.1
20	100.0	-20	.01
30	1000	-30	.001
40	10000	-40	.0001
50	100000	-50	.00001
60	1000000	-60	.000001

## WAVELENGTH AND FREQUENCY TABLES.

To use these tables which give inductance capacity values for Radio Frequencies the following examples are shown :-

1. Given a tuned circuit total capacity .0005 mfd and inductance 245 microhenries, what is the natural wavelength and frequency. Answer - the L.C. constant is  $.0005 \times 245 = .1225$ , therefore wavelength is 660 metres and frequency 454.5 Kilocycles.

2. What inductance is needed to tune a .0005 mfd. condenser to 1900 metres. Answer - L.C. for 1900 metres = 1.016, therefore inductance is 1.016 divided by .0005 which equals 2.032 microhenries.

3. A circuit with a natural frequency of 1250 Kc is required, the tuning coil inductance being 81 microhenries. What capacity should be connected across the coil.

Answer L.C. for 1250 Kc = .01622 hence capacity is  $.01622 \div 81$  which equals .0002 microfarads.

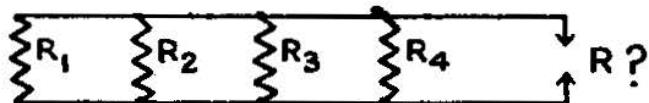
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Wave Length	Frequency Kilocycles	L.C.	Wave Length	frequency Kilocycles	L.C.
10	30000	.00028	540	555.6	.0821
15	20000	.00063	580	517.2	.0947
20	15000	.00112	620	483.9	.1082
30	10000	.000253	660	454.5	.1225
40	7500	.000450	700	428.6	.1378
50	6000	.00070	740	405.4	.1540
75	4000	.00158	780	384.64	.1712
100	3000	.00281	820	365.9	.1893
125	2500	.00405	860	348.8	.2052
154	2144	.00551	920	326.8	.2381
175	1875	.00720	960	312.5	.2595
220	1667	.00912	1000	300.0	.2816
250	1500	.01126	1100	272.7	.3404
364	1364	.01362	1200	250.0	.4052
500	1250	.01903	1300	230.0	.4757
652	1154	.02207	1400	214.3	.5518
600	1071	.02533	1500	200.0	.6335
714	882	.03255	1600	187.5	.7204
752	800	.04065	1700	176.7	.8134
652	789	.04966	1800	166.7	.9120
600	745	.05960	1900	157.9	1.0160
652	652	.07040	2000	150.0	1.1260
500	500		2500	149.0	1.7600

## OHMS LAW

<u>Amperes</u>	= Volts ÷ Resistance
"	= Watts ÷ Volts
"	= $\sqrt{\text{Watts} \div \text{Resistance}}$
<u>Volts</u>	= Resistance X Amperes
"	= Watts ÷ Amperes
"	= $\sqrt{\text{Watts} \times \text{Resistance}}$
<u>Watts</u>	= (Amperes) <sup>2</sup> X Resistance
"	= (Volts) <sup>2</sup> ÷ Resistance
"	= Amperes X Volts
<u>Resistance</u>	= Volts ÷ Amperes
"	= (Volts) <sup>2</sup> ÷ Watts
"	= Watts ÷ (Amperes) <sup>2</sup>

## RESISTANCES IN PARALLEL



$$R = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \text{ETC.}$$

2 Parallel Resistances  $R = (R_1 \times R_2) \div (R_1 + R_2)$

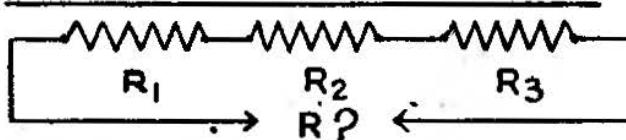
### 3 Parallel Resistances

$$R = \frac{R_1 \times R_2 \times R_3}{(R_1 \times R_2) + (R_2 \times R_3) + (R_3 \times R_1)}$$

### 4 Parallel Resistances

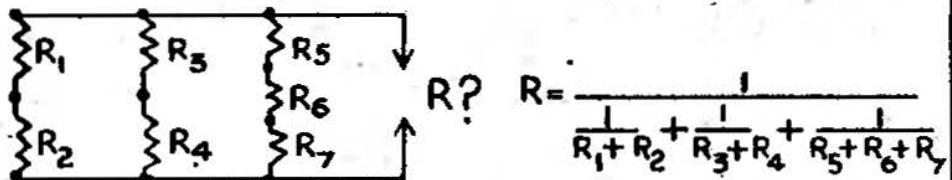
$$R = \frac{R_1 \times R_2 \times R_3 \times R_4}{(R_1 \times R_2 \times R_3) + (R_2 \times R_3 \times R_4) + (R_3 \times R_4 \times R_1) + (R_4 \times R_1 \times R_2)}$$

## RESISTANCES IN SERIES.

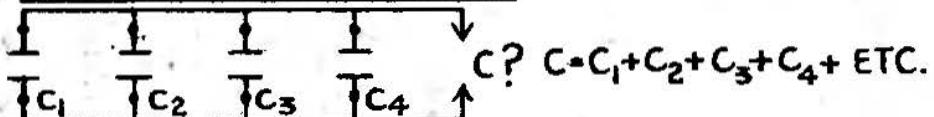


$$R = R_1 + R_2 + R_3 + \text{ETC.}$$

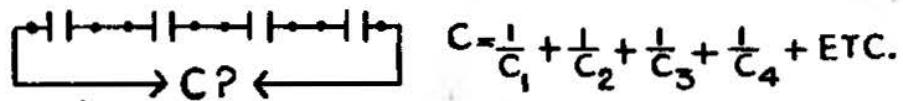
## RESISTANCE IN SERIES-PARALLEL



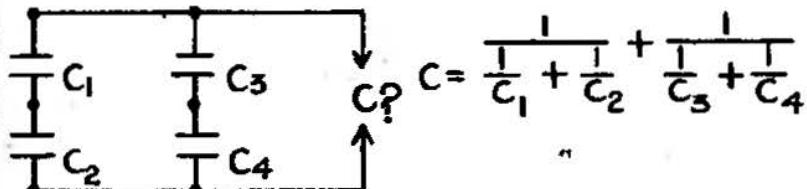
## CONDENSERS IN PARALLEL



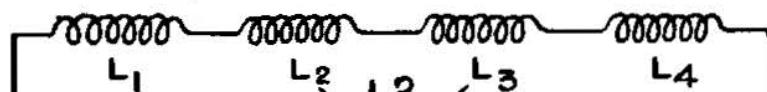
## CONDENSERS IN SERIES



## CONDENSERS IN SERIES-PARALLEL



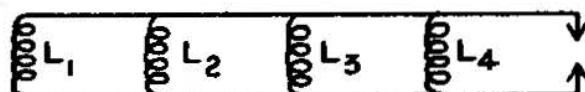
## INDUCTANCES IN SERIES



Where there is no mutual inductance

$$L = L_1 + L_2 + L_3 + L_4 + \text{ETC.}$$

## INDUCTANCES IN PARALLEL



$$\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \frac{1}{L_4} + \text{ETC.}$$

## COPPER WIRE TABLES

S.W.G.	DIA IN INCHES	RESISTANCE IN OHMS PER YD	RESISTANCE IN OHMS PER LB.	LBS PER OHM	WEIGHT IN LBS PER 1000 YDS.	YARDS PER LB.	TURNS PER INCH				
							ENAMEL COVERED	S.S.C.	D.S.C.	S.C.C.	D.C.C.
28	.0148	.1398	70.12	.0141	1.980	503.0	61.4	60.4	56.2	48.1	40.2
29	.0136	.1655	98.65	.0101	1.680	596.6	66.2	65.2	60.2	51.0	42.4
30	.0124	.1991	142.75	.0069	1.396	716.6	73.3	70.0	67.1	54.4	44.7
31	.0116	.2275	185.80	.0054	1.222	820.0	77.8	76.3	70.9	56.8	46.3
32	.0108	.2625	248.20	.0040	1.059	943.3	83.0	81.3	75.2	63.3	50.5
33	.0100	.3061	337.50	.0029	.9081	1100	88.9	87.0	80.0	66.7	52.6
34	.0092	.3617	471.00	.0023	.7686	1300	98.0	93.4	85.5	70.4	54.9
35	.0084	.4338	676.50	.0014	.6408	1556	106	101	91.8	80.6	61.0
36	.0076	.5300	1009	.00098	.5254	1903	116	110	102	86.2	64.1
37	.0068	.6620	1574	.00064	.4199	2380	128	120	110	92.6	67.6
38	.0060	.8503	2598	.00038	.3269	3056	143	133	121	100	71.4
39	.0052	1.132	4645	.00022	.2456	4066	168	149	134	109	75.8
40	.0048	1.328	6360	.00016	.2092	4766	180	159	142		
41	.0044	1.581	9020	.00011	.1758	5700	194	169	150		
42	.0040	1.913	13150	.00008	.1453	6866	211	191	167		
43	.0036	2.362	20120	.00005	.1177	7560	230	206	179		
44	.0032	2.989	32210	.00003	.0929	10766	253	225	192		
45	.0028	3.904	54980	.00002	.0712	14066	282	247	208		

## COPPER WIRE TABLES

S.W.G.	DIA IN INCHES	RESISTANCE IN OHMS PER YD.	RESISTANCE IN OHMS PER LB.	LBS PER OHM	WEIGHT IN LBS PER 1000 YDS.	YARDS PER LB.	TURNS PER INCH				
							ENAMEL COVERED.	S.S.C.	D.S.C.	S.C.C.	D.C.C.
10	.128	.001868	.0120	83.30	148.8	6.67		7.64	7.55	7.35	7.04
11	.116	.002275	.0200	50.00	122.2	8.16		8.41	8.30	8.06	7.69
12	.104	.002831	.0280	35.70	98.22	10.23		9.35	9.22	8.93	8.48
13	.092	.003617	.0550	18.10	76.86	13.00		10.5	10.4	10.00	9.43
14	.080	.004784	.0820	12.20	58.12	17.16		12.1	11.8	11.4	10.6
15	.072	.005904	.1400	7.14	47.08	21.23		13.3	13.1	12.5	11.6
16	.064	.007478	.2021	4.95	37.2	26.86	15.0	14.9	14.6	14.1	13.2
17	.056	.009762	.3423	2.38	28.48	35.00	17.1	16.9	16.5	15.9	14.7
18	.048	.01328	.6351	1.56	20.92	47.66	19.8	20.0	19.4	18.5	17.2
19	.040	.01913	1.315	.757	14.53	68.66	23.7	23.8	23.0	21.7	20.0
20	.036	.02362	2.012	.497	11.77	85.0	26.1	29.4	25.3	23.8	21.7
21	.032	.02990	3.221	.309	9.299	107.6	29.4	28.4	28.2	26.3	23.8
22	.028	.03905	5.498	.181	7.120	140.6	33.3	33.3	31.8	29.4	26.3
23	.024	.05313	10.14	.098	5.231	191.6	38.8	38.5	36.4	33.3	29.4
24	.022	.06324	14.38	.069	4.395	228.3	42.1	42.1	40.0	35.7	31.3
25	.020	.07653	21.08	.0471	3.632	275.3	46.0	46.0	43.5	38.5	33.3
26	.018	.09448	32.21	.0309	2.942	340.0	50.6	50.6	47.6	41.7	35.7
27	.0164	.11138	46.55	.0215	2.442	410.0	55.1	55.1	51.6	44.6	37.9

# MORSE AND INTERNATIONAL TELEGRAPH CODE SYMBOLS

LETTER	CODE SYMBOL	LETTER	CODE SYMBOL
A	•—	N	—•
B	—•••	O	————
C	—•—•	P	—•—.
D	—••	Q	—•—·
E	•	R	—·—
F	•—•—	S	•••
G	——•	T	—
H	••••	U	••—
I	••	V	••—·
J	—•——	W	—·—
K	—•—	X	—•—·
L	•—••	Y	—·—·
M	——	Z	————

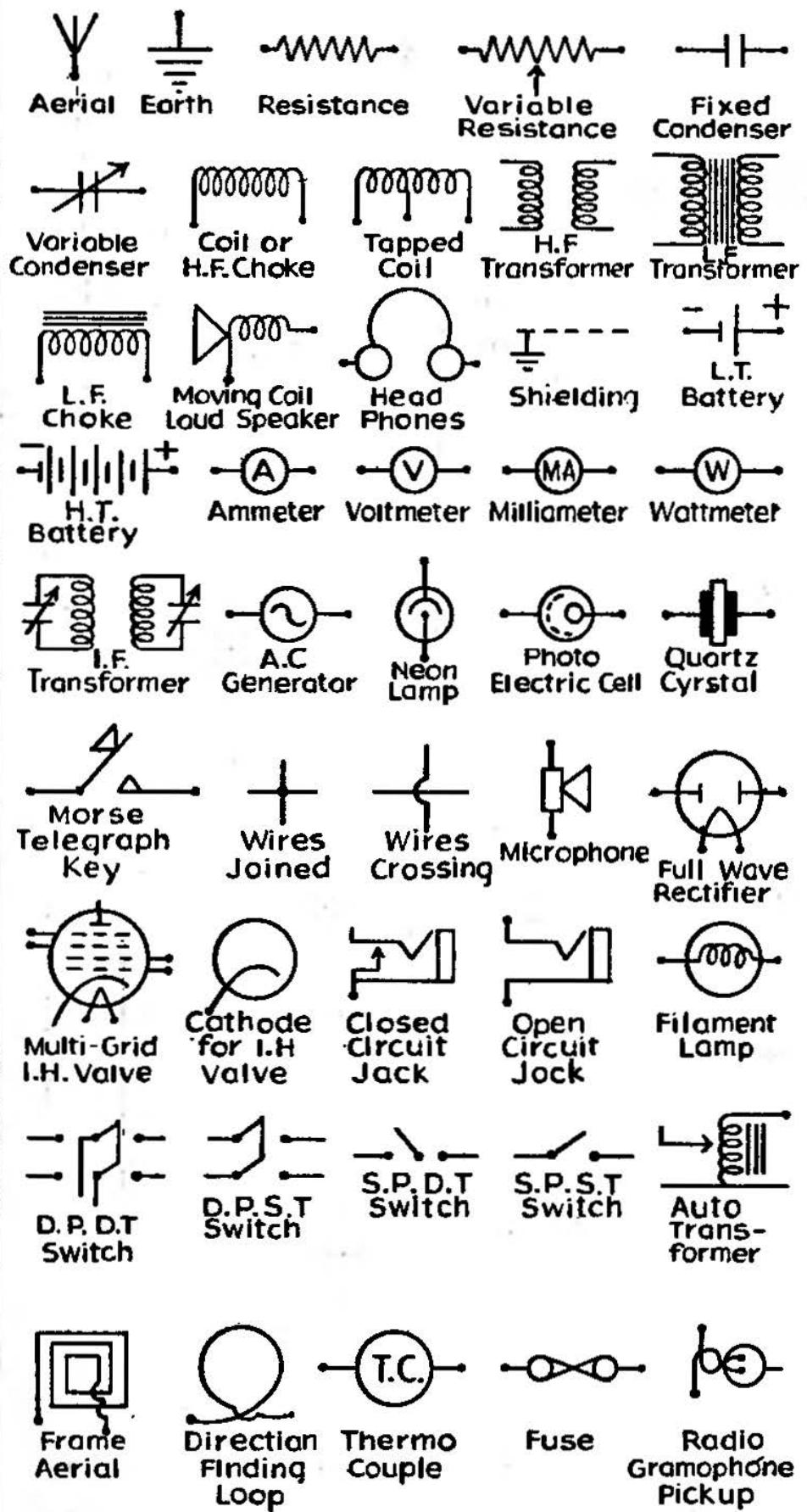
## NUMBERS

NUMBER	CODE	NUMBER	CODE
1	-----	6	·····
2	····	7	—····
3	····—	8	—····
4	····—	9	—····
5	·····	0	—····

## PUNCTUATION MARKS ETC.

PERIOD	·· ··· ···
COMMA	—····
INTERROGATION	··—···
QUOTATION MARKS	··—·—·
EXCLAMATION	—····—
COLON	—·····
SEMICOLON	—····—
PARENTHESIS	—····—
FRACTION BAR	—····
WAIT SIGN	—····
DOUBLE DASH (BREAK)	—····
ERROR (ERASE) SIGN	·······
END OF MESSAGE	—····—
END OF TRANSMISSION	······—
INTERNATIONAL DISTRESS SIGNAL (S.O.S.)	····—····

# THEORETICAL RADIO SYMBOLS



## SAFE CURRENT CARRYING CAPACITY OF BARE COPPER WIRE

SWG	AMPS	SWG	AMPS	SWG	MILLIAMPS
10	35	26	1·0	42	50
12	28	28	.7	44	50
14	19	30	.5	45	25
16	13	32	.4	46	20
18	7	34	.25	47	12
20	4	56	.15	48	8
22	2.5	38	.1	49	5
24	1.5	40	.07	50	3

## CAPACITY OF FIXED CONDENSERS.

$$C = \frac{0.885 AP(n-1)}{d}$$

$$\text{Reactance of a condenser} = \frac{1}{2\pi f C}$$

Where :-

C = capacity in farads

A = area of overlap of plates in sq cms.

P = dielectric constant of separating material

n = number of metal plates

d = distance separating plates in cms

f = frequency in cycles per seconds

Dielectric constants of insulating materials commonly used.

Air = 1. Glass = 6.8 to 10. Mica = 5 to 7.

Ebonite = 2.56 to 3.48. Shellac = 2.95 to 3.73.

Fibre = 5.1 to 5.9. India rubber (Para) = 2.34.

Paraffin Wax = 1.92 to 2.47. Vulcanised Rubber = 2.94.

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