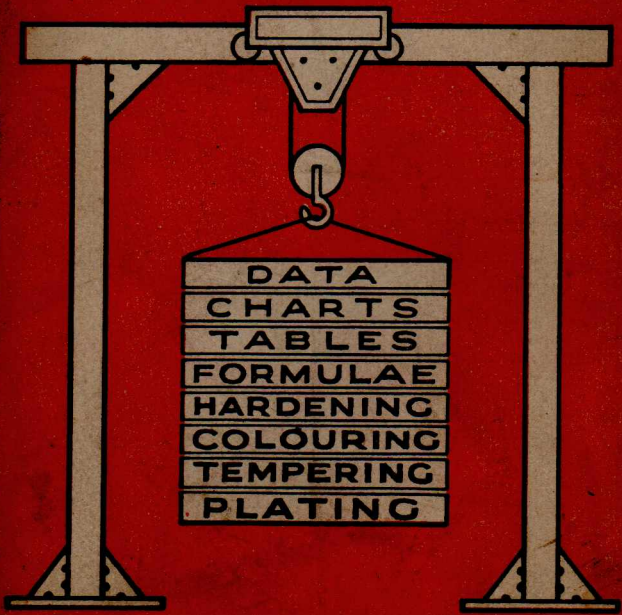
MANUAL OF

METALS AND ALLOYS

1/-



COMPOSITION OF ALLOYS
SHEET METAL GAUGES
HARDNESS TESTING
HEAT TREATMENT. WEIGHTS.
ETC. ETC.

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SOLDERING FLUXES

METAL	FLUX
Aluminium	Stearin
Iron	Chloride of Zinc or Chloride of Ammonia
Brass	" " " "
Gunmetal	" " " "
Copper	" " " "
Lead	Tallow or Resin
Block Tin	Chloride of Zinc, Tallow
Tinned Steel	" " Rosin
Galvanised Steel	Hydrochloric Acid
Zinc	"
Steel	Sal-Ammoniac
Pewter	Sweet oil, resin
Gold	Borax
Silver	"
Bismuth	Chloride of Zinc

COMPOSITION OF BRAZING SOLDERS

COLOUR	CHARACTERISTICS	COMPOSITION			
		CU	ZN	SN	PB
Reddish Yellow	Very Strong	58	42		
"	Strong	53	47		
"	Medium	48	52		
"	"	54·5	43·5	1·5	·5
White	Easily Fusible	34	66		
Grey	" "	44	50	4	2
White	White Solder	55	26	15	4

SOFT SOLDER FORMULAS

SOLDER	COMPOSITION	MELTING POINT
Blowpipe or fine	40 PB. 60 SN.	334°F
Plumbers	66 PB. 34 SN.	440°F
Woods Metal	12·5 SN. 12·5 CD. 25 PB. 50 BI.	140°F
Pewterers	25 SN. 25 PB. 50 BI.	203°F

HEAT TREATMENT AND HARDENING OF METALS

Oil Hardening Steels. are less liable to breakage due to quenching being less drastic than water. Heat to 770°C - 800°C, then soak at this temperature for ½ hour per inch of thickness. Quenching off in oil by inserting thickest part in first to obviate stresses and distortion. It is now advisable to normalise to relieve all stresses, thereby preventing possible cracking. To effect this reheat to about 100°C - 120°C for a short while, and allow to cool in natural air or in silver sand.

·9% Carbon Steel. Identical treatment as above, but quench in water. Make certain the water has had the chill removed from it.

Press Tool and Die Steels. Normally contains up to 1% carbon and Vanadium up to 3%. Heat to about 810 °C, and treat as ·9% carbon steel.

HEAT TREATMENT AND HARDENING OF METALS

HIGH CARBON-CHROME STEEL. Heat to 950°C-985°C, and soak for at least 1 hour to 1½ hours per inch of thickness, and quench in oil. If more resistance to breakage is required, and less hardness, allow to cool in strong air blast evenly, temper at 150° C-200°C. If hardness is not so necessary, but strength to shock breakage is important, then temper up to 500°C.

HIGH SPEED STEEL for 14% Tungsten content preheat to remove chill from metal and transfer to furnace at 1200°C - 1250°C, thoroughly for about 1 hour per inch of thickness of steel, then remove and cool off in air as oil quenching is liable to cause cracks and breakage. For 18% tungstan content, heat as above to 1260°C-1300°C and quench in oil.

SUPER HIGH SPEED STEEL. Heat to 1300°C-1360°C, soak thoroughly as for high speed steel, and quench in oil. Make sure prior to soaking that the steel is thoroughly preheated. It is then advisable to give a secondary treatment by heating to 550°C - 590°C and cooling off naturally in air

HARDENING AND TEMPERING. Note, the higher the carbon content, the lower the hardening temperatures of steel. It is also important to make certain that the source of heat used is of a steady nature, so that temperatures do not vary. For this purpose it is wise to judge the temperature by the colour of the steel.

CASE HARDENING. This is used for low content carbon steels, which normally do not respond to direct heat, but which can be surface hardened by the introduction of additional carbon. The depth of case varies from 1/64" to 1/8" according to length of treatment. Heat the steel to bright red and apply case hardening compound to the heated surface by sprinkling or by immersing the red steel in the compound. Allow the compound to soak in for 10 minutes or so, then reheat and repeat this process 3 or 4 times. Finally heat and rapidly quench in water at 70° F. This produces a glass hard surface, with at the same time a core that is resistant to fatigue and shocks. For a greater depth of hardness, insert the steel in a metal box or tin and surround and cover the steel with charcoal, and seal the lid of the box with pipeclay. Then insert box in a furnace at a temperature of 850°C - 950°C for a period of three to twelve hours, according to depth of case required, then remove the steel and quench in water. For emergency hardening of small objects, use molten potassium or sodium cyanide, maintained at a temperature of about 900°C, in a pot or can, and soak steel in this, the length of time depends on depth of case required, then remove and quench in water. For tempering use oil. Should long narrow objects require hardening, alway quench them in a vertical position as this prevents possible bowing

HEAT TREATMENT AND HARDENING OF METALS

or distortion. Always plug any machined holes in objects that are to be hardened with pipeclay to prevent stresses or distortion except where the hole is required specifically hard. A final note of advise is to always follow makers instructions when these are available in the special treatment of any metals.

ARTIFICIAL COLOURING OF METALS AND ALLOYS

Make certain that the metal to be coloured is absolutely clean and free from grease.

BLACK. mix copper nitrate and water in ratio of 1:3 and immerse any metal object in this solution, an alternative is a saturated solution of copper crystals and dilute sulphuric acid, treat as above.

SHINY BLACK surface on copper. Ammonium sulphite and water in ratio of 1:4, treat as above.

RICH GOLD on brass. boil object in a solution of saltpetre, salt, alum, water, and hydrochloric acid in ratio of 2:1:1:24:1.

WHITE on brass, dip in a solution of silver dissolved in nitric acid plus water and sodium chloride, this after precipitation leaves silver chloride, then add an equal amount of cream of tarter and water to make a thick paste.

BLUE-BLACK on iron. dip in a solution of photographic hypo with small amount of lead nitrate added.

BLACKING zinc, dip in solution of antimony chloride and water

GREY tinting iron. boil for 1 hr in solution of iron phosphate

BLUEING steel. pass through flame at correct temperature for which see chart, or boil for ½ hr or longer in very strong solution of hypo and lead nitrate

ANTIQUE tint on brass, copper, or bronze. brown tint is obtained by dipping in solution of sodium sulphite for copper, and by heating in a paste of sulpher and lime for brass. To get a green tint paint daily for 4 to 5 days with a solution of strong vinegar, cream of tarter, copper acetate, common salt, Sal ammoniac, and copper carbonate in ratio of 7:1:1:1:1:4.

DULLING AND TINTING aluminium. dip in hot strong solution of caustic soda, immediately rinse in warm water and dip in hot strong solution of any aniline dye. This gives a permanent colour.

OXYDIZING silver. dip in very weak solution of potassium sulphide and ammonia.

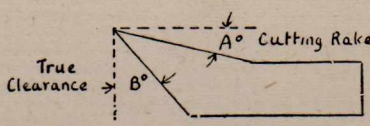
SILVERING. mix and grind silver chloride, cream of tarter and common salt in ratio of 1:2:3. add water to thin and rub in with soft cloth.

BLUE on brass dip in solution of antimony chloride, water, and hydrochloric acid in ratio of 1:20:3

GUN METAL finish on steel dip in solution of bismuth chloride, copper chloride, mercury chloride, hydrochloric acid, and water in ratio of 1:1:2:6:50.

BROWNING steel. Alcohol, tincture of iron, corrosive sublimate, sweet spirits of nitre, blue vitriol, nitric acid, warm water in ratio of 3:3:3:2:1½:80. dip in solution, dry. remove rust, redip, dry and boil in water

CUTTING ANGLES FOR TOOLS



MATERIAL	A°	B°	MATERIAL	A°	B°
Electron	5-7	5-10	S.21.	5-7	15-35
Duralumin	5-7	30-45	S.28.	5-7	10-20
Aluminium	6-8	30-45	S.61.	5-7	10-20
Copper	6-8	25	S.62.	5-7	10-20
Brass	8-10	0-5	S.65.	5-7	5-15
Silico-Aluminium	5-7	30-45	S.67.	5-7	10-20
Mild steel	5-7	15-35	S.68.	5-7	10-20
Machinery Steel	5-7	10-20	S.69	5-7	10-25
Monel Metal	8-10	15-25	S.70.	5-7	5-15
Gunmetal	6-8	0-5	S.71.	5-7	15-25
Manganese Bronze	6-8	0-5	S.76.	5-7	10-20
S.1	5-7	15-35	S.77.	5-7	15-25
S.2	5-7	5-15	S.79.	5-7	5-15
S.11	5-7	5-15	S.80.	5-7	5-15
S.14	5-7	15-35	S.81.	5-7	0-10
S.15	5-7	10-25			

METAL PLATING

COPPER PLATING. Make a strong solution of copper sulphate and water in the ratio of 4:15, then add 1 part of sulphuric acid and connect object to be plated to the negative lead of a 4 volt source of D.C. electricity and suspend the object in the solution. Suspend positive lead with a piece of pure copper plate or foil attached to it at the opposite end of the bath containing the solution. Due to the fact that electricity is used, the bath should be made of a non-conducting material such as glass or porcelain. The higher the amperage, the more rapid the depositing

NICKEL PLATING. Nickal is deposited electrically in the same manner as above by means of a nickel solution and nickel anode.

SILVER PLATING. Silver is deposited by means of a silver salts solution and electricity, and a silver anode. This method can be used to deposit practically any metal, but great care must be observed to see that the article to be plated is absolutely clean and free from grease.

METAL PLATING

CHROMIUM PLATING. is deposited by first nickel plating and then depositing the chrome on top of this.
SOLUTIONS. the following 4 solutions will be found useful as a basis for experiment in the electrical depositing of metals. Bath solutions as follows. proportions of constituents by weight.

(a) COPPER PLATING. Copper sulphate, Sulphuric acid, and water in ratio of 4 : 1 : 20
(b) NICKEL PLATING. nickel sulphate, nickel chloride, boric acid, and water, in ratio of 16 : 1 : 2.80
(c) CHROMIUM PLATING. chromic acid, sulphuric acid, and water in ratio of 80, 1 : 320
(d) SILVER PLATING. silver cyanide, sodium cyanide, and water in ratio of 10 : 11 : 320.

The amperage required to deposit the above mentioned metals will be a matter of experiment, but a safe guide is to use from 20-40 amperes, per sq. ft of surface that is required to be COVERED

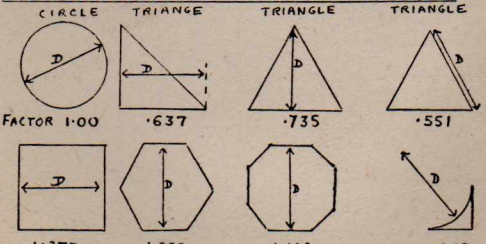
STANDARD METAL SPECIFICATIONS

S.1. Bright Mild Steel.	S.2. 55 ton alloy steel.
S.3. Mild steel sheet.	S.4. 5% nickel steel sheet.
S.6. Carbon steel.	S.11. 55 ton nickel-chrome steel.
S.14. " case hardening steel.	S.15. 3% nickel case/h steel.
S.20. Tinned steel sheets.	S.21. Carbon steel.
S.24. Bright key steel.	S.28. Air/h Nickel chrome steel.
S.61. 35 ton chrome steel.	S.62. 46 ton chrome steel.
S.65. 65 " nickel-chrome steel.	S.67. 5% nickel c/h steel.
S.68. 16% tungsten steel	S.69. 3½% nickel steel.
S.70. 55 ton carbon steel.	S.71. 30 ton carbon steel.
S.76. 40 " " " "	S.77. " " " "
S.79. 55 " " " "	S.80. stainless chrome steel.
S.81. 70 ton nickel-chrome steel.	S.82. nickel-chrome c/h steel.
S.84. Low carbon steel.	S.85. stainless steel sheets.
S.86. 45 ton nickel-chrome steel.	S.87. 60 ton nickel chrome steel.
S.88. 70 " " " "	S.90. 5% nickel c/h high tensile steel.
L.1. 25 ton Aluminium alloy.	L.3. Wrought aluminium alloy.
L.5. aluminium-zinc-copper alloy.	L.8. 12% copper " "
L.11. aluminium alloy.	L.16. 7.5 tons aluminium sheets.
L.17. soft aluminium sheets.	L.24. 'Y' aluminium alloy.
L.25. 24 ton aluminium alloy.	L.30. 98% pure aluminium
L.31. 99% pure aluminium.	L.33. Silicon aluminium alloy.
L.34. " " "	L.35. 'Y' aluminium alloy.
L.36. 7 ton aluminium wire.	L.37. 25 ton " " wire.
L.38. aluminium coated aluminium.	L.39. 20 " " alloy
L.40. 27 ton aluminium alloy.	L.42. 25 " " "
L.45. 23 " " "	L.46. soft aluminium "
L.44. soft " "	L.47. aluminium coated aluminium

CHEMICAL SYMBOLS OF ELEMENTS

NAME	SYMBOL	NAME	SYMBOL	NAME	SYMBOL
ALUMINIUM	Al	HOLMIUM	Ho	RHODIUM	Rh
ANTIMONY	Sb	HYDROGEN	H	RUBIDIUM	Rb
ARGON	A	INDIUM	In	RUTHENIUM	Ru
ARSENIC	As	IODINE	I	SAMARIUM	Sm
BARIUM	Ba	IRIDIUM	Ir	SCANDIUM	Sc
BERYLLIUM	Be	IRON	Fe	SELENIUM	Se
BISMUTH	Bi	KRYPTON	Kr	SILICON	Si
BORON	B	LANTHANUM	La	SILVER	Ag
BROMINE	Br	LEAD	Pb	SODIUM	Na
CADMIUM	Cd	LITHIUM	Li	STRONTIUM	Sr
CAESIUM	Cs	LUTICIUM	Lu	SULPHER	S
CALCIUM	Ca	MAGNESIUM	Mg	TANTALUM	Ta
CARBON	C	MANGANESE	Mn	TELLERIUM	Te
CERIUM	Ce	MERCURY	Hg	TERBIUM	Tb
CHLORINE	Cl	MOLYBDENUM	Mo	THALLIUM	Tl
CHROMIUM	Cr	NEODYMIUM	Nd	THORIUM	Th
COBALT	Co	NEON	Ne	THULIUM	Tm
COLUMBIUM	Cb	NICKEL	Ni	TIN	Sn
COPPER	Cu	NIOBIUM	Nb	TITANIUM	Ti
DYPROSIUM	Dy	NITON	Nt	TUNGSTEN	W
ERBIUM	Er	NITROGEN	N	URANIUM	U
EUROPIUM	Eu	OSMIUM	Os	VANADIUM	V
FLUORINE	F	OXYGEN	O	XENON	Xe
GADOLINIUM	Gd	PALLADIUM	Pd	YTTERBIUM	Yb
GALLIUM	Ga	PHOSPHORUS	P	YTTRIUM	Y
GERMANIUM	Ge	PLATINUM	Pt	ZINC	Z
GLUCINIUM	Gl	POTASSIUM	K	ZIRCONIUM	Zr
GOLD	Au	PRASEODYMIUM	Pr		
HELIUM	He	RADIUM	Ra		

FORMULA FOR CALCULATING WEIGHT OF BAR STOCK



MATERIAL FACTORS

ALUMINIUM	·343	BRASS	1·076	COPPER	1·123
STEEL	1·000	ZINC	·680	CAST IRON	·917
LEAD	1·448	TIN	·945	BRONZE	1·113

COMPOSITION OF METALS AND ALLOYS

NAME OF METAL OR ALLOY	CONSTITUENTS																	Tensile strength Tons per Sq in
	Cu	Pb	Sn	Ni	Zn	Al	Si	Mg	Cd	Fe	Mn	Steel	Co	Cr	Sb	Ag	Au	
Acid Bronze	73·5	17	8	1·5														
Admiralty Gunmetal	88		10		2													19
Aeral	3·5					91·85	·6	1·8	2·25									30
Aerolite	1·15				·12	91·93	·95	·38		·97								
Aeron	4					95	1											25
Aich's Metal	60·6		1·02		36·5					1·74								
Aldol	4					94·4	·6	·5			5							25 - 35
Almag	2·5					96·2	6	·7										25
Alnico				20		20						50	10					
Alpax						87	13											
Alumel				94		2	1				2·5							
Ardal	2			·6		95·7				1·7								
Argentine Metal			85·5												14·5			
Babbit's "	4 lb		24 lb												8 lb			
Bell "	80		20															
Birmabright						92		7			1							
Brass	66				34													
Britannia Metal	2		90												8			
Camelia "	70·2	14·75	4·25		10·2					·55								
Ceralumin	2·5	-		1·5		92·8	1·2	·8		1·2								18
Chinese Silver	58	-		11·5									11			2		
Chromel				80										20				
Cobalt-chrome steel							·4			80	·4		3·7	13·3				
Coinage Bronze	95		4		1													
Coinage Silver	7·2	·2														92·5		
Common Solder		50	50															

COMPOSITION OF METALS AND ALLOYS

NAME OF METAL OR ALLOY	CONSTITUENTS															TENSILE STRENGTH TONS PER SQUARE INCH
	Cu	Pb	Sn	Al	Ni	Mg	Fe	Mn	Zn	Cr	Sb	Ag	Au	Bi	Si	C	
Constantan	60				40												
Corronium	80		5						15								22
Dandelion Metal		72	10								18						
Diamond Bronze	88			10											2		
Duralumin	4			95		·5		·5									18-26
"E" Alloy	2·5			76·5		·5		·5	20								
Electrician's Solder		5·5	94·5														
English Pewter		20	80														
Eureka Alloy	57				43												
Everdur	96							1							3		25-40
Glass Cement Alloy		3	2											2·5			
Glyco Metal		70	8								22						
Goldine	90								10								
Gong Metal	80		20														
Graphite Alloy		68	15								17						
Green Gold												25	75				
Gunmetal	90		10														
Heckenham Alloy	56				44												
Hercules Metal	67			2					31								30-35
Hoskin's Alloy					90					10							
Hoyle's "		22	24								6						
Hypernik					50		50										
Imitation Platinum	80								100								
Inconel					80		6			14							
Invar					36		63	·5								·5	
Ironac							86										

COMPOSITION OF METALS AND ALLOYS

NAME OF METAL OR ALLOY	CONSTITUENTS																TENSILE STRENGTH TONS PER SQ IN
	Cu	Pb	Sn	Al	Zn	Si	Sb	Cr	Fe	C	Mn	Hg	Mg	Co	S	Ni	W	
Key Metal	80	5	10		5													
Kingston Metal	6		88									6						
Kneiss	3	42	15		40													
Kuprodur	98·75					·5										·75		
Lead Bronze	80	10	10															25
Linotype Metal		85	2				13											
Magnalite	2·5			94·2	·5								1·3			1·5		16
Magnolia Metal		78	6				16											
Manganese Bronze	56		1		41·5	·25			1		·25							30
Manganin Alloy	84										12					4		
Majak				4·1	95·86								·04					21
Metalline	30			25					10					35				
Minofor Metal	3·3		68·5		10		18·2											
Miralite				96												4		12
Monel	29·14					·06			1·19	·12	1·02				·008	68·4		
Muntz Metal	60				40													
Naval Brass	59		1		40													
Nichrome								12	26		2					60		
Nickeline	60															15		
Nickel-Silver	58															22		
Nickel-Tungsten																83	17	
Nickeltin			50													50		
Nilex									64							36		
Ni-Resist	6							2	78							14		
Otto's Alloy	68·5		31·5															
P.2. Alloy	3			88·25		4			2		·5		·5			1·75		

COMPOSITION OF METALS AND ALLOYS

NAME OF METAL OR ALLOY	CONSTITUENTS																		TENSILE STRENGTH TONS PER SQUARE INCH
	Ni	Cr	Mn	Fe	Cu	Al	Zn	Pb	Sn	W	Mg	Si	Au	Cd	Hg	Bi	Co	Sb	Ti	Mo	
Parisian Metal	19·5				69		6·5							5							
Partinium				1·3	7·4	88·5	1·7					1·1									
Pencil Lead								70							8	90					
Permalloy	78·5			21·5																	
Perminvar	45			30													25				
Platinoid	14				60		24			2											
Platnam	54				33				13												
Pot Metal					88			12													
Red Gold					25								75								
Reith's Alloy					74·5			9	11·6									4·9			
Retz's "					15			1·82	2·34									1			
Rheostan			12		84		4														
R.R. 56.	1·3			1·4	2	93·7					·8	·7							·1		
Silicon Bronze			1		95							4									25
Silver Bronze			18		67·5	1·2	13					5									
Sorels Alloy				10	10		80														
Staybnite	8	18		74																	
Steam Metal					87		3	3	7												
Stellite		15								25							55		5		
Super-Dural			·5		4	93·75					·5	1·25									
Tungam	·72			·3	82·48		·99	14·6													20–55
Tutania Metal					12·5			12·5		25			·76				25		25		
Valve "					86			8	2·5	3·5											
Wood's "									25	12·5				12·5		50					
Zinkalium					3	85	12														26
Zirkonal			8		15	76·5						·5									

TEMPERING COLOURS FOR STEEL

COLOUR	°C	°F	COLOUR	°C	°F
Dark Blue	316	600	Brown	254	490
Blue	293	560	Golden Yellow	243	470
Bright Blue	288	550	Straw	230	446
Purple	277	530	Pale Yellow	221	430
Brown to Purple	266	510			

HEAT COLOUR TEMPERATURES

COLOUR	°C	°F	COLOUR	°C	°F
Just visible red	500-600	932-1112	Orange	950-1000	1750-1835
Dull cherry red	700-750	1300-1385	Light Orange	1000-1050	1835-1925
Cherry red	750-825	1385-1517	Lemon	1100-1200	2012-2200
Bright cherry red	825-875	1517-1600	White	1200-1300	2200-2372
Brightest red	900-950	1652-1750			

TEMPERATURE CONVERSION FACTORS

F = Fahrenheit . R = Reamur . C = Centigrade

°F = 9/5 °C + 32 °R = 4/5 °C °C = 5/4 °R

°F = 9/4 °R + 32 °R = 4/9 (°F - 32) °C = 5/9 (°F - 32)

To Find Adulteration of Metals or Composition of Alloys

Let M = Weight of alloy in Air.
" P = " " " suspended in Water.
" A = Specific Gravity of first component part.
" B = " " " second " " .

For example -, Specific Gravity of Gold = 19·36.
" " " Silver = 10·51.
The alloy weighs 6 lbs in air.
" " " 5·636 in water.

∴ weight of Gold = $\frac{6 - 10{\cdot}51\,(6 - 5{\cdot}636)}{1 - \left(\frac{10{\cdot}51}{19{\cdot}36}\right)}$ = 4·755 lbs of Gold .

and weight of silver = 6 - 4·755 = 1·245 lbs.

Formula for this problem is as follows -,
The weight of one component part = $\frac{M - A(M - P)}{1 - \frac{A}{B}}$
and the weight of the second part is the total weight of the alloy weighed in air minus the weight of one component part.

PROPERTIES OF ELEMENTS AND METALS

NAME	Chemical Symbol	Specific Gravity	Weight per ft cube in lbs	Melting Point °F	Type of Structure
Aluminium	Al	2·56	159·7	1218	D
Antimony	Sb	6·71	418·7	1166	A
Barium	Ba	3·75	234	1562	D
Bismuth	Bi	9·8	611·5	520	A
Boron	B	2·6	162·2	4250	C
Brass. 80c. 20z.	-	8·6	536·6	1775	D
" 70c. 30z.	-	8·4	524·1	1775	D
" 60c. 40z.	-	8·36	521·7	1775	D
" 50c. 50z.	-	8·2	511·6	1775	D
Bronze	-	8·85	552·2	1675	A
Cadmium	Cd	8·6	536·6	610	D
Calcium	Ca	1·57	98	1490	D
Chromium	Cr	6·5	405·6	2939	A
Cobalt	Co	8·65	539·8	2696	D
Copper	Cu	8·82	550·4	1981	D
Gold	Au	19·32	1205·6	1945	D
Iridium	Ir	22·42	1339	4260	D
Iron cast	Fe	7·2	449·2	2300	A
" wrought	Fe	7·85	489·8	2750	D
Lead	Pb	11·37	709·5	621	E
Magnesium	Mg	1·74	108·6	1204	D
Manganese	Mn	7·42	463	2246	A
Mercury	Hg	13·58	847·4	-38	B
Molybdenum	Mo	8·56	534·2	4620	A
Nickel	Ni	8·8	549·1	2646	D
Platinum rolled	Pt	22·67	1414·6	3191	D
" wire	Pt	21·04	1312·9	3191	D
Potassium	K	·87	54·3	144	E
Silver	Ag	10·53	657·1	1761	D
Sodium	Na	·98	61·1	207	E
Steel	Fe	7·8	486·7	2500	D
Tellurium	Te	6·25	390	846	A
Tin	Sn	7·29	454·8	449	D
Titanium	Ti	3·54	220·9	3272	D
Tungsten	W	18·77	1171·2	6152	A
Vanadium	Va	5·5	343·2	3128	D
Zinc cast	Zn	6·86	428·1	787	A
" rolled	Zn	7·15	446·1	787	D

* A = BRITTLE. B = FLUID. C = HARD. D = MALLABLE E = SOFT

Birmingham Sheet Metal Gauge (B.G)

N°	SIZE	N°	SIZE	N°	SIZE	N°	SIZE
7/0	·6666	9	·1398	24	·0247	39	·0043
6/0	·625	10	·125	25	·022	40	·0038
5/0	·5883	11	·1113	26	·0196	41	·0034
4/0	·5416	12	·0991	27	·0174	42	·0030
3/0	·500	13	·0882	28	·0156	43	·0027
2/0	·4452	14	·0785	29	·0139	44	·0024
0	·3964	15	·0699	30	·0123	45	·0021
1	·3532	16	·0625	31	·011	46	·0019
2	·3147	17	·0556	32	·0098	47	·0017
3	·2804	18	·0495	33	·0087	48	·0016
4	·250	19	·044	34	·0077	49	·0013
5	·2225	20	·0392	35	·0069	50	·0012
6	·1981	21	·0349	36	·0061		
7	·1764	22	·0312	37	·0054		
8	·1570	23	·0278	38	·0048		

British Imperial Wire Gauge (S.W.G)

N°	SIZE	N°	SIZE	N°	SIZE	N°	SIZE
7/0	·500	9	·144	24	·022	39	·0052
6/0	·464	10	·128	25	·020	40	·0048
5/0	·432	11	·116	26	·018	41	·0044
4/0	·400	12	·104	27	·0164	42	·0040
3/0	·372	13	·092	28	·0148	43	·0036
2/0	·348	14	·080	29	·0136	44	·0032
0	·324	15	·072	30	·0124	45	·0028
1	·300	16	·064	31	·0116	46	·0024
2	·276	17	·056	32	·0108	47	·0020
3	·252	18	·048	33	·0100	48	·0016
4	·232	19	·040	34	·0092	49	·0012
5	·212	20	·036	35	·0084	50	·0010
6	·192	21	·032	36	·0076		
7	·176	22	·028	37	·0068		
8	·160	23	·024	38	·0060		

BRINELL HARDNESS NUMBER AND TENSILE STRENGTH

10 m/m ball with 3000 Kilogram load

DIAMETER OF IMPRESSION IN M/M	HARDNESS No	TONS PER SQUARE INCH	DIAMETER OF IMPRESSION	HARDNESS No	TONS per SQ INCH
2·0	946	206	4·5	179	39·5
2·1	857	187	4·6	170	38·5
2·2	782	171	4·7	163	37·5
2·3	713	155	4·8	156	36
2·4	652	142	4·9	149	34
2·5	600	131	5·0	143	33
2·6	555	121	5·1	137	31·5
2·7	512	112	5·2	131	30
2·8	477	104	5·3	126	29
2·9	444	97	5·4	121	28
3·0	418	91	5·5	116	26·5
3·1	387	84	5·6	112	25·5
3·2	364	79	5·7	107	24·5
3·3	340	74	5·8	103	23·5
3·4	321	70	5·9	99	22·75
3·5	302	66	6·0	95	22
3·6	286	62	6·1	92	21
3·7	269	59	6·2	89	20·5
3·8	255	55	6·3	86	19·75
3·9	241	52	6·4	82	19·
4·0	228	50	6·5	80	18·5
4·1	217	47	6·6	77	17·75
4·2	207	45	6·7	74	17
4·3	196	43	6·8	71·5	16·5
4·4	187	41	6·9	69	16

HARDNESS NUMBER COMPARISONS

BRINELL 10 m/m 3000 Kg	FIRTH 120 Kg	ROCKWELL "C"	ROCKWELL "B"	SCLEROSCOPE	BRINELL 10 m/m 3000 Kg	FIRTH 120 Kg	ROCKWELL "C"	ROCKWELL "B"	SCLEROSCOPE
800		72		100	276	278	30	105	42
760	1170	70		98	261	261	28	103	40
725	1060	67		96	255	255	26	102	39
682	940	65		93	245	246	24	100	37
652	867	63		89	237	235	23	99	35
614	775	61		85	224	221	21	97	33
590	727	59		81	211	213	19	95	32
552	649	56		76	203	201	17	94	31
529	606	54		74	196	197	15	92	30
502	565	52	119	70	187	186	13	91	29
477	534	49	118	67	183	183	11	90	28
451	489	47	117	65	175	174	9	88	27
427	460	45	115	62	167	168	6	87	27
401	423	43	114	58	163	162	4	85	26
375	390	41	113	55	156	154	2	83	25
362	380	39	111	53	152	150		82	24
346	352	37	110	50	147	147		80	24
331	335	36	109	47	143	144		79	23
311	312	34	108	46	140	141		77	22
293	291	32	106	44	130	130		72	22

STANDARD METALLURGICAL TESTS

ARNOLD TEST. sample piece is .375" diameter by 5" long. It is clamped in centre and held, then end alternately struck by hammer, and the number of reversal bends checked before breakage.

CHARPY TEST. The notched bar test. The ends are held in a pair of centres, and a loaded knife hits the test bar central on opposite side to notch. Standard test piece is 10 mm sq. Width of notch 1mm. 2/3 mm. radius at root of notch and its depth is 5 mm.

FIRTH HARDOMETER TEST. for hardness tests. Standard load 120 Kilograms with 2 mm. or 4 mm balls or pointed diamond. Image of impression is magnified by microscope and projected on ground glass screen at eye level.

IZOD impact test. Brittleness test by means of notched bar standard test piece 10 mm sq is gripped in a vise, knife edge pendulum hits on same side as notch and a foot pounds reading is obtained. Sq section test piece has notch 2 mm. deep, .25 mm root radius and 45° included angle. circular section test piece dia is .45" with notch .12" deep, .005 radius at root and 45° angle. Length of test bar is 75 mm. and pendulum knife edge strikes 22 mm. away from centre line of notch for metric test piece and for decimal test bar, length is 3" with notch 1.1" away from one end whilst the metric pattern has the notch placed 28 mm. from one end.

ROCKWELL hardness test. readings given in Rockwell numbers on a dial direct. 3 scales are used viz:- A scale has diamond cone with 60 kilograms load, B scale has 1/16" steel ball with 100 Kilograms load, and C scale has a 120° diamond cone indenter with a 150 kilogram load.

SHORE SCLEROSCOPE. hardness testing machine utilises the rebound or bounce principle. A small conical diamond pointed pointed hammer falls due to force of gravity striking the test piece and bounces, height of bounce is noted on a graduated scale. Height of fall is 10 inches with hammer weighing 1/12 of an oz, hammer is elevated in a glass graduated tube by means of a rubber bulb hand operated creating a vacuum.

VICKERS DIAMOND hardness test best type for very hard materials. gives a square impression used with diamond point dressed to angle of 136°. load applied is either 1, 5, 10, 20 or 30, 50, and 100 Kilograms with diamond, or 30 kilograms with 1 mm ball and 150 Kilograms with 2 mm. steel ball. The load is applied automatically and readings are taken on a ground glass screen suitably graduated.