

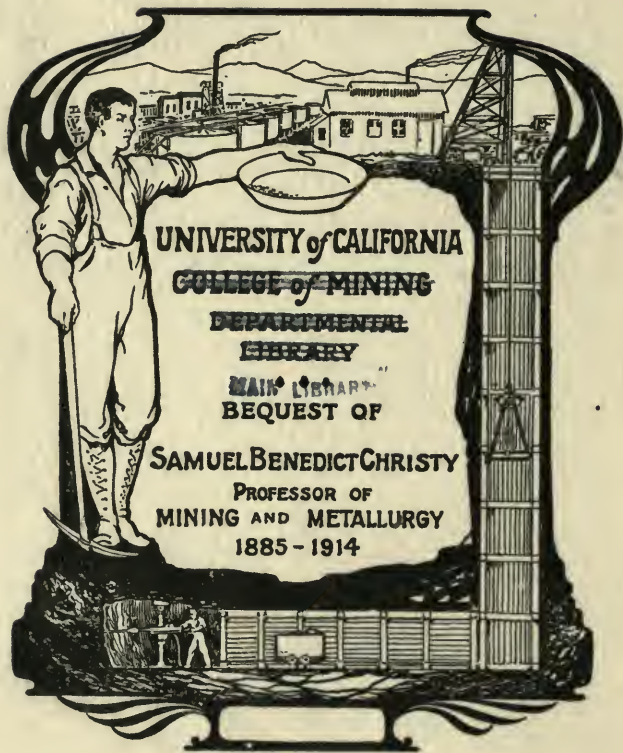
UC-NRLF



QB 546 666

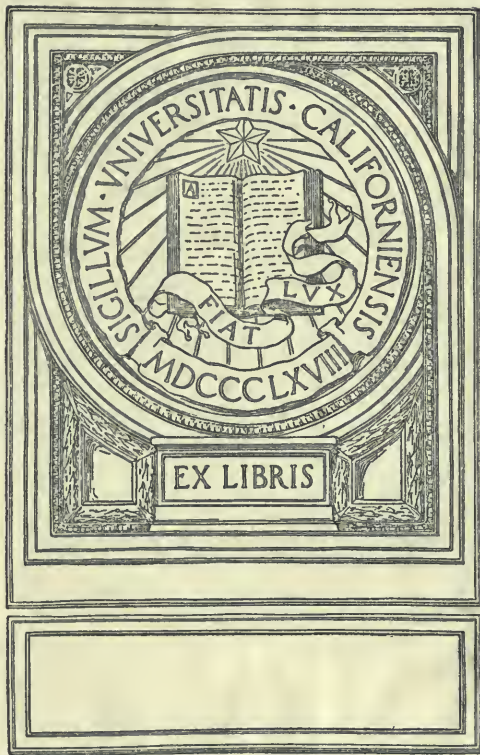
HENDY'S
HANDY ATLAS
OF THE
WORLD



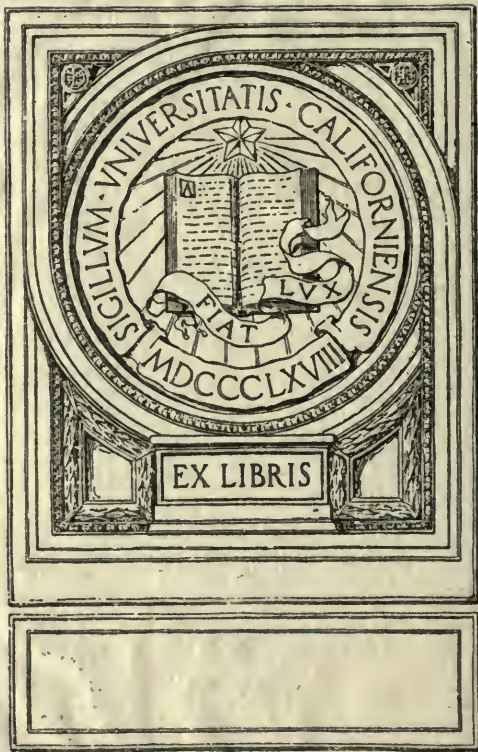


Prof

Comp



amph



SIGILLVM · VNIVERSITATIS · CALIFORNENSIS
MDCCCLXVIII

EX LIBRIS

HENDY'S Handy Atlas of the World

Containing New Maps of Each State and Territory
in the United States and Each Country in the World

Also Practical Pointers and Con-
densed Data for the Machinist,
Mechanic, Millman and Miner.



Works at Sunnyvale, California

1910

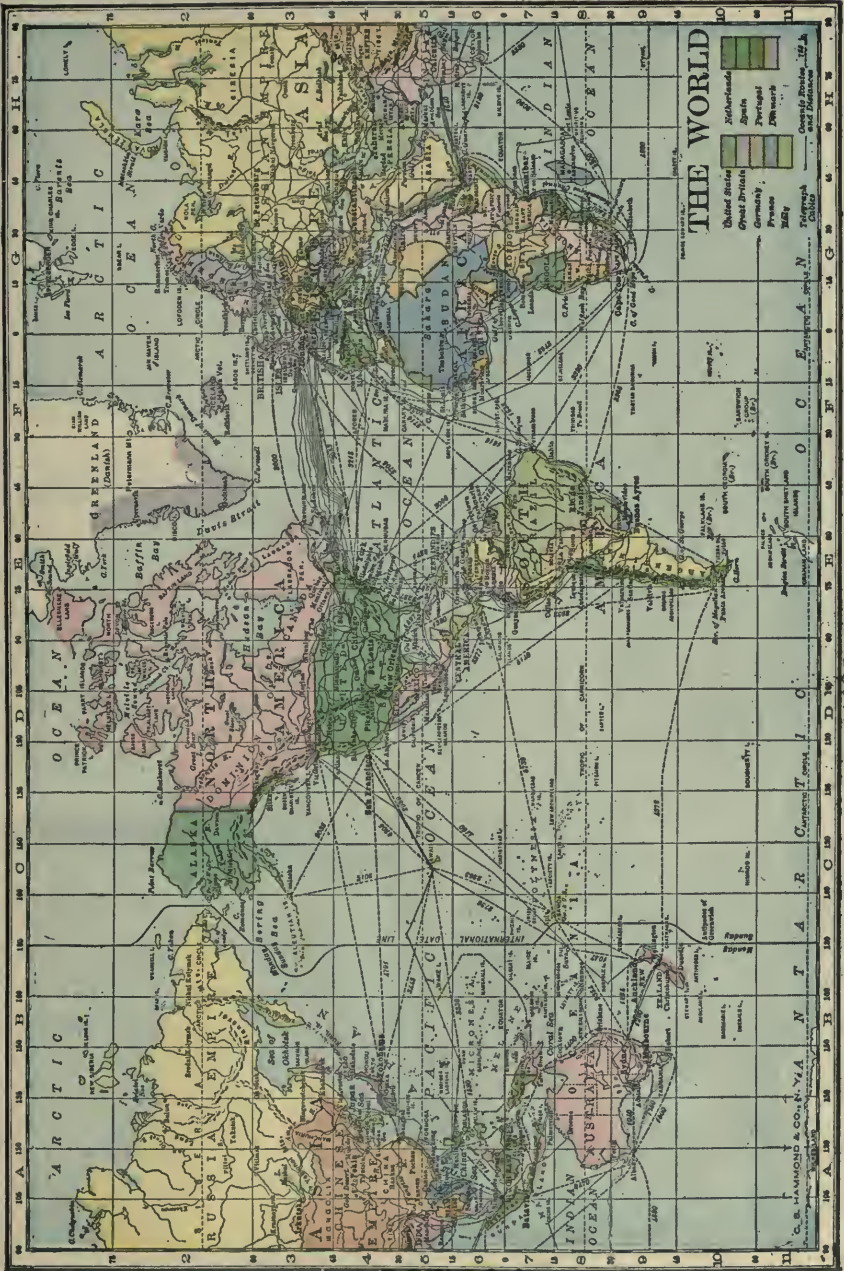
JOSHUA HENDY IRON WORKS

Office and Salesroom: 75 Fremont Street, San Francisco, Cal.

ALPHABETICAL LIST OF STATES AND COUNTRIES

Indicating the Maps in the Atlas on which they are shown

	PAGE		PAGE		PAGE		PAGE
Abyssinia	77	Egypt	77	Missouri	46	Senegambia	77
Afghanistan	80	England	79	Montana	55	Servia	78
Africa	77	Erythrea	77	Montenegro	78	Siam	80
Alabama	35	Europe	78	Morocco	77	Siberia	80
Alaska	66					Sierra Leone	77
Alberta	14	Florida	34	Natal	80	Solomon Islands	72
Algeria	77	Formosa	80	Nebraska	52	Somali Coast, British	77
Anam	80	France	78	Nepal	78	Somali Coast, French	77
Andorra	78			Netherlands	80	Somaliland, Italian	77
Angola	77	Georgia	33	Nevada	63	Somaliland, Italian	77
Antarctic Regions	83	Germany	78	New Brunswick	10	South America	76
Arabia	80	Gold Coast	77	Newfoundland	10	South Australia	81
Arctic Regions	84	Greece	78	New Guinea	52	South Carolina	32
Argentina	76	Greenland	8	New Hampshire	21	South Dakota	54
Arizona	61	Guam	18	New Jersey	26	South Polar Regions	83
Arkansas	47	Guatemala	73	New Mexico	60	Southwest Africa, German	77
Asia	80	Guiana, British	76	New South Wales	85	Spain	78
Australia	81	Guiana, Dutch	76	New York	21	Straits Settlements	80
Austria-Hungary	78	Guiana, French	76	New Zealand	81	Sudan	77
Azores Islands	77	Guinea, Portuguese	77	Nicaragua	73	Sumatra	80
				Nigeria	77	Sweden	78
Bahama Islands	71	Haiti	71	North America	8	Switzerland	78
Baluchistan	80	Hawaii	67	North Carolina	31		
Barbados	71	Holland	78	North Dakota	53	Tasmania	81
Belgium	78	Honduras	73	North Polar Regions	84, 85	Tennessee	38
Belize	73	Hungary	78	Northwest Territories	9	Texas	49
Bhutan	80			Norway	78	Togoland	77
Bokhara	80	Iceland	78	Nova Scotia	10	Tonkin	80
Bolivia	76	Idaho	57	Nubia	77	Transvaal Colony	77
Borneo	82	Illinois	43			Trinidad	71
Bosnia	78	India	80	Oceania	3	Tripoli	77
Brazil	76	Indiana	40	Ohio	39	Tunis	77
British Columbia	15	Iowa	45	Oklahoma	50	Turkey	78
British Honduras	73	Ireland	79	Oman	80	Turkey in Asia	80
British Isles	79	Italy	78	Ontario	12	Tutulla	82
Bulgaria	78	Ivory Coast	77	Orange River Colony	77		
Burma	80	Jamaica	71, 73	Oregon	64	Ungava	9
		Japan	80	Pacific Ocean	82	United States, Political	16, 17
California	62	Java	82	Palestine	80	United States, Showing Acquisitions of Territory	18
Cambochia	80			Panama	73	Uruguay	76
Canada	9	Kamerun	77	Panama Canal	88, 89	Utah	58
Canal Zone, U. S.	70	Kansas	51	Panama Canal Zone	70		
Canary Islands	77	Kentucky	37	Paraguay	76	Venezuela	76
Cape Breton I.	10	Kongo, French	77	Pennsylvania	27	Vermont	20
Cape of Good Hope	77	Kongo State	77	Persia	80	Victoria	81
Caroline Islands	82	Korea	80	Philippine Islands	68	Virginia	29
Central Africa, British	77			Porto Rico	69		
Central America	73	Leeward Islands	71	Portugal	68	Wales	79
Ceylon	80	Liberia	77	Prince Edward Island	10	Washington	65
Chile	76	Louisiana	48	Quebec	11	West Indies	71
China	80	Luxemburg	78	Queensland	81	West Virginia	30
Colombia	76			Rhode Island	23	Western Australia	81
Colorado	59	Madagascar	77	Rhodesia	77	Windward Islands	71
Connecticut	24	Madeira Islands	77	Rio de Oro	77	Wisconsin	42
Costa Rica	73	Maine	19	Rumania	78	World, on Equivalent Projection	4
Crete	78	Malta	78	Russia in Asia	78	World, Political	3
Cuba	70	Marianne Islands	82	Salvador	73	World, Showing Commercial Languages	6
Curacao	71	Maritime Provinces	10	Samoa	18	World, Showing State Organizations	5
		Marshall Islands	82	Santo Domingo	71	World, Showing Timber Supply	7
Dahomey	77	Maryland	28	Saskatchewan	14	Wyoming	56
Delaware	28	Massachusetts	22	Scotland	79		
Denmark	78	Mexico	72	Senegal	77	Yukon	9
East Africa, British	77	Michigan	41				
East Africa, German	77	Minnesota	44				
East Africa, Portuguese	77	Mississippi	36				
East Indies	82						
Ecuador	76						



337661



MAP OF THE WORLD ON THE EQUIVALENT PROJECTION

EXPLANATORY NOTE

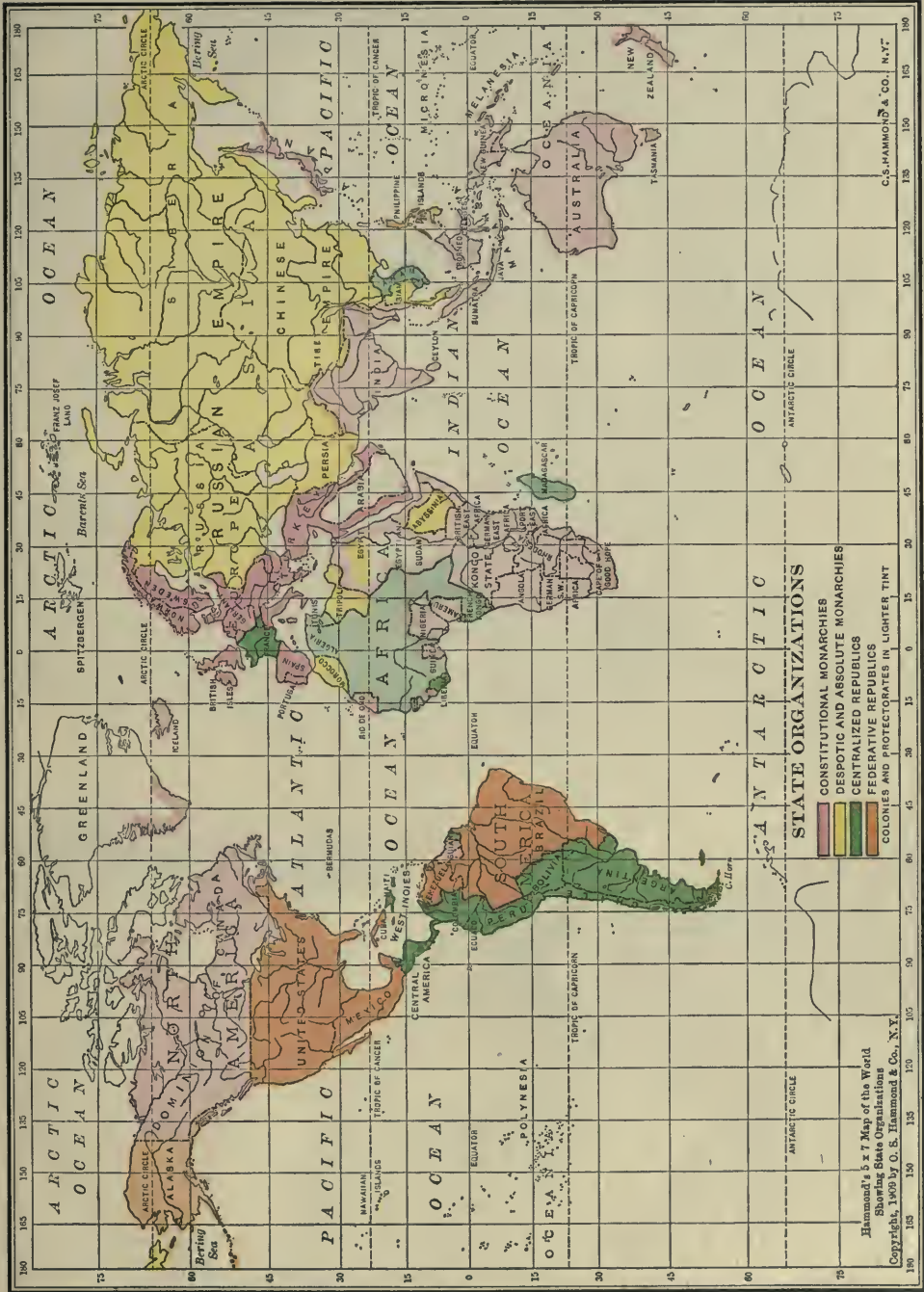
This new map presents a comprehensive view of the superficial area of the earth, not unlike that which would be displayed by the printed cover of a globe, if removed and flattened.

On this map all areas appear in their true proportion. For example, Greenland, which, on Mercator's Projection, seems to be larger than South America, here is shown in its relative proportion of size to that continent, having less than one-eighth of the latter's area. In fact, this is the only projection in which are shown the equivalent areas, or correct sizes, of all parts of the globe, in their proper relative position.

The meridians are placed fifteen degrees apart, and, since this interval is equal to one hour of time, meridians and intervals make a standard time-map for the whole earth. On the line of the Equator is given the time at each meridian, corresponding to noon at Greenwich. These figures will be found convenient for quick reference; and the approximate difference in time between any two points may be readily obtained, by simply counting the meridians, and allowing one hour for each.

FEATURES

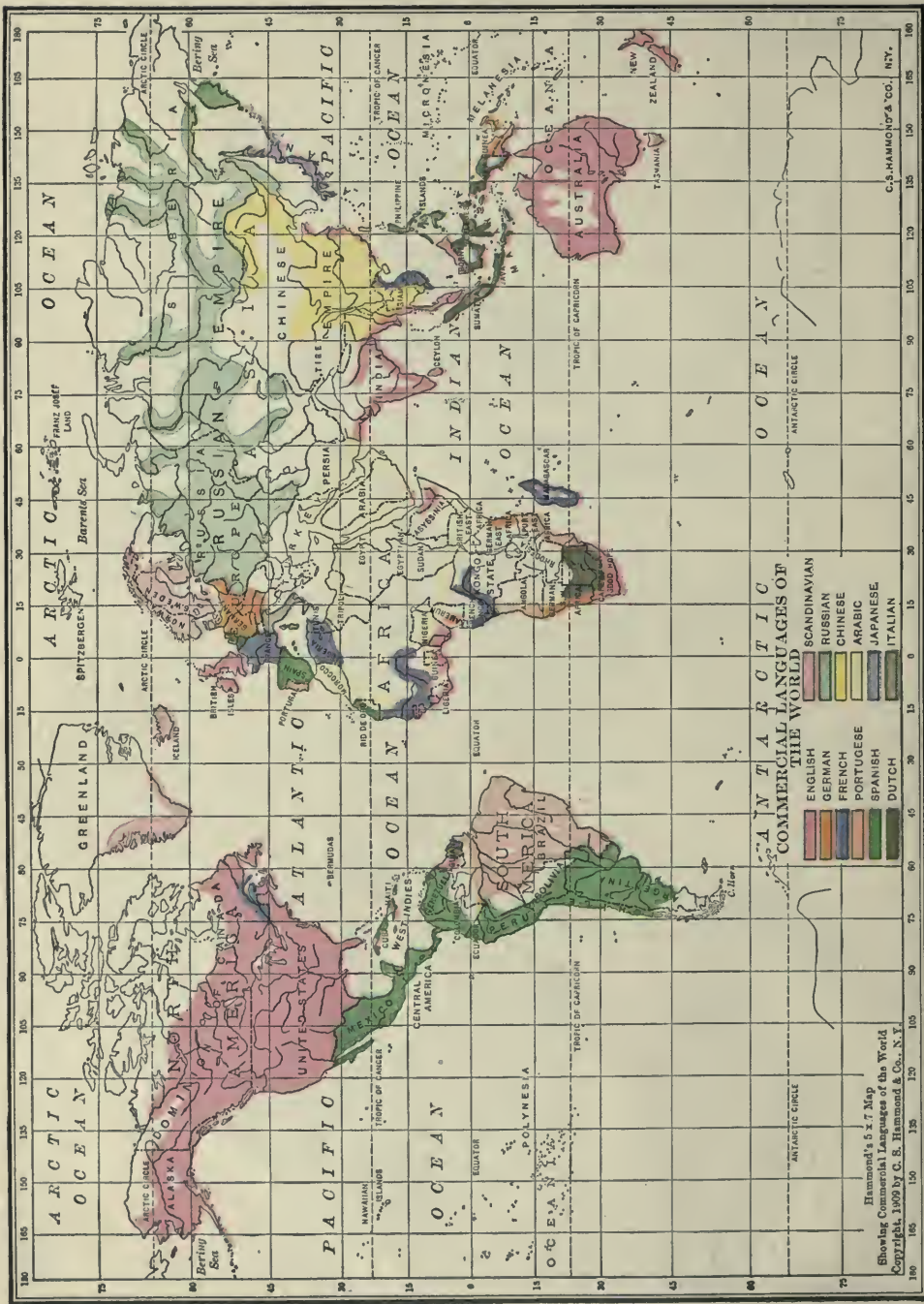
- Submarine Cables, shown in fine black lines.
- The International Date Line, as agreed upon by leading nations, shown in heavy broken line.
- Colonial possessions of European powers in Africa, Asia and Oceania, shown in colors corresponding with those used for mother countries.



STATE ORGANIZATIONS

- CONSTITUTIONAL MONARCHIES
- DESPOTISM AND ABSOLUTE MONARCHIES
- CENTRALIZED REPUBLICS
- FEDERATIVE REPUBLICS
- COLONIES AND PROTECTORATES IN LIGHTER TINT

Hammond's 5 x 7 Map of the World
 Showing State Organizations
 Copyright, 1907 by C. S. Hammond & Co., N. Y.

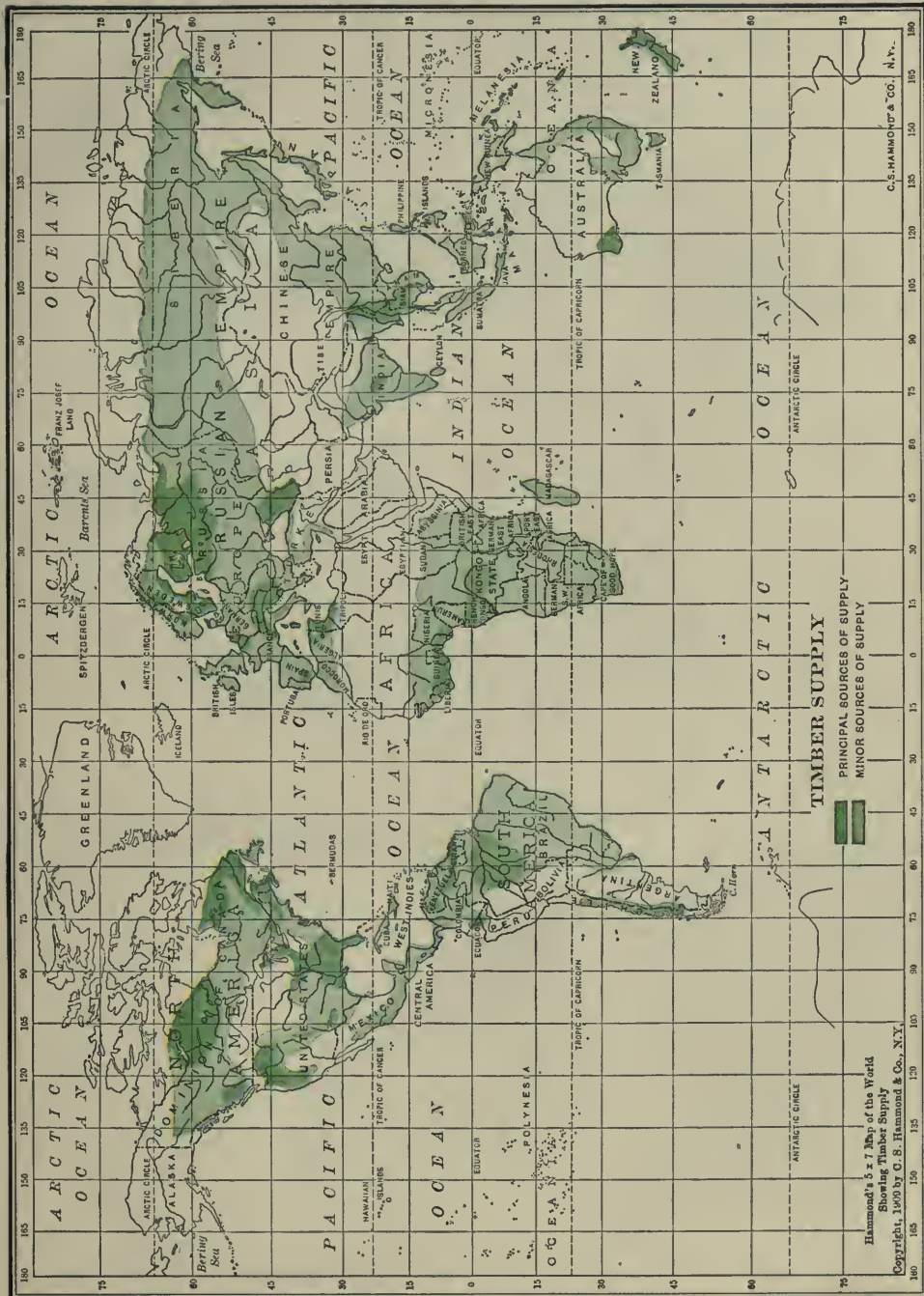


COMMERCIAL LANGUAGES OF THE WORLD

[Pink Box]	ENGLISH
[Light Blue Box]	GERMAN
[Light Green Box]	FRENCH
[Light Yellow Box]	PORTUGUESE
[Light Purple Box]	SPANISH
[Light Orange Box]	JAPANESE
[Light Red Box]	ITALIAN
[Light Cyan Box]	SCANDINAVIAN
[Light Brown Box]	RUSSIAN
[Light Grey Box]	CHINESE
[Light Blue-Gray Box]	ARABIC
[Light Green-Gray Box]	SPANISH
[Light Purple-Gray Box]	JAPANESE
[Light Red-Gray Box]	ITALIAN
[Light Orange-Gray Box]	DUTCH

Hammond's 5 & 7 Map
 Showing Commercial Languages of the World
 Copyright, 1909 by C. S. Hammond & Co., N. Y.

C. S. HAMMOND & CO., N. Y.



TIMBER SUPPLY
 PRINCIPAL SOURCES OF SUPPLY
 MINOR SOURCES OF SUPPLY

Hammond's 5 x 7 Map of the World
 Showing Timber Supply
 Copyright, 1900 by C. S. Hammond & Co., N.Y.



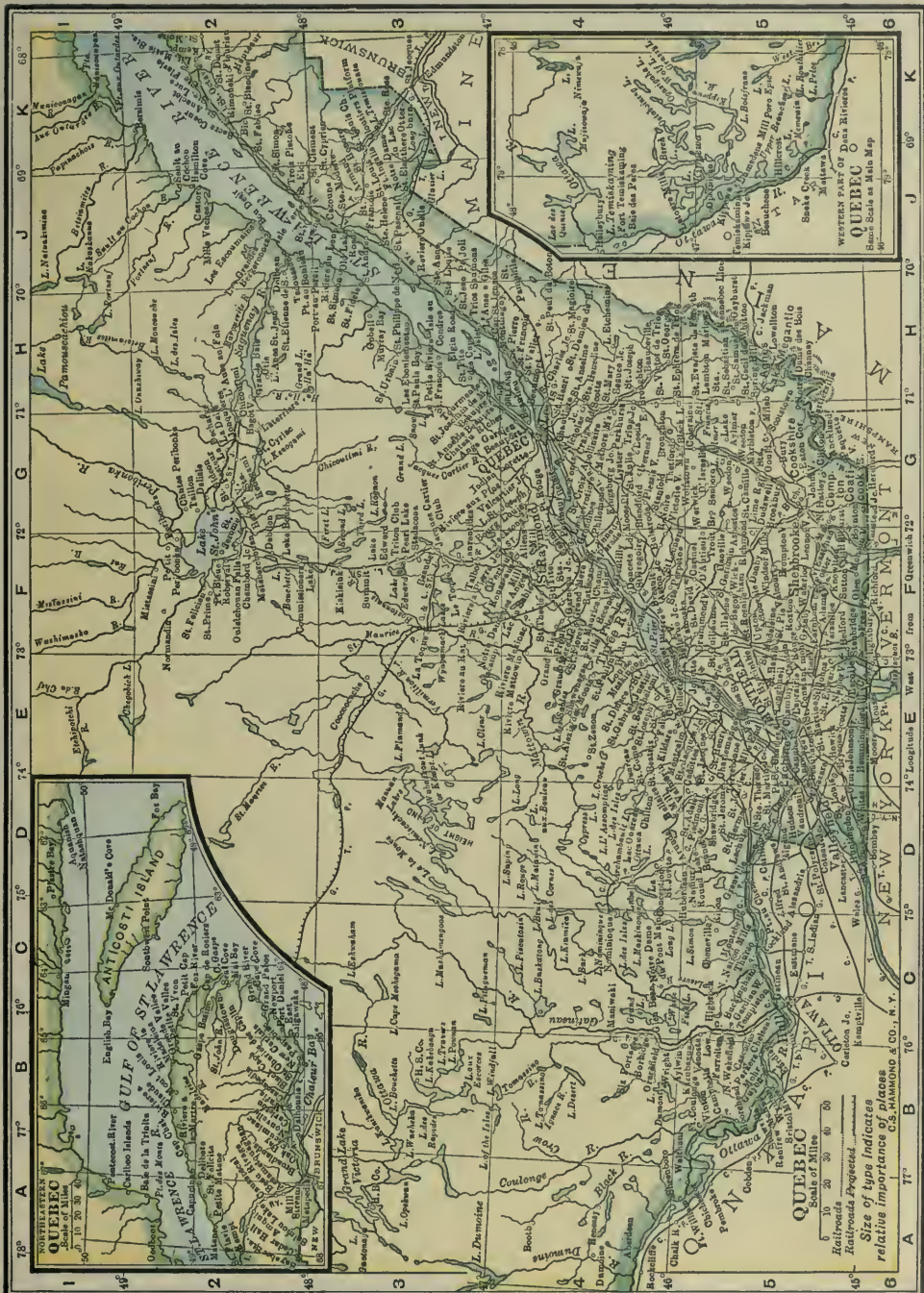


THE MARITIME PROVINCES OF CANADA
 With Inset Map of NEWFOUNDLAND
NEW BRUNSWICK, NOVA SCOTIA, PRINCE EDWARD ISLAND

Scale of Miles
 0 10 20 30 40 50 60 70 80

Railroads Steamships
 Submarine Telegraph Lines
 Capitals of Provinces
 Size of type indicates relative importance of places

G. S. HAMMOND & CO., N. Y.



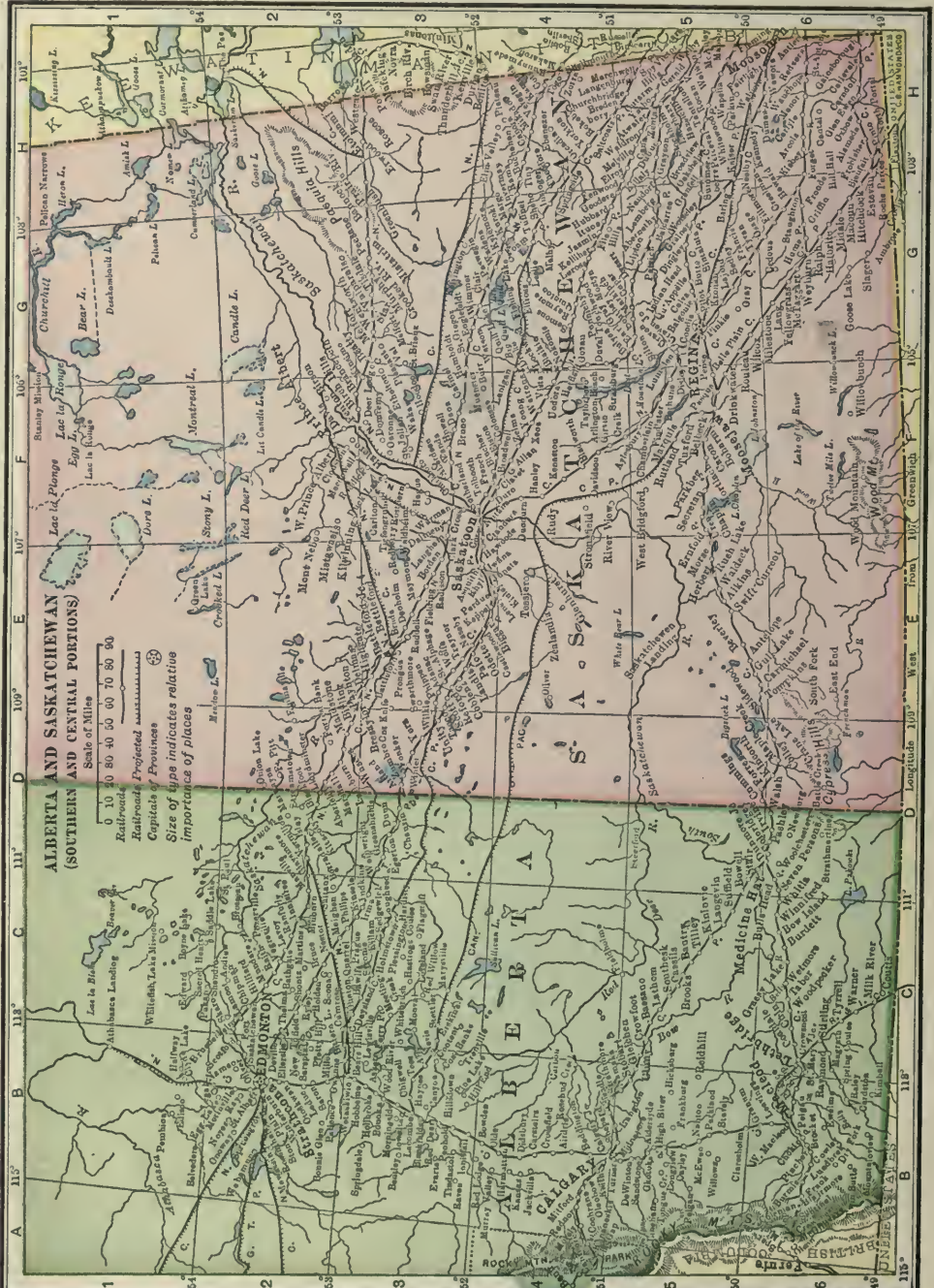
Scale of Miles
 0 20 40 60
 Railroads Projected
 Size of type indicates
 relative importance of places
 C.S. HAMMOND & CO., N.Y.



31 Longitude D West 80° from E Greenwich 79°

C.S. Hammond & Co., N.Y.







BRITISH COLUMBIA

Scale of Miles
0 50 100 150

- Railroads
- Railroads, Projected
- Important Telegraph Lines
- Capitals

Size of type indicates relative importance of places

C.S. HAMMOND & CO., N.Y.



Hammond's Map of United States.



UNITED STATES

Scale of Miles
0 50 100 200 300 400





MAINE

Scale of Miles
0 5 10 20 30 40

Size of type indicates relative importance of towns

C.S. HAMMOND & CO., N.Y.

Longitude West 69° from Greenwich 68°

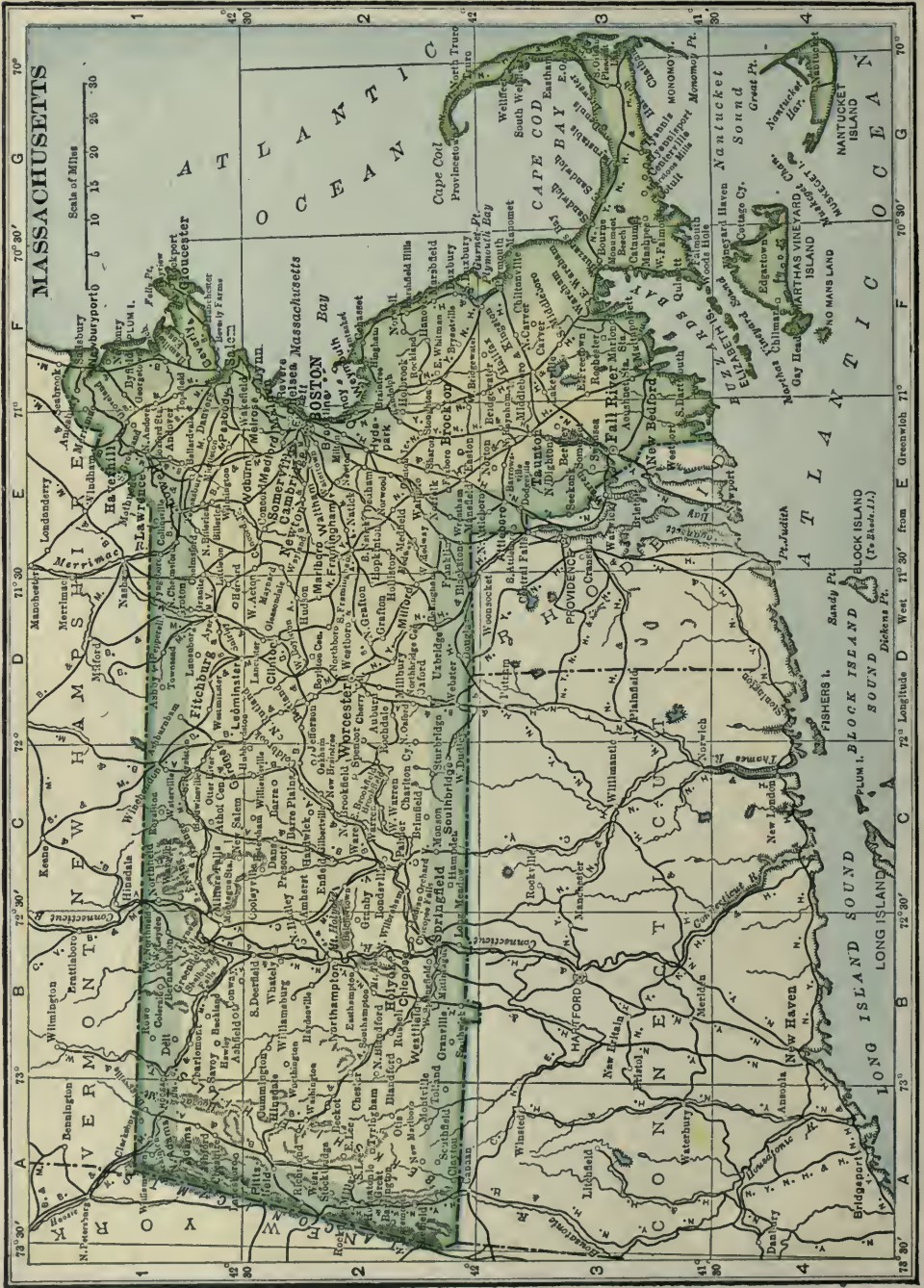


NEW HAMPSHIRE

Scale of Miles
0 10 20 30 40



A 12° 30' B Longitude 72° West C from 71° 30' Greenwich D E 70° 30'





RHODE ISLAND

Scale of Miles
0 1 2 3 4 5 6 7 8 9 10

A Longitude B West 71° 30' from C Greenwich D





NEW YORK

Scale of Miles
0 10 20 30 40 50 60



from D Greenwich 76°

West 77°

Longitude C

75°

76°

77°

78°

79°

80°

81°

82°

83°

84°

85°

86°

87°

88°

89°

90°

1
2
3
4

A
B
C
D
E
F
G

W
V
U
T
S
R
Q
P
O
N
M
L
K
J
I
H
G
F
E
D
C
B
A

1
2
3
4

A
B
C
D
E
F
G

W
V
U
T
S
R
Q
P
O
N
M
L
K
J
I
H
G
F
E
D
C
B
A

1
2
3
4



PENNSYLVANIA



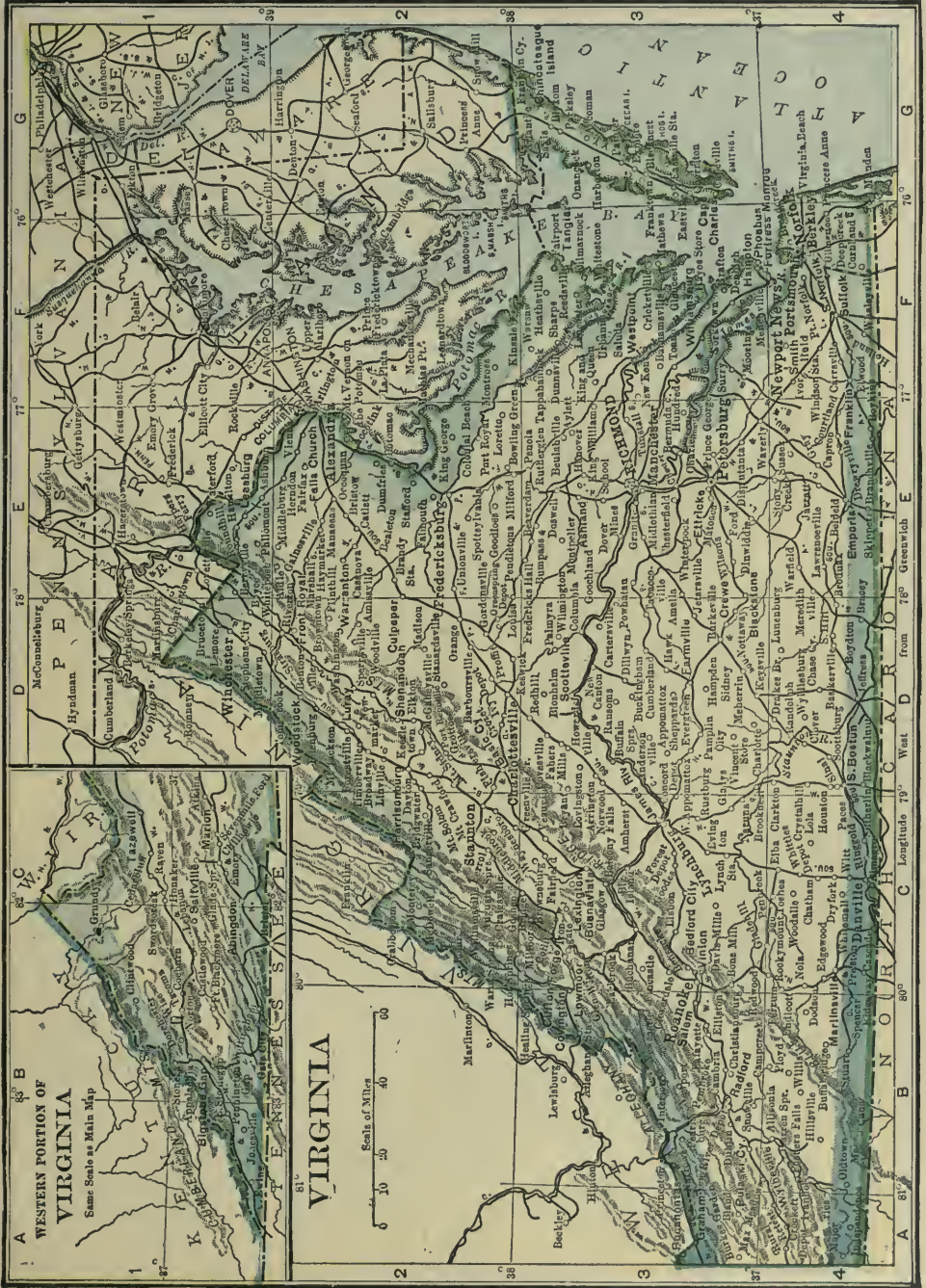
80° 79° 78° 77° 76° 75°

75° 76° 77° 78° 79° 80°

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50





WESTERN PORTION OF VIRGINIA

Same Scale as Main Map

VIRGINIA

Scale of Miles
0 10 20 40 60

Longitude 19° West from Greenwich

Latitude 38°

Latitude 40°

Latitude 42°

Latitude 44°

Latitude 46°

Latitude 48°

Latitude 50°

Latitude 52°

Latitude 54°

Latitude 56°

Latitude 58°

Latitude 60°

Latitude 62°

Latitude 64°

Longitude 76°

Longitude 78°

Longitude 80°

Longitude 82°

Longitude 84°

Longitude 86°

Longitude 88°

Longitude 90°

Longitude 92°

Longitude 94°

Longitude 96°

Longitude 98°

Longitude 100°

Longitude 102°

Longitude 104°

Longitude 106°



79° Longitude D West 78° from E Greenwich 77° L

WESTERN PART OF NORTH CAROLINA Same Scale as Main Map



SOUTH CAROLINA

Scale of Miles
0 5 10 20 30 40

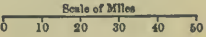
Latitude 30° 30' West G from 80° Greenwich H 75° 30' F Longitude 80° 30' West G from 80° Greenwich H 75° 30' F



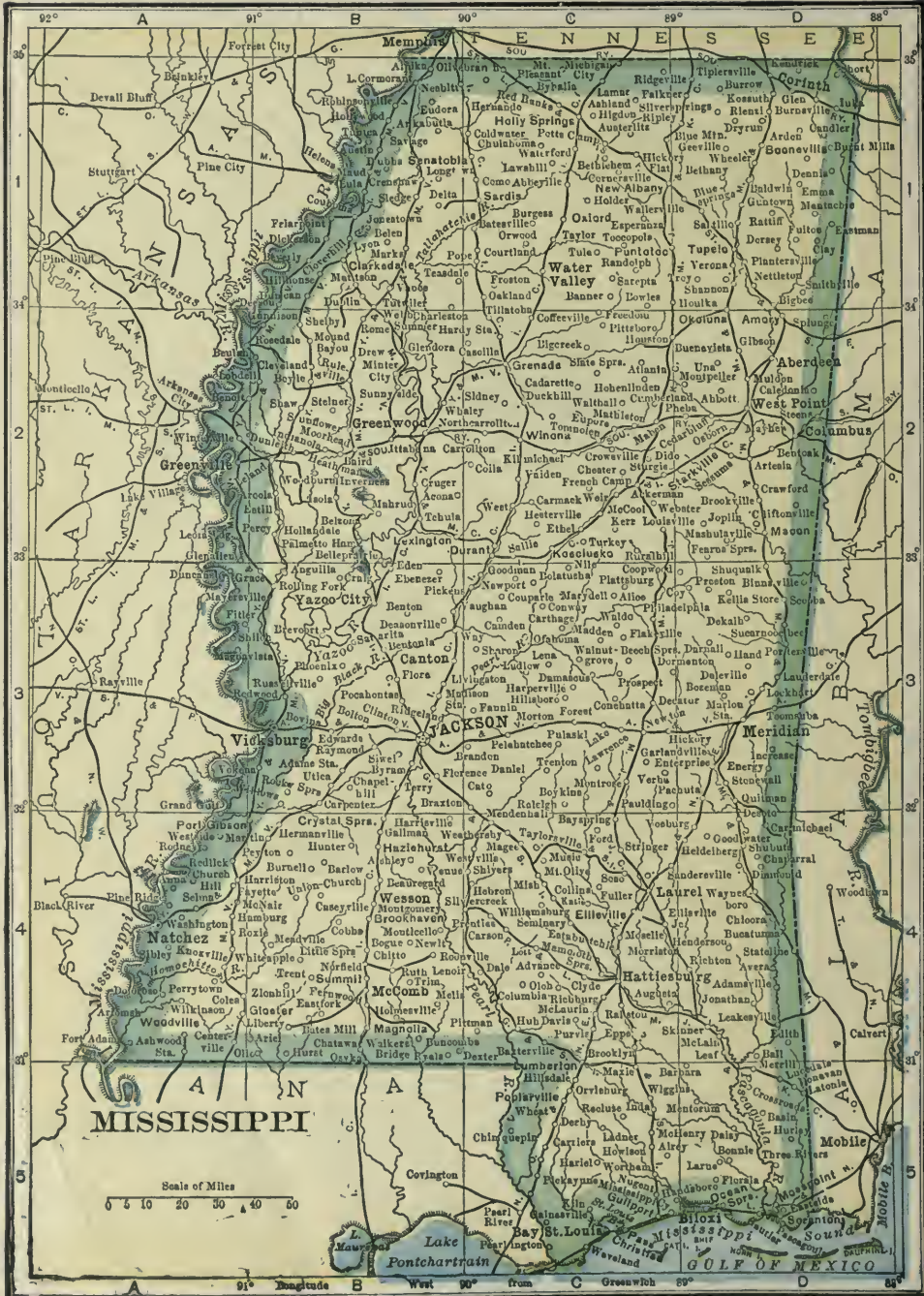


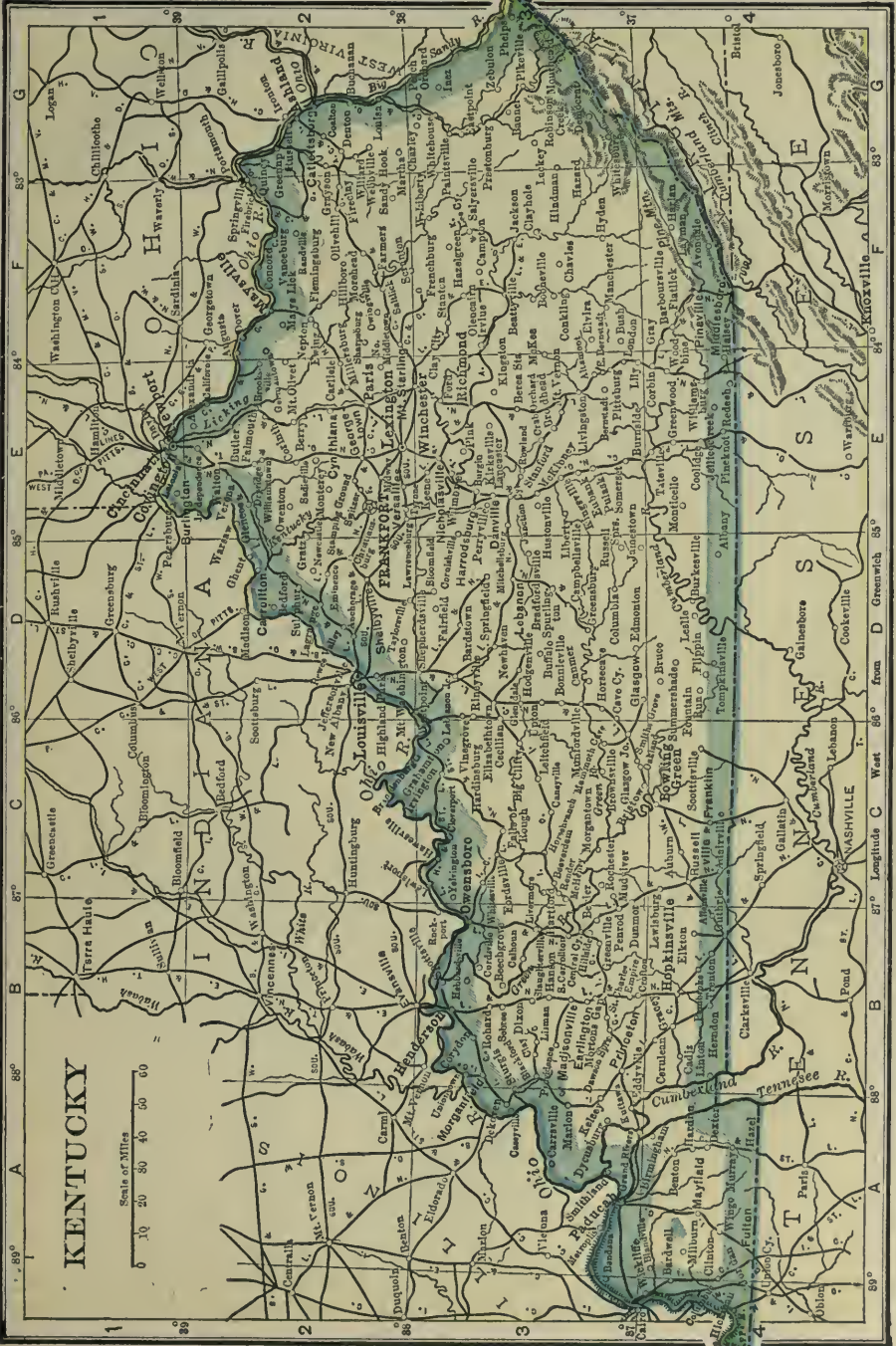


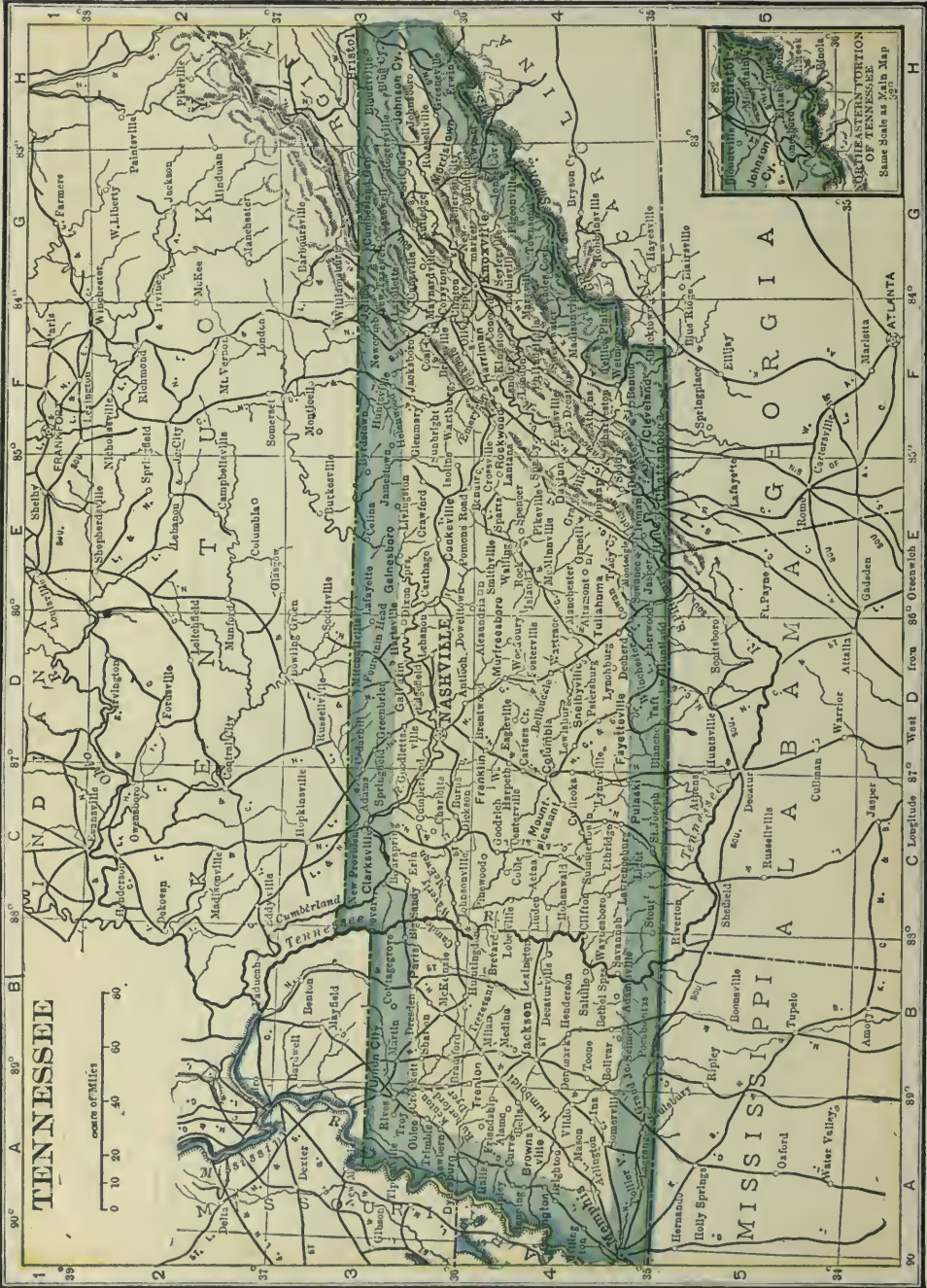
ALABAMA



GULF OF MEXICO
 Longitude 87° West from 86° Greenwich 85°







TENNESSEE

Scale of Miles: 0, 10, 20, 40, 60

MISSISSIPPI

GEORGIA





Scale of Miles

Longitude 88° West from C Greenwich 82°



INDIANA

Scale of Miles
0 10 20 30 40 50 60

88° A 87°30' B 87° C 86°30' D 86° E 85°30' F 85° G 84°30'

MICHIGAN

Scale of Miles 0 10 20 40 60 80

Scale of Miles 0 10 20 40 60 80
ISLE ROYALE
LAKE SUPERIOR
St. Ignace
St. Ignace
St. Ignace



MANITOU I.
Keweenaw Pt.
Elevation above Sea Level 602 feet

LAKE SUPERIOR
Whitefish Pt.
Grand Marais

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

Whitefish Pt.
Grand Marais
Whitefish Bay

1
2
3
4
5
6
7

1
2
3
4
5
6
7

87° West 86° West 85° West 84° West 83° West



WISCONSIN

Scale of Miles
 0 10 20 30 40 50 60

Size of type indicates
 relative importance of places.

C. S. HAMMOND & CO., N. Y.

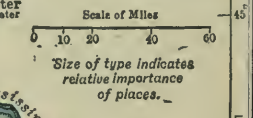
A 92° B 91° C 90° D 89° E 88° F

91° Longitude West 90° from Greenwich 89°



ILLINOIS

Scale of Miles
0 5 10 20 30 40 50 60



A 96° B 96° Longitude C West 94° from D Greenwich 93° E 92° F 91°





30
 40
 50
 60
 70
 80
 90
 100
 110
 120
 130
 140
 150
 160
 170
 180
 190
 200
 210
 220
 230
 240
 250
 260
 270
 280
 290
 300
 310
 320
 330
 340
 350
 360
 370
 380
 390
 400
 410
 420
 430
 440
 450
 460
 470
 480
 490
 500
 510
 520
 530
 540
 550
 560
 570
 580
 590
 600
 610
 620
 630
 640
 650
 660
 670
 680
 690
 700
 710
 720
 730
 740
 750
 760
 770
 780
 790
 800
 810
 820
 830
 840
 850
 860
 870
 880
 890
 900
 910
 920
 930
 940
 950
 960
 970
 980
 990
 1000
 1010
 1020
 1030
 1040
 1050
 1060
 1070
 1080
 1090
 1100
 1110
 1120
 1130
 1140
 1150
 1160
 1170
 1180
 1190
 1200
 1210
 1220
 1230
 1240
 1250
 1260
 1270
 1280
 1290
 1300
 1310
 1320
 1330
 1340
 1350
 1360
 1370
 1380
 1390
 1400
 1410
 1420
 1430
 1440
 1450
 1460
 1470
 1480
 1490
 1500
 1510
 1520
 1530
 1540
 1550
 1560
 1570
 1580
 1590
 1600
 1610
 1620
 1630
 1640
 1650
 1660
 1670
 1680
 1690
 1700
 1710
 1720
 1730
 1740
 1750
 1760
 1770
 1780
 1790
 1800
 1810
 1820
 1830
 1840
 1850
 1860
 1870
 1880
 1890
 1900
 1910
 1920
 1930
 1940
 1950
 1960
 1970
 1980
 1990
 2000
 2010
 2020
 2030
 2040
 2050
 2060
 2070
 2080
 2090
 2100
 2110
 2120
 2130
 2140
 2150
 2160
 2170
 2180
 2190
 2200
 2210
 2220
 2230
 2240
 2250
 2260
 2270
 2280
 2290
 2300
 2310
 2320
 2330
 2340
 2350
 2360
 2370
 2380
 2390
 2400
 2410
 2420
 2430
 2440
 2450
 2460
 2470
 2480
 2490
 2500
 2510
 2520
 2530
 2540
 2550
 2560
 2570
 2580
 2590
 2600
 2610
 2620
 2630
 2640
 2650
 2660
 2670
 2680
 2690
 2700
 2710
 2720
 2730
 2740
 2750
 2760
 2770
 2780
 2790
 2800
 2810
 2820
 2830
 2840
 2850
 2860
 2870
 2880
 2890
 2900
 2910
 2920
 2930
 2940
 2950
 2960
 2970
 2980
 2990
 3000
 3010
 3020
 3030
 3040
 3050
 3060
 3070
 3080
 3090
 3100
 3110
 3120
 3130
 3140
 3150
 3160
 3170
 3180
 3190
 3200
 3210
 3220
 3230
 3240
 3250
 3260
 3270
 3280
 3290
 3300
 3310
 3320
 3330
 3340
 3350
 3360
 3370
 3380
 3390
 3400
 3410
 3420
 3430
 3440
 3450
 3460
 3470
 3480
 3490
 3500
 3510
 3520
 3530
 3540
 3550
 3560
 3570
 3580
 3590
 3600
 3610
 3620
 3630
 3640
 3650
 3660
 3670
 3680
 3690
 3700
 3710
 3720
 3730
 3740
 3750
 3760
 3770
 3780
 3790
 3800
 3810
 3820
 3830
 3840
 3850
 3860
 3870
 3880
 3890
 3900
 3910
 3920
 3930
 3940
 3950
 3960
 3970
 3980
 3990
 4000
 4010
 4020
 4030
 4040
 4050
 4060
 4070
 4080
 4090
 4100
 4110
 4120
 4130
 4140
 4150
 4160
 4170
 4180
 4190
 4200
 4210
 4220
 4230
 4240
 4250
 4260
 4270
 4280
 4290
 4300
 4310
 4320
 4330
 4340
 4350
 4360
 4370
 4380
 4390
 4400
 4410
 4420
 4430
 4440
 4450
 4460
 4470
 4480
 4490
 4500
 4510
 4520
 4530
 4540
 4550
 4560
 4570
 4580
 4590
 4600
 4610
 4620
 4630
 4640
 4650
 4660
 4670
 4680
 4690
 4700
 4710
 4720
 4730
 4740
 4750
 4760
 4770
 4780
 4790
 4800
 4810
 4820
 4830
 4840
 4850
 4860
 4870
 4880
 4890
 4900
 4910
 4920
 4930
 4940
 4950
 4960
 4970
 4980
 4990
 5000
 5010
 5020
 5030
 5040
 5050
 5060
 5070
 5080
 5090
 5100
 5110
 5120
 5130
 5140
 5150
 5160
 5170
 5180
 5190
 5200
 5210
 5220
 5230
 5240
 5250
 5260
 5270
 5280
 5290
 5300
 5310
 5320
 5330
 5340
 5350
 5360
 5370
 5380
 5390
 5400
 5410
 5420
 5430
 5440
 5450
 5460
 5470
 5480
 5490
 5500
 5510
 5520
 5530
 5540
 5550
 5560
 5570
 5580
 5590
 5600
 5610
 5620
 5630
 5640
 5650
 5660
 5670
 5680
 5690
 5700
 5710
 5720
 5730
 5740
 5750
 5760
 5770
 5780
 5790
 5800
 5810
 5820
 5830
 5840
 5850
 5860
 5870
 5880
 5890
 5900
 5910
 5920
 5930
 5940
 5950
 5960
 5970
 5980
 5990
 6000
 6010
 6020
 6030
 6040
 6050
 6060
 6070
 6080
 6090
 6100
 6110
 6120
 6130
 6140
 6150
 6160
 6170
 6180
 6190
 6200
 6210
 6220
 6230
 6240
 6250
 6260
 6270
 6280
 6290
 6300
 6310
 6320
 6330
 6340
 6350
 6360
 6370
 6380
 6390
 6400
 6410
 6420
 6430
 6440
 6450
 6460
 6470
 6480
 6490
 6500
 6510
 6520
 6530
 6540
 6550
 6560
 6570
 6580
 6590
 6600
 6610
 6620
 6630
 6640
 6650
 6660
 6670
 6680
 6690
 6700
 6710
 6720
 6730
 6740
 6750
 6760
 6770
 6780
 6790
 6800
 6810
 6820
 6830
 6840
 6850
 6860
 6870
 6880
 6890
 6900
 6910
 6920
 6930
 6940
 6950
 6960
 6970
 6980
 6990
 7000
 7010
 7020
 7030
 7040
 7050
 7060
 7070
 7080
 7090
 7100
 7110
 7120
 7130
 7140
 7150
 7160
 7170
 7180
 7190
 7200
 7210
 7220
 7230
 7240
 7250
 7260
 7270
 7280
 7290
 7300
 7310
 7320
 7330
 7340
 7350
 7360
 7370
 7380
 7390
 7400
 7410
 7420
 7430
 7440
 7450
 7460
 7470
 7480
 7490
 7500
 7510
 7520
 7530
 7540
 7550
 7560
 7570
 7580
 7590
 7600
 7610
 7620
 7630
 7640
 7650
 7660
 7670
 7680
 7690
 7700
 7710
 7720
 7730
 7740
 7750
 7760
 7770
 7780
 7790
 7800
 7810
 7820
 7830
 7840
 7850
 7860
 7870
 7880
 7890
 7900
 7910
 7920
 7930
 7940
 7950
 7960
 7970
 7980
 7990
 8000
 8010
 8020
 8030
 8040
 8050
 8060
 8070
 8080
 8090
 8100
 8110
 8120
 8130
 8140
 8150
 8160
 8170
 8180
 8190
 8200
 8210
 8220
 8230
 8240
 8250
 8260
 8270
 8280
 8290
 8300
 8310
 8320
 8330
 8340
 8350
 8360
 8370
 8380
 8390
 8400
 8410
 8420
 8430
 8440
 8450
 8460
 8470
 8480
 8490
 8500
 8510
 8520
 8530
 8540
 8550
 8560
 8570
 8580
 8590
 8600
 8610
 8620
 8630
 8640
 8650
 8660
 8670
 8680
 8690
 8700
 8710
 8720
 8730
 8740
 8750
 8760
 8770
 8780
 8790
 8800
 8810
 8820
 8830
 8840
 8850
 8860
 8870
 8880
 8890
 8900
 8910
 8920
 8930
 8940
 8950
 8960
 8970
 8980
 8990
 9000
 9010
 9020
 9030
 9040
 9050
 9060
 9070
 9080
 9090
 9100
 9110
 9120
 9130
 9140
 9150
 9160
 9170
 9180
 9190
 9200
 9210
 9220
 9230
 9240
 9250
 9260
 9270
 9280
 9290
 9300
 9310
 9320
 9330
 9340
 9350
 9360
 9370
 9380
 9390
 9400
 9410
 9420
 9430
 9440
 9450
 9460
 9470
 9480
 9490
 9500
 9510
 9520
 9530
 9540
 9550
 9560
 9570
 9580
 9590
 9600
 9610
 9620
 9630
 9640
 9650
 9660
 9670
 9680
 9690
 9700
 9710
 9720
 9730
 9740
 9750
 9760
 9770
 9780
 9790
 9800
 9810
 9820
 9830
 9840
 9850
 9860
 9870
 9880
 9890
 9900
 9910
 9920
 9930
 9940
 9950
 9960
 9970
 9980
 9990
 10000





LOUISIANA

Scale of Miles
0 10 20 30 40 50 60 70

Size of type indicates relative importance of places



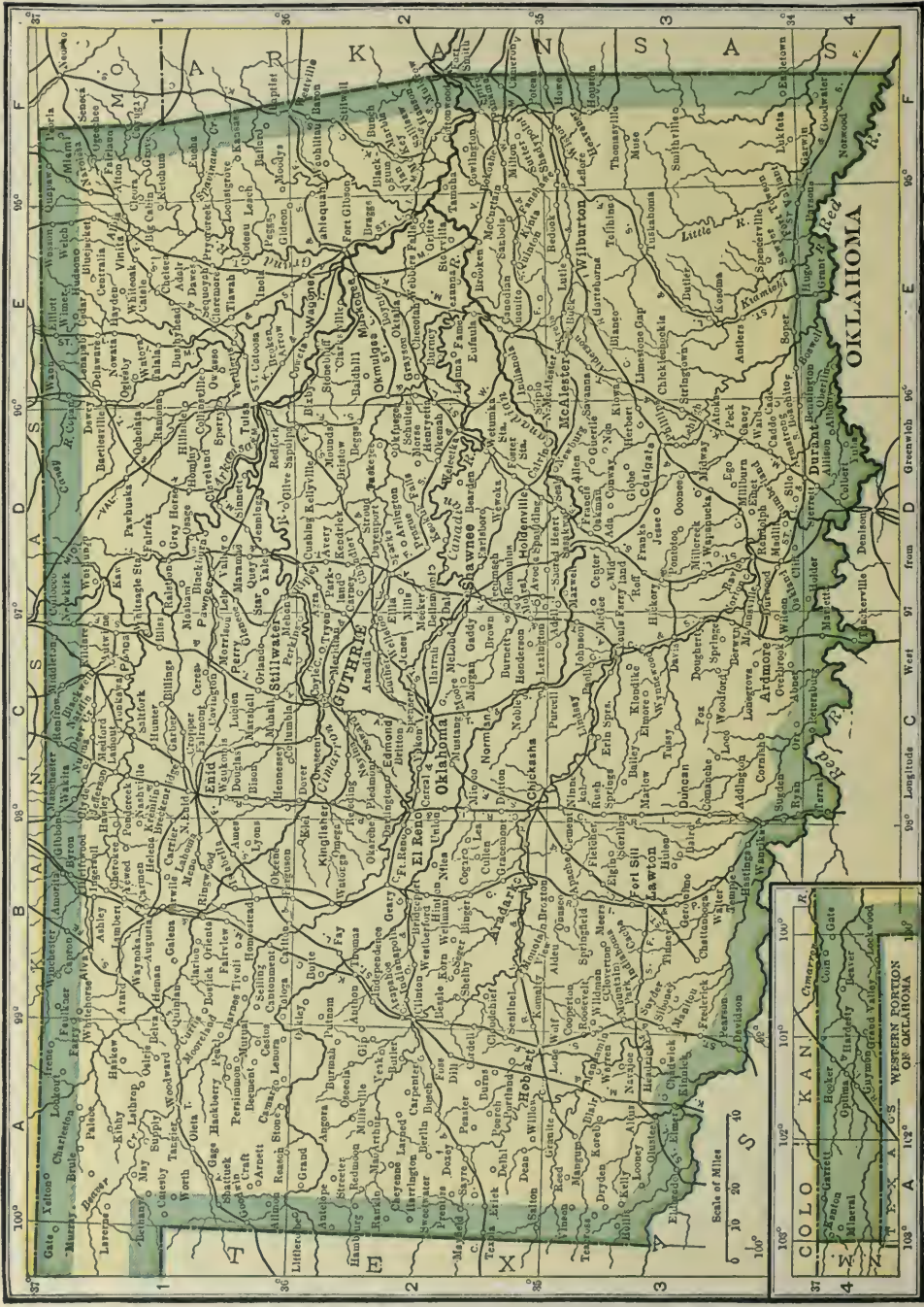
WESTERN PORTION OF TEXAS
Same Scale as Main Map
106° A B 104°

Scale of Miles
0 25 50 75 100

Size of type indicates relative importance of places.

C. S. HAMMOND & CO., N.Y.

100° Longitude C West 90° from D Greenwich 96° E 94°

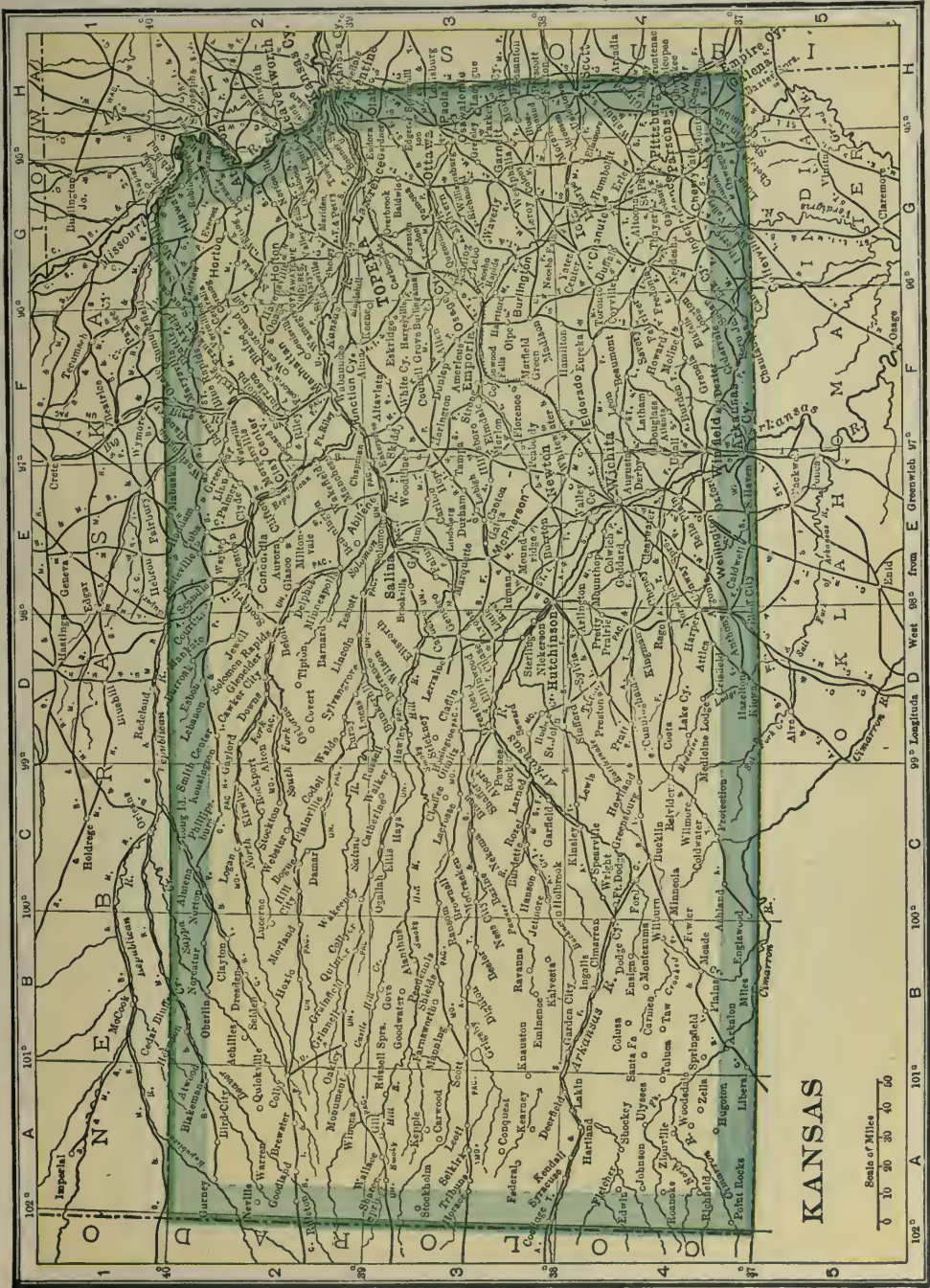


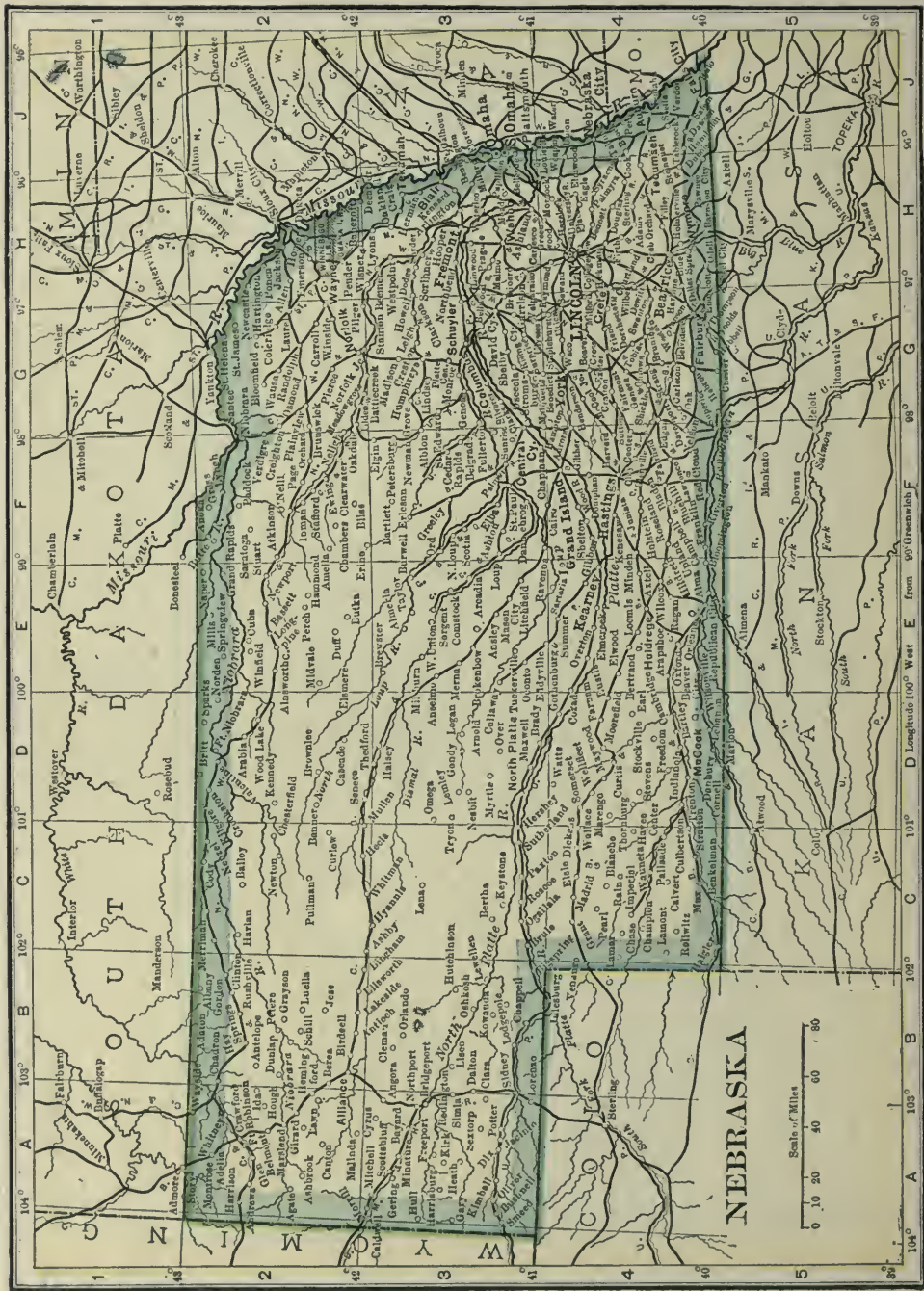
Scale of Miles
0 10 20 30

100° 100° 100°
100° 100° 100°

37 36 35
4 3 2 1

COLO KAN OKLAHOMA TEX MISSOURI
Higher Elevations
Climatic Variability
Marital
U.S. Census Bureau
WESTERN PORTION OF OKLAHOMA







NORTH DAKOTA

Scale of Miles
0 10 20 30 40 50

104° 103° 102° 101° 100° 99° 98° 97°

1 2 3 4

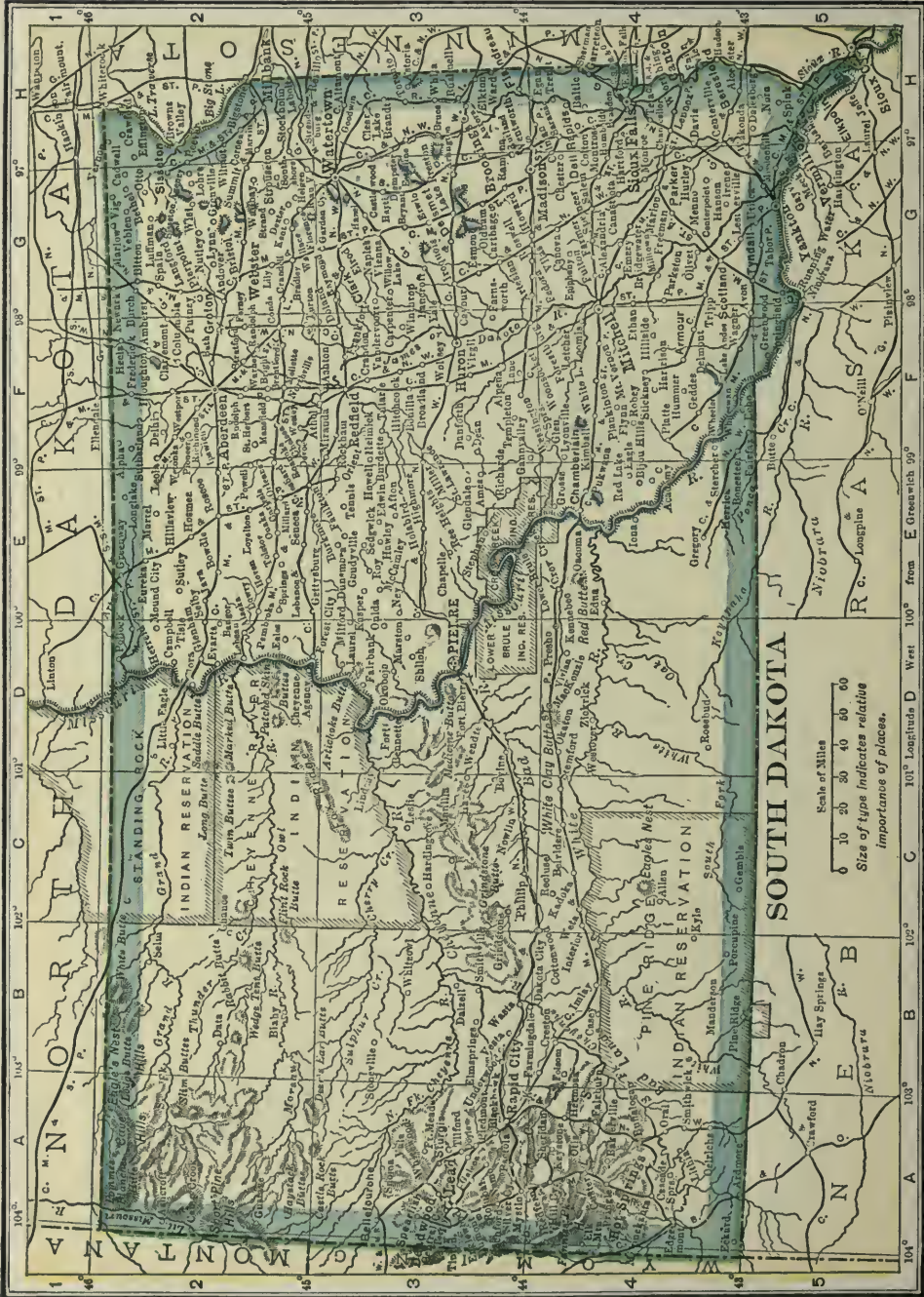
H A G F E D C B A

97° 96° 95° 94° 93° 92°

H A G F E D C B A

104° 103° 102° 101° 100° 99° 98° 97°

C. S. HAMMOND & CO., N.Y.



SOUTH DAKOTA

Scale of Miles
 0 10 20 30 40 50 60
 Size of types indicates relative importance of places.



Scale of Miles
 0 20 40 60 80 100

Size of type indicates
 relative importance of places.

C. S. HAMMOND & CO., N. Y.

MONTANA











NEW MEXICO

Scale of Miles
0 10 20 30 40 50 60 70 80

109° A 108° B 107° C 106° D 105° E 104° F 103°

31° 30' 32° 33° 34° 35° 36° 37° 38°

M E X I C O

San Pedro

Long. C West 106° from D Green. 106°

Alamogordo

Las Cruces

Albuquerque

Santa Fe

Las Vegas

Alamogordo

Las Cruces

Albuquerque

Santa Fe

Las Vegas

Alamogordo

Las Cruces

Albuquerque

Santa Fe

Las Vegas

Alamogordo

Las Cruces

Albuquerque

Santa Fe



ARIZONA

Scale of Miles

0 10 20 30 40 50 60 70

M E X I C O
Altair R. Fuentarrosa

A 114° B 113° Longitud C West 112° from D Greenwich 111° E 110° F



PART OF SOUTHEASTERN CALIFORNIA
Same Scale as Main Map

San Francisco
S. San Francisco

CALIFORNIA

Scale of Miles

Size of type indicates relative
Importance of places.

C.B. HAMMOND & CO., N.Y.

Longitude West from Greenwich

San Diego

MEXICO



NEVADA

Scale of Miles
0 10 20 30 40 50 60 70 80

- Railroads
- Railroads Projected
- State Capital
- Indian Reservations
- Forest Reservations
- Size of type indicates relative importance of places





C.S. HAMMOND & CO., N. Y.



Scale of Miles

0 100 200 300

Continuation of ALEUTIAN IS. from Main Map

ALEUTIAN ISLANDS
 ADAK IS. (C. Adak)
 AGASSIZ IS. (C. Agassiz)
 ALASKA ALEUTIC ISLANDS (C. Adak)
 ANCHUTKA IS. (C. Anchutka)
 ATKA IS. (C. Atka)
 BURLINGAME IS. (C. Burlingame)
 GARDNER PINNACLES (C. Gardner)
 KADAK IS. (C. Kadak)
 KUNIA IS. (C. Kunia)
 MURKIN IS. (C. Murkin)
 NIKOLAI IS. (C. Nikolai)
 OFUNAN IS. (C. Ofunan)
 RAGIDAN IS. (C. Ragidan)
 UNALASKA IS. (C. Unalaska)
 UNALUI IS. (C. Unalui)
 UNADULA IS. (C. Unadula)
 UNALUI GROUP (C. Unalui)
 UNALUI IS. (C. Unalui)
 UNALUI IS. (C. Unalui)
 UNALUI IS. (C. Unalui)

Same Scale as Main Map







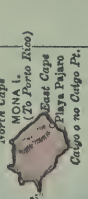
PORTO RICO

Scale of Miles
 0 5 10 15 20

Railroads Projected ————
 Railroads ————
 Improved Roads ————
 Capitals ————
 Size of type indicates relative importance of places

ISLANDS WEST OF PORTO RICO

MONTE I.
 North Cape
 MONA I.
 (20 Porto Rico)
 West Pt.
 East Cape
 Playa Fajaro
 Cayo de los Chigros Pt.



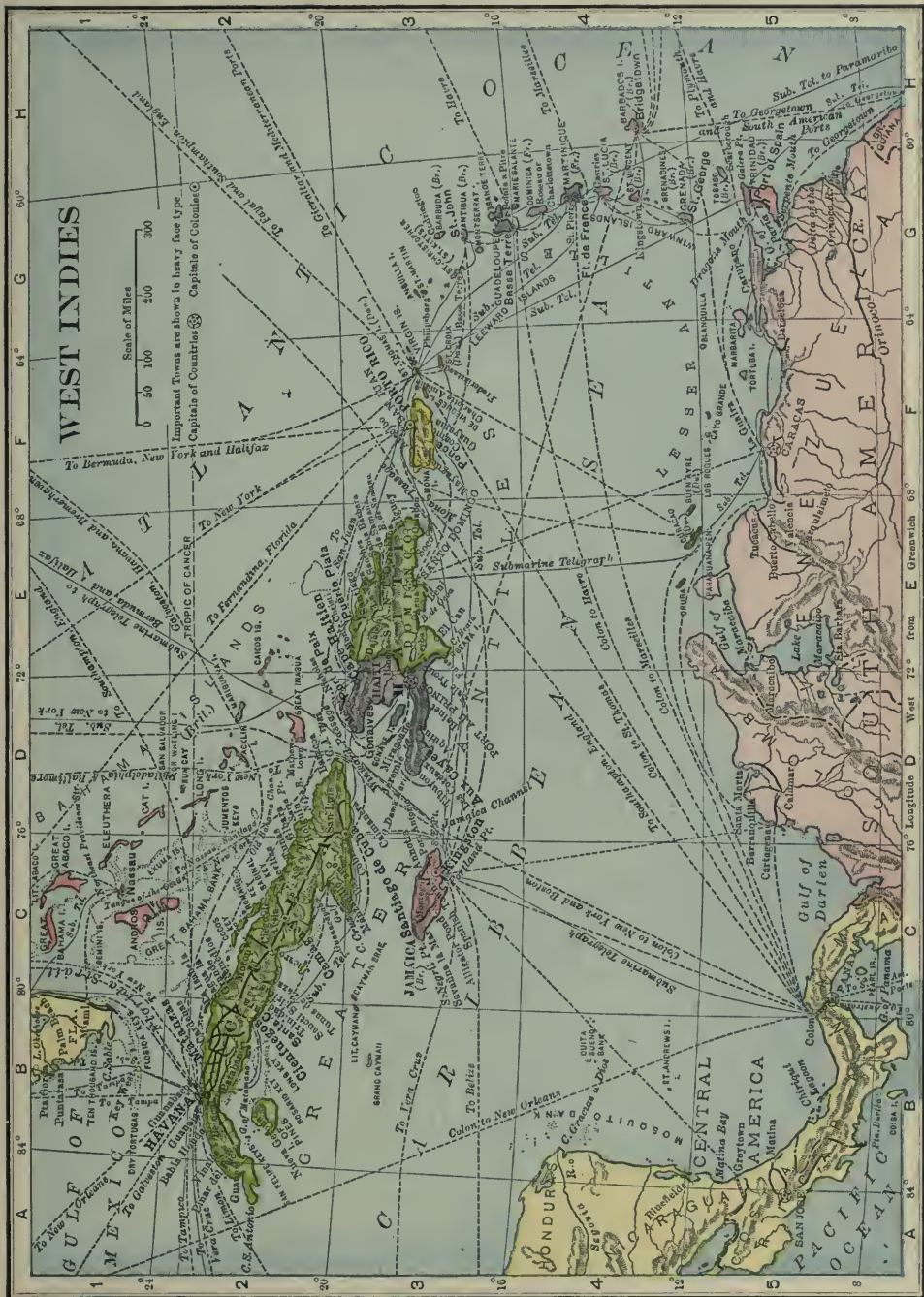
Same Scale as Main Map
 66° 15' G
 65° 30' F
 64° 45' G

66° 15' D
 66° 30' E
 66° 45' F

67° 15' A
 67° 30' B
 67° 45' C
 68° D
 68° 15' E
 68° 30' F
 68° 45' G

C.S. HAMMOND & CO., N.Y.







MEXICO

Scale of Miles
 0 50 100 150 200 250 300 400 500

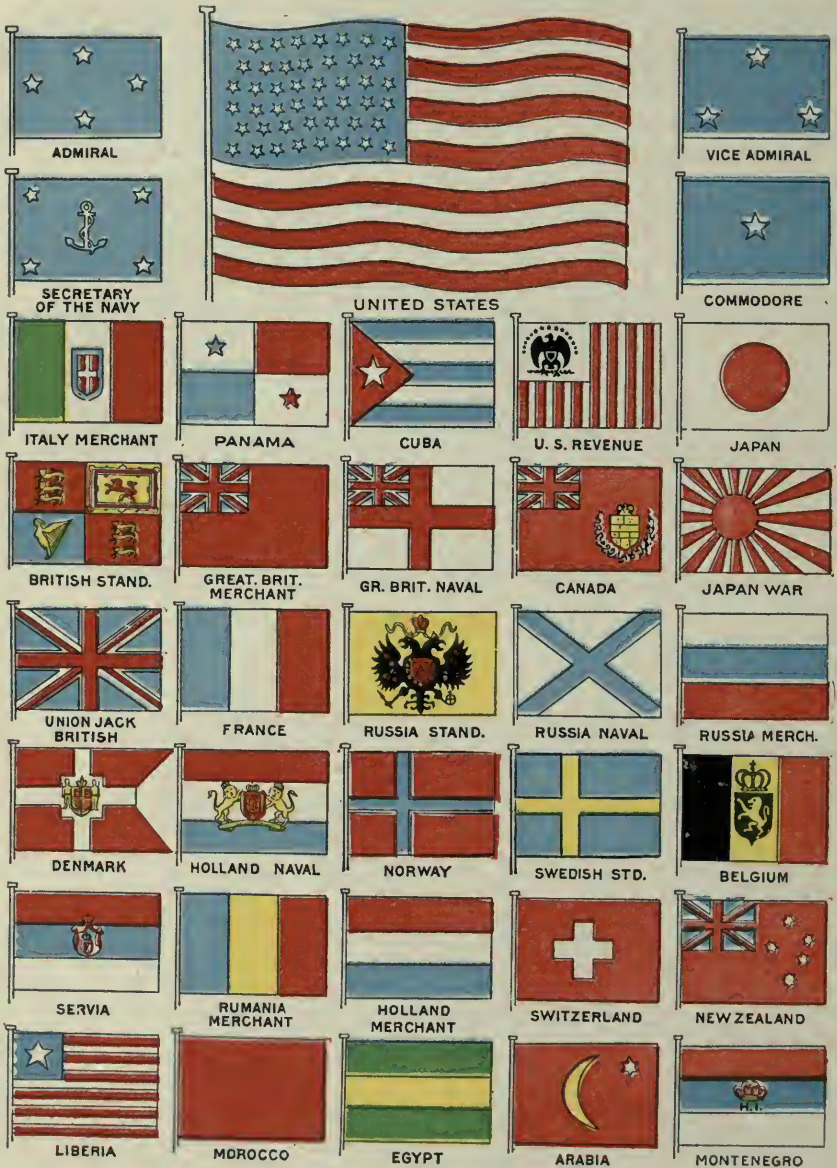
—————
 Railroads Projected
 —————
 Railroads
 Size of type indicates relative importance of places



CENTRAL AMERICA

Scale of Miles
 0 50 100 200 300

———— Railroad
 ———— Submarine Telegraph Lines
 ● Capital
 Size of type indicates Relative importance of places



FLAGS OF ALL NATIONS



MEXICO



AUSTRALIA



UNION JACK
UNITED STATES



GERMANY NAVAL



GERMAN
MERCHANT



NIGARUGA



TURKEY



SANTO DOMINGO



COSTA RICA



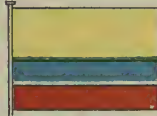
PARAGUAY



PORTUGAL



SALVADOR



ECUADOR



BOLIVIA



URUGUAY



GUATEMALA



ARGENTINE REP.



VENEZUELA



PERU



COLOMBIA



IRELAND



CHILE



KOREA



PERSIA



CHINA



HONDURAS



SIAM



BURMA



AUSTRIA



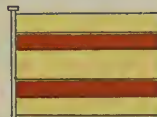
BULGARIA



BRAZIL



SPAIN ENSIGN



SPANISH MERCHANT



GREECE



HAITI

FLAGS OF ALL NATIONS









BRITISH ISLES

Scale of Miles
 0 25 50 100

Through Railroads
 Other Railroads
 Submarine Cables
 Important towns are shown
 in heavy face type

S.S. HAMMOND & CO., N.Y.

10 B 8 C 6 Longitude D West 4 from E Greenwich 2 F 0 Long. G East





AUSTRALIA

Scale of Miles
 0 100 200 400 800

Important towns are shown in heavy face type

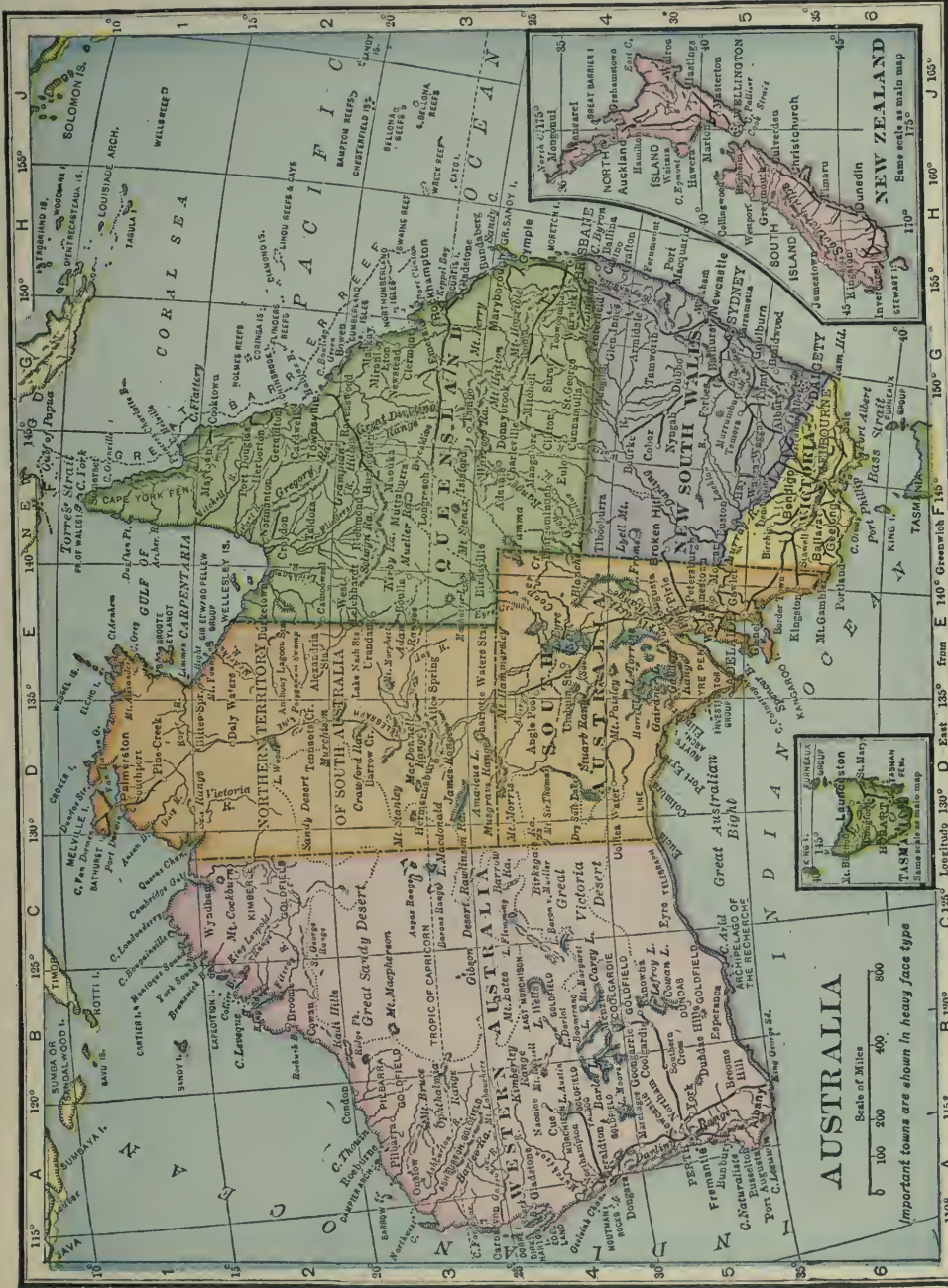


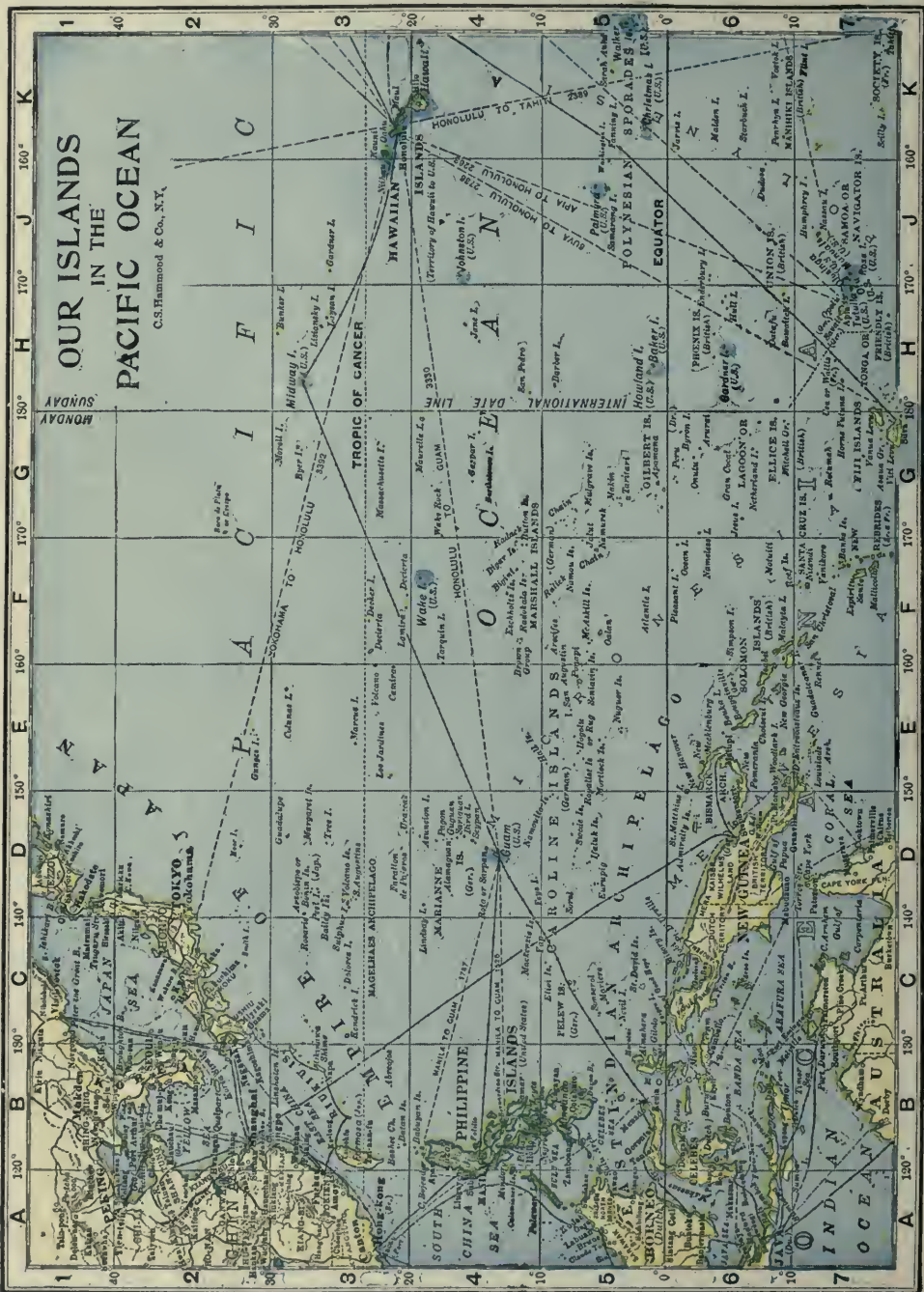
Longitude 130° D East 135° from E 140° Greenwich F. 1p° C 125° A 115° B 120°

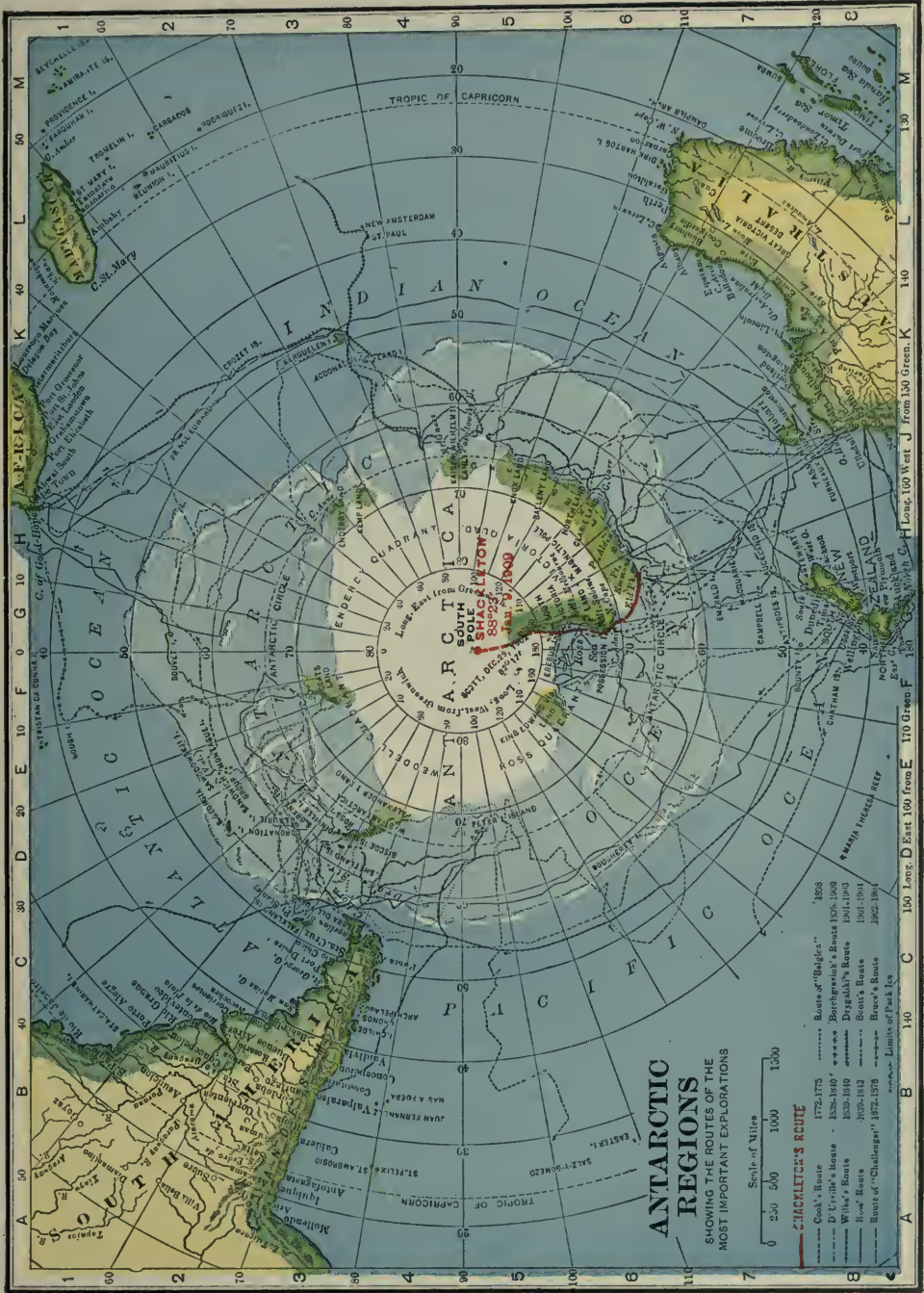
Latitude 10° 15° 20° 25° 30° 35° 40°

Longitude 150° G 155° H 160° J 165°

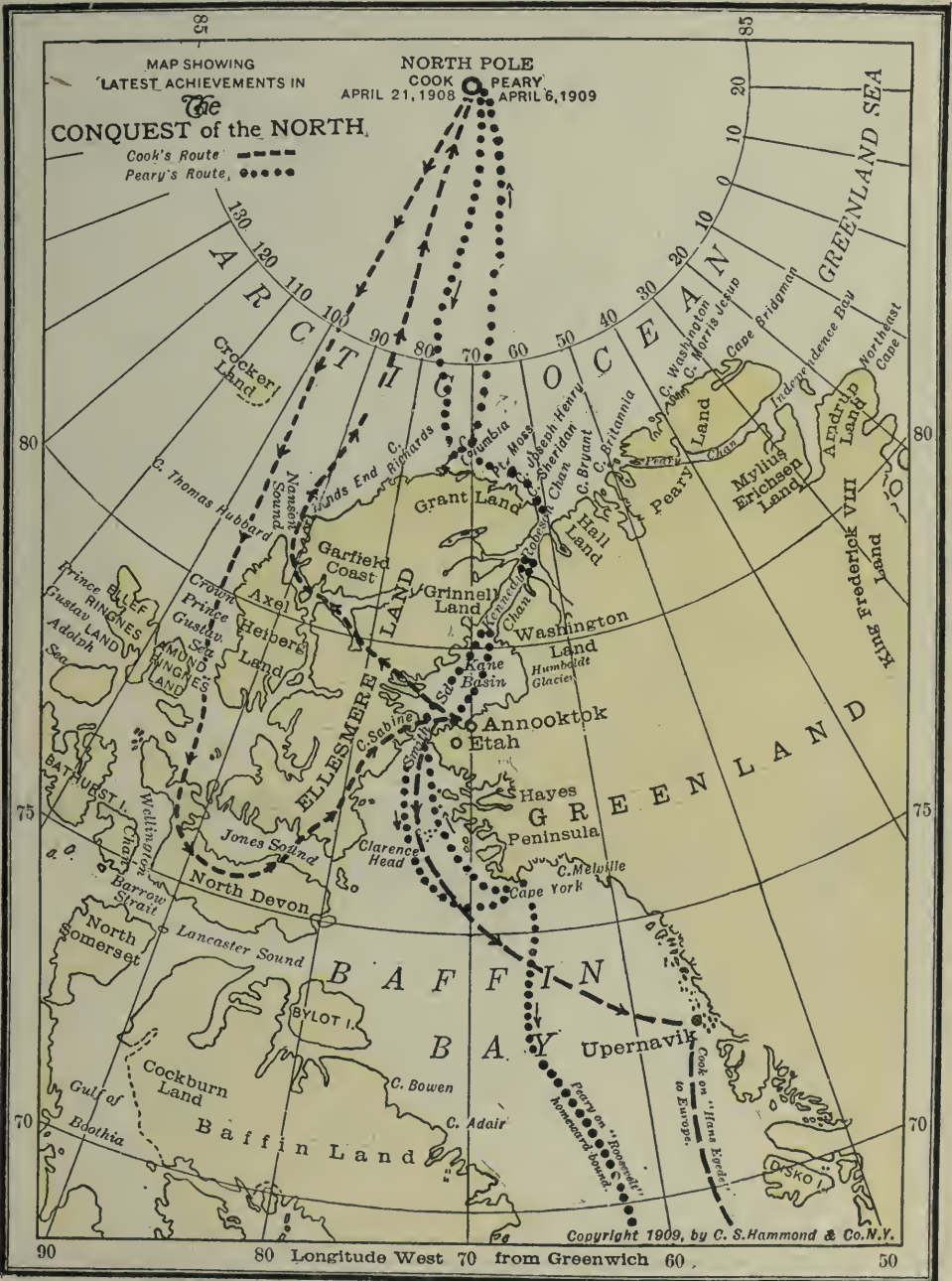
Latitude 10° 15° 20° 25° 30° 35° 40°

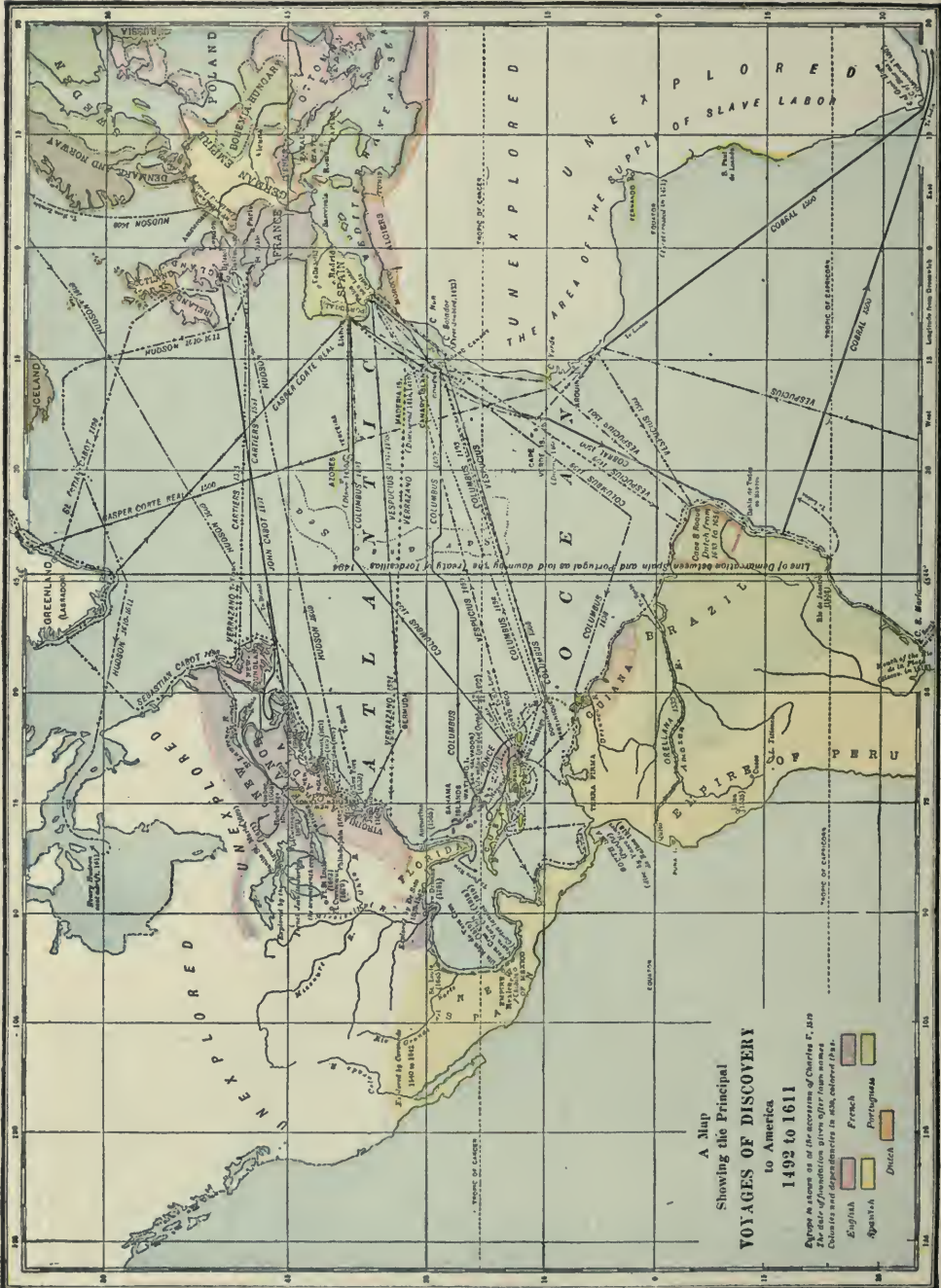










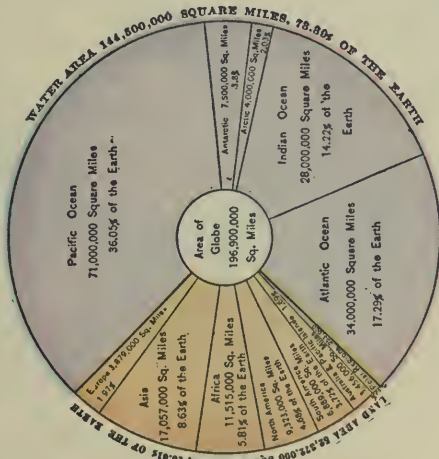


A Map
Showing the Principal
VOYAGES OF DISCOVERY
to America
1492 to 1611

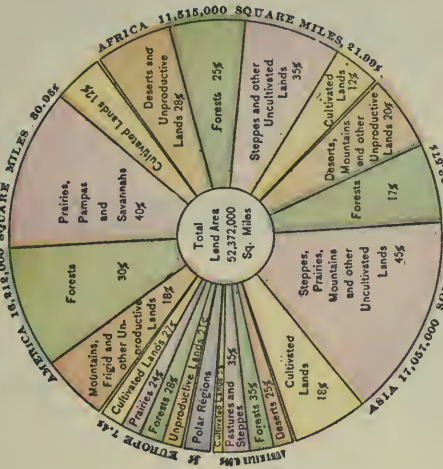
Europe as seen at the accession of Charles V, 1519
 The date of foundation given after European discovery
 Countries of discovery in this colored list

English	French	Portuguese
Spanish	Dutch	

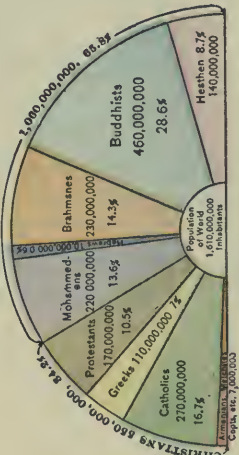
AREAS OF THE EARTH



CHARACTER OF LAND OF THE EARTH

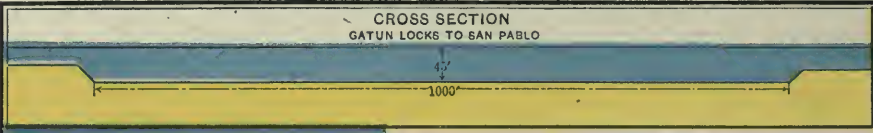
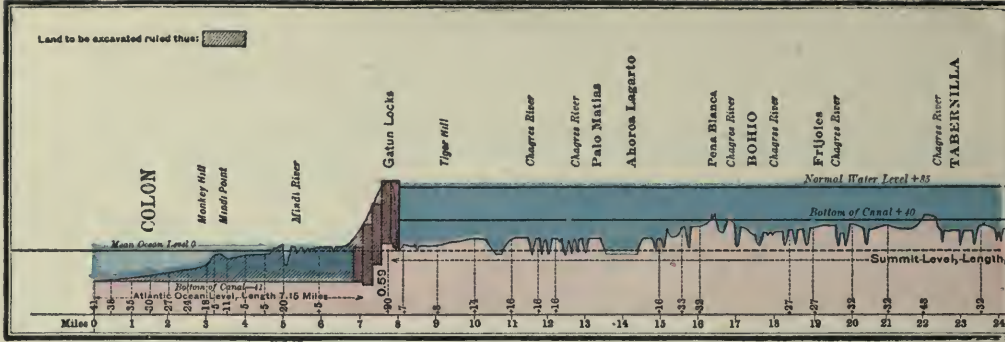


PRINCIPAL RELIGIONS OF THE WORLD



PRINCIPAL RELIGIOUS SECTS OF THE UNITED STATES

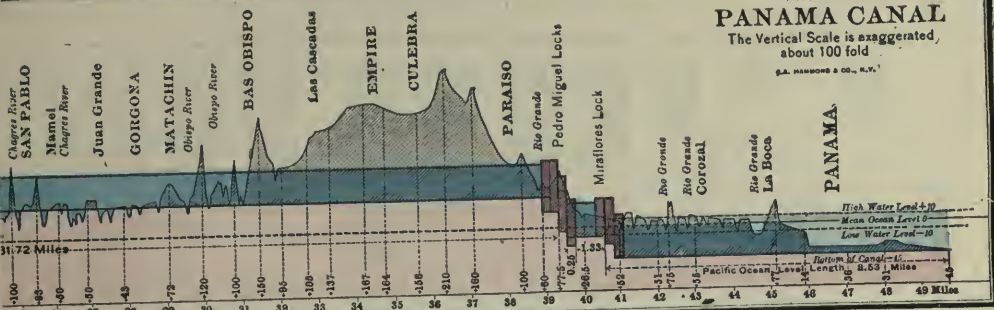




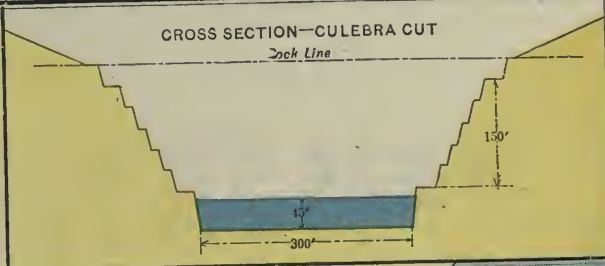
PROFILE OF PANAMA CANAL

The Vertical Scale is exaggerated, about 100 fold

G.A. HARRISS & CO., N.Y.

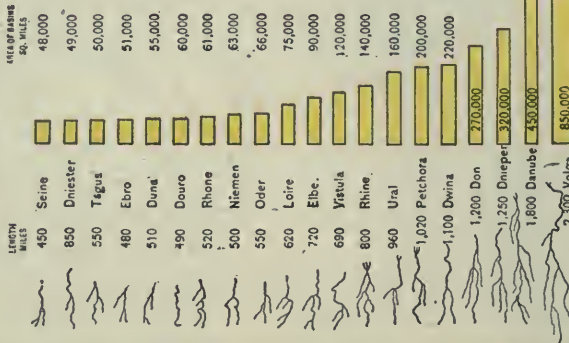


CROSS SECTION—CULEBRA CUT

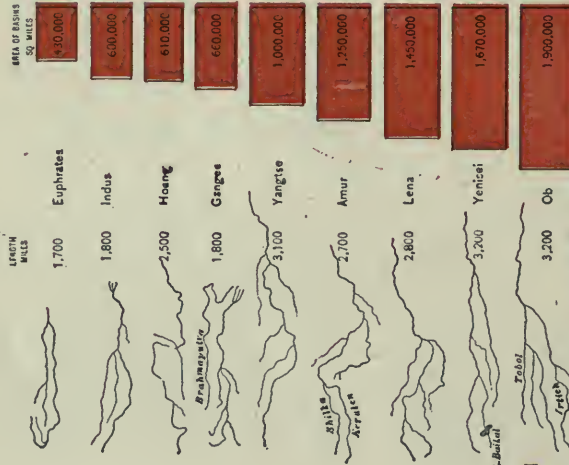


RIVER SYSTEMS OF THE WORLD

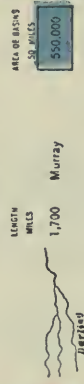
EUROPE



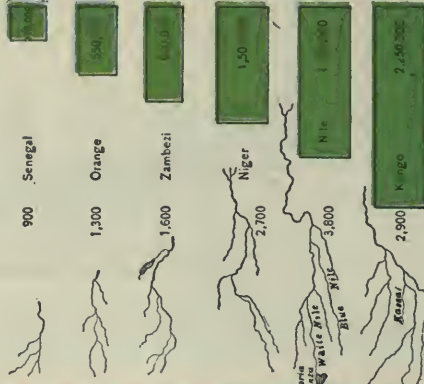
ASIA



AUSTRALIA



AFRICA



AMERICA



PRINCIPAL CITIES OF THE WORLD

The following list contains the principal towns of the world in all countries except the United States. In it will be found approximately all places of more than thirty thousand inhabitants and most of those of from twenty to thirty thousand. The date of the latest census enumerations and official estimates of the following countries is given as indicating the respective value of the figures used in the compilation: Algeria, 1901; Australia, 1901; Austria Hungary, 1900; British South African States, 1904; England and Wales, 1901, with government estimates of all towns of over 50,000 for 1905; Germany, 1901, with government estimates of Berlin, Hamburg and Essen for 1905; Japan, 1903; Philippine Islands, 1903; Sweden, 1905.

Aachen, Germany.....	135,245	Antequera, Spain.....	31,600	Barquisimeto, Venezuela....	31,476
Aalborg, Denmark.....	31,457	Antwerp, Belgium.....	261,149	Barranquilla, Colombia.....	55,000
Aarhus, Denmark.....	51,814	Apeldoorn, Netherlands.....	30,882	Barrow-in-Furness, England..	69,306
Abbeokuta, Yoruba.....	150,000	Aquila, Italy.....	21,188	Basel, Switzerland.....	124,392
Aberdare, Wales.....	43,357	Arad, Hungary.....	56,220	Basra, Turkey in Asia.....	50,000
Aberdeen, Scotland.....	167,537	Arequipa, Peru.....	35,000	Batangas, P. I.....	33,131
Abo, Russia.....	38,235	Arezzo, Italy.....	44,316	Batavia, Java.....	115,887
Accrington, England.....	48,890	Argao, P. I.....	35,448	Bath, England.....	49,817
Acireale, Italy.....	35,418	Arles, France.....	29,000	Batley, England.....	30,321
Acton, England.....	37,744	Armentieres, France.....	29,000	Batum, Russia.....	28,512
Adama, Turkey in Asia.....	45,000	Arnhem, Netherlands.....	60,528	Bauan, P. I.....	39,049
Adelaide, Australia.....	170,729	Aschersleben, Germany.....	27,335	Bautzen, Germany.....	26,125
Aden, Arabia.....	42,758	Ascoli, Italy.....	28,882	Bayonne, France.....	25,075
Adis Abeba, Abyssinia.....	35,000	Ashkabad, Russia.....	26,835	Bedford, England.....	35,144
Adrianople, Turkey in Europe	81,000	Ashton-under-Lyne, England..	43,890	Beirut, Turkey in Asia.....	118,800
Agra, India.....	180,022	Asnières, France.....	31,330	Bekes, Hungary.....	37,547
Ahmadabad, India.....	185,889	Asù, Italy.....	38,045	Belfast, Ireland.....	349,180
Aidin, Turkey in Asia.....	38,000	Aston Manor, England.....	77,310	Belfort, France.....	32,567
Aix, France.....	24,861	Astrakhan, Russia.....	121,580	Belgrade, Servia.....	69,790
Ajmer, India.....	73,739	Asuncion, Paraguay.....	60,000	Bellary, India.....	58,247
Akerman, Russia.....	32,470	Athens, Greece.....	128,735	Benares, India.....	209,331
Akita, Japan.....	34,350	Aubervilliers, France.....	31,215	Bender, Russia.....	35,741
Alcano, Italy.....	51,809	Auckland, New Zealand.....	67,228	Bendigo, Australia.....	42,666
Alcoy, Spain.....	32,053	Augsburg, Germany.....	89,170	Benevento, Italy.....	24,447
Aldershot, England.....	30,974	Aussig, Austria.....	37,265	Berbera, Br. Somaliland.....	30,000
Aleppo, Turkey in Asia.....	127,150	Avellino, Italy.....	23,760	Berdiansk, Russia.....	29,168
Alessandria, Italy.....	71,298	Avignon, France.....	46,896	Berditchef, Russia.....	53,728
Alexandria, Egypt.....	319,766	Ayr, Scotland.....	28,624	Bergamo, Italy.....	47,772
Alexandropol, Russia.....	32,018	Ayuthia, Siam.....	50,000	Bergen, Norway.....	72,251
Alexandrovsk, Russia.....	40,807	Azof, Russia.....	25,124	Berlat, Roumania.....	24,000
Algiers, Algeria.....	96,542	Badjos, Spain.....	30,899	Berlin, Germany.....	2,033,900
Alicante, Spain.....	50,142	Bagdad, Turkey in Asia.....	145,000	Bern, Switzerland.....	70,339
Aligarh, India.....	70,434	Bahia, Brazil.....	174,412	Bernburg, Germany.....	34,175
Allahabad, India.....	172,032	Bahour, India.....	56,595	Besancon, France.....	55,404
Allenstein, Germany.....	24,287	Baireuth, Germany.....	29,397	Beuthen, Germany.....	51,363
Almeria, Spain.....	47,326	Baku, Russia.....	179,133	Beziers, France.....	52,510
Alost, Belgium.....	31,655	Ballarat, Australia.....	49,202	Bhagalpur, India.....	75,500
Altenburg, Germany.....	37,110	Bamberg, Germany.....	41,823	Bhaunagar, India.....	58,442
Altendorf, Germany.....	63,238	Bangalore, India.....	159,046	Bhopal, India.....	77,023
Altona, Germany.....	161,501	Bangkok, Siam.....	600,000	Bialystok, Russia.....	63,046
Alwar, India.....	56,771	Banjernassin, Borneo.....	51,880	Biel, Switzerland.....	29,394
Ambala, India.....	78,638	Barcelona, Spain.....	533,000	Bielefeld, Germany.....	63,049
Amlens, France.....	90,758	Bareilly, India.....	131,268	Bikanor, India.....	53,078
Amoy, China.....	114,000	Barfrush, Persia.....	50,000	Bilbao, Spain.....	83,309
Amritsar, India.....	162,429	Barl, Italy.....	77,478	Birkenhead, England.....	116,035
Amsterdam, Netherlands.....	551,415	Barle, P. I.....	31,617	Birmingham, England.....	542,959
Ancona, Italy.....	56,835	Barletta, Italy.....	42,022	Bitlis, Turkey in Asia.....	38,860
Anderlecht, Belgium.....	51,921	Barmen, Germany.....	141,944	Blackburn, England.....	133,067
Andjian, Russia in Asia.....	46,882	Barnaul, Russia in Asia.....	29,850	Blackpool, England.....	47,346
Andria, Italy.....	49,569	Barnsley, England.....	41,083	Blagoveshensk, Russia in Asia	57,368
Angers, France.....	82,368	Baroda, India.....	103,790	Bloemfontein, Orange R. Col.	53,890
Angoulême, France.....	87,650			Blols, France.....	20,494

PRINCIPAL CITIES OF THE WORLD—CONTINUED

Blumenau, Brazil.....	40,000	Cartagena, Spain.....	99,871	Darbhanga, India.....	66,246
Bobrinsk, Russia.....	35,177	Caserta, Italy.....	32,709	Darlington, England.....	44,490
Bochum, Germany.....	65,551	Cassel, Germany.....	106,034	Darmstadt, Germany.....	72,381
Bogota, Colombia.....	130,000	Castellon, Spain.....	29,904	Darwen, England.....	38,211
Bologna, Italy.....	152,009	Castres, France.....	24,135	Debreczin, Hungary.....	75,006
Bolton, England.....	178,111	Catania, Italy.....	149,295	Delft, Netherlands.....	32,950
Bombay, India.....	776,006	Catanzaro, Italy.....	31,824	Delhi, India.....	208,575
Bona, Algeria.....	36,993	Cawnpur, India.....	197,170	Derby, England.....	122,207
Bonn, Germany.....	50,736	Ceara, Brazil.....	40,902	Dessau, Germany.....	60,849
Boote, England.....	62,753	Cebu, P. I.....	31,079	Deventer, Netherlands.....	27,411
Bordeaux, France.....	257,638	Celaya, Mexico.....	25,565	Devonport, England.....	78,864
Borgerhout, Belgium.....	41,075	Cette, France.....	33,246	Diarbekr, Turkey.....	34,000
Botuchany, Roumania.....	32,000	Chalon-sur-Saone, France.....	28,462	Dijon, France.....	71,326
Boulogne-sur-Mer, France.....	49,449	Changsha, China.....	230,000	Dordrecht, Netherlands.....	43,482
Boulogne-sur-Seine, France.....	44,916	Charleroi, Belgium.....	28,528	Dorpat, Russia.....	42,421
Bourges, France.....	46,551	Charlottenburg, Germany.....	189,305	Dortmund, Germany.....	142,735
Bournemouth, England.....	66,163	Chatham, England.....	40,753	Douai, France.....	33,648
Bradford, England.....	286,799	Chaux de Fonds, Switzerland.....	38,784	Dover, England.....	41,782
Braga, Portugal.....	24,202	Chefu, China.....	75,000	Drammen, Norway.....	23,003
Bralia, Roumania.....	58,392	Cheltenham, England.....	49,459	Dresden, Germany.....	460,658
Brandenburg, Germany.....	49,250	Chemnitz, Germany.....	214,030	Dublin, Ireland.....	573,179
Breda, Netherlands.....	26,949	Cherbourg, France.....	42,838	Dudley, England.....	48,809
Bremen, Germany.....	163,297	Chernigof, Russia.....	27,000	Duisburg, Germany.....	94,185
Brescia, Italy.....	70,614	Chester, England.....	38,309	Dumbarton, Scotland.....	115,176
Breslau, Germany.....	422,700	Chieta, Italy.....	20,403	Dunaburg, Russia.....	65,906
Brest, France.....	84,284	Chihuahua, Mexico.....	30,405	Dundee, Scotland.....	104,290
Brest-Litovsk, Russia.....	42,812	Chilian, Chile.....	36,681	Dunedin, New Zealand.....	62,390
Bridgetown, Barbados.....	35,000	Chimandega, Nicaragua.....	20,000	Dunkirk, France.....	38,325
Brieg, Germany.....	24,224	Chingtu, China.....	1,000,000	Durango, Mexico.....	31,062
Brighton, England.....	127,183	Chinkiang, China.....	107,000	Durban, Natal.....	79,000
Brisbane, Australia.....	358,535	Chinan, China.....	128,771	Düren, Germany.....	27,185
Bristol, England.....	52,204	Christchurch, New Zealand.....	57,041	Düsseldorf, Germany.....	213,711
Broken Hill, Australia.....	27,600	Christiania, Norway.....	22,628	Dvinsk, Russia.....	60,075
Bromberg, Germany.....	63,728	Chungking, China.....	600,000	Ealing, England.....	53,040
Bruges, Belgium.....	109,346	Cienfuegos, Cuba.....	59,428	Eastbourne, England.....	43,357
Brunn, Austria.....	128,226	Clermont, France.....	52,933	East Ham, England.....	95,959
Brunswick, Germany.....	76,303	Clichy, France.....	39,521	East London, C. of Good Hope.....	26,220
Brusel, Belgium.....	598,599	Colbridge, Scotland.....	66,981	Eccles, England.....	24,306
Budapest, Hungary.....	732,322	Coblenz, Germany.....	47,526	Ecija, Spain.....	34,395
Budweis, Austria.....	39,328	Cochabamba, Bolivia.....	21,886	Edinburgh, Scotland.....	338,577
Buenos Aires, Argentina.....	979,235	Coimbatore, India.....	53,080	Edmonton, England.....	46,890
Bukharest, Roumania.....	282,071	Colchester, England.....	38,351	Eger, Austria.....	23,675
Burgos, Spain.....	30,167	Colmar, Germany.....	36,844	Eisenach, Germany.....	31,457
Burnley, England.....	101,682	Cologne, Germany.....	372,529	Ekaterinburg, Russia.....	55,468
Burslem, England.....	38,766	Colombo, Ceylon.....	158,228	Ekaterinodar, Russia.....	65,097
Bury-upon-Trent, England.....	52,424	Combaconum, India.....	59,873	Ekaterinoslaf, Russia.....	135,552
Bury, England.....	58,954	Como, Italy.....	38,895	Eiberfeld, Germany.....	156,908
Cadiz, Spain.....	69,382	Concepcion, Chile.....	55,458	Elbing, Germany.....	62,518
Caen, France.....	44,794	Constantine, Algeria.....	49,243	Elche, Spain.....	27,380
Cagliari, Italy.....	53,747	Constantinople, Turkey.....	1,125,000	Elizavetgrad, Russia.....	66,182
Cairo, Egypt.....	570,062	Copenhagen, Denmark.....	500,479	Elizavetpol, Russia.....	33,000
Calais, France.....	59,743	Cordoba, Argent na.....	60,000	Enfield, England.....	42,728
Calcutta, India.....	1,026,987	Cordova, Spain.....	68,275	Enschede, Netherlands.....	29,510
Calicut, India.....	76,981	Cork, Ireland.....	76,122	Erfurt, Germany.....	85,202
Callao, Peru.....	31,000	Coruna, Spain.....	43,971	Eriwan, Russia.....	29,033
Caltagirone, Italy.....	44,879	Corouveville, France.....	23,796	Erzerum, Turkey in Asia.....	58,900
Caltanissetta, Italy.....	43,303	Coutra, Belgium.....	34,564	Essen, Germany.....	229,270
Camaguey, Cuba.....	25,102	Coventry, England.....	75,134	Esslingen, Germany.....	27,200
Cambridge, England.....	38,393	Craiova, Roumania.....	45,438	Exeter, England.....	47,185
Canea, Crete.....	24,537	Crefeld, Germany.....	107,908	Faizabad, India.....	75,055
Cannes, France.....	30,420	Cremona, Italy.....	37,693	Falkirk, Scotland.....	20,271
Cannstadt, Germany.....	26,575	Crewe, England.....	42,075	Farakhabad, India.....	67,338
Canterbury, England.....	24,809	Cronstadt, Russia.....	59,539	Felegyhaza, Hungary.....	33,406
Canton, China.....	900,000	Croydon, England.....	147,704	Ferrara, Italy.....	67,648
Cape Coast Castle, Gold Coast, Africa.....	28,948	Cuddalore, India.....	52,216	Ferrol, Spain.....	25,281
Cape Haitien, Haiti.....	29,000	Cuenca, Ecuador.....	30,000	Fez, Morocco.....	140,000
Cape Town, Cape of Good Hope.....	87,483	Cuneo, Italy.....	27,065	Fiume, Hungary.....	38,955
Caracas, Venezuela.....	72,429	Cuttack, India.....	51,364	Flensburg, Germany.....	49,922
Carcassonne, France.....	30,720	Czegled, Hungary.....	30,106	Florence, Italy.....	205,589
Cardenas, Cuba.....	26,448	Czenstochowa, Russia.....	53,550	Foggia, Italy.....	63,151
Cardiff, Wales.....	180,064	Czernowitz, Austria.....	67,622	Folkstone, England.....	30,634
Carear, P. I.....	31,965	Dacca, India.....	90,542	Forli, Italy.....	43,708
Carlisle, England.....	45,478	Daman, India.....	41,671	Forst, Germany.....	32,150
Carrara, Italy.....	42,067	Damanhur, Egypt.....	27,263	Fort de France, Martinique.....	22,164
		Damascus, Turkey in Asia.....	225,000	Frankfort-on-Main, Germany.....	288,989
		Danzig, Germany.....	147,301	Frankfort-on-Oder, Germany.....	61,553

PRINCIPAL CITIES OF 'THE WORLD—CONTINUED

Freetown, Sierra Leone.....	34,763	Harar, Abyssinia.....	40,000	Kaslof, Russia.....	40,367
Freiburg, Germany.....	31,000	Harbin, China.....	60,000	Kattowitz, Germany.....	31,740
Freiburg, Germany.....	61,504	Harburg, Germany.....	49,153	Kazan, Russia.....	143,707
Fremantle, Australia.....	23,006	Haeting, England.....	66,820	Kazvin, Persia.....	40,000
Fuchau, China.....	624,000	Havana, Cuba.....	262,385	Keekemet, Hungary.....	57,812
Fukuoka, Japan.....	50,155	Havre, France.....	130,198	Keighley, England.....	41,568
Fukuoka, Japan.....	71,047	Heidelberg, Germany.....	40,121	Kerbela, Turkey in Asia.....	65,000
Funchal, Madeira.....	20,844	Hellbronn, Germany.....	37,891	Kerman, Persia.....	60,000
Fünfkirchen, Hungary.....	43,982	Heider, Netherlands.....	26,681	Kermanshah, Persia.....	30,000
Fürth, Germany.....	54,142	Helsingfors, Finland.....	93,576	Kertch, Russia.....	30,342
		Herat, Afghanistan.....	45,000	Kharkov, Russia.....	197,405
Gålle, Sweden.....	30,776	Hildesheim, Germany.....	42,973	Khatmandu, Nepal.....	50,000
Galatz, Roumania.....	62,678	Himeji, Japan.....	36,443	Kherson, Russia.....	73,185
Gallipoli, Turkey.....	30,000	Hobart, Australia.....	36,509	Khojent, Russia in Asia.....	31,881
Gateshead, England.....	120,620	Hiroshima, Japan.....	121,198	Khotin, Russia.....	30,424
Gaya, India.....	71,288	Hobart, Australia.....	34,809	Kiuchau, China.....	60,000
Gelsenkirchen, Germany.....	36,935	Hodmezö-Vasarhely, Hungary.....	60,883	Kief, Russia.....	319,000
Geneva, Switzerland.....	112,736	Hof, Germany.....	32,905	Kiel, Germany.....	121,824
Genoa, Italy.....	234,710	Hongkong, China.....	136,900	Kilmarnock, Scotland.....	34,611
Georgetown, Br. Guiana.....	53,176	Honolulu, Hawaii.....	39,306	Kimberly, Cape of Good Hope.....	34,331
Gera, Germany.....	45,634	Hornsey, England.....	72,056	King's Norton, England.....	57,120
Ghent, Belgium.....	162,295	Hove, England.....	36,542	Kingston, Jamaica.....	48,642
Gibraltar, Spain.....	27,460	Howrah, India.....	157,594	Kingston-upon-Thames, Eng.....	34,373
Glessen, Germany.....	25,491	Hubli, India.....	60,214	Kioto, Japan.....	380,568
Gifu, Japan.....	40,168	Huddersfield, England.....	96,008	Kirin, China.....	250,000
Gijón, Spain.....	47,544	Hue, Anam.....	50,000	Kirkcaldy, Scotland.....	34,064
Gillingham, England.....	42,530	Hull, England.....	258,127	Kishenef, Russia.....	125,787
Girgenti, Italy.....	25,204	Hyde, England.....	32,708	Kiukiang, China.....	38,000
Gladbach, Germany.....	58,023			Kiungchau, China.....	30,000
Glasgow, Scotland.....	809,966	Ibadan, Yoruba.....	200,000	Klausenburg, Hungary.....	49,295
Glauchau, Germany.....	25,776	Ichang, China.....	45,000	Kobe, Japan.....	285,002
Gleiwitz, Germany.....	52,862	Iqtau, Austria.....	24,423	Kofu, Japan.....	44,188
Gloucester, England.....	47,955	Iford, England.....	41,240	Kokand, Russia in Asia.....	86,704
Gomel, Russia.....	45,081	Imoschi, Austria.....	36,789	Kokura, Japan.....	36,825
Gorakhpur, India.....	64,148	Indore, India.....	97,804	Kolhapur, India.....	51,373
Gorlitz, Germany.....	80,931	Innsbruck, Austria.....	27,056	Kolomea, Austria.....	34,188
Gotha, Germany.....	34,185	Inowracław, Germany.....	26,152	Kom, Persia.....	40,000
Gottenborg, Sweden.....	138,030	Insterburg, Germany.....	27,289	Koniakh, Turkey in Asia.....	44,000
Göttingen, Germany.....	39,359	Ipswich, England.....	70,802	Königsberg, Germany.....	57,619
Govan, Scotland.....	76,351	Iquique, Chile.....	43,005	Kostroma, Russia.....	41,268
Granada, Nicaragua.....	25,000	Irkutsk, Russia in Asia.....	49,106	Kotchi, Japan.....	35,815
Granada, Spain.....	75,900	Iserlohn, Germany.....	27,275	Kottbus, Germany.....	39,322
Gratz, Austria.....	158,080	Ismail, Russia.....	33,607	Kovno, Russia.....	73,743
Graudenz, Germany.....	32,786	Isfahan, Persia.....	80,000	Krakow, Austria.....	61,323
Great Grimsby, England.....	68,153	Ivanovo-Voznesensk, Russia.....	56,628	Krasnoyarsk, Russia in Asia.....	33,337
Greenock, Scotland.....	70,253	Ivry-sur-Seine, France.....	25,575	Kremenotshurg, Russia.....	58,649
Grenoble, France.....	68,615	Ixelles, Belgium.....	62,979	Kronstadt, Hungary.....	36,436
Grodno, Russia.....	41,758			Kuching, Borneo.....	25,000
Groningen, Netherlands.....	71,490	Jabalpur, India.....	90,316	Kumamoto, Japan.....	59,717
Grosswardein, Hungary.....	50,177	Jaipur, India.....	160,167	Kure, Japan.....	66,006
Guadalajara, Mexico.....	101,208	Jalandhar, India.....	67,735	Kursk, Russia.....	52,890
Guajuatato, Mexico.....	41,486	Janina, Turkey.....	25,000	Kutais, Russia.....	32,492
Guayaquil, Ecuador.....	51,000	Jaroslav, Austria.....	22,641	Kwala Kangsa, Straits Settlements.....	77,234
Guben, Germany.....	33,135	Jarrow, England.....	34,294		
Gwalior, India.....	119,433	Jassy, Roumania.....	78,069		
		Jerez, Spain.....	63,473	Lagos, Nigeria.....	42,000
Haarlem, Netherlands.....	68,518	Jerusalem, Turkey in Asia.....	48,000	Lahore, India.....	202,964
Hagen, Germany.....	50,612	Jhansi, India.....	55,724	Lalbach, Austria.....	38,547
Hague, Netherlands.....	234,459	Jodhpur, India.....	60,437	Lancaster, England.....	40,329
Haldarabad, India.....	448,448	Johannesburg, Transvaal.....	158,580	Lanchau, China.....	500,000
Hakodate, Japan.....	85,313	Jokjokarta, Java.....	58,229	Landsberg, Germany.....	33,600
Halberstadt, Germany.....	42,810	Jönköping, Sweden.....	23,240	Laos, P. I.....	34,454
Halifax, England.....	108,419	Jumet, Belgium.....	25,950	La Paz, Bolivia.....	62,000
Halifax, Nova Scotia.....	40,832			La Plata, Argentina.....	75,023
Halle, Germany.....	158,609	Kabul, Afghanistan.....	70,000	La Rochelle, France.....	31,559
Hälsingborg, Sweden.....	27,253	Kagoshima, Japan.....	59,001	Lassa, Tibet.....	45,000
Hama, Turkey in Asia.....	44,000	Kaiserleh, Turkey in Asia.....	72,000	Lausanne, Switzerland.....	51,938
Hamadan, Persia.....	40,000	Kaiserslautern, Germany.....	48,310	Laval, France.....	30,356
Hamburg, Germany.....	872,023	Kaluga, Russia.....	49,728	Le Creuzot, France.....	30,584
Hamilton, Ontario, Canada.....	52,634	Kamenetz, Russia.....	39,113	Leece, Italy.....	32,687
Hamilton, Scotland.....	32,775	Kanazawa, Japan.....	99,657	Leeds, England.....	456,787
Hamm, Germany.....	31,380	Kandahar, Afghanistan.....	60,000	Leeuwarden, Netherlands.....	34,008
Handsworth, England.....	52,921	Karachi, India.....	118,663	Leghorn, Italy.....	98,321
Hangchau, China.....	300,000	Karlskrona, Sweden.....	20,074	Leicester, England.....	228,133
Hankau, China.....	870,000	Karlsruhe, Germany.....	97,185	Leiden, Netherlands.....	56,044
Hanley, England.....	64,667	Kaschau, Hungary.....	40,102	Leigh, England.....	40,001
Hanoi, Anam.....	103,238	Kashan, Persia.....	40,000	Leipzig, Germany.....	456,124
Hanover, Germany.....	235,649	Kashgar, Turkestan.....	75,000	Leith, Scotland.....	81,677

PRINCIPAL CITIES OF THE WORLD—CONTINUED

Le Mans, France.....	63,272	Mechlin, Belgium.....	58,101	Neumünster, Germany.....	37,400
Lemberg, Austria.....	159,877	Medellin, Colombia.....	40,000	Neustadt, Austria.....	28,700
Lens, France.....	24,353	Medina, Turkey in Asia.....	48,000	Nevers, France.....	27,673
Lez, Austria.....	58,791	Medinet-el-Fayoum, Egypt.....	40,350	Newcastle, Australia.....	58,620
Leon, Mexico.....	63,263	Meerut, India.....	118,129	Newcastle, England.....	264,511
Leon, Nicaragua.....	45,000	Mehallet-el Kebir, Egypt.....	31,535	New Guatemala, Guatemala.....	96,560
Leyton, England.....	98,899	Mekinez, Morocco.....	56,000	Newport, England.....	72,880
Libau, Russia.....	64,505	Melbourne, Australia.....	508,450	Nice, France.....	105,109
Lichtenberg, Germany.....	43,371	Mendoza, Argentina.....	29,100	Niigata, Japan.....	58,576
Lieben, Austria.....	21,375	Merida, Mexico.....	43,630	Nijmegen, Netherlands.....	49,342
Liege, Belgium.....	168,552	Merthyr Tydfil, Wales.....	69,227	Nikolaief, Russia.....	92,060
Liegnitz, Germany.....	54,882	Meshed, Persia.....	60,000	Nîmes, France.....	80,605
Lima, Peru.....	130,000	Messina, Italy.....	149,778	Ningpo, China.....	200,000
Limerick, Ireland.....	45,808	Metz, Germany.....	58,462	Nissa, Servia.....	24,000
Limoges, France.....	84,121	Mexico, Mexico.....	368,777	Niuchwang, China.....	56,000
Linares, Chile.....	33,000	Middleborough, England.....	98,369	Nizhni Novgorod, Russia.....	95,124
Linares, Spain.....	38,245	Milan, Italy.....	491,460	Nordhausen, Germany.....	28,510
Lincoln, England.....	48,784	Minsk, Russia.....	91,494	Norköping, Sweden.....	44,378
Linden, Germany.....	50,628	Mirzapur, India.....	79,862	Northampton, England.....	92,441
Lipa, P. I.....	37,924	Miskolcz, Hungary.....	43,096	Norwich, England.....	116,741
Lisbon, Portugal.....	356,009	Mitau, Russia.....	35,011	Nottingham, England.....	251,671
Lisle, France.....	210,096	Mito, Japan.....	39,828	Novara, Italy.....	45,248
Liverpool, England.....	730,143	Modena, Italy.....	64,843	Novgorod, Russia.....	26,972
Lodz, Russia.....	351,570	Modica, Italy.....	48,962	Novo Cherkask, Russia.....	52,005
London, England.....	6,580,616	Mohleif, Russia.....	45,000	Nuka, Russia.....	24,811
London, Ont., Canada.....	37,983	Molenbeek, Belgium.....	61,122	Nuremberg, Germany.....	261,061
Londonderry, Ireland.....	39,832	Molletta, Italy.....	40,135	Ny-reghyaza, Hungary.....	33,088
Longton, England.....	35,825	Mombasa, Br. E. Africa.....	27,000		
Lorca, Spain.....	69,838	Monastir, Turkey.....	46,000	Oaxaca Mexico.....	35,049
Lorient, France.....	44,640	Mons, Belgium.....	27,072	Oberhausen, Germany.....	42,148
Louvain, Belgium.....	42,164	Monterey, Mexico.....	62,266	Odenburg, Hungary.....	33,478
Lübeck, Germany.....	82,098	Montevideo, Uruguay.....	276,000	Odense, Denmark.....	40,138
Lublin, Russia.....	59,152	Montlucon, France.....	35,062	Odessa, Russia.....	149,673
Luca, Italy.....	74,871	Montpellier, France.....	75,950	Offenbach, Germany.....	50,468
Lucerne, Switzerland.....	32,801	Montreal, Canada.....	267,730	Okayama, Japan.....	81,025
Lucknow, India.....	264,049	Montreuil, France.....	31,773	Oldham, Germany.....	26,656
Ludwigshafen, Germany.....	61,914	Monza, Italy.....	33,085	Oldham, England.....	140,225
Lüneburg, Germany.....	24,715	Moradabad, India.....	75,128	Olmütz, Austria.....	22,106
Luton, England.....	36,404	Morelia, Mexico.....	37,278	Omdurman, Egypt.....	69,000
Luxemburg, Luxemburg.....	20,828	Morocco, Morocco.....	60,000	Omsk, Russia in Asia.....	53,550
Lyon, France.....	459,069	Morhansk, Russia.....	25,913	Oporto, Portugal.....	172,421
		Moscow, Russia.....	1,062,360	Oppeln, Germany.....	30,175
Maastricht, Netherlands.....	36,146	Mosul, Turkey.....	61,000	Oran, Algeria.....	88,235
Macao, China.....	63,901	Motherwell, Scotland.....	30,423	Örebro, Sweden.....	25,288
Macclesfield, England.....	34,635	Mountain Ash, Wales.....	31,063	Orel, Russia.....	70,075
Madras, India.....	506,346	Mukden, China.....	190,000	Orizaba, Mexico.....	52,994
Madrid, Spain.....	530,835	Mülhausen, Germany.....	89,118	Orleans, France.....	67,311
Madura, India.....	105,984	Mülheim-on-Rhine, Germany.....	46,062	Osaka, Japan.....	985,945
Magdeburg, Germany.....	229,667	Multan, India.....	87,394	Osh, Russia.....	57,397
Maldstone, England.....	33,516	München, Germany.....	409,950	Osensbrück, Germany.....	51,573
Mai kop, Russia in Asia.....	34,101	Münster, Germany.....	63,776	Ostend, Belgium.....	41,181
Mainz, Germany.....	84,251	Murcia, Spain.....	111,539	Otaru, Japan.....	47,361
Mako, Hungary.....	33,722	Mustapha, Algeria.....	38,327	Otsu, Japan.....	59,595
Malaga, Spain.....	130,109	Muttra, India.....	60,042	Ottawa, Canada.....	98,928
Malmes, Belgium.....	58,101	Mysore, India.....	68,111	Oulgaret, India.....	54,985
Malmö, Sweden.....	70,767			Ouro Preto, Brazil.....	59,249
Managua, Nicaragua.....	30,000			Oviedo, Spain.....	48,108
Manchester, England.....	631,185	Nafa, Japan.....	43,132	Oxford, England.....	49,336
Mandalay, India.....	183,816	Nagano, Japan.....	37,202		
Manila, P. I.....	219,928	Nagasaki, Japan.....	153,293	Pachuca, Mexico.....	37,487
Manipur, India.....	67,093	Nagoya, Japan.....	288,839	Padua, Italy.....	62,281
Manissa, Turkey in Asia.....	50,000	Nagpur, India.....	127,734	Paisley, Scotland.....	85,804
Mannheim, Germany.....	141,131	Nagy-Koros, Hungary.....	26,535	Pakhoi, China.....	30,000
Mantua, Italy.....	29,142	Nakichevan, Russia.....	40,384	Palembang, Sumatra.....	53,788
Maracaibo, Venezuela.....	34,284	Namangan, Russia in Asia.....	61,906	Palermo, Italy.....	309,094
Maranhao, Brazil.....	29,308	Namur, Belgium.....	31,940	Palma, Spain.....	63,937
Maria Theresopol, Hungary.....	82,122	Nanchang, China.....	300,000	Palmas, Canary Islands.....	44,517
Mariapol, Russia.....	52,770	Nancy, France.....	102,559	Panama, Panama.....	30,000
Marsala, Italy.....	57,567	Nankin, China.....	270,000	Para, Brazil.....	100,000
Marseille, France.....	491,101	Nantes, France.....	132,990	Paramaribo, Dutch Guiana.....	32,585
Maskat, Arabia.....	60,000	Naples, Italy.....	563,540	Parana, Argentina.....	25,000
Massa, Italy.....	26,413	Nara, Japan.....	33,735	Paris, France.....	2,714,068
Matanzas, Cuba.....	45,282	Narbonne, France.....	24,670	Parma, Italy.....	49,340
Matsuyama, Japan.....	37,841	Nawanagar, India.....	53,844	Partick, Scotland.....	64,274
Matsuye, Japan.....	35,061	Nekapatam, India.....	57,190	Patala, India.....	53,545
Maulman, India.....	58,446	Neisset, Germany.....	24,967	Patna, India.....	134,785
Mayebest, Japan.....	41,714	Nelson, England.....	32,816	Patras, Greece.....	50,158
Mecca, Turkey in Asia.....	80,000	Neully, France.....	37,463	Pau, France.....	24,266

PRINCIPAL CITIES OF THE WORLD—CONTINUED

Favia, Italy.....	35,447	Reading, England.....	77,674	Sapporo, Japan.....	55,304
Peking, China.....	1,600,000	Reggia, Emilia, Italy.....	58,490	Saragossa, Spain.....	99,119
Pelotas, Brazil.....	41,591	Reggio, Calabria, Italy.....	44,415	Saratof, Russia.....	143,433
Penang, Straits Settlements...	94,086	Reichenberg, Austria.....	34,069	Sasebo, Japan.....	68,344
Penza, Russia.....	61,851	Remscheid, Germany.....	58,103	Sassari, Italy.....	38,268
Perigueux, France.....	31,976	Rennes, France.....	74,676	Savona, Italy.....	38,355
Perm, Russia.....	45,403	Resht, Persia.....	40,000	Scarborough, England.....	38,160
Pernambuco, Brazil.....	111,556	Reus, Spain.....	26,235	Schaerbeek, Belgium.....	66,617
Perpignan, France.....	36,157	Revel, Russia.....	66,292	Schiedam, Netherlands.....	28,290
Perth, Australia.....	42,474	Rheims, France.....	108,385	Schoneberg, Germany.....	95,968
Perth, Scotland.....	34,214	Rheydt, Germany.....	34,036	Schweidnitz, Germany.....	28,449
Perugia, Italy.....	61,385	Rhondda, Wales.....	113,735	Schwerin, Germany.....	38,672
Pesaro, Italy.....	25,103	Riazan, Russia.....	44,552	Sempalatinsk, Russia.....	26,350
Peshawar, India.....	95,147	Richmond, England.....	31,677	Sendai, Japan.....	100,231
Peterborough, England.....	30,870	Riga, Russia.....	282,943	Seoul, Korea.....	196,646
Pforzheim, Germany.....	42,351	Rimini, Italy.....	43,203	Seraing, Belgium.....	39,377
Philippopolis, East Roumelia.....	42,840	Rio de Janeiro, Brazil.....	750,000	Serajevo, Austria-Hungary.....	41,174
Piacenza, Italy.....	36,064	Rixdorf, Germany.....	90,422	Seres, Turkey.....	31,000
Pi'etra, Roumania.....	25,000	Roanne, France.....	34,901	Sergievsk, Russia.....	31,413
Pietermaritzburg, Natal.....	34,676	Rochdale, England.....	89,390	Seville, Spain.....	148,315
Pilsen, Austria.....	68,079	Rochefort, France.....	36,458	Shahjahanpur, India.....	76,458
Pingyang, Korea.....	74,213	Rochester, England.....	30,622	Shanghai, China.....	651,000
Pinsk, Russia.....	27,938	Rome, Italy.....	462,783	Shasi, China.....	80,000
Piotrkof, Russia.....	33,173	Rosario, Argentina.....	140,000	Sheffield, England.....	440,415
Piraeus, Greece.....	51,020	Rostock, Germany.....	54,735	Shimonoseki, Japan.....	40,280
Pirmasens, Germany.....	30,200	Rostof, Russia.....	119,889	Shiraz, Persia.....	50,004
Pisa, Italy.....	61,321	Rotherham, England.....	54,348	Shizwoka, Japan.....	48,744
Pistoia, Italy.....	62,606	Rotterdam, Netherlands.....	370,390	Sholapur, India.....	75,288
Ploauen, Germany.....	73,891	Roubaix, France.....	124,365	Shusha, Russia.....	25,658
Ploeyati, Roumania.....	42,687	Rouen, France.....	116,316	Sialkot, India.....	57,958
Plymouth, England.....	118,000	Roulers, Belgium.....	23,245	Siangtan, China.....	650,000
Pnum Penh, Cambodia.....	50,000	Rowley Regis, England.....	34,069	Siens, Italy.....	28,355
Point de Galle, Ceylon.....	48,500	Rustchuk, Bulgaria.....	32,661	Simbirsk, Russia.....	44,111
Poitiers, France.....	39,886	Ryazan, Russia.....	25,223	Simferopol, Russia.....	60,876
Pola, Austria.....	45,205	Saga, Japan.....	35,083	Singan, China.....	675,000
Poltava, Russia.....	53,060	Sahaaranpur, India.....	96,254	Singapore, Straits Settlements.....	193,068
Ponce, Porto Rico.....	27,652	Salgon, Anam.....	50,870	Siwas, Turkey in Asia.....	43,100
Pondichery, India.....	47,843	St. Denis, France.....	60,908	Skutari, Turkey in Asia.....	80,000
Poona, India.....	153,320	St. Denis, Reunion Island.....	27,392	Silvno, Eastern Roumelia.....	24,542
Pont-y-Pridd, Wales.....	32,319	St. Etienne, France.....	146,559	Smethwick, England.....	54,550
Port au Prince, Haiti.....	70,000	St. Gallen, Switzerland.....	50,625	Smilechow, Austria.....	47,135
Port Arthur, China.....		St. Gallen, Belgium.....	56,750	Smolensk, Russia.....	57,405
Port Elizabeth, Cape of Good Hope.....	32,959	St. Helens, England.....	89,843	Smyna, Turkey in Asia.....	201,000
Port Louis, Mauritius.....	52,740	St. John, New Brunswick.....	40,711	Sofia, Bulgaria.....	67,920
Porto Alegre, Brazil.....	100,000	St. Johns, Newfoundland.....	29,594	Solingen, Germany.....	45,260
Port of Spain, Trinidad.....	54,100	St. Louis, Senegal.....	24,070	Southampton, England.....	114,897
Porto Novo, Dahomey.....	50,000	St. Nazaire, France.....	35,813	Southport, England.....	48,067
Port Said, Egypt.....	50,179	St. Nicolas, Belgium.....	32,767	South Shields, England.....	109,360
Portsmouth, England.....	201,975	St. Ouen, France.....	35,436	Spandau, Germany.....	65,014
Posen, Germany.....	117,033	St. Petersburg, Russia.....	1,313,300	Spezia, Italy.....	65,613
Potosi, Bolivia.....	20,910	St. Quentin, France.....	50,278	Srinagar, India.....	122,008
Potsdam, Germany.....	59,796	Sakai, Japan.....	54,040	Stanislaw, Austria.....	29,958
Prague, Austria.....	201,589	Salem, India.....	70,621	Stargard, Germany.....	26,875
Prato, Italy.....	51,453	Salerno, Italy.....	42,727	Stavanger, Norway.....	30,613
Praya, Cape Verde Islands.....	20,000	Salford, England.....	231,514	Stavropol, Russia in Asia.....	46,965
Presburg, Hungary.....	65,867	Salonika, Turkey.....	105,000	Stettin, Germany.....	210,708
Freston, England.....	115,721	Saltillo, Mexico.....	23,966	Stockholm, Sweden.....	317,964
Freteria, Transvaal.....	36,700	Salzburg, Austria.....	33,067	Stockport, England.....	98,320
Frisend, Turkey.....	50,000	Samarang, Java.....	89,286	Stockton-on-Tees, England.....	51,476
Frossnitz, Austria.....	24,343	Samara, Russia.....	91,672	Stoke-upon-Trent, England.....	30,478
Frumynsl, Austria.....	46,295	Samarkand, Russia in Asia.....	53,194	Stolp, Germany.....	27,304
Fskof, Russia.....	30,683	San Jose, Costa Rica.....	24,600	Stralsund, Germany.....	31,178
Fueblo, Mexico.....	93,521	San Juan, Porto Rico.....	32,048	Strasbourg, Germany.....	151,041
Quebec, Canada.....	68,840	San Luis Potosi, Mexico.....	61,019	Stratford, England.....	151,041
Queretaro, Mexico.....	33,152	San Miguel, Salvador.....	24,708	Stretford, England.....	30,348
Quito, Ecuador.....	80,000	San Salvador, Salvador.....	59,540	Stryl, Austria.....	23,300
Radom, Russia.....	30,126	San Sebastian, Spain.....	37,812	Stuttgart, Germany.....	176,099
Ragusa, Italy.....	31,950	Santa Ana, Salvador.....	48,120	Suchau, China.....	500,021
Rampur, India.....	78,758	Santa Cruz, Canary Island.....	38,419	Suce, Bolivia.....	20,900
Rangoon, India.....	234,881	Santa Fe, Argentina.....	25,000	Suez, Egypt.....	24,670
Rathmines, Ireland.....	32,473	Santander, Spain.....	54,694	Suit, Egypt.....	42,078
Ratisbon, Germany.....	45,435	Santiago, Chile.....	334,538	Sumy, Russia.....	28,511
Ravenna, Italy.....	64,031	Santiago de Cuba, Cuba.....	45,478	Sunderland, England.....	152,964
Rawalpindi, India.....	87,688	Santiago, Spain.....	24,927	Surabaya, Java.....	146,940
Rawtenstall, England.....	31,052	Santo Domingo, S. Domingo.....	20,620	Surakarta, Java.....	125,000
		Santos, Brazil.....	55,000	Surat, India.....	119,300
		Sao Paulo, Brazil.....	150,934	Swansea, Wales.....	96,384
				Swatow, China.....	48,000

PRINCIPAL CITIES OF THE WORLD—CONTINUED

Bwinda, England.....	45,906	Trapani, Italy.....	59,452	Volgoda, Russia.....	27,522
Sydney, Australia.....	508,501	Trebizond, Turkey in Asia...	35,000	Volsk, Russia.....	27,572
Syracuse, Italy.....	32,987	Treves, Germany.....	43,506	Voronezh, Russia.....	84,146
Syzran, Russia.....	33,046	Treviso, Italy.....	33,987	Wakayama, Japan.....	68,527
Szeged, Hungary.....	102,991	Trichinopoly, India.....	104,721	Wakefield, England.....	41,554
Szekesfevar, Hungary.....	32,167	Trient, Austria.....	24,868	Walsley, England.....	53,580
Szentes, Hungary.....	31,306	Trieste, Austria.....	178,599	Walsall, England.....	92,968
Tabriz, Persia.....	200,000	Trikhala, Greece.....	21,149	Walthamstow, England.....	95,125
Taganrog, Russia.....	58,298	Tripoli, Tripoli.....	35,000	Warrington, England.....	68,301
Taiwan, Formosa.....	48,097	Trivandrum, India.....	57,882	Warsaw, Russia.....	756,424
Takamatsu, Japan.....	37,430	Trondheim, Norway.....	38,180	Waterford, Ireland.....	27,947
Takasaki, Japan.....	35,228	Troyes, France.....	53,146	Weimar, Germany.....	28,498
Taika, Chile.....	43,331	Tsarsyn, Russia.....	67,650	Weissenfels, Germany.....	28,296
Tambor, Russia.....	49,203	Tsu, Japan.....	36,108	Wellington, New Zealand.....	52,500
Tammerfors, Finland.....	36,344	Tucuman, Argentina.....	50,000	Wenchau, China.....	80,000
Tamsui, Formosa.....	100,000	Tula, Russia.....	109,352	West Bromwich, England.....	67,823
Tananarivo, Madagascar.....	55,579	Tunja, Russia.....	33,388	West Ham, England.....	294,907
Tangier, Morocco.....	30,058	Turin, Italy.....	178,500	West Hartlepool, England.....	62,611
Tanjore, India.....	57,870	Tver, Russia.....	335,656	Wiesbaden, Germany.....	86,111
Tanta, Egypt.....	57,289	Tynemouth, England.....	45,644	Wigan, England.....	86,581
Taranto, Italy.....	60,733	Udine, Italy.....	51,514	Wilkesden, England.....	114,815
Tarbes, France.....	20,845	Ufa, Russia.....	57,942	Wimbleton, England.....	41,904
Tarnopol, Austria.....	30,415	Ujpest, Hungary.....	49,961	Winnipeg, Manitoba.....	90,204
Tarragona, Spain.....	28,285	Ulm, Germany.....	41,858	Winterthur, Switzerland.....	25,006
Tashkend, Turkestan.....	156,414	Uman, Russia.....	42,982	Withington, England.....	36,201
Tegucigalpa, Honduras.....	34,692	Umsal, Sweden.....	28,628	Witten, Germany.....	33,535
Teheran, Persia.....	280,000	Uralsk, Russia.....	24,150	Wolverhampton, England.....	99,458
Temesvar, Hungary.....	53,033	Uskup, Turkey.....	38,919	Wood Green, England.....	34,183
Teplitz, Austria.....	24,560	Utrecht, Netherlands.....	20,000	Worcester, England.....	46,623
Terama, Italy.....	24,563	Utsunomiya, Japan.....	112,796	Worms, Germany.....	40,705
Theodosia, Russia.....	27,236	Valence, France.....	35,953	Wuchang, China.....	800,000
Thorn, Germany.....	29,470	Valencia, Spain.....	26,964	Wuchau, China.....	53,000
Tientsin, China.....	750,000	Valencia, Spain.....	213,530	Wuhu, China.....	122,000
Tiflis, Russia.....	160,645	Valencia, Venezuela.....	38,954	Wurzburg, Germany.....	75,499
Tilburg, Netherlands.....	45,625	Valenciennes, France.....	30,946	Yamagata, Japan.....	40,248
Tilsit, Germany.....	34,539	Valetta, Malta.....	61,268	Yarkand, China.....	100,000
Tipton, England.....	30,543	Valladolid, Spain.....	68,789	Yarmouth, England.....	52,353
Tiraspol, Russia.....	29,223	Valparaiso, Chile.....	143,769	Yaroslavl, Russia.....	70,610
Tiumen, Russia in Asia.....	35,000	Vancouver, Br. Columbia.....	26,133	Yelisk, Russia in Asia.....	35,446
Tlemcen, Algeria.....	35,468	Varna, Bulgaria.....	33,443	Yekaterinburg, Russia.....	55,488
Tobolsk, Russia in Asia.....	21,401	Venice, Italy.....	151,840	Yekaterinostat, Russia.....	135,552
Tojama, Japan.....	56,275	Versailles, France.....	54,982	Yelets, Russia.....	38,238
Tokat, Turkey in Asia.....	60,000	Verviers, Belgium.....	49,243	Yelzavethgrad, Russia.....	66,132
Tokyo, Japan.....	1,818,655	Viborg, Russia.....	52,312	Yezd, Persia.....	45,000
Tokushima, Japan.....	63,710	Victoria, Br. Columbia.....	20,816	Yochau, China.....	20,000
Toledo, Spain.....	23,393	Vicenza (Verona), Italy.....	74,271	Yokohama, Japan.....	326,035
Toluca, Mexico.....	29,904	Vienna, Austria.....	1,674,857	York, England.....	82,362
Tomsa, Russia in Asia.....	65,530	Villanova, India.....	41,915	Yurief, Russia.....	42,512
Toronto, Canada.....	208,040	Villa Rica, Paraguay.....	25,000	Zaandam, Netherlands.....	23,517
Torquay, England.....	33,625	Vilna, Russia.....	162,633	Zagazig, Egypt.....	35,715
Tortosa, Spain.....	25,368	Vincennes, France.....	51,405	Zanzibar, Zanzibar.....	50,000
Totoncapan, Guatemala.....	28,310	Vinnitsa, Russia.....	34,060	Zhitomer, Zanzibar.....	80,787
Tottenham, England.....	102,519	Vitebsk, Russia.....	66,143	Zittau, Germany.....	30,575
Toulon, France.....	101,602	Vitoria, Spain.....	30,701	Zurich, Switzerland.....	175,033
Toulouse, France.....	149,841	Vladikavkas, Russia.....	49,924	Zwickau, Germany.....	62,567
Tour, France.....	64,695	Vladimir, Russia.....	82,029	Zwole, Netherlands.....	82,280
Tourcoing, France.....	79,243	Vladivostok, Russia in Asia.....	38,000		
Tournaï, Belgium.....	39,940				

PRINCIPAL CITIES OF THE UNITED STATES

Latest Official Estimates of Population

This alphabetical list of cities of the United States having 10,000 inhabitants or more gives population of cities in States of Florida, Iowa, Kansas, Massachusetts, Minnesota, New Jersey, New York, North Dakota, Rhode Island, South Dakota and Wisconsin in accordance with the State enumerations of 1905, cities of Michigan in accordance with the State enumeration of 1904 and the other cities are estimated as of 1909, under the method adopted by the United States Census Bureau and known as the "arithmetical method." This method rests on the assumption that the annual increase of each year since the last census would be one-tenth of the decennial increase between the last two censuses. The country as a whole and most of the states and cities are growing with a steadily decreasing per cent. of increase. As this condition has obtained in the United States for the last twenty years it is likely to hold good in the immediate future. Under such conditions the "arithmetical method" has been proved more accurate than any alternative method available. Population of places marked thus * are estimated from reliable local sources.

City and State.	Pop.	City and State.	Pop.	City and State.	Pop.	City and State.	Pop.
Adams, Mass	12,486	Berkeley, Calif.*	35,000	Coffeyville, Kan.	13,182	El Paso, Texas.	20,930
Adrian, Mich.	10,680	Beverly, Mass.	15,223	Cohoes, N. Y.	24,183	Elwood, Ind.	22,553
Akron, Ohio.	56,342	Biddeford, Me.	17,677	Colorado Spgs, Col.	30,085	Erie, Pa.	63,622
Alameda, Calif.*	30,000	Binghamton, N. Y.	42,036	Columbia, Pa.	13,761	Escanaba, Mich.	11,098
Albany, N. Y.	98,374	Birmingham, Ala.	49,428	Columbia, S. C.	26,288	Evanston, Ill.	23,557
Alexandria, Va.	14,800	Bloomfield, N. J.	11,668	Columbus, Ga.	17,831	Evansville, Ind.	66,432
Allegheny, Pa.	152,044	Bloomington, Ill.	25,806	Columbus, Ohio.	159,229	Everett, Mass.	29,111
Allentown, Pa.	44,585	Boston, Mass.*	624,921	Concord, N. H.	21,997	Fall River, Mass.	105,762
Alpena, Mich.	12,400	Braddock, Pa.	22,938	Corning, N. Y.	13,515	Fargo, N. D.	12,512
Alton, Ill.	17,810	Bradford, Pa.	19,093	Cortland, N. Y.	11,272	Findlay, Ohio.	17,500
Altoona, Pa.	46,755	Bridgeport, Conn.	90,913	Council Bluffs, Ia.	25,231	Fitchburg, Mass.	33,021
Amsterdam, N. Y.	23,943	Bridgeton, N. J.	13,624	Covington, Ky.	47,948	Flint, Mich.	14,884
Anderson, Ind.	28,671	Brocton, Mass.	47,794	Cranston, R. I.	17,570	Fond du Lac, Wis.	17,284
Ann Arbor, Mich.	14,599	Brookline, Mass.	23,436	Cripple Creek, Col.	15,000	Fort Dodge, Ia.	14,369
Ansonia, Conn.	14,312	Buffalo, N. Y.	439,457	Cumberland, Md.	21,988	Fort Scott, Kan.	12,202
Appleton, Wis.	17,000	Bullfrog, Nev.*	12,000	Dallas, Texas,*	100,000	Fort Smith, Ark.	13,876
Asheville, N. C.	18,707	Burlington, Ia.	25,318	Danbury, Conn.	16,522	Fort Wayne, Ind.	53,865
Ashland, Wis.	14,519	Burlington, Vt.	22,285	Danville, Ill.	19,602	Fort Worth, Texas*	68,100
Ashtabula, Ohio.	17,099	Butler, Pa.	12,760	Danville, Va.	22,114	Frammingham, Mass.	11,548
Atchison, Kan.	18,257	Butte, Mont.*	60,000	Davenport, Ia.	39,797	Freeport, Ill.	16,030
Athens, Ga.	11,685	Cairo, Ill.	14,546	Dayton, Ohio.	107,035	Fresno, Calif.*	35,000
Atlanta, Ga.	112,787	Cambridge, Mass.	97,434	Decatur, Ill.	24,264	Galveston, Ill.	20,945
Atlantic City, N. J.	37,593	Camden, N. J.	83,363	Denison, Texas.	12,700	Galveston, Texas*	38,000
Attleboro, Mass.	12,702	Canton, Ohio.	36,697	Denver, Col.*	180,000	Gardner, Mass.	12,012
Auburn, Me.	14,482	Carbondale, Pa.	15,969	Des Moines, Ia.	75,629	Gary, Ind.*	20,000
Auburn, N. Y.	31,422	Cedar Rapids, Ia.	28,759	Detroit, Mich.	317,591	Geneva, N. Y.	12,249
Augusta, Ga.	45,174	Central Falls, R. I.	19,446	Dover, N. H.	13,494	Glens Falls, N. Y.	14,650
Augusta, Me.	12,723	Charleston, S. C.	56,573	Dubuque, Ia.	41,941	Gloucester, Mass.	26,011
Aurora, Ill.	28,197	Charleston, W. Va.	15,220	Duluth, Minn.	64,942	Glowersville, N. Y.	18,672
Austin, Texas.	29,173	Charlotte, N. C.*	30,000	Dunkirk, N. Y.	15,250	Goldfield, Nev.*	15,000
Baltimore, Md.	591,755	Chattanooga, Tenn.*	50,000	Dunmore, Pa.	16,424	Grand Forks, N. D.	10,127
Bangor, Me.	24,322	Cheney, Mass.	37,289	E. Liverpool, Ohio.	21,462	Grand Rapids, Mich.	95,718
Batavia, N. Y.	10,089	Chester, Pa.	46,394	E. Orange, N. J.	25,175	Great Falls, Mont.*	35,000
Bath, Me.	12,056	Cheyenne, Wyo.*	22,000	E. Providence, R. I.	13,750	Green Bay, Wis.	22,854
Baton Rouge, La.*	25,000	Chicago, Ill.	2,364,075	Easton, Pa.	34,909	Greensboro, N. C.*	20,000
Battle Creek, Mich.	22,213	Chicopee, Mass.	20,191	E. St. Louis, Ill.	42,682	Greenville, S. C.	14,788
Bay City, Mich.	27,644	Chillicothe, Ohio.	14,506	Eau Claire, Wis.	18,737	Guthrie, Okla.*	18,000
Bayonne, N. J.	42,622	Cincinnati, Ohio*	400,000	Elgin, Ill.	26,222	Hackensack, N. J.	11,098
Beaver Falls, Pa.	10,500	Cleveland, Ohio.	515,563	Elizabeth, N. J.	60,509	Hagerstown, Md.	16,717
Belleville, Ill.	19,395	Clinton, Ia.	22,756	Elkhart, Ind.	18,178	Hamilton, Ohio.	29,628
Beloit, Wis.	12,355	Clinton, Mass.	13,105	Elmira, N. Y.	34,687	Hammond, Ind.	18,629

CONCENTRATES

Produced, prepared and treated in our engineering department.



Our experience of over half a century of successful operation is a guarantee of high class, in every detail.



We manufacture mining and ore reduction machinery of every description for every character of work.



We are specialists in hydraulics.



Our shops are new and our equipment the most modern in the West.



If you do not find the information, or value you want in this sample sack of concentrates, write us—we can supply it by the carload.



Address all communications to:

JOSHUA HENDY IRON WORKS

75 Fremont St., San Francisco, Cal.

Useful Information

Useful Numbers in Calculating Weights, Measures, Etc.

Feet multiplied by .00019 equals miles.
Yards multiplied by .0006 equals miles.
Links multiplied by .22 equals yards.
Links multiplied by .66 equals feet.
Foot multiplied by 1.515 equals links.
Square inches multiplied by .00695 equals square feet.
Circular inches multiplied by .00546 equals square feet.
Square feet multiplied by .111 equals square yards.
Acres multiplied by .4840 equals square yards.
Square yards multiplied by .0002066 equals acres.
Width in chains multiplied by .8 equals acres per mile.
Cubic feet multiplied by .03704 equals cubic yards.
Cubic inches multiplied by .00058 equals cubic feet.
U. S. bushels multiplied by .0461 equals cubic yards.
U. S. bushels multiplied by 1.2444 equals cubic feet.
U. S. bushels multiplied by 2150.42 equals cubic inches.
Cubic feet multiplied by .8036 equals U. S. bushels.
Cubic inches multiplied by .000465 equals U. S. bushels.
U. S. gallons multiplied by .13367 equals cubic feet.
U. S. gallons multiplied by .231 equals cubic inches.
Cubic feet multiplied by 7.48 equals U. S. gallons.
Cylindrical feet multiplied by .0034 equals U. S. gallons.
Pounds multiplied by .009 equals cwt.
Pounds multiplied by .00045 equals long tons.
Cubic foot of water multiplied by 62.5 equals lbs. avoird.
Cubic inch of water multiplied by .03608 equals lbs. avoird.
Cylindrical inch of water multiplied by .02842 equals lbs. avoird.
Cylindrical foot of water multiplied by 49.1 equals lbs. avoird.
Cubic inches multiplied by .004329 equals U. S. gallons.
Cylindrical feet multiplied by 5.874 equals U. S. gallons.
U. S. gallons of water multiplied by 13.44 equals one cwt.
U. S. gallons of water multiplied by 268.8 equals one ton.

Cubic feet of water multiplied by 1.8 equals one cwt.
Cubic feet of water multiplied by 35.88 equals one ton.
Cylindrical foot of water multiplied by 5.875 equals U. S. gallons.
Diameter of a circle multiplied by 3.14159265 equals circumference.
Diameter of a circle multiplied by .8862 equals side of an equal square.
Diameter of a circle multiplied by .7071 equals side of an inscribed square.
Square of a diameter multiplied by .7854 equals area of circle.
Circumference of a circle multiplied by .31831 equals diameter.
Side of a square multiplied by 1.128 equals diameter of equal circle.
Square foot of an area multiplied by 1.12837 equals diameter of equal circle.
Square of the diameter of a sphere multiplied by 3.1416 equals convex surface.
Cube of the diameter of a sphere multiplied by .5236 equals solidity.
Diameter of a sphere multiplied by .806 equals dimensions of equal cube.
Diameter of a sphere multiplied by .6667 equals length of equal cylinder.
Cylindrical inches multiplied by .0004546 equals cubic feet.
Cylindrical feet multiplied by .02909 equals cubic yards.
Cubic inches multiplied by .003607 equals imperial gallons.
Cubic feet multiplied by .6232 equals imperial gallons.
Cylindrical inches multiplied by .002832 equals imperial gallons.
Cylindrical feet multiplied by 4.895 equals imperial gallons.
Lineal feet multiplied by .00019 equals statute miles.
Lineal yards multiplied by .000568 equals statute miles.
Column of water 12 inches high, 1 inch in diameter, equals .341 lbs.
183.346 circular inches equals 1 square foot.
2200 cylindrical inches equals 1 cubic foot.
French metres multiplied by 3.28 equals feet.
Kilogrammes multiplied by 2.205 equals avoird. lbs.
Grammes multiplied by .002205 equals avoird. lbs.
Square of diameter of cylinder in feet multiplied by depth in feet and by .14 equals barrels of 42 gallons.

Table of Weights and Measures

LONG MEASURE.

12 inches	1 foot
3 feet	1 yard
2 yards	1 fathom
16½ feet	1 rod
4 rods	1 chain
10 chains	1 furlong
8 furlongs	1 mile
3 miles	1 league

SQUARE MEASURE.

9 square feet	1 square yard
30¼ square yards	1 square rod
40 square rods	1 rood
8 roods	1 acre
640 acres	1 square mile

An acre is 209 square feet.

DRY MEASURE.

2 pints	1 quart
4 quarts	1 peck
4 pecks	1 bushel

LIQUID MEASURE.

4 gills	1 pint
2 pints	1 quart
4 quarts	1 gallon

TROY WEIGHT.

24 grains	1 pennyweight
20 pennyweights	1 ounce
12 ounces	1 pound

AVOIRDUPOIS WEIGHT.

16 drams	1 ounce
16 ounces	1 pound
25 pounds	1 quarter
4 quarters	1 hundred
20 hundreds	1 ton

APOTHECARIES WEIGHT.

20 grains	1 scruple
3 scruples	1 dram
8 drams	1 ounce
12 ounces	1 pound

TIME MEASURE.

60 seconds	1 minute
60 minutes	1 hour
24 hours	1 day
7 days	1 week
52 weeks	} 1 year
12 calendar months	
365 days	

CUBIC MEASURE.

1728 cubic inches	1 cubic foot
27 cubic feet	1 cubic yard
16 cubic feet	1 cord foot
8 cord feet	} 1 cord
128 cubic feet	

LAND MEASURE.

7.92 inches	1 link
25 links	1 rod
4 rods	1 chain
80 chains	1 mile

CIRCULAR MEASURE.

60 seconds	1 minute
60 minutes	1 degree
30 degrees	1 sign
60 degrees	1 sextant
90 degrees	1 quadrant
360 degrees	1 circle

TABLE OF QUANTITIES.

12 units	1 dozen
12 dozen	1 gross
20 units	1 score
24 sheets	1 quire
20 quires	1 ream

GENERAL MEASURE.

A mile	5280 feet
A knot	6080.26 feet
A cubit	2 feet
A pace	3 feet
A palm	3 inches
A hand	4 inches
A span	9 inches

Metric System

MEASURES OF WEIGHT.

(Unit Gramme.)

	Grains.	Oz. Troy	Lbs. Avoir.	Cwt.
Centigramme	0.15432			
Decigramme	1.54323	0.003		
Gramme	15.43235	0.032	0.002	
Decagramme	154.32349	0.321	0.022	
Hectogramme	1543.23488	3.215	0.220	0.001
Kilogramme	15432.34880	32.150	2.204	0.019

MEASURES OF LENGTH.

(Unit Metre.)

	Inches.	Feet	Yards	Miles
Millimetre	0.03937	0.003	0.001	
Centimetre	0.39371	0.032	0.010	
Decimetre	3.93708	0.328	0.109	
Metre	39.37079	3.280	1.093	
Decametre	393.70790	32.808	10.936	0.006
Hectometre	3937.07909	328.089	109.363	0.062
Kilometre	39370.79000	3280.899	1093.633	0.621

CONVENIENT MULTIPLES FOR CONVERSION.

To Convert

	Multiply by	
Grains to Grammes	0.065	
Ounces to Grammes	28.35	
Pounds to Grammes	453.6	
Pounds to Kilogrammes	45	
Cwts. to Kilogrammes	50.8	
Tons to Kilogrammes	1016.	
Grammes to Grains	15.4	
Grammes to Ounces	0.35	
Kilogrammes to Ounces	35.3	
Kilogrammes to Pounds	2.2	
Kilogrammes to Cwts.	0.2	
Kilogrammes to Tons	0.001	
Inches to Millimetres	25.4	
Inches to Centimetres	2.54	
Feet to Metres	3048	
Yards to Metres	9144	
Yards to Kilometres	0.009	
Miles to Kilometres	1.6	
Millimetres to Inches	0.04	
Centimetres to Inches	4	
Metres to Feet	3.3	
Metres to Yards	1.1	
Kilometres to Yards	1093.6	
Kilometres to Miles	0.62	
1 Yard=0.9144 metre.		1 Sq. Metre=1.196 sq. yd.
		1 Litre=1.760 Pints or 0.22 Gals.

Weights of Flat Iron

Per lineal-foot in pounds.

Thickness in inches.

Width in Inch.	¼	⅜	½	¾	⅞	1	1¼	1½	1¾	2
½	.422	.52	.634	.....	.....	.....	.....	.....	.....	.....
¾	.633	.79	.950	1.26	1.58	.....	.....	.....	.....	.....
1	.830	1.05	1.25	1.67	2.08	2.50	2.92	3.33	4.17	5.00
1¼	.930	1.18	1.40	1.87	2.34	2.81	3.38	3.75	4.75	5.70
1½	1.04	1.32	1.56	2.08	2.60	3.12	3.64	4.17	5.21	6.25
1⅞	1.14	1.45	1.71	2.29	2.86	3.40	4.01	4.58	5.77	6.97
1½	1.25	1.58	1.88	2.50	3.13	3.75	4.38	5.00	6.25	7.50
1¾	1.46	1.84	2.19	2.92	3.65	4.37	5.10	5.83	7.29	8.75
2	1.67	2.11	2.50	3.33	4.17	5.00	5.83	6.67	8.33	10.00
2¼	1.88	2.37	2.81	3.75	4.69	5.63	6.56	7.50	9.37	11.25
2½	2.08	2.63	3.12	4.17	5.21	6.25	7.29	8.33	10.42	12.50
2¾	2.29	2.89	3.44	4.59	5.73	6.87	8.02	9.17	11.46	13.75
3	2.50	3.16	3.75	5.00	6.25	7.50	8.75	10.00	12.50	15.00
3¼	2.70	3.42	4.06	5.41	6.77	8.12	9.47	10.83	13.65	16.47
3½	2.92	3.68	4.38	5.83	7.29	8.75	10.21	11.67	14.58	17.50
3¾	3.11	3.95	4.58	6.25	7.80	9.37	10.93	12.50	15.75	19.00
4	3.33	4.21	5.00	6.67	8.33	10.00	11.67	13.33	16.67	20.00
4½	3.75	4.74	5.63	7.50	9.38	11.25	13.13	15.00	18.75	22.50
5	4.17	5.26	6.25	8.34	10.42	12.50	14.59	16.67	20.84	25.00
6	5.00	6.32	7.50	10.00	12.50	15.00	17.50	20.00	25.01	30.00
7	5.83	7.29	8.75	11.67	14.58	17.50	20.42	23.33	29.18	35.00
8	6.67	8.33	10.00	13.33	16.67	20.00	23.33	26.67	33.35	40.00
10	8.33	10.41	12.50	16.67	20.83	25.00	29.17	33.33	41.63	50.00
12	10.00	12.50	15.00	20.00	25.00	30.00	35.00	40.00	50.01	60.00

Weights of Iron and Steel

U. S. STANDARD GAUGE

Adopted by the U. S. Government July 1, 1893.

No. of Gauge.	Thickness in Inches.		Weight per Square Foot.	No. of Gauge.	Thickness in Inches.		Weight per Square Foot.
	Fraction.	Decimals.			Fraction.	Decimals.	
0000000	1/16	.5	20.00	12	7/16	.4375	4.375
000000	1/8	.468	18.75	13	3/8	.375	3.75
00000	3/16	.437	17.50	14	5/16	.3125	3.125
0000	1/4	.406	16.25	15	3/8	.375	2.8125
000	5/16	.375	15.	16	1/2	.5	.062
00	3/8	.343	13.75	17	5/8	.625	.056
0	1/2	.312	12.50	18	3/4	.75	.05
1	5/8	.281	11.25	19	7/8	.875	.043
2	3/4	.265	10.625	20	1	1.0	.037
3	7/8	.25	10.	21	1 1/8	1.125	.034
4	1	.234	9.375	22	1 1/4	1.25	.031
5	1 1/8	.218	8.75	23	1 3/8	1.375	.028
6	1 1/4	.203	8.125	24	1 1/2	1.5	.025
7	1 1/2	.187	7.5	25	1 5/8	1.625	.021
8	1 3/4	.171	6.875	26	1 3/4	1.75	.018
9	1 7/8	.156	6.25	27	1 7/8	1.875	.017
10	2	.140	5.625	28	2	2.0	.015
11	2 1/8	.125	5.	30	2 1/8	2.125	.012

BIRMINGHAM GAUGE

No. of Gauge.	Thick-ness in Inches	Weight Square Foot	
		Iron.	Steel.
0000	.454	18.22	18.46
000	.425	17.05	17.28
00	.38	15.25	15.45
0	.34	13.64	13.82
1	.3	12.04	12.20
2	.284	11.40	11.55
3	.259	10.39	10.53
4	.238	9.55	9.68
5	.22	8.83	8.95
6	.203	8.15	8.25
7	.18	7.22	7.32
8	.165	6.62	6.71
9	.148	5.94	6.02
10	.134	5.38	5.45
11	.12	4.82	4.88
12	.109	4.37	4.43
13	.095	3.81	3.86
14	.083	3.33	3.37
15	.072	2.89	2.93
16	.065	2.61	2.64
17	.058	2.33	2.36
18	.049	1.97	1.99
19	.042	1.69	1.71
20	.035	1.40	1.42
21	.032	1.28	1.30
22	.028	1.12	1.14
23	.025	1.00	1.02
24	.022	.883	.895
25	.02	.803	.813
26	.018	.722	.732
27	.016	.642	.651
28	.014	.562	.569
29	.013	.....	.....
30	.012	.....	.....
31	.01	.....	.....

The U. S. Standard Gauge is the one commonly used in the United States.

Weights of Round and Square Steel per Lineal Foot

(Based on 489.6 lbs. per cubic foot).

SIZE. Inches.	Wt. of Round 1 ft. lg.	Wt. of Square 1 ft. lg.	SIZE. Inches.	Wt. of Round 1 ft. lg.	Wt. of Square 1 ft. lg.	SIZE. Inches.	Wt. of Round 1 ft. lg.	Wt. of Square 1 ft. lg.	SIZE. Inches.	Wt. of Round 1 ft. lg.	Wt. of Square 1 ft. lg.				
0	$\frac{1}{32}$	.0026	.0033	2	$\frac{1}{16}$	10.68	13.60	4	$\frac{1}{16}$	42.73	54.40	6	$\frac{1}{16}$	96.14	122.4
"	$\frac{1}{16}$	.0104	.0133	"	$\frac{1}{8}$	11.36	14.46	"	$\frac{1}{8}$	44.07	56.11	"	$\frac{1}{8}$	98.14	125.0
"	$\frac{3}{16}$	.0417	.0531	"	$\frac{3}{16}$	12.06	15.35	"	$\frac{3}{16}$	45.44	57.85	"	$\frac{3}{16}$	100.2	127.6
"	$\frac{1}{4}$	.0938	.1195	"	$\frac{1}{2}$	12.78	16.27	"	$\frac{1}{2}$	46.83	59.62	"	$\frac{1}{2}$	102.2	130.2
"	$\frac{5}{16}$	.1669	.2123	"	$\frac{5}{16}$	13.52	17.22	"	$\frac{5}{16}$	48.24	61.41	"	$\frac{5}{16}$	104.3	132.8
"	$\frac{3}{8}$	.2608	.3333	"	$\frac{3}{4}$	14.28	18.19	"	$\frac{3}{4}$	49.66	63.23	"	$\frac{3}{4}$	106.4	135.5
"	$\frac{7}{16}$	.3756	.4782	"	$\frac{7}{16}$	15.07	19.18	"	$\frac{7}{16}$	51.11	65.08	"	$\frac{7}{16}$	108.5	138.2
"	$\frac{1}{2}$	.5111	.6508	"	$\frac{1}{2}$	15.86	20.20	"	$\frac{1}{2}$	52.58	66.95	"	$\frac{1}{2}$	110.7	140.9
"	$\frac{9}{16}$	.6676	.8500	"	$\frac{1}{2}$	16.69	21.25	"	$\frac{1}{2}$	54.07	68.85	"	$\frac{1}{2}$	112.8	143.6
"	$\frac{5}{8}$	.8449	1.076	"	$\frac{1}{2}$	17.53	22.33	"	$\frac{1}{2}$	55.59	70.78	"	$\frac{1}{2}$	114.9	146.5
"	$\frac{3}{4}$	1.043	1.328	"	$\frac{1}{2}$	18.40	23.43	"	$\frac{1}{2}$	57.12	72.73	"	$\frac{1}{2}$	117.2	149.2
"	$\frac{7}{8}$	1.262	1.608	"	$\frac{1}{2}$	19.29	24.56	"	$\frac{1}{2}$	58.67	74.70	"	$\frac{1}{2}$	119.4	152.1
"	$\frac{3}{4}$	1.502	1.913	"	$\frac{3}{4}$	20.20	25.00	"	$\frac{3}{4}$	60.25	76.71	"	$\frac{3}{4}$	121.7	154.9
"	$\frac{13}{16}$	1.763	2.245	"	$\frac{13}{16}$	21.12	26.90	"	$\frac{13}{16}$	61.84	78.74	"	$\frac{13}{16}$	123.9	157.8
"	$\frac{7}{8}$	2.044	2.603	"	$\frac{7}{8}$	22.07	28.10	"	$\frac{7}{8}$	63.46	80.81	"	$\frac{7}{8}$	126.2	160.8
"	$\frac{15}{16}$	2.347	2.989	"	$\frac{15}{16}$	23.04	29.34	"	$\frac{15}{16}$	65.10	82.89	"	$\frac{15}{16}$	128.5	163.6
1		2.670	3.400	3		24.03	30.60	5		66.76	85.00	7		130.9	166.6
"	$\frac{1}{16}$	3.014	3.838	"	$\frac{1}{16}$	25.04	31.89	"	$\frac{1}{16}$	68.44	87.14	"	$\frac{1}{8}$	135.6	172.6
"	$\frac{1}{8}$	3.379	4.303	"	$\frac{1}{8}$	26.08	33.20	"	$\frac{1}{8}$	70.14	89.30	"	$\frac{1}{4}$	140.4	178.7
"	$\frac{3}{16}$	3.766	4.795	"	$\frac{3}{16}$	27.13	34.55	"	$\frac{3}{16}$	71.86	91.49	"	$\frac{3}{8}$	145.3	184.9
"	$\frac{1}{4}$	4.173	5.312	"	$\frac{1}{4}$	28.20	35.92	"	$\frac{1}{4}$	73.60	93.72	"	$\frac{1}{2}$	150.2	191.3
"	$\frac{5}{16}$	4.600	5.857	"	$\frac{5}{16}$	29.30	37.31	"	$\frac{5}{16}$	75.37	95.96	"	$\frac{5}{8}$	155.2	197.7
"	$\frac{3}{8}$	5.019	6.428	"	$\frac{3}{8}$	30.42	38.73	"	$\frac{3}{8}$	77.15	98.23	"	$\frac{3}{4}$	160.3	204.2
"	$\frac{7}{16}$	5.518	7.026	"	$\frac{7}{16}$	31.56	40.18	"	$\frac{7}{16}$	78.95	100.5	"	$\frac{7}{8}$	165.6	210.8
"	$\frac{1}{2}$	6.008	7.650	"	$\frac{1}{2}$	32.71	41.65	"	$\frac{1}{2}$	80.77	102.8	8		171.0	217.6
"	$\frac{9}{16}$	6.520	8.301	"	$\frac{9}{16}$	33.90	43.14	"	$\frac{9}{16}$	82.62	105.2	"	$\frac{1}{8}$	176.3	224.5
"	$\frac{5}{8}$	7.051	8.978	"	$\frac{5}{8}$	35.09	44.68	"	$\frac{5}{8}$	84.49	107.6	"	$\frac{1}{4}$	181.8	231.4
"	$\frac{11}{16}$	7.604	9.682	"	$\frac{11}{16}$	36.31	46.24	"	$\frac{11}{16}$	86.38	110.0	"	$\frac{3}{8}$	187.3	238.5
"	$\frac{3}{4}$	8.178	10.41	"	$\frac{3}{4}$	37.56	47.82	"	$\frac{3}{4}$	88.29	112.4	"	$\frac{1}{2}$	193.0	245.6
"	$\frac{13}{16}$	8.773	11.17	"	$\frac{13}{16}$	38.81	49.42	"	$\frac{13}{16}$	90.22	114.9	"	$\frac{5}{8}$	198.7	252.9
"	$\frac{7}{8}$	9.388	11.95	"	$\frac{7}{8}$	40.10	51.05	"	$\frac{7}{8}$	92.17	117.4	"	$\frac{3}{4}$	204.4	260.3
"	$\frac{15}{16}$	10.02	12.76	"	$\frac{15}{16}$	41.40	52.71	"	$\frac{15}{16}$	94.14	119.9	"	$\frac{7}{8}$	210.3	267.9

These figures represent the theoretical weights of steel. Iron will run about 2 per cent lighter.

GENERAL RULE.

For round iron, the weight per foot may be found by taking the diameter in quarter inches, squaring it, and dividing by 6.

EXAMPLE.

What is the weight of 2" round iron?

$$2'' = 8 \text{ quarter inches. } 8^2 = 64.$$

$$\frac{64}{6} = 10\frac{2}{3} \text{ lbs. per foot of 2'' round.}$$

The above rule is highly convenient, and enables mental calculations of weight to be made quickly and accurately.

EXAMPLE.

What is the weight of $\frac{3}{4}$ " round iron?

$$\frac{3}{4}'' = 3 \text{ quarter inches. } 3^2 = 9.$$

$$\frac{9}{6} = 1\frac{1}{2} \text{ lbs. per foot of } \frac{3}{4}'' \text{ round.}$$

Circumferences and Areas of Circles.

Diam.	Circumference.	Area.	Diam.	Circumference.	Area.	Diam.	Circumference.	Area.
$\frac{1}{8}$	.008	.0007	9	28.27	63.61	47	147.65	1734.94
$\frac{1}{8}$	.196	.0030	$\frac{1}{4}$	29.05	67.20	48	150.80	1809.56
$\frac{1}{8}$	.392	.0122	$\frac{1}{2}$	29.84	70.88	49	153.94	1885.74
$\frac{1}{4}$	.589	.0276	$\frac{3}{4}$	30.63	74.66	50	157.08	1963.50
$\frac{1}{4}$	.785	.0490	10	31.41	78.53	51	160.22	2042.82
$\frac{3}{8}$	.981	.0766	$\frac{1}{4}$	32.20	82.51	52	163.36	2123.72
$\frac{3}{8}$	1.178	.1104	$\frac{1}{2}$	32.98	86.59	53	166.50	2206.18
$\frac{1}{2}$	1.374	.1503	$\frac{3}{4}$	33.77	90.76	54	169.65	2290.22
$\frac{1}{2}$	1.570	.1963	11	34.55	95.03	55	172.79	2375.83
$\frac{5}{8}$	1.767	.2485	$\frac{1}{4}$	35.34	99.40	56	175.93	2463.01
$\frac{5}{8}$	1.963	.3067	$\frac{1}{2}$	36.12	103.86	57	179.07	2551.76
$\frac{3}{4}$	2.159	.3712	$\frac{3}{4}$	36.91	108.43	58	182.21	2642.08
$\frac{3}{4}$	2.356	.4417	12	37.69	113.09	59	185.35	2733.97
$\frac{7}{8}$	2.552	.5184	$\frac{1}{4}$	38.48	117.85	60	188.50	2827.43
$\frac{7}{8}$	2.748	.6013	$\frac{1}{2}$	39.27	122.71	61	191.64	2922.47
$\frac{1}{1}$	2.945	.6902	$\frac{3}{4}$	40.05	127.67	62	194.78	3019.07
1	3.141	.7854	13	40.84	132.73	63	197.92	3117.25
$\frac{1}{4}$	3.534	.9940	$\frac{1}{4}$	41.62	137.88	64	201.06	3216.99
$\frac{1}{4}$	3.927	1.227	$\frac{1}{2}$	42.41	143.13	65	204.20	3318.31
$\frac{3}{8}$	4.319	1.484	$\frac{3}{4}$	43.19	148.48	66	207.34	3421.19
$\frac{3}{8}$	4.712	1.767	14	43.98	153.93	67	210.49	3525.65
$\frac{5}{8}$	5.105	2.073	$\frac{1}{4}$	44.76	159.48	68	213.63	3631.68
$\frac{5}{8}$	5.497	2.405	$\frac{1}{2}$	45.55	165.13	69	216.77	3739.28
$\frac{3}{4}$	5.890	2.761	$\frac{3}{4}$	46.33	170.87	70	219.91	3848.25
2	6.283	3.141	15	47.12	176.78	71	223.05	3959.19
$\frac{1}{4}$	6.675	3.546	16	50.26	201.06	72	226.19	4071.50
$\frac{1}{4}$	7.068	3.976	17	53.40	226.98	73	229.34	4185.39
$\frac{3}{8}$	7.461	4.430	18	56.54	254.47	74	232.48	4300.84
$\frac{3}{8}$	7.854	4.908	19	59.69	283.53	75	235.62	4417.86
$\frac{5}{8}$	8.246	5.411	20	62.83	314.16	76	238.76	4536.46
$\frac{5}{8}$	8.639	5.939	21	65.97	346.36	77	241.90	4656.63
$\frac{7}{8}$	9.032	6.491	22	69.11	380.13	78	245.04	4778.36
3	9.424	7.068	23	72.25	415.48	79	248.19	4901.67
$\frac{1}{4}$	10.21	8.295	24	75.39	452.39	80	251.33	5026.55
$\frac{1}{4}$	10.99	9.621	25	78.54	490.87	81	254.07	5153.00
$\frac{3}{4}$	11.78	11.044	26	81.68	530.93	82	257.61	5281.02
4	12.56	12.566	27	84.82	572.56	83	260.75	5410.61
$\frac{1}{4}$	13.35	14.186	28	87.96	615.75	84	263.89	5541.77
$\frac{1}{2}$	14.13	15.904	29	91.10	660.52	85	267.04	5674.50
$\frac{3}{4}$	14.92	17.720	30	94.24	706.86	86	270.18	5808.80
5	15.70	19.635	31	97.38	754.77	87	273.32	5944.68
$\frac{1}{4}$	16.49	21.647	32	100.53	804.25	88	276.46	6082.12
$\frac{1}{2}$	17.27	23.758	33	103.67	855.30	89	279.60	6221.14
$\frac{3}{4}$	18.06	25.967	34	106.81	907.92	90	282.74	6361.73
6	18.84	28.274	35	109.96	962.11	91	285.88	6503.88
$\frac{1}{4}$	19.63	30.679	36	113.10	1017.88	92	289.03	6647.61
$\frac{1}{2}$	20.42	33.183	37	116.24	1075.21	93	292.17	6792.91
$\frac{3}{4}$	21.20	35.784	38	119.38	1134.11	94	295.31	6939.78
7	21.99	38.484	39	122.52	1194.59	95	298.45	7088.22
$\frac{1}{4}$	22.77	41.282	40	125.66	1256.64	96	301.59	7238.23
$\frac{1}{2}$	23.56	44.178	41	128.81	1320.25	97	304.73	7389.81
$\frac{3}{4}$	24.34	47.173	42	131.95	1385.44	98	307.88	7542.96
8	25.13	50.265	43	135.09	1452.20	99	311.02	7697.69
$\frac{1}{4}$	25.91	53.456	44	138.23	1520.53	100	314.16	7853.98
$\frac{1}{2}$	26.70	56.745	45	141.37	1590.43	101	317.30	8011.85
$\frac{3}{4}$	27.48	60.132	46	144.51	1661.90	102	320.44	8171.28

Workshop Recipes

BRAZING.—The edges filed or scraped clean and bright, covered with spelter and powdered borax, and exposed in a clear fire to a heat sufficient to melt the solder.

CASE HARDENING WITH PRUSSATE OF POTASH.—Heat the articles, after polishing, to a bright red, rub the surface over with prussiate of potash, allow it to cool to a dull red, and immerse it in water.

CASE HARDENING MIXTURES.—Three parts of prussiate of potash to one part of sal ammoniac, mixed; or two parts of sal ammoniac, two parts of bone dust, and one part of prussiate of potash.

MIXTURE FOR WELDING STEEL.—One part of sal ammoniac and ten parts of borax pounded together and fused until clear, when it is poured out, and when cool reduced to powder.

TEMPERING STEEL.—Steel in its hardest state being too brittle for most purposes, the requisite strength and elasticity are obtained by tempering—or letting down the temper, as it is termed—which is performed by heating the hardened steel to a certain degree and cooling it quickly. The requisite heat is usually ascertained by the color which the surface of the steel assumes from the film of oxide thus formed. The degrees of heat to which these several colors correspond are as follows:

At 430, a very faint yellow. At 450, a pale straw color.

Suitable for hard instruments; as hammer faces, drills, etc.

At 470, a full yellow. At 490, a brown color.

For instruments requiring hard edges without elasticity; as shears, scissors, turning tools, etc.

At 510, brown, with purple spots. At 53S, purple.

For tools, for cutting wood and soft metals; such as plane-irons, knives, etc.

At 550, dark blue. At 560, full blue.

For tools requiring strong edges without extreme hardness; as cold chisels, axes, cutlery, etc.

At 600, grayish blue, verging on black.

For spring temper, which will bend before breaking; as saws, sword blades, etc.

If the steel is heated higher than this, the effect of the hardening process is destroyed.

ANNEALING STEEL.—For small pieces of steel, take a piece of gas-pipe two or three inches in diameter, and put the pieces in it, first heating one end of the pipe, and drawing it together, leaving the other end open to look into. When the pieces are of a cherry red, cover the fire with sawdust, use a charcoal fire, and leave the steel in over night.

TO RENEW WORN FILES.—Thoroughly cleanse them from grease or oil with alkali, then dip them in a solution made with one part nitric acid, three parts sulphuric acid, seven parts water by weight; time, five seconds to five minutes, according to fineness of cut. Wash in hot water, dip in lime water, dry and oil them.

Specially Useful to Engineers in the Mining Districts.

CEMENT FOR CAST IRON.—Two ounces sal ammoniac, one ounce sulphur and sixteen ounces of borings or filings of cast iron, to be mixed well in a mortar and kept dry. When required for use, take one part of this powder to twenty parts of clear iron borings or filings, mix

Workshop Recipes

(Continued)

thoroughly in a mortar; make the mixture into a stiff paste with a little water, and then it is ready for use. A little fine grindstone sand improves the cement.

RED LEAD CEMENT FOR FACE JOINTS.—Equal parts of white and red lead mixed with linseed oil to the consistency.

CEMENT—STEAM BOILER.—Litharge in fine powder two parts, very fine sand and quicklime (that has been allowed to slack spontaneously in a damp place), of each one part; mix, and keep it from the air.

Used to mend cracks in boilers and to secure steam joints.

It is made into a paste with boiled oil before application.

CEMENT—STEAM PIPE.—Good linseed-oil varnish is ground with equal weights of white lead, oxide of manganese and pipe clay.

CEMENT—HYDRAULIC.—Made by slaking lime with water containing about two per cent. of gypsum and adding a little sand to the product.

The presence of the gypsum tends to delay the slaking of the lime, and also to harden the substance formed after the slaking.

CEMENT—CUTLERS'.—Black resin four parts, beeswax one part, finely powdered brickdust one part; mix well. Used to fix tools into their handles.

CEMENT—LEATHER.—Cutta-percha one pound, caoutchouc four ounces, pitch two ounces, shellac one ounce, linseed oil two ounces, melted together; must be melted before being applied.

Used for uniting leather or rubber.

SOLDERS.—For Lead, one of tin and one and one-half of lead.

For Tin, one of tin, and two of lead.

For Pewter, two of tin and one of lead.

For Brazing (hardest), three of copper and one of zinc.

For Brazing (hard), one of copper and one of zinc.

For Brazing (soft), one of tin, four of copper and three of zinc; or two of tin and one of antimony.

FLUXES FOR SOLDERING OR WELDING.—For Iron or Steel, borax or sal ammoniac.

For Tinned Iron, resin or chloride of zinc.

For Copper and Brass, sal ammoniac or chloride of zinc.

For Zinc, chloride of zinc.

For Lead, tallow or resin.

For Lead and Tin Pipes, resin and sweet oil.

TO HARDEN CAST IRON.—Many times it is very convenient to make an article of cast iron that needs to be finished, and which should be very hard. Cast iron can be hardened as easily as steel, and to such a degree of hardness that a file will not touch it. Take one-half pint of vitriol, one peck of common salt, one-half pound of saltpeter, two pounds of alum, one-quarter pound prussic potash, one-quarter pound cyanide of potash, all to be dissolved in ten gallons of soft water. Be sure that all the articles are dissolved. Heat the iron to a cherry red and dip it in the solution. If the article needs to be very hard, heat and dip the second time, and even the third time.

Workshop Recipes

(Continued)

TO INSCRIBE METAL.—Cover the part with melted beeswax; when cold, write what you desire plainly in the wax clean to the metal with scribe, then apply a mixture of $\frac{1}{2}$ oz. nitric acid, 1 oz. muriatic acid, with a feather, carefully fill each letter; let it remain from one to ten minutes, according to appearance desired, then throw on water to stop the process of cutting, heat wax to remove it, and you have your inscription.

TO KEEP MACHINERY FROM RUSTING.—Take one ounce of camphor and dissolve it in one pound of melted lard; take off the scum, and mix in as much fine black as will give it iron color. Clean the machinery and smear it with the mixture. After twenty-four hours rub clean with a soft linen cloth. It will keep clean for months under ordinary circumstances.

TO REMOVE RUST FROM STEEL.—Steel which has been rusted can be cleaned by brushing with a paste compound of $\frac{1}{2}$ oz. cyanide potassium, $\frac{1}{2}$ oz. castile soap, 1 oz. whiting, and water sufficient to form a paste. The steel should be washed with a solution of $\frac{1}{2}$ oz. cyanide potassium in 2 oz. water.

RUST JOINT, QUICK SETTING.—Take flour of sulphur, two pounds, powdered sal ammoniac one pound, iron filings eighty pounds; mix to a paste with water.

RUST JOINT, SLOW SETTING.—Take flour of sulphur one pound, powdered sal ammoniac two pounds, iron filings or borings, two hundred pounds. This is much the better joint, if time can be given to set.

HOW TO MIX PAINTS FOR TINTS.

Mixing Red and Black makes.....	Brown
Mixing Lake and White makes.....	Rose
Mixing White and Brown makes.....	Chestnut
Mixing White, Blue and Lake makes.....	Purple
Mixing Blue and Lead Color makes.....	Pearl
Mixing White and Carmine makes.....	Pink
Mixing Indigo and Lamp-Black makes.....	Silver Gray
Mixing White and Lamp-Black makes.....	Lead Color
Mixing Black and Venetian Red makes.....	Chocolate
Mixing White and Green makes.....	Bright Green
Mixing Purple and White makes.....	French White
Mixing Light Green and Black makes.....	Dark Green
Mixing White and Green makes.....	Pea Green
Mixing White and Emerald Green makes.....	Brilliant Green
Mixing Red and Yellow makes.....	Orange
Mixing White and Yellow makes.....	Straw Color
Mixing White, Blue and Black makes.....	Pearl Gray
Mixing White, Lake and Vermilion makes.....	Flesh Color
Mixing Umber, White and Venetian Red makes.....	Drab
Mixing White, Yellow and Venetian Red makes.....	Cream
Mixing Red, Blue, Black and Red makes.....	Olive
Mixing Yellow, White and a little Venetian Red makes.....	Buff

Approximate Cost of Erecting Mill Buildings Exclusive of Power House

FREE MILLING	5 STAMPS	WITH CONCENTRATORS	
Lumber, 32 M. ft. at \$25.00.....	\$800.00	Lumber, 38 M. ft. at \$25.00.....	\$950.00
Labor, at \$25.00 per M. ft.....	800.00	Labor, at \$25.00 per M. ft.....	950.00
Labor, setting machinery.....	156.00	Labor, setting machinery.....	187.00
Shingle roof*.....	105.00	Shingle roof*.....	204.00
Hardware.....	45.00	Hardware.....	60.00
Windows, 12.....	53.00	Windows, 18.....	80.00
	\$1,959.00		\$2,431.00

10 STAMPS

Lumber, 52 M. ft. at \$25.00.....	\$1,300.00	Lumber, 60 M. ft. at \$25.00.....	\$1,500.00
Labor, at \$25.00 per M. ft.....	1,300.00	Labor, at \$25.00 per M. ft.....	1,500.00
Labor, setting machinery.....	315.00	Labor, setting machinery.....	375.00
Shingle roof*.....	145.00	Shingle roof*.....	250.00
Hardware.....	62.00	Hardware.....	95.00
Windows, 16.....	71.00	Windows, 20.....	88.00
	\$3,193.00		\$3,808.00

20 STAMPS

Lumber, 63 M. ft. at \$25.00.....	\$1,575.00	Lumber, 85 M. ft. at \$25.00.....	\$2,125.00
Labor, at \$25.00 per M. ft.....	1,575.00	Labor, at \$25.00 per M. ft.....	2,125.00
Labor, setting machinery.....	470.00	Labor, setting machinery.....	562.00
Shingle roof*.....	250.00	Shingle roof*.....	440.00
Hardware.....	77.00	Hardware.....	255.00
Windows, 20.....	88.00	Windows, 26.....	115.00
	\$4,035.00		\$5,622.00

30 STAMPS

Lumber, 90 M. ft. at \$25.00.....	\$2,250.00	Lumber, 106 M. ft. at \$25.00.....	\$2,650.00
Labor, at \$25.00 per M. ft.....	2,250.00	Labor, at \$25.00 per M. ft.....	2,650.00
Labor, setting machinery.....	550.00	Labor, setting machinery.....	750.00
Shingle roof*.....	330.00	Shingle roof*.....	605.00
Hardware.....	220.00	Hardware.....	320.00
Windows, 24.....	106.00	Windows, 30.....	132.00
	\$5,706.00		\$7,107.00

40 STAMPS

Lumber, 108 M. ft. at \$25.00.....	\$2,700.00	Lumber, 130 M. ft. at \$25.00.....	\$3,250.00
Labor, at \$25.00 per M. ft.....	2,700.00	Labor, at \$25.00 per M. ft.....	\$3,250.00
Labor, setting machinery.....	715.00	Labor, setting machinery.....	875.00
Shingle roof*.....	430.00	Shingle roof*.....	770.00
Hardware.....	319.00	Hardware.....	390.00
Windows, 28.....	125.00	Windows, 34.....	150.00
	\$6,989.00		\$8,685.00

* Add 20 per cent. to roof item for No. 26 corrugated iron roofing.

Amount of Material Required for Buildings

SHINGLES.—250 to 1 bundle. 4 bundles = 1,000 shingles, will cover 100 sq. ft. of surface, laid 4" to the weather.

1 bundle of 16" shingles will cover 30 sq. ft., while the same number of 18" shingles will cover 33 sq. ft. when laid 5½" to the weather.

LATH.—1,000 laths will cover 70 sq. yds. of surface.

SHAKES.—1,000 shakes, 6"x36", laid 16" to the weather, will cover 650 sq. ft. of surface; add for doubling top and bottom courses one extra shake for each ft. in the length of roof.

CORRUGATED GALVANIZED ROOFING.—Size of sheets, 26 inches by from 6 to 10 ft. flat steel, made corrugated with corrugations about 1" in depth and 5" between centers of corrugations, laying 24" wide, with from 3" to 6" lap, according to pitch of roof, weigh about one-third more than flat sheets of same area.

For roofing, No. 24 is more generally used, while No. 26 is used for siding. Tack with wire nails on ends only and lap one corrugation on sides and from one to two inches on ends. The nail heads are sometimes soldered to assure absolute impermeability. The usual method, however, is to place lead washers under the heads.

LUMBER.—When computing the amount of material required to cover a specified area, add to the area:

For 1"x6" tongue and groove,	20%.
" 1"x4" "	" "
" 1"x4" " "	25%.
" 1"x4" " "	" "
" rustic,	25%.
" kiln dried,	30%.

NAILS.—For 1,000 shingles allow 4 lbs. of 4d nails or 3½ lbs. of 3d nails.

For 1,000 lath allow 6 lbs. 3d fine nails.

" 1,000 ft. of clapboarding allow 18 lbs. of 6d box nails.

" 1,000 ft. of board siding allow 20 lbs. 8d or 25 lbs. 10d common nails.

" 10 ft. of partition studding allow 1 lb. of 10d common nails.

" 1,000 ft. of 1"x3" flooring allow 45 lbs. 10d common nails.

" 1,000 ft. of 1"x2" flooring allow 65 lbs. 10d common nails.

" 1,000 ft. of pine finish allow 30 lbs. of 8d wire nails.

BRICK.—A 4½" wall requires 7 brick per sq. ft. of surface

9"	"	"	14	"	"	"	"
13"	"	"	20	"	"	"	"
18"	"	"	26½	"	"	"	"
21"	"	"	33	"	"	"	"
27"	"	"	39½	"	"	"	"

The weight of brickwork is 112 pounds per cu. ft.

Laid brick will crush at 500 lbs. per sq. in. or at 72,000 lbs. per sq. ft.

Fire brick weighs 150 lbs. per cu. ft.

Cement concrete weighs 140 lbs. per cu. ft.

A bricklayer should average 1,500 bricks in 8 hours, and 2,000 to 2,400 when starting wall before staging or ladder is used. Staging is used above 4 ft.

Brick at \$10.00 and labor at \$7.50 per 1,000 should be considered good work.

CONCRETE.

Formula No. 1.

For retaining walls and machinery foundations.

60 cu. ft. of rock that will pass a 3-inch mesh screen.

20 cu. ft. of clean, sharp, coarse sand.

10 cu. ft. of Portland cement.

Formula No. 2.

For concrete mortar blocks for stamp batteries.

52 cu. ft. of rock.

32 cu. ft. of sand.

16 cu. ft. of cement.

If broken rock is not available, clean creek gravel of the same size may be substituted, but in no case use clay, loam or very fine sand.

Mix all together dry. When required for use, mix small quantities with sufficient water to make a thick mortar, use immediately and tamp with a tamping bar.

Concrete will set sufficiently in 24 hours to sustain a load, and in from three to four days in medium dry weather machinery may be run on the foundations.

Water and Pumping

A United States gallon of fresh water weighs 8.33 pounds and contains 231 cubic inches.

A cubic foot of water weighs 62.4 pounds and contains 1728 cubic inches, or 7.5 gallons.

A British Imperial gallon contains 277.27 cubic inches, which is equivalent to 1.20 United States gallons, or 10 pounds in weight.

The normal pressure of the atmosphere is 14.7 pounds per square inch; it is equal to a column of water 34 feet high, though 20 feet is the greatest suction lift it is advisable to use.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434. To find the head in feet, multiply the pressure in pounds by 2.31.

The term "head" in connection with pumps is understood to be the sum of the actual elevation and the friction head. The elevation, or lift, is the vertical distance from the surface of the suction water to the center of the discharge outlet.

Friction is that due to the passage of water through the suction and discharge pipes.

In practice, the size of the suction and discharge pipes is usually larger than the openings in the pump. This is especially desirable when the pipe is of any length. The friction head may be greater than the actual elevation, and the cost of the increased pipe size will be saved in a short time by the difference in horse-power. The friction increases with the velocity, and users are reminded that rather than to run the pump considerably above its capacity, it is better to install a larger pump and pipe line.

Doubling the diameter of a pipe increases its capacity four times. Friction of liquids in pipes increases as the square of the velocity.

To find the diameter of a pump cylinder to move a given quantity of water per minute (100 feet of piston being the standard of speed), divide the number of gallons by 4, then extract the square root, and the product will be the diameter in inches of the pump cylinder.

To find quantity of water elevated in one minute, running at 100 feet of piston speed per minute. Square the diameter of the water cylinder in inches and multiply by 4.

Example—Capacity of a 5 inch cylinder is desired. The square of the diameter (5 inches) is 25, which, multiplied by 4, gives 100, the number of gallons per minute (approximately).

To find the horsepower necessary to elevate water to a given height, multiply the weight of the water elevated per minute in pounds by the height in feet, and divide the product by 33,000, (an allowance should be added for water friction, and a further allowance for loss in steam cylinder, say from 20 to 30 per cent).

The area of the steam piston, multiplied by the steam pressure, gives the total amount of pressure that can be exerted. The area of the water piston, multiplied by the pressure of water per square inch, gives the resistance. A margin must be made between the power and the resistance to move the pistons at the required speed, say from 20 to 40 per cent., according to speed and other conditions.

Quantity of water in gallons per minute and velocity of flow in feet per second being given to find area of pipe in square inches, multiply quantity by 231 and divide by velocity multiplied by 720. Area of pipe and velocity being given, to find quantity delivered, multiply area of pipe by velocity and by 720, and divide product by 231.

A "miners inch" of water in California is regulated by law and is equal to a flow of one and one-half cubic feet of water per minute through any opening and under any pressure.

Standard Dimensions of Wrought-Iron Pipe for Water, Gas or Steam

Nominal Size.	Actual Inside Diameter.	Actual Outside Diameter.	Diameter at Bottom of Thread at End of Pipe	Diameter at Top of Thread at End of Pipe	Number of Threads per Inch.	Length of Perfect Screw.	Weight per Foot of Length.	Contents in U. S. Gallons per Foot.
INCH.	INCH.	INCH.	INCH.	INCH.		INCH.	LBS.	
1/8	.270	.405	.334	.393	27	.19	.241	.0006
1/4	.364	.540	.433	.522	18	.29	.420	.0026
3/8	.494	.675	.567	.656	18	.30	.559	.0057
1/2	.623	.840	.701	.815	14	.39	.837	.0102
3/4	.824	1.050	.911	1.025	14	.40	1.115	.0230
1	1.048	1.315	1.144	1.283	11 1/2	.51	1.668	.0408
1 1/4	1.380	1.660	1.488	1.627	11 1/2	.54	2.244	.0638
1 1/2	1.610	1.900	1.727	1.866	11 1/2	.55	2.678	.0918
2	2.067	2.375	2.200	2.339	11 1/2	.58	3.609	.1632
2 1/2	2.468	2.875	2.620	2.820	8	.89	5.739	.2550
3	3.067	3.500	3.241	3.441	8	.95	7.536	.3673
3 1/2	3.548	4.000	3.738	3.938	8	1.00	9.001	.4998
4	4.026	4.500	4.235	4.435	8	1.05	10.665	.6528
4 1/2	4.508	5.000	4.732	4.932	8	1.10	12.490	.8263
5	5.045	5.563	5.291	5.491	8	1.16	14.502	1.020
6	6.065	6.625	6.346	6.546	8	1.26	18.762	1.469
7	7.023	7.625	7.340	7.540	8	1.36	23.271	1.999
8	7.982	8.625	8.334	8.534	8	1.46	28.177	2.611
9	9.000	9.625	9.327	9.527	8	1.57	33.701	3.300
10	10.019	10.750	10.445	10.645	8	1.68	40.065	4.081
12	12.000	12.750	12.431	12.631	8	1.87	48.985	5.875

1 1/4 inch and below are butt-welded and tested to 300 lbs. per sq. in.

1 1/2 inch and above are lap-welded and tested to 500 lbs. per sq. in.

Light Wrought-Iron Artesian, Salt, Oil and Gas Well Casing

Nominal Inside Diameter. Inches.	Actual Outside Diameter. Inches.	Nominal Weight per Foot. Pounds.	No. Threads per Inch of Screw.	Nominal Inside Diameter. Inches.	Actual Outside Diameter. Inches.	Nominal Weight per Foot. Pounds.	No. Threads per Inch of Screw.
2	2 1/4	2.22	14	5 5/8	6	10.46	14
2 1/4	2 1/2	2.82	14	5 5/8	6	12.04	11 1/2
2 1/2	2 3/4	3.13	14	5 5/8	6	14.20	11 1/2
2 3/4	3	3.45	14	5 5/8	6	16.70	11 1/2
3	3 1/4	4.10	14	6 1/4	6 5/8	11.58	14
3 1/4	3 1/2	4.45	14	6 1/4	6 5/8	13.32	14 and 11 1/2
3 1/2	3 3/4	4.78	14	6 1/4	6 5/8	17.02	11 1/2
3 3/4	4	5.56	14	6 5/8	7	12.34	14
4	4 1/4	6.00	14	6 5/8	7	17.51	11 1/2 and 10
4 1/4	4 1/2	6.36	14	7 1/4	7 5/8	13.55	14
4 1/2	4 3/4	9.38	14	7 5/8	8	15.41	11 1/2
4 3/4	4 3/4	6.73	14	7 5/8	8	20.17	11 1/2
4 1/2	4 3/4	9.39	14	8 1/4	8 5/8	16.07	11 1/2
4 3/4	5	7.80	14	8 1/4	8 5/8	20.10	11 1/2
5	5 1/4	8.20	14	8 1/4	8 5/8	24.38	11 1/2 and 8
5	5 1/4	9.86	14	8 5/8	9	17.60	11 1/2
5	5 1/4	12.80	11 1/2	9 5/8	10	21.90	11 1/2
5	5 1/4	15.88	11 1/2	10 5/8	11	26.72	11 1/2
5 5/16	5 1/2	8.62	14	11 5/8	12	30.35	11 1/2
5 5/16	5 1/2	12.49	11 1/2	12 1/2	13	33.78	11 1/2

Horse Power or Capacity of Boilers

Steam Boilers are nearly always rated and sold on the basis of a certain number of square feet of heating surface. The basis of the rating heating surface varies, however, so much by different builders, that it is a very unsatisfactory method of rating. For instance Boilers are rated:

Return Tabular at from 12 to 15 square feet for each horse power.

Portable Locomotive and Vertical Boilers on from 9 to 11 square feet.

Water Tube and Scotch Marine Boilers on from $7\frac{1}{2}$ to 10 square feet.

The Centennial Rating of boiler capacity is the most practical and satisfactory. It provides for the evaporation or turning into steam of 30 pounds of water for each horse power per hour. This is a moderate rating, and any boiler that is not capable of evaporating that amount of water for each horse-power of its rated capacity and without forcing the firing or draft, must be in bad condition or over-rated. The safest method for all purchasers, will be to first ascertain the number of horse-power of work required from the engines for which the boiler is to be provided and then calculate the amount of steam the engine or engines will consume in developing that amount of power. By dividing by 30 they will arrive at the horse-power of boiler required to supply the engines.

Amount of Steam Required by Various Engines

The following allowance of pounds of water or steam for each indicated horse-power for engines of different kinds, will be found a safe calculation:

Triple Expansion (Condensing) Engines.....	15 pounds
Triple Expansion (Non-Condensing) Engines.....	20 "
Compound Condensing Corliss Engines.....	18 "
Compound Non-Condensing Corliss Engines.....	22 "
Simple or Single Corliss Engine (Condensing).....	23 "
Simple or Single Corliss Engine (Non-Condensing).....	25 "
Automatic Compound Condensing Engines.....	23 "
Automatic Compound Engine (Non-Condensing).....	30 "
High-Speed Automatic Engines.....	33 "
Side Valve Engines with Adjustable Cut-off.....	35 "
Plain Slide Valve Engines.....	40 "
Steam Pumps (Compound Condensing).....	40 "
Steam Pumps (Compound Non-Condensing).....	60 "
Steam Pumps, Single or Duplex.....	75 "

Water Consumption of Boilers

From the foregoing, it is evident that to arrive at the amount of water required by a boiler, it is only a matter of multiplying its horse-power by 30 pounds of water per hour. In some cases, an allowance of as much as 60 pounds or $7\frac{1}{2}$ gallons of water per horse-power of boilers is allowed, but this is excessive, and a boiler should not be expected to evaporate more than 30 to 40 pounds of water per horse-power per hour, except under stress.

Fuel Consumption of Boilers

Provided that feed water is delivered to a boiler as hot as it can be made with exhaust steam, that is at 200° F., a good boiler with ample draft and grate surface and carefully fired should be capable of evaporating from 8 to 10 pounds of water for each pound of good coal.

In practice, however, the question of water evaporated for each pound of coal varies between 6 and 8 pounds of water and in many larger plants where mine slack is used, the evaporation of water, is between 6 and 7 pounds.

The average consumption of coal for steam boilers is 12 lbs. per hour for each square foot of grate surface.

To evaporate one cubic foot of water requires the consumption of $7\frac{1}{2}$ lbs. of ordinary coal, or about 1 lb. of coal to 1 gallon of water.

One pound of crude petroleum will evaporate 12 to 16 lbs. of water.

One pound of natural gas (25 cubic feet) will evaporate about 20 lbs. of water. One ton of coal is equal to about 22,450 cubic feet natural gas. (Atmospheric pressure).

One ton of coal is equal to $3\frac{1}{2}$ to 4 barrels of petroleum.

One ton of coal is equal to one cord of hickory.

One ton of coal is equal to $1\frac{1}{4}$ cords of white oak.

One ton of coal is equal to $1\frac{1}{2}$ cords of black oak.

One ton of coal is equal to 2 cords of pine.

One cubic foot of anthracite coal weighs about 53 pounds.

One cubic foot of bituminous coal weighs from 47 to 50 pounds.

Safety Valve Rules

To find the distance, ball should be placed on lever when the weight is known, or to find weight when distance is known:

Multiply the pressure required by area of valve, then multiply this answer by the fulcrum, subtract the weight of the lever, valve and stem, and divide by the weight of the ball for distance; or divide by distance for the weight of the ball with the same example.

To find the pressure when the area of the valve, the weight of lever valve and stem, the fulcrum and the weight of ball is known:

Divide fulcrum into length of lever, multiply the answer by weight of ball, add weight of lever, valve and stem, and divide by area of valve; the answer will be the steam pressure.

The mean effective weight of valve lever and stem is found by connecting the lever at fulcrum, tie the valve stem to lever, attach a spring scale to lever immediately over the valve, and raise until the valve is clear of its seat.

By the fulcrum is meant the distance the valve stem is from where the lever is connected.

Safety valves should be allowed to blow straight out into the room and not hitched on to a leading pipe which may allow water to stand on the valve, increasing its weight, or to freeze up if the boiler is laid up. When the valve blows into the room it will be known when steam is escaping, whether from leakage or over pressure.

Don't depend too much upon the glass gauge, but try the cocks often enough to keep your hand in, in telling the height of water by them. If a gauge cock has a tendency to leak, fix it thoroughly; if you do not, you will neglect to use it for fear of the work which you may have, to stop the leak after using.

To determine the heating surface in the Tubes of any Boiler multiply the number of feet of Tubes by .523 for 2 inch; by .654 for $2\frac{1}{2}$ inch; by .785 for 3 inch; by .916 for $3\frac{1}{2}$ inch, and by 1.047 for 4 inch.

Horse Power

A Standard Engine Horse Power is 33,000 foot-pounds per minute—that is 33,000 pounds raised one foot in one minute, or 3,300 pounds raised ten feet, or 330 pounds raised one hundred feet, and so on.

To calculate the horse power of an engine, multiply together the area of the steam piston in square inches, the piston speed in feet per minute and the mean effective pressure of the steam in pounds per square inch and divide the result by 33,000. This will give the horse power in the cylinder, or Indicated Horse Power. From this must be taken the horse power consumed by the engine in friction, etc., to obtain the Net or Actual Horse Power.

Table of Mean Effective Pressure

The M. E. P. in the table are for non-condensing Engines. One pound is allowed for back pressure of Exhaust. Ten pounds added to any of the M. E. P. given will give the M. E. P. for Condensing Engines.

Initial Pressure in Pounds per Square Inch.	POINTS OF CUT-OFF.													
	1/4	2/7	3/10	1/3	3/8	2/5	3/7	4/9	1/2	5/9	2/3	5/8	2/3	3/4
30	10.75	12.75	13.75	15.50	17.50	18.50	19.50	20.00	22.00	23.50	24.75	25.25	26.00	27.25
35	13.75	16.00	17.00	19.00	21.00	22.25	23.50	24.25	26.25	28.00	29.25	29.50	30.75	32.35
40	16.75	19.25	20.25	22.50	24.75	26.00	27.00	28.25	30.50	32.50	33.75	34.50	35.50	37.00
45	19.75	22.50	23.75	26.00	28.50	30.00	31.50	32.25	34.75	36.75	38.25	39.25	40.25	41.75
50	22.75	25.75	27.00	29.50	32.25	33.75	35.50	36.25	39.00	40.50	42.75	43.75	45.00	46.50
55	25.75	29.00	30.25	33.00	36.00	37.50	39.25	40.25	43.25	45.75	47.25	48.25	49.50	51.50
60	28.75	32.25	33.75	36.50	39.75	41.50	43.25	44.25	47.50	50.00	51.75	52.75	54.25	56.25
65	31.75	35.50	37.00	40.00	43.50	45.25	47.25	48.25	51.75	54.50	56.50	57.50	59.90	61.25
70	34.75	38.50	40.00	43.50	47.00	49.00	51.25	52.25	56.00	58.75	61.00	62.00	63.50	66.00
75	37.75	41.75	43.00	47.00	50.75	53.00	55.25	56.25	60.25	63.25	65.50	66.50	68.50	71.00
80	40.75	45.00	46.75	50.50	54.50	56.75	59.25	60.25	64.50	67.75	70.00	71.25	73.00	75.75
85	43.75	48.25	50.25	54.00	58.25	60.50	63.00	64.50	68.75	72.00	74.50	75.75	77.75	80.50
90	46.75	51.50	53.25	57.00	62.00	64.25	67.00	68.50	73.00	76.50	79.25	80.50	82.25	85.25
95	49.75	54.75	57.00	61.50	65.75	68.25	71.00	72.50	77.25	81.00	83.50	85.00	87.00	90.25
100	52.50	58.00	60.25	64.50	69.50	72.00	75.00	76.50	81.25	85.25	88.25	89.50	91.75	95.00
105	55.50	61.25	63.50	68.00	73.00	75.75	78.75	80.50	85.50	89.75	92.75	94.25	96.50	99.75
110	58.50	64.50	66.75	71.50	76.75	79.75	82.75	84.50	89.75	94.25	97.25	98.75	101.00	104.75
115	61.50	67.50	70.00	75.00	80.50	83.50	86.25	88.50	94.00	98.50	101.75	103.50	105.75	109.50
120	64.50	70.75	73.25	78.50	84.25	87.50	90.25	92.50	98.25	102.75	106.25	108.00	110.00	114.25
125	67.50	73.75	76.50	81.00	88.00	91.25	94.25	96.50	102.25	107.00	110.75	112.50	114.50	119.25

How to Center an Engine

The "dead center" is the point in the stroke where the crank and piston rod are in the same right line. To find dead center, turn engine in the direction it runs until cross-head is within a short distance of its limit of motion. Mark guide at end of cross-head shoe. Mark some revolving circular part of engine, as disk crank or fly wheel, and place one point of a fixed tram in this mark and the other on some fixed object in line. Now turn engine past the center in the direction she runs until end of cross-head shoe passes mark on guide. Turn back till shoe reaches mark. Holding tram still on the fixed object, place other point on selected revolving part and mark as before. Bisect distance between marks on revolving part and turn engine till point of tram rests on central mark, and the engine is on "dead center."

Horizontal engines, when practicable, should be run over rather than under, as the thrust will then come downward upon the foundation rather than upon the caps of the boxes and the upper guides.

Power Required for Different Parts of Gold and Silver Mills

Each Stamp, Dropping 100 Times per Minute, Requires:

Weight per stamp in lbs.	750	800	850	900	950	1000	1050	1100	1200	1300	1350
Horse Power each Stamp	1.5	1.6	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.6	2.7

Each Dodge Crusher, Requires:

Each Blake Type Crusher, Requires:

Size of crusher	6x6	7x8	8x12	11x15	Size of crusher	6x7½	7x9	8x12	10x16
Horse power	4	6	8	12	Horse power	4	5	8	12
Revolutions per minute.	350	300	250	225	Rev. per minute.	275	275	250	225

Each Standard Crushing Rolls, Requires:

Size of rolls	20x8	20x12	27x14	30x14	36x16
Horse power	3-6	4-8	5-10	8-15	10-20
Revolutions per minute	100-150	100-150	75-125	65-85	50-75

Each 6-foot Belt Concentrator, requires about ½ horse-power.

Each 18-inch Amalgam Barrel, requires from 1 to 2 horse-power.

Each 24-inch Amalgam Barrel, requires from 2 to 3 horse-power.

Each 36-inch Clean-up Pan, requires from 1 to 1½ horse-power.

Each 48-inch Clean-up Pan requires from 1½ to 2 horse-power.

Each 4-foot Combination Pan, 65 revolutions per-minute, requires from 3 to 6 horse-power.

Each 5-foot Combination Pan, 65 revolutions per minute, requires from 5 to 10 horse-power.

Each 8-foot Settler, 14 revolutions per minute, requires 2.5 horse-power.

Each 8-foot Agitator, 16 revolutions per minute, requires 3 horse-power.

Each Quicksilver Elevator requires from .25 to 2 horse-power.

Each Revolving Dryer requires 5 horse-power.

Each Howell-White Roasting Furnace requires from 4 to 6 horse-power.

Each Bruckner Furnace, 8 x 18 feet, requires from 5 to 8 horse-power.

Above estimates include the friction of the parts named, but not that of the power transmitting machinery, for which an additional allowance should be made.

Water Required for Various Parts of Gold and Silver Mills

Boiler feed for each horse-power, per hour, 5 gallons.

For each stamp, per hour, from 60 to 80 gallons.

For each 5-foot Pan, per hour, 100 gallons.

For each 8-foot Settler, per hour, 80 gallons.

For each Concentrator, per hour, from 200 to 300 gallons.

For each Graupner or Huntington 5-foot mill, per hour, 1000 to 1200 gallons.

When water is settled and returned to the mill for re-use, a reduction of 50 per cent. may be safely estimated for all except the boiler, which must have clear water.

Horse-Power Shafting Will Transmit

Diameter of Shaft.	Weight per Foot.	Revolutions per Minute.									
		100	125	150	175	200	225	250	300	350	400
1 ⁵ / ₈	2.05	1.2	1.4	1.7	2.1	2.4	2.6	3.1	3.6	4.3	5.0
1 ³ / ₄	3.77	2.4	3.1	3.7	4.3	4.9	5.5	6.1	7.3	8.5	9.7
1 ⁷ / ₈	5.52	4.3	5.3	6.4	7.4	8.5	9.5	10.5	12.7	14.8	16.9
1 ¹ / ₂	7.61	6.7	8.4	10.1	11.7	13.4	15.1	16.7	20.1	23.4	26.8
1 ³ / ₂	10.03	10.0	12.5	15.0	17.5	20.0	22.5	25.0	30.0	35.0	40.0
2 ³ / ₈	12.80	14.3	17.8	21.4	24.9	28.5	32.1	35.6	42.7	49.8	57.0
2 ¹ / ₂	15.89	19.5	24.4	29.3	34.1	39.0	44.1	48.7	58.5	68.2	78.0
2 ³ / ₄	19.31	26.0	32.5	39.0	43.5	52.0	58.5	65.0	78.0	87.0	104.0
2 ⁵ / ₈	23.06	33.8	42.2	50.6	59.1	67.5	75.9	84.4	101.3	118.2	135.0
3 ¹ / ₈	27.16	43.0	53.6	64.4	75.1	85.8	96.6	107.3	128.7	150.3	171.6
3 ¹ / ₂	31.58	53.6	67.0	79.4	93.8	107.2	120.1	134.0	158.8	187.6	214.4
3 ³ / ₄	36.40	65.9	82.4	97.9	115.4	121.8	148.3	164.8	195.7	230.7	243.6
4 ¹ / ₂	41.40	80.0	100.0	120.0	140.0	160.0	180.0	200.0	240.0	280.0	320.0
4 ³ / ₄	52.58	113.9	142.4	170.8	199.3	227.8	256.2	284.7	341.7	398.6	455.6
4 ⁵ / ₈	65.10	156.3	195.3	234.4	273.4	312.5	351.5	390.6	468.7	546.8	625.0

To Obtain the Size and Speed of Pulleys, Gears, or Sprocket Wheels

Diameter of Driver—Diameter of driven multiplied by revolutions of driven, and the product obtained divided by the revolutions of driver.

Diameter of Driven—Diameter of driver multiplied by revolutions of driver, and the product obtained divided by revolutions of driven.

Revolutions of Driven.—Diameter of driver multiplied by revolutions of driver, and the product obtained divided by the revolutions of driven.

Revolutions of Driver.—Diameter of driven multiplied by the revolutions of driven, and the product obtained divided by the diameter of the driver.

The driving pulley is called the driver, and the driven pulley the driven.

If the number of teeth in gears or sprocket wheels are used instead of diameter in these calculations, number of teeth must be substituted whenever diameter occurs.

Horse-Power of Gearing

The following table is for cast-iron gears, and is based upon a factor of safety of eight, with an ultimate tensile strength of 30,000 pounds.

Speed of gear, 100 feet per minute at pitch line.

Spur Gears, Horse Power.	Pitch.	Face.	Bevel Gears, Horse Power.
1.40	1	2 ¹ / ₂	1.01
2.52	1 ¹ / ₄	3 ¹ / ₄	1.78
3.84	1 ¹ / ₂	4	2.61
5.48	1 ³ / ₄	5	3.73
6.83	2	6	4.68
8.98	2 ¹ / ₄	6 ¹ / ₂	6.39
10.70	2 ¹ / ₂	7	7.52
15.39	3	9	10.54

The horse-power of gears increases and decreases directly with the speed.

Belting

SINGLE LEATHER

Speed in Feet per Minute.	WIDTH OF BELT IN INCHES.									
	2	3	4	5	6	8	10	12	14	16
	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.
400	1	1½	2	2½	3	4	5	6	7	8
600	1½	2¼	3	3¾	4½	6	7½	9	10½	12
800	2	3	4	5	6	8	10	12	14	16
1000	2½	3¾	5	6¼	7½	10	12½	15	17½	20
1200	3	4½	6	7½	9	12	15	18	21	24
1500	3¾	5¾	7½	9½	11½	15	18¾	22½	26½	30
1800	4½	6¾	9	11¼	13½	18	22½	27	31½	36
2000	5	7½	10	12½	15	20	25	30	35	40
2400	6	9	12	15	18	24	30	36	42	48
2800	7	10½	14	17½	21	28	35	42	49	56
3000	7½	11¼	15	18¾	22½	30	37½	45	52½	60
3500	8¾	13	17½	22	26	35	44	52½	61	70
4000	10	15	20	25	30	40	50	60	70	80
4500	11¼	17	22½	28	34	45	57	69	78	90
5000	12½	19	25	31	37½	50	62½	75	87½	100

DOUBLE LEATHER

Speed in Feet per Minute.	WIDTH OF BELT IN INCHES.								
	4	6	8	10	12	14	16	18	20
	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.	H.-P.
400	2¾	4¼	5¾	7¼	8½	10	11½	13	14½
600	4¼	6½	8¾	11	13	15	17½	19½	22
800	5¾	8½	11½	14½	17½	20½	23	26	29
1000	7¼	11	14½	18¼	21½	25½	29	32½	36
1200	8½	13	17½	22	26	30½	34½	39	44
1500	10¾	16¼	21¾	27¼	32½	38	43½	49	54½
1800	13	19½	26	32¾	39	45½	52	59	65½
2000	14½	21¾	29	36½	43½	50½	58	65½	72½
2400	17¼	26	34¾	44	52½	60½	69½	78½	88
2800	20¼	30½	40½	51	61	71	81	91½	102
3000	21½	32½	43½	54½	65½	76	87½	98	108
3500	25½	38	50¾	63½	76	89	101	114	127
4000	29	43½	58¼	72¾	87	101	116	131	145
4500	32½	49	65	82	98	114	131	147	163
5000	36½	51½	72¾	91	109	127	145	163	182

The above tables are based on the following equivalents:

Single Belting, one inch wide, 800 feet per minute = one horse-power, equal to four ply rubber = working tension of 42 pounds.

Double Belting, one inch wide, 550 feet per minute = one horse-power, equal to six ply rubber = Working tension of 60 pounds.

Board Measure

Length in Feet.

SIZE.	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1x8	8	9 ¹ / ₂	10 ² / ₃	12	13 ¹ / ₂	14 ² / ₃	16	17 ¹ / ₂	18 ² / ₃	20	21 ¹ / ₂	22 ² / ₃	24	25 ¹ / ₂	26 ² / ₃
1x10	10	11 ¹ / ₂	13 ¹ / ₂	15	16 ² / ₃	18 ¹ / ₂	20	21 ¹ / ₂	23 ¹ / ₂	25	26 ² / ₃	28 ¹ / ₂	30	31 ² / ₃	33 ¹ / ₂
1x12	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1x14	14	16 ¹ / ₂	18 ² / ₃	21	23 ¹ / ₂	25 ² / ₃	28	30 ¹ / ₂	32 ² / ₃	35	37 ¹ / ₂	39 ² / ₃	42	44 ¹ / ₂	46 ² / ₃
1x16	16	18 ² / ₃	21 ¹ / ₂	24	26 ² / ₃	29 ¹ / ₂	32	34 ² / ₃	37 ¹ / ₂	40	42 ² / ₃	45 ¹ / ₂	48	50 ² / ₃	53 ¹ / ₂
2x3	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2x4	8	9 ¹ / ₂	10 ² / ₃	12	13 ¹ / ₂	14 ² / ₃	16	17 ¹ / ₂	18 ² / ₃	20	21 ¹ / ₂	22 ² / ₃	24	25 ¹ / ₂	26 ² / ₃
2x6	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
2x8	16	18 ² / ₃	21 ¹ / ₂	24	26 ² / ₃	29 ¹ / ₂	32	34 ² / ₃	37 ¹ / ₂	40	42 ² / ₃	45 ¹ / ₂	48	50 ² / ₃	53 ¹ / ₂
2x10	20	23 ¹ / ₂	26 ² / ₃	30	33 ¹ / ₂	36 ² / ₃	40	43 ¹ / ₂	46 ² / ₃	50	53 ¹ / ₂	56 ² / ₃	60	63 ¹ / ₂	66 ² / ₃
2x12	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
2x14	28	32 ² / ₃	37 ¹ / ₂	42	46 ² / ₃	51 ¹ / ₂	56	60 ² / ₃	65 ¹ / ₂	70	74 ² / ₃	79 ¹ / ₂	84	88 ² / ₃	93 ¹ / ₂
2x16	32	37 ¹ / ₂	42 ² / ₃	48	53 ¹ / ₂	58 ² / ₃	64	69 ¹ / ₂	74 ² / ₃	80	85 ¹ / ₂	90 ² / ₃	96	101 ¹ / ₂	106 ² / ₃
3x4	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
3x6	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
3x8	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
3x10	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
3x12	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
3x14	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
3x16	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
4x4	16	18 ² / ₃	21 ¹ / ₂	24	26 ² / ₃	29 ¹ / ₂	32	34 ² / ₃	37 ¹ / ₂	40	42 ² / ₃	45 ¹ / ₂	48	50 ² / ₃	53 ¹ / ₂
4x6	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
4x8	32	37 ¹ / ₂	42 ² / ₃	48	53 ¹ / ₂	58 ² / ₃	64	69 ¹ / ₂	74 ² / ₃	80	85 ¹ / ₂	90 ² / ₃	96	101 ¹ / ₂	106 ² / ₃
4x10	40	46 ² / ₃	53 ¹ / ₂	60	66 ² / ₃	73 ¹ / ₂	80	86 ² / ₃	93 ¹ / ₂	100	106 ² / ₃	113 ¹ / ₂	120	126 ² / ₃	133 ¹ / ₂
4x12	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
4x14	56	65 ¹ / ₂	74 ² / ₃	84	93 ¹ / ₂	102 ² / ₃	112	121 ¹ / ₂	130 ² / ₃	140	149 ¹ / ₂	158 ² / ₃	168	177 ¹ / ₂	186 ² / ₃
4x16	64	74 ² / ₃	85 ¹ / ₂	96	106 ² / ₃	117 ¹ / ₂	128	138 ² / ₃	149 ¹ / ₂	160	170 ² / ₃	181 ¹ / ₂	192	202 ² / ₃	213 ¹ / ₂
6x6	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
6x8	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
6x10	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
6x12	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
6x14	84	98	112	126	140	154	168	182	196	210	224	238	252	266	280
6x16	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
8x8	64	74 ² / ₃	85 ¹ / ₂	96	106 ² / ₃	117 ¹ / ₂	128	138 ² / ₃	149 ¹ / ₂	160	170 ² / ₃	181 ¹ / ₂	192	202 ² / ₃	213 ¹ / ₂
8x10	80	93 ¹ / ₂	106 ² / ₃	120	133 ¹ / ₂	146 ² / ₃	160	173 ¹ / ₂	186 ² / ₃	200	213 ¹ / ₂	226 ² / ₃	240	253 ¹ / ₂	266 ² / ₃
8x12	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
8x14	112	130 ² / ₃	149 ¹ / ₂	168	186 ² / ₃	205 ¹ / ₂	224	242 ² / ₃	261 ¹ / ₂	280	298 ² / ₃	317 ¹ / ₂	336	354 ² / ₃	373 ¹ / ₂
8x16	128	149 ¹ / ₂	170 ² / ₃	192	213 ¹ / ₂	234 ² / ₃	256	277 ¹ / ₂	298 ² / ₃	320	341 ¹ / ₂	362 ² / ₃	384	405 ¹ / ₂	426 ² / ₃
10x10	100	116 ² / ₃	133 ¹ / ₂	150	166 ² / ₃	183 ¹ / ₂	200	216 ² / ₃	233 ¹ / ₂	250	266 ² / ₃	283 ¹ / ₂	300	316 ² / ₃	333 ¹ / ₂
10x12	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
10x14	140	163 ¹ / ₂	186 ² / ₃	210	233 ¹ / ₂	256 ² / ₃	280	303 ¹ / ₂	326 ² / ₃	350	373 ¹ / ₂	396 ² / ₃	410	443 ¹ / ₂	466 ² / ₃
10x16	160	186 ² / ₃	213 ¹ / ₂	240	266 ² / ₃	293 ¹ / ₂	320	346 ² / ₃	373 ¹ / ₂	400	426 ² / ₃	453 ¹ / ₂	480	506 ² / ₃	533 ¹ / ₂
12x12	144	168	192	216	240	264	288	312	336	360	384	408	432	456	480
12x14	168	196	224	252	280	308	336	364	392	420	448	476	504	532	560
12x16	192	224	256	288	320	352	384	416	448	480	512	544	576	608	640
14x14	196	228 ² / ₃	261 ¹ / ₂	294	326 ² / ₃	359 ¹ / ₂	392	424 ² / ₃	457 ¹ / ₂	490	522 ² / ₃	555 ¹ / ₂	588	620 ² / ₃	653 ¹ / ₂
14x16	224	261 ¹ / ₂	298 ² / ₃	336	373 ¹ / ₂	410 ² / ₃	448	485 ¹ / ₂	522 ² / ₃	560	597 ¹ / ₂	634 ² / ₃	672	709 ¹ / ₂	746 ² / ₃
16x16	256	298 ² / ₃	341 ¹ / ₂	384	426 ² / ₃	469 ¹ / ₂	512	554 ² / ₃	597 ¹ / ₂	640	682 ² / ₃	725 ¹ / ₂	768	810 ² / ₃	853 ¹ / ₂

Note—By simply multiplying or dividing the above amounts, the number of feet contained in other dimensions can be obtained.

Board and Timber Measure

BOARD MEASURE

In board measure boards are assumed to be one inch in thickness.

To compute the measure or surface in square feet—

When all dimensions are in feet:

Rule—Multiply the length by the breadth, and the product will give the surface required.

When either of the dimensions are in inches:

Rule—Multiply as above and divide the product by 12.

When all dimensions are in inches:

Rule—Multiply as before and divide product by 144.

TIMBER MEASURE

To compute the volume of round timber—

When all dimensions are in feet:

Rule—Multiply the length by the square of one-quarter of the main girt, and the product will give the measurement in cubic feet.

When length is given in feet and girt in inches:

Rule—Multiply as before and divide by 144.

When all the dimensions are in inches:

Rule—Multiply as before and divide by 1,728.

Sawed or hewed timber is measured by the cubic foot.

To compute the volume of square timber—

When all dimensions are in feet:

Rule—Multiply the product of the breadth by the depth by the length, and the product will give the volume in cubic feet.

When either of the dimensions are in inches:

Rule—Multiply as above and divide the product by 12.

When any two of the dimensions are in inches:

Rule—Multiply as before and divide the product by 144.

Simple Problems in Air Compression

Extracts from an address delivered before the Mining Association of the University of California, By Edward A. Rix.

Allow 20 hp. for every 100 cu. ft. of cylinder-displacement, to compress air to 90 or 95 lb. receiver gauge-pressure at sea-level.

It would be well in small plants, up to 400 cu. ft. capacity to make no distinction between single and two-stage machines.

In using compressed air at 90 lb. pressure cold, it will take 24 cu. ft. free air per minute to give one horse-power in plain slide-valve engines and 15 cu. ft. with good expansion-valve gearing; between these two limits will lie all the various types of engines. If the air be re-heated to about 300° F, it will reduce the above quantities about one-third.

For operating ordinary station and sinking pumps of the direct-acting type, which is the ordinary stock pump used in mining operations, it will be safe to calculate that one cubic foot of free air compressed to 90 lb. gauge-pressure will do 135 foot-gallons of pumping.

Ordinary mining hoists have a mechanical efficiency of about 75 per cent.

For the determination of sizes of pipes, losses of pressure, and terminal pressures for compressed-air transmission, use the formula:

$$P_1^2 - P_2^2 = \frac{0.0006V^2L}{A^5}$$

P_1 = absolute initial air-pressure.
 P_2 = absolute terminal air-pressure.
 V = free air equivalent passing through the pipe.
 L = length of pipe in feet.
 A = diameter in inches.

Problem.—Given a water-power distant 5000 ft. from a mine, it is desired to generate compressed air and transmit it to the collar of the shaft to perform work as follows:

One hundred tons of ore and waste to be hoisted in 20 hours.

Thirty gallons of water per minute to be pumped.

Five 2¼-in standard piston rock-drills to be operated.

Three air-hammer drills to be operated.

General Conditions:

Depth of shaft, 600 ft.

Weight of skip and rope, 1,000 lb.

Weight of ore hoisted, 1 ton.

Initial air-pressure, 95 lb.

Final air-pressure, 90 lb.

Altitude, sea-level.

Geared hoist and unbalanced hoisting.

Required:

Size of compressor.

Diameter of air-pipe.

Brake horse-power.

Altitude factors.

Re-heating coefficients.

Note: Reduce all requirements to cubic feet of free air, because free air is the basis for all power-calculations.

To determine the free air required for hoisting:

100 tons of ore and waste hoisted in 20 hours = 5 tons per hour, each load contains one ton = a load hoisted every 12 minutes. 2000 lb. material and 1000 lb. rope and skip = a total of 3000 lb. 3000 lb. lifted 600 ft. = 1,800,000 foot-pounds, or 54 hp. theoretical, at 75% efficiency, the 54 hp. becomes 72 brake-power actually required. Using cold air, it requires, 24 cu. ft. free air per horse-power. Then the hoist will consume to make a lift, $24 \times 72 = 1728$ cu. ft. of free air. This gives us direct results without taking into consideration the element of time or the dimensions of the hoist.

Simple Problems in Air Compression

(Continued)

If 1728 cu. ft. are required to make a hoist every 12 minutes the compressor must furnish 144 cu. ft. free air per minute continuously, and we assume that we hoist at the rate of 300 ft. per min.; it will take 2 minutes to make the lift, and the hoist will be lowering and idle during the next 10 minutes, the compressor delivering $10 \times 144 = 1440$ cu. ft. free air which must be stored. Sufficient storage capacity is the vital point of hoisting economically with compressed air.

While we have allowed 4 hours in 24, or 1 hr. 20 min. on each shift, for hoisting and lowering men, timbers, supplies, etc., it is probable that at least once every hour someone will be going up and down the shaft, and it would be practical therefore to say that the hoist would handle 6 loads per hour, instead of 5, and we must therefore add 20% to the 144 cu. ft. making the hoisting requirement say, 175 cu. ft. per min.

To determine the amount of compressed air required for pumping:

For pumping 30 gallons per min. 600 ft., requires 30×600 , or 18,000 foot gallons of work. If one cu. ft. of free air at 90 lb. gauge-pressure will give 135 ft.-gal., we shall require 133 cu. ft. free air for the pumping. This requirement is constant.

To determine the amount of compressed air required for drilling:

Five $2\frac{1}{4}$ -in. rock-drills will require 50 ft. free air each, or 250 cu. ft.

Three air-hammer drills will require 25 cu. ft. each, or 75 cu. ft.

To get these amounts, take about 80% of the requirements as stated in rock-drill catalogues, which always give quantities in compressor-cylinder displacement, which do not deliver on an average within 20% of their displacement, except in large machines.

Total requirements will therefore be:

Work.	Cubic Feet.
Hoisting	175
Pumping	133
Drilling	325
Total	633

Allow for a 5% pipe-leakage on the entire system. This would bring requirement up to 665.

Allow for a volumetric efficiency of at least 80%, this will require a total cylinder displacement of 830 cu. ft. per minute, and with the power factor of 20 hp. per 100 cu. ft., 166 hp. delivered on the water-wheel shaft is required to drive compressor.

To determine the size of the pipe: Allow 5 lb. drop in pressure for friction loss.

$$\text{Formula: } P_1^2 - P_2^2 = \frac{0.0006V_2L}{A^5}$$

P_1 , initial pressure absolute = $95 + 14.7$, or 109.7, and its square is 12034.

P_2 , the terminal pressure, 5 lb. less than the initial, or 90 lb., or 104.7 absolute, and, its square is 10962.

The difference between these two or $P_1^2 - P_2^2 = 1072$.

Simple Problems in Air Compression

(Continued)

Substituting this in our equation, and also the values for L. and V, we have

$$1072 = \frac{6 \times 5000 \times 633 \times 633}{10,000 \times A^5}$$

reducing, we have

$$1072 \times A^5 = 3 \times 633^2, \text{ or } A^5 = 1121$$

$$A = 4\text{-in. pipe.}$$

In General:

Refer to trade catalogues and tables and look up a satisfactory compressor, having a displacement of 830 cu. ft. For this capacity it is advisable to select a two-stage compressor, because it has a higher volumetric efficiency, requires less power to operate, is easier to lubricate on account of lower temperatures and has less strain on mechanism.

The first thing to consider is the speed at which the compressor will operate. If a limited sum is to be expended, as high a working speed as possible will be selected, because, the higher the speed, the smaller the compressor. If the future is to be taken into consideration, more air will be wanted as shaft goes deeper and more water encountered. It would then be wise to select a machine which at say two-thirds of its rated speed would produce the present requirements and give a 50 per cent. margin for the future.

Altitude:

(original)

As the altitude increases, the initial absolute pressure diminishes and as the final pressure remains the same, the pressure ratio grows larger as the altitude increases. For example, at 10,000 ft. elevation the atmospheric pressure is 10 lbs. instead of 14.7 lbs at sea level. In the problem, the ratio of compression at sea level is 7.5 while at 10,000 feet elevation it would be 10.5. The sea-level compressor must be increased, therefore, $10.5 \div 7.5$, or 1.4 times, to give the same weight of compressed air at 10,000 ft. altitude. In other words the altitude compressor must be about 40 per cent. larger to do the same work.

TABLE OF EFFICIENCIES AND CAPACITIES AT VARIOUS ALTITUDES.

Altitude above Sea-level Feet.	Absolute Pressure per sq. in. Lbs.	Barometric Pressure Inches.	Cubic Feet of Free Air Remaining Constant.		Cubic Feet of Compressed Air Remaining Constant.	
			Volumetric Efficiency	Power Required.	Increased Capacity of Compressor	Increased Horse Power Required.
0	14.79	30.0	100%	100%	0%	0%
1000	14.15	28.8	97%	98.2%	3.3%	2.2%
2000	13.61	27.8	93%	96.5%	7.6%	3.9%
3000	13.10	26.7	90%	94.8%	10.3%	5.6%
4000	12.61	25.7	87%	93.1%	14%	7.3%
5000	12.14	24.8	84%	91.5%	18%	8.9%
6000	11.68	23.8	81%	89.9%	22%	10.6%
7000	11.24	22.9	78%	88.4%	26%	12.3%
8000	10.82	22.1	76%	86.9%	31%	14.2%
9000	10.42	21.3	73%	85.4%	36%	16.2%
10000	10.03	20.5	70%	83.9%	40%	18.2%
11000	9.66	19.7	68%	82.4%	45%	20.3%
12000	9.30	19.0	65%	80.9%	50%	22.4%

Simple Problems in Air Compression

(Continued)

To determine the amount of compressed air required by re-heating:

It is practical to re-heat air to from 300° to 400° F in various ways, and great economy is realized especially for pumping and hoisting, and if it is possible you may reduce the quantities of cold air figured for this character of work by the ratio of the atmospheric to the compressed-air temperatures absolute. Thus, if the atmosphere is at 60° F or 520° absolute, and the compressed air is used at 300° F or 760° absolute, then the volume of cold air for your work may be taken at the ratio of 520 ÷ 760, or about 70%, thus making a saving of 30 per cent.

TABLE I.—CUBIC FEET OF FREE AIR REQUIRED TO RUN ONE DRILL OF THE SIZE AND AT THE PRESSURE STATED BELOW.

Gauge Pressure	CYLINDER DIAMETER OF DRILL.												
	2"	2¼"	2½"	2¾"	3"	3⅛"	3⅜"	3½"	3⅝"	3¾"	4"	5"	5½"
60	50	60	68	82	90	95	97	100	108	113	130	150	164
70	56	68	77	93	102	108	110	113	124	129	147	170	181
80	63	76	86	104	114	120	123	127	131	143	164	190	207
90	70	84	95	115	126	133	136	141	152	159	182	210	230
100	77	92	104	126	138	146	149	154	166	174	199	240	252

TABLE II.—MULTIPLIERS TO DETERMINE COMPRESSOR CAPACITY REQUIRED TO OPERATE FROM 1 TO 70 ROCK DRILLS AT ALTITUDES COMPARED WITH SEA LEVEL.

Altitude Above Sea Level	NUMBER OF DRILLS																		
	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	40	50	60	70
	MULTIPLIERS																		
0	1.	1.8	2.7	3.4	4.1	4.8	5.4	6.0	6.5	7.1	8.1	9.5	11.7	13.7	15.8	21.4	25.5	29.4	33.2
1000	1.03	1.85	2.78	3.5	4.22	4.94	5.56	6.18	6.69	7.3	8.34	9.78	12.05	14.1	16.3	22.0	26.26	30.3	34.2
2000	1.07	1.92	2.89	3.64	4.39	5.14	5.78	6.42	6.95	7.60	8.67	10.17	12.52	14.66	16.9	22.9	27.28	31.46	35.52
3000	1.10	1.98	2.97	3.74	4.51	5.28	5.94	6.6	7.15	7.81	8.91	10.45	12.87	15.07	17.38	23.54	28.05	32.34	36.52
4000	1.14	2.05	3.08	3.88	4.67	5.47	6.15	6.84	7.41	8.09	9.23	10.83	13.34	15.62	18.01	24.4	29.07	33.52	37.8
5000	1.17	2.10	3.16	3.98	4.8	5.62	6.32	7.02	7.61	8.31	9.48	11.12	13.69	16.03	18.49	25.04	29.84	34.4	38.84
6000	1.20	2.16	3.24	4.08	4.9	5.76	6.48	7.2	7.8	8.52	9.72	11.4	14.04	16.44	18.96	25.68	30.6	35.4	39.84
7000	1.23	2.21	3.32	4.18	5.04	5.9	6.64	7.38	7.99	8.73	9.96	11.68	14.39	16.85	19.43	26.32	31.36	36.16	40.84
8000	1.26	2.27	3.40	4.28	5.17	6.05	6.8	7.56	8.19	8.95	10.21	11.97	14.74	17.26	19.9	26.66	32.13	37.04	41.83
9000	1.29	2.32	3.48	4.39	5.29	6.19	6.96	7.74	8.38	9.16	10.45	12.26	15.09	17.67	20.38	27.6	32.9	37.92	42.83
10000	1.32	2.38	3.56	4.49	5.41	6.34	7.13	7.92	8.58	9.37	10.69	12.54	15.44	18.08	20.86	28.25	33.66	38.8	43.82
12000	1.37	2.47	3.7	4.66	5.62	6.57	7.4	8.22	8.9	9.73	11.1	13.02	16.03	18.77	21.64	29.32	34.94	40.28	45.48

Example.—Required the amount of free air necessary to operate thirty 5 inch drills at 9,000 feet altitude, using to operate these drills air at a gauge pressure of 80 pounds per square inch.

From Table I we find, when operating the drills at 80 pounds gauge pressure at sea level, that one 5-inch drill requires 190 cubic feet of free air per minute.

From Table II we also find that the factor for 30 drills at 9,000 feet altitude is 20.38; multiplying 190 cubic feet by 20.38 gives 3,872 cubic feet free air per minute, which is the displacement of a compressor for the above outfit under average conditions, to which must be added pipe line losses, such as friction and leakage.

Table for Computing Effective Strains and Loads on Inclines

I. Degree.	II. Sine.	III. Cosecant.	I. Degree.	II. Sine.	III. Cosecant.
90	1.000	1.000	45	.707	1.414
89	1.000	1.000	44	.695	1.440
88	.999	1.001	43	.682	1.466
87	.999	1.001	42	.669	1.494
86	.998	1.002	41	.656	1.524
85	.996	1.004	40	.643	1.556
84	.995	1.006	39	.629	1.589
83	.993	1.008	38	.616	1.624
82	.990	1.010	37	.602	1.662
81	.988	1.012	36	.588	1.701
80	.985	1.015	35	.574	1.743
79	.982	1.019	34	.559	1.788
78	.978	1.022	33	.545	1.836
77	.974	1.026	32	.530	1.887
76	.970	1.031	31	.515	1.942
75	.966	1.035	30	.500	2.000
74	.961	1.040	29	.485	2.063
73	.956	1.046	28	.469	2.130
72	.951	1.051	27	.454	2.203
71	.946	1.058	26	.438	2.281
70	.940	1.064	25	.423	2.366
69	.934	1.071	24	.407	2.459
68	.927	1.079	23	.391	2.559
67	.921	1.086	22	.375	2.669
66	.914	1.095	21	.358	2.790
65	.906	1.103	20	.342	2.924
64	.899	1.113	19	.326	3.071
63	.891	1.122	18	.309	3.236
62	.883	1.133	17	.292	3.420
61	.875	1.143	16	.276	3.628
60	.866	1.155	15	.259	3.864
59	.857	1.167	14	.242	4.134
58	.848	1.179	13	.225	4.445
57	.839	1.192	12	.208	4.810
56	.829	1.206	11	.191	5.241
55	.819	1.221	10	.174	5.759
54	.809	1.236	9	.156	6.392
53	.799	1.252	8	.139	7.185
52	.788	1.269	7	.122	8.206
51	.777	1.287	6	.105	9.567
50	.766	1.305	5	.087	11.474
49	.755	1.325	4	.070	14.336
48	.743	1.346	3	.052	19.107
47	.731	1.367	2	.035	28.654
46	.719	1.390	1	.017	57.299

The table will be found useful where hoisting is done in inclined shafts. It may also be applied to "gravity tramways" or "inclined planes."

The following examples will show its uses: Suppose the weight of ore is 10,000 lbs.; skip, 6,000 lbs.; rope, 7,500 lbs.; and that the shaft has an inclination of 55 degrees from the horizontal. What is the strain of the rope? Total load, $10,000 + 6,000 + 7,500 = 23,500$.

Rule:—For each pound weight, the effective load on rope for the angle of incline from the horizontal given in column I will be found opposite in column II.

Therefore, find 55 degrees in column I and opposite in column II is .819, which multiplied by 23,500 = 19,246.5 lbs., the total effective strain on rope.

Suppose an engine can raise 5,000 lbs. in a vertical shaft, what can it pull up an incline 30 degrees from the horizontal?

Rule:—For each pound which an engine can lift vertically, it can raise the amount given in column III up an incline of the angle given in column I. Therefore, find 30 degrees in column I, and opposite in column III is 2, which multiplied by 5,000 = 10,000 lbs., the amount engine can pull up a 30 degree incline.

If the proper working strain of the rope were 5,000 lbs., on a vertical lift, it would be 10,000 lbs. on a 30 degree incline; the process is the same.

Note:—In using the table, it must not be overlooked that the friction of drawing the car, skip or cage on the rails or guides is to be added to the effective weight in order to obtain the total amount of strain borne by the rope. This friction is termed "traction" or "tractile effort" and varies between thirty and one hundred pounds per ton, according to circumstances and is of more importance on inclines of small angle.

Standard Hoisting Ropes

Composed of 6 Strands of 19 wires each, with Hemp Center.

Dia.	Weight per foot in pounds.	Allowable working strain in tons of 2,000 lbs. Factor of Safety = 5.				Minimum Size of Drum or Sheave in Feet.			
		Plough Steel.	Ex. Strong Crucible Steel.	Cast Steel.	Swedish Iron.	Plough Steel.	Ex. Strong Crucible Steel.	Cast Steel.	Swedish Iron.
2¾	12.	61.	53.	45.	22.8	11	10	10	16
2½	10.	50.	45.	38.	18.9	10	9½	9½	15
2¼	8.	41.	36.	31.	15.6	9	8½	8½	13
2	6.30	33.	28.	24.	12.4	8	8	8	12
1¾	4.85	25.	22.	19.	9.6	7½	7¼	7¼	10
1⅝	4.15	22.	19.	16.	8.4	6	6¼	6¼	8½
1½	3.55	19.	16.	14.	7.2	5½	5¾	5¾	7½
1⅜	3.00	16.	14.	12.	6.2	5¼	5½	5½	7
1¼	2.45	13.	11.	10.	5.0	5	5	5	6½
1⅓	2.00	11.	9.8	8.4	4.2	4½	4½	4½	6
1	1.58	8.8	7.8	6.8	3.4	4¼	4	4	5¼
7/8	1.20	6.8	6.0	5.2	2.6	3¾	3½	3½	4½
3/4	0.89	5.0	4.4	3.88	1.94	3½	3	3	4
5/8	0.62	3.6	3.16	2.72	1.36	3	2¾	2¾	3½
1/2	0.50	2.9	2.54	2.20	1.10	2½	1¾	1¾	2¾
1/2	0.39	2.28	2.02	1.76	.88	2	1½	1½	2¼
7/8	0.30	1.77	1.56	1.36	.68	1½	1¼	1¼	2
3/8	0.22	1.31	1.15	1.00	.50	1	1	1	1½
5/8	0.15	0.90	0.81	0.68	.34	7/8	2/8	2/8	1
1/4	0.10	0.60	0.54	0.48	.24	2/8	1/2	1/2	3/4

Practical Hints Regarding Saw Mills and the Care of Saws

A Right Hand Mill has the saw at the sawyer's right and runs toward him.

A Left Hand Mill has the saw at the sawyer's left and runs toward him.

SIZE OF SAWS.—With the Variable Feed Mill, any size saw can be used according to the size of logs—regardless of the amount of power used. With a large saw, a large pulley must be used on the mandrel to reduce the speed to correspond with the size of the saw and the power. The diameter of the saw should be about one and a half times the diameter of the log to be cut—a 36-inch log requires a 54-inch saw—a 40-inch log requires a 60-inch saw, and so on.

SPEED OF SAWS.—Speeding saws too high is a very common mistake—usually a serious and a foolish error of judgment. Manufacturers, in their catalogues, give the maximum speeds at which their saws may be operated with safety on the basis of the highest power the saws are calculated to withstand. These speeds cannot properly be used for portable mills for the reason that often the power used is not sufficient—they are put there for selling purposes of the saw-makers and to show what the saw will stand, not what it is supposed to do in practical work. While speed is power—it's easy to consume all the power in speed without doing any work. A 48-inch saw run by a 10 H. P. engine should have a speed of 300 revolutions a minute—slower if the saw has the usual number of teeth. About twenty-four teeth are necessary to give the best results at 300 revolutions—the usual number is 30—and usually works satisfactorily.

PORTABLE MILLS running with 20 H. P. and under should run the rim of the saw at a speed not exceeding 360 ft. per minute to each horse power. For example, multiply 360 by 10 H. P., and divide this by 12 ft. (circumference of the 48-inch saw), and you get 300 revolutions per minute. For smaller power the speed should be some higher in proportion, but the saw should have fewer teeth to make up for the higher speed. 20 H. P. and above should have more speed in proportion to the larger number of teeth. With this power the teeth should be 5 inches apart, which will give 30 teeth to the 48-inch saw. For a larger power, the teeth should be closer together until they reach the limit of 3 inches apart, and then as the power is increased the speed of the saw is increased to correspond. A saw must be speeded right to give the best results.

To aid in the selection of a saw and to determine its proper speed, we give the following table, based on a saw 48 inches in diameter:

Power	Distance from Point to Point of Teeth	Number of Teeth	Speed of Saw
6 H. P.	7 inches	22	300
8 "	7 "	22	300
10 "	6 "	24	300
12 "	6 "	24	350
15 "	5 "	30	400
20 "	5 "	30	450

To find the proper speed of larger or smaller saws, multiply the speed given of a 48-inch saw by 48 and divide the product by the size of the saw selected. A larger saw should have a greater number of teeth, and a smaller saw a lesser number, the distance apart remaining approximately the same.

Saws for cutting hardwood or frozen timber are usually run at higher speed and have a greater number of teeth.

Practical Hints Regarding Saw Mills and the Care of Saws

(Continued)

In ordering a saw mill or saw, the amount of power used, size and speed of driving pulley should always be given so that a pulley of the proper size may be sent with the mill and a suitable saw selected.

PROPER GAUGE OF SAWS.—For portable mills as a general rule we recommend 8"x9" gauge saws. For larger power where saws are run at high speed, or for cutting valuable hard woods we recommend 9"x10" gauge.

HOW TO HANG AND LINE SAWS.—It does not follow that because one saw will work well that another will do so on the same mandrel, or that two saws will hang alike on the same mandrel.

In hanging a new saw, after screwing it up between the collars examine carefully on the front or log side, and see if the front of the saw is flat. If it is found to be rounding on the log side, cut a ring of paper about half an inch wide, the size of the collar on the outside, oil it and stick it on the face of the fast collar around the outer edge. Then cut another ring of paper the same width, making the hole the same size as the hole in the loose collar; put this small ring between the loose collar and the saw, and screw up the collar. If the two rings are not enough, put in more until the saw comes flat and true. If the saw hangs dishing on the log side, reverse the rings of paper; that is, put the small rings between the saw and the fast collar, and the large ring against the loose collar. To do proper work, the saw must be perfectly flat and straight on the side next to the log.

DIRECTIONS FOR RUNNING CHISEL TOOTH SAWS.—First the saw should be placed on the mandrel where it is to be run, observing directions for hanging circular saws.

Should the saw run a little out of true on the rim, it may be made to run true by packing with writing paper between the saw and fast collar. It is necessary that the saw mandrel should be **perfectly level** so that the saw will hang **exactly plumb**.

Never attempt to run a saw **that is dishing** on the log side as it will be sure to draw towards the log. **The carriage track must be straight and level, so that the carriage can run true.**

HOW TO FILE AND KEEP IN ORDER CIRCULAR SAWS.—It is not well to file all of the teeth of circular saws from the same side of the saw, especially if each alternate tooth is bent for the set, but file one-half of the teeth from each side of the saw, and of the teeth that are bent from you, so as to leave them on a slight bevel—leave the outer corners a little the longest.

Never file any saw to sharp or acute angles at the throats or roots of the teeth, but on circular lines, as all saws are liable to crack from sharp corners.

Keep your saw round, so that each tooth will do its proportional part of the work.

Saw teeth wear narrow at the extreme points; consequently they must be kept spread so that they will be widest at the very points of the teeth; otherwise saws will not work successfully.

Teeth should be kept as near a uniform shape and distance apart as possible, in order to keep a circular saw in balance and condition for business.

Frosted steel is always brittle. No intelligent woodsman will use a good chopping axe on hard frozen timber until after he has taken the frost out of it, and no intelligent sawyer will attempt to set teeth of any saw without taking out the frost.

Practical Hints Regarding Saw Mills and the Care of Saws

(Continued)

The greatest wear on the saw is on the under edges of the teeth. File nearly to an edge (but not quite), leaving a short bevel of $\frac{1}{16}$ of an inch wide on the under side of the point. **But in no instance file to a fine point and thin wire edge.**

Be sure that the saw hangs properly on the mandrel.

The saw must be in proper line with the carriage and the carriage run true.

The mandrel must be level and run freely in the boxes.

Do nearly all the filing on the under sides of the teeth, and see that they are **well spread** at the points; file square and have them project alike on both sides of the saw.

If the saw heats in the center when the mandrel runs cool in the boxes, cool it off and line it into the log a little.

If the saw heats on the rim and not in the center, cool it off and line it out of the log a little—and vice versa if it heats in the centre. Every sawyer should have a side file to keep the teeth the same width.

Before commencing to insert the teeth, provide a cup of oil, which, together with the teeth, place conveniently near where you will stand, at the back of the saw. Take the wrench, place the pins in the holes in the shank, and turn it so that the hook projects sufficiently to receive the bit, pick up a tooth with the other hand and dip its grooved segment into the oil; then place in position and hold it firmly and even with the sides of the blade, while at the same time press the wrench downward until the shank fits into its place.

The chisel teeth are exact in width, and the spread uniformly good, and make smoother lumber than is made by the solid saw, even when not in the hands of first-class sawyers; but if extra nice work is desired, try a gauge on the side of each tooth, and if any are found to project a trifle too far, reduce them with a side file, being careful to preserve the same relief of the corner. No flat surface should be allowed on the sides of the teeth; they must be relieved from the very edge; then the saw will run straight, and with the least possible expenditure of power, and make smooth lumber. Practical use of the chisel bits has proven conclusively that in order to get the most and best use of them, when a set has been inserted and properly adjusted, they should remain until they are worn out, and as often as may be required edge them up by applying a file to their face or under side; after being sharpened several times they should be relieved on the side, so as to keep their corners sharp. Should a shank become straight or compressed, by reason of the saw having been run on iron, so that it will not hold the bit firmly, lay it on an anvil and strike it with a hammer on the inner edge until expended sufficiently to hold the bit.

Do not try the experiment of bending each alternate tooth for the set when using Inserted Tooth Saws.

Use a light hammer in swedging, about $\frac{3}{4}$ to 1 pound weight, holding the swedge so that the teeth will be spread at the points.

IN FILING SOLID-TOOTH CIRCULAR SAWS keep the throats or roots of the teeth round, or as the saws are when new. **Angles or square corners** filed at the roots of the teeth will almost invariably cause a saw to crack. The filing of such angles or square corners will cancel the warranty on any saw. **The back or top of the tooth leads or guides the saw** and should be filed square across. The under sides of the teeth may be filed a little beveled when they are bent alternately for the set, so as to leave the outer corner of the cutting edge longest.

LIST of BULLETINS

Issued to date by the

Joshua Hendy Iron Works

Iron Founders, Engineers and
Machinery Merchants

75 Fremont St., San Francisco, Cal.

No.	Subject	Date	Condition
100	Pinder Concentrator	Nov. 1906,	Issued
101	Hendy Two and Three-stamp Mills,	Nov. 1906,	Exhausted (See No. 113)
102	Davis Horse Whim	Oct. 1906,	Issued
103	Ore and Water Buckets	Jan. 1907,	Issued
104	Hendy Standard Ore Cars	Mar. 1907,	Issued
105	Hydraulic Water Gates, etc.	Feb. 1907,	Issued
106	Hendy Hydraulic Giants	April 1907,	Issued
107	Ore Crushers	May 1907,	Exhausted (See No. 117)
108	Winches, Derricks, etc.	Nov. 1907,	Issued
110	Hendy Fire Monitors	Nov. 1907,	Issued
111	Hendy Gravel Elevators	Aug. 1908,	Issued
113	Hendy Two and Three-stamp Mills,	June 1908,	Issued
114	Tangential Water Wheels, etc.	Dec. 1908,	Issued
115	Matteson Ore Cars	Dec. 1908,	Issued
116	Graupner Centrifugal Roller Mill	Dec. 1908,	Issued
117	Crushers and Crushing Rolls	Dec. 1908,	Exhausted (See No. 121)
118	Challenge Ore Feeders	Dec. 1908,	Issued
119	Stamp Mills, Standard	Jan. 1910,	In Press
120	Stamp Mill Accessories	Jan. 1910,	Issued
121	Crushers and Crushing Rolls	Jan. 1910,	Issued

Other Bulletins in Preparation

January 15th, 1910

INDEX

	Page
Air, Compression of	120-123
Areas of Circles	104
Belting	117
Board Measure	118-119
Boilers	112-113
Buildings, Mill, Approx. Cost of	108
Buildings, Mill, Material for	109
Casing, Oil Gas and Well	111
Circles, Areas and Circumferences	104
Concrete, Mixture of	109
Drills, Air required for	123
Engines, Horsepower of	114
Factors, Mathematical	100
Gauges, Standard Iron and Steel Plate	102
Gears, Horsepower of	116
Hoisting on Inclines	124-125
Inclines, Hoisting on	124-125
Iron, Weights of	102-103
Measure, Board	118-119
Measure Tables	101
Metric Tables	101
Mills, Saw	126
Mills, Stamp	108-109
Miners Inch of Water	110
Multipliers, Useful	100
Pipe, Gas, Water and Steam	111
Power Required for Mill Parts	115
Pulleys	116
Pumping	110
Recipes, Workshop	105-107
Ropes, Wire	125
Saws	126-128
Shafting	116
Steel, Weights of	102-103
Water	110
Water Required for Mill Parts	115
Weight Tables	101

UNIVERSITY OF CALIFORNIA LIBRARY

This book is DUE on the last date stamped below
Fine schedule: 25 cents on first day overdue
50 cents on fourth day overdue
One dollar on seventh day overdue.

NOV 4 1947

18 Mar '49 LB

6 May '49 GR

E 24 Mar '52 SA

10 Mar 5 21

5 Feb '60 RB

REC'D LD

JAN 26 1954

337661

Heady

UNIVERSITY OF CALIFORNIA LIBRARY

