ELECTRICAL

ENGINEERS & ELECTRICIANS HANDBOOK

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ETC.

WIRE &
CABLE
SIZES
A.C. & D.C.
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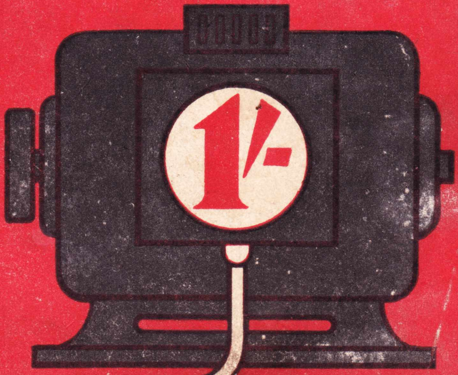

BERNARDS, 77, THE GRAMPIANS, WESTERN GATE, LONDON, W.6

CABLE SIZES

NOMINAL Area Sq. Inch	OLD Standard No. S.W.G.	NEW Standard No Inch	DIAM Inches	Weight per 1000 yds in lbs	Maximum Resistance per 1000 yds in OHMS	Length of circuit per volt drop in Feet	Capacity of single Cables in Amps
·001	1/20	1/·036	·036	11·77	24·29	30	4·1
·0015	—	1/·044	·044	17·58	16·26	30	6·1
·002	—	3/·029	·062	23·37	12·61	30	7·8
·003	3/20	3/·036	·078	36·02	8·180	29	12·0
·003	1/16	1/·064	·064	37·20	7·687	29	12·9
·0045	—	7/·029	·087	54·39	5·387	28	18·2
·007	7/20	7/·036	·108	83·81	3·496	33	24
·01	—	7/·044	·132	125·2	2·340	39	31
·0145	—	7/·052	·156	174·9	1·675	45	37
·0225	7/16	7/·064	·192	264·9	1·106	55	46
·03	—	19/·044	·220	340·4	·8637	61	53
·04	19/17	19/·052	·260	475·5	·6184	71	64
·06	19/16	19/·064	·320	720·3	·4082	83	83
·075	19/15	19/·072	—	911·6	·3225	90	97
·10	—	19/·083	·415	1211	·2427	98	118
·12	37/16	37/·064	—	1403	·2097	103	130
·15	37/15	37/·072	·504	1776	·1657	112	152
·20	—	37/·083	·581	2360	·1247	123	184
·25	—	37/·093	—	2963	·09933	132	214
·30	—	37/·103	·721	3635	·08089	145	240
·40	—	61/·093	·837	4886	·06026	162	288
·50	—	61/·103	·927	5994	·04913	172	332
·60	—	91/·093	—	7290	·04040	181	384
·75	—	91/·103	1·133	8942	·03294	185	461
·85	—	127/·093	—	10175	·02895	190	512
1·00	—	127/·103	1·339	12481	·02360	200	595

FLEXIBLE CORDS

SIZE	AREA in Sq Inches	Current rating in amps	Resistance per 1000 yds single core	Maximum weight in lbs	Yards per lb for twin silk Twisted
14/·0076	·0006	2	39·7	3	17·5
23/·0076	·0010	3	24·2	5	13·3
40/·0076	·0017	5	13·9	10	9·75
70/·0076	·0030	10	7·94	10	6·55
110/·0076	·0048	15	5·05	10	4 65
162/·0076	·0070	20	3·43	10	3·33

MAXIMUM CURRENT RATING OF CABLES

SIZE	Rating in Amps. A.C. and Voltage Drop per 100 feet				SIZE	Rating in Amps. A.C. and Voltage Drop per 100 Feet			
	Cores in one sheath					Cores in one sheath			
	Up to 4		upto 8			Upto 2		Upto 4	
	Amps	Volts	Amps	Volts		Amps	Volts	Amps	Volts
1/·044	5	2·8	5	2·8	19/·052	78	1·75	62	1·4
3/·029	5	2·1	5	2·1	19/·064	102	1·55	82	1·19
3/·036	10	2·8	8	2·4	19/·083	147	1·35	118	1·04
7/·029	15	2·9	12	2·4	37/·072	189	1·28	151	·98
	Up to 2 cores in 1 sheath		Upto 4 cores in 1 sheath		37/·083	229	1·26	183	·98
7/·036	29	3·3	23	2·9	37/·103	298	1·28	238	·98
7/·044	38	3·1	30	2·4	61/·093	358	1·38	286	1·04
7/·052	45	2·7	36	2·2	61/·103	413	1·5	330	1·16
7/·064	56	2·2	45	1·75	91/·103	530	1·8	—	—
19/·044	65	2·0	52	1·6	127/·103	648	2·1	—	—

FLEXIBLE CONDUIT SIZES DIA IN INCHES

OUTSIDE DIA	·48	·61	·78	·90	1·15	1·46	1·69	2·25
INSIDE DIA	3/8"	1/2"	5/8"	3/4"	1"	1 1/4"	1 1/2"	2"

Maximum Cable Bends in Installations

V.I.R. Taped, armoured, and braided	6D
V.I.R. Taped, and braided	4D
Impregnated paper taped, armoured, and braided	8D
" " taped, and braided	8D
Lead or any metal sheathed cable	6D
Conduit (inside radius)	2·25D

Where D is equal to outside overall diameter of cable

ELECTRICAL PIPE AND THREAD DIMENSIONS

Gas or Water Pipe			Electric Conduit		
inside Dia in inches	Outside Dia in inches	Threads per inch	Inside Dia in inches	Outside Dia in inches	Threads per inch
1/8"	·38	28	—	—	—
1/4"	·52	19	·388	·50	18
3/8"	·66	19	·497	·625	18
1/2"	·83	14	·606	·75	16
5/8"	·90	14	·731	·875	16
3/4	1·04	14	·856	1·00	16
7/8"	1·19	14	1·106	1·25	16
1"	1·31	11	1·34	1·50	14
1 1/4"	1·65	11	1·816	2·00	14

All the above threads are of Whitworth Form

CAPACITY OF FUSES IN AMPERES

Fuse rating in amps	Tinned Copper Wire DIA.	S.W.G.	Standard Alloy Wire DIA	S.W.G.	Fuse rating in amps	Tinned Copper Wire DIA	S.W.G.	Standard Alloy Wire DIA	S.W.G.
1·8	—	—	·0164	27	30	·032	21	—	—
3	·006	38	·024	23	37	·04	19	—	—
5	·0084	35	·032	21	46	·048	18	—	—
8·5	·0124	30	—	—	53	·048	18	—	—
10	·0136	29	—	—	60	·056	17	—	—
15	·02	25	—	—	64	·056	17	—	—
17	·022	24	—	—	83	·072	15	—	—
20	·024	23	—	—	100	·08	14	—	—
24	·028	22	—	—					

AVERAGE EFFICIENCY AND POWER FACTORS FOR MOTORS

H.P. Rating	D.C. efficiency	A.C. Single Phase Efficiency	P.F.	Two Phase Efficiency	P.F.	Three Phase Efficiency	P.F.
1	·76	·65	·80	·72	·79	·74	·80
5	·83	·80	·82	·78	·80	·79	·82
10	·86	·82	·83	·86	·80	·85	·83
20	·87	·84	·83	·87	·81	·87	·85
30	·88	·84	·83	·88	·83	·89	·89
40	·89	·85	·83	·89	·87	·90	·90
50	·90	85	·83	·90	·89	·91	·90
75	·92	·83	·84	·90	·90	·92	·92
100	·93	·82	·85	·91	·91	·93	·92

1 H.P. = 746 watts = ·746 Kilowatt. 1 Board of Trade unit = 1000 watt hours = 1 Kilowatt hour. 1 H.P. = 33000 ft lbs per minute. Torque = $\frac{H.P. \times 33000}{R.P.M. \times 2\pi}$

ELECTRIC HEATING FORMULAS

Let T = nomber of pints, N = number of lbs, V = temperature rise in °F W = watts. S = specific heat, and E = efficiency

(a) To heat T pints of water, it requires $\frac{T \times V \times 21.96}{E \times W}$ minutes

(b) To " N lbs " " " " $\frac{N \times V \times 17.57}{E \times W}$ "

(c) To " N lbs of substance of specific heat "S" it requires $\frac{N \times S \times V \times 17.57}{E \times W}$ minutes

Specific heat of common substances. Aluminium = ·212 Iron = ·112. Oil = ·41 to ·52. Petrol = ·51. Copper = ·093 to ·1. Steel = ·118. Air = ·237 Brass = ·094. Water = 1·000

ELECTRIC HEATING FOR ROOMS

Allow 1 to 2·5 watts per cubic ft of space according to requirements

SWITCH AND SWITCH PLATE SIZES

Standard Switch fixing centres = 1·6875" inches
Small " " = 1·500 "
1 gang switch plate = 3"x3". 2 gang switch plate = 5¼"x 3"
3 " " " = 7½"x 3". Hole diameter switch plate = ¾"
Centre distance on switch plate = 2¼"

LIGHTING AND ILLUMINATION

The illumination "T" varies inversely as to the square of the distance. Thus if "T" is the intensity at distance "B", then the intensity at distance "P" is equal to $\frac{B^2}{P^2} \times T$

Measurement of Light, the unit used is the Lumen, which is the intensity with which 1 sq ft is illuminated by 1 candle power at a distance of 1 foot, also 1 candle can be equal to 12·57 lumens as a sphere of 1 ft internal radius would have 12·57 sq ft of area illuminated by 1 candlepower suspended at its centre, therefore Lumens = foot candles x area in sq ft, and footcandles = Lumens divided by area in sq ft

LUMENS VALUE FOR GASFILLED LAMPS

Rated Watts	LUMENS 100/130 Volts	LUMENS 200/250 Volts	Rated Watts	LUMENS 100/130 Volts	LUMENS 200/250 Volts
15	140	118	150	—	2030
25	240	215	200	—	2900
40	470	345	300	—	4720
60	790	610	500	—	8470
75	1060	820	700	—	13610
100	1500	1210	1000	—	19100

COLOUR REFLECTIVE FACTORS

COLOUR	%	COLOUR	%	COLOUR	%	COLOUR	%
White Paper	84	Primrose	70	Brown	60	Olive Green	21
Light Grey	70	Pink	50	Deal Board	40	Dark Grey	20
Buff	60	Sky Blue	36	Red	16	Black Velvet	0·4

SUGGESTED ILLUMINATION VALUES

Situation	Foot Candles	Situation	Foot Candles
Street Lighting	·5	Workshops	8
Outside Yards	1·5	Machine Shop	10
Corridors	1·5	Toolmaking	15
Houselighting General	6	Drawing Office	25
Typesetting	15	Shop Windows	35
Billiard Table	18	Operating Theatre	60

DATA ON ALTERNATING CURRENTS

OHMS LAW for A.C. is modified as follows

$$A = \frac{E}{\sqrt{\left[R^2 + \left(LM - \frac{1}{CM}\right)^2\right]}}$$

Where E = voltage. A = amperes R = ohms resistance. C = capacitance in farads L = inductance in henries. F = frequency, and M = 2πF

Note for 50 cycles supply M = 314·16
" " 60 " " M = 376·99

Special formula for Resistance only A = E ÷ R
" " " Capacitance " A = ECM
" " " Inductance " A = E ÷ LM

R.M.S. (Root mean Square) values, is the value of A.C. that has the same heating effect as D.C.
In the case of Sine Waves which generally apply
Maximum value = π ÷ 2 average value = $\sqrt{2}$ R.M.S value

Form Factor = $\frac{\text{R.M.S value}}{\text{Average value}} = \frac{\pi}{2\sqrt{2}}$. Average Value = 2 ÷ π x maximum value

Power Factor = P.F or equivalent cos Ø. P.F. is equal to the cosine of the angle of lag between voltage and current in the case of Sine Waves
= $\frac{\text{Watts}}{\text{Volts x Amps}}$

Power in A.C. circuits Single Phase Watts = Volts x amps x Cos Ø

2 phase. Watts = 2 x volts x amps x cos Ø
3 " " = $\sqrt{3}$ x volts x amps x cos Ø

Where in each case the amps is the line current and volts the voltage between lines (This is incorrect for common wires in 2 and 3 phase circuits

Delta connection 3 phase motors. Voltage across phase windings = Line Volts. Current in phase windings = Line current ÷ $\sqrt{3}$

Star connections 3 phase motors. Voltage across phase windings = Line Volts ÷ $\sqrt{3}$. Current in phase windings = Line current

3 phase supply. the black wire is neutral and the red, green, and white wires are the 3 phase leads. If single phase connection is desired use neutral and any one of the three coloured wires. 3 phase voltage between phase wires is equal to $\sqrt{3}$ x single phase voltage

USEFUL FORMULAE

Theoretical power of single phase circuit in K.V.A. = $\frac{\text{Volts x Amps}}{1000}$

Real power of single phase circuit in Kilowatts = (Volts x Amps x P.F.) ÷ 1000
Apparent power of 2 phase circuit in K.V.A = (2 x volts x Amps) ÷ 1000
Real power of 2 phase circuit in Kilowatts = (2 x volts x Amps x P.F.) ÷ 1000
Theoretical power of 3 phase circuit in K V A. = (1·73 x volts x Amps) ÷ 1000
Real power of 3 phase circuit in Kilowatts = (1·73 x volts x amps x P.F.) ÷ 1000

Input of 1, 2, or 3 phase Motor in K V A = $\frac{\text{H.P. x ·746}}{\text{Efficiency x P.F.}}$

Output of 1, 2 or 3 phase Motors in H.P. = $\frac{\text{input in K.V.A x Efficiency x P.F.}}{·746}$

ELECTRICAL CURRENT HEATING EFFECTS

The heating effect of an electric current varies as (1) The square of the voltage applied or (2) as the square of the current applied

Heating constants 1 kilowatt hour = 3415 British Thermal units. 1 cubic ft of coal gas = 450 B.T.U's. 1 lb gasoline or petrol = 17700 B.T.U's, and 1 lb of steam coal = 14000 B.T.U's approximately.

180 B.T.U's. are required to raise 1 lb. of water from freezing to boiling point and 225 B.T.U's are required for 1 pint of water

WIRING CAPACITY OF CONDUITS

CONDUIT DIA		1/2"		5/8"		3/4"		1"		1¼"		1½"		2"		2½"	
CABLE SIZE		S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B
NO	DIA																
7/·044	·15	2	2	5	4	7	6	13	10	20	14						
3/·029	·18			4	3	7	5	12	10	20	14						
3/·036	·20			3	2	5	4	10	8	18	12						
7/·029	·21			2	2	5	4	8	6	12	10						
7/·036	·235					3	2	6	5	10	8						
7/·044	·27					2	–	4	4	8	7						
7/·052	·30							4	3	6	5	8	6				
7/·064	·345							3	2	4	4	7	6				
19/·044	·38									4	3	6	5	10	7	12	8
19/·052	·425											5	4	8	6	9	7
19/·064	·50											3	3	6	5	8	6
19/·083	·63													4	3	5	4
37/·072	·75													2	2	3	2

"S" denotes conduit runs up to 14 ft between boxes and a deflection of upto 15° from the straight

"B" denotes conduit runs with deflactions of over 15° from the straight

LIGHT ABSORBTION FACTORS

COLOUR	%	COLOUR	%	COLOUR	%	COLOUR	%
Clear Glass	5-10	Opal Glass	20-40	Signal Glass	85	Cobalt Blue	95
Ribbed "	15-30	Ground "	20-30	Ruby "	90	Black Glass	100

RELATIVE LAMP COSTS AND EFFICIENCY

Watts	Relative Lamp Costs	Lumens Total	Lamp Cost per Lumen	Current cost per Lumen
60 Pearl	1	595	3·75	1·93
100 "	1·43	1180	3·6	1·62
150 Clear	2·86	1945	3·28	1·48
200 "	4·28	2730	3·5	1·4
300 "	5·71	4380	2·91	1·31
500 "	7·15	7920	2·02	1·21
1000 "	9·14	17900	1·14	1·068

SAFE CURRENT CARRYING CAPACITY OF BARE COPPER WIRE

S.W.G	AMPERES	S.W.G	AMPERES	S.W.G.	AMPERES
10	35	26	1·0	42	·05
12	28	28	·7	44	·03
14	19	30	·5	45	·025
16	13	32	·4	46	·02
18	7	34	·25	47	·012
20	4	36	·15	48	·008
22	2·5	38	·1	49	·005
24	1·5	40	·07	50	·003

SPACING OF CABLE SADDLES

CABLE SIZES	MAXIMUM PERMISSIBLE SPACING	
	HORIZONTAL	VERTICAL
Up to 7/·029	9	15
7/·029 to 7/·044	12	15
7/·052 to 19/·044	15	18
19/·052 to 19/·064	18	21