DEPARTMENT OF COMMERCE

CIRCULAR

OF THE

BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 43

JEWELERS' AND SILVERSMITHS' WEIGHTS AND MEASURES

(2d Edition)

A revised and enlarged edition of Bureau of Standards Circular No. 43 (1st edition), issued November 1, 1913 entitled "The Metric Carat"

JANUARY 24, 1921

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JEWELERS' AND SILVERSMITHS' WEIGHTS AND MEASURES [1]

CONTENTS

[1] Prepared by A. F. Beal, Associate Physicist, Bureau of Standards.

I. INTRODUCTION

1. ADOPTION OF THE NEW METRIC CARAT

The carat weights in use previous to July 1, 1913, in different countries had differed greatly, scarcely any two of the important countries having the same standard. Even within the United States there was not agreement in the standard used, the various makers of weights using slightly different standards. This led to considerable confusion in the weighing of gems, and was the more serious because of the great value of the article.

Beginning July 1, 1913, the international metric carat of 200 milligrams as the unit of weight for diamonds and other precious stones was put into commercial use in the United States by practically all the dealers in gems and precious stones through the efforts of a committee representing all the principal firms handling gems. On the same date the Treasury Department of the United States Government also began the use of this unit in the customs service for the levying of import duties on precious stones, and the Bureau of Standards recognized this unit for purposes of certification of all carat weights submitted to the Bureau for test.

The movement for the adoption of a uniform, decimally divided standard was a decided step forward and therefore has met with success. The new metric carat of 200 milligrams is universally used in the United States and has been officially adopted by Belgium, Bulgaria, Denmark, England, France, Germany, Holland, Italy, Japan, Norway, Portugal, Roumania, Spain, Sweden, and Switzerland. The Bureau of Standards in 1913 prepared tables for converting "old" carats to new metric carats, and vice versa, and published them as Circular No. 43. These tables were of great aid at the time to the transition from the old unit of about 205.3 milligrams and binary fractions to the new unit and decimal fractions.

2. PROPOSED ADOPTION OF THE METRIC SYSTEM

The inconvenience and inefficient use of the present system of pennyweights and grains as opposed to the benefits derived from the use of the new metric decimally divided carat has become so pronounced that the Bureau was invited to prepare a practical working outline of the metric system that would suit the needs of the jewelry trade and allied industries. The purpose of this is to make it easily possible for jewelers and silversmiths to substitute the gram for the dual unit of pennyweights and grains [2] and also to use the metric system in all of their work.

[2] It is desirable to note in this connection that all medical prescriptions of the U. S. Army must be expressed in metric units, not in grains.

The Bureau therefore is publishing this circular giving tables of the relations between the customary units and the corresponding ones of the metric system. There is also given information that is of interest to other branches of the jewelry trade, such as the comparative table for the diameters corresponding to the sizes of watches.

With this edition, the material on the metric carat has been revised, and, because of the large amount of new material which has been added to the publication, the title has been changed.

II. THE METRIC SYSTEM

1. DESCRIPTION

(a) LEGAL STATUS

The metric system was rendered legal for all transactions in the United States by an act of Congress, approved July 28, 1866, and is now legal or obligatory in all commercial countries. Many industries in the United States are using it. In Europe, and also in many other parts of the world, more measurements are made in metric terms than in any other system. The metric system must be understood by those who deal intelligently with their customers in the metric countries.

(b) GENERAL OUTLINE

The meter for measuring length, the liter for measuring capacity, and the gram for weight form the basis of the metric system. These units, together with the multiples and subdivisions given in the following table,[3] are sufficient for practical purposes and are recognized in all countries.

	Correct English spelling	Standard abbreviations
Length	10 millimeters = 1 centimeter	10 mm = 1 cm
	100 centimeters = 1 meter	100 cm = 1 m
	1000 meters = 1 kilometer	1000 m = 1 km
Capacity	1000 milliliters = 1 liter	1000 ml = 1 l
Weight	1000 milligrams = 1 gram	1000 mg = 1 g
	1000 grams = 1 kilogram	1000 g = 1 kg
	1000 kilograms = 1 metric ton	1000 kg = 1 t

[3] Additional units, multiples, and subdivisions, which may be needed occasionally, are given later under "Definitions of Units," pp. 11 to 14.
Tables giving the interrelation of units of measurement may be found in Bureau Circular No. 47.

FIG. 1.—*Relative values of the centimeter and the inch.*

Slight changes in the paper due to humidity will alter the absolute but not the relative dimensions shown

Complete metric tables are formed by combining the words "METER," "LITER," and "GRAM" with the six numerical prefixes as in the following tables:

Prefixes	Meaning			Units
milli-	= *one-thousandth*	$\frac{1}{1000}$	.001	
centi-	= *one-hundredth*	$\frac{1}{100}$	.01	"meter" *for length*
deci-	= *one-tenth*	$\frac{1}{10}$	.1	
Unit	= *one*		1	"liter" *for capacity*
deka-	= *ten*	$\frac{10}{1}$	10	
hecto-	= *one hundred*	$\frac{100}{1}$	100	"gram" *for weight or mass*
kilo-	= *one thousand*	$\frac{1000}{1}$	1000	

The metric unit of length for jewelers and silversmiths is the millimeter, or one-thousandth of a meter; the millimeter is the size of the smallest space shown in Fig. 1. It is also very nearly the diameter of a No. 18 wire of American (Brown & Sharpe) wire gage. For very small values of length, such as the thickness of the plating on an electroplated article, it is convenient to use the "micron," which is one-thousandth of a millimeter. The smallest subdivision on the head of a micrometer with a millimeter screw usually is 0.01 millimeter, or 10 microns. In working material to a given dimension within a quarter of a thousandth of an inch, the accuracy obtained is 6 microns. An inch equals almost exactly 25.4 millimeters.

The liter is the standard unit of capacity and is divided into a thousand equal parts called milliliters. For ordinary purposes, the liter [4] is equivalent to a

[4] There is a minute distinction between the liter and 1000 cubic centimeters which is used only in work of extreme precision. See "Fundamental Relationship," page 9.

cubic measure 10 centimeters on each edge, or 1000 cubic centimeters. A liter is a trifle larger than a U. S. liquid quart.

The gram is the unit of mass (or weight); 1000 grams make a kilogram. The kilogram is exactly the mass of a liter of water when at the temperature of 4° C (39.2° F). The gram is frequently subdivided into 1000 parts called milligrams. For a small article (less than 1 gram) the weight usually is expressed in milligrams. A piece of platinum wire one-half inch long and American (B. & S.) wire gage No. 30 weighs about 14 milligrams; if of copper wire it weighs about 6 milligrams. A one-half carat diamond weighs exactly 100 milligrams. For large weighings, or in expressing the sum of several weighings, it is convenient to use the gram even up to about 10 000 grams, or 10 kilograms, thus avoiding the change from one unit to another. In the metric system a quantity is always expressed in terms of only one unit. The gram equals about 15.4 grains, and the kilogram is about 2.2 avoirdupois pounds.

A change to a larger or smaller metric measure of length, area, volume, capacity, or weight is effected by merely multiplying or dividing by 10 or a multiple of 10. This enables those who use the metric system to make accurate mental and written calculations with a rapidity which would otherwise be impossible.

(c) FUNDAMENTAL RELATIONSHIPS

The tables in this circular have been prepared to aid in changing values from one system of weights and measures to another. The U. S. units are referred to except when otherwise indicated. The tables have been based upon the following equivalents:

39.37 United States inches	=1 meter
1 United States gallon	=231 cubic inches
1 liter	=1000.027 cubic centimeters
1 United States avoirdupois pound	=0.4535924277 kilogram

The values in most of the tables have been expressed with the accuracy usually required at the bench. In some cases, however, many figures are given for use in connection with precise work. Equivalents, such as those in the tables given on pages 15, 20, 21, and 22, should be used only to the required degree of accuracy. For example, in Table 2, page 15, it is stated that 4 inches are equal to 10.16002 centimeters. This may be rounded off, giving 4 inches equal to 10.2 centimeters, or, if less accuracy is desired, the approximate value of 10 centimeters may be used.

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(d) SPELLING AND ABBREVIATION OF UNITS

The spelling of the names of metric units is that given in the law of July 28, 1866, legalizing the metric system in the United States.

The following principles of abbreviation have been adopted by the Bureau in conformity with international agreement.

1. The period is omitted after the abbreviations of the metric units, while it is used after those of the customary system.

2. The same abbreviation is used for both singular and plural.

3. Unless all of the text is printed in capital letters, only small letters are used for abbreviations (except in the case of A. for acre, where the use of the capital letter is general).

4. The exponents "^{2}" and "^{3}" following abbreviations of units of length, are used to signify area and volume, respectively, in the case of the metric units instead of the longer prefixes "sq." and "cu." In conformity with this principle the abbreviation for cubic centimeter is "cm^3" in preference to any other usual practice.

(e) SPECIAL WAYS TO USE THE TABLES

When the tables do not give the equivalent of any desired quantity directly and completely, the equivalent can usually be obtained without the necessity of making a multiplication. This is done by using quantities from different parts of the same table or from several tables, making a shift of decimal points if necessary, and merely adding the results. For example:

1. Convert 27.3 millimeters into inches. (Refer to Table 1, p. 15.)

2 mm=0.07874 inch, hence	20.0 mm=0.7874 inch
	7.0 mm= .27559 inch
3 mm= .11811 inch, hence	.3 mm= .01181 inch
	27.3 mm=1.0748 inches

2. Convert 1.0748 inches into millimeters. (Refer to Table 1, p. 15.)

1 inch		=25.400 mm
7 inches=177.8 mm, hence	0.07 inch	= 1.778 mm
4 inches=101.6 mm, hence	.004 inch	= .102 mm
8 inches=203.2 mm, hence	.0008 inch	= .020 mm
	1.0748 inches	=27.300 mm

3. Convert 253 pennyweights 13.5 grains into grams.

200 pennyweights (Table 34, p. 24)	=311.035 g
53 pennyweights (Table 34, p. 24)	= 82.424 g
13 grains (Table 32, p. 23)	= .842 g
5 grains=0.324 g, hence 0.5 grain	= .032 g
253 pennyweights 13.5 grains	=394.333 g

2. DEFINITIONS OF UNITS

(a) LENGTH

Fundamental Units

A METER (m) is a unit of length equivalent to the distance between the defining lines on the international prototype meter at the International Bureau of Weights and Measures when this standard is at the temperature of melting ice (0° C).

A YARD (yd.) is a unit of length equivalent to $\frac{3600}{3937}$ of a meter.

Multiples and Submultiples

1 kilometer (km) = 1000 meters.
1 hectometer (hm) = 100 meters.
1 dekameter (dkm) = 10 meters.
1 decimeter (dm) = 0.1 meter.
1 centimeter (cm) = 0.01 meter.
1 millimeter (mm) = 0.001 meter = 0.1 centimeter.
1 micron (μ) = 0.000001 meter = 0.001 millimeter.
1 millimicron (mμ) = 0.000000001 meter = 0.001 micron.
1 foot (ft.) = $\frac{1}{3}$ yard = $\frac{1200}{3937}$ meter.
1 inch (in.) = $\frac{1}{36}$ yard = $\frac{1}{12}$ foot = $\frac{100}{3937}$ meter.
1 link (li.) = 0.22 yard = 7.92 inches.
1 rod (rd.) = $5\frac{1}{2}$ yards = $16\frac{1}{2}$ feet.
1 chain (ch.) = 22 yards = 100 links = 66 feet = 4 rods.
1 furlong (fur.) = 220 yards = 40 rods = 10 chains.
1 statute mile (mi.) = 1760 yards = 5280 feet = 320 rods.
1 hand = 4 inches.
1 point (printers') = $\frac{1}{72}$ inch (approximately).
1 point (silversmiths') = $\frac{1}{4000}$ inch.
1 mil = 0.001 inch.
1 fathom = 6 feet.
1 span = 9 inches = $\frac{1}{8}$ fathom.
1 nautical mile
1 sea mile
1 geographical mile
} United States = 6080.20 feet = 1.151553 statute miles = 1853.249 meters.

(b) AREA

Fundamental Units

A SQUARE METER (m^2) is a unit of area equivalent to the area of a square the sides of which are 1 meter.

A SQUARE YARD (sq. yd.) is a unit of area equivalent to the area of a square the sides of which are 1 yard.

Multiples and Submultiples

1 square kilometer (km^2) = 1 000 000 square meters.
1 hectare (ha), or square hectometer (hm^2) = 10 000 square meters.
1 are (a), or square dekameter (dkm^2) = 100 square meters.
1 centare (ca) = 1 square meter.
1 square decimeter (dm^2) = 0.01 square meter.
1 square centimeter (cm^2) = 0.0001 square meter.
1 square millimeter (mm^2) = 0.000001 square meter = 0.01 square centimeter.
1 square foot (sq. ft.) = $\frac{1}{9}$ square yard.
1 square inch (sq. in.) = $\frac{1}{1296}$ square yard = $\frac{1}{144}$ square foot.
1 square link (sq. li.) = 0.0484 square yard = 62.7264 square inches.
1 square rod (sq. rd.) = 30.25 square yards = 272.25 square feet = 625 square links.
1 square chain (sq. ch.) = 484 square yards = 16 square rods = 100 000 square links.
1 acre (A.) = 4840 square yards = 160 square rods = 10 square chains.
1 square mile (sq. mi.) = 3 097 600 square yards = 640 acres.

(c) VOLUME

Fundamental Units

A CUBIC METER (m^3) is a unit of volume equivalent to a cube the edges of which are 1 meter.

A CUBIC YARD (cu. yd.) is a unit of volume equivalent to a cube the edges of which are 1 yard.

Multiples and Submultiples

1 cubic kilometer (km^3) = 1 000 000 000 cubic meters.
1 cubic hectometer (hm^3) = 1 000 000 cubic meters.
1 cubic dekameter (dkm^3) = 1000 cubic meters.
1 stere (s) = 1 cubic meter.
1 cubic decimeter (dm^3) = 0.001 cubic meter.
1 cubic centimeter (cm^3) = 0.000001 cubic meter = 0.001 cubic decimeter.
1 cubic millimeter (mm^3) = 0.000000001 cubic meter = 0.001 cubic centimeter.
1 cubic foot (cu. ft.) = $\frac{1}{27}$ cubic yard.
1 cubic inch (cu. in.) = $\frac{1}{46656}$ cubic yard = $\frac{1}{1728}$ cubic foot.
1 board foot = 144 cubic inches = $\frac{1}{12}$ cubic foot.
1 cord (cd.) = 128 cubic feet.

(d) CAPACITY

Fundamental Units

A LITER (l) is a unit of capacity equivalent to the volume occupied by the mass of 1 kilogram of pure water at its maximum density (at a temperature of 4° C, practically) and under the standard atmospheric pressure (of 760 mm). It is equivalent in volume to 1.000027 cubic decimeters.

A GALLON (gal.) is a unit of capacity equivalent to the volume of 231 cubic inches. It is used for the measurement of liquid commodities only.

A BUSHEL (bu.) is a unit of capacity equivalent to the volume of 2150.42 cubic inches. It is used in the measurement of dry commodities only.[5]

Multiples and Submultiples

1 hectoliter (hl) = 100 liters.
1 dekaliter (dkl) = 10 liters.
1 deciliter (dl) = 0.1 liter.
1 centiliter (cl) = 0.01 liter.
1 milliliter (ml) = 0.001 liter = 1.000027 cubic centimeters.
1 liquid quart (liq. qt.) = $\frac{1}{4}$ gallon = 57.75 cubic inches.
1 liquid pint (liq. pt.) = $\frac{1}{8}$ gallon = $\frac{1}{2}$ liquid quart = 28.875 cubic inches.
1 gill (gi.) = $\frac{1}{32}$ gallon = $\frac{1}{4}$ liquid pint = 7.21875 cubic inches.
1 fluid ounce (fl. oz.) = $\frac{1}{128}$ gallon = $\frac{1}{16}$ liquid pint.
1 fluid dram (fl. dr.) = $\frac{1}{8}$ fluid ounce = $\frac{1}{128}$ liquid pint.
1 minim (min. or ♏) = $\frac{1}{60}$ fluid dram = $\frac{1}{480}$ fluid ounce.
1 firkin = 9 gallons.
1 peck (pk.) = $\frac{1}{4}$ bushel = 537.605 cubic inches.
1 dry quart (dry qt.) = $\frac{1}{32}$ bushel = $\frac{1}{8}$ peck = 67.200625 cubic inches.
1 dry pint (dry pt.) = $\frac{1}{64}$ bushel = $\frac{1}{2}$ dry quart = 33.6003125 cubic inches.
1 barrel (for fruit, vegetables, and other dry commodities)[6] = 7056 cubic inches = 105 dry quarts.

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[5] The above bushel is the so-called stricken or struck bushel. Many dry commodities are sold by heaped bushel, which is generally specified in the State laws to be the usual stricken bushel measure "duly heaped in the form of a cone as high as the article will admit" or "heaped as high as may be without special effort or design." The heaped bushel was originally intended to be 25 per cent greater than the stricken bushel.

[6] As fixed by United States statute, approved Mar. 4, 1915.

(e) MASS

Fundamental Units

A KILOGRAM (kg) is a unit of mass equivalent to the mass of the international prototype kilogram at the International Bureau of Weights and Measures.

An AVOIRDUPOIS POUND (lb. av.) is a unit of mass equivalent to 0.4535924277 kilogram.

A GRAM (g) is a unit of mass equivalent to one-thousandth of the mass of the international prototype kilogram at the International Bureau of Weights and Measures.

A TROY POUND (lb. t.) is a unit of mass equivalent to $\frac{5760}{7000}$ of that of the avoirdupois pound.

Multiples and Submultiples

1 metric ton (t) = 1000 kilograms.

1 hectogram (hg) = 100 grams = 0.1 kilogram.

1 dekagram (dkg) = 10 grams = 0.01 kilogram.

1 decigram (dg) = 0.1 gram.

1 centigram (cg) = 0.01 gram.

1 milligram (mg) = 0.001 gram.

1 avoirdupois ounce (oz. av.) = $\frac{1}{16}$ avoirdupois pound.

1 avoirdupois dram (dr. av.) = $\frac{1}{256}$ avoirdupois pound = $\frac{1}{16}$ avoirdupois ounce.

1 grain (gr.) = $\frac{1}{7000}$ avoirdupois pound = $\frac{16}{4375}$ avoirdupois ounce = $\frac{1}{5760}$ troy pound.

1 apothecaries' pound (lb. ap.) = 1 troy pound = $\frac{5760}{7000}$ avoirdupois pound.

1 apothecaries' or troy ounce (oz. ap., or ℥, or oz. t.) = $\frac{1}{12}$ troy pound = $\frac{480}{7000}$ avoirdupois pound = 480 grains.

1 apothecaries' dram (dr. ap. or ʒ) = $\frac{1}{96}$ apothecaries' pound = ⅛ apothecaries' ounce = 60 grains.

1 pennyweight (dwt.) = $\frac{1}{20}$ troy ounce = 24 grains.

1 apothecaries' scruple (s. ap. or ℈) = ⅓ apothecaries' dram = 20 grains.

1 metric carat (c) = 200 milligrams = 0.2 gram.

1 short hundredweight (sh. cwt.) = 100 avoirdupois pounds.

1 long hundredweight (l. cwt.) = 112 avoirdupois pounds.

1 short ton = 2000 avoirdupois pounds.

1 long ton = 2240 avoirdupois pounds.

3. LENGTH CONVERSION TABLES

TABLE 1		TABLE 2		TABLE 3		TABLE 4	
Inches [a]	Millimeters [a]	Inches	Centimeters	Feet	Meters	Yards	Meters
1	= 25.4001	1	= 2.54001	1	= 0.304801	1	= 0.914402
2	= 50.8001	2	= 5.08001	2	= .609601	2	= 1.828804
3	= 76.2002	3	= 7.62002	3	= .914402	3	= 2.743205
4	= 101.6002	4	= 10.16002	4	= 1.219202	4	= 3.657607
5	= 127.0003	5	= 12.70003	5	= 1.524003	5	= 4.572009
6	= 152.4003	6	= 15.24003	6	= 1.828804	6	= 5.486411
7	= 177.8004	7	= 17.78004	7	= 2.133604	7	= 6.400813
8	= 203.2004	8	= 20.32004	8	= 2.438405	8	= 7.315215
9	= 228.6005	9	= 22.86005	9	= 2.743205	9	= 8.229616
0.03937 =	1	0.3937 =	1	3.28083 =	1	1.093611 =	1
.07874 =	2	.7874 =	2	6.56167 =	2	2.187222 =	2
.11811 =	3	1.1811 =	3	9.84250 =	3	3.280833 =	3
.15748 =	4	1.5748 =	4	13.12333 =	4	4.374444 =	4
.19685 =	5	1.9685 =	5	16.40417 =	5	5.468056 =	5
.23622 =	6	2.3622 =	6	19.68500 =	6	6.561667 =	6
.27559 =	7	2.7559 =	7	22.96583 =	7	7.655278 =	7
.31496 =	8	3.1496 =	8	26.24667 =	8	8.748889 =	8
.35433 =	9	3.5433 =	9	29.52750 =	9	9.842500 =	9

[a] See also extended Tables 6 and 7.

TABLE 5.—Decimal and Metric Equivalents of Common (Binary) Fractions of an Inch

Fractions of inch: Eighths and quarters	Fractions of inch: Decimal	Equivalent in millimeters
1/8	0.125	3.175
1/4	.250	6.350
3/8	.375	9.525
1/2	.500	12.700
5/8	.625	15.875
3/4	.750	19.050
7/8	.875	22.225
Sixteenths:		
1	.0625	1.588
3	.1875	4.763
5	.3125	7.938
7	.4375	11.113
9	.5625	14.288
11	.6875	17.463
13	.8125	20.638
15	.9375	23.813
Thirty-seconds:		
1	.03125	.794
3	.09375	2.381
5	.15625	3.969
7	.21875	5.556
9	.28125	7.144
11	.34375	8.731
13	.40625	10.319
15	.46875	11.906
17	.53125	13.494
19	.59375	15.081
21	.65625	16.669
23	.71875	18.256
25	.78125	19.844
27	.84375	21.431
29	.90625	23.019
31	.96875	24.606

Fractions of inch: Sixty-fourths	Fractions of inch: Decimal	Equivalent in millimeters
1	0.015625	0.397
3	.046875	1.191
5	.078125	1.984
7	.109375	2.778
9	.140625	3.572
11	.171875	4.366
13	.203125	5.159
15	.234375	5.953
17	.265625	6.747
19	.296875	7.541
21	.328125	8.334
23	.359375	9.128
25	.390625	9.922
27	.421875	10.716
29	.453125	11.509
31	.484375	12.303
33	.515625	13.097
35	.546875	13.891
37	.578125	14.684
39	.609375	15.478
41	.640625	16.272
43	.671875	17.066
45	.703125	17.859
47	.734375	18.653
49	.765625	19.447
51	.796875	20.241
53	.828125	21.034
55	.859375	21.828
57	.890625	22.622
59	.921875	23.416
61	.953125	24.209
63	.984375	25.003

TABLE 6.—Conversion of Inches to Millimeters

[From 0.000 to 1.000 inch by 0.001 inch; 1 inch = 25.40005 mm. 1 "point" (as used by silversmiths) = one-fourth of one thousandth of an inch[a]]

Points[a]	Inch	Millimeters	Inch	Millimeters	Inch	Millimeters	Inch	Millimeters	Inch	Millimeters	Inch	Millimeters	Inch	Millimeters	Inch	Millimeters	Inch	Millimeters	Inch	Millimeters	Inch	Millimeters
0	0.0000	0.000	0.000	0.000	0.100	2.54	0.200	5.08	0.300	7.62	0.400	10.16	0.500	12.70	0.600	15.24	0.700	17.78	0.800	20.32	0.900	22.86
1	.00025	.006	.001	.025	.101	2.57	.201	5.11	.301	7.65	.401	10.19	.501	12.73	.601	15.27	.701	17.81	.801	20.35	.901	22.89
2	.0005	.013	.002	.051	.102	2.59	.202	5.13	.302	7.67	.402	10.21	.502	12.75	.602	15.29	.702	17.83	.802	20.37	.902	22.91
3	.00075	.019	.003	.076	.103	2.62	.203	5.16	.303	7.70	.403	10.24	.503	12.78	.603	15.32	.703	17.86	.803	20.40	.903	22.94
4	.001	.025	.004	.102	.104	2.64	.204	5.18	.304	7.72	.404	10.26	.504	12.80	.604	15.34	.704	17.88	.804	20.42	.904	22.96
5	.00125	.032	.005	.127	.105	2.67	.205	5.21	.305	7.75	.405	10.29	.505	12.83	.605	15.37	.705	17.91	.805	20.45	.905	22.99
6	.0015	.038	.006	.152	.106	2.69	.206	5.23	.306	7.77	.406	10.31	.506	12.85	.606	15.39	.706	17.93	.806	20.47	.906	23.01
7	.00175	.044	.007	.178	.107	2.72	.207	5.26	.307	7.80	.407	10.34	.507	12.88	.607	15.42	.707	17.96	.807	20.50	.907	23.04
8	.002	.051	.008	.203	.108	2.74	.208	5.28	.308	7.82	.408	10.36	.508	12.90	.608	15.44	.708	17.98	.808	20.52	.908	23.06
9	.00225	.057	.009	.229	.109	2.77	.209	5.31	.309	7.85	.409	10.39	.509	12.93	.609	15.47	.709	18.01	.809	20.55	.909	23.09
10	.0025	.064	.010	.254	.110	2.79	.210	5.33	.310	7.87	.410	10.41	.510	12.95	.610	15.49	.710	18.03	.810	20.57	.910	23.11
11	.00275	.070	.011	.279	.111	2.82	.211	5.36	.311	7.90	.411	10.44	.511	12.98	.611	15.52	.711	18.06	.811	20.60	.911	23.14
12	.003	.076	.012	.305	.112	2.84	.212	5.38	.312	7.92	.412	10.46	.512	13.00	.612	15.54	.712	18.08	.812	20.62	.912	23.16
13	.00325	.083	.013	.330	.113	2.87	.213	5.41	.313	7.95	.413	10.49	.513	13.03	.613	15.57	.713	18.11	.813	20.65	.913	23.19
14	.0035	.089	.014	.356	.114	2.90	.214	5.44	.314	7.98	.414	10.52	.514	13.06	.614	15.60	.714	18.14	.814	20.68	.914	23.22
15	.00375	.095	.015	.381	.115	2.92	.215	5.46	.315	8.00	.415	10.54	.515	13.08	.615	15.62	.715	18.16	.815	20.70	.915	23.24
16	.004	.102	.016	.406	.116	2.95	.216	5.49	.316	8.03	.416	10.57	.516	13.11	.616	15.65	.716	18.19	.816	20.73	.916	23.27
17	.00425	.108	.017	.432	.117	2.97	.217	5.51	.317	8.05	.417	10.59	.517	13.13	.617	15.67	.717	18.21	.817	20.75	.917	23.29
18	.0045	.114	.018	.457	.118	3.00	.218	5.54	.318	8.08	.418	10.62	.518	13.16	.618	15.70	.718	18.24	.818	20.78	.918	23.32
19	.00475	.121	.019	.483	.119	3.02	.219	5.56	.319	8.10	.419	10.64	.519	13.18	.619	15.72	.719	18.26	.819	20.80	.919	23.34
20	.005	.127	.020	.508	.120	3.05	.220	5.59	.320	8.13	.420	10.67	.520	13.21	.620	15.75	.720	18.29	.820	20.83	.920	23.37
21	.00525	.133	.021	.533	.121	3.07	.221	5.61	.321	8.15	.421	10.69	.521	13.23	.621	15.77	.721	18.31	.821	20.85	.921	23.39
22	.0055	.140	.022	.559	.122	3.10	.222	5.64	.322	8.18	.422	10.72	.522	13.26	.622	15.80	.722	18.34	.822	20.88	.922	23.42
23	.00575	.146	.023	.584	.123	3.12	.223	5.66	.323	8.20	.423	10.74	.523	13.28	.623	15.82	.723	18.36	.823	20.90	.923	23.44
24	.006	.152	.024	.610	.124	3.15	.224	5.69	.324	8.23	.424	10.77	.524	13.31	.624	15.85	.724	18.39	.824	20.93	.924	23.47
25	.00625	.159	.025	.635	.125	3.18	.225	5.72	.325	8.26	.425	10.80	.525	13.34	.625	15.88	.725	18.42	.825	20.96	.925	23.50
26	.0065	.165	.026	.660	.126	3.20	.226	5.74	.326	8.28	.426	10.82	.526	13.36	.626	15.90	.726	18.44	.826	20.98	.926	23.52
27	.00675	.171	.027	.686	.127	3.23	.227	5.77	.327	8.31	.427	10.85	.527	13.39	.627	15.93	.727	18.47	.827	21.01	.927	23.55
28	.007	.178	.028	.711	.128	3.25	.228	5.79	.328	8.33	.428	10.87	.528	13.41	.628	15.95	.728	18.49	.828	21.03	.928	23.57
29	.00725	.184	.029	.737	.129	3.28	.229	5.82	.329	8.36	.429	10.90	.529	13.44	.629	15.98	.729	18.52	.829	21.06	.929	23.60
30	.0075	.191	.030	.762	.130	3.30	.230	5.84	.330	8.38	.430	10.92	.530	13.46	.630	16.00	.730	18.54	.830	21.08	.930	23.62
31	.00775	.197	.031	.787	.131	3.33	.231	5.87	.331	8.41	.431	10.95	.531	13.49	.631	16.03	.731	18.57	.831	21.11	.931	23.65
32	.008	.203	.032	.813	.132	3.35	.232	5.89	.332	8.43	.432	10.97	.532	13.51	.632	16.05	.732	18.59	.832	21.13	.932	23.67
33	.00825	.210	.033	.838	.133	3.38	.233	5.92	.333	8.46	.433	11.00	.533	13.54	.633	16.08	.733	18.62	.833	21.16	.933	23.70
34	.0085	.216	.034	.864	.134	3.40	.234	5.94	.334	8.48	.434	11.02	.534	13.56	.634	16.10	.734	18.64	.834	21.18	.934	23.72
35	.00875	.222	.035	.889	.135	3.43	.235	5.97	.335	8.51	.435	11.05	.535	13.59	.635	16.13	.735	18.67	.835	21.21	.935	23.75
36	.009	.229	.036	.914	.136	3.45	.236	5.99	.336	8.53	.436	11.07	.536	13.61	.636	16.15	.736	18.69	.836	21.23	.936	23.77
37	.00925	.235	.037	.940	.137	3.48	.237	6.02	.337	8.56	.437	11.10	.537	13.64	.637	16.18	.737	18.72	.837	21.26	.937	23.80
38	.0095	.241	.038	.965	.138	3.51	.238	6.05	.338	8.59	.438	11.13	.538	13.67	.638	16.21	.738	18.75	.838	21.29	.938	23.83
39	.00975	.248	.039	.991	.139	3.53	.239	6.07	.339	8.61	.439	11.15	.539	13.69	.639	16.23	.739	18.77	.839	21.31	.939	23.85
40	.010	.254	.040	1.016	.140	3.56	.240	6.10	.340	8.64	.440	11.18	.540	13.72	.640	16.26	.740	18.80	.840	21.34	.940	23.88
41	.01025	.260	.041	1.041	.141	3.58	.241	6.12	.341	8.66	.441	11.20	.541	13.74	.641	16.28	.741	18.82	.841	21.36	.941	23.90
42	.0105	.267	.042	1.067	.142	3.61	.242	6.15	.342	8.69	.442	11.23	.542	13.77	.642	16.31	.742	18.85	.842	21.39	.942	23.93
43	.01075	.273	.043	1.092	.143	3.63	.243	6.17	.343	8.71	.443	11.25	.543	13.79	.643	16.33	.743	18.87	.843	21.41	.943	23.95
44	.011	.279	.044	1.118	.144	3.66	.244	6.20	.344	8.74	.444	11.28	.544	13.82	.644	16.36	.744	18.90	.844	21.44	.944	23.98
45	.01125	.286	.045	1.143	.145	3.68	.245	6.22	.345	8.76	.445	11.30	.545	13.84	.645	16.38	.745	18.92	.845	21.46	.945	24.00
46	.0115	.292	.046	1.168	.146	3.71	.246	6.25	.346	8.79	.446	11.33	.446	13.87	.646	16.41	.746	18.95	.846	21.49	.946	24.03
47	.01175	.298	.047	1.194	.147	3.73	.247	6.27	.347	8.81	.447	11.35	.547	13.89	.647	16.43	.747	18.97	.847	21.51	.947	24.05
48	.012	.305	.048	1.219	.148	3.76	.248	6.30	.348	8.84	.448	11.38	.548	13.92	.648	16.46	.748	19.00	.848	21.54	.948	24.08
49	.01225	.311	.049	1.245	.149	3.78	.249	6.32	.349	8.86	.449	11.40	.549	13.94	.649	16.48	.749	19.02	.849	21.56	.949	24.10

50	.0125	.318	.050	1.270	.150	3.81	.250	6.35	.350	8.89	.450	11.43	.550	13.97	.650	16.51	.750	19.05	.850	21.59	.950	24.13
51	.01275	.324	.051	1.295	.151	3.84	.251	6.38	.351	8.92	.451	11.46	.551	14.00	.651	16.54	.751	19.08	.851	21.62	.951	24.16
52	.013	.330	.052	1.321	.152	3.86	.252	6.40	.352	8.94	.452	11.48	.552	14.02	.652	16.56	.752	19.10	.852	21.64	.952	24.18
53	.01325	.337	.053	1.346	.153	3.89	.253	6.43	.353	8.97	.453	11.51	.553	14.05	.653	16.59	.753	19.13	.853	21.67	.953	24.21
54	.0135	.343	.054	1.372	.154	3.91	.254	6.45	.354	8.99	.454	11.53	.554	14.07	.654	16.61	.754	19.15	.854	21.69	.954	24.23
55	.01375	.349	.055	1.397	.155	3.94	.255	6.48	.355	9.02	.455	11.56	.555	14.10	.655	16.64	.755	19.18	.855	21.72	.955	24.26
56	.014	.356	.056	1.422	.156	3.96	.256	6.50	.356	9.04	.456	11.58	.556	14.12	.656	16.66	.756	19.20	.856	21.74	.956	24.28
57	.01425	.362	.057	1.448	.157	3.99	.257	6.53	.357	9.07	.457	11.61	.557	14.15	.657	16.69	.757	19.23	.857	21.77	.957	24.31
58	.0145	.368	.058	1.473	.158	4.01	.258	6.55	.358	9.09	.458	11.63	.558	14.17	.658	16.71	.758	19.25	.858	21.79	.958	24.33
59	.01475	.375	.059	1.499	.159	4.04	.259	6.58	.359	9.12	.459	11.66	.559	14.20	.659	16.74	.759	19.28	.859	21.82	.959	24.36
60	.015	.381	.060	1.524	.160	4.06	.260	6.60	.360	9.14	.460	11.68	.560	14.22	.660	16.76	.760	19.30	.860	21.84	.960	24.38
61	.01525	.387	.061	1.549	.161	4.09	.261	6.63	.361	9.17	.461	11.71	.561	14.25	.661	16.79	.761	19.33	.861	21.87	.961	24.41
62	.0155	.394	.062	1.575	.162	4.11	.262	6.65	.362	9.19	.462	11.73	.562	14.27	.662	16.81	.762	19.35	.862	21.89	.962	24.43
63	.01575	.400	.063	1.600	.163	4.14	.263	6.68	.363	9.22	.463	11.76	.563	14.30	.663	16.84	.763	19.38	.863	21.92	.963	24.46
64	.016	.406	.064	1.626	.164	4.17	.264	6.71	.364	9.25	.464	11.79	.564	14.33	.664	16.87	.764	19.41	.864	21.95	.964	24.49
65	.01625	.413	.065	1.651	.165	4.19	.265	6.73	.365	9.27	.465	11.81	.565	14.35	.665	16.89	.765	19.43	.865	21.97	.965	24.51
66	.0165	.419	.066	1.676	.166	4.22	.266	6.76	.366	9.30	.466	11.84	.566	14.38	.666	16.92	.766	19.46	.866	22.00	.966	24.54
67	.01675	.425	.067	1.702	.167	4.24	.267	6.78	.367	9.32	.467	11.86	.567	14.40	.667	16.94	.767	19.48	.867	22.02	.967	24.56
68	.017	.432	.068	1.727	.168	4.27	.268	6.81	.368	9.35	.468	11.89	.568	14.43	.668	16.97	.768	19.51	.868	22.05	.968	24.59
69	.01725	.438	.069	1.753	.169	4.29	.269	6.83	.369	9.37	.469	11.91	.569	14.45	.669	16.99	.769	19.53	.869	22.07	.969	24.61
70	.0175	.445	.070	1.778	.170	4.32	.270	6.86	.370	9.40	.470	11.94	.570	14.48	.670	17.02	.770	19.56	.870	22.10	.970	24.64
71	.01775	.451	.071	1.803	.171	4.34	.271	6.88	.371	9.42	.471	11.96	.571	14.50	.671	17.04	.771	19.58	.871	22.12	.971	24.66
72	.018	.457	.072	1.829	.172	4.37	.272	6.91	.372	9.45	.472	11.99	.572	14.53	.672	17.07	.772	19.61	.872	22.15	.972	24.69
73	.01825	.464	.073	1.854	.173	4.39	.273	6.93	.373	9.47	.473	12.01	.573	14.55	.673	17.09	.773	19.63	.873	22.17	.973	24.71
74	.0185	.470	.074	1.880	.174	4.42	.274	6.96	.374	9.50	.474	12.04	.574	14.58	.674	17.12	.774	19.66	.874	22.20	.974	24.74
75	.01875	.476	.075	1.905	.175	4.45	.275	6.99	.375	9.53	.475	12.07	.575	14.61	.675	17.15	.775	19.69	.875	22.23	.975	24.77
76	.019	.483	.076	1.930	.176	4.47	.276	7.01	.376	9.55	.476	12.09	.576	14.63	.676	17.17	.776	19.71	.876	22.25	.976	24.79
77	.01925	.489	.077	1.956	.177	4.50	.277	7.04	.377	9.58	.477	12.12	.577	14.66	.677	17.20	.777	19.74	.877	22.28	.977	24.82
78	.0195	.495	.078	1.981	.178	4.52	.278	7.06	.378	9.60	.478	12.14	.578	14.68	.678	17.22	.778	19.76	.878	22.30	.978	24.84
79	.01975	.502	.079	2.007	.179	4.55	.279	7.09	.379	9.63	.479	12.17	.579	14.71	.679	17.25	.779	19.79	.879	22.33	.979	24.87
80	.020	.508	.080	2.032	.180	4.57	.280	7.11	.380	9.65	.480	12.19	.580	14.73	.680	17.27	.780	19.81	.880	22.35	.980	24.89
81	.02025	.514	.081	2.057	.181	4.60	.281	7.14	.381	9.68	.481	12.22	.581	14.76	.681	17.30	.781	19.84	.881	22.38	.981	24.92
82	.0205	.521	.082	2.083	.182	4.62	.282	7.16	.382	9.70	.482	12.24	.582	14.78	.682	17.32	.782	19.86	.882	22.40	.982	24.94
83	.02075	.527	.083	2.108	.183	4.65	.283	7.19	.383	9.73	.483	12.27	.583	14.81	.683	17.35	.783	19.89	.883	22.43	.983	24.97
84	.021	.533	.084	2.134	.184	4.67	.284	7.21	.384	9.75	.484	12.29	.584	14.83	.684	17.37	.784	19.91	.884	22.45	.984	24.99
85	.02125	.540	.085	2.159	.185	4.70	.285	7.24	.385	9.78	.485	12.32	.585	14.86	.685	17.40	.785	19.94	.885	22.48	.985	25.02
86	.0215	.546	.086	2.184	.186	4.72	.286	7.26	.386	9.80	.486	12.34	.586	14.88	.686	17.42	.786	19.96	.886	22.50	.986	25.04
87	.02175	.552	.087	2.210	.187	4.75	.287	7.29	.387	9.83	.487	12.37	.587	14.91	.687	17.45	.787	19.99	.887	22.53	.987	25.07
88	.022	.559	.088	2.235	.188	4.78	.288	7.32	.388	9.86	.488	12.40	.588	14.94	.688	17.48	.788	20.02	.888	22.56	.988	25.10
89	.02225	.565	.089	2.261	.189	4.80	.289	7.34	.389	9.88	.489	12.42	.589	14.96	.689	17.50	.789	20.04	.889	22.58	.989	25.12
90	.0225	.572	.090	2.286	.190	4.83	.290	7.37	.390	9.91	.490	12.45	.590	14.99	.690	17.53	.790	20.07	.890	22.61	.990	25.15
91	.02275	.578	.091	2.311	.191	4.85	.291	7.39	.391	9.93	.491	12.47	.591	15.01	.691	17.55	.791	20.09	.891	22.63	.991	25.17
92	.023	.584	.092	2.337	.192	4.88	.292	7.42	.392	9.96	.492	12.50	.592	15.04	.692	17.58	.792	20.12	.892	22.66	.992	25.20
93	.02325	.591	.093	2.362	.193	4.90	.293	7.44	.393	9.98	.493	12.52	.593	15.06	.693	17.60	.793	20.14	.893	22.68	.993	25.22
94	.0235	.597	.094	2.388	.194	4.93	.294	7.47	.394	10.01	.494	12.55	.594	15.09	.694	17.63	.794	20.17	.894	22.71	.994	25.25
95	.02375	.603	.095	2.413	.195	4.95	.295	7.49	.395	10.03	.495	12.57	.595	15.11	.695	17.65	.795	20.19	.895	22.73	.995	25.27
96	.024	.610	.096	2.438	.196	4.98	.296	7.52	.396	10.06	.496	12.60	.596	15.14	.696	17.68	.796	20.22	.896	22.76	.996	25.30
97	.02425	.616	.097	2.464	.197	5.00	.297	7.54	.397	10.08	.497	12.62	.597	15.16	.697	17.70	.797	20.24	.897	22.78	.997	25.32
98	.0245	.622	.098	2.489	.198	5.03	.298	7.57	.398	10.11	.498	12.65	.598	15.19	.698	17.73	.798	20.27	.898	22.81	.998	25.35
99	.02475	.629	.099	2.515	.199	5.05	.299	7.59	.399	10.13	.499	12.67	.599	15.21	.699	17.75	.799	20.29	.899	22.83	.999	25.37

1 inch = 25.40 mm	5 inches=127.00 mm	9 inches=228.60 mm	13 inches=330.20 mm	17 inches=431.80 mm
2 inches= 50.80 mm	6 inches=152.40 mm	10 inches=254.00 mm	14 inches=355.60 mm	18 inches=457.20 mm
3 inches= 76.20 mm	7 inches=177.80 mm	11 inches=279.40 mm	15 inches=381.00 mm	19 inches=482.60 mm
4 inches=101.60 mm	8 inches=203.20 mm	12 inches=304.80 mm	16 inches=406.40 mm	20 inches=508.00 mm

[a] The "point" as used by silversmiths is one-fourth of one-thousandth of an inch; the printer's point is approximately one seventy-second of an inch.

TABLE 7.—Conversion of Millimeters to Inches

[From 0.00 to 10.00 millimeters by 0.01 millimeter. 1 millimeter=0.03937 inch]

Milli-meters	Inch	Milli-meters	Inch	Milli-meters	Inch	Milli-meters	Inch	Milli-meters	In ch	Milli-meters	Inch	Milli-meters	Inch	Milli-meters	Inch	Milli-meters	Inch	Milli-meters	Inch
0.00	0.0000	1.00	0.0394	2.00	0.0787	3.00	0.1181	4.00	0.1575	5.00	0.1968	6.00	0.2362	7.00	0.2756	8.00	0.3150	9.00	0.3543
.01	.0004	1.01	.0398	2.01	.0791	3.01	.1185	4.01	.1579	5.01	.1972	6.01	.2366	7.01	.2760	8.01	.3154	9.01	.3547
.02	.0008	1.02	.0402	2.02	.0795	3.02	.1189	4.02	.1583	5.02	.1976	6.02	.2370	7.02	.2764	8.02	.3157	9.02	.3551
.03	.0012	1.03	.0406	2.03	.0799	3.03	.1193	4.03	.1587	5.03	.1980	6.03	.2374	7.03	.2768	8.03	.3161	9.03	.3555
.04	.0016	1.04	.0409	2.04	.0803	3.04	.1197	4.04	.1591	5.04	.1984	6.04	.2378	7.04	.2772	8.04	.3165	9.04	.3559
.05	.0020	1.05	.0413	2.05	.0807	3.05	.1201	4.05	.1594	5.05	.1988	6.05	.2382	7.05	.2776	8.05	.3169	9.05	.3563
.06	.0024	1.06	.0417	2.06	.0811	3.06	.1205	4.06	.1598	5.06	.1992	6.06	.2386	7.06	.2780	8.06	.3173	9.06	.3567
.07	.0028	1.07	.0421	2.07	.0815	3.07	.1209	4.07	.1602	5.07	.1996	6.07	.2390	7.07	.2783	8.07	.3177	9.07	.3571
.08	.0031	1.08	.0425	2.08	.0819	3.08	.1213	4.08	.1606	5.08	.2000	6.08	.2394	7.08	.2787	8.08	.3181	9.08	.3575
.09	.0035	1.09	.0429	2.09	.0823	3.09	.1217	4.09	.1610	5.09	.2004	6.09	.2398	7.09	.2791	8.09	.3185	9.09	.3579
.10	.0039	1.10	.0433	2.10	.0827	3.10	.1220	4.10	.1614	5.10	.2008	6.10	.2402	7.10	.2795	8.10	.3189	9.10	.3583
.11	.0043	1.11	.0437	2.11	.0831	3.11	.1224	4 11	.1618	5.11	.2012	6.11	.2406	7.11	.2799	8.11	.3193	9.11	.3587
.12	.0047	1.12	.0441	2.12	.0835	3.12	.1228	4.12	.1622	5.12	.2016	6.12	.2409	7.12	.2803	8.12	.3197	9.12	.3591
.13	.0051	1.13	.0445	2.13	.0839	3.13	.1232	4.13	.1626	5.13	.2020	6.13	.2413	7.13	.2807	8.13	.3201	9.13	.3594
.14	.0055	1.14	.0449	2.14	.0843	3.14	.1236	4.14	.1630	5.14	.2024	6.14	.2417	7.14	.2811	8.14	.3205	9.14	.3598
.15	.0059	1.15	.0453	2.15	.0846	3.15	.1240	4.15	.1634	5.15	.2028	6.15	.2421	7.15	.2815	8.15	.3209	9.15	.3602
.16	.0063	1.16	.0457	2.16	.0850	3.16	.1244	4.16	.1638	5.16	.2031	6.16	.2425	7.16	.2819	8.16	.3213	9.16	.3606
.17	.0067	1.17	.0461	2.17	.0854	3.17	.1248	4.17	.1642	5.17	.2035	6.17	.2429	7.17	.2823	8.17	.3217	9.17	.3610
.18	.0071	1.18	.0465	2.18	.0858	3.18	.1252	4.18	.1646	5.18	.2039	6.18	.2433	7.18	.2827	8.18	.3220	9.18	.3614
.19	.0075	1.19	.0469	2.19	.0862	3.19	.1256	4.19	.1650	5.19	.2043	6.19	.2437	7.19	.2831	8.19	.3224	9.19	.3618
.20	.0079	1.20	.0472	2.20	.0866	3.20	.1260	4.20	.1654	5.20	.2047	6.20	.2441	7.20	.2835	8.20	.3228	9.20	.3622
.21	.0083	1.21	.0476	2.21	.0870	3.21	.1264	4.21	.1657	5.21	.2051	6.21	.2445	7.21	.2839	8.21	.3232	9.21	.3626
.22	.0087	1.22	.0480	2.22	.0874	3.22	.1268	4.22	.1661	5.22	.2055	6.22	.2449	7.22	.2843	8.22	.3236	9.22	.3630
.23	.0091	1.23	.0484	2.23	.0878	3.23	.1272	4.23	.1665	5.23	.2059	6.23	.2453	7.23	.2846	8.23	.3240	9.23	.3634
.24	.0094	1.24	.0488	2.24	.0882	3.24	.1276	4.24	.1669	5.24	.2063	6.24	.2457	7.24	.2850	8.24	.3244	9.24	.3638
.25	.0098	1.25	.0492	2.25	.0886	3.25	.1280	4.25	.1673	5.25	.2067	6.25	.2461	7.25	.2854	8.25	.3248	9.25	.3642
.26	.0102	1.26	.0496	2.26	.0890	3.26	.1283	4.26	.1677	5.26	.2071	6.26	.2465	7.26	.2858	8.26	.3252	9.26	.3646
.27	.0106	1.27	.0500	2.27	.0894	3.27	.1287	4.27	.1681	5.27	.2075	6.27	.2468	7.27	.2862	8.27	.3256	9.27	.3650
.28	.0110	1.28	.0504	2.28	.0898	3.28	.1291	4.28	.1685	5.28	.2079	6.28	.2472	7.28	.2866	8.28	.3260	9.28	.3654
.29	.0114	1.29	.0508	2.29	.0902	3.29	.1295	4.29	.1689	5.29	.2083	6.29	.2476	7.29	.2870	8.29	.3264	9.29	.3657
.30	.0118	1.30	.0512	2.30	.0906	3.30	.1299	4.30	.1693	5.30	.2087	6.30	.2480	7.30	.2874	8.30	.3268	9.30	.3661
.31	.0122	1.31	.0516	2.31	.0909	3.31	.1303	4.31	.1697	5.31	.2091	6.31	.2484	7.31	.2878	8.31	.3272	9.31	.3665
.32	.0126	1.32	.0520	2.32	.0913	3.32	.1307	4.32	.1701	5.32	.2094	6.32	.2488	7.32	.2882	8.32	.3276	9.32	.3669
.33	.0130	1.33	.0524	2.33	.0917	3.33	.1311	4.33	.1705	5.33	.2098	6.33	.2492	7.33	.2886	8.33	.3280	9.33	.3673
.34	.0134	1.34	.0528	2.34	.0921	3.34	.1315	4.34	.1709	5.34	.2102	6.34	.2496	7.34	.2890	8.34	.3283	9.34	.3677
.35	.0138	1.35	.0531	2.35	.0925	3.35	.1319	4.35	.1713	5.35	.2106	6.35	.2500	7.35	.2894	8.35	.3287	9.35	.3681
.36	.0142	1.36	.0535	2.36	.0929	3.36	.1323	4.36	.1717	5.36	.2110	6.36	.2504	7.36	.2898	8.36	.3291	9.36	.3685
.37	.0146	1.37	.0539	2.37	.0933	3.37	.1327	4.37	.1720	5.37	.2114	6.37	.2508	7.37	.2902	8.37	.3295	9.37	.3689
.38	.0150	1.38	.0543	2.38	.0937	3.38	.1331	4.38	.1724	5.38	.2118	6.38	.2512	7.38	.2906	8.38	.3299	9.38	.3693
.39	.0154	1.39	.0547	2.39	.0941	3.39	.1335	4.39	.1728	5.39	.2122	6.39	.2516	7.39	.2909	8.39	.3303	9.39	.3697
.40	.0157	1.40	.0551	2.40	.0945	3.40	.1339	4.40	.1732	5.40	.2126	6.40	.2520	7.40	.2913	8.40	.3307	9.40	.3701
.41	.0161	1.41	.0555	2.41	.0949	3.41	.1343	4.41	.1736	5.41	.2130	6.41	.2524	7.41	.2917	8.41	.3311	9.41	.3705
.42	.0165	1.42	.0559	2.42	.0953	3.42	.1346	4.42	.1740	5.42	.2134	6.42	.2528	7.42	.2921	8.42	.3315	9.42	.3709
.43	.0169	1.43	.0563	2.43	.0957	3.43	.1350	4.43	.1744	5.43	.2138	6.43	.2531	7.43	.2925	8.43	.3319	9.43	.3713
.44	.0173	1.44	.0567	2.44	.0961	3.44	.1354	4.44	.1748	5.44	.2142	6.44	.2535	7.44	.2929	8.44	.3323	9.44	.3717
.45	.0177	1.45	.0571	2.45	.0965	3.45	.1358	4.45	.1752	5.45	.2146	6.45	.2539	7.45	.2933	8.45	.3327	9.45	.3720
.46	.0181	1.46	.0575	2.46	.0969	3.46	.1362	4.46	.1756	5.46	.2150	6.46	.2543	7.46	.2937	8.46	.3331	9.46	.3724
.47	.0185	1.47	.0579	2.47	.0972	3.47	.1366	4.47	.1760	5.47	.2154	6.47	.2547	7.47	.2941	8.47	.3335	9.47	.3728
.48	.0189	1.48	.0583	2.48	.0976	3.48	.1370	4.48	.1764	5.48	.2157	6.48	.2551	7.48	.2945	8.48	.3339	9.48	.3732
.49	.0193	1.49	.0587	2.49	.0980	3.49	.1374	4.49	.1768	5.49	.2161	6.49	.2555	7.49	.2949	8.49	.3343	9.49	.3736

.50	.0197	1.50	.0591	2.50	.0984	3.50	.1378	4.50	.1772	5.50	.2165	6.50	.2559	7.50	.2953	8.50	.3346	9.50	.3740
.51	.0201	1.51	.0594	2.51	.0988	3.51	.1382	4.51	.1776	5.51	.2169	6.51	.2563	7.51	.2957	8.51	.3350	9.51	.3744
.52	.0205	1.52	.0598	2.52	.0992	3.52	.1386	4.52	.1780	5.52	.2173	6.52	.2567	7.52	.2961	8.52	.3354	9.52	.3748
.53	.0209	1.53	.0602	2.53	.0996	3.53	.1390	4.53	.1783	5.53	.2177	6.53	.2571	7.53	.2965	8.53	.3358	9.53	.3752
.54	.0213	1.54	.0606	2.54	.1000	3.54	.1394	4.54	.1787	5.54	.2181	6.54	.2575	7.54	.2968	8.54	.3362	9.54	.3756
.55	.0217	1.55	.0610	2.55	.1004	3.55	.1398	4.55	.1791	5.55	.2185	6.55	.2579	7.55	.2972	8.55	.3366	9.55	.3760
.56	.0220	1.56	.0614	2.56	.1008	3.56	.1402	4.56	.1795	5.56	.2189	6.56	.2583	7.56	.2976	8.56	.3370	9.56	.3764
.57	.0224	1.57	.0618	2.57	.1012	3.57	.1406	4.57	.1799	5.57	.2193	6.57	.2587	7.57	.2980	8.57	3374	9.57	.3768
.58	.0228	1.58	.0622	2.58	.1016	3.58	.1409	4.58	.1803	5.58	.2197	6.58	.2591	7.58	.2984	8.58	.3378	9.58	.3772
.59	.0232	1.59	.0626	2.59	.1020	3.59	.1413	4.59	.1807	5.59	.2201	6.59	.2594	7.59	.2988	8.59	.3382	9.59	.3776
.60	.0236	1.60	.0630	2.60	.1024	3.60	.1417	4.60	.1811	5.60	.2205	6.60	.2598	7.60	.2992	8.60	.3386	9.60	.3780
.61	.0240	1.61	.0634	2.61	.1028	3.61	.1421	4.61	.1815	5.61	.2209	6.61	.2602	7.61	.2996	8.61	.3390	9.61	.3783
.62	.0244	1.62	.0638	2.62	.1031	3.62	.1425	4.62	.1819	5.62	.2213	6.62	.2606	7.62	.3000	8.62	.3394	9.62	.3787
.63	.0248	1.63	.0642	2.63	.1035	3.63	.1429	4.63	.1823	5.63	.2217	6.63	.2610	7.63	.3004	8.63	.3398	9.63	.3791
.64	.0252	1.64	.0646	2.64	.1039	3.64	.1433	4.64	.1827	5.64	.2220	6.64	.2614	7.64	.3008	8.64	.3402	9.64	.3795
.65	.0256	1.65	.0650	2.65	.1043	3.65	.1437	4.65	.1831	5.65	.2224	6.65	.2618	7.65	.3012	8.65	.3406	9.65	.3799
.66	.0260	1.66	.0654	2.66	.1047	3.66	.1441	4.66	.1835	5.66	.2228	6.66	.2622	7.66	.3016	8.66	.3409	9.66	.3803
.67	.0264	1.67	.0657	2.67	.1051	3.67	.1445	4.67	.1839	5.67	.2232	6.67	.2626	7.67	.3020	8.67	.3413	9.67	.3807
.68	.0268	1.68	.0661	2.68	.1055	3.68	.1449	4.68	.1843	5.68	.2236	6.68	.2630	7.68	.3024	8.68	.3417	9.68	.3811
.69	.0272	1.69	.0665	2.69	.1059	3.69	.1453	4.69	.1846	5.69	.2240	6.69	.2634	7.69	.3028	8.69	.3421	9.69	.3815
.70	.0276	1.70	.0669	2.70	.1063	3.70	.1457	4.70	.1850	5.70	.2244	6.70	.2638	7.70	.3031	8.70	.3425	9.70	.3819
.71	.0280	1.71	.0673	2.71	.1067	3.71	.1461	4.71	.1854	5.71	.2248	6.71	.2642	7.71	.3035	8.71	.3429	9.71	.3823
.72	.0283	1.72	.0677	2.72	.1071	3.72	.1465	4.72	.1858	5.72	.2252	6.72	.2646	7.72	.3039	8.72	.3433	9.72	.3827
.73	.0287	1.73	.0681	2.73	.1075	3.73	.1469	4.73	.1862	5.73	.2256	6.73	.2650	7.73	.3043	8.73	.3437	9.73	.3831
.74	.0291	1.74	.0685	2.74	.1079	3.74	.1472	4.74	.1866	5.74	.2260	6.74	.2654	7.74	.3047	8.74	.3441	9.74	.3835
.75	.0295	1.75	.0689	2.75	.1083	3.75	.1476	4.75	.1870	5.75	.2264	6.75	.2657	7.75	.3051	8.75	.3445	9.75	.3839
.76	.0299	1.76	.0693	2.76	.1087	3.76	.1480	4.76	.1874	5.76	.2268	6.76	.2661	7.76	.3055	8.76	.3449	9.76	.3843
.77	.0303	1.77	.0697	2.77	.1091	3.77	.1484	4.77	.1878	5.77	.2272	6.77	.2665	7.77	.3059	8.77	.3453	9.77	.3846
.78	.0307	1.78	.0701	2.78	.1094	3.78	.1488	4.78	.1882	5.78	.2276	6.78	.2669	7.78	.3063	8.78	.3457	9.78	.3850
.79	.0311	1.79	.0705	2.79	.1098	3.79	.1492	4.79	.1886	5.79	.2280	6.79	.2673	7.79	.3067	8.79	.3461	9.79	.3854
.80	.0315	1.80	.0709	2.80	.1102	3.80	.1496	4.80	.1890	5.80	.2283	6.80	.2677	7.80	.3071	8.80	.3465	9.80	.3858
.81	.0319	1.81	.0713	2.81	.1106	3.81	.1500	4.81	.1894	5.81	.2287	6.81	.2681	7.81	.3075	8.81	.3468	9.81	.3862
.82	.0323	1.82	.0717	2.82	.1110	3.82	.1504	4.82	.1898	5.82	.2291	6.82	.2685	7.82	.3079	8.82	.3472	9.82	.3866
.83	.0327	1.83	.0720	2.83	.1114	3.83	.1508	4.83	.1902	5.83	.2295	6.83	.2689	7.83	.3083	8.83	.3476	9.83	.3870
.84	.0331	1.84	.0724	2.84	.1118	3.84	.1512	4.84	.1906	5.84	.2299	6.84	.2693	7.84	.3087	8.84	.3480	9.84	.3874
.85	.0335	1.85	.0728	2.85	.1122	3.85	.1516	4.85	.1909	5.85	.2303	6.85	.2697	7.85	.3091	8.85	.3484	9.85	.3878
.86	.0339	1.86	.0732	2.86	.1126	3.86	.1520	4.86	.1913	5.86	.2307	6.86	.2701	7.86	.3094	8.86	.3488	9.86	.3882
.87	.0343	1.87	.0736	2.87	.1130	3.87	.1524	4.87	.1917	5.87	.2311	6.87	.2705	7.87	.3098	8.87	.3492	9.87	.3886
.88	.0346	1.88	.0740	2.88	.1134	3.88	.1528	4.88	.1921	5.88	.2315	6.88	.2709	7.88	.3102	8.88	.3496	9.88	.3890
.89	.0350	1.89	.0744	2.89	.1138	3.89	.1531	4.89	.1925	5.89	.2319	6.89	.2713	7.89	.3106	8.89	.3500	9.89	.3894
.90	.0354	1.90	.0748	2.90	.1142	3.90	.1535	4.90	.1929	5.90	.2323	6.90	.2717	7.90	.3110	8.90	.3504	9.90	.3898
.91	.0358	1.91	.0752	2.91	.1146	3.91	.1539	4.91	.1933	5.91	.2327	6.91	.2720	7.91	.3114	8.91	.3508	9.91	.3902
.92	.0362	1.92	.0756	2.92	.1150	3.92	.1543	4.92	.1937	5.92	.2331	6.92	.2724	7.92	.3118	8.92	.3512	9.92	.3906
.93	.0366	1.93	.0760	2.93	.1154	3.93	.1547	4.93	.1941	5.93	.2335	6.93	.2728	7.93	.3122	8.93	.3516	9.93	.3909
.94	.0370	1.94	.0764	2.94	.1157	3.94	.1551	4.94	.1945	5.94	.2339	6.94	.2732	7.94	.3126	8.94	.3520	9.94	.3913
.95	.0374	1.95	.0768	2.95	.1161	3.95	.1555	4.95	.1949	5.95	.2343	6.95	.2736	7.95	.3130	8.95	.3524	9.95	3917
.96	.0378	1.96	.0772	2.96	.1165	3.96	.1559	4.96	.1953	5.96	.2346	6.96	.2740	7.96	.3134	8.96	.3528	9.96	.3921
.97	.0382	1.97	.0776	2.97	.1169	3.97	.1563	4.97	.1957	5.97	.2350	6.97	.2744	7.97	.3138	8.97	.3531	9.97	.3925
.98	.0386	1.98	.0780	2.98	.1173	3.98	.1567	4.98	.1961	5.98	.2354	6.98	.2748	7.98	.3142	8.98	.3535	9.98	.3929
.99	.0390	1.99	.0783	2.99	.1177	3.99	.1571	4.99	.1965	5.99	.2358	6.99	.2752	7.99	.3146	8.99	.3539	9.99	.3933

1 micron =0.000039 inch	5 microns=0.000197 inch	9 microns=0.000354 inch	13 microns=0.000512 inch	17 microns=0.000669 inch
2 microns= .000079 inch	6 microns= .000236 inch	10 microns= .000394 inch	14 microns= .000551 inch	18 microns= .000709 inch
3 microns= .000118 inch	7 microns= .000276 inch	11 microns= .000433 inch	15 microns= .000591 inch	19 microns= .000748 inch
4 microns= .000157 inch	8 microns= .000315 inch	12 microns= .000472 inch	16 microns= .000630 inch	20 microns= .000787 inch

4. TABLES OF AREA

TABLE 8

Square inches	Square centimeters
1	= 6.452
2	=12.903
3	=19.355
4	=25.807
5	=32.258
6	=38.710
7	=45.161
8	=51.613
9	=58.065
0.1550=	1
.3100=	2
.4650=	3
.6200=	4
.7750=	5
.9300=	6
1.0850=	7
1.2400=	8
1.3950=	9

TABLE 9

Square feet	Square meters
1	=0.0929
2	= .1858
3	= .2787
4	= .3716
5	= .4645
6	= .5574
7	= .6503
8	= .7432
9	= .8361
10.764=	1
21.528=	2
32.292=	3
43.055=	4
53.819=	5
64.583=	6
75.347=	7
86.111=	8
96.875=	9

TABLE 10

Square yards	Square meters
1	=0.836
2	=1.672
3	=2.508
4	=3.345
5	=4.181
6	=5.017
7	=5.853
8	=6.689
9	=7.525
1.196=	1
2.392=	2
3.588=	3
4.784=	4
5.980=	5
7.176=	6
8.372=	7
9.568=	8
10.764=	9

5. TABLES OF VOLUME

TABLE 11

Cubic inches	Cubic centimeters
1	= 16.387
2	= 32.774
3	= 49.161
4	= 65.549
5	= 81.936
6	= 98.323
7	=114.710
8	=131.097
9	=147.484
0.0610=	1
.1220=	2
.1831=	3
.2441=	4
.3051=	5
.3661=	6
.4272=	7
.4882=	8
.5492=	9

TABLE 12

Cubic feet	Cubic meters
1	=0.0283
2	= .0566
3	= .0850
4	= .1133
5	= .1416
6	= .1699
7	= .1982
8	= .2265
9	= .2549
35.314=	1
70.629=	2
105.943=	3
141.258=	4
176.572=	5
211.887=	6
247.201=	7
282.516=	8
317.830=	9

TABLE 13

Cubic yards	Cubic meters
1	=0.7646
2	=1.5291
3	=2.2937
4	=3.0582
5	=3.8228
6	=4.5874
7	=5.3519
8	=6.1165
9	=6.8810
1.3079=	1
2.6159=	2
3.9238=	3
5.2318=	4
6.5397=	5
7.8477=	6
9.1556=	7
10.4635=	8
11.7715=	9

TABLE 14

Cubic inches	Liters
1	=0.0164
2	= .0328
3	= .0492
4	= .0655
5	= .0819
6	= .0983
7	= .1147
8	= .1311
9	= .1475
61.03=	1
122.05=	2
183.08=	3
244.10=	4
305.13=	5
366.15=	6
427.18=	7
488.20=	8
549.23=	9

TABLE 15

Cubic feet	Liters
1	= 28.316
2	= 56.633
3	= 84.949
4	=113.265
5	=141.581
6	=169.898
7	=198.214
8	=226.530
9	=254.846
0.03532=	1
.07063=	2
.10595=	3
.14126=	4
.17658=	5
.21189=	6
.24721=	7
.28252=	8
.31784=	9

6. TABLES OF CAPACITY

TABLE 16

Minims	Milliliters
1 =	0.062
2 =	.123
3 =	.185
4 =	.246
5 =	.308
6 =	.370
7 =	.431
8 =	.493
9 =	.554
16.23 =	1
32.46 =	2
48.69 =	3
64.92 =	4
81.16 =	5
97.39 =	6
113.62 =	7
129.85 =	8
146.08 =	9

TABLE 17

U. S. fluid drams	Milliliters
1 =	3.70
2 =	7.39
3 =	11.09
4 =	14.79
5 =	18.48
6 =	22.18
7 =	25.88
8 =	29.57
9 =	33.27
0.271 =	1
.541 =	2
.812 =	3
1.082 =	4
1.353 =	5
1.623 =	6
1.894 =	7
2.164 =	8
2.435 =	9

TABLE 18

U. S. fluid drams	U.S. fluid ounce	Milliliters
½ =	1/16 =	1.85
1 =	⅛ =	3.70
1½ =	3/16 =	5.54
2 =	¼ =	7.39
2½ =	5/16 =	9.24
3 =	⅜ =	11.09
3½ =	7/16 =	12.94
4 =	½ =	14.79
4½ =	9/16 =	16.63
5 =	⅝ =	18.48
5½ =	11/16 =	20.33
6 =	¾ =	22.18
6½ =	13/16 =	24.03
7 =	⅞ =	25.88
7½ =	15/16 =	27.72
8 =	1 =	29.57

TABLE 19

U. S. fluid ounces	Milliliters
1 =	29.57
2 =	59.15
3 =	88.72
4 =	118.29
5 =	147.86
6 =	177.44
7 =	207.01
8 =	236.58
9 =	266.16
10 =	295.73
11 =	325.30
12 =	354.87
13 =	384.45
14 =	414.02
15 =	443.59
16 =	473.17

TABLE 20

U. S. fluid ounces	Milliliters
0.0338 =	1
.0676 =	2
.1014 =	3
.1353 =	4
.1691 =	5
.2029 =	6
.2367 =	7
.2705 =	8
.3043 =	9
.3381 =	10
.6763 =	20
1.0144 =	30
1.3526 =	40
1.6907 =	50
2.0289 =	60
2.3670 =	70
2.7052 =	80
3.0433 =	90

TABLE 21

U. S. liquid pints	Liters
1 =	0.473
2 =	.946
3 =	1.419
4 =	1.893
5 =	2.366
6 =	2.839
7 =	3.312
8 =	3.785
9 =	4.258
2.113 =	1
4.227 =	2
6.340 =	3
8.454 =	4
10.567 =	5
12.681 =	6
14.794 =	7
16.907 =	8
19.021 =	9

TABLE 22

U. S. liquid quarts	Liters
1 =	0.946
2 =	1.893
3 =	2.839
4 =	3.785
5 =	4.732
6 =	5.678
7 =	6.624
8 =	7.571
9 =	8.517
1.057 =	1
2.113 =	2
3.170 =	3
4.227 =	4
5.284 =	5
6.340 =	6
7.397 =	7
8.454 =	8
9.510 =	9

TABLE 23

U. S. gallons	Liters
1 =	3.785
2 =	7.571
3 =	11.356
4 =	15.141
5 =	18.927
6 =	22.712
7 =	26.497
8 =	30.283
9 =	34.068
0.2642 =	1
.5284 =	2
.7925 =	3
1.0567 =	4
1.3209 =	5
1.5851 =	6
1.8492 =	7
2.1134 =	8
2.3776 =	9

TABLE 24

British Imperial gallons	Liters
1 =	4.546
2 =	9.092
3 =	13.638
4 =	18.184
5 =	22.730
6 =	27.276
7 =	31.822
8 =	36.368
9 =	40.914
0.2200 =	1
.4400 =	2
.6599 =	3
.8799 =	4
1.0999 =	5
1.3199 =	6
1.5398 =	7
1.7598 =	8
1.9798 =	9

TABLE 25

U. S. gallons	British Imperial gallons
1 =	0.8327
2 =	1.6654
3 =	2.4980
4 =	3.3307
5 =	4.1634
6 =	4.9961
7 =	5.8287
8 =	6.6614
9 =	7.4941
1.2009 =	1
2.4019 =	2
3.6028 =	3
4.8038 =	4
6.0047 =	5
7.2057 =	6
8.4066 =	7
9.6075 =	8
10.8085 =	9

7. TABLES OF MASS (WEIGHT)

TABLE 26		TABLE 27		TABLE 28	
Grains [a]	Grams [a]	Pennyweights [b]	Grams [b]	Troy ounces [c]	Grams [c]
1	=0.06480	1	= 1.55517	1	= 31.10348
2	= .12960	2	= 3.11035	2	= 62.20696
3	= .19440	3	= 4.66552	3	= 93.31044
4	= .25920	4	= 6.22070	4	=124.41392
5	= .32399	5	= 7.77587	5	=155.51740
6	= .38879	6	= 9.33104	6	=186.62088
7	= .45359	7	=10.88622	7	=217.72437
8	= .51839	8	=12.44139	8	=248.82785
9	= .58319	9	=13.99657	9	=279.93133
15.4324=	1	0.64301=	1	0.03215=	1
30.8647=	2	1.28603=	2	.06430=	2
46.2971=	3	1.92904=	3	.09645=	3
61.7294=	4	2.57206=	4	.12860=	4
77.1618=	5	3.21507=	5	.16075=	5
92.5941=	6	3.85809=	6	.19290=	6
108.0265=	7	4.50110=	7	.22506=	7
123.4589=	8	5.14412=	8	.25721=	8
138.8912=	9	5.78713=	9	.28936=	9

[a] See also extended Tables 32 and 33.
[b] See also extended Tables 34 and 35.
[c] See also extended Tables 36 and 37.

TABLE 29

Avoirdupois ounces	Grams	Avoirdupois ounces	Grams	Avoirdupois ounces	Grams	Avoirdupois ounces	Grams
		4	=113.398	8	=226.796	12	=340.194
¼=	7.087	4¼=	120.485	8¼=	233.884	12¼=	347.282
½=	14.175	4½=	127.573	8½=	240.971	12½=	354.369
¾=	21.262	4¾=	134.660	8¾=	248.058	12¾=	361.456
1 =	28.350	5	=141.748	9	=255.146	13	=368.544
1¼=	35.437	5¼=	148.835	9¼=	262.233	13¼=	375.631
1½=	42.524	5½=	155.922	9½=	269.321	13½=	382.719
1¾=	49.612	5¾=	163.010	9¾=	276.408	13¾=	389.806
2 =	56.699	6	=170.097	10	=283.495	14	=396.893
2¼=	63.786	6¼=	177.185	10¼=	290.583	14¼=	403.981
2½=	70.874	6½=	184.272	10½=	297.670	14½=	411.068
2¾=	77.961	6¾=	191.359	10¾=	304.757	14¾=	418.156
3 =	85.049	7	=198.447	11	=311.845	15	=425.243
3¼=	92.136	7¼=	205.534	11¼=	318.932	15¼=	432.330
3½=	99.223	7½=	212.621	11½=	326.020	15½=	439.418
3¾=	106.311	7¾=	219.709	11¾=	333.107	15¾=	446.505
						16	=453.592

TABLE 30		TABLE 31	
Avoirdupois pounds [a]	Kilograms [a]	Short tons	Metric tons
1	=0.45359	1	=0.90718
2	= .90718	2	=1.81437
3	=1.36078	3	=2.72155
4	=1.81437	4	=3.62874
5	=2.26796	5	=4.53592
6	=2.72155	6	=5.44311
7	=3.17515	7	=6.35029
8	=3.62874	8	=7.25748
9	=4.08233	9	=8.16466
2.20462=	1	1.10231=	1
4.40924=	2	2.20462=	2
6.61387=	3	3.30693=	3
8.81849=	4	4.40924=	4
11.02311=	5	5.51156=	5
13.22773=	6	6.61387=	6
15.43236=	7	7.71618=	7
17.63698=	8	8.81849=	8
19.84160=	9	9.92080=	9

[a] See also extended Tables 38 and 39.

MASS—GRAINS AND GRAMS

TABLE 32

[1 grain=0.06479892 gram]

Grains	Grams	Grains	Grams
0	0.000	55	3.564
1	.065	56	3.629
2	.130	57	3.694
3	.194	58	3.758
4	.259	59	3.823
5	.324	60	3.888
6	.389	61	3.953
7	.454	62	4.018
8	.518	63	4.082
9	.583	64	4.147
10	.648	65	4.212
11	.713	66	4.277
12	.778	67	4.342
13	.842	68	4.406
14	.907	69	4.471
15	.972	70	4.536
16	1.037	71	4.601
17	1.102	72	4.666
18	1.166	73	4.730
19	1.231	74	4.795
20	1.296	75	4.860
21	1.361	76	4.925
22	1.426	77	4.990
23	1.490	78	5.054
24	1.555	79	5.119
25	1.620	80	5.184
26	1.685	81	5.249
27	1.750	82	5.314
28	1.814	83	5.378
29	1.879	84	5.443
30	1.944	85	5.508
31	2.009	86	5.573
32	2.074	87	5.638
33	2.138	88	5.702
34	2.203	89	5.767
35	2.268	90	5.832
36	2.333	91	5.897
37	2.398	92	5.962
38	2.462	93	6.026
39	2.527	94	6.091
40	2.592	95	6.156
41	2.657	96	6.221
42	2.722	97	6.285
43	2.786	98	6.350
44	2.851	99	6.415
45	2.916	100	6.480
46	2.981	200	12.960
47	3.046	300	19.440
48	3.110	400	25.920
49	3.175	500	32.399
50	3.240	600	38.879
51	3.305	700	45.359
52	3.370	800	51.839
53	3.434	900	58.319
54	3.499	1000	64.799

TABLE 33

[1 gram=15.4323564 grains]

Grams	Grains	Grams	Grains
0	0.00	55	848.78
1	15.43	56	864.21
2	30.86	57	879.64
3	46.30	58	895.08
4	61.73	59	910.51
5	77.16	60	925.94
6	92.59	61	941.37
7	108.03	62	956.81
8	123.46	63	972.24
9	138.89	64	987.67
10	154.32	65	1003.10
11	169.76	66	1018.54
12	185.19	67	1033.97
13	200.62	68	1049.40
14	216.05	69	1064.83
15	231.49	70	1080.26
16	246.92	71	1095.70
17	262.35	72	1111.13
18	277.78	73	1126.56
19	293.21	74	1141.99
20	308.65	75	1157.43
21	324.08	76	1172.86
22	339.51	77	1188.29
23	354.94	78	1203.72
24	370.38	79	1219.16
25	385.81	80	1234.59
26	401.24	81	1250.02
27	416.67	82	1265.45
28	432.11	83	1280.89
29	447.54	84	1296.32
30	462.97	85	1311.75
31	478.40	86	1327.18
32	493.84	87	1342.62
33	509.27	88	1358.05
34	524.70	89	1373.48
35	540.13	90	1388.91
36	555.56	91	1404.34
37	571.00	92	1419.78
38	586.43	93	1435.21
39	601.86	94	1450.64
40	617.29	95	1466.07
41	632.73	96	1481.51
42	648.16	97	1496.94
43	663.59	98	1512.37
44	679.02	99	1527.80
45	694.46	100	1543.24
46	709.89	200	3086.47
47	725.32	300	4629.71
48	740.75	400	6172.94
49	756.19	500	7716.18
50	771.62	600	9259.41
51	787.05	700	10802.65
52	802.48	800	12345.89
53	817.91	900	13889.12
54	833.35	1000	15432.36

MASS—PENNYWEIGHTS AND GRAMS

TABLE 34

[1 pennyweight=1.55517404 grams]

Penny-weight	Gram	Penny-weight	Grams	Penny-weights	Grams	Penny-weights	Grams
0.00	0.000	0.55	0.855	0	0.000	55	85.535
.01	.016	.56	.871	1	1.555	56	87.090
.02	.031	.57	.886	2	3.110	57	88.645
.03	.047	.58	.902	3	4.666	58	90.200
.04	.062	.59	.918	4	6.221	59	91.755
.05	.078	.60	.933	5	7.776	60	93.310
.06	.093	.61	.949	6	9.331	61	94.866
.07	.109	.62	.964	7	10.886	62	96.421
.08	.124	.63	.980	8	12.441	63	97.976
.09	.140	.64	.995	9	13.997	64	99.531
.10	.156	.65	1.011	10	15.552	65	101.086
.11	.171	.66	1.026	11	17.107	66	102.641
.12	.187	.67	1.042	12	18.662	67	104.197
.13	.202	.68	1.058	13	20.217	68	105.752
.14	.218	.69	1.073	14	21.772	69	107.307
.15	.233	.70	1.089	15	23.328	70	108.862
.16	.249	.71	1.104	16	24.883	71	110.417
.17	.264	.72	1.120	17	26.438	72	111.973
.18	.280	.73	1.135	18	27.993	73	113.528
.19	.295	.74	1.151	19	29.548	74	115.083
.20	.311	.75	1.166	20	31.103	75	116.638
.21	.327	.76	1.182	21	32.659	76	118.193
.22	.342	.77	1.197	22	34.214	77	119.748
.23	.358	.78	1.213	23	35.769	78	121.304
.24	.373	.79	1.229	24	37.324	79	122.859
.25	.389	.80	1.244	25	38.879	80	124.414
.26	.404	.81	1.260	26	40.435	81	125.969
.27	.420	.82	1.275	27	41.990	82	127.524
.28	.435	.83	1.291	28	43.545	83	129.079
.29	.451	.84	1.306	29	45.100	84	130.635
.30	.467	.85	1.322	30	46.655	85	132.190
.31	.482	.86	1.337	31	48.210	86	133.745
.32	.498	.87	1.353	32	49.766	87	135.300
.33	.513	.88	1.369	33	51.321	88	136.855
.34	.529	.89	1.384	34	52.876	89	138.410
.35	.544	.90	1.400	35	54.431	90	139.966
.36	.560	.91	1.415	36	55.986	91	141.521
.37	.575	.92	1.431	37	57.541	92	143.076
.38	.591	.93	1.446	38	59.097	93	144.631
.39	.607	.94	1.462	39	60.652	94	146.186
.40	.622	.95	1.477	40	62.207	95	147.742
.41	.638	.96	1.493	41	63.762	96	149.297
.42	.653	.97	1.509	42	65.317	97	150.852
.43	.669	.98	1.524	43	66.872	98	152.407
.44	.684	.99	1.540	44	68.428	99	153.962
.45	.700	1.00	1.555	45	69.983	100	155.517
.46	.715			46	71.538	200	311.035
.47	.731			47	73.093	300	466.552
.48	.746			48	74.648	400	622.070
.49	.762	1/8	0.194	49	76.204	500	777.587
		1/4	.389				
.50	.778	3/8	.583	50	77.759	600	933.104
.51	.793	1/2	.778	51	79.314	700	1088.622
.52	.809	5/8	.972	52	80.869	800	1244.139
.53	.824	3/4	1.166	53	82.424	900	1399.657
.54	.840	7/8	1.361	54	83.979	1000	1555.174

TABLE 35

[1 gram=0.64301485 pennyweight]

Grams	Penny-weights	Grams	Penny-weights
0	0.000	55	35.366
1	.643	56	36.009
2	1.286	57	36.652
3	1.929	58	37.295
4	2.572	59	37.938
5	3.215	60	38.581
6	3.858	61	39.224
7	4.501	62	39.867
8	5.144	63	40.510
9	5.787	64	41.153
10	6.430	65	41.796
11	7.073	66	42.439
12	7.716	67	43.082
13	8.359	68	43.725
14	9.002	69	44.368
15	9.645	70	45.011
16	10.288	71	45.654
17	10.931	72	46.297
18	11.574	73	46.940
19	12.217	74	47.583
20	12.860	75	48.226
21	13.503	76	48.869
22	14.146	77	49.512
23	14.789	78	50.155
24	15.432	79	50.798
25	16.075	80	51.441
26	16.718	81	52.084
27	17.361	82	52.727
28	18.004	83	53.370
29	18.647	84	54.013
30	19.290	85	54.656
31	19.933	86	55.299
32	20.576	87	55.942
33	21.219	88	56.585
34	21.863	89	57.228
35	22.506	90	57.871
36	23.149	91	58.514
37	23.792	92	59.157
38	24.435	93	59.800
39	25.078	94	60.443
40	25.721	95	61.086
41	26.364	96	61.729
42	27.007	97	62.372
43	27.650	98	63.015
44	28.293	99	63.658
45	28.936	100	64.301
46	29.579	200	128.603
47	30.222	300	192.904
48	30.865	400	257.206
49	31.508	500	321.507
50	32.151	600	385.809
51	32.794	700	450.110
52	33.437	800	514.412
53	34.080	900	578.713
54	34.723	1000	643.015

MASS—TROY OUNCES AND GRAMS

TABLE 36

[1 troy ounce=31.1034808 grams]

Troy ounce	Grams	Troy ounce	Grams	Troy ounces	Grams	Troy ounces	Grams
0.00	0.000	0.55	17.107	0	0.000	55	1710.691
.01	.311	.56	17.418	1	31.103	56	1741.795
.02	.622	.57	17.729	2	62.207	57	1772.898
.03	.933	.58	18.040	3	93.310	58	1804.002
.04	1.244	.59	18.351	4	124.414	59	1835.105
.05	1.555	.60	18.662	5	155.517	60	1866.209
.06	1.866	.61	18.973	6	186.621	61	1897.312
.07	2.177	.62	19.284	7	217.724	62	1928.416
.08	2.488	.63	19.595	8	248.828	63	1959.519
.09	2.799	.64	19.906	9	279.931	64	1990.623
.10	3.110	.65	20.217	10	311.035	65	2021.726
.11	3.421	.66	20.528	11	342.138	66	2052.830
.12	3.732	.67	20.839	12	373.242	67	2083.933
.13	4.043	.68	21.150	13	404.345	68	2115.037
.14	4.354	.69	21.461	14	435.449	69	2146.140
.15	4.666	.70	21.772	15	466.552	70	2177.244
.16	4.977	.71	22.083	16	497.656	71	2208.347
.17	5.288	.72	22.395	17	528.759	72	2239.451
.18	5.599	.73	22.706	18	559.863	73	2270.554
.19	5.910	.74	23.017	19	590.966	74	2301.658
.20	6.221	.75	23.328	20	622.070	75	2332.761
.21	6.532	.76	23.639	21	653.173	76	2363.865
.22	6.843	.77	23.950	22	684.277	77	2394.968
.23	7.154	.78	24.261	23	715.380	78	2426.071
.24	7.465	.79	24.572	24	746.484	79	2457.175
.25	7.776	.80	24.883	25	777.587	80	2488.278
.26	8.087	.81	25.194	26	808.690	81	2519.382
.27	8.398	.82	25.505	27	839.794	82	2550.485
.28	8.709	.83	25.816	28	870.897	83	2581.589
.29	9.020	.84	26.127	29	902.001	84	2612.692
.30	9.331	.85	26.438	30	933.104	85	2643.796
.31	9.642	.86	26.749	31	964.208	86	2674.899
.32	9.953	.87	27.060	32	995.311	87	2706.003
.33	10.264	.88	27.371	33	1026.415	88	2737.106
.34	10.575	.89	27.682	34	1057.518	89	2768.210
.35	10.886	.90	27.993	35	1088.622	90	2799.313
.36	11.197	.91	28.304	36	1119.725	91	2830.417
.37	11.508	.92	28.615	37	1150.829	92	2861.520
.38	11.819	.93	28.926	38	1181.932	93	2892.624
.39	12.130	.94	29.237	39	1213.036	94	2923.727
.40	12.441	.95	29.548	40	1244.139	95	2954.831
.41	12.752	.96	29.859	41	1275.243	96	2985.934
.42	13.063	.97	30.170	42	1306.346	97	3017.038
.43	13.374	.98	30.481	43	1337.450	98	3048.141
.44	13.686	.99	30.792	44	1368.553	99	3079.245
.45	13.997	1.00	31.103	45	1399.657	100	3110.348
.46	14.308			46	1430.760	200	6220.696
.47	14.619			47	1461.864	300	9331.044
.48	14.930			48	1492.967	400	12441.392
.49	15.241			49	1524.071	500	15551.740
.50	15.552			50	1555.174	600	18662.088
.51	15.863			51	1586.278	700	21772.437
.52	16.174			52	1617.381	800	24882.785
.53	16.485			53	1648.484	900	27993.133
.54	16.796			54	1679.588	1000	31103.481

TABLE 37

[1 gram=0.03215074 troy ounce]

Grams	Troy ounces	Grams	Troy ounces
0	0.0000	55	1.7683
1	.0322	56	1.8004
2	.0643	57	1.8326
3	.0965	58	1.8647
4	.1286	59	1.8969
5	.1608	60	1.9290
6	.1929	61	1.9612
7	.2251	62	1.9933
8	.2572	63	2.0255
9	.2894	64	2.0576
10	.3215	65	2.0898
11	.3537	66	2.1219
12	.3858	67	2.1541
13	.4180	68	2.1863
14	.4501	69	2.2184
15	.4823	70	2.2506
16	.5144	71	2.2827
17	.5466	72	2.3149
18	.5787	73	2.3470
19	.6109	74	2.3792
20	.6430	75	2.4113
21	.6752	76	2.4435
22	.7073	77	2.4756
23	.7395	78	2.5078
24	.7716	79	2.5399
25	.8038	80	2.5721
26	.8359	81	2.6042
27	.8681	82	2.6364
28	.9002	83	2.6685
29	.9324	84	2.7007
30	.9645	85	2.7328
31	.9967	86	2.7650
32	1.0288	87	2.7971
33	1.0610	88	2.8293
34	1.0931	89	2.8614
35	1.1253	90	2.8936
36	1.1574	91	2.9257
37	1.1896	92	2.9579
38	1.2217	93	2.9900
39	1.2539	94	3.0222
40	1.2860	95	3.0543
41	1.3182	96	3.0865
42	1.3503	97	3.1186
43	1.3825	98	3.1508
44	1.4146	99	3.1829
45	1.4468	100	3.2151
46	1.4789	200	6.4301
47	1.5111	300	9.6452
48	1.5432	400	12.8603
49	1.5754	500	16.0754
50	1.6075	600	19.2904
51	1.6397	700	22.5055
52	1.6718	800	25.7206
53	1.7040	900	28.9357
54	1.7361	1000	32.1507

MASS—POUNDS AND KILOGRAMS

TABLE 38

[1 avoirdupois pound=0.4535924277 kilogram]

Avoirdupois pounds[a]	Kilograms[a]	Avoirdupois pounds	Kilograms
0	0.0	55	24.9
1	.5	56	25.4
2	.9	57	25.9
3	1.4	58	26.3
4	1.8	59	26.8
5	2.3	60	27.2
6	2.7	61	27.7
7	3.2	62	28.1
8	3.6	63	28.6
9	4.1	64	29.0
10	4.5	65	29.5
11	5.0	66	29.9
12	5.4	67	30.4
13	5.9	68	30.8
14	6.4	69	31.3
15	6.8	70	31.8
16	7.3	71	32.2
17	7.7	72	32.7
18	8.2	73	33.1
19	8.6	74	33.6
20	9.1	75	34.0
21	9.5	76	34.5
22	10.0	77	34.9
23	10.4	78	35.4
24	10.9	79	35.8
25	11.3	80	36.3
26	11.8	81	36.7
27	12.2	82	37.2
28	12.7	83	37.6
29	13.2	84	38.1
30	13.6	85	38.6
31	14.1	86	39.0
32	14.5	87	39.5
33	15.0	88	39.9
34	15.4	89	40.4
35	15.9	90	40.8
36	16.3	91	41.3
37	16.8	92	41.7
38	17.2	93	42.2
39	17.7	94	42.6
40	18.1	95	43.1
41	18.6	96	43.5
42	19.1	97	44.0
43	19.5	98	44.5
44	20.0	99	44.9
45	20.4	100	45.4
46	20.9	200	90.7
47	21.3	300	136.1
48	21.8	400	181.4
49	22.2	500	226.8
50	22.7	600	272.2
51	23.1	700	317.5
52	23.6	800	362.9
53	24.0	900	408.2
54	24.5	1000	453.6

TABLE 39

[1 kilogram=2.20462234 avoirdupois pounds]

Kilograms[a]	Avoirdupois pounds[a]	Kilograms	Avoirdupois pounds
0	0.0	55	121.3
1	2.2	56	123.5
2	4.4	57	125.7
3	6.6	58	127.9
4	8.8	59	130.1
5	11.0	60	132.3
6	13.2	61	134.5
7	15.4	62	136.7
8	17.6	63	138.9
9	19.8	64	141.1
10	22.0	65	143.3
11	24.3	66	145.5
12	26.5	67	147.7
13	28.7	68	149.9
14	30.9	69	152.1
15	33.1	70	154.3
16	35.3	71	156.5
17	37.5	72	158.7
18	39.7	73	160.9
19	41.9	74	163.1
20	44.1	75	165.3
21	46.3	76	167.6
22	48.5	77	169.8
23	50.7	78	172.0
24	52.9	79	174.2
25	55.1	80	176.4
26	57.3	81	178.6
27	59.5	82	180.8
28	61.7	83	183.0
29	63.9	84	185.2
30	66.1	85	187.4
31	68.3	86	189.6
32	70.5	87	191.8
33	72.8	88	194.0
34	75.0	89	196.2
35	77.2	90	198.4
36	79.4	91	200.6
37	81.6	92	202.8
38	83.8	93	205.0
39	86.0	94	207.2
40	88.2	95	209.4
41	90.4	96	211.6
42	92.6	97	213.8
43	94.8	98	216.1
44	97.0	99	218.3
45	99.2	100	220.5
46	101.4	200	440.9
47	103.6	300	661.4
48	105.8	400	881.8
49	108.0	500	1102.3
50	110.2	600	1322.8
51	112.4	700	1543.2
52	114.6	800	1763.7
53	116.8	900	1984.2
54	119.0	1000	2204.6

[a] For the conversion of avoirdupois ounces to grams see Table 29.

III. THE METRIC CARAT

1. DEFINITION

The carat which had been in use prior to July 1, 1913, in the United States, while varying, has been nearer the value 205.3 mg than any other. This value has therefore been taken in making up the tables of equivalents given in this circular. The old carat has usually been subdivided on the binary system, the smallest subdivision used being usually one sixty-fourth of the carat. The equivalents in fractions of a carat in these tables are, therefore, given in sixty-fourths. One of the improvements introduced with the new carat of exactly 200 mg is the subdivision of it on the decimal system. The fractions of the new carat in these tables are accordingly given to hundredths of a carat.

2. CONVERSION TABLES

Tables 40 and 41 are for the conversion of quantities in the old unit to the equivalent weight in terms of the new metric carat. Table 40 is used for the conversion of fractions of a carat, while Table 41 gives the equivalent of each unit or whole carat from 1 to 100 of the old system in terms of new metric carats and hundredths of a carat. If it is desired to convert whole carats and fractions of a carat of the old unit to the new, the two tables can be used in combination; that is, by adding the quantities obtained from each, thus: Suppose it is desired to obtain the equivalent of $28\frac{45}{64}$ old carats in terms of the metric carats:

From Table 40..	$\frac{45}{64}$	old carats =	0. 72 metric carats
From Table 41..	28	old carats =	28. 74 metric carats
Adding...	$28\frac{45}{64}$	old carats =	29. 46 metric carats.

Or, if it is desired to convert a larger quantity involving several hundred or thousand carats, one uses the equivalents in the last column of Table 41 for each hundred and thousand of the old carats up to ten hundred and ten thousand—thus, to convert $3225\frac{3}{4}$ old carats to metric carats:

From Table 40..	$\frac{3}{4}$	old carats =	0. 77 metric carats
From Table 41..	25	old carats =	25. 66 metric carats
	200	old carats =	205. 30 metric carats
	3000	old carats =	3079. 50 metric carats
Adding...	$3225\frac{3}{4}$	old carats =	3311. 23 metric carats.

TABLE 40.—Equivalents of Fractions of the Old Carat Weight in New Decimal Metric Carats

[Computed on the basis of 1 old carat=205.3 mg; 1 new metric carat=200 mg]

Old carat						New metric carats	Old carat							New metric carats
1/2's	1/4's	8ths	16ths	32ds	64ths		1 carat	1/2's	1/4's	8ths	16ths	32ds	64ths	
					1	=0.02							33	=0.53
				1	2	= .03						17	34	= .55
					3	= .05							35	= .56
			1	2	4	= .06					9	18	36	= .58
					5	= .08							37	= .59
				3	6	= .10						19	38	= .61
					7	= .11							39	= .63
		1	2	4	8	= .13				5	10	20	40	= .64
					9	= .14							41	= .66
				5	10	= .16						21	42	= .67
					11	= .18							43	= .69
			3	6	12	= .19					11	22	44	= .71
					13	= .21							45	= .72
				7	14	= .22						23	46	= .74
					15	= .24							47	= .75
	1	2	4	8	16	= .26			3	6	12	24	48	= .77
					17	= .27							49	= .79
				9	18	= .29						25	50	= .80
					19	= .30							51	= .82
			5	10	20	= .32					13	26	52	= .83
					21	= .34							53	= .85
				11	22	= .35						27	54	= .87
					23	= .37							55	= .88
		3	6	12	24	= .38				7	14	28	56	= .90
					25	= .40							57	= .91
				13	26	= .42						29	58	= .93
					27	= .43							59	= .95
			7	14	28	= .45					15	30	60	= .96
					29	= .47							61	= .98
				15	30	= .48						31	62	= .99
					31	= .50							63	=1.01
1	2	4	8	16	32	= .51	1	2	4	8	16	32	64	=1.03

TABLE 41.—Equivalents of the Old Carats in New Decimal Metric Carats

[Computed on the basis of 1 old carat=205.3 mg; 1 new metric carat=200 mg]

Old carats	New metric carats	Old carats	New metric carats	Old carats	New metric carats	Old carats	New metric carats	Old carats	New metric carats
1	1. 03	26	26. 69	51	52. 35	76	78. 01	200	205. 30
2	2. 05	27	27. 72	52	53. 38	77	79. 04	300	307. 95
3	3. 08	28	28. 74	53	54. 40	78	80. 07	400	410. 60
4	4. 11	29	29. 77	54	55. 43	79	81. 09	500	513. 25
5	5. 13	30	30. 80	55	56. 46	80	82. 12	600	615. 90
6	6. 16	31	31. 82	56	57. 48	81	83. 15	700	718. 55
7	7. 19	32	32. 85	57	58. 51	82	84. 17	800	821. 20
8	8. 21	33	33. 87	58	59. 54	83	85. 20	900	923. 85
9	9. 24	34	34. 90	59	60. 56	84	86. 23	1000	1026. 50
10	10. 26	35	35. 93	60	61. 59	85	87. 25	2000	2053. 00
11	11. 29	36	36. 95	61	62. 62	86	88. 28	3000	3079. 50
12	12. 32	37	37. 98	62	63. 64	87	89. 31	4000	4106. 00
13	13. 34	38	39. 01	63	64. 67	88	90. 33	5000	5132. 50
14	14. 37	39	40. 03	64	65. 70	89	91. 36	6000	6159. 00
15	15. 40	40	41. 06	65	66. 72	90	92. 38	7000	7185. 50
16	16. 42	41	42. 09	66	67. 75	91	93. 41	8000	8212. 00
17	17. 45	42	43. 11	67	68. 78	92	94. 44	9000	9238. 50
18	18. 48	43	44. 14	68	69. 80	93	95. 46	10 000	10265. 00
19	19. 50	44	45. 17	69	70. 83	94	96. 49		
20	20. 53	45	46. 19	70	71. 86	95	97. 52		
21	21. 56	46	47. 22	71	72. 88	96	98. 54		
22	22. 58	47	48. 25	72	73. 91	97	99. 57		
23	23. 61	48	49. 27	73	74. 93	98	100. 60		
24	24. 64	49	50. 30	74	75. 96	99	101. 62		
25	25. 66	50	51. 32	75	76. 99	100	102. 65		

IV. GAGES[7] (WIRE AND DRILL)

1. EXISTING PRACTICE IN GAGING MATERIALS

The sizes of materials were for many years indicated in commercial practice almost entirely by gage numbers. This practice was accompanied by considerable confusion because numerous gages were in use. In general, gage sizes are used much less now than formerly.[8]

In so far as wire gages are now in use in the United States, the practice has been practically limited to the use of *two gages*. For iron plates, there is only one gage—viz, the "U. S. standard." For drills there are two, with an additional one for drill rod and steel wire. Finally, there are some special gages, including several music wire gages.

The trend of practice in the gaging of materials is increasingly toward *the direct specification of the dimensions in decimal fractions of an inch or millimeter* without the use of gage numbers. Numerous engineering societies have gone on record as in favor of the direct use of diameters. This is similar to the practice in Germany, France, and Italy, where sizes are specified directly by the diameter in millimeters.

[7] This information about gages was gathered from the statements on the subject in the catalogues of manufacturers and in scientific literature, including B. S. Circular No. 31.

[8] In an article written in 1887 (S. S. Wheeler, Elec. World, **10**, p. 254; 1887), over 30 gages were described, 19 of which were wire gages.

2. WIRE GAGES [9]

Among the wire gages that have survived, two are used extensively in this country, viz, the "American wire gage" (Brown & Sharpe) and the "Steel wire gage" (variously called the "Washburn & Moen," "Roebling," and "American Steel & Wire Co.'s"). Three other gages are still used to some extent, viz, the "Stubs' steel wire gage," the "Birmingham wire gage" (Stubs), and the "Old English wire gage" (London). In England one wire gage has been made legal and is in use generally, viz, the "Standard wire gage." The diameters corresponding to the gage number of five of the general wire gages mentioned are given in both inches and in millimeters in Table 43.

(a) American wire gage

The American wire gage is frequently called the "Brown & Sharpe gage." Its sizes are not utterly arbitrary and the differences between successive diameters are more regular than those of other gages. It is the only wire gage now in use whose successive sizes are determined by a mathematical law. The law of geometrical progression on which the gage is based is that the ratio of any diameter to the next smaller is a *constant number* (1.1229322). It is derived from the fundamental definition of the gage, which is that size No. 4–0 shall be 0.4600 inch in diameter, size No. 36 shall be 0.0050 inch in diameter, and 38 intermediary sizes or diameters shall be formed by geometrical progression.

(b) Steel wire gage

The "Steel wire gage" [10] with a number of its sizes expressed only to the nearest thousandth of an inch, has been known as the Roebling gage. It was originally established about the year 1830, and was named after the Washburn & Moen Manufacturing Co. This company was later merged into the American Steel & Wire Co., which continued the use of the Washburn & Moen gage for steel wire, giving it the name "American Steel & Wire Co.'s gage."

(c) Stubs' steel wire gage

The Stubs' steel wire gage has a somewhat limited use for tool steel wire and drill rods. This gage should not be confused with the Birmingham wire gage, which is sometimes known as Stubs'

[9] For a more complete discussion of wire gages, see B. S. Circular No. 31, Copper Wire Tables.

[10] The name "Steel wire gage" was suggested by the Bureau of Standards in its correspondence with various companies, and it met with practically unanimous approval. It was necessary to decide upon a name for this gage, and the three names which have been used for it in the past were all open to the objection that they were the names of particular companies. These companies have accepted the new name. The abbreviation of the name of the gage should be "Stl. W. G.," to distinguish it from "S. W. G.," the abbreviation for the (British) Standard wire gage. When it is necessary to distinguish the name of this gage from others which may be used for steel wire—e. g., the (British) Standard wire gage—it may be called the United States steel wire gage.

iron wire gage. The diameters of its sizes are very nearly identical with the diameters of the corresponding sizes of drill gages, as is shown in Tables 45, 46, and 47.

(d) BIRMINGHAM WIRE GAGE

Of the various wire gages which have remained in use but are now nearly obsolete, the one most frequently mentioned is the Birmingham. Its steps are quite irregular. Some of the later gages were based on the Birmingham, and by the repeated copying of old specifications its use has persisted to some extent, both in England and the United States. In the past this gage held certain departmental sanction in the United States Government, but this sanction was removed in 1914.

(e) STANDARD WIRE GAGE

The "Standard wire gage," otherwise known as the new British standard, the English legal standard, or the Imperial wire gage, is the legal standard of Great Britain for all wires, as fixed by order in Council, August 23, 1883. It was constructed by improving the Birmingham wire gage.

(f) OLD ENGLISH OR LONDON GAGE

The Old English or London gage, the sizes of which differ very little from those of the Birmingham gage, has had considerable use in the past for brass and copper wires, and is now used to some extent in the drawing of brass wire for weaving. It is nearly obsolete.

3. TWIST DRILL AND STEEL WIRE GAGES

The confusion in the use of gages for twist drills, drill rod, and steel wire is a constant source of trouble. The differences between the diameters of the corresponding sizes of the various gages are very small, generally being less than 0.002 inch. In this field also, the manufacturers (of drills) are encouraging the direct use of diameters in place of specifying sizes by gage numbers. At the present time there are three gages in extensive use in this field. These are (1) the Stubs' steel wire gage, (2) the drill gage used by the Standard Tool Co., and (3) the drill gage used by various other leading manufacturers of twist drills. This latter gage is referred to in the tables which follow as "various manufacturers" but in other publications it is sometimes referred to as "manufacturers' standard."

All of these gages have 26 lettered sizes and 80 numbered sizes. The lettered sizes of all three gages are identical. (See Table 44.) For the numbered sizes, the Stubs' steel wire gage does not agree with either of the drill gages. For Nos. 1 to 60 (Table 45) the gage of the Standard Tool Co. agrees with the corresponding sizes of the gage used by various other manufacturers; for sizes Nos. 61 to 80 (Tables 46 and 47) there are numerous, but small, differences. The Standard Tool Co. gage sizes were the original, which, for sizes 61 to 80, were changed by certain manufacturers. The old size numbers and diameters were retained by the Standard Tool Co., which, in turn, began to manufacture drills of the new diameters as determined by the modified gage numbers of the other manufacturers, but assigned them gage sizes by inserting so-called half-sizes into their own gage. The relationships between the diameters and the various gage sizes are shown in Table 47.

4. TABLES OF GAGE SIZES (INCHES AND MILLIMETERS)

TABLE 42.—Douzième Caliper [a]

[Equivalent of each graduation on douzième spring caliper.[a] 1 douzième=1/12 ligne; 1 ligne=2.2559 mm]

Douzièmes	Inch.	mm	Douzièmes	Inch	mm
1	0.0074	0.188	37	0.2738	6.956
2	.0148	.376	38	.2812	7.144
3	.0222	.564	39	.2886	7.332
4	.0296	.752	40	.2960	7.520
5	.0370	.940	41	.3035	7.708
6	.0444	1.128	42	.3109	7.896
7	.0518	1.316	43	.3183	8.084
8	.0592	1.504	44	.3257	8.272
9	.0666	1.692	45	.3331	8.460
10	.0740	1.880	46	.3405	8.648
11	.0814	2.068	47	.3479	8.836
1 ligne =12	.0888	2.256	4 lignes=48	.3553	9.024
13	.0962	2.444	49	.3627	9.212
14	.1036	2.632	50	.3701	9.400
15	.1110	2.820	51	.3775	9.588
16	.1184	3.008	52	.3849	9.776
17	.1258	3.196	53	.3923	9.964
18	.1332	3.384	54	.3997	10.152
19	.1406	3.572	55	.4071	10.340
20	.1480	3.760	56	.4145	10.528
21	.1554	3.948	57	.4219	10.716
22	.1628	4.136	58	.4293	10.904
23	.1702	4.324	59	.4367	11.092
2 lignes=24	.1776	4.512	5 lignes=60	.4441	11.280
25	.1850	4.700	61	.4515	11.467
26	.1924	4.888	62	.4589	11.655
27	.1998	5.076	63	.4663	11.843
28	.2072	5.264	64	.4737	12.031
29	.2146	5.452	65	.4811	12.219
30	.2220	5.640	66	.4885	12.407
31	.2294	5.828	67	.4959	12.595
32	.2368	6.016	68	.5033	12.783
33	.2442	6.204	69	.5107	12.971
34	.2516	6.392	70	.5181	13.159
35	.2590	6.580	71	.5255	13.347
3 lignes=36	.2664	6.768	6 lignes=72	.5329	13.535

[a] This caliper must not be confused with the tenth-millimeter spring caliper, which is similar in appearance to the douzième caliper. For the graduation equivalents of the gage, or caliper, referred to by the various names of screw, point, or dial gage, using the values of "points" as used by silversmiths, or quarter-thousandths of an inch, see the first column of Table 6.

TABLE 43.—Tabular Comparison of Wire Gages

Gage No.	American wire gage (Brown & Sharpe)		Steel wire gage [a]		Birmingham wire gage (Stubs')		Stubs' steel wire gage		(British) Standard wire gage	
	Inch	mm [b]	Inch	mm	Inch	mm	Inch	mm	Inch	mm
7–0	....	....	0. 4900	12. 45	....	....	....	....	0. 500	12. 70
6–0	....	....	. 4615	11. 72	....	....	....	....	. 464	11. 79
5–0	....	....	. 4305	10. 93	....	....	....	....	. 432	10. 97
4–0	0. 4600	11. 68	. 3938	10. 00	0. 454	11. 53	....	....	. 400	10. 16
3–0	. 4096	10. 40	. 3625	9. 21	. 425	10. 80	....	....	. 372	9. 45
2–0	. 3648	9. 27	. 3310	8. 41	. 380	9. 65	....	....	. 348	8. 84
0	. 3249	8. 25	. 3065	7. 79	. 340	8. 64	....	....	. 324	8. 23
1	. 2893	7. 35	. 2830	7. 19	. 300	7. 62	0. 227	5. 77	. 300	7. 62
2	. 2576	6. 54	. 2625	6. 67	. 284	7. 21	. 219	5. 56	. 276	7. 01
3	. 2294	5. 83	. 2437	6. 19	. 259	6. 58	. 212	5. 38	. 252	6. 40
4	. 2043	5. 19	. 2253	5. 72	. 238	6. 05	. 207	5. 26	. 232	5. 89
5	. 1819	4. 621	. 2070	5. 26	. 220	5. 59	. 204	5. 18	. 212	5. 38
6	. 1620	4. 115	. 1920	4. 88	. 203	5. 16	. 201	5. 11	. 192	4. 88
7	. 1443	3. 665	. 1770	4. 50	. 180	4. 57	. 199	5. 05	. 176	4. 47
8	. 1285	3. 264	. 1620	4. 11	. 165	4. 19	. 197	5. 00	. 160	4. 06
9	. 1144	2. 906	. 1483	3. 77	. 148	3. 76	. 194	4. 93	. 144	3. 66
10	. 1019	2. 588	. 1350	3. 43	. 134	3. 40	. 191	4. 85	. 128	3. 25
11	. 0907	2. 305	. 1205	3. 06	. 120	3. 05	. 188	4. 78	. 116	2. 95
12	. 0808	2. 053	. 1055	2. 68	. 109	2. 77	. 185	4. 70	. 104	2. 64
13	. 0720	1. 828	. 0915	2. 32	. 095	2. 41	. 182	4. 62	. 092	2. 34
14	. 0641	1. 628	. 0800	2. 03	. 083	2. 11	. 180	4. 57	. 080	2. 03
15	. 0571	1. 450	. 0720	1. 829	. 072	1. 83	. 178	4. 52	. 072	1. 83
16	. 0508	1. 291	. 0625	1. 588	. 065	1. 65	. 175	4. 45	. 064	1. 63
17	. 0453	1. 150	. 0540	1. 372	. 058	1. 47	. 172	4. 37	. 056	1. 42
18	. 0403	1. 024	. 0475	1. 207	. 049	1. 24	. 168	4. 27	. 048	1. 22
19	. 0359	. 912	. 0410	1. 041	. 042	1. 07	. 164	4. 17	. 040	1. 02
20	. 0320	. 812	. 0348	. 884	. 035	. 889	. 161	4. 09	. 036	. 91
21	. 0285	. 723	. 0317	. 805	. 032	. 813	. 157	3. 99	. 032	. 81
22	. 0253	. 644	. 0286	. 726	. 028	. 711	. 155	3. 94	. 028	. 71
23	. 0226	. 573	. 0258	. 655	. 025	. 635	. 153	3. 89	. 024	. 61
24	. 0201	. 511	. 0230	. 584	. 022	. 559	. 151	3. 84	. 022	. 56
25	. 0179	. 455	. 0204	. 518	. 020	. 508	. 148	3. 76	. 020	. 51
26	. 0159	. 405	. 0181	. 460	. 018	. 457	. 146	3. 71	. 018	. 46
27	. 0142	. 361	. 0173	. 439	. 016	. 406	. 143	3. 63	. 0164	. 417
28	. 0126	. 321	. 0162	. 411	. 014	. 356	. 139	3. 53	. 0148	. 376
29	. 0113	. 286	. 0150	. 381	. 013	. 330	. 134	3. 40	. 0136	. 345
30	. 0100	. 255	. 0140	. 356	. 012	. 305	. 127	3. 23	. 0124	. 315
31	. 0089	. 227	. 0132	. 335	. 010	. 254	. 120	3. 05	. 0116	. 295
32	. 0080	. 202	. 0128	. 325	. 009	. 229	. 115	2. 92	. 0108	. 274
33	. 0071	. 180	. 0118	. 300	. 008	. 203	. 112	2. 84	. 0100	. 254
34	. 0063	. 160	. 0104	. 264	. 007	. 178	. 110	2. 79	. 0092	. 234
35	. 0056	. 143	. 0095	. 241	. 005	. 127	. 108	2. 74	. 0084	. 213
36	. 0050	. 127	. 0090	. 229	. 004	. 102	. 106	2. 69	. 0076	. 193
37	. 0045	. 113	. 0085	. 216	....	....	. 103	2. 62	. 0068	. 173
38	. 0040	. 101	. 0080	. 203	....	....	. 101	2. 57	. 0060	. 152
39	. 0035	. 090	. 0075	. 191	....	....	. 099	2. 51	. 0052	. 132
40	. 0031	. 080	. 0070	. 178	....	....	. 097	2. 46	. 0048	. 122
41	. 0028	. 071	. 0066	. 168	....	....	. 095	2. 41	. 0044	. 112
42	. 0025	. 063	. 0062	. 157	....	....	. 092	2. 34	. 0040	. 102
43	. 0022	. 056	. 0060	. 152	....	....	. 088	2. 24	. 0036	. 091
44	. 0020	. 050	. 0058	. 147	....	....	. 085	2. 16	. 0032	. 081
45	. 0018	. 045	. 0055	. 140	....	....	. 081	2. 06	. 0028	. 071
46	. 0016	. 040	. 0052	. 132	....	....	. 079	2. 01	. 0024	. 061
47	. 0014	. 035	. 0050	. 127	....	....	. 077	1. 96	. 0020	. 051
48	. 0012	. 032	. 0048	. 122	....	....	. 075	1. 91	. 0016	. 041
49	. 0011	. 028	. 0046	. 117	....	....	. 072	1. 83	. 0012	. 030
50	. 0010	. 025	. 0044	. 112	....	....	. 069	1. 75	. 0010	. 025

[a] The Steel wire gage is the same gage which has been known by the various names: "Washburn & Moen," "Roebling," and "American Steel & Wire Co's." Its abbreviation should be written "Stl. W. G." to distinguish it from "S. W. G.," the usual abbreviation for the (British) Standard wire gage.

[b] The millimeter diameters given for the American wire gage were obtained by multiplying by 25.40005 the mathematically correct values in inches before the latter were rounded off in the fourth decimal place as shown in the second column of the table.

TABLE 44.—Equivalents of Lettered Sizes for Drills and Stubs' Steel Wire Gage

Letter	Size of letter		Letter	Size of letter		Letter	Size of letter	
	Inch	mm		Inch	mm		Inch	mm
Z	0.413	10.49	P	0.323	8.20	F	0.257	6.53
Y	.404	10.26	O	.316	8.03	E	.250	6.35
X	.397	10.08	N	.302	7.67	D	.246	6.25
W	.386	9.80	M	.295	7.49	C	.242	6.15
V	.377	9.58	L	.290	7.37	B	.238	6.05
						A	.234	5.94
U	.368	9.35	K	.281	7.14			
T	.358	9.09	J	.277	7.04			
S	.348	8.84	I	.272	6.91			
R	.339	8.61	H	.266	6.76			
Q	.332	8.43	G	.261	6.63			

TABLE 45.—Numbered Sizes, 1 to 60, for Drills and Stubs' Steel Wire Gage

Gage No.	Stubs' steelwire gage		Drill gage [a]		Gage No.	Stubs' steelwire gage		Drill gage [a]	
	Inch	mm	Inch	mm		Inch	mm	Inch	mm
1	0.227	5.766	0.2280	5.791	30	0.127	3.226	0.1285	3.264
2	.219	5.563	.2210	5.613	31	.120	3.048	.1200	3.048
3	.212	5.385	.2130	5.410	32	.115	2.921	.1160	2.946
4	.207	5.258	.2090	5.309	33	.112	2.845	.1130	2.870
					34	.110	2.794	.1110	2.819
5	.204	5.182	.2055	5.220					
6	.201	5.105	.2040	5.182	35	.108	2.743	.1100	2.794
7	.199	5.055	.2010	5.105	36	.106	2.692	.1065	2.705
8	.197	5.004	.1990	5.055	37	.103	2.616	.1040	2.642
9	.194	4.928	.1960	4.978	38	.101	2.565	.1015	2.578
					39	.099	2.515	.0995	2.527
10	.191	4.851	.1935	4.915					
11	.188	4.775	.1910	4.851	40	.097	2.464	.0980	2.489
12	.185	4.699	.1890	4.801	41	.095	2.413	.0960	2.438
13	.182	4.623	.1850	4.699	42	.092	2.337	.0935	2.375
14	.180	4.572	.1820	4.623	43	.088	2.235	.0890	2.261
					44	.085	2.159	.0860	2.184
15	.178	4.521	.1800	4.572					
16	.175	4.445	.1770	4.496	45	.081	2.057	.0820	2.083
17	.172	4.369	.1730	4.394	46	.079	2.007	.0810	2.057
18	.168	4.267	.1695	4.305	47	.077	1.956	.0785	1.994
19	.164	4.166	.1660	4.216	48	.075	1.905	.0760	1.930
					49	.072	1.829	.0730	1.854
20	.161	4.089	.1610	4.089					
21	.157	3.988	.1590	4.039	50	.069	1.753	.0700	1.778
22	.155	3.937	.1570	3.988	51	.066	1.676	.0670	1.702
23	.153	3.886	.1540	3.912	52	.063	1.600	.0635	1.613
24	.151	3.835	.1520	3.861	53	.058	1.473	.0595	1.511
					54	.055	1.397	.0550	1.397
25	.148	3.759	.1495	3.797					
26	.146	3.708	.1470	3.734	55	.050	1.270	.0520	1.321
27	.143	3.632	.1440	3.658	56	.045	1.143	.0465	1.181
28	.139	3.531	.1405	3.569	57	.042	1.067	.0430	1.092
29	.134	3.404	.1360	3.454	58	.041	1.041	.0420	1.067
					59	.040	1.016	.0410	1.041
					60	.039	0.991	.0400	1.016

[a] For sizes 1 to 60 the dimensions for both drill gages—Standard Tool and "various manufacturers"—are identical, but differ from the Stubs' steel wire gage.

TABLE 46.—Numbered Sizes, 60 to 80, for Drills and Stubs' Steel Wire Gage

Gage No.	Stubs' steel wire gage		Standard Tool Co. drill gage		Various manufacturers	
	Inch	mm	Inch	mm	Inch	mm
60	0.039	0.991	0.0400	1.016	0.0400	1.016
60½	....	....	.0390	.991	....	......
61	.038	.965	.0380	.965	.0390	.991
62	.037	.940	.0370	.940	.0380	.965
63	.036	.914	.0360	.914	.0370	.940
64	.035	.889	.0350	.889	.0360	.914
65	.033	.838	.0330	.838	.0350	.889
66	.032	.813	.0320	.813	.0330	.838
67	.031	.787	.0310	.787	.0320	.813
68	.030	.762	.0300	.762	.0310	.787
68½	....	....	.02925	.743	....	......
69	.029	.737	.0290	.737	.02925	.743
69½	....	....	.0280	.711	....	......
70	.027	.686	.0270	.686	.0280	.711
71	.026	.660	.0260	.660	.0260	.660
71½	....	....	.0250	.635	....	......
72	.024	.610	.0240	.610	.0250	.635
73	.023	.584	.0230	.584	.0240	.610
73½	....	....	.0225	.572	....	......
74	.022	.559	.0220	.559	.0225	.572
74½	....	....	.0210	.533	....	......
75	.020	.508	.0200	.508	.0210	.533
76	.018	.457	.0180	.457	.0200	.508
77	.016	.406	.0160	.406	.0180	.457
78	.015	.381	.0150	.381	.0160	.406
78½	....	....	.0145	.368	....	......
79	.014	.356	.0140	.356	.0145	.368
79½	....	....	.0135	.343	....	......
80	.013	.330	.0130	.330	.0135	.343

TABLE 47.—Index to Numbered Sizes, 60 to 80, for Drills and Stubs' Steel Wire Gage

Diameter of drill		Gage numbers			Diameter of drill		Gage numbers		
Inch	mm	Stubs' steel wire gage	Standard Tool Co. drill gage	Various manufacturers	Inch	mm	Stubs' steel wire gage	Standard Tool Co. drill gage	Various manufacturers
0.0400	1.016	59	60	60	0.0250	0.635	....	71½	72
.0390	.991	60	60½	61	.0240	.610	72	72	73
.0380	.965	61	61	62	.0230	.584	73	73	....
.0370	.940	62	62	63	.0225	.572	....	73½	74
.0360	.914	63	63	64	.0220	.559	74	74	....
.0350	.889	64	64	65	.0210	.533	....	74½	75
.0330	.838	65	65	66	.0200	.508	75	75	76
.0320	.813	66	66	67	.0180	.457	76	76	77
.0310	.787	67	67	68	.0160	.406	77	77	78
.0300	.762	68	68	....	0150	.381	78	78	....
.02925	.743	....	68½	69	.0145	.368	....	78½	79
.0290	.737	69	69	....	.0140	.356	79	79	....
.0280	.711	....	69½	70	.0135	.343	....	79½	80
.0270	.686	70	70	....	.0130	.330	80	80	....
.0260	.660	71	71	71					

V. WATCH GLASSES

1. GAGE SIZES FOR WATCH GLASSES

The systems upon which the gaging of watch glasses is based are in need of revision. Most manufacturers and dealers are labeling their glasses with several sets of numbers, each set indicating the diameter according to some system of gaging, most of which are based upon some subdivision of the ligne.[11] The most common of these units based upon the ligne is frequently referred to as "sixteenths," because in this system the fraction over an integral number of lignes is expressed in sixteenths. Some of these labels include systems of gaging which are practically, if not entirely, obsolete. On the other hand, several manufacturers use the metric system, the unit for diameters being the tenth-millimeter.

2. REASONS FOR ADOPTION OF METRIC GAGE SIZES

The metric system of gaging is recommended for use in preference to the ligne and its division into sixteenths, for the following reasons:

(*a*) The step, or change in diameter, between consecutive sizes in the tenth-millimeter system is less than the corresponding steps for glasses gaged by lignes and "sixteenths," thereby making it possible to secure a better fit in placing a glass into a watchcase.

(*b*) Many watch glasses are manufactured in metric sizes and are sold in ligne sizes to satisfy the habits of the retail trade in the United States. On the continent of Europe metric sizes are used.

(*c*) The ligne as a unit of length is obsolete except in a few industries, and among them it is falling into disuse; the millimeter is universal in most commercial countries.

3. SPECIMEN LABELS

In Fig. 2 there are shown two sample labels of watch glasses giving the diameters in tenth-millimeters and in lignes (frequently spoken of as sixteenths); the last number given on each of these labels indicates by gage number the free height under the center of the glass to the plane formed by the circumference or rim. (See Table 49, p. 37). The basis by which the height of a watch glass is gaged is that a flat glass is gage No. 10, and that for each unit distance of 0.4 millimeter in height, the gage number decreases by unity.

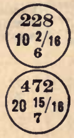

FIG. 2.—*Specimen watch glass labels*

This system of labeling is recommended by the Bureau of Standards as the most satisfactory for the present, at least so long as the ligne sizes are used in appreciable quantities. The manufacturers would prefer that metric sizes be used exclusively, but it depends largely upon the retail establishments to simplify existing conditions.

[11] The origin of the ligne is from the old, now practically obsolete, French toise (fathom) as follows: 12 lignes=1 pouce, 12 pouce=1 pied, 6 pied=1 toise. The relation between the toise and meter is 1 toise=1.949090 meters. (Guillaume, "Unités et Étalons," page 64.)

4. INFLUENCE OF WATCHCASE DESIGN

The number of sizes of watch glasses which it is necessary for retail establishments to carry in stock is almost appalling. In the table of diameters given below (Table 48), there are 272 sizes shown, which apply to each of the various models. The Bureau desires to suggest that the number of necessary sizes can be eventually reduced about 50 per cent if watchcase manufacturers would confine themselves to the manufacture of cases requiring only glasses whose sizes are an integral number of millimeters; to provide for odd sizes resulting from inaccurate workmanship, there would be supplied about two tenth-millimeter sizes below and above each integral or whole millimeter size.

5. CONVERSION TABLES

Table 48 is a conversion table for the reduction of diameters expressed in lignes into tenth-millimeter sizes. Table 49 gives the height of glasses in both millimeters and inches.

TABLE 48.—Diameter of Watch Glasses——Conversion of Lignes (16ths) into Tenth-millimeters

[1 ligne = 2.2559 mm]

Size	$\frac{0}{16}$	$\frac{1}{16}$	$\frac{2}{16}$	$\frac{3}{16}$	$\frac{4}{16}$	$\frac{5}{16}$	$\frac{6}{16}$	$\frac{7}{16}$	$\frac{8}{16}$	$\frac{9}{16}$	$\frac{10}{16}$	$\frac{11}{16}$	$\frac{12}{16}$	$\frac{13}{16}$	$\frac{14}{16}$	$\frac{15}{16}$
6	135	137	138	140	141	142	144	145	147	148	149	151	152	154	155	157
7	158	159	161	162	164	165	166	168	169	171	172	173	175	176	178	179
8	180	182	183	185	186	188	189	190	192	193	195	196	197	199	200	202
9	203	204	206	207	209	210	211	213	214	216	217	219	220	221	223	224
10	226	227	228	230	231	233	234	235	237	238	240	241	243	244	245	247
11	248	250	251	252	254	255	257	258	259	261	262	264	265	266	268	269
12	271	272	274	275	276	278	279	281	282	283	285	286	288	289	290	292
13	293	295	296	297	299	300	302	303	305	306	307	309	310	312	313	314
14	316	317	319	320	321	323	324	326	327	329	330	331	333	334	336	337
15	338	340	341	343	344	345	347	348	350	351	352	354	355	357	358	360
16	361	362	364	365	367	368	369	371	372	374	375	376	378	379	381	382
17	384	385	386	388	389	391	392	393	395	396	398	399	400	402	403	405
18	406	407	409	410	412	413	415	416	417	419	420	422	423	424	426	427
19	429	430	431	433	434	436	437	438	440	441	443	444	446	447	448	450
20	451	453	454	455	457	458	460	461	462	464	465	467	468	470	471	472
21	474	475	477	478	479	481	482	484	485	486	488	489	491	492	493	495
22	496	498	499	501	502	503	505	506	508	509	510	512	513	515	516	517

TABLE 49.—Height of Watch Glasses

Gage No.	Height		Gage No.	Height	
	mm	Inch		mm	Inch
10	0.0	0.000	4	2.4	0.094
9	.4	.016	3	2.8	.110
8	.8	.031	2	3.2	.126
7	1.2	.047	1	3.6	.142
6	1.6	.063	0	4.0	.157
5	2.0	.079			

VI. SIZES OF WATCHES

Watch sizes are based upon the diameter of the pillar plate. Watch movements made on the continent of Europe have their diameters expressed either in millimeters or in lignes, the former method being somewhat uncommon. A watch movement made in the United States has its diameter expressed in terms of a certain "Size No." The diameter of the 0-size watch is 1 5/30ths of an inch; the size number increases for each 30th of an inch. The diameter of a 12-size watch movement is therefore 47/30ths of an inch (1.567 inches, or 39.79 millimeters).

From the third column of Table 50 it is seen that an 18-ligne watch equals almost exactly a 13-size and that a 15-ligne equals very closely a 5-size. In connection with the most common sizes it is well to note that the diameter of a 16-size watch is nearest to 19 lignes, 12-size to 18 lignes, and 0-size to 13 lignes.

TABLE 50.—Watch Sizes

[Based upon the diameter of pillar plate. 1 ligne=2.2559 millimeters; 1 inch=25.40005 millimeters, Size No.=Number of thirtieths (30th's) of an inch in excess of 35 thirtieths (35/30) of an inch]

Watch size No.	Pillar plate diameter				Watch size No.	Pillar plate diameter			
	Lignes	mm	Inches	30th's of an inch		Lignes	mm	Inches	30th's of an inch
32		56.73	2.233	67	8		36.41	1.433	43
	25	56.40	2.220			16	36.09	1.421	
31		55.88	2.200	66					
30		55.03	2.167	65	7		35.56	1.400	42
29		54.19	2.133	64	6		34.71	1.367	41
					5		33.87	1.333	40
	24	54.14	2.132			15	33.84	1.332	
28		53.34	2.100	63	4		33.02	1.300	39
27		52.49	2.067	62					
	23	51.89	2.043		3		32.17	1.267	38
26		51.65	2.033	61		14	31.58	1.243	
					2		31.33	1.233	37
25		50.80	2.000	60	1		30.48	1.200	36
24		49.95	1.967	59	0		29.63	1.167	35
	22	49.63	1.954						
23		49.11	1.933	58		13	29.33	1.155	
22		48.26	1.900	57	2/0		28.79	1.133	34
					3/0		27.94	1.100	33
21		47.41	1.867	56	4/0		27.09	1.067	32
	21	47.37	1.865			12	27.07	1.066	
20		46.57	1.833	55					
19		45.72	1.800	54	5/0		26.25	1.033	31
	20	45.12	1.776		6/0		25.40	1.000	30
						11	24.81	.977	
18		44.87	1.767	53	7/0		24.55	.967	29
17		44.03	1.733	52	8/0		23.71	.933	28
16		43.18	1.700	51					
	19	42.86	1.687			10½	23.69	.933	
15		42.33	1.667	50	9/0		22.86	.900	27
						10	22.56	.888	
14		41.49	1.633	49	10/0		22.01	.867	26
13		40.64	1.600	48		9½	21.43	.844	
	18	40.61	1.599						
12		39.79	1.567	47		9	20.30	.799	
11		38.95	1.533	46		8½	19.18	.755	
						8	18.05	.711	
	17	38.35	1.510			7½	16.92	.666	
10		38.10	1.500	45		7	15.79	.622	
9		37.25	1.467	44		6	13.54	.533	

VII. RING SIZES

1. ORIGINAL STANDARD

The gages for finger rings that are in use in the United States are almost universally of the cone type, and are designated by two trade names. One is "F. E. Allen's"; the other is "U. S. Standard." Apparently the principle of a metal cone with graduations from 1 to 13 or 0 to 13 is the same on the two gages, the only apparent difference between the two being in the shape of the wooden handles. All attempts to find any printed statement as to what the dimensions of the various sizes are supposed to be, have been unsuccessful. The earliest known patent on the conical ring gage was obtained by F. E. Allen on February 3, 1874, U. S. Patent No. 146974. In this patent there is described quite accurately the conical gage with sizes 1 to 13, and quarter sizes, as is used to-day; there is also described the auxiliary scale on the side for showing the circumference for each of the various sizes. The dimensions of the sizes are not stated.

2. INTRODUCTION OF ERRORS

From the accurate description of the present gage in Allen's patent, it may be presumed, perhaps erroneously although probably correctly, that the scale of sizes now in use was well known and in use at that time. There probably also is little doubt but that the present gage sizes have descended from those in use at that time, but by what steps and intermediary process it is impossible to state. Differences in the sizes have likely been introduced by the adoption of a common commercial copy as a pattern or standard. In fact, a standard was once obtained in this manner. A manufacturing company in 1917 wrote to the Bureau of Standards stating that they had been making these gages for nearly 25 years and that "our standard was probably obtained from a commercial Allen ring gage and there *appears to be considerable variations in the ring gages on the market.*"

3. MANY SIMILAR STANDARDS

While there apparently is only one standard in use in the United States, in reality, because of the lack of specific dimensions and because of the errors introduced by the adoption of a common commercial article as a pattern, there are many, although similar, standards. One establishment recently purchased a considerable number of platinum blank rings from a certain well-known and highly advertised manufacturer. The ring blanks as delivered tested out about one-quarter size smaller than the size ordered, and as can be readily understood, there is no means of recourse even though there had been a desire on the part of the purchaser to obtain it. From the gages examined in a few retail establishments in the same city, there were discovered differences corresponding to about a third of a size. Continued search in other cities may be expected to disclose much larger differences. Letters from one important manufacturer of ring gages state that the diameters they use corresponding to sizes 1 and 13 are 0.485 and 0.877 inch, respectively; from another, they are 0.491 and 0.877 inch, respectively. On the other hand, measurements obtained during one afternoon for gages in use in retail houses in one locality gave a range of values for size 1 from 0.480 to 0.491 inch, and for size 13 from 0.870 to 0.878 inch.

4. CONFUSION ALSO IN USE OF GAGE

Not only is there confusion in the ring sizes and standards but confusion also exists in the method of use of the gages. Some companies bring the top of the ring to the mark on the gage, others use the middle of the ring, while still others use the lower edge of the ring. These differences in the method of use are equivalent for broad rings to an appreciable part of a size, and serve to increase the differences between the various standards. The differences between the various gages for any one size are somewhat small in comparison with the latitude permissible in the retail trade, but for the jobbers and manufacturers it seems desirable, however, that the diameter used for each of the various sizes and the method of use of the gage should be identical.

5. OUTLINE OF THE PROBLEM

The figures given in the preceding paragraphs show approximately the dimensions of the gages in use as compared with those of the standards of two ring gage manufacturers. The Bureau of Standards intends to take up this problem by obtaining more complete information as to the dimensions of gages in different parts of the country, and with the cooperation of those fundamentally interested in this problem, it hopes to be able to select some values which best represent the average dimensions of existing standards.

VIII. MISCELLANEOUS TABLES

TABLE 51.—Decimal Equivalents of Gold Karats [a]

[The number of karats indicates the number of 24ths of pure gold in an alloy]

Number of karats	Pure gold	Number of karats	Pure gold
	Fineness		Fineness
1 K	0.0417	13 K	0.5417
2 K	.0833	14 K	.5833
3 K	.1250	15 K	.6250
4 K	.1667	16 K	.6667
5 K	.2083	17 K	.7083
6 K	.2500	18 K	.7500
7 K	.2917	19 K	.7917
8 K	.3333	20 K	.8333
9 K	.3750	21 K	.8750
10 K	.4167	22 K	.9167
11 K	.4583	23 K	.9583
12 K	.5000	24 K	1.0000

[a] The spelling "karat" is in general use among jewelers to designate the gold karat (fineness of gold) and is consistent with the accepted abbreviation for this term, "K"; also, it affords a distinctive term as compared with "carat," which, abbreviated by "c" designates a unit of weight used in measuring precious stones.

TABLE 52.—Densities [a] of Various Metals

Metal	Density	Metal	Density
	g/cm³		g/cm³
Aluminum	2.70	Manganese	7.42
Antimony	6.618	Nickel	8.75
Bismuth	9.781	Osmium	22.5
Cadmium	8.648	Palladium	12.16
Chromium	6.92	Platinum	21.37
Cobalt	8.71	Rhodium	12.44
Copper	8.89	Silver	10.48
Gold	19.33	Tantalum	16.6
Iridium	22.42	Tin	7.29
Iron	7.86	Tungsten	18.8
Lead	11.342	Zinc	7.10

[a] The values in this table are taken from "Smithsonian Physical Tables," 7th revised edition, p. 110.

TABLE 53.—Melting Points [a] of Various Metals [b]

Metal	Melting point	Melting point	Metal	Melting point	Melting point
	°C	°F		°C	°F
Mercury	−38.87	−37.97	Manganese	1230	2246
Tin	+231.9	+449.4	Nickel	1452	2646
Bismuth	271	520	Cobalt	1480	2696
Cadmium	320.9	609.6	Iron	1530	2786
Lead	327.4	621.3	Palladium	1550	2822
Zinc	419.4	786.9	Chromium	1615	2939
Antimony	630.0	1166.0	Platinum	1755	3191
Aluminum	658.7	1217.7	Rhodium	1950	3542
Radium	700	1292	Iridium	2350(?)	4260
Silver	960.5	1760.9	Osmium	2700(?)	4890
Gold	1063.0	1945.5	Tantalum	2900	5250
Copper	1083.0	1981.4	Tungsten	3400	6152

[a] At high temperatures some of the values are somewhat uncertain. Temperatures centigrade are rounded off, and the exact Fahrenheit equivalents are usually given.
[b] This table is taken from B. S. Circular No. 35, 4th edition (revision of Dec. 1, 1919), which gives the melting points for all of the elements.

TABLE 54.—Conversion of Centigrade Temperatures (C) into Fahrenheit Temperatures (F)

[Temperature Fahrenheit=9/5 temperature centigrade +32]

° C	° F	° C	° F	° C	° F
−40	− 40	60	140	200	392
−35	− 31	65	149	300	572
−30	− 22	70	158	400	752
−25	− 13	75	167	500	932
−20	− 4	80	176	600	1112
−15	+ 5	85	185	700	1292
−10	14	90	194	800	1472
− 5	23	95	203	900	1652
Zero	32	100	212	1000	1832
+ 5	41	105	221	1100	2012
10	50	110	230	1200	2192
15	59	115	239	1300	2372
20	68	120	248	1400	2552
25	77	125	257	1500	2732
30	86	130	266	1600	2912
35	95	135	275	1700	3092
40	104	140	284	1800	3272
45	113	145	293	1900	3452
50	122	150	302	2000	3632
55	131	155	311	2500	4532

TABLE 55.—Conversion of Fahrenheit Temperatures (F) into Centigrade Temperatures (C)

[Temperature centigrade=5/9 (temperature Fahrenheit −32)]

° F	° C	° F	° C	° F	° C	° F	° C
−40	−40.0	60	15.6	165	73.9	500	260.0
−35	−37.2	65	18.3	170	76.7	600	315.6
−30	−34.4	70	21.1	175	79.4	700	371.1
−25	−31.7	75	23.9	180	82.2	800	426.7
−20	−28.9	80	26.7	185	85.0	900	482.2
−15	−26.1	85	29.4	190	87.8	1000	537.8
−10	−23.3	90	32.2	195	90.6	1100	593.3
− 5	−20.6	95	35.0	200	93.3	1200	648.9
Zero	−17.8	100	37.8	205	96.1	1300	704.4
+ 5	−15.0	105	40.6	210	98.9	1400	760.0
10	−12.2	110	43.3	212	100.0	1500	815.6
15	− 9.4	115	46.1	215	101.7	1600	871.1
20	− 6.7	120	48.9	220	104.4	1700	926.7
25	− 3.9	125	51.7	225	107.2	1800	982.2
30	− 1.1	130	54.4	230	110.0	1900	1037.8
32	Zero	135	57.2	235	112.8	2000	1093.3
35	+ 1.7	140	60.0	240	115.6	2500	1371.1
40	4.4	145	62.8	245	118.3	3000	1648.9
45	7.2	150	65.6	250	121.1	3500	1926.7
50	10.0	155	68.3	300	148.9	4000	2204.4
55	12.8	160	71.1	400	204.4	4500	2482.2

1. APPROXIMATE TEMPERATURES BY COLOR

The estimation of temperature by the color of a hot body is influenced by so many factors that it is attended with great uncertainties. The chart shown in Fig. 3, taken from Bullens' "Steel and Its Heat Treatment," page 369, is appended as a rough guide for such temperature estimation.

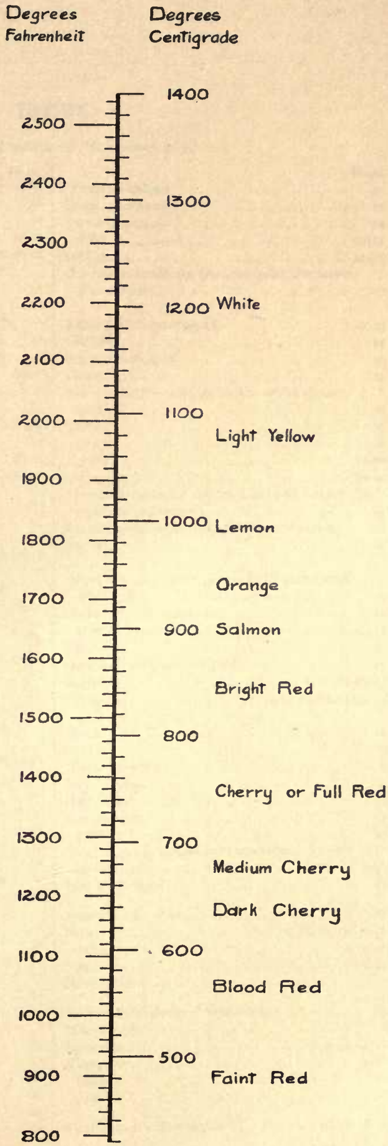

FIG. 3.—*Temperature and color of hot body*

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[For analytical outline see "Contents," p. 3.]