# The New Tinsmith's Helper and Pattern Book

▲ TEXTBOOK AND WORKING GUIDE A for the ambitious apprentice, busy mechanic or trade school student, giving a practical explanation of the properties of circles, the mensuration of surfaces and solids, simple geometrical drawing, the forming of seams, laps and joints, and one hundred problems on the layout and cutting of Conical Vessels, Elbows and Piping, Furnace Fittings, Ducts, Gutters, Leaders and Roofing, Tinclad Fireproof Doors, Cornice and Skylight Work; with ninety-two tables and many shop kinks, recipes, and formulas.

New York

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#### **PREFACE**

For many years "The Tinsmith's Helper and Pattern Book" has been one of the most popular books on tinsmithing and elementary sheet metal work. It is to be found in the majority of the shops, because it explains the elements of pattern drafting and shows how the rules of mensuration are applied to the problems which come up daily. This New Helper is an outgrowth of that practical guide.

At first it was intended to merely revise the old book, but it soon became apparent that an entirely new treatment of the subject was necessary in order to cover the ground. This book is new with the exception of the chapter on Mensuration, which has been re-arranged and amplified, and possibly some fifty pages of problems and tables which are classified according to the phase of the work they cover.

The present work has 312 pages, 247 figures and 24 tables as against the 120 pages, 53 figures and 24 tables contained in the former work.

The additional matter covers simple geometry and every phase of modern pattern cutting, from the making of every type of seam, lap and joint, to conical problems and tinware, elbows, piping, ducts, gutters, leaders, cornice and skylight work, and furnace fittings. The use of triangulation in the development of pattern problems is simply ex-

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plained. Information is also included on tin roofing, corrugated iron work, laying metal shingles, tile, slate, etc.

The chapter of tables contains practically all the data the sheet metal worker requires, from the weight of iron and steel, copper, brass and aluminum sheets and bars, to the capacities of cylinders and rectangular tanks in U. S. gallons. Our Canadian and English friends will find complete tables of capacities based on their standard Imperial gallon. The metric equivalents of all our measures are also given.

The chapter on Recipes and Formulas gives the mixtures for all the soft and hard solders, soldering fluxes, cements, putties, inks for making sheet metal work, rust preventives, etc.

It is the belief of the editor and publishers that this handy little volume is the most complete text-book and guide for the apprentice or trade school student, as well as an up-to-date reference book for the mechanic and shop foreman. Anyone who fails to find the intermation which he thinks ought to be in the book will confer a favor by writing the publishers.

New York, April, 1917.

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# THE NEW TINSMITH'S HELPER

#### CHAPTER I

#### Mensuration

Mensuration is that branch of mathematics which is employed in ascertaining the extension, solidities and capacities of bodies capable of being measured.

#### Definitions of Arithmetical Signs

| = Sig          | gn of | Equality, and s | ignifies | as  | 4 + 6 = 10.           |
|----------------|-------|-----------------|----------|-----|-----------------------|
| +              | 66    | Addition,       | "        | as  | 6+6=12,               |
|                |       |                 |          |     | the Sum.              |
|                | "     | Subtraction,    | "        | as  | 6-2=4,                |
|                |       |                 |          |     | Remainder.            |
| X              | "     | Multiplication, | "        | as  | $8 \times 3 = 24$     |
|                |       |                 |          |     | Product.              |
| ÷              | "     | Division,       | "        | as  | $24 \div 3 = 8$ .     |
| ٧              | "     | Square Root,    | "        | Ex  | traction of           |
|                |       |                 |          |     | Square Root.          |
| 6²             | "     | to be squared,  | "        | thu | $1 \times 8^2 = 64$ . |
| 7 <sup>3</sup> | "     | to be cubed,    | "        | thu | is $3^8 = 27$ .       |
|                |       |                 |          |     | •                     |

#### SURFACE MENSURATION

#### The Square, Rectangle, Cube, Etc.

- 1. The side of a square equals the square root of its area.
- 2. The area of a square equals the square of one of its sides.
- 3. The diagonal of a square equals the square root of twice the square of its side.
- 4. The side of a square is equal to the square root of half the square of its diagonal.
- 5. The side of a square equal to the diagonal of a given square contains double the area of the given square.
- 6. The area of a rectangle equals its length multiplied by its breadth.
- 7. The length of a rectangle equals the area divided by the breadth; or the breadth equals the area divided by the length.

#### To Measure or Ascertain the Quantity of Surface in Any Right Lined Figure Whose Sides are Parallel to Each Other.

Rule: Multiply the length by the breadth or perpendicular height, and the product will be the area or superficial contents.

Example: The sides of a square piece of iron are 97% inches in length, required the area of this sheet of iron.

Ans.: Decimal equivalent to the fraction  $\frac{7}{8}$  = .875, and 9.875  $\times$  9.875 = 97.5, etc., square inches, the area.

Example: The length of a roof is 60 feet 4

inches and its width 25 feet 3 inches; required the area of the roof.

Ans.: 4 inches = .333 and 3 inches = .25 (see table of equivalents), hence,  $60.333 \times 25.25 = 1523.4$  square feet, the area; or, to convert back to feet and inches, 1523 square feet and 57% square inches.

#### Triangles

- 1. The complement of an angle is its defect from a right angle.
- 2. The supplement of an angle is its defect from two right angles.
- 3. The three angles of every triangle are equal to two right angles: hence the oblique angles of a right angled triangle are each other's complements.
- 4. The sum of the squares of two given sides of a right angled triangle is equal to the square of the hypothenuse.
- 5. The difference between the squares of the hypothenuse and given side of a right angled triangle is equal to the square of the required side.
- 6. The area of a triangle equals half the product of the base multiplied by the perpendicular height of the triangle.

# To Find the Area of a Triangle When the Base and Perpendicular are Given.

Rule: Multiply the base by the perpendicular height and half the product is the area.

**Example:** The base of the triangle is 3 feet 6 inches in length and the height 1 foot 9 inches; required the area.

Ans.: 6 in. = .5 and 9 in. = .75, hence,  

$$\frac{3.5 \times 1.75}{2} = 3.0625$$

square feet, the area.

## To Find the Hypothenuse When the Base and Perpendicular are Given.

Rule: Add the square of the base to the square of the perpendicular and the square root of the sum will be the hypothenuse.

**Example:** The base of the triangle is 4 feet and the perpendicular 3 feet; required the hypothenuse.

**Ans.**:  $4^2 + 3^2 = 25$ ,  $\sqrt{25} = 5$  feet, the hypothenuse.

## To Find the Perpendicular When the Hypothenuse and Base are Given.

Rule: From the square of the hypothenuse subtract the square of the base, and the square root of the remainder will be the perpendicular.

**Example:** The hypothenuse of the triangle is 5 feet and the base 4 feet; required the perpendicular.

Ans.:  $5^2 - 4^2 = 9$ , and  $\sqrt{9} = 3$ , the perpendicular.

# To Find the Base When the Hypothenuse and Perpendicular are Given.

Rule: From the square of the hypothenuse subtract the square of the perpendicular, and the square root of the remainder will be the base.

**Example:** The hypothenuse of a triangle is 5 feet and the perpendicular is 3 feet, required the base.

**Ans.**:  $5^2 - 3^2 = 16$  and  $\sqrt{16} = 4$ , the base.

#### **Polygons**

The side of any regular polygon multiplied by its apothem or perpendicular, and by the number of its sides, equals twice the area.

#### To Find the Area of a Regular Polygon.

Rule: Multiply the length of a side by half the distance from the side to the center, and that product by the number of sides; the last product will be the area of the figure.

**Example:** The side of a regular hexagon is 12 inches, and the distance therefrom to the center of the figure is 10 inches; required the area of the hexagon.

Ans.:  $\frac{10}{2} \times 12 \times 6 = 360$  square inches =  $2\frac{1}{2}$  square feet.

# To Find the Area of a Regular Polygon When the Side Only is Given.

Rule: Multiply the square of the side by the multiplier opposite to the name of the polygon in the ninth column of the following table, and the product will be the area.

**Example:** A hexagon side is 12 inches, required its area.

Ans.:  $12^2 = 144$ ;  $144 \times 2.598076 = 374.1229$  square feet.

#### Table of Angles

Table of angles relative to the construction of Regular Polygons with the aid of the sector, and of coefficients to facilitate their construction without it; also, of coefficients to aid in finding the area of the figure, the side only being given.

| Names.    | Number of sides. | Angle at<br>center. | Angle at<br>circum. | Perp'n side<br>being 1. | Length of side rad.<br>being 1. | Rad. of cir. side be-<br>ing 1. | Rad. of cir.<br>per. be-<br>ing 1. | Area side<br>being 1. |
|-----------|------------------|---------------------|---------------------|-------------------------|---------------------------------|---------------------------------|------------------------------------|-----------------------|
| Triangle  | . 3              | 120                 | 60                  | . 28868                 | 1.782                           | . 5773                          | 2.                                 | . 433012              |
| Square    | . 4              | 90                  | 90                  | . 5                     | 1.414                           | . 7071                          | 1.414                              | 1.                    |
| Pentagon  | 5                | 72                  | 108                 | . 68 <b>82</b>          | 1.175                           | . 8506                          | 1.238                              | 1.720477              |
| Hexagon   | . 6              | 60                  | <b>12</b> 0         | . 866                   | 1.                              | 1.                              | 1.156                              | 2.598076              |
| Heptagon  | . 7              | 51 <b>3-</b> 7      | 1284-7              | 1.0382                  | . 8672                          | 1.152                           | 1.11                               | 3.633912              |
| Octagon   | . 8              | 45                  | 135                 | 1.2071                  | . 7654                          | 1.3065                          | 1.08                               | 4.828427              |
| Nonagon   | . 9              | 40                  | 140                 | 1.3737                  | . 684                           | 1.4619                          | 1.06                               | 6.181824              |
| Decagon   | 10               | <b>3</b> 6          | 144                 | 1.5388                  | . 618                           | 1.618                           | 1.05                               | 7.694208              |
| Undecagon | 11               | 32 8-11             | 147 3-11            | 1.7028                  | . 5634                          | 1.7747                          | 1.04                               | 9.36564               |
| Dodecagon | 12               | <b>3</b> 0          | 150                 | 1.866                   | . 5176                          | 1.9318                          | 1.037                              | 11.196152             |

Note.—"Angle at center" means the angle of radii passing from the center to the circumference or corners of the figure. "Angle at circumference" means the angle which any two adjoining sides make with each other.

#### The Circle

- 1. The radius of a circle is a straight line drawn from the center to the circumference.
- 2. The diameter of a circle is a straight line drawn through the center and terminating both ways in the circumference.
- 3. A chord is a straight line joining any two points of the circumference.
- 4. The versed sine is a straight line joining the chord and the circumference.
  - 5. An arc is any part of the circumference.
- 6. A semicircle is half the circle cut off by a diameter.
- 7. A segment is any portion of a circle cut off by a chord.

- 8. A sector is a part of a circle cut off by two radii.
- 9. The circle contains a greater area than any other plane figure bounded by an equal perimeter or outline.
- 10. The areas of circles are to each other as the squares of their diameters. Any circle twice the diameter of another contains four times the area of the other.
- 11. The circumference of a circle equals its diameter multiplied by 3.1416.
- 12. The diameter of a circle equals its circumference multiplied by .31831.
- 13. The area of a circle equals the square of its diameter multiplied by .7854.
- 14. The square root of the area of a circle multiplied by 1.12837 equals its diameter.
- 15. The diameter of a circle multiplied by .8862, or the circumference multiplied by .2821, equals the side of a square of equal area.
- 16. The side of a square multiplied by 1.128 equals the diameter of a circle of equal area.
- 17. The number of degrees contained in the arc of a circle multiplied by the diameter of the circle and by .008727, the product equals the length of the arc in equal terms of unity.
- 18. The length of the arc of a sector of a circle multiplied by its radius equals twice the area of the sector.
- 19. The area of the segment of a circle equals the area of the sector, minus the area of a triangle

whose vertex is the center and whose base equals the chord of the segment.

20. The sum of the diameters of two concentric circles multiplied by their difference and by .7854 equals the area of the ring or space contained between them.

### To Find the Circumference of a Circle Whose Diameter is Given.

Rule: Multiply the diameter by 3.1416.

**Example:** The diameter of a circle being 5 feet 6 inches, required its circumference.

Ans.:  $5.5 \times 3.1416 = 17.27880$  feet, the circumference, or, converting back to feet and inches, 17 feet and 3.5/16 inches.

# To Find the Diameter of a Circle When the Circumference is Given.

Rule: Multiply the circumference by .31831.

**Example:** A straight line or the circumference of a circle being 17.27880 feet, required the circle's diameter corresponding thereto.

Ans.:  $17.27880 \times .31831 = 5.5000148280$  feet, diameter, or actually  $5\frac{1}{2}$  feet.

# To Find the Area of a Circle When the Diameter is Given.

Rule: Multiply the square of the diameter by .7854.

Example: The diameter of a circle is 9% inches; what is its area in square inches?

Ans.:  $9.375^2 = 87.89$ , etc.,  $\times .7854 = 69.029$ , etc., square inches, the area. 0.29 feet equal about  $\frac{1}{3}$  of a square inch.

To Find the Diameter of a Circle When the Area is Given.

Rule: Extract the square root and multiply it by 1.12837.

**Example:** What must the diameter of a circle be to contain an area equal to 69.029296875 square inches?

Ans:  $\sqrt{69.02929}$ , etc., = 8.3091  $\times$  1.12837 = 9.375, etc., or 93% inches, the diameter.

Given the Diameter of a Circle to Find the Side of a Square of Equal Area to the Circle.

Rule: Multiply the diameter by .8862.

**Example:** The diameter of a circle is 15½ inches; what must each side of a square be to be equal in area to the given circle?

Ans.:  $15.5 \times .8862 = 13.73$ , etc., inches, length of side.

Given the Side of a Square to Find the Diameter of a Circle of Equal Area.

Rule: Multiply the side of the square by 1.128.

**Example:** Each side of a square is 13.736 inches in length; what must the diameter of a circle be to contain an area equal to the given square?

**Ans.:**  $13.736 \times 1.128 = 15.49$ , etc., or  $15\frac{1}{2}$  inches, the diameter.

To Find the Diameter of a Circle Any Chord and Versed Sine Being Given.

Rule: Divide the sum of the squares of the versed sine and one-half the chord by the versed sine; the quotient is the diameter of corresponding circle.

**Example:** The chord of a circle equals 8 feet and the versed sine equals 1½; required the circle's diameter.

**Ans.**:  $8^2 + 1.5^2 = 66.25 \div 1.5 = 44.16$  feet, the diameter.

**Example:** In the curve of a railway a stretched line is 80 feet in length and the distance from the line to the curve is found to be 9 inches; required the circle's diameter.

**Ans.**:  $80^2 + .75^2 = 640.5625 \div 2 = 320.28$ , etc., feet, the diameter.

To Find the Length of Any Arc of a Circle.

Rule: From eight times the chord of half the arc subtract the chord of the whole arc, and one-third of the remainder will be the length, nearly.

Example: Required the length of an arc, the chord of half the arc being  $8\frac{1}{2}$  feet and chord of whole arc 16 feet 8 inches.

Ans.: 
$$8.5 \times 8 = 68.0 - 16.666 = \frac{51.334}{3} = 17.111\frac{1}{3}$$
 feet, the length of the arc.

To Find the Area of the Sector of a Circle.

Rule: Multiply the length of the arc by half the length of the radius.

Example: The length of the arc equals  $9\frac{1}{2}$  inches and the radii equal each 7 inches; required the area.

**Ans.:**  $9.5 \times 3.5 = 33.25$  inches, the area.

To Find the Area of a Segment of a Circle.

Rule: Find the area of a sector by the rule given for sector of a circle, whose arc is equal to that of the given segment, and if it be less than a semicircle subtract the area of the triangle formed by the chord of segment and radii of its extremities; but if more than a semicircle add area of triangle to the area of the sector, and the remainder or sum is the area of the segment.

To Find the Area of the Space Contained Between Two Concentric Circles, that is to say, the Area of a Circular Ring.

Rule 1: Multiply the sum of the inside and outside diameters by their difference and by .7854; the product is the area.

Rule 2: The difference of the area of the two circles will be the area of the ring or space.

**Example:** Suppose the external circle equals 4 feet and the internal circle  $2\frac{1}{2}$  feet, required the area of space contained between them or area of a ring.

**Ans.:** 4 + 2.5 = 6.5 and 4 - 2.5 = 1.5, hence,  $6.5 \times 1.5 \times .7854 = 7.65$  feet, the area; or,

The area of 4 feet is 12.566; the area of 2.5 is 4.9081. (See table of areas of circles.) 12.566 - 4.9081 = 7.6579, the area.

#### Cylinders

The circumference of a cylinder multiplied by its length or height equals its convex surface.

To Find the Convex Surface of a Cylinder.

Rule: Multiply the circumference by the height or length, the product will be the surface.

Example: The circumference of a cylinder is 6

feet 4 inches and its length 15 feet, required the convex surface.

Ans.:  $6.333 \times 15 = 94.995$  square feet, the surface.

#### Ellipses or Ovals

- 1. The square root of half the sum of the squares of the two diameters of an ellipse multiplied by 3.1416 equals its circumference.
- 2. The product of the two axes of an ellipse multiplied by .7854 equals its area.

#### To Find the Area of an Ellipse or Oval.

Rule: Multiply the diameters together and their product by .7854.

**Example:** An oval is 20 x 15 inches, what are its superficial contents?

Ans.:  $20 \times 15 \times .7854 = 235.62$  inches, the area.

#### To Find the Circumference of an Ellipse or Oval.

Rule: Multiply half the sum of the two diameters by 3.1416 and the product will be the circumference.

**Example:** An oval is 20 x 15 inches, what is the circumference?

Ans.: 
$$\frac{20+15}{2} = 17.5 \times 3.1416 = 54.978$$

inches, the circumference.

#### Cones and Pyramids

I. The curve surface of a cone is equal to half the product of the circumference of its base multiplied by its slant side, to which, if the area of the base be added, the sum is the whole surface.

# To Find the Convex Surface of a Right Cone or Pyramid.

Rule: Multiply the circumference of the base by the slant height and half the product is the slant surface; if the surface of the entire figure is required, add the area of the base to the convex surface.

**Example:** The base of a cone is 5 feet diameter and the slant height is 7 feet, what is the convex surface?

Ans.:  $5 \times 3.1416 = 15.70$  circumference of the base and  $\frac{15.70 \times 7}{2} = 54.95$  square feet, the convex surface. Converting feet to inches, .95 square feet equal 13645 square inches.

# To Find the Convex Surface of a Frustum of a Cone or Pyramid.

Rule: Multiply the sum of the circumference of the two ends by the slant height and half the product will be the slant surface.

**Example:** The diameter of the top of the frustum of a cone is 3 feet, the base 5 feet, the slant height 7 feet 3 inches; required the slant surface.

**Ans.:** 
$$9.42 + 15.7 = \frac{25.12 \times 7.25}{2} = 91.06$$

square feet, slant surface. To change to square inches, .06 square feet equal 103/4 square inches.

#### Spheres

- 1. The square of the diameter of a sphere multiplied by 3.1416 equals its convex surface.
- 2. The height of any spherical segment or zone, multiplied by the diameter of the sphere of which

it is a part and by 3.1416, equals the area or convex surface of the segment; or,

3. The height of the segment muliplied by the circumference of the sphere of which it is a part equals the area.

To Find the Convex Surface of a Sphere or Globe.

Rule 1: Multiply the diameter of the sphere by its circumference and the product is its surface; or,

Rule 2: Multiply the square of the diameter by 3.1416; the product is the surface.

Example: What is the convex surface of a globe  $6\frac{1}{2}$ , feet in diameter?

Ans.:  $6.5 \times 3.1416 \times 6.5 = 132.73$  square feet; or,  $6.5^2 = 42.25 \times 3.1416 = 132.73$  square feet, the convex surface.

# MENSURATION OF SOLIDS AND CAPACITIES OF BODIES

- 1. The solidity of a cube equals the area of one of its sides multiplied by the length or breadth of one of its sides.
- 2. The length of a side of a cube equals the cube root of its solidity.

# To Find the Solidity or Capacity of Any Figures in the Cubical Form.

Rule: Multiply the length of any one side by its breadth and by the depth or distance to its opposite side, and the product is the solidity in equal terms of measurement.

Example: The side of a cube is 20 inches; what its solidity?

Ans.:  $20 \times 20 \times 20 = 8000$  cubic inches, or 4.6296 cubic feet.

Example: A rectangular tank is in length 6 feet, in breadth 4½ feet and its depth 3 feet; required its capacity in cubic feet; also its capacity in United States standard gallons.

Ans:  $6 \times 4.5 \times 3 = 81$  cubic feet;  $81 \times 1728 = 139,968 \div 231 = 605.92$  gallons.

#### Cylinders

- 1. The area of the end of a cylinder multiplied by its length equals its solid contents.
- 2. The area of the internal diameter of a cylinder multiplied by its depth equals its cubical capacity.
- 3. The square of the diameter of a cylinder multiplied by its length and divided by any other required length, the square root of the quotient equals the diameter of the other cylinder of equal contents or capacity.
- 4. The capacity of a cylinder, 1 inch in diameter and 1 inch in length, equals .0034 United States gallon.
- 5. The capacity of a cylinder, I inch in diameter and I foot in length, equals .0408 United States gallon.
- 6. The capacity of a cylinder, I foot in diameter and I foot in length, equals 5.875 United States gallons.
- 7. The capacity of any other cylinder in United States gallons is obtained by multiplying the square of its diameter by its length, or the capacity of any other sphere by the cube of its diameter and by the

number of United States gallons contained as above in the unity of its measurement.

#### To Find the Solidity of Cylinders.

Rule: Multiply the area of the base by the height and the product is its solidity.

**Example:** The base of a cylinder is 18 inches and height 40 inches. What is its capacity?

Ans.:  $18^2 \times .7854 \times 40 = 10,178.7840$  cubic inches.

#### To Find the Contents in Gallons of Cylindrical Vessels.

Rule: Take the dimensions in inches and decimal parts of an inch. Square the diameter, multiply it by the height, then multiply the product by .0034 for wine gallons, or by .002785 for beer gallons.

**Example:** How many United States gallons will a cylinder contain whose diameter is 18 inches and length 30 inches?

Ans.:  $18^2 \times 30 = 9720 \times .0034 = 33.04$ , etc., gallons.

#### Cones and Pyramids

- 1. The solidity of a cone equals one-third the product of its base multiplied by its height.
- 2. The square of the diameters of the two ends of the frustum of a cone added to the product of the two diameters, and that sum multiplied by its height and by .2618, equals its solidity.

Nearly all appliances for measuring liquids are frustums of cones in shape, rather than cylinders; so it might be well to pay particular attention to gallon capacities in the examples for frustums. To Find the Solidity of a Cone or a Pyramid.

Rule: Multiply the area of the base by the perpendicular height and one-third the product will be the solidity.

Example: The base of a cone is  $2\frac{1}{4}$  feet and the height is  $3\frac{3}{4}$  feet, what is the solidity?

Ans.: 
$$\frac{2.25^2 \times .7854 \times 3.75}{3} = 4.97$$
 cubic feet, the solidity.

To Find the Solidity of the Frustum of a Cone.

Rule: To the product of the diameters of the ends add one-third the square of the difference of the diameters; multiply the sum by .7854 and the product will be the mean area between the ends, which multiplied by the perpendicular height of frustum gives the solidity.

Example: The diameter of the large end of a frustum of a cone is 10 feet, at of the smaller end is 6 feet and the perpendicular height 12 feet, what is its solidity?

**Ans.**:  $10 - 6 = 4^2 = 16 \div 3 = 5.333$  square of difference of ends; and  $10 \times 6 + 5.333 = 65.333 \times .7854 \times 12 = 615.75$  cubic feet, the solidity.

# To Find the Contents in U. S. Standard Gallons of the Frustum of a Cone.

Rule: To the product of the diameters, in inches and decimal parts of an inch, of the ends, add onethird the square of the difference of the diameters. Multiply the sum by the perpendicular height in inches and decimal parts of an inch and multiply that product by .0034 for wine gallons, and by .002785 for beer gallons.

Example: The diameter of the large end of a frustum of a cone is 8 feet, that of the smaller end is 4 feet and the perpendicular height 10 feet; what are the contents in United States standard gallons?

Ans.: 
$$96 - 48 = 48^2 = 2304 \div 3 = 768$$
;  $96 \times 48 + 768 = 5376 \times 120 \times .0034 = 2193.4$  gallons.

#### To Find the Solidity of the Frustum of a Pyramid.

Rule: Add to the areas of the two ends of the frustum the square root of their product, and this sum multiplied by one-third of the perpendicular height will give the solidity.

**Example:** What is the solidity of a hexagonal pyramid, a side of the large end being 12 feet, one of the smaller ends 6 feet and the perpendicular height 8 feet?

Ans.: 
$$374.122 \times 93.53 = \sqrt{34.991.63} = 187.06$$
.  
 $374.122 + 93.53 + 187.06 = \frac{654.712 \times 8}{3} = 1745.898$  cubic feet, solidity.

#### Spheres

- 1. The cube of the diameter of a sphere multiplied by .5236 equals its solid contents.
- 2. The capacity of a sphere I inch in diameter equals .002266 United States gallon.
- 3. The capacity of a sphere I foot in diameter equals 3.9168 United States gallons.
- 4. The solidity of any spherical segment is equal to three times the square of the radius of its base,

plus the square of its height, multiplied by its height and by .5236.

5. The solidity of a spherical zone equals the sum of the squares of the radii of its two ends and one-third the square of its height, multiplied by the height and by 1.5708.

#### To Find the Solidity of a Sphere.

Rule: Multiply the cube of the diameter by .5236 and the product is the solidity.

Example: What is the solidity of a sphere, the diameter being 20 inches?

Ans.:  $20^3 = 8000 \times .5236 = 4188.8$  cubic inches, the solidity.

The oblate spheroid, the prolate spheroid and a few other shapes have not been discussed because they are not generally used in the shop, and this manual has been boiled down so as to give the greatest amount of usable material in the space available herein.

Further information on the practical application of mensuration to shop and outside problems is given in Neubecker's "Mensuration for Sheet Metal Workers."

#### CHAPTER II

#### Simple Geometrical Problems

A knowledge of geometry is very useful, and while some of the mechanics who read this chapter may feel that they can do all that is required of them by rule of thumb, it is recommended that they study the methods given in these simple problems. No one who hopes to become an expert pattern drafter should fail to study geometry, for it is the foundation on which all the principles of pattern cutting are based.

The problems presented in this chapter have been selected for their importance, and a more comprehensive treatment of the subject is given in "The New Metal Worker Pattern Book."

#### To Erect a Perpendicular to a Straight Line

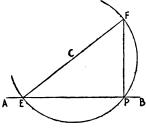


Fig. 1.—Erecting a Perpendicular.

In Fig. 1 A B is the straight line, and P the point at which perpendicular is to be erected. Take any point, C, outside of line A B as center, and with radius C to P strike an arc. Draw a line from where arc cuts line A B through C to arc

again, thus establishing point F. A line drawn from F to P is the required perpendicular.

#### To Erect a Perpendicular to an Arc

In Fig. 2, ADB is the given arc. With A and then B as centers, with a radius greater than half the length of the arc AB, describe arcs XX and YY. Then draw a line, FDE, through the points where the arcs XX and YY cross each other and the result is the perpendicular required; always use extreme care in the operations.

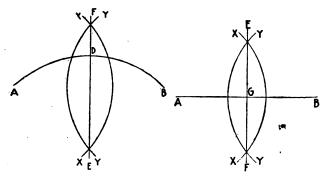


FIG. 2.—To Erect a Perpendicular to an Arc. FIG. 3.—To Divide a Straight Line

#### To Divide a Straight Line into Equal Parts

In Fig. 3, A B is the given line. With the points A and B as centers and with radius greater than one-half the length of A B, draw arcs X X and Y Y as shown. Then draw a line E F through the points where these arcs cross each other, thus dividing line A B into two equal parts at G. Incidentally E G or F G are perpendiculars to A B, so that this method will do for erecting perpendiculars, at G, to A B.

#### To Find the Center of an Arc

Let H K in Fig. 4 represent the given arc. Span dividers any convenient radius and describe small arcs, as at V and O, being sure to have the point of the dividers on the arc H K. Draw lines through them, as shown by dotted lines, and the intersection, S, will be the center sought. Arc B from V and O, bisects angle V S O.

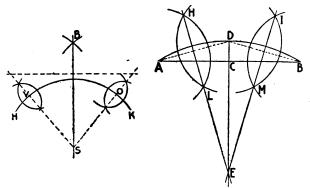


Fig. 4.—Finding the Center of Fig. 5.—Finding the Center of the Arc.

#### Having Chord and Height of Segment to Find Center of the Arc

In Fig. 5 let A B be the chord and C D the height of the segment, then draw lines A D and B D. Bisect these lines as shown and extend the lines H L and I M until they intersect each other as at point E, then E is the center sought. Continuing line D C until it cuts either H L or I M is another method in which but one bisecting line, either H L or I M, is used.

#### To Bisect an Angle

In Fig. 6 A C B is the given angle, and to bisect it strike an arc, to any convenient radius, using B as center and establishing points D and E. With the compass set to a radius more than half the distance from D to E and with these points as centers strike intersecting arcs, thus producing point H. A line from H to B bisects the given angle A B C; in part, a similar procedure to that of Fig. 4.

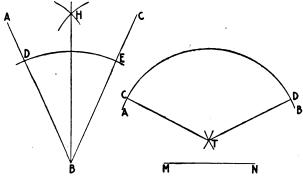


Fig. 6.-Bisecting an Angle.

Fig. 7.-Locating the Center.

#### Arc and Radius Given, to Locate the Center

In Fig. 7, assume that A B is the given arc and line M N the radius. Set the compass to radius M N and with any point on arc, say C, as center, describe a short arc. With any other point on arc A B, as D, for center describe another arc cutting the first one at T, which is the center of the given arc A B.

#### To Draw a Straight Line Parallel to Another

In Fig. 8, let A B be the given line. Select any two points on line A B as C and D and with compass set to radius equal to distance the parallel lines are to be apart, strike short arcs using points C and D for centers as shown. Then draw a line touching these arcs as E F, and that line, E F, will be parallel to, and the required distance from line A B.

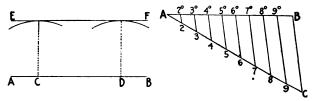


Fig. 8.—Drawing Parallel Lines. Fig. 9.—Dividing a Line Equally.

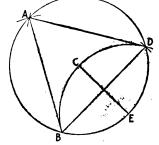
# To Divide a Straight Line into a Number of Equal Parts

In Fig. 9, assume that line A B is to be divided into nine equal spaces. From A draw another line, at any convenient angle. Step this line off into nine equal spaces as shown on line A C by setting the dividers at will, but trying to arrange it so the last swing will come near the end of the line A C. From C draw a line to B and then draw lines, parallel to line C B, from the points on line A C to intersect the line A B, giving points A 2°, 3°, 4°, 5°, 6°, 7°, 8°, 9° and B. These spaces on A B are all equal and divide A B into nine spaces. Both problems on this page are very useful and the reader will do well to memorize them.

#### To Draw a Tangent to a Circle or Arc

In Fig. 10, let M D N be the given arc of the circle and to draw a tangent at D set the compass to a convenient radius and with D as center describe arc cutting M D N at A B. Join points A and B. Then set compass to radius equal to distance between D and the line A B. With this radius and with B as center describe an arc above line A B.

Then draw a line extending through point D and touching the second arc as shown by E D H, which is the tangent.



M

Fig. 10.—Drawing the Tangent. Fig. 11.—A Triangle in a Circle.

#### To Inscribe an Equilateral Triangle in a Circle

In Fig. 11, let A D B be given circle, then with compass set to radius of the circle and from any point on it at will as E describe arc B C D cutting circle at points B and D and naturally passing through center of circle C. Draw line B D, which is one side of the triangle. With the compass set to a radius equal to space B D and with B and then D as centers describe arcs giving point A. Draw lines from A to D and A to B completing the triangle. The same method of drawing a triangle may be followed when one side is given, as B D.

#### To Inscribe a Square in a Circle

In Fig. 12, let T be given circle. Through its center A draw two diameter lines at right angles to each other as CD and EF. To be sure you have a square set your dividers to the distance between points CE and using that as a guide check the length of the other sides. Drawing lines from F to D, D to E, E to C and C to F completes the square.

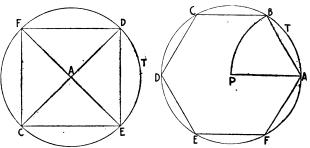


Fig. 12.—A Square in a Circle. Fig. 13.—A Hexagon in a Circle.

#### To Inscribe a Hexagon in a Circle

In Fig. 13, let T be the given circle; choose any point for center, as A, on the circle and with a radius equal to that of the circle describe arc P B, P of course being the center of the circle T. Set dividers to space A B and step around circle as B C, C D and so on. In other words, the radius of the given circle equals one side of the hexagon, so all that is necessary to get the other five sides is to step off the length of the radius as often as possible on the circumference, beginning at A. The sixth point should be A.

#### To Inscribe an Octagon within a Given Square

Draw diagonal lines from corner to corner and the intersection is the center H, as shown in Fig. 14. With the compasses set to a radius from center to corner, and one foot set successively at each corner, describe arcs, as shown. The points at which they cut the square, as K V, will be the corners of the octagon. Draw lines from point to point to complete the figure.

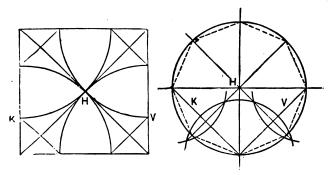


Fig. 14.—An Octagon Within a Fig. 15.—An Octagon Within a Circle.

#### To Inscribe an Octagon within a Given Circle

Draw lines at right angles passing through center H as in Fig. 15. This divides the circle into four parts, which need only to be subdivided into equal parts again to form the corners for the octagon. This may be easily done by drawing the lines K V, and bisecting them, as shown, and drawing lines to the circle through the bisecting arcs locates desired points.

#### Heart with Square and Compass

Draw line H K the breadth of the heart and describe two semicircles on it as shown in Fig. 16. These semicircles should be of the same size and radius. About the best way to do this would be to divide line H K into four equal parts and then use the first space point from H, and also from K, as centers describe a semicircle from H and then K. Span dividers from H to K and with H as center make sweep K to V. Then with same radius and K as center, make sweep H to V.

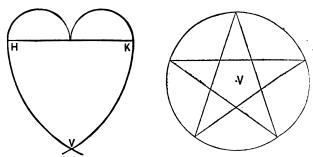


Fig. 16.-A Geometrical Heart. Fig. 17.-A Five Pointed Star.

#### To Describe a Star

With V in Fig. 17 as center strike circle size of star desired. Divide circle in five parts and draw lines to points.

There is a rule for finding the points of a star other than stepping, but it is not given here because it has been found that this mode is the quickest and most accurate; in fact, it is about the quickest way to draw any polygon.

#### To Describe an Oval or Ellipse with a Compass

Draw horizontal line F K the length of the oval desired, as shown in Fig. 18, then span the dividers one-third the required major diameter F K, and from V and O as centers describe circles, as shown; then span dividers two-thirds entire length V to K,

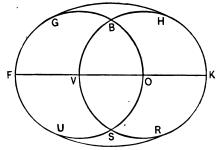


Fig. 18.—Quick Way to Draw an Oval.

and, with one foot at the intersection of the circles, as S and B, draw the arcs G H and U R, stopping them where they touch the circles drawn with O and V as centers, which of course is G H U and R, which completes the oval.

The proportion of the diameters is about as three to four, and makes an oval—or, strictly speaking, an ellipse, that is satisfactory for all ordinary purposes. Drawing straight lines from G to H and from U to R describes an oval that is quite popular for furnace pipes. Or, draw a rectangle as wide as the required oval and as long as the distance from center to center of semicircular ends. Strike half-circles from the centers of the ends of the rectangle.

# To Describe an Oval Having Diameters as Five to Eight with a Square and Compass

Draw horizontal line H K the length desired as shown in Fig. 19. Span compasses one-quarter

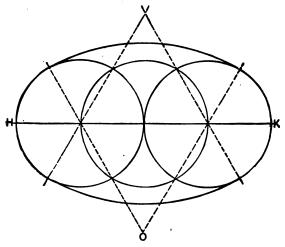


Fig. 19.—Another Method of Drawing an Oval or Ellipse.

the long diameter and describe three circles with that radius, as shown by diagram. Then draw lines through centers of outer circles and their intersections with the inner circle as shown. The oval is completed by drawing the arcs, connecting the outer circles, from points V and O as centers; the dotted lines being the terminus points.

By comparing the diagram, Fig. 19, with the other diagram, Fig. 18, it will be seen that this method gives a more accurate ellipse.

# To Describe an Oval with a Square and Compass. Third Method

Draw horizontal line HK and erect line VO perpendicular to it as shown in Fig. 20.

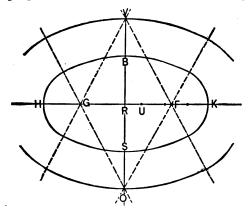


Fig. 20.—A Third Method of Drawing an Oval or Ellipse.

Let HK equal the long or transverse diameter, and SB the short or conjugate. Lay off the distance SB on the line HK, as from H to U. Divide the distance UK into three equal parts. From R, the center, set off two of the parts each side, as GF. On the line VO set off the distance GF from R, as RV and RO. From V and O draw lines passing through G and F, as shown. From the points V, O, G, F as centers describe the arcs that complete the ellipse.

As may be observed, the foregoing procedure more nearly approaches the usual prescribed geometrical procedure.

# To Describe an Oval with a Square and Compass. Fourth Method

Construct the parallelogram equal in length and width to the long and short diameters of the oval

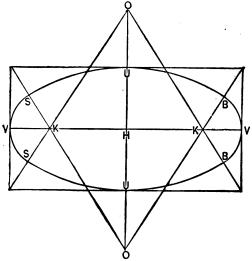


Fig. 21.—A Fourth Method of Drawing an Oval or Ellipse.

desired, as shown in Fig. 21. Divide it into four equal parts by drawing lines through the center, crossing at H. Mark the points K and K one-third the distance from V to H, and draw lines from the corners through these points until they intersect, as shown at O. Then from O and O as centers describe the arcs S U B and S U B; from K and K as centers the segments B V B and S V S; thus completing the required figure.

## To Describe Oval with String, Pins and Pencil

Erect perpendicular line H K equal to short diameter and at right angles to it VO, as shown in

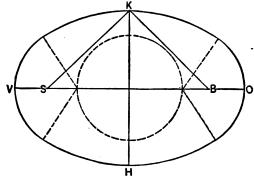


Fig. 22.-Drawing Oval with a String.

Fig. 22. Span dividers one-half the length of the oval, and with H and K as centers describe the arcs S and B. Set pins at these points, and, with a string (one that will not stretch) tied around them so that the loop when drawn tight will reach H or K, as shown, draw the figure with pencil, keeping string equally tense while going around. The various rules for drawing ovals, or rather ellipses, by the use of dividers and other means have been given in this work for the benefit of the student and so the mechanic may select and use the one that seems easiest to him.

This is a mechanical process and there are many other mechanical devices for drawing ellipses. There are also numerous other geometrical processes like developing the oblique section of a cylinder.

#### To Draw a True Oval

Strictly speaking the foregoing problems are not ovals, but ellipses. A true oval is egg-shaped, and

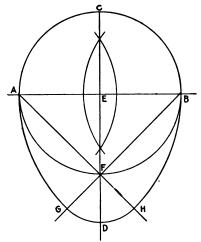


Fig. 23.—Drawing a True Oval.

in Fig. 23 is shown a geometrical method of drawing such a figure. Draw a horizontal line A B the length of the narrowest dimension of the figure. Draw a vertical line C D the length of the longest dimension of the oval; line C D is to pass exactly in the center of line A B by method of Fig. 3, giving point E. With E as center and radius A describe full circle. Draw lines from A and B through F indefinitely. With A and then B as centers describe arcs A G and B H. With F as center and a radius equal to F G describe arc G D H, which will complete the oval.

### To Draw a Simple Spiral or Scroll

The scroll or spiral is a typical geometrical problem and, of the many different methods, the follow-

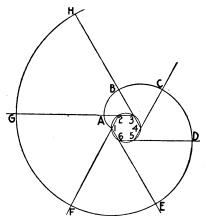


Fig. 24.-A Simple Spiral.

ing one is recommended for its simplicity. Draw any polygon, for example a hexagon as in Fig. 13. Continue the various sides as shown in Fig. 24. Then with 2 as center and 2 to 1 as radius describe arc 1 A. With 3 as center and A to 3 as radius, describe arc A B. With 4 as center and B to 4 as radius, describe arc B C. With 5 as center and C to 5 as radius, describe arc C D. With 6 as center and D to 6 as radius, describe arc D E. With 1 as center and E to 1 as radius, describe arc E F, completing revolution. As many revolutions as desired may be drawn by just continuing in this wise, as shown in the diagram.

# Practical Application of Mensuration and Geometry

This problem is presented in concluding the chapter on geometry to show the practical application of mensuration and geometry to actual shop problems. Fig. 25 illustrates an ordinary hip roof with a flat deck to be covered with tin. In handling work of this character the sheet metal worker is required to calculate the areas of flat surface for the tin, the length of the hips, etc.

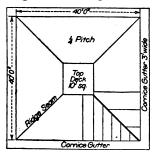


Fig. 25.—Sketch of Practical Problem.

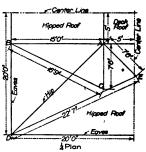


Fig. 26.—Method of Measuring Roof.

Fig. 26 shows the steps followed in determining the area of the roof. This is one quarter of the plan with the cornice gutter omitted. The length is 40 feet on the eaves line for each side, or 40 feet 6 inches over all for each side.

The deck is 10 x 10 feet or 100 square feet of area. Now, the pitch of the roof, as usually figured, is 6 inches to 1 foot of horizontal line, that is to say, one-quarter of the span of the roof. Should this "fer though from the reader's idea of pitch, it is to

be said that the mathematical operations as herewith expounded would be the same, simply a substituting of his rise per foot for that given here. As it is 15 feet on the horizontal lines from eaves to deck, the rise of the deck above the eaves would be  $15 \times 6$  inches or 7 feet 6 inches.

Draw the quarter plan to a convenient scale as in Fig. 26 which may be made 3/8 inches to the foot. Continue deck line to eaves as A B. At right angles to A B draw line A C, 7 feet 6 inches by scale. Connect B and C and scale, learning thereby that the line is 16 feet 9 inches, which is the slant measurement of the roof from eaves to deck. Determine the area of the roof by the rules given in the chapter on mensuration, viz.: Add the length of the deck to the length of the eaves, divide into one-half and multiply the result by the slant length of the roof, which in turn is multiplied by 4 (the number of sides of the That is, 10 + 40 = 50;  $50 \div 2 = 25$ ;  $25 \times 16$  feet 9 inches = 418 feet 9 inches; 418 feet 9 inches  $\times$  4 = 1675 square feet as the area of the hipped roof.

The length of the hip A D is ascertained by drawing a line from A, at right angles to it, and seven feet six inches long, to scale, thus locating point E. Connect E and D. Scale and it will be found that the slant of the hips measures twenty-two feet seven inches from the eaves to the deck.

#### CHAPTER III

### Conical Problems and Tinware

#### Pattern for Cone

In Fig. 27, H K V represents a cone for which an envelope is wanted. And by envelope is meant the surface of the cone, for pattern cutting is the science of the developing the surface of solids.

Span the dividers from V to H and describe the arc O S. Set off the arc equal in length to the cir-

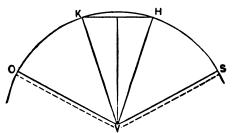


Fig. 27.-Cutting a Cone Pattern.

cumference of the required cone. Draw the lines VO and VS, allowing for locks or laps, as shown by the dotted lines.

For the circumference, refer to the tables in Chapter XII or obtain by some of the rules given in Chapter I. By using the rules familiarity with them is obtained, which is desirable. Of course, tepping around a circle of the required diameter and also do.

### The Old German Rule for Developing the Patterns for the Cone

Take the slant height of the cone H K, in Fig. 28, as a radius, and describe a circle. Divide the diam-

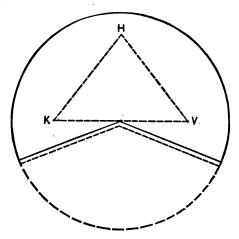


Fig. 28.-A German Rule for Cones.

eter of the base of the cone KV into seven equal parts and set off a space equal to twenty-two of these parts on the circle already struck. From the extremities thus measured off draw lines to the center.

The dotted lines shown parallel to the solid lines from the center, represent allowances for locks for seaming after forming the metal into shape. Of course, these laps are allowed in accordance with the method used for making the seam and a lap should be allowed on the outer circle if required.

#### Steamer or Pitched Cover

Strike circle I inch larger than rim burred. Draw line through center H, as shown in Fig. 29, and from either side cut I inch on circle to I inch from center K. Draw lines and cut out. Or, strike circle the same or larger. Draw line through center and cut on it to center. After burring put in rim; draw up and mark, cut out triangular piece and solder. The latter method is much quicker and equally as good as the first.

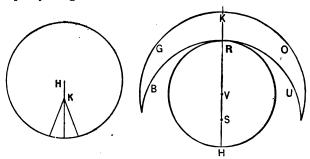


Fig. 29.-A Pitched Cover.

Fig. 30.-Measure Lip Pattern.

### A Measure Lip

Draw line H K as shown in Fig. 30, and upon it, with V as center, describe a circle the size of measure. With S, half the distance from V to H, as center, describe semicircle B U. Make R K the desired width. With V as center and the compass set to the radius V K, describe the arc G O; continuing the arc to both sides, until it intersects arc B U. Cut on arcs B U and G O to obtain the required lip pattern.

### Flaring Vessel in Three Pieces

Draw line H K; then locate points V and O as far apart as the height of the vessel, as shown in Fig. 31. With the intersections V and O for centers, describe circles equal in size to the top and the bottom of vessel. These circles, or rather arcs, are

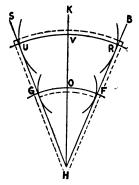


Fig. 31.-Pattern in Three Pieces.

to be described on both sides of line K H as shown in the diagram. Draw lines S H and B H touching on or, more properly speaking, tangent to these arcs or circles. With intersection H as center and with the radius H V, describe the segment U R. Then with the radius H O describe the segment G F.

Allow for locks, as shown by dotted lines. It is to be understood, of course, that it takes three of these to make the girth or entire pattern; meaning, that for an entire pattern, arcs U V R and G O F are continued to both sides and made the same length as U to R, and G to F. Then lines are drawn to H.

#### Pattern for Frustum of a Cone

Lay the square on your sheet and construct the right angle H K V, as shown in Fig. 32. Draw line O S parallel to K V, making the distance K O

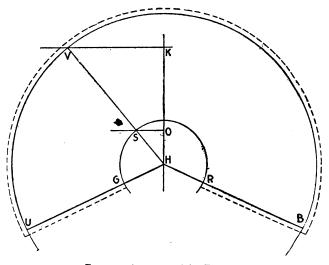


Fig. 32.— One Method for Frustums.

the altitude. On these lines lay off one-half the diameter of the large and small ends. Draw a line through points V and S to the intersection at H. Then, with H as the center, describe the semicircles B U, R G. Lay off circumference of large end on line B U and draw lines to center H. Allow for all edges. For two sections take one-half of the piece, allowing edges on piece used for pattern.

# Another Method of Developing the Pattern of a Frustum of a Cone

Draw perpendicular line H K, as shown in Fig. 33, and from K lay off diameter of large end, as V O. On the line H K lay off the height of frustum, as K S. Draw line parallel to V O, and on it lay off small diameter, as B U. Draw lines through

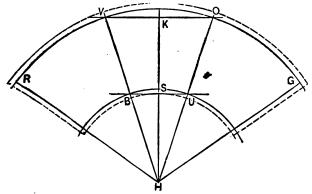


Fig. 33.—Another Case of Cone Frustums.

points V B and O U until they intersect at H. With H V as radius draw large arc R G; and with H B as radius describe small arc. Make arc R G equal to the circumference of the large end and draw lines from R and G to center H. To find this circumference refer to the tables, Chapter XII, or draw a circle with V O as diameter and step it with the dividers.

Allow for all edges, wire, burr and locks as shown by the dotted lines. This forms a pattern in one piece.

### To Describe Pattern for Flaring Vessels

For example, it is desired to describe pattern for pail 12 inches in diameter at top, 9 inches at bottom and 9 inches deep, which is a very common article in tinsmithing and the dimensions are the usual ones.

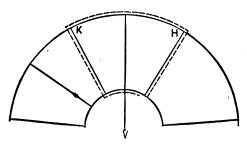


Fig. 34.-Flaring Vessels.

Take the difference between large and small diameters (3 inches) for the first term, the height for the second and the large diameter for the third, thus, 3:9::12.

 $12 \times 9 \div 3$ , this gives radius by which the pattern may be described. Span the dividers (or use beam compasses, piece of wire, straight edge or any convenient device) 36 inches and strike large circle as in Fig. 34. With radius less the slant height of pail strike small circle. Ascertain the circumference required and divide by the number of pieces to be used. Lay off on outer circle and draw lines to center, as H K V.

Allow for locks, burr and wire as may be required according to the process of making pails.

### To Describe Patterns for Flaring Tinware

In Fig. 35 is given a popular rule for flaring tinware. Let HKVO represent the elevation of an ordinary tin pan, constructed in four pieces, 15½ inches in diameter at the top. Below the elevation is shown the same in plan. The pan is a

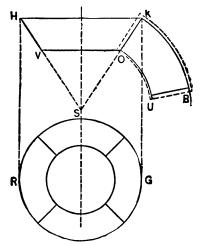


Fig. 35.-A Popular Rule for Flaring Tinware.

frustum of a cone, and if the sides of the pan were continued down until they intersected at S, as shown, the cone would be complete. The radius of the envelope of the cone must be either S H or S K. To describe the section of the frustum which is required, place one foot of the dividers at the center S, and with the radius S H describe the arc K B. With the radius S V describe O U. This gives the width of the pattern and the proper sweep.

To get the length of the piece, refer to the table of circumferences or find, by the rules given, the circumference of the article, which in this case is 485% inches. There being four pieces, divide by four, which gives 12 5-32 inches. Span the dividers I inch, step off the 12 and add the fraction. Draw line from the center S to the point last ascertained; which is S to B.

Allow for locks, wire edge and burr; all as indicated on the pattern by the dotted lines.

The pattern for the bottom is the smaller circle with edges allowed for seaming.

## Strainer Pail or Watering Pot Breast

Strike a circle the size of the pail or pot desired as in Fig. 36. With the radius V K 134 inches

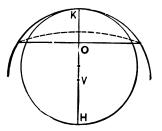


Fig. 36 .- Pail Breast Pattern.

more or less than radius of circle described according to the pitch desired and with point V as center describe an arc. Draw the chord, making the segment K O which is the pattern of the desired width. The breast may be cut out if preferred, as shown by dotted lines.

#### Can Breasts-First Case

Draw horizontal line H K and, parallel to it, at a distance equal to the height of breast, draw line V O, as shown in Fig. 37. On H K lay off diameter of can, as S B. On V O lay off the size of opening, as U R. Then extend lines B R, S U, until they cross G. With G as center and G S as radius, describe outer circle. G to U as radius and G as center, de-

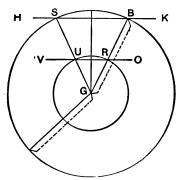


Fig. 37.-First Case of Breasts for Cans.

scribe inner circle. Starting at B set off the outer circle, by stepping with the dividers, the length of the circumference of a circle having a diameter equal to space S to B. Of course, this circumference can be readily found by referring to the circumference table herein.

This is the usual procedure for all flaring articles and follows the general principles of all previous cone problems. The various laps and locks are provided on the pattern as shown by the dotted lines on the pattern.

#### Can Breasts—Second Case

Can breasts, as a rule, mean the sloping tops of cylindrical cans. The small opening is usually fitted with a screw cap spun from zinc or brass; or else, a small inverted frustum of a cone is soldered on, and an ordinary cork is thrust into it for a stopper.

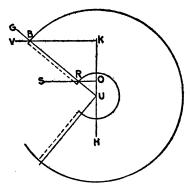


Fig. 38.-Second Case of Breasts for Cans.

Draw the two horizontal lines, KV and OS, and perpendicular to them the line KH, as in Fig. 38. Set off on line KV from the point K one-half the diameter of the can. On OS the point R is one-half the diameter of the opening. Produce the line UG, touching the points B and R, until it intersects HK. With U as center and the radius UB, describe the outer circle. With the same center and the radius UR, describe the inner. Then span from K to B and step six times on large circle to obtain size of breast. Draw line to center and allow for locks, as shown by dotted lines.

#### Can Breasts-Third Case

Describe a circle the size of can desired, as indicated by medium sized circle in Fig. 39. Draw line through center and mark point H at three-fourths of diameter. Then with the three-fourths of diameter as radius and with H as center strike circle K V. Span to diameter of can and step three times on large circle.

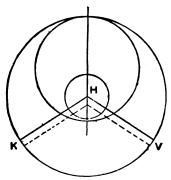


Fig. 39.—Third Case of Breasts for Cans.

Draw line from center to point KV, allowing for edges and locks as may be required by the process of making the can. For more or less pitch make circle KV larger or smaller.

Small circle in center for opening in top. Hoods and pitched covers may be cut by same rule inasmuch as they are like bodies.

These problems are based on the principles of cone envelopes. The years of success of this treatise attest the usefulness of these problems and they are again presented for this reason.

### Rectangular Funnel

Draw side of the rectangular funnel, as shown by H K V in Fig. 40. Continue side lines, as shown by dots. From point of intersection as center, describe arc and chord K V and H. Draw end O K S, producing lines to intersect at B. From B

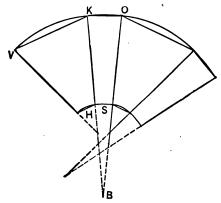


Fig. 40.—Pattern Process for Square Funnels.

as center describe arc and chord O K and S. The other side and end obtained in the same manner, as shown in cut. Can be made in two or more pieces by dividing the pattern. It is to be understood that this funnel has sides of different dimensions. Should a square funnel be wanted the same procedure would apply.

All locks and edges must be allowed for on the pattern piece, which are not, however, shown in the diagram. The provision for these depends on how the seam is to be made.

### Flaring Square Vessel or Frustum of a Pyramid

In Fig. 41 let K V and B U represent the width of the bottom and top of one of the sides, respectively, the distance between them being the slant height. Continue lines until they intersect at R. With radius R B strike circle U B G. With R as

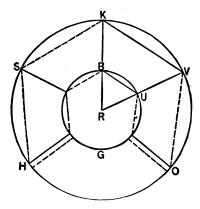


Fig. 41.—Pattern for Square Vessel.

center and R K as radius describe the outer circle. Span dividers from K to V and set off on outer circle the distance, as V O, K S, etc.; draw lines through these points tending toward the center R, also the chords, as shown by dotted lines. Allow for edges. Can be made in two pieces by dividing and allowing for extra lock or seam at the place of division in the pattern.

All three problems are interesting, as they show how cone developments can be employed for objects of rectangular or square shape.

# Flaring Hexagon Article or Frustum of a Hexagonal Pyramid

Let VO represent width of the bottom of one side and RG the width of the top of one side, the distance between the slant height. Produce side lines until they cross in the center, as shown by dotted lines. Span dividers from center to O, and

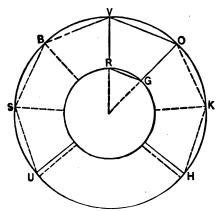


Fig. 42.-Pattern of Hexagon Article.

describe circle HOU; span to G and describe inner circle; span again from V to O and step on the outer circle three spaces each side from O, as K, H, B, S, U. Draw lines from these points tending toward center, and connect by chords as HK, KO, etc., as shown.

Cut out piece H U, allowing for the locks, as shown in Fig. 42. Pattern for a pentagon article may be described by the same rule, in which case the pattern would have five parts.

# Tapering Octagon Article or Frustum of an Octagonal Pyramid

Draw bottom K H and top V of one side, with distance between the slant height, and continue side lines until they intersect at O. With O as a center and the radii O V and O H, describe inner and

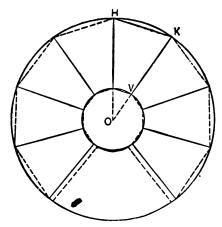


Fig. 43.—Pattern of Octagon Article.

outer circles. Set off on them distances equal to H K and V, and connect by chords, shown dotted.

Allow for locks and edges as in Fig. 43, and as stated in the other problems preceding this, the pattern can be subdivided along such lines as V K to suit requirements.

All the foregoing problems like this one are of exceptional value in the tinsmith trade and the principles embodied therein are applicable to innumerable cases.

# Flaring Article with Square Top and Base a Rectangle. Two or Four Pieces

Draw rectangular base H K and square top V in center of base. Draw perpendiculars O S and R U. Also place the height of the article O B and

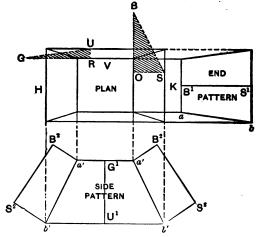


Fig. 44.—Pattern of a Square Flaring Article.

R G. Place the slant height B S on B<sup>1</sup> S<sup>1</sup> and draw lines a and b which intersect as shown, which gives pattern for end. Place G U on G<sup>1</sup> U<sup>1</sup>, draw lines a' and b' which intersect as shown, which gives pattern for side. Join half of end pattern to either side of side pattern as shown by similar letters, which gives half pattern as shown in Fig. 44. Naturally, if it was so required, the half of pattern G<sup>1</sup> U<sup>1</sup> a' b' could be attached to the end pattern B<sup>1</sup> S<sup>1</sup> a and b.

### To Find Length of Sheet Required for Oval Boiler. Common Method

The diagram, Fig. 45, represents the contour of the universal type of oval clothes boiler or like articles. First describe bottom, length and width desired, cut it out of the metal, then burr and from H as a starting point, first making a mark on the

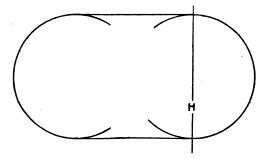


Fig. 45.-Oval Boiler Bottom.

bench where H was, roll on the bench to obtain the circumference.

Some tinsmiths, however, do not first burr the metal but find the circumference by working a thin strip of tin around the bottom and then deduct from this the amount of take-up of the double-seam. If three pieces are to be used for the body of the boiler divide the circumference into three parts and allow edges; if made in two pieces, divide by two. Always divide the circumference by the number of pieces desired. Cut the cover the same size as the bottom, providing it is to be a flat cover; if pitched cover is wanted see the following problems.

# Rapid Method of Laying Out an Oval Boiler Cover

In Fig. 46 is shown a rapid method for developing the pattern of an oval boiler cover. First draw line A K, and from R as center describe circle G U, size of boiler outside of rod. Make A K equal to one-half of entire length of boiler, and K S three-

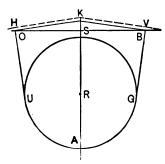


Fig. 46.-Pattern for Oval Boiler Cover.

eighths of an inch, or more if more pitch is desired. Through S draw the perpendicular line H V. Lay corner of square on line H, one blade at K, the other touching circle, describe lines U H K; in similar manner obtain K V G, completing the half pattern.

In the diagram, the dotted lines at H K and K V are allowances for the groove seam to join the two halves of the cover. A double allowance along the line B G A U O should be made for the clinch edge by which the rim of the cover is fastened on. As a rule the cover is formed to shape by making slight bends on lines K A U to K and G to K, and rounding up between bends before joining the halves.

# To Describe Pattern for Oval Flaring Vessel. Four Pieces

Describe bottom as by Fig. 21. Obtain length of arcs SUB and SVS of that diagram, also length of corresponding arcs at the top of vessel. Now, in Fig. 47, draw horizontal lines HK and VO, making the distance between the desired slant height.

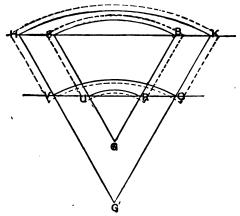


Fig. 47.—Pattern of Oval Vessel.

Make H K equal in length to that of the piece at the top, and VO to that of the bottom, for the sides. S B and U R for the end pieces. Produce lines through these points to intersect at G and G'. Describe the arcs from these points.

Allow for all edges, locks, wire and burr, as indicated by the dotted lines: also carefully lay out the various notches, as poor or careless notching spoils otherwise good work.

## To Describe Pattern for Flaring Article with Straight Sides and Round Ends. Two Pieces

Draw the outline of the bottom and side, as in Fig. 48. Erect two perpendicular lines, HV, KO, distance between the length of sides AB; at right angles to these, two lines, distance between the slant

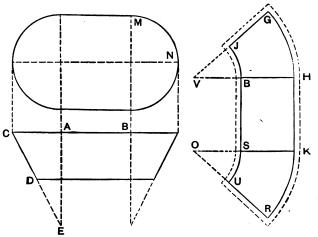


Fig. 48.—Pattern of Article with Round Ends.

height of article C D. On H V and K O set off the radius C E as V and O. From V and O as centers, with radii V B, V H and O S, O K, draw the arcs B J, H G and S U, K R. Make the arcs H G and K R equal to one-half the circumference of the ends M N and draw lines to V and O. Allow for all edges, locks, wire and burr, as shown in the pattern at the right of the diagrams.

# To Describe Pattern for Flaring Oval Vessel. Two Pieces

Draw plan according to rule given in Fig. 18, or any other method. Construct right angle triangle T H<sup>1</sup> S<sup>1</sup> in Fig. 49, and parallel to H<sup>1</sup> S<sup>1</sup>,

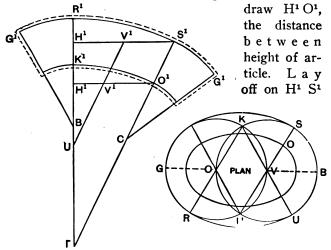


Fig. 49.—Pattern for Flaring Oval Article.

the distances HS and VS in plan and on  $H^1$   $O^1$  the distances HO and VO in plan. Draw lines through these points to intersect the line  $R^1$  T at U and T. Using T as center draw the arcs  $O^1$   $K^1$  and  $S^1$   $R^1$ , making the distance along the arc  $S^1$   $R^1$  equal to UR in plan. Draw line from  $R^1$  to T. Take radius  $V^1$  U on the lines  $R^1$  T and  $S^1$  T and obtain centers B and C, with which describe the arcs  $R^1$   $G^1$  and  $S^1$   $G^1$ , which make equal in length to G R or U B in plan. Draw lines to centers B and C.

# Flaring Article, Top and Base a Rectangle. Two Pieces

Draw side elevation in Fig. 50, as H K, V O, of the longest side. Span dividers the difference between the shortest side of the base and longest side of top. From V and O as centers describe arcs S and S. With blade of square resting on arcs and the corner at H and K, draw lines H B and K G. Set off H B and K G equal one-half of shortest

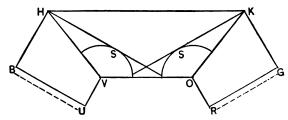


Fig. 50.-Pattern of Transition Article.

sides of base and draw lines B U and G R at right angles to H B and K G; also lines U V and R O at right angles to U B and G R.

Allow for all edges, locks, wire and burr, as showr in the pattern at B U, R G of Fig. 50, by the dotted lines; notching, of course, is governed by the widths of locks, machines used and in general method followed in the particular shop; careful notching bespeaks the careful mechanic and enhances the looks of the finished article.

It is to be understood that this is a quick method, a more strictly accurate method is as shown by Fig. 44.

### Round Base and Square Top Article. Two Pieces

Referring to Fig. 51 for the procedure, first erect perpendicular line. Span dividers to three-quarters diameter of base and describe semicircle H K V. Make K V and K H each equal to one-quarter the circumference of the round base and draw lines to center. Span dividers to three-quar-

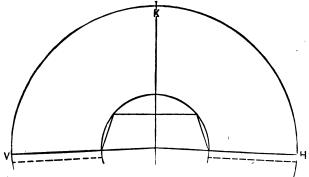


Fig. 51 .- Pattern of Square to Round Article.

ters size of top from corner to corner and describe inner circle. Lay out sides of top, size required, on circle, as shown.

Allow laps as shown by the dotted lines which are for the seam to join the two halves; other edges are to be provided in accord with the requirements of the article. This procedure is a quick rule, the more accurate method would be by the modern system of triangulation. Triangulation is a science of pattern cutting that is fast becoming the only method used for developing patterns for bodies of irregular shapes, and should therefore be studied.

## Rectangular Base and Round Top Article. Two Pieces

Referring to Fig. 52 for the procedure, first draw horizontal lines HK, VO. Make HK equal to the longest side of base, VO equal to one-fourth the circumference of the top, the distance between slant height; draw side lines through these points. With radii one-half the difference between

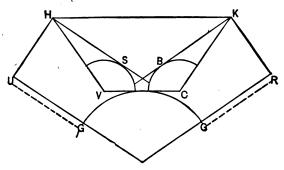


Fig. 52.—Rectangular Base to Round Top Pattern.

V O and the shortest side of the base, describe the arcs S, B; with blade of square resting on arcs, and corner at H and K, draw lines K R, H U, equal to one-half the short side; at right angles to K R, H U, draw lines R G and U G; U G and R G produced will intersect; from this point span dividers to line V O and describe the arc.

Allow for locks and edges, as shown in the diagram, other edges depending on requirements. These methods are a rapid substitute for triangulation.

### Square Base and Round Top Article. Two Pieces

Referring to Fig. 53 for the procedure, first draw horizontal lines HK, VO; HK equal to the length of one side of the base, VO equal to one-fourth the circumference of the top, the distance between the slant height; draw lines through

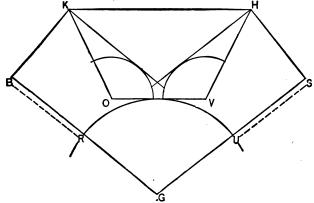


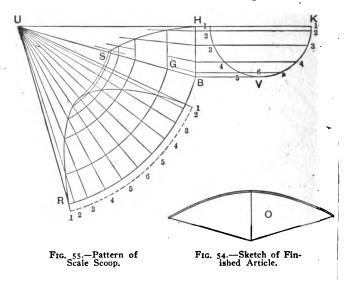
Fig. 53.—Pattern for Article of Square Base and Round Top.

these points. With radii one-half the difference between KH and OV, describe arcs; with blade of square resting on arcs and the corner at H and K, draw lines HS and KB, equal to one-half the base; at right angles to HS and KB draw SU and BR, produced to intersect at G. Span dividers from G to line VO and describe the arc.

The providing of edges for seams and other essentials can only be prescribed in a general way owing to conditions being different in each case. The dotted lines at BR and US show laps.

### Scale Tray or Scoop

A sketch of the finished article is shown in Fig. 54, it being made in two pieces with a seam at its cross center. As may be noticed, the problem em-



braces the conical or flaring method of developing patterns, technically known as developing the surface of solids by radial lines.

To develop the pattern but one section, O, Fig. 54, need be drawn; so, as in Fig. 55, construct a sectional view as HKV and let HSB represent one-half elevation of it, or O in Fig. 54. Continue lines BS and KH until they cross at U. Divide HKV into any given number of spaces, continuing the same to the line HB, as shown by short lines.

Draw lines from the division points on H B to the point U, thus obtaining the intersections on the line S H. With the T square at right angles with H U, drop the points thus obtained on H S, onto the line B S.

With U as center and U B as a radius describe the arc B R. Step off upon this arc spaces equal to those in H K V, using dividers, which gives the length B R. Draw radial lines from U to space marks on line B R, as shown.

With U as center and the various points on SB as radii, describe arcs, intersecting similar radial lines as shown. Then a line traced through the points thus obtained, together with the arc BR, will be the outline of the required pattern. Allow for edges, as shown by dotted lines.

It is to be understood, of course, that the dotted lines show allowed edge for the groove seam at the cross-section center line of the scoop, as shown by the vertical line in Fig. 54. As a rule, a wire is curled into the outer edge of such articles, and in that case an edge should be provided for the wire along the outer line of the pattern. This edge to be of a size suitable for the thickness of wire used; some mechanics allow three times the diameter of the wire, that depending on the mode of wiring.

Using the design of Fig. 54, scoops could also be treated as parts of cylinders and the patterns developed by the parallel line system. Some have part O of Fig. 54 as shown, but the other part has its nose continued around to form a bag filling funnel, the pattern of which is cut by the same methods.

## Funnel Pattern by Short Rule

As the usual way of making funnels requires no fixed proportions, advantage can be taken of a geometrical coincidence for the rapid development of the flaring body.

By proportions is meant the diameter of the circle at the top of the body proper, that is, the width

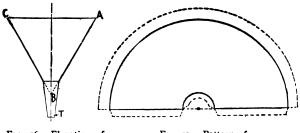


Fig. 56.—Elevation of Object.

Fig. 57.—Pattern of Object,

across as CA in Fig. 56 and the depth of the body or slant height CB, so that the body forms an equilateral triangle as shown by ABC.

In Fig. 56 is shown an ordinary funnel and if the distance AB is the same as AC no elevation is required; simply span the compasses to the diameter of what is wanted for the large end and strike a half-circle as in Fig. 57. Now set the compasses to the diameter of the small end and strike the half-circle shown. The spout T of Fig. 56 is laid out as in Fig. 33.

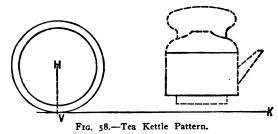
Allow edges for seams and wire, as shown by the dotted lines in Fig. 57.

# To Obtain Length of Piece for Tea Kettle Body

The old-time tinsmith had many well tried methods like this; however, modern ideas are more along strictly scientific lines.

Tea kettles like these are mostly made by coppersmiths and in the book "Art of Coppersmithing" there is a detailed discussion on the making of tea kettles.

The way in general practice is to roll the bottom after burring on the bench to obtain circumference,



and use strip 3/4 inch less in length, as shown by figure. H represents the pit; KV the length of the strip or sheet, these remarks naturally referring to Fig. 58.

Of course, the length of the body could be found by reference to the table of circumferences herein. The pattern of the spout and breast, also cover, is governed by the design, methods employed in the particular shops and so on. As they are usually raised or hammered to shape, the patterns, no matter how obtained, although most likely the radial line method could be used, would only be approximate.

# Mode of Stringing Together a Number of Patterns

Fig. 59 represents the three pieces of a 6-quart pan usually cut from one sheet of 10 x 14 tin. Instead of using one piece for pattern and placing it three times, three pieces are fastened together by soldering on two strips of tin with a heavy hem on each side, and all placed at once, thus saving time

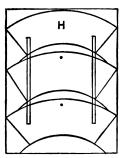


Fig. 59.—Rapid Method of Marking Out Blanks.

and vexation. To use to advantage begin at the bottom of the string pattern and mark around on the outside first, and then mark in the centers right across.

If the strips of tin with the hem edges are not stiff enough; why, light band iron could be substituted. These should be riveted on instead of soldered as for the tin strips.

The lines curving beyond the patterns show how the sheet is first cut into. The bands being narrow no attention need be paid to the part of the sheet not marked under them.

# Another Mode of Stringing Patterns

Fig. 60 represents a string of rim or hoop patterns, fastened as shown in the same manner as described in Fig. 59. Rims of any width can be put together in this manner and a great saving of time is the result when once properly done. Patterns for all articles of tinware should be strung in this way, when more than one piece is obtained from a sheet, that the marking out may be ex-

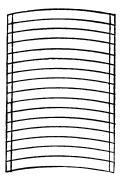


Fig. 60.-Another Rapid Method.

pedited and less tedious. A space should be left between each pattern for the scratch-awl.

If the material to be cut is of light weight, two or more sheets can be cut at one time by pinning together; for instance, mark out one sheet, lay it evenly on two more sheets, notch in along the edges about an inch and on a slant and, say, six inches apart. Bend notches over with the pliers and flatten down with the mallet. In this case the notches could be at the top and bottom of sheets.

# Description of Boiler Block, for Shaping or Truing the Bodies of Oval Articles

By Fig. 61 is represented a block for truing up boilers after they are formed up in the rollers and locked together. Many mechanics depend upon the stake and the accuracy of the eye, but after using

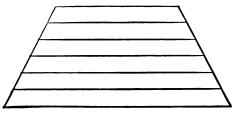


Fig. 61.-Elevation of Block.

this method would not abandon it, as better results are obtained and in much less time. The block is made of 2-inch plank, by placing one on another and securing with four long bolts passing completely through them. The proper dimensions are as follows:

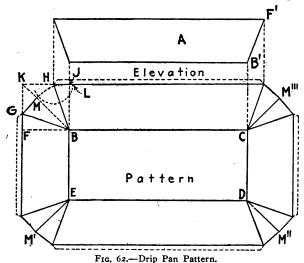
Bottom, 13 inches wide, 25 inches long. Top, 10 " " 19 " " Height, 12 "

As the shaping of the boiler bodies are dependent on this block it follows that extreme care is requisite when shaping the block especially as it tapers.

The procedure, in using the block, is to force the boiler body down on the block as far as it will go and then to tap on the wired edge of the boiler body with a mallet.

## Pattern for a Drip or Roasting Pan

In Fig. 62, A is the elevation of the pan; now, draw a rectangle B C D E. Draw the sides of the pan to this; that is, B F equals B' F' of the elevation. Distance F G equals H J, as the flare is equal



all around. Bisect angle G H B by drawing line to K. With the compass at H and set to almost touch line K B, as shown, swing around to L. With B as center swing an arc from L to line K B, locating point M. Point M shows amount of fold or material for each corner, so that pan can be made in one piece with water-tight corners. Complete each corner the same way, M' M" and M" being the point M just mentioned. Provide edge, as shown dotted for the wire.

## Pattern for a Chimney Cap

To design and develop patterns of the object shown in Fig. 63 it is to be said that the pattern

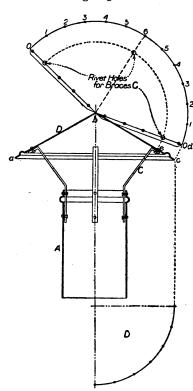


Fig. 63.—Pattern for Chimney Cap.

problem comprises developing the surface of a cone. In the sketch, which is for an 8-inch pipe and drawn onetwelfth full size. A is simply a short joint pipe, which, of course, can also be. square-toа chimney round base. C and C are the braces and D the cap. Inasmuch as there are no fixed rules for proportioning the cap, and as most mechanics have a 30deg. triangle, and as that amount of pitch for the cap would seem pleasing to the eye, the lines a b and b c are

so drawn, as shown. The length of these lines may be as wanted, only it should be remembered that the cap must be of a sufficient height above the pipe to allow a free passage of the smoke. It is better to err by making the space between the cap and pipe too great rather than too small. It is also to be remembered that the longer the lines  $a\ b$  and  $b\ c$  are, or which is the same thing, the larger the cap the more storm-proof it is, and as it naturally covers a larger area it can be raised so much more above the pipe.

For the pattern of the cap the leg of the compasses is set at b and the other leg at c and a long arc drawn. On this arc a point is chosen as d and from this point the half-circumference of the base of the cap or cone which is shown as a quarter-section at d is set off; that is, from 0 to 6 is set off twice in the arc as shown. If a full pattern is desired this is doubled.

The braces C are made from  $\frac{1}{8}$ - and 1-inch tinned straps which bind the bundles of sheet iron, and after they are punched and formed to shape, as indicated in the drawing, they are first riveted to the cap and then to the pipe. The holes for the rivets are accurately spaced on the pattern for the pipe and punched with a solid punch before the pipe is rolled up. The holes in the cap can best be spaced by swinging an arc from e with b as center and then intersecting with a line drawn from b to b. The holes together with those of the seams are punched before the cap is formed to shape, the forming being done by coaxing it over a blown horn stake. As shown in the sketch, a bead can be swadged on the cap and the pipe to stiffen them.

## CHAPTER IV

# Elbows and Piping

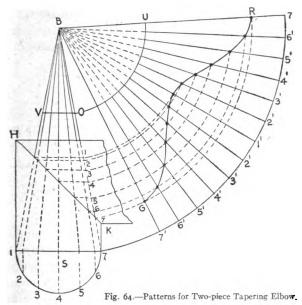
## To Describe a Tapering Elbow

Draw elevation of elbow at any angle desired and draw miter line HK as shown. Establish height and diameter of small end as VO and extend the lines I-V and 7-O until they meet at B. Draw half profile S, which space into equal parts and draw vertical lines to 1-7, from which draw radial lines to the apex B, which will cross the miter line H K as shown. From these intersections draw horizontal lines to the side B-7 as shown from I to 7. With B-7 as radius, draw the arc 7'-7' equal to the circumference of the circle S. From the points on 7'-7' draw radial lines to the apex B, which intersect by arcs struck from B as center, with radii equal to the points between I and 7. URGO is the pattern for the upper arm and R G 7'-7' pattern for the lower arm. See Fig. 64 on opposite page for the diagram referred to.

It is to be understood that the smaller piece is to be turned half way around when joining the two pieces. That is to say, the seam for the largest or first piece is at the throat, while the seam for the smaller or second piece will be at the heel; throat and heel being the common terms of the trade.

Edges should be allowed for along the miter line for seaming, also along the sides, depending on the method of seaming used.

These methods are the basic principles for the system of developing tapering elbows of three or more pieces. The system must only conform to the rule that all the pieces are to be parts of one cone, or its frustum. That is to say, the various pieces



are turned on their axes so that they constitute a cone, as was done with the two pieces in Fig. 64.

A better system for three or more pieces would be to have the pieces at each end of the elbow straight and the taper provided for in the intermediate pieces; which means that the end pieces would be cut by the parallel line system and the others by triangulation.

## A Square or Right Angle Elbow, in Two Pieces

Draw the elevation of the elbow, as BS, OV, KH. Draw line from V to O. Divide one-half of the plan into a convenient number of equal parts, as shown by dotted lines; erect lines to intersect OV. Make the line BR equal in length to the circumference of the elbow. Set off on this line spaces cor-

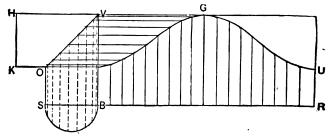


Fig. 65.—Two-piece Elbow Pattern.

responding to those in the plan, the same number each side of the center line; then draw lines parallel to the arm of the elbow, cutting the corresponding lines as indicated. By tracing through these points the irregular line U G the pattern is obtained, referring to Fig. 65. Allow edges for lock and provide lap for the rivets.

The general principle for cutting elbow patterns is the same throughout, and to understand the principle is to be able to describe pattern for any elbow, at any angle and of any number of pieces. It is the design of this work to make the principle clear to the readers.

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## Quick Method for Cutting Two-piece Elbow

In Fig. 65 is shown the strictly scientific method, according to orthographic projection, of developing two-piece elbow patterns. Now, in Fig. 66 is given a method based on a geometrical coincidence which is employed to save time in developing such patterns.

As may be seen, no elevation, plan or other view

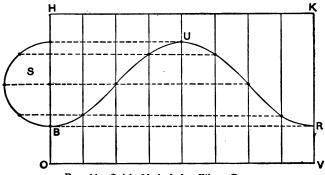


Fig. 66.—Quick Method for Elbow Pattern.

or views of the elbow need be drawn; no preliminary drawings whatsoever.

Lay out on sheet length required for elbow, as HKVO. Describe semicircle S the desired size of pipe, which divide into four parts. Space the length of the sheet into twice the number of squares in S, and draw vertical and horizontal lines until they intersect. OBURV is then the pattern.

Allow for flanges for seaming the two parts together, also edges for locks or rivet flange for vertical seams of the two pieces.

### A Square Three-piece Elbow

This is a complete demonstration, as shown in Figs. 67 and 68, of the method of developing patterns for a three-piece elbow. It is not the shortest way of proceeding, nevertheless it is strictly correct

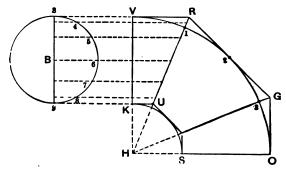


Fig. 67.-Elevation of Elbow.

and based on the principles of orthographic projection.

Let H K be the throat and K V the diameter of the elbow. Draw the quadrant V O, which divide into four equal parts, as shown by 1, 2, 3. Draw miter lines through 1 and 3 as H R and H G. Draw the circle B equal to diameter of elbow and divide one-half of B in equal parts, as shown; draw lines to intersect miter line R U, as directed by the diagram in Fig. 67.

Referring now to Fig. 68, which is the complete set of patterns, and referring to Fig. 67 when required by reference letters in the text, continue as follows:

Construct parallelogram H K V O equal in length to the circumference of B. Through the spaces on H K draw parallel lines as shown. Measuring from V K, take the various distances to the miter line R U and place them on similar lines measuring from H K. H S B K is then the pattern for the end. Double the distance from 3 to R' and place it from

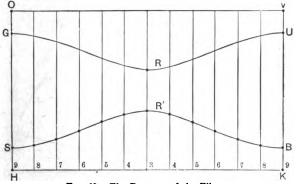


Fig. 68.-The Patterns of the Elbow.

S to G and B to U and transfer the miter line SR'B to GRU. Place HS as shown by GO and UV and draw OV, which completes the three, patterns.

Allow for seams and so forth in accordance with the scheme used for making elbows.

Attention is called to the grouping of the three patterns to form a rectangle; the idea being to cut the three pieces from a sheet without waste. This is the customary shop procedure and patterns for preservation should be bound together in the manner of stringing patterns given in Fig. 59.

# A Four-piece Right Angle Elbow

As for the three-piece elbow, this is a complete demonstration of the exact method of cutting four-piece elbows, as shown in Figs. 69 and 70.

As was stated in the previous problems, this method is not the quickest but it is the truly scientific procedure and a good one for demonstrations.

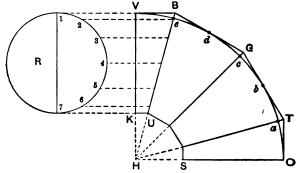


Fig. 69.-Elevation of Four-piece Elbow.

It may be of interest to state that elbows of any shape are developed by the method explained in connection with these problems of pieced elbows; for instance, profile R could be elliptical.

Let H K be the throat and K V the diameter of the elbow. Draw the quarter circle V O, which divide into six equal parts, as shown by a b c d e. Draw miter lines through a, c and e, as shown by H B, H G and H T. Draw the circle R, which space as shown, and draw lines to intersect the miter line B U, as in Fig. 69; which is the preliminary drawing.

Referring now to Fig. 70, which is the complete set of patterns and referring to Fig. 69 when so directed by the reference letters in the text, proceed as follows:

Construct parallelogram H K V O, equal in length to the circle R, as shown by similar figures on H K, through which draw parallel lines as shown.

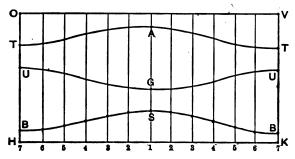


Fig. 70.-Complete Set of Patterns.

Measuring from VK, take the various distances to the miter line BU and place them on similar lines in the pattern, measuring from HK, and obtain BSB. Double IS and place at BU and BU and trace the miter cut BSB as shown by UGU. Place SG at UT and UT and trace UGU as shown by TAT. Make TO and TV equal to SI and draw line OV, which completes the four patterns.

Allow for locks for the various seams for joining the pieces together and the rivet or lock edges for the vertical seam of each piece.

## A Five-piece Right Angle Elbow

As with the foregoing problems of this nature, the following is a demonstration of the complete steps of developing patterns for a five-piece elbow as shown in Figs. 71 and 72.

The principles embodied in the procedure exemplified in these four or five problems should make

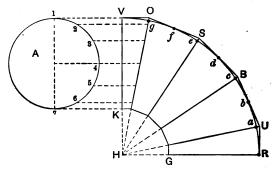


Fig. 71.—Elevation of a Five-piece Elbow.

the procedure quite clear for the developing of elbows of any number of pieces and indeed, at other than a right angle.

Draw throat HK and diameter KV. Draw quadrant HVR, which divide into eight parts as shown from a to g; draw miter lines HU, HB, HS and HO. Divide profile A into equal spaces, and draw lines from these points to miter line HO, as shown in Fig. 71.

Referring now to Fig. 72, which is the complete set of patterns, and referring to Fig. 71 when so

directed by the reference letters in the text, proceed as follows:

Make I I equal to circumference of profile A. Draw parallel lines as shown in pattern. Use dividers and measure various distances from V K to miter line H O, which transfer to similar lines measuring from I I, and obtain miter cut H K V.

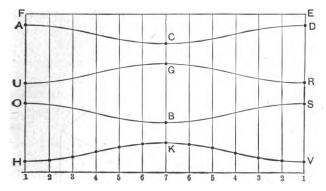


Fig. 72.—Complete Set of Patterns for Five-piece Elbow.

Double 7 K and place at HO and VS and draw miter cut OBS. Place KB at OU and SR and draw miter cut UGR. Make UA and RD equal to HO and draw miter cut ACD. Make AF and DE equal to HI and draw FE, which completes the five patterns. It is to be understood that this system of grouping the patterns causes the seams to come opposite each other in adjoining pieces, which is a decidedly good feature.

Allow for locks and so on as previously directed, inasmuch as these problems are all similar.

## An Offsetting or Obtuse Elbow

When the pattern for an obtuse or rather an elbow offsetting, as shown in Fig. 73, is desired it is only necessary to draw a cor-

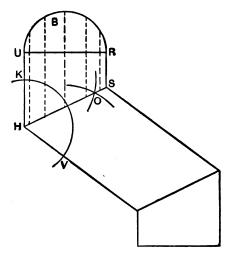


Fig. 73.-Rise of Miter Line in Elbows.

rect representation of the elbow and obtain the miter line, as follows: With H as center, draw the arc KV. With any desired radius, and using K and V as centers, intersect arcs at O. Draw the miter line HOS. Place the half profile B in position as shown, which space, and draw parallel lines to the miter line HS. Then proceed as by the rules already given in the four or five foregoing problems of like problems.

#### Rises for Elbow Miter Lines

The rise in an elbow is equal to the difference in length between the longest side and the shortest

side of an end piece. In Fig. 74, showing a three-piece elbow, the distance AB is the rise. The following are the rises of elbows of from 3 to 10 pieces, the diameters of which are 1 inch:

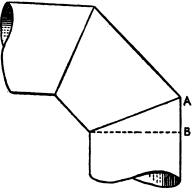


Fig. 74.-Rise of Miter Line in Elbows.

#### Table of Rises

| 3 P | iece | , 0.414 or, | 13-32 i | nch | rise | 7 F | iece | , 0.132 or, 9-64 | inch | rise |
|-----|------|-------------|---------|-----|------|-----|------|------------------|------|------|
| 4   | "    | 0.268 or,   | 17-64   | "   | "    | 8   | "    | 0.113 or, 7-64   | "    | "    |
| 5   | "    | o. 199 or,  | 3-16    | "   | "    | 9   | "    | 0.098 or, 3-32   | "    | "    |
| 6   | "    | 0.158 or.   | 5-32    | "   | "    | 10  | "    | 0.087 or, 5-64   | "    | "    |

# To Find the Miter Line Rise for an Elbow of Any Number of Pieces and of Any Diameter

Rule: Multiply the rise given in the above table by the diameter in inches of the desired elbow and the result will be the rise in inches for the miter line of the desired elbow.

**Example:** Find the rise for a seven-piece elbow the diameter of which is 11 inches.

Answer: Table gives rise as 0.132; then, 0.132  $\times$  11 = 1.452 or 1 15/32 inches, the desired rise.

## Gray's Practical Elbow Chart

There are many devices to cut elbow patterns. Also charts have been prepared for figuring the number of pieces to use in making up an elbow of angle from the standard elbow patterns, as in Fig. 75.

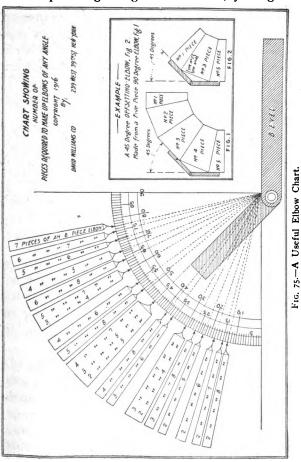
Although useful in many other ways, the main purpose of this chart is to instantly tell how to make offsetting elbows from the patterns of rightangled elbows of different number of pieces.

The regular elbow patterns can be developed for right-angled elbows, to full size, by following the instructions given herein for right-angled elbows of various number of pieces. Those who do not want to bother laying out their own patterns may purchase full size sets on heavy paper, all ready to lay on the metal. They are known as "Gray's Perfect Elbow Patterns," sets A and B.

Supposing you have a set of patterns at hand and, as per the example given in the chart, you have an offsetting angle in a run of piping that is 45 degrees from the original line of run. In fact, you do not know what degree the angle is but are able to set a bevel to the angle.

Now, this bevel is laid on the chart as shown, and it points to 45 degrees. Reading up the dotted line to the box tail of the arrow pointer on that degree, three combinations will be found in the box.

Deciding that, as in the example on the chart, a three-piece angle elbow will do, you select the first piece pattern of a right-angled five-piece elbow and cut out two pieces like the pattern. You also cut out one piece of any one of the middle sections of this five-piece right-angled elbow and, joining the



three pieces as in the chart, you obtain the required angle elbow.

#### Ideal Rule for Elbow Patterns

One of the nicest, most accurate and rapid methods of cutting elbow patterns is in this manner. Make a small memorandum chart—it even need not be drawn to scale—of the rises per foot of elbow miter lines as in Fig. 76. The rises here shown were found by drawing elbow elevations, as in Fig. 71, for instance, and, of course, could be carried up to any number of pieces.

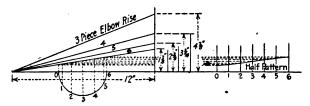


Fig. 76.-Cutting Elbow Patterns.

Now, supposing a six-piece elbow 4 inches in diameter is wanted. Simply draw a straight line 12 inches long and at one end erect a perpendicular line 17/8 inches high. Draw a line completing the triangle, as shown in Fig. 76, this line being the required miter line.

Anywhere on this line locate a center and scribe a 4-inch half-circle, as shown. Divide into a number of spaces. Place these spaces on the extended 12-inch line, as shown at the right of Fig. 76. Erect perpendicular lines, which in turn are intersected by lines projected from the miter line, which gives the half-pattern, the set being complete as in, say, Fig. 72.

## Rectangular Elbows-First Case

Rectangular elbows are common fittings. To cut the pattern for an elbow in which the turn is on the wide side of the pipe, first lay out a full-size side elevation (the profile really is not necessary) in this manner: Draw horizontal line A 7 and ver-

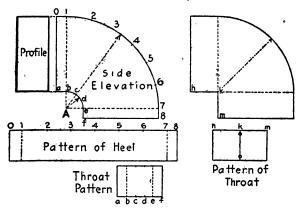


Fig. 77.—Elevation and Patterns of Rectangular Elbows.

tical line A I. A is the center, and scribe throat to required radius as b to e. Scribe heel the distance away from throat equal to widest dimension of pipe. Add the straight parts 0 I ab and ef78.

The pattern for the heel is just a rectangular piece the width of narrowest dimensions of pipe and the length of the stretchout in elevation 0 to 8. The same is true for the throat pattern. Sometimes the throat is made as in the diagram at the right of Fig. 77, in which case the pattern is as shown below the diagram; a square bend is made along line k.

## Rectangular Elbows-Second Case

The making of rectangular piping, or as some call it, duct work, is an important part of the sheet metal trade. Wall stacks for heating and ventilating, often of huge dimensions, are made this shape. And, too, the wall risers in furnace heating are frequently made rectangular as well as other fittings in this line, like cold air boxes for furnaces.

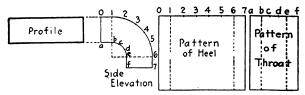


Fig. 78.—Elevation and Patterns of Rectangular Elbows.

The problems in rectangular elbows discussed here are those of frequent occurrences and lead up to complicated designs in unusual cases.

The turn, as in Fig. 78, can be on the narrowest side of the pipe or rectangle, just the opposite of the case of Fig. 77, and especial care must be exercised in laying out these types of elbows to be sure and have the turn on the right side. With rectangles of the proportions here shown the chance of error, while possible, is not as great as when the dimensions are almost equal.

As was directed for the other elbow, first draw side elevation, then take stretchouts of the heel and throat and cut out sheets the length of these stretchouts and to the width of the widest dimension of the rectangle. Provide for laps, etc.

## Compound Elbows in Rectangular Piping— First Case

First draw where convenient, an outline of the rectangular duct as 8 A B C, which will represent the end of the horizontal duct. The correct distance below this and also as far to the right as it should be, draw the horizontal line 21 D to represent

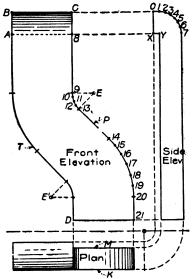
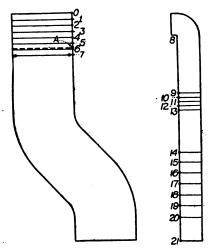


Fig. 79.-Shows Procedure in Making Elbow.

the wide side of the end of the vertical duct. As can be seen, there is ample room between these two ducts to make an easy connecting offset and square elbow, as shown by this front elevation. Note that this is the regulation method of making elbow offsets in pipe work, which is merely the choosing of

convenient points like E and E', as centers and scribing throat and heel sweeps of the turn.

Although not absolutely necessary, a plan is drawn as directed by Fig. 79, as it will help indicate the relative positions of the two duct ends. From the front elevation and plan a side elevation is projected which will indicate the regulation



Figs. 80 and 81.-Patterns of Wide Offsetting Part.

square elbow OXY7 required to make the turn from vertical to horizontal. Observe that the throat has a square bend which is customary when, owing to restricted space, a throat of a sweep like the heel is impossible.

Now then, Fig. 79 shows that the scheme in mind is to make the connection between the two ducts by a composite elbow, two offsetting elbows, the turn

being made on the widest side of the pipe, as shown by the front elevation and a square elbow, the turn or cheeks being on the narrowest side.

If this is duct work, the three elbows would be made separately and joined by the usual method of slips or angle irons. However, the patterns as here shown are all in one. To make more clear Fig. 80 is given and is just a reproduction of the offsetting elbows of the front elevation of Fig. 79 up to point 8. Point 8 is called 7 in Fig. 80 and from 7 up is nothing more than the stretchout 0 to 7 of the heel of the square elbow of the side elevation of Fig. 79. This pattern is for the side nearest the observer of the front elevation of Fig. 79 or K in the plan. The opposite side, M in the plan, has the same pattern as Fig. 80 except that above 7 the throat stretchout, X Y of Fig. 79, is placed which would mean that the pattern stops there or as at A.

After having cut the two patterns from the metal it is to be noted that the piece terminating at A would have a square bend at 7, while the other piece would be rounded to the shape of the side elevation, starting the rounding at 7.

The pattern of the narrowest sides is given in Fig. 81, the cheeks of the square elbow, shown in the side elevation, Fig. 79, are reproduced and then from point 8 down is the stretchout 8 to 21 of the front elevation, Fig. 79. Of course, this pattern is for side P of the front elevation, Fig. 79, but the stretchout for side T is the same. The only difference is that the smaller curve is toward the bottom of the pattern instead of towards the top.

## Compound Elbows in Rectangular Piping— Second Case

The discussion herein of these two cases of compound elbows in rectangular piping is based on actual work. They were originally prepared in response to a query on how to make fittings for these situations. Many solutions of compound elbows

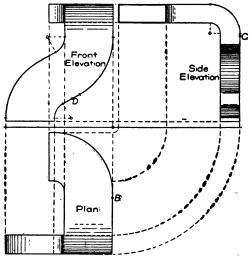


Fig. 82.-Projected View of Second Problem.

treat of a twisting elbow throughout which might be all right in certain cases but principally good problems for technical pattern drafting rather than actual shop practice like these solutions.

The second problem seemingly is more complicated, but an inspection of Fig. 82 will reveal that nothing more is needed than an additional elbow

so that the composition consists of double offsetting elbows shown in the front elevation, a square elbow with cheeks on narrow sides as shown in the side elevation and the additional elbow to make the quarter turn horizontally which has its cheeks on the wide sides, as indicated by the plan of the diagrams, Fig. 82.

From the description of the method of developing the patterns for the first problem, it is assumed that the method of obtaining the patterns for the second case requires no explanation; attention is called, though, to the throats, which are all rounded; the patterns of which are obtained by taking the girth of the throat quadrant as explained before.

It should be understood that in the foregoing an attempt was made to describe how such problems would be studied and solved in actual practice. For, assuming that the pipe is 3 x 8 feet, it will be seen that no more extraordinary situation occurs, in either case, than arises on most every job of heating, ventilation or kindred work, and it is common practice, when space is available as it was in these problems, to use just such combinations of common elbows because these fittings are all easily made and erected. It is to be remembered, too, that the slip joints are used so as to cut out the material with the least waste; generally they would be at, say, B in plan, C in side elevation, and D in the front elevation; as shown in Fig. 82.

Full information on the development of compound elbows by the "twist" method are given in the book, "Piping and Heavy Sheet Metal Work."

#### CHAPTER V

# Furnace Fittings

# Patterns for an "A" Smoke Jack

This problem is introduced not only because it is a good design for a chimney top, but also because two problems occurring quite frequently in furnace smoke pipe work are involved, namely, a

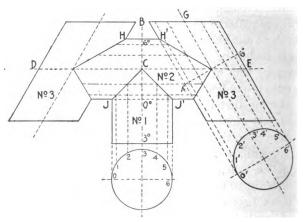


Fig. 83.-A Smoke Jack.

tee joint at a square angle and a tee joint at other than a right angle. Arms No. 1 and No. 2—square tee joint and No. 2 and No. 3 angle tee joint.

As in Fig. 83, draw a vertical line 3 B; also a horizontal line crossing this at C, as D E. Again, axes lines of inclined arms to suit desired propor-

tions. Draw the two profiles of the parts, as o to 6 and o' to 6' and divide into equal spaces as shown. Draw the dotted lines from these spaces, also line 4" 6" at right angles to line 3' G.

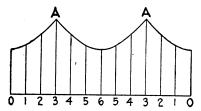


Fig. 84.—Pattern of No. 1 Piece.

Many designers do not cut the tops and bottoms of arms, No. 3, on a horizontal line as shown, but

leave the arms straight, that is, on a line parallel to line 4" 6". As may be imagined, this does not look as well as the design of Fig. 83, but it saves considerable cutting, which might be quite a factor when figuring for a low cost, especially as the operating of the jack would be the same in either case.

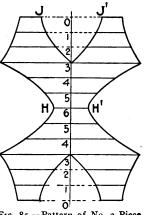


Fig. 85 .- Pattern of No. 2 Piece.

piece No. 1 draw a For the pattern of the line as 0 to 0 in Fig. 84, with the spaces 0 to 6 to 0 of the profile is Fig. 83. Draw the right angled lines Z Hamilton Fish Park Branch

38 Last Houston St.

from these spaces. Then carry distances from like lines in Fig. 83 to Fig. 84; thus, line 3° C in Fig. 83 equals line 3 A in Fig. 84, and so on.

For the pattern of piece No. 2 place stretchout on a line as shown in Fig. 85, also right angle lines. Carry the lengths from both sides of line 3° B in

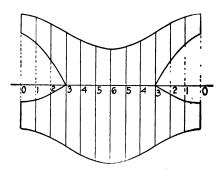


Fig. 86.—Pattern of No. 3 Pieces.

Fig. 83 to both sides of line o to o in Fig. 85. Thus, spaces 6 H 6 H' in Fig. 85 is 6° H and 6° H' of Fig. 83. Also for the cut-out or hole; for instance, o J and o J' of Fig. 85 is o° J and o° J' of Fig. 83, and so on.

For the arm pieces, in No. 3, Fig. 83, place stretchout on line 0 to 0 as in Fig. 86 and continue as explained before, measuring from the line 4" 6" in Fig. 83; that is to say, the lengths are taken from line 4" 6", in Fig. 83, to the top of the arm and are placed above the stretchout line of Fig. 86. Then, lengths taken below line 4" 6", of Fig. 83 to the bottom, are placed below stretchout line in Fig. 86.

# Laying Out a Chimney Base

Proceed as in Fig. 87, in which 1, 2, 3, 4 is the outline of the bottom of the base and A the size of the round pipe. From the corners of the rectangu-

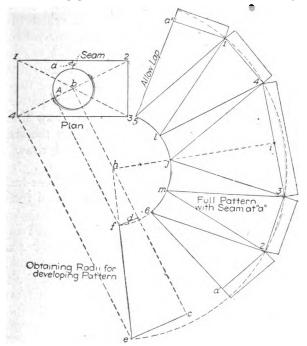


Fig. 87.-Short, Simple Rule for Laying Out Chimney Bases.

lar base, draw the two diagonals, and where they intersect will be the center b used for striking the desired size of the smoke pipe A. Now, at right angles to either one of the diagonal lines, in this case 4 b, draw lines indefinitely from points 4, A

and b as shown. Now draw any line as ce parallel to 4b and make the height cd equal to the desired height of the base. From d draw the line df parallel to ce until it intersects the perpendicular line drawn from A parallel to de at de. Draw a line from de through de until it intersects the center line at de, de and de then become the radii for striking the pattern. Now, using these radii, with de as center, describe the arcs de and de arc sequal to 1-4, 4-3 and 3-2 in plan, and place these distances on the outer arc as shown in the pattern from 1 to 4, 4 to 3, and 3 to 2. Now draw lines from 1 to 4, 4 to 3 and 3 to 2 and bisect the side 3-4, thus obtaining the point de, from which draw a radial line to de, cutting the inner arc at de.

Take the girth of full circle A, and place one-half of it on either side of the inner arc, as shown from i to 5 and i to 6. Bisect j 5 and j 6 and obtain points l and m, respectively. Now, draw lines from point I on the outer arc to 5 and b; from point 4 to l and j; from point 3 to j and m and from point 2 to m and 6. These lines indicate where slight bends would be made, so as to obtain the transition from square corners to round top. As the seam in this case is to come between I and 2 in plan or in the center of the long side at a, then to obtain this joint line in the pattern, use ji in the pattern as radius, and, with 5 and 6 as centers, draw the arcs a" and a', respectively; then using 3 i or 4 i as radius and 1 and 2 as centers, intersect arcs previously drawn at a'' and a'. Draw lines from 1 to a'' to 5, and from 2 to a' to 6, which completes the pattern.

#### Pattern for a Furnace Center Boot

Of all the fittings that are made for furnace work, boots or shoes or starters, etc., as they are called, according to the different localities in which they are made, form one of the most important problems. They have offsets one way or two ways.

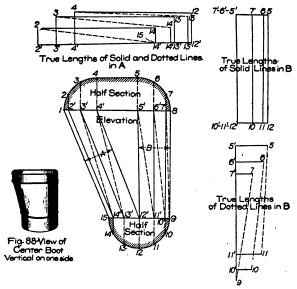


Fig. 89.-Elevation and True Lengths.

They have their collars at various angles to each other and, in fact, are so diverse in designs that quite a number of articles could be written about them; the style shown in Fig. 88 is a common one and the pattern procedure is as shown in Figs. 89 and 90.

Divide the quarter circles of elliptical section, in the same number of divisions as the quarter circles in the half section and number the points from 1 to 4, 5 to 8 and 9 to 15 as shown. From the divisions in the elliptical section 1 to 8 at right angles to the line 1-8 draw lines intersecting the line 1-8 at 2', 3', 4', 5', 6' and 7'. In a similar manner, at right angles to the line 9-15 from the intersections

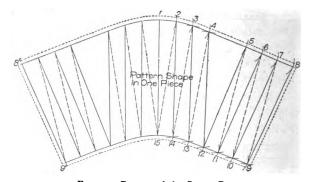


Fig. 90.-Pattern of the Center Boot.

10 to 14, draw lines cutting the line 9-15 at 10', 11', 12', 13' and 14'. Connect solid lines in elevation as shown, and connect the opposite points by dotted lines all as indicated in the parts marked A and B.

To obtain the true length of the solid lines in A in elevation proceed as follows: Take the various lengths of the solid lines 4' to 12', 3' to 13' and 2' to 14', and place them as shown by similar numbers in the diagram of true lengths in A. From these various points perpendiculars are erected equal to the various heights in the semi-sections in elevation.

For example, the heights of 4'-4 in the semi-elliptical section and 12'-12 in the semi-circle are placed on the proper perpendiculars in diagram for true lengths in A, as indicated by 4'-4 and 12'-12. A line drawn from 4 to 12 is the true length of the line 4'-12' in elevation. Similarly, obtain the true lengths of the dotted lines in A in elevation, also the true lengths of the solid and dotted lines in B.

Cut the pattern as follows. Assuming that the seam is to come along 8-9 in elevation then take the length of 1-15, which shows its true length, and place it as shown by 1-15 in the pattern. Now with 1-2 in the half section as radius, and 1 in pattern as center, describe the arc 2, which intersect by an arc struck from 15 as center and 15-2 in the true lengths in A as radius. Now using 15-14 in the half section as radius, and 15 in pattern as center, describe the arc 14, which intersect by another arc struck from 2 as center and 2-14 in the true lengths in A as radius.

Proceed in this manner, using alternately first the proper division in the semi-elliptical section, then the proper true length of the dotted lines; then the proper division of the semi-circular section, and the proper true length of the solid lines, always following the dotted and solid lines in elevation as a guide, until the seam line 8-9 in pattern is obtained, which equals 8-9 (its true length) in elevation. Trace a line through points thus obtained, as shown by 1-8-9-15 in the pattern, which shows the half pattern. • If a full pattern is desired, trace this half opposite the line 1-15, as shown by 8°-9°.

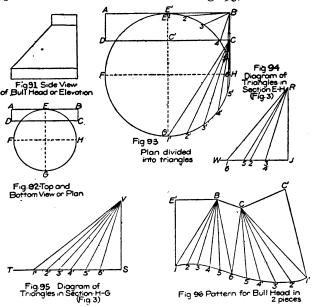
# Round to Rectangle Furnace Boot

The problem is an object having a round base and transforms to a rectangular form at the top. This rectangle is so situated in respect to the round base, as to have what is termed a straight back, which is to say, the long center line of the rectangle does not lie in the same vertical plane as does the cross diameter of the round; however, the short center line of the rectangle does lie in the same vertical plane as a diameter, at right angles to the one mentioned, of the round. This then makes a problem of symmetrical halves so that the pattern for one-half will answer for the other half.

First, divide the circle into quarters. Then divide the two quarters represented by EHG into equal divisions, and, from the points in the section E H, draw lines to the corner of the top, represented by B, in Fig. 93, and, from the divisions in section H G, draw lines to the corner of the top represented by C, Fig. 93. It will be necessary to construct the two diagrams of triangles, one for each corner, shown in Fig. 93, so as to obtain the true length of each line. Lay off the line, R J, in Fig. 94, equal to the height of the fitting made to suit the work on which it is to be used. From the point J, and at right angles to the line R J, set off the length of lines in the section E to H, making I I equal to B I. I 2 equal to B 2, etc. From the points thus established in the line J W, Fig. 94, draw lines to R.

To obtain triangles for the section HG, draw lines as shown in Fig. 95, the same as in Fig. 94.

Make VS the same height as R J, Fig. 94; draw S T at right angles to V S, and, on the line S T set off the lengths of the lines in section H G, making S I' equal to C I', S 2' equal to C 2', etc.; from the points thus established in S T, Fig. 95, draw lines



Figs. 91 to 96 .- Various Details of Object.

to V, as shown. To obtain the pattern, lay off line I E' in Fig. 96, and from point E', and at right angles to I E', draw line E' B equal in length to E' B of plan Fig. 93, which is the same as half the length of the long side of the top. Set the dividers to R I, Fig. 94, and with B of pattern as center, strike an arc cutting the line E' I at I. Then join I-B, Fig.

96. With B as center and R 2 in Fig. 94 as radius, describe an arc. With 1, of pattern as center, and 1'-2' of plan as radius, strike a small arc intersecting at 2 with the arc previously drawn. With B, Fig. 96, as center, and R 3, Fig. 94, as radius, describe an arc, and with the dividers set to same space used in stepping off the plan, strike small arc intersecting at 3 of the pattern. Proceed in the same way to lay off the lines 4, 5 and 6. Then, to obtain the point C, of pattern, set the dividers to BC of plan, Fig. 93, and, with B of pattern as center, and BC of plan as radius, describe an arc. Now, with V6', Fig. 95, as radius, and 6, of the pattern, as center, strike an arc, intersecting with the arc already drawn. This will give the point C of the pattern. With C of the pattern as center and V 5', Fig. 95, as radius, describe an arc. Now, with the dividers set to same space used in stepping off plan at 6-5', using 6 of the pattern as center, strike a small arc intersecting the other at 5'. The remaining lines, 4', 3', 2' and 1' are established in the same way as the preceding one. To complete the pattern, set the dividers to C'-C, and, with C of pattern as center, strike a small arc. Now, from I' of pattern as center, and the slant height of bullhead Fig. 91, as radius, strike an arc intersecting. at C'. Lines traced through the points thus obtained will give the pattern required minus laps.

Drafting the pattern for boot with an offset is done in exactly the same way, only be sure to draw the right amount of offset in the plan and elevation and then proceed as previously explained.

### Pattern for an Angular Furnace Boot

A sketch of the fitting is given in Fig. 97 and it is to be understood that this procedure will apply for any combination of sizes, position and dimensions of rectangular collar. The methods and design here explained are scientifically correct and a much better method than the so-called channel boot, which is merely a square box with collars let into it.

By position and dimensions of rectangular collar and combination of sizes in respect to the round collar, is meant that if, for instance, the rectangle collar was turned one-quarter around in relation to its present position an ordinary offset boot would result. Such boots are commonly used when the wall pipe is in a partition over a girder and it is necessary to offset over this girder to make the connection to collar pipe and transition in shape at this place, from the round collar pipe to the rectangular shape of the wall pipe or riser.

Also, if the wall pipe had a shape of what is commonly called "oval," that is to say, a rectangle with semi-circular ends, the procedure here outlined would be in a measure, similar; that is, very little adjusting of the methods would be required.

Now, even if the round collar was situated at a different angle, as say, somewhat off the vertical line in which it is now, so that the boot could be connected to the pitched collar pipe without using an angle elbow, the procedure would be identical to that herein explained.

The first step is to draw the side elevation, as

shown by 1'-2'-3'-9 in Fig. 98. On the line 1'-2' place the half section of the  $3\frac{1}{2} \times 10$ -inch pipe, as shown, and on the line 3-9 place the half section of the 9-inch pipe, also shown.

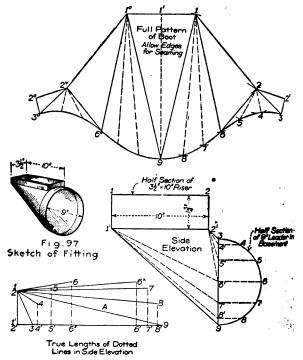


Fig. 98 .- Various Details of the Object.

Divide the semi-circle in any number of equal spaces; in this case 6, as indicated by the small figures, 4, 5, 6, 7 and 8. From these points at right angles to 3-9 draw lines intersecting, 3-9 at 4', 5',

6', 7' and 8'. From the intersections 3, 4', 5' and 6' draw lines to the corner 2'; and from the intersections 6', 7', 8' and 9 draw lines to the corner 1'. These lines represent the bases of sections which will be constructed whose altitudes will equal the various heights in the half sections. For an example: To find the true length of the line 1'-6' in side elevation, take this distance and place it as shown from 1' to 6' in diagram A. From the points 1' and 6' at right angles to 1'-6', erect the lines I'-I and  $6'-6^x$ , equal in height to I'-I and 6'-6 in the half sections. A line drawn from I to 6x in A is the desired length. In similar manner take the various lengths I' to 7', I' to 8' and I' to o in the side elevation and place them as shown by similar numbers in diagram A and erect perpendicular lines equal to the proper height in the half sections. Also, take the lengths 2' to 3, 2' to 4', 2' to 5' and 2' to 6' in the side elevation and place them in diagram A, as shown by similar numbers, and obtain the heights from the half sections.

It will be noticed that the height of the sections at 1' and 2' in the side elevation is equal to 1'-1 and 2'-2 respectively, both heights being similar, as shown in diagram A, while the heights at 4', 5', 6', 7' and 8' in the side elevation vary, as shown in the semi-circle at 4, 5, 6, 7 and 8, respectively.

Having obtained the true lengths in A, the pattern is now in order, and is developed as follows: Take the length of 1'-9 in the side elevation which shows its true length and place it on the vertical line in the pattern, shown by 1'-9. Now with a

radius equal to 1'-1 in the half section in the side elevation, and 1' in the pattern as center, describe the arc 1, which intersects by an arc, struck from 9 as center and 9-1 in the true length A as radius. Now with radii equal to 1-8, 1-7 and 1-6 $^{\infty}$  in diagram A and using 1 in the pattern as center, describe the short arcs 8, 7 and 6. Set the dividers equal to the divisions 9-8, 8-7 and 7-6 in the semi-circular section in the side elevation, and starting from 9 in the pattern step to arc 8, 7 and 6 respectively, and draw a line from 6 to 1 and 1 to 9 and trace the curve from 9 to 6.

Now with a radius equal to 2-6 in diagram A and with 6 in the pattern as center, describe the arc 2, which intersect by an arc struck from I as center, and I-2 of the half section in the side elevation as radius. With radii equal to 2-5, 2-4 and 2-3 in diagram A and 2 in the pattern as center, describe the arcs 5, 4 and 3. Again set the dividers equal to the divisions 6 to 5, 5 to 5 and 4 to 3 in the semi-circular section in the side elevation and starting from 6 in the pattern, step to arc 5, 4 and 3. Draw a line from 3 to 2 and 2 to 6.

Now with radius equal to 3-2' in the side elevation, which shows its true length, and 3 in pattern as center, draw the arc 2', which intersect by an arc struck from 2 as center and 2-2' in the semi-rectangular section in the side elevation as radius. Connect points in the pattern by tracing the curve from 6 to 3, and draw lines from 3 to 2', 2' to 2, 2 to 1 and 1 to 1'. 1'-9-3-2'-2-1-1' is the half pattern; and,  $1^{\circ}-2^{\circ}-2^{\circ}-3^{\circ}-6^{\circ}-9$  added is the full pattern.

## Pattern for a Y Fitting

Trunk line systems in furnace heating are becoming quite popular and require special fittings as, for instance, the Y branch. The principles as explained for this case can be applied to any size fitting, no matter what angle the fitting may have, providing the two forks are symmetrical when viewed in plan as shown in diagram X in Fig. 99. As the angles of the forks in this case are the same as shown in the elevation, the one pattern will answer for both. If, however, the angle of the one fork was 45 deg. and the other 30 deg., a separate pattern would have to be developed for each, using the same method as will now be described.

The first step in this procedure is to draw any line as  $8\text{-}10^{\circ}$  equal to 14 inches, which bisect and obtain a. From a erect the perpendicular a 14, equal to one-half of 14 inches, or 7 inches. From a draw the angles desired, as a e and a d. Make these two lines of the desired length and through e and d, perpendicular to the lines just drawn, draw the line 1-7 the desired diameter, or 10 in. Using e as center, with e 1 as radius, draw the half section of the pipe. In similar manner, using e as center, with radius equal to e 8, draw the half section of the large pipe, also the half section of the intersection between the two forks on line e 14. It may be of interest to state that the profile e 14 11° could be arbitrarily drawn if the conditions required it.

Thus 1-4-7 is the half section of the 10-inch pipe; 8-11-11° the half section of the 14-inch pipe and a-11°-14 the half section of the joint line between the two forks. Now divide the half sections into equal parts, as shown by the small figures, from which draw perpendicular lines to their respective base lines as shown. Draw solid and dotted lines

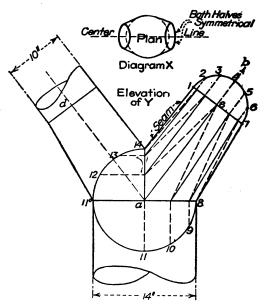


Fig. 99.—First Steps for Developing the Pattern.

as indicated, which will represent the base lines of sections which will be constructed whose altitudes are equal to their respective heights in the various sections. Thus to find the true length of the solid line 12 to 3 in the elevation of the left fork, take that distance and set it on the line A B as shown in Fig. 100. From 12 and 3 erect perpendicular lines

equal to the heights to 12 and 3 in the sections, measuring from their respective base lines. The heavy line in the diagram 12-3 will be the true length. In similar manner are the balance of the true lengths for solid and dotted lines found, as shown by similar numbers on the horizontal lines A B of Fig. 100 and C D in Fig. 101.

The next steps are for the pattern shape, so

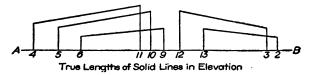


Fig. 100.—Triangulating the Solid Lines.

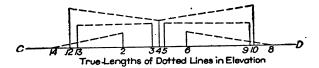


Fig. 101.—Triangulating the Dotted Lines.

proceed as follows: As the seam is to come along the top at 1-14 in. elevation, take the distance of the lower line 7-8, which shows its true length, and place it as indicated by 7-8 in the pattern, Fig. 102. Now with 7-6 in the half section as radius and 7 in the pattern as center, describe the arc 6, which intersect by an arc struck from 8 as center and 8-6 in the dotted true lengths as radius. Now using 8-9 in the lower half section as radius and 8 in the pattern as center, describe the arc 9, which intersect by an arc struck from 6 as center and 6-9 in the

solid true lengths as radius. Proceed in this manner, using alternately first the divisions in the top section, then the proper dotted length; again the proper division in the lower section, then the proper true solid length, all as indicated by similar numbers in the pattern, the length of I-I4 being obtained from I-I4 in elevation. Trace a line through points thus obtained as shown, which will be the

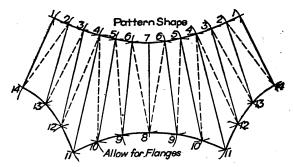


Fig. 102.-The Procedure for the Pattern.

desired pattern for both forks, to which edges must be allowed for seaming, or riveting, inasmuch as the two arms are most always joined by riveting, although by using extreme care they could be double-seamed together.

Forks or Y branches have had the close attention of many draftsmen, and no doubt a book of this size could be written about them alone; however, the fundamental principles embodied in this problem are really involved in all and merely require an adjusting in applying these principles to the case at hand.

#### Pattern for a Furnace Collar

As stated farther on in the exposition of this subject, the opening in the conical top, or, as it is called in some shops, a furnace bonnet, would be marked by scribing around the collar. Should it be desired to cut it out on the flat, one would proceed to do so by developing the pattern of the top by the radial line method as explained in conical problems, like the scoop problem of Fig. 55. Points 2'-3' and 4' are carried across parallel to the base line A (referring to Fig. 104) to the line where points 1' and 5' are; thence swung radially around to like element line in the pattern just as was done in the scoop problem, thus obtaining the opening in the top for the collar.

In Fig. 104 are shown the true principles for developing a collar intersecting a conical furnace top, which can be applied to any angle, no matter what size the top or collar may have. The diameter of the furnace collar in this case has been made larger and is out of proportion, so that the points of intersections may be more clearly shown.

Referring first to Fig. 104 on next page, A B C D represent the one-half elevation of the conical top, below which in its proper position is drawn the one-quarter plan shown by F B A. Establish at pleasure any two points on the outline of the plan as a and b, from which points draw radial lines to the center F. From these points a and b in plan, erect vertical lines intersecting the base line A B of the cone in elevation as is also indicated by

a and b, from which points radial lines are drawn, toward the apex E as shown. Establish the angle which the collar is to have as shown by the center line  $3^{\circ}$  3 and with any point on this line as d as

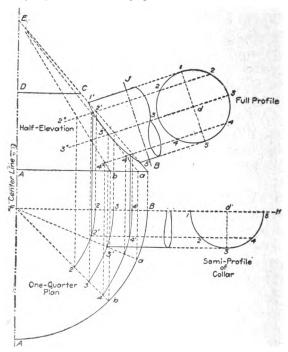


Fig. 104.—Geometrical Procedure for Acquiring Collar Pattern.

center, describe the profile of the collar as shown. Divide this profile into an equal number of spaces, in this case eight, as shown by the small figures 1 to 5 to 1, through which points draw lines parallel to 33°, extending them partly in the elevation as

\*

shown by 22°, 33° and 44°. The lines drawn from points 1 and 5 in the full profile show their true points of intersection with the furnace top at 1' and 5'.

Where the planes or lines  $22^{\circ}$ ,  $33^{\circ}$  and  $44^{\circ}$  intersect the radial lines drawn from B a and b in elevation, drop vertical lines to the plan, intersecting similar radial lines also drawn from B a and b in plan; as will be clearly understood by following the dotted lines. Through the points of intersections thus obtained trace the curves 22, 33 and 44. Then will these curves 22, 33 and 44 in plan represent the horizontal sections on the lines shown in elevation by  $22^{\circ}$ ,  $33^{\circ}$  and  $44^{\circ}$ , respectively.

Extend the line FB in plan as FH and with any point on same as d' draw the semi-profile of the collar as shown. Divide this into one-half the number of spaces contained in the full profile as shown. Parallel to FH through the point 3 in the semi-profile draw a line until it intersects the horizontal section 3 3 in plan at 3'. In a similar manner through the points 4 and 2 in the semi-profile draw a line until it intersects the horizontal sections 44 and 22 in plan at 4' and 2', respectively. From these intersections 2', 3' and 4' in plan, erect vertical lines, intersecting similar numbered planes or lines in elevation as 22°, 33° and 44° at 2', 3' and 4', respectively. Through the intersections 1', 2', 3', 4' and 5' in elevation trace the intersecting line between the collar and conical top as shown in Fig. 104 on the opposite page.

Fig. 105.—Net Pattern for urnace Collar.

The line of intersection, or miter line, having been obtained the pattern is now in order. As in Fig. 104, at pleasure draw any line as IB in elevation at right angles to 33° as shown. Draw any vertical line as J° B°, Fig. 105, upon which place the girth of the full profile as shown by similar numbers. From these points I to 5 to I, at right angles to J° B° draw lines indefinitely. Measuring in each instance from the line I B in the half elevation, take the various distances to points I', 2', 3', 4' and 5' and place them on similar numbered lines in the pattern, measuring in each instance from the line J° B°. Trace a line through points thus obtained; then will L M II be the pattern for the desired furnace collar, to which flanges must be allowed for seaming.

The opening in the conical top has not been developed as this is not necessary, because after the collar is developed, rolled up and seamed it may be held in its desired position on the conical top and the opening scribed around the collar with a lead pencil. The opening may then be cut out partly with a small chisel, after which it is correctly trimmed with the circular shears. Practical methods for joining the collars to the bonnets are explained at length in Chapter IX.

#### CHAPTER VI

#### Leaders and Gutters

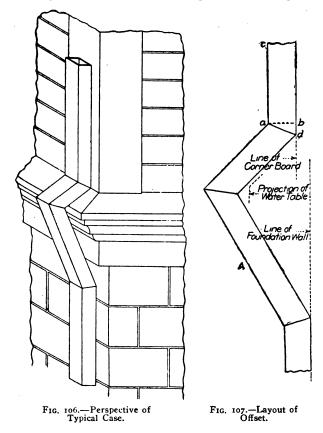
## Making Offsets in Leader Pipes

The following is a description of the method whereby offsets or elbows are made in square leader pipe; a method always found eminently practical and expeditious and for an example a case where the leader passes over the water table of the usual type of frame building is shown, as illustrated in Fig. 106.

The usual procedure when following this method is to send out to the job full lengths of leader, say 10 feet in length, and all offsets and elbows or the like are made there by the mechanic, and in this case measurements would be taken of the water table and in some convenient place, like the cement or stone walk or inside on the floor of one of the rooms of the building if it is not as yet finished, the offset would be drawn full size as shown at A of Fig. 107; a good idea being to use chalk and a line in a way known to all workmen. Now, as all the cuts, or miters, it should be said, would be obtained in identically the same manner, that for the upper one only will be here elucidated to avoid repetition of explanations.

Therefore, at a draw a line as a b at right angles to a c, as shown, employing a small square for the purpose. Many mechanics do not carry a small

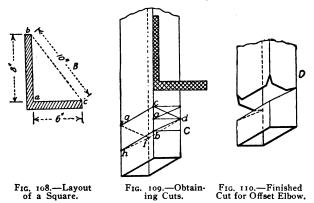
carpenter's square in their kit of tools. Before proceeding farther it is well to explain how a square



can be cut from a piece of sheet metal. As in B of Fig. 108, draw a line a b 8 inches long; with the compasses set to span 6 inches and with one leg set

at a describe an arc toward c. Then set the compasses again to 10 inches, and with one leg at b describe an arc intersecting the one previously drawn at c. A line drawn from c to a will give a right angle, the basis for a piece of sheet metal cut like B. Stiffen as may be required.

Taking a full length of leader, a point a (of C, Fig. 109) is marked on it at the right distance from



the end of the length of leader in relation to the distance point a is from the soil pipe connection (if the leader is connected to the plumbing system, the discharging shoe otherwise), providing the mechanic is working from the bottom up, or if from the top down, the relation point a is in the matter of distance from the last length of leader erected, for it is to be understood that good judgment is to be exercised in placing this point to obviate the need of cutting off some of the leader at the ends or, worse still, adding some leader to the ends which

would make the job look piecy and decidedly unworkmanlike.

The distance b d of A is now placed to both sides of point a in C, as indicated by the points b and c. Holding one leg of the aforementioned square in line with the side of the leader pipe as shown in C, lines are drawn across the pipe from these three points as shown, though only the middle one is required, the idea being to prove accuracy by seeing that all three lines are parallel; from d to c and b lines are drawn as shown, and then from d square across the back to f, and from c and b square across the front to the other side, as shown by g and h; connect these with b and the space between f, g, c, d, band h is then to be cut out of the pipe, allowing laps at the top, so that the water will not flow against but with the seam, after which the leader pipe at that place will look like at D, Fig. 110 of the group of diagrams.

The lap shown at the front of the pipe is bent outward with the pliers, and then by carefully coaxing the pipe, it is caused to bend along the line  $\bar{d}$  f of C until point h touches g or b touches c and the joint well soaked with solder. Like everything else, the work is to be done right to be of any value, and it should be obvious that the method outlined in the foregoing is superior to chopping off two pieces of the leader and trimming the ends to a miter and thereby making individual elbows for each bend in the offset, necessitating two joints to each bend which certainly will make the job appear patchy and require more time, solder and pipe.

## An Oblique Leader Elbow

A leader pipe elbow pattern 2-inch by 3-inch is to be developed. The elbow is to reach around the corner of a building, the angle of which is 90 deg.,

as shown in Fig. 111, at an incline or rake of 45 deg. The flat or 3-inch side of the conductor is to face the building on both sides. In Fig. 112 is shown a simple method of finding the miter lock between two similarly sized pipes by means of simple projections. Using this method it will not be necessary to go through the operations of raking or

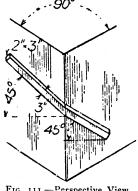


Fig. 111.—Perspective View of Problem.

changing of profiles, and the same area of the pipes is maintained. Where the intersection between the two pipes takes place there will not be a true miter line, but rather an intersecting lock, similar to that shown in the perspective in Fig. 113, which, however, is perfectly practical, and this method can be used, no matter what size the pipe may be, or at what angle or rake they incline.

The method of finding the joint line and developing the pattern is shown in detail in Fig. 112. First draw the wall line represented by FC in the elevation and from any point on it, as 6, draw the desired rake of the pipe, in this case 45 deg., as shown by 6-B. Draw the perpendicular BE equal to 3

definitely parallel to B-6. At right angles to the wall line F C draw the line C D equal to 2 inches on the narrow side, and from D, parallel to CF, draw a line until it intersects the line previously drawn from E at 2. From intersection 2 draw the dotted horizontal line, cutting the line of the pipe C-6 extended at 1. Also, from aftern Shape 6 draw the solid Elevation horizontal line cutting the outside line of the pipe erected from D, at 4. These are all the projecting

Above and in line Fig. 112.—Developing Pattern Shape. with B E draw the

points required previous to developing the

pattern.

section of the rectangular pipe and from point I in the elevation, which represents the seam line in the rear flat side of the pipe, draw a line parallel to 6-B, cutting the section at I. In a similar man-

ner project back to the section the corner indicated by 4 in the elevation, which in this case happens to fall on the same line projected from the corner I in the elevation. These points, I and 4 in the section, are used when laying out the girth or stretch-

out of the pipe. Below the line C D in the elevation place a duplicate of the section in its proper position by A. For the pattern extend line BE, which was drawn at right angles to B-6, as shown by FG. Upon this place the girth of the section from I to 6 to I. as shown by similar numbers on FG. Through these small figures, at right angles to FG, draw the usual measuring lines which are intersected



Fig. 113.—Perspective View of Finished Elbow.

by lines drawn at right angles to B-6 in the elevation from similarly numbered intersections in the joint line in the elevation. Trace a line through the points thus obtained, as shown by JLM, then will I, J, L, M, I be the desired pattern of which two will be required both formed the same way, allowing laps for seaming, riveting and soldering.

# True Angle of an Oblique Leader Elbow

This is an interesting problem in leader work and herewith is the solution of the problem as taught in the Gray's Correspondence School of Sheet Metal Pattern Drafting, New York City.

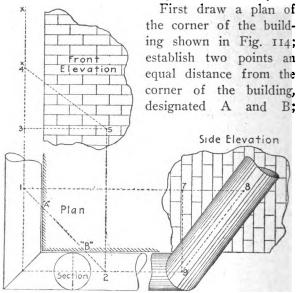


Fig. 114.—The First Steps in the Procedure.

draw a line through these two points, intersecting the center line of both arms of the elbow at 1 and 2. The next operation is to draw the front elevation, the center line of the elbow is all that is wanted as shown by line  $4^x$  3 and 3 5. Connect  $4^x$  and 5, this line will represent the pitch of the elbow. Now, draw the side elevation to

the right of the plan, as shown; distance 78 is the same as 34<sup>x</sup> in the front elevation in this case, but may be otherwise, and line 89 is the pitch of

the center line of the elbow in this view.

The true angle of the elbow is now found by taking the distance of line 7 to 8 of the side elevation and placing it on line 34<sup>x</sup>, measuring from 4<sup>x</sup>, giving point X, in the front elevation. Now take the full length

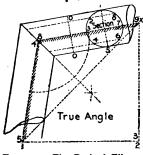


Fig. 115.-The Desired Elbow.

of line 3 to  $\boldsymbol{X}$  and place in the true angle diagram.

Again, take the distance of line 12 in the plan, Fig. 114, and place at right angles to line 3 X in



Fig. 116.—The Pattern of Elbow.

Fig. 115. Take the distance 4 to 5 in the front elevation and place it at 45 in the true angle diagram by swinging a small arc of this radius as shown. Do the same with distance of line 89 of side elevation getting the point of intersection of the two arcs as 48. Then 5489 X is the true angle sought for.

Bisect this angle. Draw the rest of the elbow as shown and develop the pattern in Fig. 116 as previously directed in the other chapters. The pattern being the same for both arms of the elbow; it can be of any desired length.

#### Sizes and Other Facts About Leaders

A good rule to follow for quickly computing the size to be allowed for a leader is to figure up to eighteen hundred square feet of roof area for a three-inch round leader or its equivalent in area for a square-shaped leader. From eighteen hundred to two thousand two hundred and fifty square feet for a three and one-half inch round leader or its equivalent in square leader. From two thousand two hundred and fifty to three thousand square feet for a four-inch round leader or its equivalent in square leader. From three thousand to five thousand square feet for a five-inch round leader or its equivalent in square leader. From five thousand to seven thousand square feet for a six-inch round leader or its equivalent in square leader. Horizontal leaders should be larger and should be set with as much inclination as possible from the horizontal.

It is to be understood that judgment should tell what size leader to use when the roof area passes from one size or factor to another. For it is more economical to use, say, a four-inch leader for three thousand square feet of roof area; but, however, a five-inch leader would give a greater factor of safety in case of an unusual rainfall.

It is not considered good practice to use leaders less than three inches in diameter because of the danger of stoppage or freezing. Two-inch leaders, however, are often used for small porch roofs or the gutters on turret skylights. In corrugated leader, the corrugations are not figured but the smallest diameter of the pipe is called the size of the leader.

#### A Plain Leader Head

Where just utility and not appearance is requisite the leader head shown in Fig. 117 is ideal, inasmuch

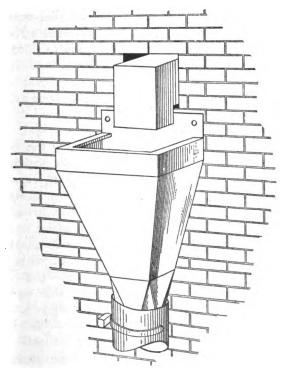


Fig. 117 .- View of Leader Head, Leader and Roof Outlet.

as there are no members forming ledges on which damp dirt would accumulate, which naturally would hasten the decay of the head. This is especially true of the tube connection and attention is

called to the manner of making this connection so that the flow of water is not retarded and all shelves in the leader are eliminated.

The pattern is obtained, as in Fig. 118, by drawing the side elevation, the front elevation and the

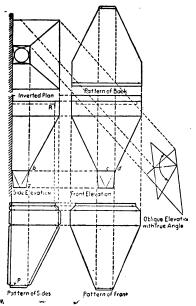


Fig. 118.—Developing the Pattern and Finding True Angle of Hips.

inverted plan, as shown. The patterns are developed by placing stretchout adjoining the various views and projecting the points in like position in various views to pattern, as shown.

The true angle along the hip, or miter, of the front with the side — the back and side naturally being a right angle — is found by projecting an oblique elevation.

Assume any two points on the side and front of head as indicated in the inverted plan. Project these to base line of oblique elevation. Project a line at right angle to hip line from the point in base line to touch the hip line and through the point in the base line, parallel to hip line, draw

Rather than cut this guard to allow the 1/8 x 1-inch galvanized band iron braces to pass through, the braces are bent as indicated, for at a test it was found that they had sufficient rigidity at the bend q to resist all strains. All braces are formed and punched exactly alike, and when handable lengths of the gutter are assembled in the shop these braces are riveted on, as shown, and by simply keeping the bend q against the gravel guard, when drawing the rivet through the gutter flange, the front of the gutter naturally will be straight, when bolt f is put in. The rivet is soldered to the underside of the gutter flange to make it watertight, although there would be little danger of a leak at this point for there would be plenty of tar around the brace. The gutter being so heavy the braces are for this reason spaced 2 ft. apart. Obviously by placing the braces in position before the lengths of gutter left the shop, the gutter is not forced out of shape in shipping, and they materially assist in handling and hoisting. The threads of the bolts, holding the braces, should be upset to prevent loosening of the nuts.

When the gravel roofer has run on all his felt the gutter lengths are set in place, the flange nailed every 3 inches with roofing nails and a heavy wood screw driven through the hole in the other end of the brace, as shown. All seams are now riveted where access would allow, and heavily soldered; likewise outlets are soldered in and connected to the leaders. The gravel roofer, prior to spreading his hot tar and pushing in the gravel, swabs a generous quantity of hot tar along the gutter flange and around the braces and before the tar is cool a heavy strip of felt is placed so as to cover the gutter flange down to the gravel guard and up to the roof a few inches. This felt strip also covers the braces. As this would be the weak point of the roof, especial care should be used to thoroughly tar in here.

# Developing the Square and Angle Miter Patterns for Plain Gutter

The methods used to make a square miter for a plain gutter are shown in Fig. 123. It is to be un-

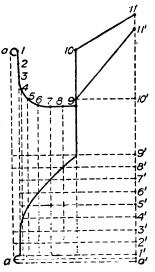


Fig. 123.—Square Miter for Plain Gutter.

derstood that although slightly different in design, the methods here explained can be used to cut the patterns for a gutter shown in the last problem. A profile is first laid out full size, as shown at a. I, 9, 10 and 11, Fig. 123. The angles 9, 10, 11, represent the angle made by the pitch of the roof, that is, if the roof pitch is 9 inches in 12 inches, then the rise from 10, 11 should be so laid out. a is the bead for which 11/2-

inch of stock is allowed when wired with a ½-inch rod. The front side of the gutter being

curved, is spaced into any number of equal spaces, as shown by 1, 2, 3, 4 to 9. Of course, 7 to 9 is really flat and number 8 could be omitted but number 8 is used here to better explain the procedure, in case it was round.

The line 9 to 10 is the back of the gutter and is straight. The line 10 to 11 is also straight and represents the roof angle. Draw vertical lines as shown from the numbered points, lay out the stretchout line as shown by a', 10', 11', in Fig. 123, making the spaces on the line marked 1', 2' to 10', 11' in each instance equal to the spaces 1, 2 and 10, 11 on the profile. Now, through these points, on the vertical stretchout line, draw horizontal line to intersect the vertical lines from the profile. Thus, horizontal line from say, 3' on stretchout line is to intersect vertical line dropped from point 3 on the profile, and so on.

Then a line drawn through the points of intersection will be the pattern. It will be noticed that at a the diameter of the rod is laid off, a representing a point in the center of the bead directly opposite I. In laying out the stretchout  $1\frac{1}{2}$  inches are allowed for the bead miter drawn as shown. Also notice that the points I to 3 are in a straight line, hence the points of intersection as, I, 2, 3, 1', 2', 3' are on the same line, making the straight section on the top of the front side of the gutter. The line 9 to 10 is also straight and is placed as shown in Fig. 123. The line 10 to 11 is the pitch of the roof, and a vertical line is drawn through these points as shown, intersecting the horizontal line 10', 11', which

represents the points 10 and 11 on the stretchout line. Then the line drawn from the intersection points 10, 10' and 11, 11', as shown, gives the proper bevel for the pattern. It probably would have been better to have the pattern placed much more below the profile so that the pattern would

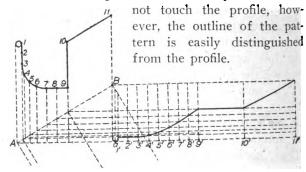


Fig. 124.—Angle Miter for a Plain Gutter.

The method used when the miter is to be other than a right angle is shown in Fig. 124. Let A B be the miter line on the angle required. Then place the stretchout as shown. Draw vertical lines from points in the profile to the angle line and draw the stretchout lines a 11' at right angles to the vertical lines on the profile, also vertical lines from points on the stretchout line from a to 11', placed at distances equal to the spaces in the profile, as shown. Draw horizontal lines from the several points of intersection on miter line as shown, then a line drawn through the intersection will be the pattern required. This method can also be used for a right angle by placing the miter line at an angle of 45 deg.

# Straight Eaves Trough Tube Pattern and Opening in Trough

With most mechanics the usual procedure would be to roll up and seam a straight tube small enough to slip easily into the leader. They would then lay a length of the trough upside down on the bench and, while holding the tube in position against the bottom of the trough with one hand, they would scribe around the tube with a compass. The compass would be held steadily against the trough bottom so that the correct varying line would be marked on the tube.

The tube would then be trimmed on this line with the tinner's snips. A quarter inch line would now be scribed along the irregular cut of the tube for a guide line in flanging. This flanging would be done by holding the tube to the mark against any sharp block of iron or bench stake. Then, with the peen of the hammer a flange would be thrown off the irregularly cut end of the tube.

The tube is again held to the bottom of the trough as before, only this time at the correct place on the trough. A line is then scribed around the inside of the tube onto the bottom of the trough. Now, while the helper holds a block of wood or a lead cake against the part of the trough to be cut out, the mechanic chisels along the scribed line. Or else, a small hole is first cut within the scribed line and the balance cut out with a tinner's circular snips. The tube would then be inserted in the hole in the trough and the flange heavily soldered.

A better way is to draw a section of trough and the tube, as in Fig. 125; also the half profile of the

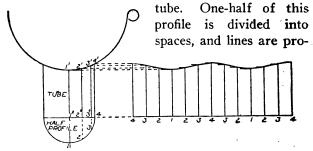


Fig. 125.-Pattern of Tube.

jected from the points I to 4 up to the trough. A horizontal stretchout line is now drawn and twelve spaces of the half profile placed thereon as 4 to 4. Vertical lines are erected from these points and are



Fig. 126.—Opening in Trough.

in turn intersected by lines projected across from the section of the trough, which completes the pattern for the tube.

To develop the opening in the trough, draw a line as 4'-4' in Fig.

126, and beginning at some point near the middle set off each way the spaces I'-4' in the half profile and through the points draw indefinite perpendiculars, on each of which set off, measuring from and on each side of 4'-4', the half distances through the tube at these points taken from the half profile. As from I' set off to I", in Fig. 125, and from 2' set off 2 to 2" and etc. Connecting the points thus located will produce the net pattern for the opening.

## Flaring Eaves Trough Tube

The problem, as presented in Fig. 127, which shows an end view of the trough with the flaring tube, is for a geometrical proposition of a frustum of a right cone, intersecting a cylinder their axes being at right angles. Draw the elevation and continue the outlines of the tube until they intersect the center line as at A. Bisect the line that represents the base of the cone or d'-d and with this point as center and radius to d describe a half profile of the base. Space half this semi-circle into a number of equal spaces and project the points, parallel with the center line, to the base of the cone, as a', b', and etc., and from the points on the base draw lines to apex A, and where these lines or elements cross the trough as q, f, e, d, will be miter points between the two pieces. The miter points are all, excepting d, located on fore-shortened lines or those that do not show their true lengths. To find the true lengths or distances the points are from the apex, the points are revolved around the cone by projecting them at right angles to the center line in elevation, to one of the outlines which is a true length. As g is projected to A-d and then A- $q^{\circ}$  is the true length of A-g; f is similarly projected and then A-f° will be the true length of A-f, and etc.

With A as center and radius to d, describe an indefinite arc on which place four times the lengths of the spaces in the quarter profile and from the points draw lines to the apex, and these lines will correspond to the elements of the cone, as shown. With A as center, radially transfer or radially project the points on the outline A-d to lines of corresponding letters. Connect the intersections and then will  $d-d^r-x-x'$  be the net pattern of the flaring tube. At the ends material is added for a groove seam and to x-x' material for a joint to

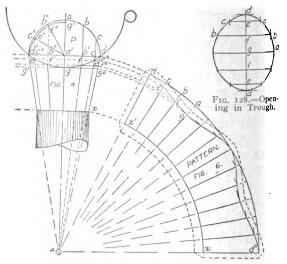


Fig. 127.—Pattern of Flaring Tube.

the leader. To d-d<sup>v</sup> an allowance is made for a flange to rivet the tube to the trough; all these allowances are shown by dotted lines in the pattern, which, of course, can vary according to conditions.

To develop the opening in the trough it is first necessary to find the half distance through the miter points on the intersection and a part plan of this intersection is requisite. To avoid confusion of lines the left half of P is used and corresponding points lettered the same. From a' draw lines to the points on the profile of the base as a'-a, a'-b'', a'-c' and, etc., and these lines will be the plans of the elements of corresponding lines in the elevation. By projecting the miter points, parallel with the center line, to their corresponding plan elements will locate the miter points in the plan. As f' is located on A-b°, it is projected to the corresponding line a-b'' and its location will be f'' in the plan and the distance b°-f'' will be the half distance through the cone, front to back through the point f' and etc. The distance through g will be g-g''.

In Fig. 128 draw a line and from some point near the middle begin to set off, each way, the spaces g-f, f-e, and e-d in Fig. 127. g to d being the amount in length on the trough that half the tube intersects, and through the points draw indefinite perpendiculars. Measuring on each side of and from the intersections on d-g-d transfer the half distances through the cone on similarly lettered points to perpendiculars of the same letters. As from e, set off e''- $c^{\circ}$ , from f set off f''- $b^{\circ}$  and etc. Connecting the points obtained in this manner will result in the net pattern for the opening in the trough for the tube.

The straight part of tube is just a rectangular piece, its width to be equal to the height required and its length or girth equal to the distance from X' to X of the pattern in Fig. 127. There would be no lap allowed where this straight tube joins the flaring tube as the pattern in Fig. 127 has the lap.

# Developing the Patterns and Making Right-Angle Eave Trough Miters

Eave troughs are usually made half round or semicircular with a bead on the front edge, there being two kinds of right angle miters. An outside miter to fit an exterior or external angle, as Fig. 129, and





Fig. 129.-Outside miter.

Fig. 130.-Inside Miter.

an inside miter to fit an interior or internal angle, as Fig. 130. Naturally, these remarks refer also to miters at other than a right angle.

When the pattern for either is developed the pattern for the other naturally results from the same process, being simply the reverse cut or the piece cut away from the one.

The method here used is the short method in which the patterns are said to be produced directly from the profile. Technically, this statement is not correct, but as error cannot occur it probably is just as well to continue describing the method or process in that manner. By this it is meant that according to the strict geometrical method, the lines from the profile should be first dropped to a miter line, thence to the pattern stretchout; instead of directly to the pattern from the profile.

As in Fig. 131, draw the profile so that the top edge will be horizontal or level and the back at 19 be as high as the head at 8. If there is enough mate-

rial it will make a better trough if the back is as high as c. To strengthen the edge an angle is sometimes turned as at b. The circular part of the trough

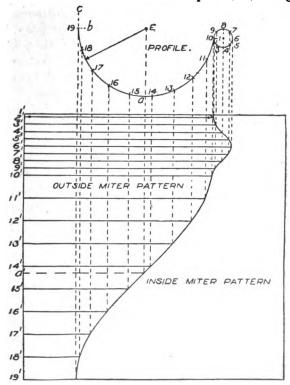


Fig. 131.-The Pattern Developing Process.

will intersect the bead at the point 10, and from 10 the profile of the trough is spaced into a number of equal spaces. Also space the bead into equal spaces in which 2 will be opposite or touch 10.

At right angles to the top of the profile draw a line as 1'-19' and transfer to this line all the spaces in the profile, including a division between 14 and 15, as a, which has been projected from E to locate the bottom center and will be the point on the pattern edge where a convex curve will join a concave curve. From all the points on 1'-19' draw parallel lines that are at right angles to I'-19' and





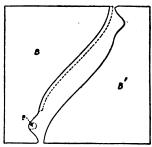


Fig. 133.—Nesting Inside Miter Patterns.

are parallel to the top of the trough. Project at right angles and to these parallel lines the points in the profile having the same numbers. As to line 2' project point 2, to line 3' point 3, to line 12' point 12, etc. Connecting these intersections will produce the net patterns as shown by the inside and outside miter patterns.

There are several ways to put the parts together, one of which is to cut both parts on the net lines as A, Fig. 132, and B', Fig. 133, butt them together and solder a seam strip or butt strap over the joint. Another way is to leave a lap on one piece as in A' and B in which the bead is cut on the net edge and butted, sometimes leaving a lip as d and e to bend onto the adjoining bead and then be soldered. The lap allowed must be turned, half in and half out, to fit the adjoining piece.

A third way to join the pieces is by a double seam, and when this is done the amount of lap or seam allowance on one piece is twice that on the other piece, and the two parts are put together in a manner similar to an elbow, but with the seam flattened. The laps or edges must in this case be turned full or the beads will gap and not come together.

To save material outside miters are cut from sheets as at A and A' and inside miters as at B and B', and are formed right and left if formed before beading, or beaded right and left if beaded before forming.

The material for trough miters should always be trimmed so that opposite edges are parallel, and after beading and forming, temporary braces should be soldered in them so they will retain their shapes free from twists, and the edges 8 and 19 must be parallel and in line with each other when viewed along the arrow pointer N, Fig. 129. The pieces are to be formed to profile as nearly as possible, for a trough miter should be true to shape, and if not true it will result in high, low and twisted joints or joints with the front or back, that are high or low where it joins the main trough in spite of all a workman can do to prevent such conditions when out on a job.

It may be well to state that should a roof flange be required, as in Fig. 124, the procedure would not vary in the least from the foregoing.

#### CHAPTER VII

#### Cornice Problems

# Describing an Ogee and Cove Molding

It is not intended to include expositions on architectural subjects in this treatise, nevertheless the sheet metal worker is called upon to do quite some designing and drafting when engaged in making sheet metal work for the ornamentation of building, and he should, therefore, read good books on architecture. One of the subjects of importance is the designing of moldings and, as with all things, authorities differ as to what is correct; however a good book giving the various designs should be at hand.

The system best suited for sheet metal working is that in which all rounds and the like are composed of parts of circles which allows greater ease and accuracy in bending on the usual machines. Now, the ogee and cove are the most common members and indeed the basis of the other types; so in Fig. 134 is detailed one method of drafting a molding composed of such members as well as straight members like fillets and fascias. Just what proportions to give these members depends a good deal on what authority is consulted or other factors.

The first thing to do is to draw a vertical line, generally called the wall line, as A B, and place thereon the vertical dimensions of the members. Draw horizontal lines through these points and, measuring

from A B on the topmost line, place thereon the desired projection of the molding, as C. Draw line C D and continue downward dotted to E. Draw diagonal line E F at 45 deg. Line F G is now drawn and diagonal line G D. Draw horizontal line H I

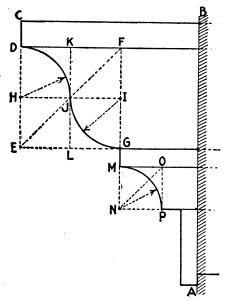


Fig. 134.—An Ogee and Cove Molding.

and vertical line K L. Using H as center, describe quarter-circle D J; using I as center, describe quarter-circle J G, completing the ogee member.

Continue line from G to M and dotted to N. Draw 45 deg. diagonal NO. Draw OP, and now using N as center, describe quarter-round MP. Finish the other members as shown.

#### A Square Miter

One of the most important miters in cornice work is the square return miter, and Figs. 135A and 135B show how that kind of a miter may be laid out. Of course, line A B of Fig. 135A could be extended downward and the pattern stretchout, A B of Fig.

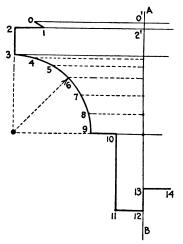


Fig. 135A.-Profile of the Problem.

135B, placed thereon and the points in the profile prodownward iected about is as plained in the gutter problems of the preceding chapter. The method here expounded is very useful, as the chances are about ways even that this scheme must be employed to the other; especially as many me-

chanics first draw the profile on paper and then develop the pattern directly on the sheet metal with a steel square and scratch awl.

Another good reason for using this system of carrying the distances rather than projecting them to the parallel lines of the stretchout is, in cornice work often the detail is exceedingly large and composed of many profiles and members, and by this system each profile and member could be developed separately and where convenient.

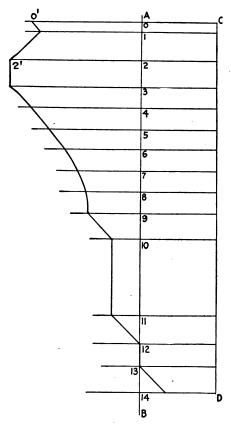


Fig. 1358.-The Pattern of the Profile.

As the system applies, no matter how elaborate the design of the profile may be, a simple contour

was adopted to better explain the procedure. Draw line A B in Fig. 135A and place thereon the heights of the members and complete the profile as directed by the diagram. Divide the quarter round or cove into equal spaces and number all points as shown in Fig. 135A.

Now, in Fig. 135B, draw the vertical line A B and place thereon the stretchout, from 0 to 14 of the profile in Fig. 135A. Draw horizontal lines through these points indefinitely, always measuring from line A B, in Fig. 135A, to numbered points, carry the various horizontal distances to like horizontal lines in Fig. 135B. For instance—0 0' of Fig. 135A is 0 0' of Fig. 135B, and 2 2' of Fig. 135A is 2 2' of Fig. 135B. Note, however, that point 14 is on the other side of line A B in both Fig. 135A and Fig. 135B.

Having obtained these points in this manner, a line is traced through them which is the outline of the miter cut. The length of pattern can be as desired, as shown by line CD of Fig. 135B. Note also how small circles are placed on those horizontal lines which are bending lines, so that there is some sort of a guide to indicate these lines when dotting out on the metal; and, naturally, it is to be understood that if so desired the process of Fig. 135B can be done direct on the sheet metal after Fig. 135B was drawn precisely as explained, and where convenient, as aforementioned.

As explained in connection with the eaves trough problem, an inside miter would be the reverse cut to the right of Fig. 135B.

# A Butt Miter Against a Curved Surface.

The problem discussed here, Fig. 136, is exactly like the angle-face miter following. It is intended that this problem will show that the plane or miter line against which the parallel measuring lines of

miter, problems butt, need not be a straight line or surface, but can be a curve or, indeed, another molding. This problem is also intended to show the measuring lines projected direct to the parallel lines of the stretchout, as discussed in the preceding problem.

The curved surface is described with A as center. Note, also, that members in the pattern, as, I to 2, 6 to 7 and 8 to 9, have curved outlines at the butt miter of equal radius to the curved

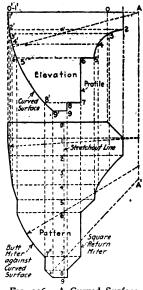


Fig. 136.—A Curved Surface Miter.

surface and the center for the radius of each is found, for instance, by using 7" as center and striking an arc on line dropped from A, giving center A'.

#### Miter at an Angle in Plan

Next in importance to the square return miter is that of a miter at an angle in plan, other than a right angle or square return. The principles explained in connection with this problem and delineated in Fig. 137 and Fig. 138 not only apply to a case like this, but also to many other situations.

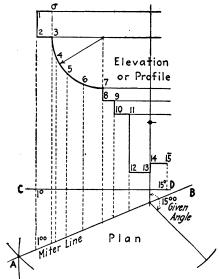


Fig. 137.—Elevation of Molding and Miter Line.

For instance, a butt miter at an angle in plan; as, if this profile was the horizontal molding of a bay window butting against a wall, the miter line A B, in Fig. 137, would represent the wall line. And again, in butt miter cases, miter line A B might be curved just the reverse of the preceding problem,

or another molding, or many other diverse objects.

As for the square return miter, the pattern of Fig. 138 could be developed by projecting lines from the miter line direct to the stretchout line, as was done

in one of the preceding problems. However, it was the intention of the original author to explain a common shop practice of carrying distances, as he explains in the elbow problems.

Therefore, draw the required profile, as in Fig. 137, and also the given angle, which in the diagram is an octagon angle, as shown. Bisect this angle and obtain the miter line A B. Divide the round of the profile into equal spaces and number the entire profile and drop lines to miter line. Establish any horizontal line as C D.

Now, as in Fig. 138, draw a vertical line EF with the stretchout on it of the profile, then measuring always from this line CD, in Fig. 138, carry the distances from the plan in Fig.

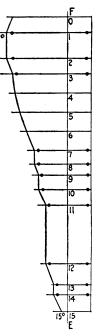


Fig. 138.—The Net Pattern.

137 to like numbered lines of Fig. 138. To explain: 1° 1°° of Fig. 137 is 11° in Fig. 138; also, 15° 15°° in Fig. 137 is 15 15° of Fig. 138 and so on. The small circles on certain lines indicate where square or angle bends are to be made.

#### A Square Face Miter

In Fig. 139 is given a profile often employed in panel work, and if the pattern for the face miter was to be developed by projecting lines from the profile to the parallel lines of the stretchout line, the

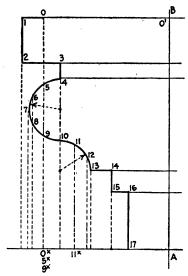


Fig. 139.—The Profile and Lengths.

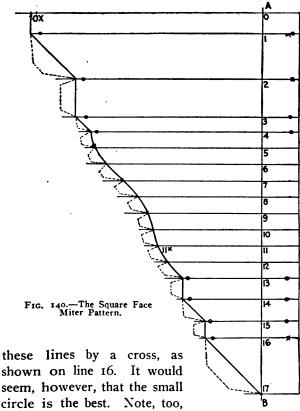
stretchout line would then be drawn at right angles to line AB of Fig. 139 and the projecting lines would be a continuance of those lines like 00'.

That is to say, the parallel lines through the stretchout line points would be parallel to the dotted lines in Fig. 139. So, then, to carry the distances, simply take the lengths of

these dotted lines. In Fig. 140, line AB is the stretchout line, with the parallel lines at right angles to it and through the stretchout points, as shown by 0 to 17 Fig. 140.

Carry the lengths from like numbered lines in Fig. 139 to Fig. 140; thus, 0 0° Fig. 139 is 0 0° Fig. 140, 11 11° Fig. 139 is 11 11° Fig. 140, etc.

Note the small circles to indicate the bending lines, and it might be said that some cutters indicate



shown on line 16. It would seem, however, that the small circle is the best. Note, too, how laps would be provided, as shown by the dotted lines. Laps cut so will not interfere with the bending or soldering operations, but give the best assistance.

### Angle-Face Miter

The cutting of pattern, or rather the developing of the surfaces of solids, is merely the manipulating of certain geometrical principles and the application of the science of orthographic projection to accomplish desired results. In the preceding problem advantage was taken of a situation, so to speak, in

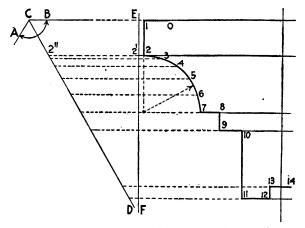


Fig. 141.—Profile and Miter Line of an Angle-Face Miter.

projection, which allows of using shorter methods to arrive at desired results. Now, strictly speaking, and as mentioned elsewhere in this book in connection with such problems, that method is not absolutely in accord with true projection, which might also be said of the square return miter, although a strictly correct pattern is obtained in both cases by this procedure.

The correct method is to use a miter line, and in

face miter problems the line is situated as shown in Fig. 141. In that diagram A B is the given angle, which is bisected to get the miter line C D. The given profile is shown at the right of this line with

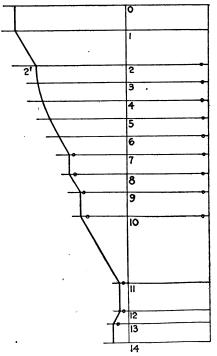


Fig. 142.—Pattern of Angle-Face Miter.

its division points I to I4, which are projected across horizontally to the miter line. The angle A C B is bisected according to the method given in Fig. 6, in the chapter on geometry.

Assume any measuring line which would be vertical and established, as indicated by line E.F. For the pattern draw where convenient a vertical line on which is placed the stretchout of the profile I to 14, in Fig. 141, as shown by line with 0 to 14 division points, in Fig. 142. Draw indefinite horizontal lines, and, measuring from line E.F. to miter line C.D. of Fig. 141, carry the distances to Fig. 142, measuring from the vertical stretchout line. Like this, point 2 in Fig. 141 is measured from 2' to 2" and placed from 2 to 2' in Fig. 142, and so forth.

It is to be understood that this problem is the basis of numerous other miter cuts—the apex of a gable molding, the bottom cut of a gable molding finishing on a horizontal line, the cut of a horizontal dormer window molding against a pitch roof and many other like miters.

There are three distinct methods of cutting patterns, or rather, developing the surfaces of solids, to wit: Parallel line system, radial line system and triangulating system. The few foregoing problems were in the category of parallel line problems or miter cutting. Now, the parallel line system can be divided into several divisions. One division in which these problems enter, a simple elevation or plan of the joint gave the miter line and its relation to the profile—if no miter was used a series of measuring lines would be employed.

A considerable number of problems would be comprehended in another division in which quite some preliminary work is requisite before cutting the pattern and a few are to follow.

### Raking Miter

One of the best courses in sheet metal pattern drafting is that of Gray's School of Correspondence, and among the one hundred and twenty-five or more plates are several teaching the cutting of different cases of raking miters, one of which is that of Fig. 143A. This is a typical case of such miters and applies when the normal profile is placed in the inclined molding, thus raking or changing, or as some call it, modifying the profile of the horizontal molding.

Quite a number of problems are in the class of raking miters; however, the underlying principles are practically the same in all raking problems. That is, conditions perforce certain requirements as, say, the inclination of the gable and whether the given or normal profile is to be in the gable or horizontal molding, and so forth. Or again, the horizontal molding can miter at other than a right angle, or there is to be a raked return at the apex of the gable and so on.

First draw profile and elevation of foot mold and erect center line. Next draw line C, the angle required intersecting 8 in modified profile, and continue line to center line. Place normal profile A on line C so that point 8 intersects line C. Space profile A into any convenient number of equal spaces, as shown by I to 16; place T square parallel with line C; draw lines through all spaces intersecting center line and foot mold, drawing lines from 8 to 16 indefinitely for modified profile. Next draw plan,

placing normal profile A on line D, as shown; draw miter line in plan the angle required, draw lines

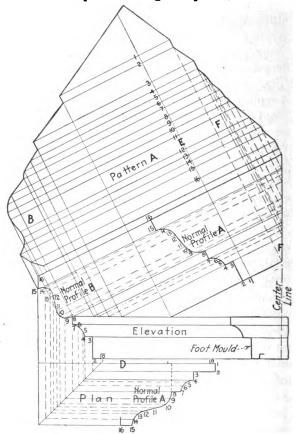


Fig. 143A.—Developing the Pattern for a Raking Miter.

from spacings in profile 8 to 16 intersecting miter line; place T square at right angles to line D; draw

lines from intersections in miter line of plan, also intersecting lines of corresponding numbers drawn from normal profile A in elevation. Drawing lines through the intersecting points will give modified profile B. Draw stretchout line E and place spacings on same I to 16 from normal profile A. Draw lines through all spacings in stretchout line at right

angles to line E indefinitely. Place T square parallel with line E; draw lines from all points in modified profile intersecting lines of corresponding numbers in stretchout B, also draw lines from all points in miter line F to lines of corresponding numbers in stretchout. Drawing

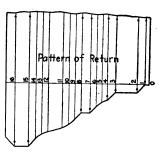


Fig. 143B.—Developing the Horizontal Molding Pattern.

lines through the intersecting points will give the patterns B and F, as shown in pattern A, just above the elevation, Fig. 143A.

To develop the pattern of the horizontal molding, draw a horizontal line, as in Fig. 143B, and place thereon spacings of modified profile B, as 0 to 16. Draw the vertical lines shown and then taking the various distances from the line D to the miter line in the plan of Fig. 143A, place them on the stretchout line of Fig. 143B.

From 0 to 8 of Fig. 143B is the foot mold pattern; shown from number 0 to the dotted line in the plan, Fig. 143A.

#### Gable Molding on Square Tower

As was stated in the foregoing article, Gray's School of Sheet Metal Pattern Drafting teaches by numerous specimen plates of the highest possible order that it is possible to make, and in Fig. 144, herewith, is presented the school's lesson on an interesting problem in gable molding cases. Note that the miter at the apex, or rather ridge, bears out the statement made in connection with the problem in angle face miters that face miter cutting, as explained in that problem, would apply to the miter in this case at the ridge.

First draw elevation the pitch required, placing profile A on line C, as shown; space the curved parts of profile A in any convenient number of equal parts and draw lines through all points parallel with line C intersecting miter line E, and extend them indefinitely at D. Next draw profile B, as shown, spacing the curved part of file the same as profile A. Extend lines from all points in profile B intersecting lines of same numbers just drawn from profile A. Drawing lines through intersecting points will give miter line D. Draw stretchout line for pattern at right angles to line C and place spacings on same from profile A. Draw parallel lines indefinitely through all points in stretchout. Place T square at right angles to line C; draw lines from all points in miter lines E and D intersecting lines of corresponding numbers in stretchout. Drawing lines through the intersecting points will give pattern required.

The foregoing explanation had to do with the molding only for this problem. Should a pattern be wanted for the lower or tower proper, the pat-

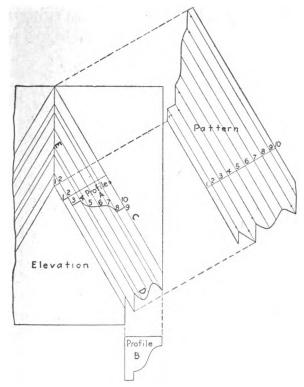


Fig. 144.—Developing the Pattern for a Gable Molding on a Square Tower.

tern would be a duplication of the part of Fig. 144 marked elevation. The triangular roof part can be added to the pattern on line 9.

### Hip Finials

Only such drawings are used as will make clear the method of obtaining the patterns. Even though the design is simple, the patterns should be laid out with great care so that the finial will be true and firm when assembled.

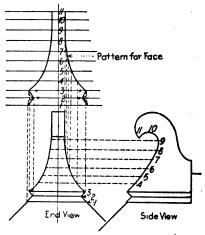


Fig. 145 .- Obtaining Face Pattern.

The end and side views of the finial are shown in Fig. 145, also the pattern of the face. As will be noted, the side elevation is stepped off as indicated by the points from 4 to 11. Lines are projected from these points to the front elevation, as shown, then the lines are run up or down as the case may be to the stretchout, as shown from point 9. From point 9 up, the side of the finial is straight. The reason for stepping off the side is to get a true

elevation of the face. The lines are then projected to the end view, which shows the miter lines at the corners of the end elevation.

The pattern for the side is developed, as shown in Fig. 146, in which the treatment is reversed from the foregoing. The points are stepped off on the end elevation.

e n d elevation. Then lines are projected to the side elevation and thence to the stretchout shown above the side view.

The pattern for the rear of the finial is as shown in Fig. 147. The pattern is shown with laps on the top and bottom. The top strip is developed as

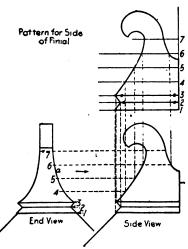


Fig. 146.—Obtaining Side Pattern.

shown at A2 in Fig. 147, and to get the point the side elevation is stepped off, as shown from 1 to 9, then projected over to the end elevation and from there to the stretchout. Only 1, 2 and 3 need be projected to the face as that is the length of the flare. The rest is straight and can be struck off with a pencil and straight edge.

To form up this finial the side pieces can be nicely shaped by running through rolls set lightly.

After the parts are all set together and are tacked with solder and the finial is found to be true, it can be more securely soldered and, if of large size, the finial should be riveted together and bosses the full length of the inside of the corners should be soldered in. These bosses not only strengthen the

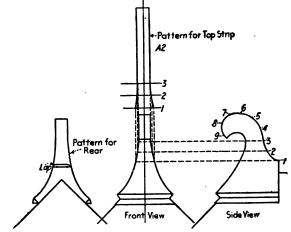


Fig. 147.—Obtaining Rear at Top Strip Pattern.

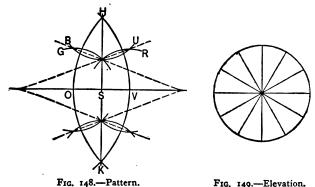
finial, but if the corner should ever spring a leak, they would throw the water off on the roof. For small finials under 18 inch in height, this bracing and bossing is not necessary; but for larger sizes they should be even more heavily braced, as more surface is exposed to the wind and storm.

Finials are useful for ornamenting ridges, towers or other such parts of buildings and any number of designs can be thought of like crosses or other insignias for religious buildings, weather vanes, etc.

#### The Gore Pattern for Balls

The method given in Fig. 148 is the old-time tinsmith's procedure. Another method would be by the parallel system of projecting lines from a gore.

Erect perpendicular line H K equal to one-half the circumference of the ball; divide this line into one-half the number of pieces required in full ball;



make the line V O equal to one of these pieces, cutting H K through the center at right angles; then with H and K as centers, with radius greater than one-half the distance K S, describe the two arcs B U; with V and O as centers, arcs R G; draw lines through these points, as shown by dotted lines. From points of intersection describe arcs H V K and H O K, and so obtain pattern for one piece. Allow for laps or seams. The more pieces used the better globe produced. Good results are obtained by slightly raising the pieces. Fig. 148 is the pattern and Fig. 149 shows the gores.

#### CHAPTER VIII

# Skylights

# Single Pitch Skylight

A number of very interesting and practical problems on skylight work are given in the correspondence course offered by Gray's School of Sheet Metal Pattern Drafting, and they have been good enough to grant permission to reproduce two or three of these in the following pages. Those who wish to get a more extended exposition of skylight pattern problems than is given in this little treatise will do well to look into Gray's School, and Volume VIII of the series entitled "Practical Sheet Metal Work and Demonstrated Patterns."

From the time saving standpoint, every one interested in skylight work should have the Full Sized Sheet Metal Patterns prepared by G. L. Gray, as they cover hip, gable and single pitch skylights with various stretchouts of profile, so that they may be made up in any size. Turrets, Louvres and Ventilator patterns are also included. The patterns are all full size and all the sheet metal worker has to do is lay them on the metal, make the proper allowance for distances between his measuring points, prick off the pattern with his awl, and cut out the patterns.

Another timesaver is Smith's Skylight and Roof Tables. This gives the lengths of hip and jack bars at any of the standard pitches for any size skylight. All you have to do is, turn to the table containing the curb dimensions and you will get the length of either the common, jack or hip bar at a glance.

Fig. 150 is a view of a single pitch skylight. In these problems the important part of the work is to make the sections and profiles properly and then

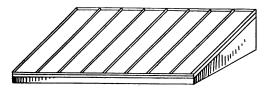


Fig. 150.—Perspective of a Flat or Single Pitch Skylight,

to make a plan showing the correct miter lines, as in Fig. 151. Although single pitch, or rather, flat skylights, involve the elementary constructive characteristics of the entire category of skylights, they are nevertheless the fundamentals in the matter of constructive features, and much time and thought have been expended in experiments to simplify the design and learn a mode of expeditious handling.

The cardinal principles to remember when designing any type of skylight are: To design it of ample strength to resist imposed stresses or loads; sections or profiles of curbs, bars and the like must be as simple as consistent with required strength to allow of rapid forming into shape on the brake and the girth to be such that they will cut out of sheets without waste.

There are several kinds of flat skylights, and the one presented herewith is the most common style, that which is set on a raised curb of sufficient height above the roof to insure imperviousness to storms; the necessary pitch being in the roof proper. The dimensions and shapes of this design are ample for skylights of say eight feet in width, and it is to be

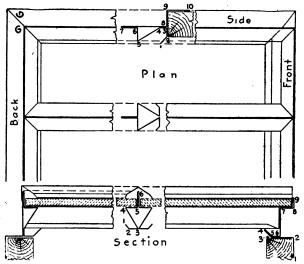


Fig. 151.—Design of a Flat or Single Pitch Skylight.

understood that any length of the skylight is possible for the construction of the roof proper governs this factor, for with proper anchoring of the bottom curb of skylight to the roof curb the length is unlimited. The drainage of the roof back of the skylight, however, must be considered, for with ordinary widths a roof saddle would shed the water to either side of the skylight, whereas with a very long skylight it is best to employ the built-in type, so that the water would flow directly over it. As for the width, naturally, by reinforcing the bar with

a core plate, as shown in the large section of a bar, a long bar can be used so that the skylight width could be increased up to at least three-fold possible with the plain bar. A diagram, or section of

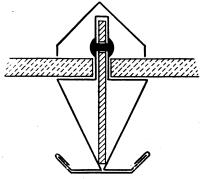


Fig. 152.—Reinforced Bar for Excessive Lengths.

such bars is given in Fig. 152. Note the core plate of band iron, which should be thick enough to withstand imposed stresses.

Once it has been definitely decided how to design the constructive features of a skylight, to suit the peculiar conditions of the place where the skylight is to be installed, the pattern cutting can follow prescribed courses, for that is the least of the difficulties.

Now, for the skylight shown in Fig. 151, let it be supposed that the sections as shown are as wanted. Then, the first pattern to be developed would be for the front, as given in Fig. 153. The stretchout of the front section is placed on a line as shown from 1 to 9, the usual parallel lines drawn

through these and the miter cut, as shown at the left of the pattern, can be developed either by pro-

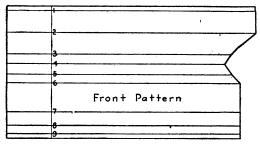


Fig. 153.-One of the Patterns.

jecting lines direct to the pattern from the plan of the miter cut, as directed by like preceding problems, or distances could be carried from the miter plan of Fig. 151 to Fig. 153 as directed in the elbow

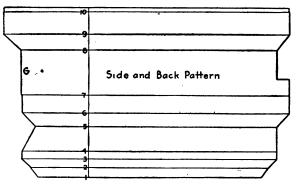


Fig. 154.-Pattern for Two Parts.

or cornice problems. Note that the cut would be the same at each bottom corner of the skylight, so that the miter cut will be the same at each end of the pattern.

For the pattern of the side and back—both have the same profile or section—the stretchout is placed on a line, as in Fig. 154, and the process repeated as directed for the front pattern. If the reader wishes to check up the development he can set his dividers to the length of each of the lines in Fig.

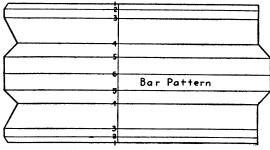


Fig. 155.-The Last Pattern,

154 and try the dividers on like lines in the plan, Fig. 151, making allowances, of course, for discrepancies due to the small size of the diagrams. Observe that there are two different cuts on this pattern, because the miter at the bottom is to fit to the miter of the front, while the other miter is to fit, at G Fig. 151, to the back. This means that when cutting out the back pattern, miter cut G Fig. 154, is to be placed at both ends of the pattern. Two sides like Fig. 154 are required for each skylight and are to be bent right and left.

The pattern for the bar is developed likewise and would appear as shown in Fig. 155. The cap pat-

tern, too, not given herewith, is developed in the same manner. Laps are to be provided on all patterns as experience may dictate and by adding a triangle piece to the pattern at line 8, Fig. 154, from a flat to a single pitch skylight is obtained.

### Gable Skylight.

A perspective view of the gable skylight, or as it is often called, a double pitch skylight, is presented as Fig. 156. The same remarks in the introduction to the skylight chapter anent constructions and so forth, are just as pertinent to this type as they are to the single pitch type.

The design and patterns for a gable skylight, Fig. 156, given in Fig. 157, are of an ideal construc-

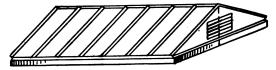


Fig. 156.-Perspective of a Gable Skylight.

tion, and it may be said that a single pitch skylight can be made from these patterns by simply forming just a half ridge bar and carrying a straight back down from the ridge and forming a curb of like contour to the others.

When ventilation is required it is customary to place a louvre frame in the sides, or gable ends, as shown in the sketch, or else an elbow can be turned out of each end and a ventilator top placed thereon. As may be seen, the gable end can be made in one

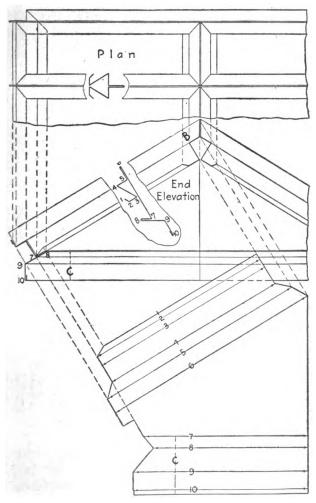


Fig. 157.—Details and Pattern of a Gable Skylight.

piece, but it is best to make them in two pieces, as then they can be cut out and formed-up on the

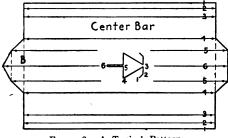
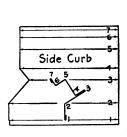
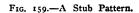


Fig. 158.-A Typical Pattern.

brake much more easily, also they cut out of the sheet with less waste.

The end elevation in Fig. 157 shows the section of a gable; the ridge bar, B, and the bottom curb.





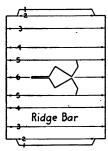


Fig. 160.—Another Stub Pattern.

Fig. 157 also shows a plan of the skylight to portray the various joints. A pattern of one-half the gable end is also given in this diagram and the method of obtaining this pattern should be apparent. Note particularly that part C is not developed by projecting lines but by carrying distances, measuring from line C in both elevation and pattern.

The center bar pattern is given in Fig. 158 and obtained in the usual manner; cut B being for the ridge end at B of Fig. 157. The curb pattern is given in Fig. 159 and the ridge bar in Fig. 160. The profiles are shown on each pattern, which is a good idea, as it instantly identifies the patterns. Laps should be allowed as required, as patterns are net.

# Jack and Rafter Bar for a Hipped Skylight

Hipped skylights are one of the most important types made and a perspective view of such is given in Fig. 161. As a rule this type is set on a level roof curb for the four glazed sides provide the necessary inclination to shed snow and rain. Hip

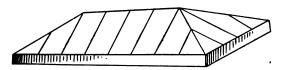


Fig. 161.—Perspective of a Hipped Skylight.

skylights are quite popular and many mechanics claim that they can be much more easily made than a gable skylight and are stronger.

As was stated before, the design is the essential requisite and in Fig. 162 is given a plan of a corner of a hipped skylight, showing the many joints in this type. A part elevation, or section, is also shown in this diagram. Note that the ridge bar can be changed to a ventilator neck, if that is

wanted; or, better still, for ventilation a ventilator can be placed directly over ridge bar.

Draw elevation of jack bar at 1-3 pitch, which is 71/4 inches in 12 inches; draw profile of the bar in

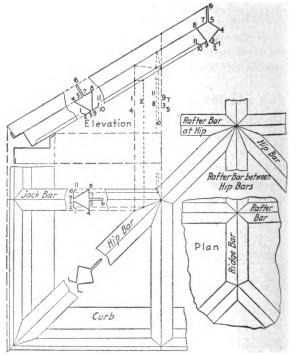


Fig. 162.—Preliminary Steps for Obtaining Patterns.

elevation and draw lines through all points in this profile indefinitely as shown in Fig. 162. Place T square at right angles to jack bar in plan, draw lines from all points in miter lines of hip inter-

secting lines of corresponding numbers in elevation. Drawing lines through the intersecting points will

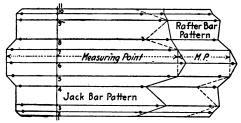
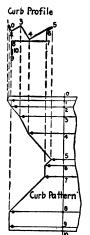


Fig. 163.—Composite Pattern.

give the miter lines in elevation. Draw stretchout lines for jack bar parallel with jack bar in elevation.

Place T square at right angles to stretchout lines, draw lines from all points in miter lines of elevation intersecting lines of corresponding numbers in stretchout. Drawing lines through the intersecting points will give the pattern for jack bar. Or, as in Fig. 163, carry distances as explained before.

To make the pattern for jack bar it is not necessary to draw all the bars, as shown in plan. They are shown here more to clearly delineate how the many different bars should have their miters de- Fig. 164.—Developing Curb Pattern. veloped. The dotted lines in the



jack bar pattern give the pattern for rafter bar between hip bars. The rafter bar pattern is developed on the same stretchout as jack bar. The dotted lines in the rafter bar pattern give the pattern for rafter bar against hip.

The developing of the curb pattern is as directed by Fig. 164. Owing to lack of space on these pages, the curb profile was transferred to avoid confusion. Divide and number the profile, as shown. Draw line with this stretchout and drop lines from points in the profile to like numbered lines of stretchout.

The measuring points should always be marked on the patterns to prevent error. It would also be a good idea to place a diagram of the profile on each pattern as was done in the patterns for the gable skylight. Laps should be allowed as required, for all these patterns are net.

# Hip Bar for Hipped Skylight

In the article preceding this the developing of the curb, jack and rafter bar patterns, for a hipped skylight was explained. Now, there is another bar to have its pattern developed which is the important part of this type skylight and that is the hip bar.

To make the pattern for a hip bar: First draw the transverse section, which is a section showing half the width of skylight. Drop lines from curb and ridge bar, as shown in Fig. 165, which forms the plan of skylight. Draw plan of hip bar and place profile of bar A on hip bar as shown, draw lines from all points in profile A intersecting lines of corresponding numbers in curb and miter lines at ridge bar. Next draw elevation of hip bar at a convenient distance from hip bar in plan, first draw

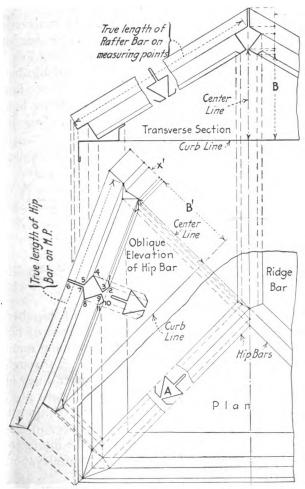


Fig. 165.—Developing Correct View of Hip Bar.

curb line parallel with hip bar of plan and erect center line the same length as center line in transverse section. Next draw line B in transverse section and from points I to 6 draw lines intersecting line B at right angles, erect line B' in elevation of hip bar, and space it the same as line B in transverse section; place T square at right angles to line B', draw lines from points I to 6 indefinitely. Place T square

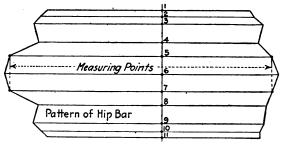


Fig. 166.-Developing the Hip Bar Pattern.

parallel with center line in elevation of hip bar, draw lines from points I to II in miter lines of hip bar in plan intersecting lines of corresponding numbers just drawn from line B', draw lines through the intersecting points will give the miter lines in elevation of hip bar, with the T square in same position draw lines from all points at bottom of hip bar intersecting lines of corresponding numbers in elevation of hip bar, draw lines through the intersecting points gives the miter line at bottom of elevation of hip bar.

Draw profile A as shown in elevation of hip bar, erect lines from all points in profile A intersecting

lines of corresponding numbers in elevation of hip bar; drawing lines through the intersecting points will give the profile of hip bar.

Draw stretchout line for pattern and place spacings on same I to II from profile of hip bar, draw lines from all points in stretchout line indefinitely, place T square parallel with stretchout line, draw lines from all points in miter lines of elevation of hip bar intersecting lines of corresponding numbers in stretchout, drawing lines through the intersecting points will give the pattern for the hip bar.

As was explained before, another way would be to draw a line and place thereon the stretchout of the hip bar as in Fig. 166. Through these points indefinite lines are drawn. Then, carrying the lengths from Fig. 165, to like numbered lines in Fig. 166, the two miter cuts are obtained. Measuring points should be marked on this pattern, also laps provided as wanted. And, too, if desired, the profile should be marked thereon. The ridge bar pattern is the same as shown in Fig. 160.

## Finding Lengths of Bars

The first thing a cutter should do when he gets measurements for a skylight is to make a working plan, scaled I inch to the foot, marking the size of skylight; also lay out the bars to suit the glass which is to be used; then put down the measurements that all bars are to be cut. In this way the cutter has all measurements and is ready to go ahead and cut the skylight.

A typical layout like this is shown in Fig. 167,

which is for a four by five feet skylight. The lengths of these bars are found by a diagram of pitch or tables of lengths computed mathematically.

As was stated in the introduction to this chapter, there are books to give the lengths of skylight bars at a glance. It might be said that Gray's full-size working patterns have a chart accompanying them

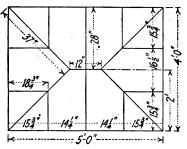


Fig. 167.—Layout of a Typical Size Hipped Skylight.

that gives the measurements for hip, jack and rafter bars, for any size skylight up to thirty feet wide for the pitch used for these patterns.

For those who do not wish to make a chart as

suggested before, it can be mentioned that certain mathematical processes could be employed to determine lengths of bars. Without going into a lengthy explanation of these processes it will suffice to say that two factors are established, viz.: 1.158 inches for jack and rafter bars and 1.117 inches for hip bars, for a pitch used for the patterns given in this book. These computations will give very nearly the same results as developing triangles on a scale drawing, as was done for Fig. 164 as referring to charts.

To illustrate: In Fig. 164 one-half the width of the skylight from the length gives 12 inches, which

will be the length of the ridge bar. Now, one-half the width of the skylight is 24 inches and  $24 \times 1.178$  gives  $28.272 = 28\frac{1}{4}$  inches. The jack bar is spaced  $15\frac{3}{4}$  inches, so  $15\frac{3}{4} \times 1.178 = 18.553 = 18\frac{1}{2}$  inches. The hip bar length is found by the second factor, so one-half the width is 24 inches and  $24 \times 1.546 = 37.104 = 37^{1}/_{16}$ .

It will be observed that these bar lengths are a little bit full in comparison to those given in Fig. 164. This, however, is not of much consequence, inasmuch as so slight a difference would make no discernible variation in the pitch of the skylight. It would be serious, though, if the proportion of dimensions between jack or rafter bars and the hip bar was right, for then either the jack or rafter bars would not fit to the hip or else the hip would not suit the lengths of the jack or rafter bars, depending whether the hip bars were first set in or the rafter bars first when assembling. Now, as scaling from a diagram or calculating with factors takes as much labor it would seem best to use the factors.



#### CHAPTER IX

# Seams, Joints and Processes

# Provisions for Laps and Seams on Patterns

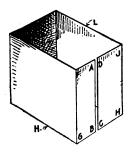
Very few writers of sheet metal subjects consider the importance of seams, joints, laps and similar essentials when demonstrating the development of sheet metal patterns. As a rule, they treat the problem in a geometrical sense, the object (for which the pattern is to be cut) being an imaginary body in space, so to speak. The final results or rather the desired pattern is then net, which is to say, just the envelope or outer imaginary surface of the solid or body. The providing of laps and one thing or another is then dismissed with the remark to provide laps and edges for seams and so forth.

Special attention has been paid to this important phase of the subject in this volume. While it no doubt suffices to simply present an elucidation of the procedure to develop the net pattern, modern writers are beginning to realize the need of treating these expositions along more practical lines. That is to say, they bear in mind that the actual use for which the problem in hand is intended must be considered and spoken of, along with the geometrical demonstration of the problem. Take, for instance, the problem illustrated in Fig. 63; it not only shows how to cut the pattern but also gives as much information as possible about the laying

out of the holes for the band iron supports, the providing of all edges, and even shows the swaging necessary to stiffen the object. This is just one example of the large number given herein.

#### Facts about Flat Seams

Flat seams are probably the most common of all the seams in sheet metal working. By flat seam is meant any seam in which the opposite edges to be joined lie in the same flat or curved plane and in



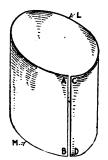


Fig. 168. A Body of Rectangular Contour.

Fig. 169. A Body of Round Contour.

which said edges constitute a straight line. To illustrate, in Fig. 168, a sheet of metal has been shaped into a body of rectangular contour and edges AB and CD are to be joined together by a method depending on different circumstances. As should be apparent, edges AB and CD lie in the same flat plane, FGH and J; and edges AB and CD are truly straight lines, totally devoid of any curvature from A to B or C to D, and if a groove seam was to be used the edges could be bent in

the brake or folder. Again, by referring to Fig. 169, it will be seen what is meant by the seam being also flat when employed for joining bodies which may be a cylinder, or a cone, or any irregular shaped body providing only that edges A B and C D—Fig. 169—are straight lines.

#### Facts about Butt Seams

When making seams the first thing that would come to mind is the butt seam, meaning a seam where edges A B and C D, of Figs. 168 and 169 are merely brought together as in Fig. 170, and connected by some of the usual methods in vogue. Probably the most popular method is by welding in which perhaps one of the edges would be slightly scarfed—thinned out—on both sides and the other

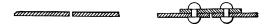


Fig. 170. A Butt Seam. Fig. 171. A Riveted Butt Seam.

edge is split (cleft weld) enough for the wedge of the other edge to enter. With these two edges held firmly together by clamps, or other means depending on circumstance and, after heating to a white heat and fluxing, with borax or some other flux, the joint is hammered and otherwise manipulated according to blacksmithing practice.

Such welds would be more usable for heavy plate work rather than tinsmithing, and would really be in the province of the blacksmith. Still, welding is rapidly displacing riveting and, indeed, even lock seaming on black iron goods up to as light

as 26 gauge and is quite popular for gauges like number 16 or 14. It is to be understood though that such welding is not the old-fashioned method of the blacksmith, but the modern hot flame process. using the electric arc or oxy-acetylene torch. Spot welding by electricity is also rapidly being substituted for riveting and is now extensively used for joining structural shapes, like angle iron, to sheet iron; and the joining together of the various parts, like the ovens of French ranges, gas ranges and so on. For full seam welding the electric arc is often used, but not as extensively now as the highly developed oxy-acetylene process, known also as the hot flame method. This process has been brought to so high a point of perfection that modern sheet metal working shops employ it for making the seams on pieced elbows, ship ventilators, hotel kitchen goods, metal windows, doors, interior trim, and a host of articles heretofore riveted, doubleseamed or otherwise joined. Were it not for this process the automobile sheet metal industry would not be so far advanced because sheet aluminum was a difficult material to use prior to the coming of this process; so it can readily be seen that it behooves the sheet metal worker to second his skill with seaming and riveting tools, with a knowledge of the hot flame process and spot welding.

# A Discussion of Oxy-acetylene Welding

It may not be necessary for the owners of average sheet metal working shops to equip their plants with a complete welding outfit to meet this modern

demand, for in most manufacturing centers there are concerns who specialize in welding for the trade. In that case all they would have to do is to get it shaped up and ready for welding. That is done as follows:

Taking a two-piece elbow to make of 14-gauge black iron as an example, the two pieces would be very accurately cut from the metal, especially at the miter cut. There would be no allowance for lap on the longitudinal seams as with the former riveted seams, but proper allowance should be made in the girth for the thickness of the metal-say an allowance of seven times the thickness of the metal added to the girth. This girth will be the same for both pieces, particularly along the miter line because the miter cuts of the two pieces are to butt and not lap into each other as for a riveted joint. Of course, a small and large end are to be provided depending on the manner of connecting the elbow to the round pipe, or whatever the elbow is to join.

The two pieces are now carefully rolled to true shape and a wire is bound about them to hold the longitudinal seam together. The two pieces are now held together on their miter cuts to see that they accurately butt, because if there are any openings it will be necessary for the welder to load up the holes with metal, as the welders charge extra for poor fits. The two parts can now be shipped to the welder and unless the welder is instructed not to, he will very likely smooth off the joints with a file and emery wheel. This adds to the cost, and

if a little roughness (like the solder or any soldered seam) does not matter it could remain.

It should be plain that with this system much punching of holes and laborious flanging of the parts are obviated, and if quite a number of elbows are required the manufacturing cost is lessened to an appreciable extent. Even if these elbows were specified to be of galvanized iron they could be galvanized after welding and a splendid job acquired thereby. The use of the hot flame for cutting metal is also important enough to be worth the study of sheet metal workers.

Coming back to the usual sheet metal working procedure, it is to be said that for plate work a butt seam can only be riveted by employing another strip as in Fig. 171. This method is the fundamental of many more or less elaborate methods used in boiler work, but a discussion of such would be out of place here.

## Making Lap Seams

From the butt seam the next step in flat seam methods is the lap seam. In plate work lap seams may be welded by the old blacksmith's method as mentioned before, welded by the hot flame process, or, as would be more likely, by riveting. An ordinary riveted lap seam for plate work would appear as shown in Fig. 172. These seams are made steam tight by caulking along edge A; the caulking being done by a chisel-like tool which cleaves the edge of the upper plate and forces a burr of metal down to the under plate.

For seams which are required to be flush on one side the upper plate would be offsetted as shown in Fig. 173, though it is also probable that then the strip method would be used as in Fig. 171; with countersunk head rivets instead of round head.

The seam that, without question, is the most used for sheet metal working is the soldered lap seam shown in Fig. 174. The articles or places where this seam is employed are so well known that it is needless to list them. It goes without dispute that inasmuch as the solder is the means of uniting the parts, the solder should be thoroughly soaked in as shown by the shaded lines.

A riveted lap seam is given in Fig. 175, and when these seams are to be water-tight they are also soldered as in Fig. 174, but need not be so



Fig. 172. A Riveted Fig. 173. Flush Riveted Fig. 174. Soldered Lap Seam for Plate. Lap Seam. Lap Seam.

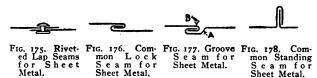
thoroughly sweated in, because the rivets, rather than the solder, are depended on to hold the seam.

#### Lock and Groove Seams

Some clever genius invented the hook seam shown in Fig. 176 and thereby gave the trade a decidedly useful method of joining sheet metal. This lock seam, as some call it, is merely the turning of edges the opposite way for opposing sides to be joined and then hooking them together and flattening them tight with a mallet like in tin-roofing. These seams can be soldered; however, if positive assurance

against unhooking is required, these seams should be grooved as in Fig. 177. The shoulder at A prevents B from slipping out.

There are many methods for making this groove—either by pounding the seam into a slot cut in a rail, or by grooving irons; or again, by grooving machines having a traveling revolving wheel with a groove in it. From the hook seam it is but a step to the standing seam shown in Fig. 178, which can be employed in a number of cases.

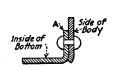


### Double and Flange Seams

The seams and methods expounded in the foregoing pages are really the fundamentals of all seams. If a bottom was to be seamed 1 at M to the article shown in Figs. 168 and 169, a little different procedure would be necessary. In the case of Fig. 169, the hooks, flanges, etc., are similar, but the edge is curved and would require a modification of the flat seam method.

Fig. 179 shows how a bottom would be joined to the body in plate work, Fig. 180 being a reverse joint of the same. In the case of Fig. 168 the flanges (A) would be bent up in machines like a brake, but in the case of Fig. 169 the turned up edge would be done by what is termed flangeing. There are machines which do this work with pre-

cision, but more often a mechanic would be required to draw up the flange by hammering; an operation that requires the highest order of skill. The joints shown are the basis of many others, such as joining the branch to the pipe in a tee joint.



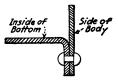


Fig. 179. Seaming a Bottom on in Plate Work.

Fig. 180. A Reverse Seam for Bottoms in Plate Work.

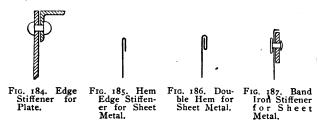
In light gauge work a bottom could be simply hooked on as shown in Fig. 181. Often the seam is left that way, but it has nothing to prevent its being unhooked. This can be overcome by doubling over the edge, which gives the well-known double seam shown in Fig. 182. Fig. 183 is a reverse joint like Fig. 180, and is useful where the inside of the



body is inaccessible for the holding of a dolly bar against the seam for throwing over the edges like, when there is a bottom at M and a head is to be placed at L, Fig. 168-169. Either the method of Fig. 181 or else the method of Fig. 183 would be used if a head was to be placed at L, Fig. 169. Fig. 183 is a seam made by power double seamers.

### Stiffening Processes

Plate work, as a rule, has enough inherent stiffness without reinforcing bands. Should reinforcements be required, however, they most likely would be of structural steel shapes like angles, tees, channels and so on. Now, supposing the objects shown in Figs. 168 and 169 are made of plates, and it is required that they be stiffened at L. Usually an angle iron would be riveted there as shown in Fig. 184. This method would also be useful if two of



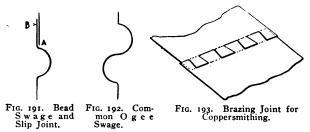
these objects were to be joined at L. Structural shapes would also be employed in a similar manner for ducts and other light gauge work.

It is more probable, though, if edge L is to be stiffened in light gauge work, that the ordinary hem edge shown in Fig. 185 would be used. This could be made stronger by doubling as in Fig. 186. A band iron stiffener shown in Fig. 187 is naturally the strongest of the three methods.

It would seem that the wiring scheme for stiffening should be so well known as to need no description. Still, it may be well to state that the customary method is to first let the edge stand out straight as in Fig. 188; said edge to be about threequarters the circumference of the wire. Secondly, the edge is thrown over and tucked in, as in Fig. 189, by malleting and using the peen of the hammer. It may also be done on the machines made for that purpose.



Should it be required that a body, like Fig. 168, be stiffened somewhere between its top and bottom, many schemes are available. Structural shapes, band arms, or sheet metal could be bent, as in Fig. 190, and riveted or soldered to the object.



For such objects, as in Fig. 169, swaging is the most common procedure. Swaging is done on machines having two wheels grooved to the required profile of the swage. These wheels engage each other at these grooves and when the sheet metal object is caused to revolve between these wheels, the sheet metal is shaped according to these grooves.

Fig. 191 is a bead groove and Fig. 192 is an ogee groove. These two swages are very useful for joining two lengths of pipes, for they not only stiffen the pipe but also act as a stop, as shown at A in Fig. 191. In such cases edge B, Fig. 191, would probably be crimped by the same kind of a machine, only the wheels would have gear teeth.

## Brazed Joint in Coppersmithing

All the methods just described apply to coppersmithing. There is a special method for brazing joints in flat seam work in coppersmithing, however, in which both edges are thinned out and then one edge is notched in to the length of the scarf. Both edges are brought together and the one notch is placed outside while the next is placed inside, about as shown in Fig. 193. Then, while the edges are firmly held together, the joint is brazed and completed by hammering out the joint and otherwise smoothing it off.

### Flat Seam in Metal Roofing

The hook seam, shown in Fig. 176, is probably the most used method in metal or tin roofing, regardless of what general system is employed for laying the metal. The custom of nailing through the sheet in flat seam work, at the left of Fig. 194, is a serious error, and should never be done, particularly for copper, and cleats should be used as shown at the right of Fig. 194. The actual appearance of the seams in both of these diagrams is somewhat distorted inside to show the details mentioned.

When "knocking out" strips for flashing, gutters and for long strip, or standing seam roofing, the seam shown in Fig. 176 would be used ninety-nine times out of a hundred. However, a double-lock seam is sometimes used to avoid soldering or to allow for expansion and contraction. Such seams are decidedly difficult to make. The four successive



Fig. 194. Usual Flat Seam Method for Tin Roofing.

steps for making the seam are shown in Fig. 196. An adjustable folding machine is necessary to turn these edges because the first edge, No. 1, has to be turned, being considerably less in width than the second edge, No. 3. It should be clear, too, that in the turning operation of the second edge extreme care is requisite to prevent squashing of

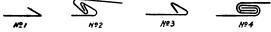


Fig. 195. Double-lock Seam for Tin Roofing.

the first edge. Diagram No. 2 shows the appearance of the seam after the two sheets have been slid together. This is then malleted down tight and will look as shown by diagram No. 4 when finished.

#### A Novel Flat Seam Procedure

In tin roofing it is often necessary to make a flat seam as the work progresses and sometimes the hook edge of the upper sheet can not be slipped into

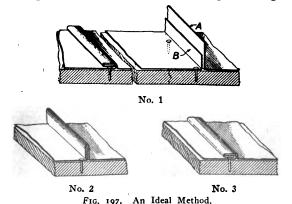
the lower sheet because the other side of the upper sheet is fast, or for some other reason. In that case, the edge of the upper sheet is not bent en-

tirely over but almost square. Then, as in Fig. 196, the peen of the hammer is used to "peen in" the edge, after which it is flattened down with the mallet

Another method would be to turn up square the Fig. 196. Peening an Edge. edge of the lower sheet as



at B in diagram No. 1 of Fig. 197. The edge A of the upper sheet is also turned up square, only this edge A should be double the height of edge B.



Edge A is then turned over edge B in any desired manner and appears as in diagram No. 2. This is malleted down and finished like diagram No. 3. This method would be very handy for joining a new hanging gutter to an old tin roof. The tin should be cut to a straight line and enough left to turn up as high as A in No. I diagram and still

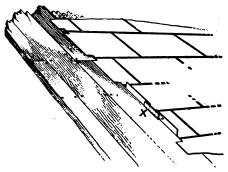


Fig. 198. Example of a Possible Situation.

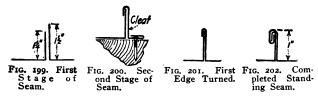
leave enough to connect to the gutter roof flange. No attempt is made to turn up the cross seam locks of the tin, but they are cut away and a small piece of tin inserted, as at X of Fig. 198, and the rest of the seam made as described before.

### Standing Seams for Roofing

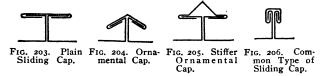
Standing seams are used in tin roofing and often in copper roofing, for the long seams; that is, the seams running from the eaves to the ridge, the cross seams being the usual flat seam. The ordinary standing seam shown in Fig. 175 is often used but that does not give satisfaction unless the roof is very steep, or when it is used for siding.

The standing seam, which is doubled over at its top a couple of times, is the most used. The di-

mensions for opposing edges are shown in Fig. 199. Cleats are nailed to the roof and hooked onto the shortest edge, as in Fig. 200. Sometimes the cleat is placed on the high edge, depending on how the strips are laid, but that gives two turns to the cleat



which is troublesome. With the cleat in place, the next strip is laid and the quarter-inch edge turned over, either with a mallet and roofing iron or with roofing double-seamers, and the seam will look as in Fig. 201. This edge is again turned over as in Fig. 202, which completes the seam which should be one inch high or three-quarters of an inch if



one inch and one inch and a quarter edges are used.

There are different ways of finishing this seam at the eaves, hip and ridge; that which is most often used is to flatten the seam down for a short distance and seam it right in with the connecting edges to the gutter, hip or ridge.

The sliding cap type shown in Fig. 203 is sufficiently clear to be self-explanatory. By bending a

V in the cap an ornamental effect is obtained as in Fig. 204. In Fig. 205 is shown how a plain V cap gives a somewhat ornamental appearance and more strength to that of Fig. 203.

A common type of sliding cap is given in Fig. 206, and it goes without saying that all these seams must be carefully cut out, bent up and handled because it is not an easy matter to slide these caps onto the upstanding edges. As with the regular type of standing seam, Fig. 200, cleats are the means of fastening the sheets to the roof boards or, if there are no boards, to the roof purlins.

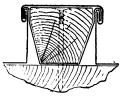


Fig. 207. Ideal Type of Batten Seam.

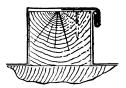


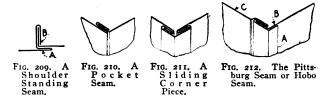
Fig. 208. Quicker Method for Batten Seams.

The wood batten type of roofing is also very common, especially for copper roofing, as it allows maximum provision for expansion and contraction. It is highly desirable when an ornamental and architectural effect is required for a tin roof. Fig. 207 shows the shape of the wood batten which allows movement of the pan in its expansion.

These caps are not slid on but are double-seamed by the customary operations. Fig. 208 shows how the cap can be eliminated and the pan formed to pass over the batten and seamed to the other pan. All the seams so far spoken of are adaptable for many kinds of roofing and the majority of the other types of seams for roofing are just a modification of these.

#### Seams in Duct Work

Duct work usually means pipe, elbows and other fittings which are rectangular in cross section, as illustrated in Fig. 168. In this class of work nearly all the seams so far discussed can be employed to advantage. The plain standing seam shown in Fig. 175 is frequently used, especially as it helps stiffen the duct. That seam, however, must be strongly



riveted through its upstanding edges to hold together at all. The seam shown in Fig. 209 has a shoulder, A, bent under the opposite side as shown. After clinching edge B, seam cannot come apart.

Should it be desired to have the seam of the pipe at a corner instead of where it is in Fig. 168, many of the methods already mentioned could be used. Still, there are other ways like the pocket seam in Fig. 210—the edge is held in the pocket by soldering or riveting here and there.

A corner seam in which a slide piece is used is shown in Fig. 211. A slide piece like this, only without the square bend, is used at times for a flat.

seam, but it is not popular because the parts become undone too easily. This method is useful for joining the parts of a casing about a radiator in indirect steam heating.

A seam that is fast superseding the double seam to join the parts of rectangular elbows at their corners, is the Pittsburg or, as some term it, the hobo seam, which is shown in Fig. 212. The edge A is left standing out straight while forming this seam and when assembling the parts; the edge on part B

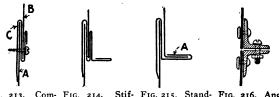


Fig. 213. Com- Fig. 214. Stif- Fig. 215. Stand- Fig. 216. Angle mon S Slip. fened S Slip. ling Edge Slip. Connection.

is forced into the pocket of part C and then edge A is hammered over, locking parts C and B firmly together. Note particularly the shoulder on piece C which gives a flush surface and prevents distortion when closing edge A.

#### Horizontal Joints in Ducts

In all duct work it is necessary to join two or more lengths of pipe at their edges L, Fig. 168. The method generally used is the S slip shown at C in Fig. 213. Part A is the lower length of duct and part B the upper length. The slip is first placed on A and then B is slipped into it. Holes are then drilled through all wherever it is desired to fasten them together and metal screws are inserted.

As ducts are often very wide it is necessary to have a rigid slip and Fig. 214 shows how the hem edge of the S slip is carried down, bent out and then hemmed. This method is really the basis of many other styles used. Sometimes a band iron, or an angle iron or indeed furring strips of wood are encased in this slip to reinforce them.

The popular standing edge slip is shown in Fig. 215. With this method the slip is firmly riveted to the lower duct and the clinch edge A should be standing up square. The upper duct has a square edge bent out and when this is in place the clinch edge is malleted down.



Fig. 217. Slip Joint for Furnace Work.

Fig. 218. Gutter Bead in Lieu of Wire.

Fig. 219. Tapped Band Iron Joint.

For heavy work structural shapes would be used as in Fig. 216. In Fig. 217 is shown the slip joint which is a familiar procedure to old furnace men and is used for cold air boxes. The ducts would be made in four parts, seaming the parts on the corners. Prior to doing this the wires are inserted and on the lower duct about two inches are folded over as shown. A wire drawn through holes in the ducts holds both securely together. Sometimes the gutter bead of Fig. 218 is used in lieu of a wire or rod of Fig. 217.

Quite frequently a joint is to be made where it is impossible to get at the inside for riveting, and it is required that the joint be easily unmade. A good method would be to rivet a band iron to the one part A, as in Fig. 219. Holes are then punched or drilled through the part and the band iron; after which the holes are tapped with a thread suitable for stove bolts. Holes are now accurately punched in the other part, B, to match those in part A, and then stove bolts screwed into the band iron hold all together.

## Expansion Joints for Long Gutters

When a large roof is to be covered, and a long copper gutter is used, an expansion joint is constructed and placed at the highest point of the gutter, the water shedding either way to the leader. The method of constructing this joint is shown in Fig. 220. It makes no difference what shape the gutter may have, the same method is employed.

The gutters A and B meet at the highest point: two heads or bottoms C and D are flanged and soldered in the gutter, having an upper flange bent towards the inside of the gutter, as shown. On the roof part of the gutter a lock is bent as shown by E and F. Over these locks E and F and over the flanges on the heads a lock is slipped as shown by H, allowing it to run under the lock of the gutter as shown by J, the lock of the gutter being broken, to clearly show the slip. At the bottom the slip is allowed to project slightly over the front edge of the gutter, as shown by I.

The roof covering shown by L is locked to the gutter, overlapping the slip J as shown. Thus it will be seen that no soldering has been done, which allows the gutter to work as desired. To avoid the water from following the top of the slip H and dripping off over the front edge of the gutter, a V-shaped guard is soldered to the top of the slip

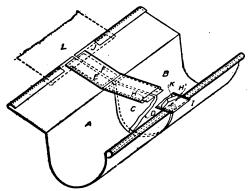


Fig. 220. Expansion Joint in Long Gutter.

H, as shown at K, which leads the water right and left into the gutter as at H<sup>1</sup>.

### Connecting Furnace Pipes to Furnace Tops

When furnace warm-air pipes are to be connected to furnace hoods, as shown in A in Fig. 221, it is well to know the different methods which are used, so that the one best adapted can be employed in making the connections. As every collar in most cases has a different angle, the collars are usually trimmed at the job as follows: Run a line or spool wire from the register box on the first floor, or

from the stacks leading to the upper floors, to the bonnet or hood, as indicated by the dotted lines a, b and c, which gives the proper angle at which the collars are to be cut to fit against the hood.

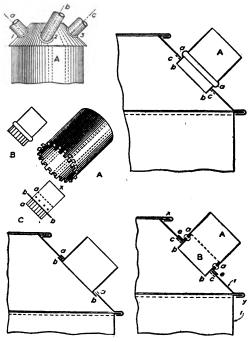


Fig. 221. Connecting Furnace Pipes to Tops.

After the collar has been fitted accurately it is held tightly against the hood and a pencil mark made on the hood and carefully cut out with the circular shears. Each collar is marked to correspond to the opening in the hood, as shown by I, 2, 3, etc., as shown. The collars can now be joined to the hood by either one of the methods shown, A showing a notched or dove-tailed collar; B, a beaded notched collar and C, a flanged and notched collar.

Note in the collar A the alternate flanges are turned out at right angles, as shown, so that when the collar is joined to the hood, as shown in the diagram below C in the accompanying illustration, the edges just turned lie tight against the outside of the hood at a a, while the unturned edges are turned on the inside of the bonnet at b b. These edges are dressed down firmly, which secures the collar ready to connect with the warmair pipe.

When the collar is beaded and notched, as shown by B, this collar is secured to the hood, as shown in the diagram in the upper right-hand corner of the illustration at A. The collar is set in the opening in the hood, with the bead snugly against the hood, as shown by a a, after which the flange b b, which is already notched, is turned over as shown by c c. The flanging and notching of the collar c0 is accomplished by first flanging the collar c2 at c3 and c4 until this flange fits snugly against the hood. A separate collar c4 a is now riveted to the main collar c5 as shown and notched at c6.

When connecting this collar to the hood as shown in the diagram in the lower left-hand corner of the illustration, the main collar A is set tightly against the hood as shown by *e e* and the notched portion *b b\_of* the collar B which had previously

been riveted to the collar A at a and a is then turned against the inside of the hood at c and c. Of course it is understood that the seaming at x and y is not done until the collars have been joined to the hood. After the collars were all fitted a mark was made at I on the hood and I on the casing as shown, after which the hood was removed from the casing, the collars secured and the hood set back again on the casing in its proper position as shown by the marks I and I and then seams x and y closed.

### Connecting Collars to Register Boxes

Another method of seaming collars is shown in Fig. 222, where in diagram 1 it will be seen that

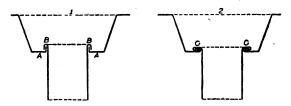


Fig. 222. First Method of Seaming Collars to Register Boxes.

the flange of the circular opening in the bottom is turned upward as shown at A, and the collar has a flange turned over and pressed tight with the flat pliers as shown by B. This seam B is now turned down as indicated in diagram 2 at C.

Fig. 223 shows the second method of securing the collar by means of flanging and notching. After the proper size circle has been cut in the bottom of

the register box, the collar is prepared, around which another short collar about 2 inches high shown by a in diagram 1 is riveted at b, being careful to turn out a flange of about 1/4 inch on a before

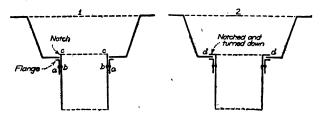


Fig. 223. Second Method of Seaming Collars.

riveting to the main collar c. Rivet this short collar a about  $\frac{3}{6}$  inch below the main collar as shown in the cut; then set the collar in the position as shown in diagram 1, notch with the snips the projecting flange c and dress down tightly on the stake as shown by d in diagram 2.

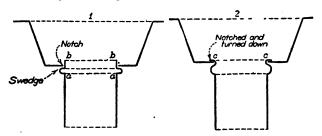


Fig. 224. Third Method of Fastening Collars.

The third method shown in Fig. 224 shows how the collar can be secured to the box by swaging and notching. Turn a swage or bead  $\frac{1}{6}$  or  $\frac{1}{4}$  inch deep on to the end of the collar, about  $\frac{3}{6}$  inch away from the ends as shown by a a in diagram I. See that it fits snugly in the circular opening in the bottom of the register box, then notch the projecting flange b and dress it down tightly on the stake, so that when finished it will have the appearance shown by c in diagram 2.

While the last two methods are quick and simple, still either one of the first two methods are to be recommended as they are more rigid and tighter.

# Expansion Joint of Skylight

Some large buildings, especially if they are built largely of steel or the more modern reinforced con-

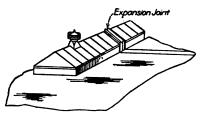


Fig. 225. Skylight with Expansion Joint.

crete type, have expansion joints, and often skylights or other work which sheet metal workers do come directly over these joints, and then the designers, as a rule, insist that that joint be also followed through this work.

The example given in Fig. 225 is for a skylight of the double pitch type and is about 20 feet wide at the curb line by some 600 feet in length. The

skylight is directly over three expansion joints of the building transversing it. The expansion joints are in everything, the steel work, the walls, the concrete roof slabs, the gravel roofs, the curb, the flashing and the skylight.

In Fig. 226 is shown a rough idea of how the special bar is made. Spanning the space between two bars is a heavy sheet lead cap which is brass bolted to the bars and bent as shown for the obvious reason of allowing extension and compression and also to give the necessary rigidity. The

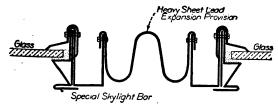


Fig. 226. Special Expansion Skylight Bar.

gravel roof and the curb flashing have a combination sheet metal and tar expansion joint, and the sheet lead cap mentioned and the apron of the skylight were made to fit loosely over this curb joint, for it would not do to miter and carry the sheet lead cap down the curb to form an apron over the joint inasmuch as said miter would be so stiff as to nullify the freedom of the cap. This applies to mitering the caps together at the ridge, and they were simply kept a short distance from each other and the opening covered with a sheet lead cap not fastened to the other caps but beneath to the ridge bar of one part of the skylight.

# Joints for Corrugated Iron

Corrugated sheets may be had in many lengths and widths and corrugated in many styles and dimensions. A popular style is shown in Fig. 228.

Specifications for sheet metal enclosures usually call for a sheet like Fig. 227 for siding, as it gives one corrugation lap. For roofing the specifications prescribe sheets like that in Fig. 228, which give one and one-half corrugation.

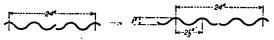


Fig. 227. One Corrugation Lap. Fig. 228. One and One-Half Corrugation Lap.

When lapping sheets of Fig. 228 they would appear as in Fig. 229. Horizontal laps are merely lap seams and should lap at least six inches. Sheets should never be lapped as in Fig. 230, because the standing edge will show buckled and is therefore



Fig. 229. Proper Method of Lapping.



Fig. 230. Improper Method of Lapping.

unsightly. It will not leak, however, though water will get under the first lap and, having no chance to dry out, will eventually rot out the sheets. In the ideal method of Fig. 229 edge a should not go down into the corrugation because capillary attraction will draw water up under the edge a.

The method of finishing against the gable or sides of the structure is shown in Fig. 231; note how one or two corrugations are flattened out and then bent

up to form a base flashing. At the eaves, of course, the sheets would lap over the roof flange of the gutter. Fig. 232 shows how a molding can be connected to the corrugated roofing. This is an

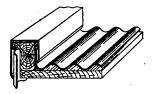


Fig. 231. Finish Against a Side Parapet.

ideal method and could also be used in a case like Fig. 231. A pocket in the foot of the molding is the means of finishing the molding to the siding.

The joints given in Figs. 231 and 232 are the basis for all other joints like window and door cas-

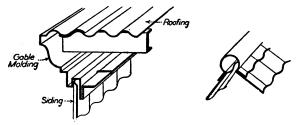


Fig. 232. Joining a Gable Mold- Fig. 233. Ridge Finish, Showing to Corrugated Roof. ing Ridge Roll.

ings. Fig. 233 shows the ridge finish, in which the apron of the ridge molding is corrugated to match the corrugated sheets. Pockets are not desirable at a ridge owing to the need of making them very deep to keep rain or snow from beating in the pocket and under the sheets into the building.

# Straight Cornice Seams

Nearly all the common seams presented in this chapter can be used for architectural sheet metal work. As a rule, all vertical seams in straight cornices are the lap seam kind, soldered and riveted. The horizontal seams are also very often just lap seams soldered and riveted. The same is true of

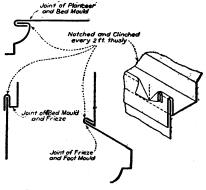


Fig. 234. Several Types of Joints for Straight Cornices.

the seams used for joining the different minor parts to the body of the cornice.

In Fig. 234 is shown a popular system for making the horizontal joints in cornices. These are all just clinched edge seams as shown. And while they are tacked with solder here and there, they are further strengthened and made fireproof by notching the standing edges and folding them over tightly as shown. The notching should not be done with a chisel as that mars the work, but with a special stubby point snips.

#### Seams in Circular Cornices

As in straight cornice work, the vertical seams in circular cornice work are lap seams soldered and riveted. In horizontal seams, however, the clinched

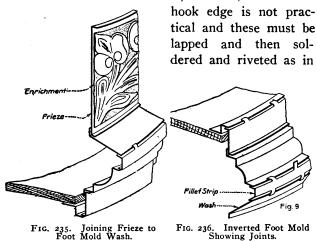


Fig. 235. Many shops greatly strengthen these seams by first notching the edges and turning up small laps, about one-quarter of an inch wide and about six inches apart. Then as the parts of the cornice are gradually worked together, as in Fig. 236, these laps are hammered down and strongly soldered along the soldering of the edges.

The two diagrams do not show a complete cornice because the crown mold is not there; however, the same methods apply to that part of the cornice or rather entablature. Note how the parts are fastened to a circular wood template while assembling.

## Sheet Metal Shingle Locks

Sheet metal shingles and tiles can be had from the manufacturers in single units or several on a sheet. There is not much difference in the procedure of laying sheet metal shingles or tiles from that of clay tiles or wooden shingles except that the joints are different.

The horizontal seams are always lap seams, the lower edge of the tile or shingle is slightly curled



Fig. 237.—Common Metal Shingle Joint.



Fig. 238.—High Grade Shingle Lock.

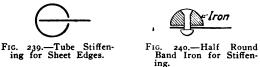
to stiffen it and the upper edge has a series of guide corrugations to both stiffen and act as a guide for laying the next course.

The vertical seams have special pocket features to obviate soldering and still have tight joints. These pockets vary with each manufacturer and are patented. They all follow, however, a basic idea as given in Fig. 237. It will be seen that a tile, or shingle, is laid and a couple of roofing nails are driven into the edge provided for these nails; the adjoining tile or shingle has its edge slipped into the pocket and its edge nailed and so on. Fig. 238 shows another style of side joint.

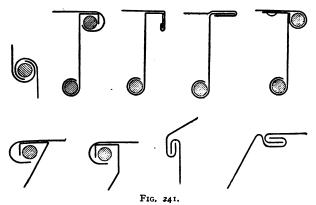
# Joints in Automobiles:

Modern automobile making is essentially quantity production and most work, such as forming,

joining, etc., is done on special automatic machines. These joints, seams and so forth are adaptations of the old tinsmith's processes, even to the swaging, riveting and stiffening of the sheet metal.



The average tinsmith is not concerned with these methods except for repairing and, in that case, he



Diagrams Detailing Some of the Principal Automobile Joints.

would have the guidance of the article to be repaired.

Wood is seldom used now, but where it is, the joining of the metal to wood is by customary methods of pockets in the sheet metal and by screws or holts.

One of the methods for stiffening edges is by splitting a tube longitudinally and slipping the sheet metal into the slot in the tube as in Fig. 239. These tubes are curved if necessary and are fastened to the sheet by welding or soldering. Another method is shown in Fig. 240, which is by a half-round band iron flush riveted to the sheet. Other joints for dash boards, mud guards, hinge joints and body seams are shown in Fig. 241.

#### Tin Clad Fire Doors-Joints and Seams

A sketch of a fire door is shown in Fig. 242. These doors are built up of two or more ply of

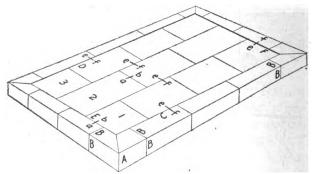


Fig. 242.-Tin Clad Fire Door.

seven-eighth boards firmly clinched-nailed together in accordance with the underwriter's specifications. They are then covered on both sides with tin plates of practically the same kind as for tin roofing. The seams, however, are not the same as in tin roofing.

The corner pieces A are made separate and are put on first. These are made in one piece and

folded, much like the corners of a drip pan, as shown in Fig. 243. There are no nails placed in the folded miter so that it requires care to keep the miter from gaping. One or two roofing nails may be driven in under the hook edges at B, Fig. 242, to hold the pan in position.

The casing from B to B, Fig. 242, is made in one piece by knocking out a strip like that used for flash-

ing. This is then bent to bind around the edge of the door, and two hook edges are also bent out. These casings are then seamed to the corner pans at B, and roofing nails may be driven in under C, here and there,

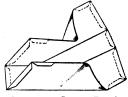


Fig. 243.—Corner Pan in One Piece.

to keep the casing in place and to a true line.

The tin sheets are now notched and bent to look like Fig. 244, except those for the last course, at D, Fig. 242, which have the standing edge on both long

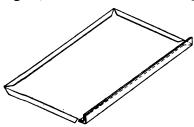


Fig. 244.—How Sheets Are Bent.

sides. The sheets are laid by beginning at E, Fig. 242. The edge bent out square is inserted in the edge of pan and casing, as in

Fig. 245, which is a section on line a b of Fig. 242. With the sheet standing up square, long barb wire nails are driven in in the edges as in Fig. 245. The

sheet is now carefully folded down over the nails like in Fig. 246, which is also a section of the pan and casing seams on line a b, Fig. 242.



FIG. 245 .- The First Step in Laying the Sheets.

The turned under edge of the standing seams is now forced into the hook seam of the pan and casing as in Fig. 247. before, long barb wire nails are driven in shown. The next sheet is

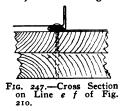
then put on in the same way and then the third finishing to the top pan and casing F, Fig. 242, with the standing edge seam.



Fig. 246.—The Flat-hooked Seams.



The next course, No. 2, is laid in the same manner, then No. 3 course, after which the standing



edges are carefully malleted down, as in Fig. 248 to cover the nails which, by the way, should be three inches apart.

The door is now turned over and the other side covered in a like manner.

labels are to be attached they should be riveted and soldered to one of the sheets before the sheet is laid. And, if the door is to be exposed to the weather, the upper seam at F would be a hooked flat seam on the exposed side of the door, so that the rain would flow over and not into the seam.

#### CHAPTER X

# Roofing Slates and Tiles

One branch of tinsmithing is metal roofing using terne plates or copper or other sheet metal to cover the entire roof surface. There are, however, many other kinds of material used for roof covering; but, in most cases, it is necessary to use sheet metal in connection with this material. It is probably for this reason that the tinsmith is called upon to lay slate or vitrified tile roofing. It is always, therefore, a good idea for the tinsmith to know something about these materials, hence the presentation of this short chapter written by an expert in a wellknown publication. Further information of all kinds of roofing is given in the series entitled "Practical Sheet Metal Worker and Demonstrated Patterns."

## Laying Roofing-Tiles

Roofing-tiles have been laid directly on a porous book tile or concrete base or on a sheathed surface over such base, or they have been fastened to stripping over the sheathing or wooden or steel purlins by means of copper wires. When thus fastened by wires, the joints were usually pointed on the under side after they were laid, to prevent the entrance of dust or dry snow. Tiles of the older patterns were nailed to the sheathing, but later

on this method was superseded by the practice of fastening with copper wires from pierced lugs near the lower ends of the tiles.

The best modern method, however, seems to be the one involving a solid continuous base for the roofing-tiles, whether or not purlins are used. "Such purlins should be filled in between either with book tiles or a concrete base and felt should be laid thereon. The book tiles, if used, should be of a porous quality. Instead of regarding the nailing of tiles as a defective method, it has been found that it is the only proper method of fastening tiles and has eliminated the stripping of sheathed roofs and the use of copper wires. Such methods would do in some portions of central Europe where the winds and other climatic conditions are not severe. but through a twenty-five years' experience in the varied climatic conditions of the United States it was found that the nailing of tiles with copper nails is the only satisfactory method of application. It was also found that a roof should be sheathed and covered with a good asphaltum-felt to prevent wind-suction and condensation.

Valuable information, of course, can be had in the literature furnished by makers of tiles. These remarks apply to the many types of tiles as flat tiles, pan and roll tiles and Spanish tiles. It is also of interest to state that tiles can be had transparent, like glass, for the admission of light to the interior of the structure. Tiles can also be had which are made of cement or cement and asbestos, also of sheet metal.

# Best Sizes for Slate Roofing

The size of slates best adapted for plain roofs are the large wide slates, such as 12 x 16 inches, 18 x 12 inches, 20 x 12 inches, or 24 x 14 inches. Slates from 8 x 16 to 10 x 20 inches are popular sizes, 9 x 18-inch slates being probably used oftener than those of any other size. The 11 x 22 and 12 x 24-inch slates are used principally on very large high buildings. The lower grades of slate are used largely on warehouses and barns. The larger sizes make fewer joints in the roof, require fewer nails, and diminish the number of small pieces at hips and valleys. For roofs cut up into small sections the smaller sizes, such as 14 x 7 inches or 16 x 8 inches, look the best.

#### Measuring for Slates

Slates are sold by the square, by which is meant a sufficient number of slates of any size to cover 100 square feet of surface on a roof, with 3 inches of lap, over the head of those in the second course below. The square is also the basis on which the cost of laying is measured. Tables giving the weight and number of slate required per square of roof are given on page 297. Eaves, hips, valleys and cuttings against walls or dormers are measured extra; I foot wide of their whole length, the extra charge being made for waste material and the increased labor required in cutting and fitting. Openings less than 3 square feet are not deducted, and all cuttings around them are measured extra. Extra charges are also made for borders, figures, and any change

of color of the work and for steeples, towers and perpendicular surfaces.

Slates from the quarry must be in carload lots to get the best freight rates. If a contract does not require a carload, it can be made up of various kinds of slates for stock in hand; it is good stock and can be realized on any time.

# Laying Slates

Slates are laid either on a board sheathing (rough, or tongued and grooved) covered with tarred or water-proof paper or felt, or on roofing-laths from 2 to 3 inches wide and from 1 to 11/4 inches thick, nailed to the rafters at distances apart to suit the gauge of the slates. Each slate should lap the slate in the second course below, 3 inches. The slates are fastened with two threepenny or fourpenny nails, one near each upper corner. For slates 20 x 10 inches or larger, fourpenny nails should be used. Copper, composition, tinned, or galvanized nails should be used. Plain-iron nails are speedily weakened by rust, and they break and allow the slates to be blown off. On iron roofs slates are often placed directly on small iron purlins spaced at suitable distances apart to receive them, and fastened with wire or special forms of fasteners. The gauge of a slate is the portion exposed to the weather, which should be one-half the remainder obtained by subtracting 3 inches from the length of the slate. Roofs to be covered with slate should have a rise of not less than 6 inches to the foot for 20-inch or 24-inch slates, or 8 inches for smaller sizes. When driving the nails

into the slates extreme care is to be used because, if nails are driven too tight the slate may crack, or if it does not while driving the nails, freezing weather, followed by a thaw, will crack them or burst the nail head through allowing the slate to fall down. If the nails are driven too loose the slates will not be held firmly to the sheathing and may break the slate above which is lying on it.

In first-class work the top course of slate on the ridge, and slate for from 2 to 4 feet from all gutters and I foot each way from all valleys and hips, should be bedded in elastic cement.

Counterflashings are of lead or zinc, and are laid between the courses in brick, and turned down over the flashings. In flashings against stonework, grooves or reglets often have to be cut to receive the counterflashings.

## Close and Open Valleys

A close valley is one in which the slates are mitered and flashed in each course and laid in cement. In such valleys no metal can be seen. Close valleys should only be used for pitches above 45°. An open valley is one formed of sheets of copper or zinc 15 or 16 inches wide, over which the slates are laid.

## Old English Method of Laying Slates

This method of laying slates involves the use of different shades of colored slates in graduated courses and in random widths beginning at the eaves, for example, with slates 28 inches long and

11/4 inches thick, and using the different thicknesses from 11/4 to 3/8 inch, in shorter lengths, in working upward on the roof. The use of this kind of work for roofs has increased in recent years and the method possesses vast possibilities for carrying out architects' ideas for varied artistic effects. The slates are made with rough-cut edges in all thicknesses from 3/16 to 11/2 inches, in a combination of various shades carefully selected in such proportion as to produce the best possible harmony, when laid. As all of these colors and shades are unfading, the weathered effect is obtained at once and is permanent. These slates are made not only in usual sizes, but in the Old English style, to be laid in graduated courses of different lengths and in random widths. When graduated courses are desired, specifications should call for the number of courses to be laid in each length and thickness beginning at the eaves courses, where the thickest slates are used in the largest sizes, sometimes 30 or even 36 inches in length, and working upward on the roof with the shorter lengths and thinner slates to the ridges where the smallest sizes and thinnest slates are used. To secure a rough effect at minimum cost, use Old English color-combination, all slates fully 1/4 inch thick with rough cut edges and graduated courses in sizes ranging from 24 by 16 to 12 by 6 inches, with nail-holes drilled and countersunk. To secure the best rough effect, use not less than 34 inch thick for the eaves, and any desired number of courses in each length and thickness.

#### CHAPTER XI

# Handy Receipts and Formulas

#### Aluminum Solders

The following aluminum solders have been successfully used:

| Tin   | Alum-<br>inum | Zinc    | Copper    | Bis-<br>muth | Lead I      | hosphor   | r- Sil-<br>ver | Anti-<br>mony | Cad-<br>mium | Magnes-<br>ium |
|-------|---------------|---------|-----------|--------------|-------------|-----------|----------------|---------------|--------------|----------------|
|       |               |         |           |              |             |           |                |               |              |                |
| 95.00 |               |         |           | 5.00         |             |           |                |               |              |                |
| 78.50 | 2.00          | 19.00   |           |              |             | 0.50      |                |               |              |                |
|       | 66.70         |         |           |              |             |           | 33.30          |               |              |                |
| 20.00 | 70.00         |         |           |              |             |           | 10.00          |               |              |                |
| 97.00 |               |         |           | 3.00         |             |           |                |               |              |                |
|       | 6.00          | 89.50   | 4.50      |              |             |           |                |               |              |                |
| 71.25 | 2.25          | 26.00   |           |              |             | 0.50      |                |               |              |                |
| 60.00 | 4.00          | 8.00    | 4.00      |              | 12.00       |           | 12.00          |               |              |                |
| 37.50 |               |         |           | • • • • •    |             | • • • • • |                | • • • • •     | • • • • •    | • • • • •      |
| 37.30 |               | 25.00   | 37.50     | • • • • •    | • • • • • • | • • • • • | • • • • •      | • • • • •     |              | • • • • • •    |
|       | 8.00          | 92.00   |           | • • • • •    | • • • • •   | • • • • • | • • • • •      | • • • • •     | *****        |                |
| 30.00 |               | 20.00   |           | • • • • •    | • • • •     | *: *: ::  | • • • •        |               | 50.00        | • • • • •      |
| 80.00 | 2.25          | 17.00   |           |              |             | 0.75      |                |               |              |                |
| 66.00 | 15.50         |         |           | 9.00         |             |           |                | 7.00          |              | † 2.25         |
| 15.50 | 2.50          | 78.25   |           |              | 2.50        | 1.25      |                |               |              |                |
|       | 20.00         | 65.00   | 15.00     |              |             |           |                |               |              |                |
| 49.05 |               | 20.31   | 1.15      |              | 26.06       |           |                | 3.43          |              |                |
| 30.00 | 70.00         |         |           |              |             |           |                |               |              |                |
|       | 4.00          | 94.00   | 2.00      |              |             |           |                |               |              |                |
| 85.10 | 10.80         |         |           |              |             |           |                |               | 1.35         |                |
| 60.00 |               | 15.00   |           | 5.00         | 10.00       |           |                | 5.00          |              | 1              |
| 86.00 |               | 20.00   |           | 14.00        |             |           |                |               |              |                |
| 98.00 | 1.00          |         |           | 1.00         |             |           |                |               |              |                |
| 20.00 | 70.00         |         | 10.00     |              |             |           |                |               |              |                |
| 48.00 | 2.00          | 27 00   |           | • • • • •    | 23.00       | • • • • • | • • • • •      | • • • • •     | • • • • •    | • • • • •      |
|       |               | 27.00   |           |              |             | • • • • • | • • • • •      | • • • • •     | • • • • •    | • • • • •      |
| 90.00 | 5.00          | • • • • | • • • • • | 5.00         |             | • • • • • | • • • • •      | • • • • •     |              | • • • • •      |
| 84.95 |               |         |           | 15.05        |             |           |                |               |              |                |

<sup>\* 10%</sup> phosphorous. † This solder also contains 0.25% vanadium. ‡ This solder also contains 5% chromium.

#### Novel's Solder for Aluminum Bronze

Tin, 900 parts, copper, 100, bismuth, 2 to 3. It is claimed that this solder is also suitable for joining aluminum to copper, brass, zinc, iron or

#### Novel's Solders for Aluminum

| Tin, | 100  | parts, | lead, 5;          | melts | $\mathbf{a}\mathbf{t}$ | 536° | to | 572° | F. |  |
|------|------|--------|-------------------|-------|------------------------|------|----|------|----|--|
| u    | 100  | u      | zinc, 5;          | u     | u                      | 536  | u  | 612  |    |  |
| u    | 1000 | u      | copper, 10 to 15; | u     | u                      | 662  | u  | 842  |    |  |
| "    | 1000 | "      | nickel, 10 to 15: | u     | "                      | 662  | u  | 842  |    |  |

#### Soldering and Welding Aluminum

Another authority states that aluminum can be readily electrically welded, but soldering is not altogether satisfactory. The high heat conductivity of the aluminum withdraws the heat of the molten solder so rapidly that it "freezes" before it can flow sufficiently. A German solder, said to give good results, is made of 80% tin to 20% zinc, using a flux composed of 80 parts stearic acid, 10 parts chloride of zinc, and 10 parts of chloride of tin. Pure tin, fusing at 250° C., has also been used as a solder. The use of chloride of silver as a flux has been patented, and used with ordinary soft solder has given some success. A pure nickel soldering-bit should be used, as it does not discolor aluminum as copper bits do.

#### Preparation and Application of Aluminum Solders

Tin, 95 to 99: Bismuth, 5 to 8.

This composition, which is an ordinary soft solder, is adapted for soldering aluminum by means of the common soldering iron.

| No.      | 1  |       | No.      | 2  |       | No.      | 3  |       |
|----------|----|-------|----------|----|-------|----------|----|-------|
| Zinc     | 80 | parts | Zinc     | 85 | parts | Zinc     | 90 | parts |
| Copper   | 8  | parts | Copper   | 6  | parts | Copper   | 4  | parts |
| Aluminum | 12 | parts | Aluminum | 5  | parts | Aluminum | 6  | parts |

In preparing aluminum solders the alloy of copper and aluminum is always made first and the zinc added. The zinc used should contain no iron as it will affect the fusibility and durability of the solder. In preparing the solder, first melt all the copper, then add the aluminum gradually. The two metals are of a very different density and the mixture should be stirred with an iron rod to unite them as far as possible. There is no solder which operates with aluminum in the same way as ordinary solder works with copper, tin, etc. This is due to the fact that aluminum will not alloy readily with solders with temperatures so low as the other metals require. Then, it is also covered with a thin coating of aluminum oxide, which is very refractory. All the surface to which it is intended that the solder shall adhere must first be tinned. is accomplished by heating the metal to a temperature above the fusion point of the solder used and then rubbing the surface with a stick of the solder, thus rubbing the oxide off the surface with the solder itself and covering the exposed points with melted solder all in the same motion. After the edges to be united are thus tinned they may be sweated together with pure block tin with the aid either of a soldering iron or blast lamp. It is well to bear in mind that solder will not flow into an aluminum joint even when tinned, by capillary action, as it does into copper or tin joints, and it is therefore necessary to place on the surface of the metal all of the material necessary to sweat them together before the edges are brought into contact.

| Black So              | lder No. 1                 | Black Solo                 | ier No. 2                  |
|-----------------------|----------------------------|----------------------------|----------------------------|
| Copper<br>Zinc<br>Tin | -                          | Sheet brass<br>Zinc<br>Tin | 20 pounds 1 pound 6 pounds |
|                       | der for Brass<br>per No. 1 | Yellow Solde<br>or Brass   |                            |

| or Copper | No. 1     | or Bra | ss No. 2 |
|-----------|-----------|--------|----------|
| Copper    | 32 pounds | Copper | 1 pound  |
| Zinc      | 29 pounds | Zinc   | 1 pound  |
| Tin       | 1 pound   | Tin    |          |

The formula on the left is stronger than the other.

# Best Soft Solder for Cast Britannia Ware

Tin 8 pounds Lead 5 pounds

#### White Solder for Raised Britannia Ware

Tin 100 pounds Copper 3 ounces
To make it free, add 3 ounces of lead.

| Solder fo | r Copper  | German-silve | r Solder |
|-----------|-----------|--------------|----------|
| Copper    | 10 pounds | Copper       | 38 parts |
| Zinc      | 9 pounds  | Zinc         | 54 parts |
| Nickel    |           | Nickel       | 8 parts  |

## Gold Solder for 14-Carat Gold

Gold, 25 parts; silver, 25; brass, 121/2; zinc, 1.

#### Soft Gold Solder .

Is composed of 4 parts gold, I of silver and I of copper. It can be made softer by adding brass, but the solder becomes more liable to oxidize.

| Gold Solde    | er No. 1            | Gold Solder 1     | No. 2     |
|---------------|---------------------|-------------------|-----------|
| Gold          | 14 parts            | Gold, 6 penny     | weights   |
| Silver        | 14 parts<br>6 parts | Silver, 1 penny   |           |
| Copper        | 4 parts             | Copper, 2 penny   | _         |
|               | Solder              |                   |           |
| Copper, 2;    | zinc, 1 part.       | Tin, 2; lead, 1   | part.     |
|               |                     | Tinmen's S        | older     |
| Lead          | 2 parts             | Lead I            | ½ parts   |
| Tin           | 1 part              | Tin I             | part      |
| Hal           | f and Half, T       | insmiths' Solder  |           |
| Lead          | 1 part              | Tin               | 1 part    |
| Silver Sold   | ler No. 1           | Silver Solder     | No. 2     |
|               |                     | Silver 1.         |           |
|               |                     |                   | 73 parts  |
| Zinc<br>Tin   | II½ parts           | Zinc              | 4 parts   |
|               |                     | the Use of Jewele | ers       |
| Fine silver   | 19 pwts.            | Sheet brass       | o pwts.   |
|               | Copper,             |                   | 1         |
|               | White Solde         | r for Silver      |           |
| Silver        | I ounce             | Tin               | I ounce   |
| Si            | lver Solder fo      | r Plated Metal    |           |
| Fine silver ' | I ounce             | Brass             | o pwts.   |
|               | Solder for S        | Steel Joints      |           |
| Silver        | 19 pwts.            | Copper            | I pwt.    |
|               | Brass               | 2 pwts.           | •         |
| Melt these    |                     | a coat of charco  | oal dust. |

## Composition and Fusing Point of Soft Solders

Fusing point of tin-lead alloys (figures are approximate):

| Tin, | 1 | to | lead, | 25 | 558° | F. | Tin, | 11/2 | to | lead, | 1 | .334° | F. |
|------|---|----|-------|----|------|----|------|------|----|-------|---|-------|----|
| u    | 1 | u  | u     | 10 | 541  |    | u    | 2    | "  | u     | 1 | . 340 |    |
| u    | 1 | u  | u     | 5  | 511  |    | u    | 3    | u  | "     | 1 | 356   |    |
| u    | 1 | u  | u     | 3  | 482  |    | u    | 4    | u  | ĸ     | 1 | . 365 |    |
| u    | 1 | u  | u     | 2  | 441  |    | u    | 5    | u  | u     | 1 | .378  |    |
| "    | 1 | u  | u     | 1  | 370  |    | u    | 6    | u  | u     | 1 | 381   |    |

The melting point of the tin-lead alloys decreases almost proportionately to the increase of tin, from 619° F., the melting point of pure lead, to 356° F., when the alloy contains 68% of tin, and then increases to 448° F., the melting point of pure tin. Alloys on either side of the 68% mixture begin to soften materially at 356° F., because at that temperature the eutectic alloy melts and permits the whole alloy to soften.

The relative hardness of the various tin and lead solders has been determined by Brinell's method. The results are as follows:

| % Tin    | 0     | 10    | 20    | 30    | 40    | 50    | 60    |
|----------|-------|-------|-------|-------|-------|-------|-------|
| Hardness | 3.90  | 10.10 | 12.16 | 14.46 | 15.76 | 14.90 | 14.58 |
| % Tin    | 66    | 67    | 68    | 70    | 80    | 90    | 100   |
| Hardness | 16.66 | 15.40 | 14.58 | 15.84 | 15.20 | 13.25 | 4.14  |

The hardest solder is the one composed of 2 parts of tin and 1 part of lead. It is the eutectic, or the one with the lowest melting point of all the mixtures given in the table.

#### Common Pewter

Common pewter contains 4 parts of lead to 1 part of tin.

#### Composition and Fusing Points of Hard Solders

|                      |               | Fusing- |                    |              |
|----------------------|---------------|---------|--------------------|--------------|
| Kind                 | Zinc          | Copper  | Silver             |              |
| Spelter, hardesthard | 1<br>2        | 2 3     |                    | 700°<br>550° |
| " soft               | $\frac{1}{2}$ | ${f 1}$ | 1/4                |              |
| Silver, hard medium  |               | 1       | <b>4</b> 3         |              |
| " soft               |               | ī       | $\mathbf{\hat{2}}$ |              |

## Coloring Solder to Match Copper Work

To color the solder on copper work to correspond in color with the copper, dissolve crystal sulphate of copper (blue vitriol) in water and apply with a brush or iron rod. The more coats of this solution that are applied, the deeper and nearer copper color is obtained.

For copper cornice work the exposed soldering may be concealed by first applying shellac dissolved in alcohol, and before it can dry freely sprinkle with powdered copper bronze; or the copper bronze can be placed in banana oil and applied where wanted with a brush. Do not make up more than needed because it dries up quickly.

## Pattenizing or Ageing Copper Work

The weathering, that is to say, the beautiful greenich tint of aged and exposed copper, can be hastened by generously painting the copper with a solution of salt and vinegar or sal ammoniac and water. Some use a powerful acid solution. In all

cases the operator must be careful not to get any on his clothes or person.

#### Cleaning Soldering Coppers

The modern method of cleaning soldering irons is to quickly dip them, while hot, into a cleaning liquid, which often is composed of just water and sal ammoniac. It has, however, been found that the coppers "smoke" excessively with this liquid so some workmen use water and boiled acid to the proportion of say one of acid to five of water; the objection to this liquid is that it soon eats small holes in the coppers, but it is to be remembered that eventually happens no matter what solution is used.

#### How to Judge Solder

The appearance of the solder when cold is what plumbers judge the quality by, and as plumber's solder is akin to that used by tinsmiths, only not so fine, it follows that this method will apply for tinsmith's solder; naturally, though, more tin is to be looked for. A small quantity is poured out on a level stone or brick and the color on setting is noted, also the number and size of bright spots on its surface. On a piece about the size of a silver dollar will appear, if the correct proportions are present, about four spots one-eighth inch or so in diameter. The side of the solder which was in contact with the stone will be bright. Adding lead to the solder will reduce the size or number of bright@spots, and if continued will turn out solder of chalky appearance and coarse texture; adding more tin to the solder will brighten it.

The solder should be well stirred before a test is made or an incorrect impression of its quality will be received and the rate of cooling also affects its appearance. If cooled too quickly, as would happen when the solder is poured on an iron plate, the metal will appear much finer than it really is. If the appearance is chalky with numerous minute bright spots, there is probably a small percentage of zinc or antimony in it, which, of course, means that it is not as pure as it should be.

#### **Doctoring Solder**

A well known writer on plumbing states in one of his books how much plumber's solder may be refined and as tinsmith's solder is practically the same and they often remelt scrap solder, it would seem that this method is equally useful to both classes of workmen.

You may have spoiled your solder also by overheating it or you may have been tinning your brass couplings by dipping them. This should never be done owing to the risk of overheating the brass and releasing a proportion of the zinc. It may also have happened by pouring the solder when at too high a temperature over a brass ferrule in the process of wiping a joint, or in the case of tinsmiths much soldering in galvanized iron would permeate the scrap solder with an excess of zinc. Now for the cure.

Your solder should be made extra hot, almost twice the temperature it should be if all were right. Plumber's solder melts at 440° F. To clean it you want to raise it to 800° F. Why? Because

zinc melts off at 773°. Do not make it red hot in the daylight or you will have reached a temperature of about 1,100° F. and you will spoil it. Throw in a lump of sulphur (rosin also helps) and this mixing with the zinc helps it to float. Stir up the contents and skim off the top, which will be a mixture of lead oxide, putty powder, sulphur and zinc. Then when it has cooled down to about the working point stir in tallow and some more rosin and skim again. Then add a little tin to replace what was burned out in raising the metal to such a high temperature, and it should be ready to wipe with again; or for tinsmithing add tin to a generous amount.

Another way to obtain the same result is to granulate the solder by pounding it. When it reaches the cooling point it will break up as fine as sawdust. Then put it into a dish and cover it with muriatic acid and allow it to stand over night. This will remove all traces of zinc.

If solder becomes overheated through inattention do not stir it until it has cooled to about the correct wiping temperature; otherwise more tin will oxidize on the surface and be lost. If you consider that tin forms putty powder at 428° F. and lead oxidizes at 612° F., the two together at 440° F., you will understand what happens when you allow it to become red hot in the daylight, for it is then about 700° hotter than it should be. Do not add fine or scrap solder to your pot unless you are certain of its purity.

Solder may be adulterated with antimony or bis-

muth to secure brightness and it will then be exceedingly difficult to wipe a joint that will not drop at the bottom and, too, for soldering purposes will not flow well. Be careful always to put paper below a joint to catch your surplus solder, never allow brass or zinc to mix with it and never melt zinc in a pot that is to be used again for solder. Refer to the tables on page 234 for information on the melting point of solder and its component parts and other useful information.

## Common Soldering Fluxes

In tinsmithing, or rather sheet metal working, the common fluxes for soldering purposes are: Commercial muriatic acid used raw on galvanized iron work when the solder alone is the means of joining the parts together. Boiled acid, zinc chloride, for galvanized iron work when the solder is just to make a water or air-tight joint and rivets. or a groove or double seam hold the parts together.

Raw acid should be used for zinc work, but especial care is necessary so that the acid will not eat holes in the metal and all acid should be carefully cleaned away after soldering. If the zinc is very clean and bright boiled acid could be used.

Boiled acid is used for soft soldering copper or brass work, though if the copper is dirty it should first be cleaned with raw acid, which should be washed off before applying the boiled acid. Some workmen use rosin, but it is not as satisfactory as acid, especially for speedy work.

Rosin is used for tin roofing and tinware, though for rapid work on the latter boiled acid should be

used and the article carefully cleaned in hot water after soldering. By "boiled" acid is meant muriatic acid to which small pieces of zinc have been fed until the acid ceases to boil, after which a large piece of zinc is placed in and the acid allowed to stand awhile before using; use a strong jar for a container and do not do this indoors because the fumes are disagreeable.

## Flux for Soldering Tin Roof

One part rosin and 2 parts binnacle oil mixed hot and used the same as rosin alone; or, cut with alcohol I pint as much rosin as possible and put on with a swab. Either, good when the wind blows. Or, saponified or red oil used with a swab along the seams. Solder flows more freely than with rosin alone as the flux.

# Special Soldering Fluid or Flux

Prussiate of potash, borax and copperas, each I dram; sal ammoniac, ½ ounce, muriatic acid, 3½ ounces, well mixed, then add as much zinc as it will dissolve. Add I pint or more water according to strength required.

Flux of Sal Ammoniac, Borax and Zinc Chloride
Sal ammoniac and borax, each I dram; chloride of
zinc, I ounce, water, I pint. It will not eat copper
or tarnish tin. Use less water and it will be stronger.

#### Cleaning Brass

The articles to be cleaned must be warmed and then rubbed with a mixture of roche alum one part to water sixteen parts. Then finish with fine tripoli, according to requirements.

#### Case Hardening

Place the article to be case hardened in an iron box with horn, hoof, bone-dust or shreds of leather and heat blood red. Then dip the article in cold water.

Another method is to heat the article, after polishing, to a bright red and then rub the surface with prussiate of potash. Allow it to cool to a dull red and dip it in water.

# Case Hardening Mixture Case Hardening Mixture No. 1 No. 2

Prussiate of Potash.3 parts Sal ammoniac.....1 part Prussiate of Potash.1 part Sal ammoniac.....2 parts Bone Dust.......2 parts

Either mixture may be used with satisfactory results.

## Ink for Marking Galvanized Iron Work

A marking fluid or ink that will not readily rub off when used on galvanized iron (or copper) is made by saving the filings from the soldering irons and depositing them in a glass receptacle which contains muriatic acid. After standing a short time this ink is ready for use and is applied as in ordinary writing or sketching, with a pointed hardwood stick. Remove the stick when not in use.

# Ink for Marking Tinware

Tinware can be marked with an ink made by reducing asphalt or black varnish with turpentine to the desired consistency. It should be kept in a corked bottle and well shaken before using.

This ink can be used for marking any bright article and is easily removed by means of a cloth dipped

in coal oil or turpentine. Another excellent ink for such articles is composed of shellac varnish and alcohol and colored with fine lamp black. This forms a jet black lusterless ink, insoluble in water, but removable with alcohol.

#### Rust-Proof Coating for Steel

Dissolve one part of caoutchouc and sixteen parts of turpentine with a low temperature. Then add eight parts of boiled oil. Mix them by bringing them to the boiling point. Apply to the steel with a brush just as you would in varnishing. The coating may be removed with turpentine.

#### Removing Rust from Steel

Brush with a paste compound of one-half ounce cyanide of potassium, one-half ounce castile soap, one ounce whiting and enough water to make a paste. The steel should then be washed with a solution of one-half ounce cyanide of potassium in two ounces of water.

## Cement for Fastening Brass to Glass Vessels

Melt rosin 150 parts, wax 30, and add burnt ocher 30 and calcined plaster 2 parts. Apply warm.

# A Cheap Cement

Melted brimstone, either alone or mixed with rosin and brick dust, forms a tolerably good and very cheap cement.

## Cement for Fastening Blades, Files, Etc.

Shellac 2 parts, prepared chalk 1, powdered and mixed. The opening for the blade is filled with

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this powder, the lower end of the iron heated and pressed in.

#### China Cement

Take the curd of milk, dried and powdered, 10 ounces; quicklime, 1 ounce; camphor, 2 drams. Mix and keep in closely stoppered bottles. When used, a portion is to be mixed with a little water into a paste, to be applied quickly.

#### Cement to Render Cisterns and Casks Water Tight

An excellent cement for resisting moisture is made by incorporating thoroughly 8 parts of melted glue, of the consistence used by carpenters, with 4 parts of linseed oil, boiled into varnish with litharge. This cement hardens in about 48 hours and renders the joints of wooden cisterns and casks air and water tight. A compound of glue with one-quarter its weight of Venice turpentine, made as above, serves to cement glass, metal and wood to one another. Fresh made cheese curd and old skim milk cheese, boiled in water to a slimy consistency, dissolved in a solution of bicarbonate of potash are said to form a good cement for glass and porcelain. The gluten of wheat, well prepared, is also a good cement. White of eggs with flour and water, well mixed, and smeared over linen cloth, forms a ready lute for steam joints in small apparatus.

#### Cement for Holes in Castings

The best cement for this purpose is made by mixing 1 part of sulphur in powder, 2 parts of sal ammoniac and 80 parts of clean powdered iron turn-

ings. Sufficient water must be added to make it into a thick paste, which should be pressed into the holes or seams which are to be filled up. The ingredients composing this cement should be kept separate and not mixed until required for use. It is to be applied cold, and the casting should not be used for two or three days afterward.

#### Cement for Coppersmiths and Engineers

Boiled linseed oil and red lead mixed together into a putty is often used by coppersmiths and engineers to secure joints. The washers of leather or cloth are smeared with this mixture in a pasty state.

#### Cement for Corks

The bituminous or black cement for bottle corks consists of pitch hardened by the addition of rosin and brick dust.

#### Cement for Mending Earthen and Glass Ware

1. Heat the article to be mended a little above boiling water heat, then apply a thin coating of gum shellac on both surfaces of the broken vessel, and when cold it will be as strong as it was originally.

2. Dissolve gum shellac in alcohol, apply the solution and bind the parts firmly together until the cement is perfectly dry.

#### Gas Fitters' Cement.

Mix together resin 4½ parts, wax I part, and Venetian red 3 parts.

#### Transparent Cement for Glass

Dissolve I part of India rubber in 64 of chloroform, then add gum mastic in powder 14 to 24 parts, and digest for two days with frequent shaking. Apply with camel's-hair brush.

#### Cement for Iron Pots and Pans

Take 2 parts of sulphur, and I part, by weight, of fine black lead; put the sulphur in an old iron pan, holding it over the fire until it begins to melt, then add the lead, stir well until all is mixed and melted, then pour out on an iron plate or smooth stone. When cool, break into small pieces. A sufficient quantity of this compound being placed upon the crack of the iron pot to be mended, can be soldered by a hot iron in the same way a tinsmith solders his sheets. If there is a small hole in the pot, drive a copper rivet in it and then solder over it with this cement.

# Iron Rust Cement Nos. 1 and 2

Is made from 50 to 100 parts of iron borings, pounded and sifted, mixed with 1 part of sal ammoniac, and when it is to be applied, moistened with as much water as will give it a pasty consistency. Another composition of the same kind is made by mixing 4 parts of fine borings or filings of iron, 2 parts of potters' clay and 1 part of pounded potsherds, and making them into a paste with salt and water to the proportions required.

Rust Joint Cement No. 3

Quick setting

Sal ammoniac I part

Flour of sulphur 2 parts

Iron borings 80 parts

Rust Joint Cement No. 4
Slow setting
Sal ammoniac 2 parts
Flour of sulphur 1 part
Iron borings 200 parts

The slow setting is the best if the joint is not required for immediate use.

#### Cement for Iron Tubes, Boilers, etc.

Finely powdered iron, 66 parts; sal ammoniac, I part; water of a sufficient quantity to form a suitable paste, by mixing all thoroughly together.

## Cement for Ivory, Mother of Pearl, etc.

Dissolve I part of isinglass and 2 of white glue in 30 of water, strain and evaporate to 6 parts. Add I-30 part of gum mastic, dissolve in ½ part of alcohol and I part of white zinc. When this receipt is required for use warm it carefully in an apparatus like a glue pot, and then shake it up.

#### Cements for Leather

A mixture of India rubber and shellac varnish makes a very adhesive leather cement. A strong solution of common isinglass, with a little diluted alcohol added to it, makes another excellent cement for leather.

#### Marble Cement

Take plaster of Paris and soak it in a saturated solution of alum, then bake the two in an oven, the same as gypsum is baked to make it plaster of Paris;

after which they are ground to powder. It is then used as wanted, being mixed up with water like plaster and applied. It sets into a very hard composition capable of taking a very high polish. It may be fixed with various coloring minerals to produce a cement of any color capable of imitating marble.

## Cement for Marble Workers and Coppersmiths

White of an egg alone, or mixed with finely sifted quicklime, will answer for uniting objects which are not exposed to moisture. The latter combination is very strong and is much employed for joining pieces of spar and marble ornaments. A similar composition is used by coppersmiths to secure the edges and rivets of boilers, only bullock's blood is the albuminous matter used instead of the white of an egg.

#### Cement for Joining Metals and Wood

Melt rosin and stir in calcined plaster until reduced to a paste, to which add boiled oil a sufficient quantity to bring it to the consistence of honey; apply warm. Or, melt rosin 180 parts and stir in burnt umber 30 parts, calcined plaster 15 parts and boiled oil 8 parts.

# Non-Combustible and Waterproof Cement Paint

If hydraulic cement be mixed with oil, it forms a first rate anti-combustible and excellent water proof paint for roofs of buildings, walls, etc.

#### Plumbers' Cement

Black rosin, I part; brick dust, 2 parts; well incorporated by a melting heat.

#### Red Lead Cement for Face Joints

Mix one part of white lead and one part of red lead with linseed oil, using enough oil to give it the proper consistency.

#### Cement for Stone Ware

Another cement in which an analogous substance, the curd of milk, is employed, is made by boiling slices of skim milk cheese into a gluey consistence in a great quantity of water, and then incorporating it with quicklime on a slab with a muller, or in a marble mortar. When this compound is applied warm to broken edges of stone ware, it unites them very firmly after it is cold.

#### Waterproof Cement

Zinc white rubbed up with copal varnish to fill up the indentures; when dry, to be covered with the same mass somewhat thinner, and lastly with copal varnish alone.

#### Cement for Cracks in Wood

Make a paste of slaked lime I part, rye meal 2 parts, with a sufficient quantity of linseed oil. Or dissolve I part of glue in 16 parts of water, when almost cool stir in sawdust and prepared chalk a sufficient quantity. Or oil varnish thickened with a mixture of equal parts of white lead, red lead, litharge and chalk.

#### A Good General Cement

Shellac, dissolved in alcohol or in a solution of borax, forms a pretty good cement.

#### Cement for Repairing Fractured Bodies of All Kinds

White lead ground upon a slab with linseed oil varnish and kept out of contact of air affords a cement capable of repairing fractured bodies of all kinds. It requires a few weeks to harden. When stone and iron are to be cemented together, a compound of equal parts of sulphur with pitch answers very well.

#### Cement to Stop a Leaky Roof

Twenty-five pounds yellow ocher, I pound litharge, 6 pounds black lead, I pound fine salt; boil well in oil. Soak strips of cloth in the above and paste over the seams; first thoroughly cleaning the spot of all dirt and loose paint. Good where solder is not practicable.

#### Putty for Skylights

As a rule it is the cheapest in the end to buy your putty for skylight work. Each manufacturer has his own formula, but it is well to keep in mind that the cheapest putty is the dearest in the end. Only pure linseed oil putty should be used. If too soft thicken with whiting, and if too hard soften with linseed oil.

A good home-made putty is composed of fine white sand, litharge and rosin mixed in boiled linseed oil. Or just mix whiting in linseed oil to the consistency of dough.

#### Acid-proof Putty

- 1. Melt I part of gum elastic with 2 parts of linseed oil and mix with the necessary quantity of white bole by continued kneading to the desired consistency. Hydrochloric acid and nitric acid do not attack this putty, it softens somewhat when warm and does not dry readily on the surface. The drying and hardening is effected by an admixture of ½ part of litharge or red lead.
- 2. A putty which will even resist boiling sulphuric acid is prepared by melting caoutchouc at a moderate heat, then adding 8 per cent of tallow, stirring constantly, whereupon sufficiently slaked lime is added until the whole has the consistency of soft dough. Finally about 20 per cent of red lead is still added, which causes the mass to set immediately and to harden and dry. A solution of caoutchouc in double its weight of linseed oil, added by means of heat and with the like quantity (weight) of pipe clay, gives a plastic mass which likewise resists most acids.

#### Black Putty

Mix whiting and antimony sulphide, the latter finely powdered, with soluble glass. This putty, it is claimed, can be polished, after hardening, by means of a burnishing agate.

#### Glaziers' Putty

1. For puttying panes or looking glasses into picture frames a mixture prepared as follows is well adapted: Make a solution of gum elastic in ben-

zine, strong enough so that a syrup-like fluid results. If the solution be too thin, wait until the benzine evaporates. Then grind white lead in linseed-oil varnish to a stiff paste and add the gum solution. This putty may be used, besides the above purposes, for the tight puttying-in of window panes into their frames. The putty is applied on the glass lap of the frames and the panes are firmly pressed into it. The glass plates thereby obtain a good, firm support and stick to the wood, as the putty adheres both to the glass and to the wood.

- 2. A useful putty for mirrors, etc., is prepared by dissolving gummi elasticum (caoutchouc) in benzol to a syrupy solution, and incorporating this latter with a mixture of white lead and linseed oil to make a stiff pulp. The putty adheres strongly to both glass and wood, and may therefore be applied to the framework of the window, mirror, etc., to be glazed, the glass being then pressed firmly on the cementing layer thus formed. Surplus putty should be cleaned off
- 3. Mix seventy pounds of whiting, thirty pounds of boiled oil and two gallons of water. If this is too thin, add more whiting. If too thick, add more oil until of suitable consistency.

#### To Soften Old Putty

To remove old putty from broken windows, dip a small brush in nitro-muriatic acid or caustic soda and apply it to the putty. In about an hour the putty will have become so soft that it may be easily removed with a glazier's putty knife.

#### To Soften Glaziers' Putty

- I. Glaziers' putty which has become hard can be softened with the following mixture: Mix carefully equal parts of crude powdered potash and freshly burnt lime and make it into a paste with a little water. This dough, to which about ¼ part of soft soap is still added, is applied on the putty to be softened, but care has to be taken not to cover other paint, as it would be surely destroyed thereby. After a few hours the hardest putty will be softened by caustic mass and can be removed from glass and wood.
- 2. A good way to make the putty soft and plastic enough in a few hours so that it can be taken off like fresh putty, is by the use of kerosene, which entirely dissolves the linseed oil of the putty, transformed into rosin, and quickly penetrates it.

#### Hard Putty

This is used by carriage painters and jewelers. Boil 4 pounds brown umber and 7 pounds linseed oil for 2 hours; stir in 2 ounces beeswax; take from the fire and mix in 5½ pounds chalk and 11 pounds white lead; the mixing must be done very thoroughly by constantly stirring or kneading.

#### Painters' Putty and Rough Stuff

Gradually knead sifted dry chalk (whiting) or else rye flour, powdered white lead, zinc white, or lithopone white with good linseed-oil varnish. The best putty is produced from varnish with plenty of chalk and some zinc white. This mixture can be tinted with earth colors. These oil putties must be well kneaded together and rather compact (like glaziers' putty).

If flour paste is boiled (this is best produced by scalding with hot water, pouring in, gradually, the rye flour which has been previously dissolved in a little cold water and stirring constantly until the proper consistency is attained) and dry sifted chalk and a little varnish are added, a good stuff for wood or iron is obtained, which can be rubbed. This may also be produced from glaziers' oil putty by gradually kneading into it flour paste and a little more sifted dry chalk as may be required.

#### Waterproof Putties

1. Grind powdered white lead or minium (red lead) with thick linseed oil varnish to a stiff paste. This putty is used extensively for tightening wrought-iron gas pipes, for tightening rivet seams on gas meters, hot-water furnaces, cast-iron flange pipes for hot-water heating, etc. The putty made with minium dries very slowly, but becomes tight even before it is quite hard, and holds very firmly after solidification. Sometimes a little ground gypsum is added to it.

The two following putties are cheaper than the above-mentioned red lead putty:

- 2. One part white lead, I part manganese, one part white pipe clay, mix with linseed oil varnish.
- 3. Two parts red lead, 5 parts white lead, 4 parts clay, ground in or prepared with linseed oil varnish.
  - 4. Excellent putty, which has been found invalu-

able where waterproof closing and permanent adhesion are desired, is made from litharge and glycerine. The litharge must be finely pulverized and the glycerine very concentrated, thickly liquid, and clear as water. Both substances are mixed into viscid, thickly liquid lumps. The pegs of kerosene lamps, for instance, can be fixed in so firmly with this putty that they can only be removed by chiseling it out. For putting in the glass panes of aquariums it is equally valuable. As it can withstand higher temperature it may be successfully used for fixing tools, curling irons, forks, etc., in the wooden handles. The thickish putty mass is rubbed into the hole, and the part to be fixed is inserted. As this putty hardens very quickly it cannot be prepared in large quantities, and only enough for immediate use must be compounded in each case.

- 5. Five parts of hydraulic lime, 0.3 parts of tar, 0.3 parts of rosin, I part of horn water (the decoction resulting from boiling horn in water and decanting the latter). The materials are to be mixed and boiled. After cooling, the putty is ready for use. This is an excellent cement for glass, and may be used also for reservoirs and any vessels for holding water, to cement the cracks; also for many other purposes. It will not give way, and is equally good for glass, wood, and metal.
- 6. This is especially recommended for boiler leaks: Mix well together 6 parts of powdered graphite, 3 parts of slaked lime, 8 parts of heavy spar (barytes), and 8 parts of thick linseed oil varnish, and apply in the ordinary way to the spots.

#### Concrete Mixtures

The right kind of concrete should have the voids completely filled so that one stone should not touch another, and one grain of sand should be separated from the next by the fine cement. Water will go through concrete male from ordinary mixtures, but I part cement, 1½ to 2 parts of sand and 4 parts of 34-inch stone will be fairly watertight. Waterproofing of some kind is most always used.

The best proportions for ordinary work is: 1:3:6, for best work;  $1:1\frac{1}{2}:4$  is used for ordinary work—tanks, etc. The units are taken by measure and not by weight.

#### CHAPTER X

# Useful Tables

#### TABLE I

## Black Sheet Iron and Wire Gauge

Black Sheets are rolled to the following Standard Gauges adopted by the United States, taking effect July 1, 1803.

|                  | Тню  | CKNESS   | WE  | GHT  |
|------------------|--|--|---|--|
| Number of Gauge. | Approximate<br>Thickness<br>in Fractions<br>of an Inch | Approximate<br>Thickness<br>in Decimal Parts<br>of an Inch | Steel<br>Weight Per<br>Square Foot<br>in Pounds | Tron<br>Weight Per<br>Square Foot<br>in Pounds |
| 8                | _  | .1719  | 7.012   | 6.875  |
| 9                |  | .1563  | 6.375   | 6.250  |
| 10               |  | .140625  | 5.737   | 5.625  |
| 11               |  | .125   | 5.100   | 5.000  |
| 12               |  | . 109375   | 4.462   | 4.375  |
| 13               | . 3-32   | .09375   | 3.825   | 3.750  |
| 14.'             | . 5-64   | .078125  | 3.157   | 3.125  |
| 15               | . 9-128  | .0703125   | 2.869   | <b>2.8125</b>                                  |
| 16               | . 1-16   | .0625  | 2.550   | 2.500  |
| 17               | . 9-16   | .05625   | 2.295   | 2.250  |
| 18               | . 1-20   | .05  | 2.040   | 2.000  |
| 19               | . 7-16   | .04375   | 1.785   | 1.750  |
| $20\ldots\ldots$ |  | .0375  | 1.530   | 1.500  |
| 21               |  | .034375  | 1.402   | 1.375  |
| 22               |  | .03125   | 1.275   | 1.250  |
| 23               |  | .028125  | 1.147   | 1.125  |
| $24\ldots\ldots$ |  | .025   | 1.020   | 1.000  |
| $25.\ldots$      |  | .02187.  | 0.892   | .875   |
| $26.\dots$       | . 3-16   | .01875   | 0.765   | .750   |
| 27               |  | .0171875   | 0.701   | .6875  |
| 28               |  | .015625  | 0.637   | .625   |
| 29               |  | .0140625   | 0.574   | . 5625   |
| 30               |  | .0125  | 0.510   | . 500  |
| 31               | . 7-64   | .0109375   | 0.446   | . 4375   |
| <b>32</b>        | . 13-128   | .01015625  | 0.414   | .40625   |

A variation of 21/2 per cent. either way is allowed

TABLE 2

Weights of Plate Iron Per Lineal Foot in Pounds

| Widths                                  |  |  |   |  | •   |   | E    | Thickness                               | in Inches                              | S                                       |  |  |   |  |  |  |
|---|--|--|---|--|---|---|------|---|--|---|--|--|---|--|--|--|
| Inches                                  | 1/16   | 1/8  | 3/16                                      | 1/4                                      | \$/16                                     | 8/8                                     | 7/16 | 1/2                                     | 9/16                                   | 8/9                                     | 11/16  | */*  | 13/16                                     | 8/2  | 15/16  | 1  |
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Weights of Flat Rolled Iron Per Lineal Foot in Pounds TABLE 3

|             |              |          | ر<br>د    |             |          |             | 2          |               |            |          |             | 1                | •         |                   | ?               |                |
|-------------|--------------|----------|-----------|-------------|----------|-------------|------------|---------------|------------|----------|-------------|------------------|-----------|-------------------|-----------------|----------------|
| Widths      |              | ŢŢ       | Thickness | in Inches   | SS       |             |            | Iron weighing | ighing 4   | 480 lbs. | per cubi    | cubic foot.      | For steel | el add 2          | add 2 per cent. | نب             |
| Inches      | 1/16         | 1/8      | 2/16      | 1/1         | 5/16     | 3/8         | 7/16       | 1/2           | 91/6       | 8/9      | 11/16       | 3/4              | 12/16     | 8/2               | 15/16           | -              |
| 1           | 0.208        | 0.417    | 0.625     | 0.833       | 1.04     | 1.25        | 1.46       |               | 1.88       | 2.08     | 2.29        | 2.50             |           | 2.92              | 3.13            | 33             |
| 17.         | 260          | .521     | .781      | 20.         | 1.30     | 1.56        | 1.82       |               | 2.34       | 2.69     | 2.86        | 3.13             |           | 3.65              | 3.91            | 4.17           |
| 23          | .313         | .625     | .938      | 1.25        | 1.56     | 1.88        | 2.19       |               | 2.81       | 3.13     | 3.44        | 3.75             |           | 4.38              | 4.69            | 2.00           |
| 13%         | .365         | .729     | 1.09      | 1.46        | 1.82     | 2.19        | 2.55       |               | 3.28       | 3.65     | 4.01        | 4.38             |           | 5.10              | 5.47            | 5.83           |
| <b>6</b> 7  | .417         | .833     | 1.25      | 1.67        | 2.08     | 2.50        | 2.92       |               | 3.75       | 4.17     | 4.58        | 2.00             |           | 5.83              | 6.25            | 9.9            |
| 2,7%        | .469         | .938     | 1.41      | 1.88        | 2.34     | 2.81        | 3.<br>28   |               | 4.22       | 4.69     | 5.16        | 5.<br>83         |           | 6.56              | 8               | 8              |
| 22          | .521         | 1.04     | 1.56      | .08<br>8    | 2.<br>89 | 3.13        | 3.65       |               | 4.69       | 5.21     | 5.73        | 6.25             |           | 2.38              | 7.81            | &<br>83        |
| %<br>%      | 573          | 1.15     | 1.72      | 53<br>73    | 2.86     | 3.44        | 4.01       |               | 5.16       | 5.73     | 6.30        | 98<br>98         |           | 8<br>07           | &<br>&          | 9.17           |
| 0           | .625         | 1.25     | 1.88<br>8 | 2<br>2<br>2 | 3.13     | 3.75        | 4.38       |               | 5.63       | 6.25     | 88.<br>88.  | 2.20             |           | 8.75              | 6<br>88<br>88   | 90.08          |
| 37%         | .677         | 1.35     | 2.03      | 2.71        | 3.39     | 4.06        | 4.74       |               | 60.<br>9   | 6.77     | 7.45        | 8.13             |           | 9.48              | 10.16           | 10.83          |
| 37%         | .729         | 1.46     | 2.19      | 2.95        | 3.65     | 4.38        | 5.10       |               | 6.56       | 2.39     | 8.02        | 8.75             |           | 10.21             | 10.94           | 11.67          |
| 3%          | .781         | 1.56     | 2.34      | 3.13        | 3.91     | 4.09        | 5.47       |               | 7.03       | 7.81     | 8.59        | 9.38             |           | 10.94             | 11.72           | 12.50          |
| 4           | .833         | 1.67     | 2.50      | 3.33        | 4.17     | 5.00        | 5.83       |               | 2.50       | 8.33     | 9.17        | 10.00            |           | 11.67             | 12.50           | 13.33          |
| 41/         | .885         | 1.77     | 2.66      | 3.54        | 4.43     | 5.31        | 6.20<br>80 |               | 7.97       | 8.85     | 9.74        | 10.63            |           | 12.40             | 13.28           | 14.17          |
| 47%         | 886.         | 1.88     | 2.81      | 3.75        | 4.69     | 5.63        | 6.56       |               | 8.44       | 9.38     | 10.31       | 11.25            |           | 13.13             | 14.06           | 15.00          |
| 4%          | <u>6</u>     | 1.98     | 2.97      | 3.96        | 4.95     | 5.94        | 6.93       |               | 8.91       | 9.90     | 10.89       | 11.88            |           | 13.85             | 14.84           | 15.83          |
| 2           | <b>1</b> .04 | 2.08     | 3.13      | 4.17        | 5.21     | 6.25        | 2.3        |               | 9.38       | 10.42    | 11.46       | 12.50            |           | 14.58             | 15.63           | 16.67          |
| 2%          | 89.          | 2.19     | 3.28      | 4.38        | 5.47     | 6.56        | 7.66       |               | <b>8</b> . | 10.94    | 12.03       | 13.13            |           | 15.31             | 16.41           | 17.50          |
| 2%          | 1.15         | 2.29     | 3.44      | 4.58        | 5.73     | 88.<br>88   | 8<br>8     |               | 10.31      | 11.46    | 12.60       | 13.75            |           | 16.0 <u>4</u>     | 17.19           | 18.33          |
| 2%          | 2            | 2.40     | 3.59      | 4.79        | 5.99     | 7.19        | 8<br>30    |               | 10.78      | 11.98    | 13.18       | 14.38            |           | 16.77             | 17.97           | 19.17          |
| <b>©</b>    | .25          | 2.50     | 3.75      | 2.00        | 6.25     | 7.50        | 8.75       |               | 11.25      | 12.50    | 13.75       | 15.00            |           | 2.2               | 18.75           | 8<br>8<br>8    |
| %           | 30           | 9.<br>9. | 3.91      | 5.21        | 6.51     | 7.81        | 9.11       | 10.42         | 11.72      | 13.02    | 14.32       | 15.63            | 16.93     | 18.23             | 19.53           | 8              |
| 27          | 35           | 2.71     | 4.<br>8.  | 5.42        | 6.77     | 8.13        | 9.48       |               | 12.19      | 13.54    | 14.90       | 16.25            |           | 18.96             | 20.31           | 21.67          |
| ,<br>%      | 1.41         | 2.81     | 4.22      | 5.63        | 7.03     | 8.44        | 8<br>8     |               | 12.56      | 14.06    | 15.47       | 16.88            |           | 19.69             | 21.09           | 22.50          |
| 7           | 1.46         | 2.92     | 4.38      |             | 83       | 8.75        | 10.21      |               | 13.13      | 14.58    | 16.04       | 17.30            |           | 20.42             | 21.88           | 23<br>23<br>33 |
| 7.72        | 1.56         | 3.13     | 4.69      | 6.25        | .81      | 9.38        | 10.9       |               | 14.06      | 15.63    | 17.19       | 18.75            |           | 21.88             | 23.44           | 25.00          |
| 00          | 1.67         | 3.33     | 2.00      | 6.67        | 89<br>83 | 10.00       | 11.67      |               | 15.00      | 16.67    | 18.33       | 8                |           | 83<br>83          | 22.00           | 20.67          |
| 8<br>2<br>2 | 1.77         | 7        | 5.31      | 8           | 8        | 10.63<br>63 | 12.41      |               | 15.94      | 17.71    | 19.48       | 21.25            |           | 7 <del>7</del> 79 | 28.56<br>28.56  | 28.33          |
| ع د         | 88           | 3.75     | 5.63      | 2.50        | 6.38     | 11.25       | 13.13      |               | 16.88      | 18.75    | 8<br>8<br>8 | 2<br>2<br>2<br>3 |           | 26.25             | 28.13           | 2              |
| 3=          | 38           | 71.4     | 07.0      | × 00        | 10.42    | 12.50       | 14.58      |               | 18.75      | 8<br>8   | 55.<br>85.  | 22.00            |           | 29.17             | 31.25           | 33             |
| 2           | 2            | 5        | 95        | 3.5         | 11.46    | 13.75       | 91         |               | 20°63      | 25.85    | 25.21       | 24.50            |           | 35.08             | 34.38           | 36 67          |
|             | :            | ,        | 3         | 3           | 12.50    | (K). GI     | 16.71      |               | 22.50      | 25.00    | 27.50       | 30.00<br>20.00   |           | 35.00             | 37.50           | 40.00          |

Weights of Flat Rolled Iron Per Lineal Foot in Pounds TABLE 3 (Continued)

TABLE 4

## Plate Iron

The following table gives the weight per square foot for iron plates 1/16 inch up to 2 inches thick.

| Thickness      | Weight in Lbs. | Thickness        | Weight in Lbs. |
|----------------|----------------|------------------|----------------|
| 16             | 2.5            | 116              | 42.5           |
| 1/8            | 5.0            | 11/8             | 45.0           |
| 3              | 7.5            | $1\frac{3}{16}$  | 47.5           |
| 1/4            | 10.0           | 11/4             | 50.0           |
| <del>5</del>   | 12.5           | $1\frac{5}{16}$  | 52.5           |
| 3/8<br>7<br>16 | 15.0           | 15/8             | <b>55.0</b>    |
| 7<br>16        | 17.5           | $1\frac{7}{16}$  | <b>57</b> .5   |
| 1/2            | 20.0           | 11/2             | 60.0           |
| 1/2<br>9<br>16 | 22.5           | $1\frac{9}{16}$  | 62.5           |
| 15/8           | 25.0           | 15/8             | 65.0           |
| 11             | 27.5           | $1\frac{11}{16}$ | 67.5           |
| 3/4            | 30.0           | $1\frac{3}{4}$   | 70.0           |
| 13<br>16       | 32.5           | 113              | 72.5           |
| <b>7∕8</b>     | 35.0           | 17/8             | 75.0           |
| 15<br>16       | 37.5           | $1\frac{15}{16}$ | <b>7</b> 7.5   |
| 1              | 40.0           | $2^{-}$          | 80.0           |

TABLE 5

# Weight of Russia Sheet Iron with Approximate U. S. Guage Number

| Russian<br>Gauge Number | U. S. Gauge<br>Number (Approx.) | Weight Per Sheet (28" = 56") Pounds |
|-------------------------|---------------------------------|-------------------------------------|
| 16                      | 21                              | 141/2                               |
| 15                      | $22\frac{3}{8}$                 | $13\frac{1}{2}$                     |
| 14                      | $23\frac{1}{2}$                 | $12\frac{1}{2}$                     |
| 13                      | 23                              | 12                                  |
| 12                      | <b>24</b>                       | 11                                  |
| 11                      | 25                              | 10                                  |
| 10                      | 26                              | 9                                   |
| 9                       | 27                              | 8 .                                 |
| 8                       | 28                              | 71/4                                |
| 7                       | 29                              | $6\frac{1}{4}$                      |

Average net weight per bundle is about 225 pounds.

Table 6

Weight Per Sheet of Wood's Patent-Planished
Iron in Pounds and Equivalent Russian Gauge

| Gauges,<br>Approx.<br>Russian<br>Gauge   | 18  | 20   | 22<br>14   | Sq. Ft.<br>per<br>Sheet  |
|--|---|--|--|--|
| 28 × 45<br>28 × 48<br>28 × 56<br>28 × 60<br>28 × 72<br>28 × 84<br>30 × 48<br>30 × 60<br>30 × 72<br>30 × 84                       | 16. 25 to 17<br>17. 25 to 18<br>20. 25 to 21<br>21. 5 to 21. 75<br>26 to 27<br>30. 5 to 31. 25<br>17. 25 to 18<br>18. 25 to 19<br>21. 25 to 22<br>23 to 23. 75<br>27. 5 to 28. 25<br>32. 25 to 33                 | 12 to 12.5<br>13 to 13.5<br>14.75 to 15.25<br>16.25 to 16.75<br>18.5 to 19.22.75 to 23.5<br>13 to 13.75<br>14 to 14.75<br>16.25 to 16.75<br>17.25 to 17.75<br>20.75 to 21.25<br>24.5 to 25                 | 10 to 10.25<br>10.5 to 10.75<br>12.25 to 12.5<br>13.25 to 13.5<br>16 to 16.25<br>18.75 to 19<br>10.25 to 10.75<br>11.25 to 11.75<br>13.25 to 13.75<br>14.25 to 14.75<br>19.75 to 20.25         | 8 75<br>9 33<br>10 89<br>11 66<br>14<br>16 33<br>9 37<br>10<br>11 66<br>12 5<br>15         |
| Gauges,<br>Approx.<br>Russian  | 23  | 24   | 25   | Sq. Ft.  |
| Gauge  | 13  | 12   | 11   | Sheet  |
| 28 × 45<br>28 × 48<br>28 × 56<br>28 × 72<br>28 × 84<br>30 × 45<br>30 × 48<br>30 × 60<br>30 × 72<br>30 × 84                       | 9. 25 to 9. 5<br>10 to 10. 25<br>11. 25 to 11. 5<br>12. 5 to 12. 75<br>15. 25 to 15. 5<br>17. 25 to 17. 5<br>10. 25 to 10. 5<br>10. 75 to 11. 25<br>12. 5 to 13<br>13. 5 to 14<br>16. 25 to 16. 75<br>19 to 19. 5 | 8. 25 to 8. 5<br>8. 75 to 9<br>10. 25 to 10. 5<br>10. 75 to 10. 25<br>13. 25 to 13. 5<br>15. 5 to 16<br>8. 5 to 9<br>9. 25 to 9. 75<br>11. 25 to 11. 75<br>12 to 12. 5<br>14 to 14. 75<br>16. 25 to 16. 75 | 7. 25 to 7. 5<br>7. 75 to 8<br>9. 5 to 9. 5<br>9. 75 to 10. 25<br>11. 75 to 12. 25<br>13. 75 to 14. 25<br>7. 5 to 8<br>8. 25 to 8. 75<br>9. 5 to 9. 75<br>10. 25 to 12. 75<br>14. 25 to 14. 75 | 8.75<br>9.33<br>10.89<br>11.66<br>14<br>16.33<br>9.37<br>10<br>11.66<br>12.5<br>15         |
| Gauges,<br>Approx.<br>Russian  | 26  | 27   | 28   | Sq. Ft.  |
| Gauge  | 10  | 9  | 8  | per<br>Sheet   |
| 28 × 45<br>28 × 48<br>28 × 56<br>28 × 60<br>28 × 72<br>28 × 84<br>30 × 45<br>30 × 56<br>30 × 60<br>30 × 60<br>30 × 62<br>30 × 84 | 6. 5 to 6. 75<br>7 to 7. 25<br>8. 25 to 8. 25<br>8. 75 to 9. 25<br>10. 75 to 11<br>12. 75 to 13<br>7 to 7. 25<br>7. 5 to 8<br>9 to 9. 25<br>9. 5 to 9. 75<br>11. 5 to 11. 75<br>13. 5 to 13. 75                   | 6.25 to 6.5<br>6.75 to 7.25<br>7.75 to 8.25<br>8 to 8.5<br>10 to 10.5<br>11.5 to 12<br>6.5 to 6.75<br>7 to 7.5<br>8.25 to 8.5<br>9 to 9.25<br>10.25 to 10.75<br>10.25 to 12.75                             | 5.5 to 5.75<br>6 to 6.25<br>6.75 to 7.25<br>7.5 to 8<br>9 to 9.5<br>10.5 to 11<br>6 to 6.25<br>6.5 to 6.25<br>7.25 to 7.5<br>8 to 8.25<br>9.5 to 9.75<br>11.25 to 11.5                         | 8.75<br>9.33<br>10.89<br>11.66<br>14<br>16.33<br>9.37<br>10<br>11.66<br>12.5<br>15<br>17.5 |

Weight of Area of TABLE 7 Weights and Areas of Square and Round Steel Bars\* Area of Thickness Weight of Area of Area of Circum. of Weight of

|   | ·<br>•   |
|---|--|
| Weight of O Bar per Ft. in Lbs.             | 22 670<br>22 670<br>23 670<br>24 773<br>25 773<br>26 773<br>27 773 |
| Area of<br>O Bar<br>in<br>Sq. Inches        | 0 785<br>0 9887<br>0 9887<br>1 1 1 2 1 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2   |
| Weight of ☐ Bar per Ft. in Lbs.             | 28 28 28 28 28 28 28 28 28 28 28 28 28 2   |
| Area of  Bar in Sq. Inches                  | 8.2523   |
| Thickness<br>or Diameter in<br>Inches       |  |
| Circum. of<br>O Bar<br>in<br>Ins.           | 0.1963<br>0.2454<br>0.2454<br>0.3436<br>0.3436<br>0.4509<br>0.6531<br>0.6531<br>0.7364<br>0.9337<br>0.9337<br>0.9337<br>0.9337<br>0.9337<br>0.9337<br>0.9337<br>0.9337<br>0.9337<br>1.1763<br>1.1763<br>1.1763<br>1.6690<br>1.6690<br>2.3563<br>2.3563<br>2.3563<br>2.744<br>2.1508<br>2.3563<br>2.3563<br>2.7452<br>2.7452  |
| Area of<br>O Bar<br>in<br>Sq. Ins.          | 0 0031<br>0 0048<br>0 0069<br>0 01528<br>0 01527<br>0 0274<br>0 0491<br>0 0491<br>0 01508<br>0 01508   |
| Area of Bar in Sq. Ins.                     | 0.0039 0.00611 0.00839 0.01200 0.01244 0.01244 0.02442 0.04139 0.04737 0.1182 0.0937 0.1182 0.0937 0.1182 0.1182 0.1183 0.0937 0.1183 0.2197  |
| Weight of<br>O Bar<br>1 Ft. Long<br>in Lbs. | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  |
| Weight of  Bar  Rt. Long in Lbs.            | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  |
| Thickness<br>or Diameter<br>in Inches       | は、時間、なる、計画、は、計画、対点、は、は、自然、は、自然、は、自然、は、は、は、は、は、は、は、は、は、は、は、   |

| Weight of             | per Pr.    | in Lbs.    | 66.78 | 68.44             | 70.14 | 71.86 | 73.68 | 75.37 | 77.15   | 78.95       | 22.08 | 85. <b>62</b> | <b>25</b> | 86.38 | 88.29 | 30.<br>30.  | 92.17        | 94.14 | 96.14 | 100.2 | 104.3        | 108.5 | 112.8 | 117.2       | 121.7 | 126.2 | 130.9            | 140.4 | 150.2 | 160.3   | 171.0    | 181.8 | 193.0    | <b>204</b> .4 | Book.            |
|-----------------------|------------|------------|-------|-------------------|-------|-------|-------|-------|---------|-------------|-------|---------------|-----------|-------|-------|-------------|--------------|-------|-------|-------|--------------|-------|-------|-------------|-------|-------|------------------|-------|-------|---------|----------|-------|----------|---------------|------------------|
| Area of               | 000        | Inches     | 10.64 | 20.13             | 20.63 | 21.14 | 21.65 | 22.17 | 22.69   | 23.22       | 23.76 | 24.30         | 24.85     | 25.41 | 25.97 | <b>25</b> . | 27.11        | 27.69 | 28.27 | 29.47 | 30.68<br>30. | 31.92 | 33.18 | 34.47       | 35.79 | 37.12 | 38.49            | 41.28 | 44.18 | 47.17   | 50.27    | 53.46 | 56.75    | 90.13         | 1 Co. Hand       |
| Weight of             | 1          | in Lbs.    | 85.00 | 87.14             | 80.30 | 91.49 | 93.72 | 95.96 | 98.23   | 100.5       | 102.8 | 105.2         | 107.6     | 110.0 | 112.4 | 114.9       | 117.4        | 119.9 | 122.4 | 127.6 | 132.8        | 138.2 | 143.6 | 149.2       | 154.9 | 160.8 | 166.6            | 178.7 | 191.3 | 204.2   | 217.6    | 231.4 | 245.6    | 260.3         | umbria Stee      |
| Area of               | !<br>!     | Sq. Inches |       |                   |       |       |       |       |         |             | 30.25 |               |           |       |       |             |              |       |       |       |              |       |       |             |       |       |                  |       |       |         |          |       |          |               | ion of the C     |
| Thickness<br>or Diam- | eter in    | Inches     | 100   | 5. <del>1</del> 4 | 51%   | 5,4   | 5%    | 2     | ,<br>%; | <b>6</b> /4 | 35    | 2             | 2%        | ŧ     | 58%   | #           | , <u>,</u> , | 100   |       | 61%   | 67,          | 63%   | 61%   | <b>6</b> 2% | 83%   | 67%   | -                | 7,7   | 7.7   | 787     | ·<br>••• | 874   | 87%      | <b>8%</b>     | m the 1912 edit  |
| Weight of             |            | in Lbs.    | 24.03 | 25.04             | 26.08 | 27.13 | 28.36 | 29.30 | 30.42   | 31.56       | 32.71 | 33.90         | 35.00     | 36.31 | 37.56 | 38.81       | 40.10        | 41.40 | 42.73 | 44.07 | 45.44        | 46.83 | 48.24 | 49.66       | 51.11 | 52.58 | 54.07            | 55.59 | 57.12 | 58.67   | 66.25    | 61.84 | 63.46    | 65.10         | oot. Adapted fro |
| Area of               | .E         | d. inches  | 7.069 | 7.366             | 7.670 | 7.980 | 8.296 | 8.618 | 8.946   | 9.281       | 9.631 | 9.968         | 10.32     | 10.68 | 11.05 | 11.42       | 11.79        | 12.18 | 12.57 | 12.96 | 13.36        | 13.77 | 14.19 | 14.61       | 15.03 | 15.47 | 15.90            | 16.35 | 16.80 | 17.26   | 17.72    | 18.19 | 18.67    | 19.15         | s. per cubic f   |
| Weight of             |            |            | 30.60 | 31.89             | 33.20 | 34.55 | 35.92 | 37.31 | 38.73   | 40.18       | 41.65 | 43.14         | 44.68     | 46.24 | 47.82 | 49.42       | 51.05        | 52.71 | 54.40 | 56.11 | 57.85        | 59.62 | 61.41 | 63.23       | 82.08 | 66.95 | 68.85            | 70.78 | 72.73 | 74 . 70 | 76.71    | 78.74 | 80.81    | 85.89         | l at 489.6 lb    |
| Area of               | . <u>.</u> | Sq. Inches | 9.000 | 9.379             | 9.766 | 10.16 | 10.56 | 10.97 | 11.39   | 11.82       | 12.25 | 12.69         | 13.14     | 13.60 | 14.06 | 14.54       | 15.02        | 15.50 | 16.00 | 16.50 | 17.02        | 17.54 | 18.06 | 18.60       | 19.14 | 19.69 | 20.25            | 20.82 | 21.39 | 21.97   | 22.56    | 23.16 | 23.77    | 24.38         | s are for steel  |
| Thickness             |            |            | •     | 34                | 37,   | 3     | 37.   | 3     | 3%      | 34          | 3-1/2 | <u>ب</u>      | 3%        | 346   | 33%   | 3+          | 3%           | 346   | •     | 44    | 47%          | 44    | 474   | 4.4         | 43%   | 414   | <del>-</del> 1/2 | 44    | 45%   | 444     | <b>4</b> | 4     | <b>*</b> | 4#            | * Weights        |

TABLE 8
Weights and Safe Loads of Carnegie Angles

|                                    | 0      |           |       |       |                                    |               |        | ,      |
|------------------------------------|--------|-----------|-------|-------|------------------------------------|---------------|--------|--------|
| Unequa                             | l Legs | Weight    | Safe  | Safe  | Equal                              | Legs          | Weight | Safe   |
| Size of                            | Thick- |           | Load  | Load  | Size of                            | Thick-        | Per    | Load   |
| Angle,                             | ness.  | Foot,     | Short | Long  |                                    | ness,         | Foot,  | 1-Foot |
| Inches                             | Inches |           | Leg   | Leg   | Inches                             | Inches        |        | Span   |
|                                    |        |           |       |       |                                    |               |        |        |
| $41 \times 3$                      | 13/16  | 18.5      | 18.24 | 38.61 | 8 × 8                              | 1 1/8         | 56.9   | 186.99 |
| • • •                              | 9/16   | 13.3      | 13.33 | 28.16 |                                    | 13/16         |        | 139.84 |
|                                    | 5/16   | 7.7       | 8.00  | 16.43 |                                    | 1/2           | 26.4   | 89.28  |
| $4 \times 3\frac{1}{4}$            | 13/16  | 18.5      | 24.53 | 31.15 | $6 \times 6$                       | 1             | 37.4   | 91.41  |
| - // -/                            | 9/16   | 13.3      | 17.92 | 20.93 | 0 / 0                              | 11/16         | 26.5   | 65.81  |
|                                    | 5/16   | 7.7       | 10.67 | 13.44 |                                    | 3/8           | 14.9   | 37.65  |
| $4 \times 3$                       | 13/16  | 17.1      | 17.92 | 30.61 | $5 \times 5$                       | 1 0,0         | 30.6   | 61.87  |
| 1 / 0                              | 9/16   | 12.4      | 13.12 | 22.40 | 0 / 0                              | 11/16         |        | 44.80  |
|                                    | 1/4    | 5.8       | 6.40  | 10.67 |                                    | 3/8           | 12.3   | 25.81  |
| $3\frac{1}{2} \times 3$            | 13/16  | 15.8      | 17.60 | 23.47 | 4 × 4                              | 13/16         | 19.9   | 32.11  |
| 01 / 0                             | 9/16   | 11.4      | 12.91 | 17.17 | * ^ *                              | 9/16          | 14.3   | 23.36  |
|                                    | 1/4    | 5.4       | 6.19  | 8.32  |                                    | 1/4           | 6.6    | 11.20  |
| $3\frac{1}{4} \times 2\frac{1}{4}$ | 11/16  | 12.5      | 10.56 | 19.73 | $3\frac{1}{2} \times 3\frac{1}{2}$ | 13/16         | 17.1   | 24.00  |
| 37 7 23                            | 1/2    | 9.4       | 8.11  | 15.04 | 02 \ 03                            | 9/16          | 12.4   | 17.60  |
|                                    |        |           |       |       |                                    |               |        | 8.43   |
| 9 1/ 01                            | 1/4    | 4.9       | 4.37  | 8.00  | 3 × 3                              | 1/4           | 5.8    | 13.87  |
| $3 \times 2$                       | 9/16   | 9.5       | 8.75  | 12.27 | $3 \times 3$                       | 5/8           | 11.5   |        |
|                                    | 7/16   | 7.6       | 7.04  | 9.92  |                                    | 7/16          | 8.3    | 10.13  |
|                                    | 1/4    | 4.5       | 4.27  | 5.97  |                                    | 1/4           | 4.9    | 6.19   |
| $3 \times 2$                       | 1/2    | 7.7       | 5.01  | 10.67 | $2\frac{1}{2} \times 2\frac{1}{2}$ | $\frac{1}{2}$ | 7.7    | 7.79   |
|                                    | 3/8    | 5.9       | 3.95  | 8.32  |                                    | 5/16          | 5.0    | 5.12   |
|                                    | 1/4    | 4.1       | 2.77  | 5.76  |                                    | 1/8           | 2.08   | 2.13   |
| $2\frac{1}{2} \times 2$            | 1/2    | 6.8       | 4.91  | 7.47  | $2 \times 2$                       | 7/16          | 5.3    | 4.27   |
|                                    | 5/16   | 4.5       | 3.31  | 5.01  |                                    | 1/4           | 3.19   | 2.67   |
|                                    | 1/8    | 1.86      | 1.49  | 2.13  |                                    | 1/8           | 1.65   | 1.39   |
| $2\frac{1}{2} \times 1\frac{1}{2}$ | 5/16   | 3.92      | 1.81  | 4.69  | $1\frac{1}{4} \times 1\frac{1}{4}$ | 7/16          | 4.6    | 3.20   |
|                                    | 3/16   | 2.44      | 1.17  | 2.99  |                                    | 5/16          | 3.39   | 2.45   |
| $2\frac{1}{4} \times 1\frac{1}{4}$ | 1/2    | <b>56</b> | 2.77  | 5.76  |                                    | 1/8           | 1.44   | 1.07   |
|                                    | 3/16   | 2.28      | 1.17  | 2.45  | $1\frac{1}{2} \times 1\frac{1}{2}$ | 3/8           | 3.35   | 2.03   |
| $2 \times 1$                       | 3/8    | 3.99      | 2.13  | 3.63  |                                    | 1/4           | 2.34   | 1.39   |
| _                                  | 1/8    | 1.44      | 0.80  | 1.39  |                                    | 1/8           | 1.23   | 0.77   |
| $2 \times 11$                      | 1/4    | 2.55      | 1.04  | 2.45  | $1\frac{1}{2} \times 1\frac{1}{2}$ | 5/16          | 2.33   | 1.17   |
|                                    | 3/16   | 1.96      | 0.80  | 1.92  | • • •                              | 3/16          | 1.48   | 0.76   |
| $1\frac{1}{4} \times 1\frac{1}{4}$ | 1/4    | 2.34      | 1.01  | 1.92  |                                    | 1/8           | 1.01   | 0.52   |
| • •                                | 1/8    | 1.23      | 0.56  | 1.00  | 1 × 1                              | 1/4           | 1.49   | 0.60   |
| $1\frac{1}{4} \times 1\frac{1}{4}$ | 5/16   | 2.59      | 1.17  | 1.71  |                                    | 3/16          | 1.16   | 0.47   |
| /                                  | 3/16   | 1.64      | 0.78  | 1.07  |                                    | 1/8           | 0.80   | 0.33   |
| Sofo los                           |        |           |       |       | ande for o                         |               |        | 5.00   |

Safe loads are given in thousands of pounds for one foot span.

TABLE 9

# Weights and Safe Loads of Carnegie Channels

| Depth of<br>Channel | Weight<br>per Foot                                  | Area of<br>Section   | Thickness<br>of Web  | Width of<br>Flange   | Maximum<br>Safe Load<br>in Thou-  |
|---------------------|---|--|--|--|---|
| Inches              | Lbs.  | Sq. In.  | Inches   | Inches   | sands of Lbs.   |
| 5                   | 11½<br>9.<br>6½<br>7¼<br>6¼<br>5¼<br>6.<br>5.<br>4. | 3.38<br>2.65<br>1.95<br>2.13<br>1.84<br>1.55<br>1.76<br>1.47 | 0.48<br>0.33<br>0.19<br>0.33<br>0.25<br>0.18<br>0.36<br>0.26 | 2.04<br>1.89<br>1.75<br>1.73<br>1.65<br>1.58<br>1.60<br>1.50 | 44.4<br>33.0<br>+19.0<br>24.4<br>20.2<br>+14.4<br>14.7<br>13.1<br>-10.2 |

TABLE 10

# Weights and Safe Loads of Carnegie T-Shapes

| Size, Flange by Stem. —  |  | mum<br>ss, Inches  | Weight per<br>Foot, Lb.                   | 1 Ft. Span,<br>Safe Load |
|--|--|--|---|--------------------------|
| Inches   | Flange                                 | Stem.  | · root, Lb.                               | Safe Doad                |
| 5 × 3  | 1/2<br>3/8<br>16                       | ÷  | 13.4                                      | 11.41                    |
| 5 × 2½   | %8                                     | 176  | 10.9                                      | 8.96                     |
| 4½ × 3½  | 16                                     | <del>jj</del> .  | 15.7                                      | 22.72                    |
| 4½ X 3   | 3/8                                    | 3/8  | 9.8                                       | 9.71                     |
| $4\frac{1}{2} \times 3$  | 15                                     | 16   | $\begin{array}{c} 8.4 \\ 9.2 \end{array}$ | 8.32                     |
| $\begin{array}{c} 4\frac{1}{2} \times 2\frac{1}{2} \dots \\ 4\frac{1}{2} \times 2\frac{1}{2} \dots \end{array}$  | 3/8                                    | 3/8  | 7.8                                       | 6.72                     |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 15                                     | 16   | 7.8<br>15.3                               | 5.76<br>33.39            |
| 4 × 5  | 72                                     | 14<br>1/2<br>3/8<br>1/2<br>3/8<br>1/2<br>3/8<br>1/2<br>8/8<br>1/2<br>8/8 | 11.9                                      | 25.92                    |
| 4 × 4½   | 8/8<br>1/2                             | . 78   | 14.4                                      | 27.09                    |
| 4 × 4½   | 72<br>3/                               | 72<br>3/   | 11.2                                      | 21.12                    |
| 4 × 4  | 3/8<br>1/2<br>3/8                      | 78<br>1/   | 13.5                                      | 21.12                    |
| 4 × 4  | 72<br>32                               | 72<br>8/   | 10.5                                      | 16.85                    |
| 4 ×3   | 3/8                                    | 78<br>8/   | 9.2                                       | 9.60                     |
| 4 × 3  | 16                                     | 78   | 7.8                                       | 8.21                     |
| 4 × 2½   | 3%<br>8                                | 86   | 8.5                                       | 6.61                     |
| 4 Y 21/2   | 16                                     | <b>1</b> 2   | 7.2                                       | 5.65                     |
| 4 × 2<br>4 × 2<br>3½ × 4<br>3½ × 4   | 3/8                                    | 8%   | 7.8                                       | 4.27                     |
| 4 × 2  | 16                                     | 4  | 6.7                                       | 3.63                     |
| 3½ × 4   | 1%                                     | 1/2  | 12.6                                      | 21.12                    |
| $3\frac{1}{2} \times 4$  | 8%                                     | 8%   | 9.8                                       | 16.53                    |
| $3\frac{1}{2} \times 3\frac{1}{2} \dots$   | íš                                     | 1%   | 11.7                                      | 16.32                    |
| $3\frac{1}{4} \times 3\frac{1}{4} \dots$   | 1/2<br>8/8<br>1/2<br>8/8<br>1/2<br>8/8 | 3/2  | 9.2                                       | 12.69                    |
| 3½ X 3   | 1/3                                    | 1/3  | 10.8                                      | 12.05                    |
| $3\frac{1}{2} \times 3$  | 3/8                                    | 3/8  | 8.5                                       | 9.49                     |
| $3\frac{1}{2}\times3$  |  | 3/8  | 7.5                                       | 9.07                     |
| 3 × 4  | 1/2                                    | 1/2  | 11.7                                      | 20.69                    |
| 3 × 4  | **  **  **  **  **  **  **  **  **  ** | 16   | 10.5                                      | 18.35                    |
| 3 × 4  | 3/8                                    | 3/8  | 9.2                                       | 16.11                    |
| 3 × 3½   | ⅓2                                     | 1/2  | 10.8                                      | 15.89                    |
| 3 × 3½   | 16                                     | 16   | 9.7                                       | 14.19                    |
| $3 \times 3\frac{1}{2}$  | 3/8                                    | 3∕8  | 8.5                                       | 12.37                    |
| 3 × 3 · · · · · · · · · · · · · · · · ·  | 1/2                                    | 1/2  | 9.9                                       | 11.73                    |
| 3 X3   | 16<br>8/8                              | 16   | 8.9                                       | 10.45                    |
| 3 × 3  | %≉                                     | ₹8   | 7.8                                       | 9.17                     |
| 3 × 3  | 16                                     | 18   | 6.7                                       | 7.89                     |
| $3 \times 2\frac{1}{2}$  | 3∕8                                    | ₹8   | 7.1                                       | 6.40                     |
| 3 × 2½   | 15                                     | ŢŠ.  | 6.1                                       | 5.55                     |
| $2\frac{1}{2} \times 3$  | 74                                     | *4   | 5.0                                       | 4.59                     |
| 2½ × 3   | 3/8                                    | %  | 7.1                                       | 8.96                     |
| 2½ × 3<br>2½ × 2½  | 16<br>8/                               | 176  | 6.1                                       | 7.68                     |
| 2½ × 1¼  | 3/8<br>18                              | 78   | 6.4                                       | 6.29                     |
| $2\frac{1}{2}$ $\times$ $1\frac{1}{4}$   | 16                                     | ***************************************                                  | 2.87<br>4.9                               | $0.93 \\ 4.37$           |
| $\frac{1}{2}$ $\stackrel{1}{\times}$ $\frac{1}{2}$ $\stackrel{1}{\times}$ $\stackrel{1}$ | 16<br>L                                | 14   | 4.3                                       | 3.31                     |
| 2 × 11/4   | 16                                     | 16   | 3.09                                      | 1.60                     |
| 18/ > 18/  | 1/4                                    | 1/2  | 3.09                                      | 2.03                     |
| 1½ × 1½  | 1/2                                    | 12   | 2.47                                      | 1.49                     |
| 1½ × 1½<br>1¼ × 1¼   | 17                                     | í,   | 2.02                                      | 1.01                     |
| 1 × 1  | 14<br>18                               | <b>∤</b> 4<br><b>16</b>  | 1.25                                      | 0.49                     |

# How to Estimate on Quantity and Cost of Corrugated Sheets

First, select the best lengths of sheets that will fit the space you intend covering, not forgetting the end laps.

On siding, a one-inch or two-inch end lap is sufficient, but on roofing it varies from three to six inches, according to pitch of roof.

Our common 2½-inch corrugated sheets will lay 24 inches wide with a side lap of one corrugation, but the selling measurement is 26 inches wide.

| Α | 6  | -foot | sheet | will | measure | 13    | sq. ft. | and | lay | 12 | sq. ft |
|---|----|-------|-------|------|---------|-------|---------|-----|-----|----|--------|
| u | 7  | "     | 4     | "    | 4       | 151/6 | - 4     | "   | "-  | 14 | "      |
| u | 8  | 4     | ű     | "    | 4       | 1716  | æ       | "   | "   | 16 | 44     |
| " | 9  | "     | u     | "    | "       | 191%  | u       | "   | u   | 18 | "      |
| u | 10 | "     | "     | u    | 4       | 21%   | u       | "   | "   | 20 | . "    |

In the above table, end laps are not considered. You make your own allowance for end laps.

The extreme length of corrugated sheets is 10 feet.

# TABLE II Measurements of Corrugated Sheets

| Kind of<br>Corruga-<br>tion,<br>Inches |    |          | tions to | Covering Width Lapped One Corrugation, Inches | Width of<br>Sheet<br>Corru-<br>gated,<br>Inches | Length of<br>Longest<br>Sheets<br>Fur-<br>nished,<br>Feet |
|--|----|----------|----------|---|---|---|
| 5                                      | 5  | 1        | 6        | 24  | 27  | 10  |
| 2½                                     | 2½ | ½ to 5/8 | 10       | 24  | 26  | 10  |
| 1¼                                     | 1¼ | 3/8 to ½ | 19½      | 24  | 26  | 10  |
| 84                                     | 84 | 1/4      | 34½      | 25  | 26  | 8   |

#### TABLE 12

# Weight of Corrugated Sheets Per Square for Sheets 30½ Inches Wide Before Corrugating

| Num-<br>ber<br>by<br>Birm-       | Thick-<br>ness,                              | per  | Weight<br>per<br>Sq. Ft.<br>Corru-<br>gated. | Feet,<br>Lap i<br>One                  | when<br>in Ler<br>Corr                | Laid, gth as ugation She | Allow<br>nd 2½<br>on in               | ing 6 1<br>2 Inch<br>Widt             | inches<br>nes or<br>hof<br>of         | Weight per Sq. Ft. Flat Galvan-              |
|----------------------------------|--|--|--|--|---------------------------------------|--------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|
| ingham<br>Gauge                  | Inches                                       | Lus.                                       | Lbs.   | 5<br>Feet                              | $_{\rm Feet}^6$                       | 7<br>Feet                | 8<br>Feet                             | 9<br>Feet                             | 10                                    | ized   |
| 16<br>18<br>20<br>22<br>24<br>26 | .065<br>.049<br>.035<br>.028<br>.022<br>.018 | 2.61<br>1.97<br>1.40<br>1.12<br>.88<br>.72 | 3.28<br>2.48<br>1.76<br>1.41<br>1.11         | 365<br>275<br>196<br>156<br>123<br>101 | 358<br>270<br>192<br>154<br>121<br>99 | 119                      | 350<br>264<br>188<br>150<br>118<br>97 | 348<br>262<br>186<br>149<br>117<br>96 | 346<br>261<br>185<br>148<br>117<br>95 | 2.95<br>2.31<br>1.74<br>1.46<br>1.22<br>1.06 |

TABLE 13

# Weight of Corrugated Sheets Per 100 Square Feet in Pounds

| Corruga-<br>tions,   | 5∕8                             | in.                                 | 11/4  | in.   | 2   | in.  | 2½<br>26<br>Wi   | in.   | 21/2<br>271/2<br>Wi |   | 3 i     | n.   | 5 i        | in.  |
|--|---------------------------------|-------------------------------------|---|---|---|--|--|---|---------------------|---|---------|--|------------|--|
| U. S. Std.<br>Sheet<br>Metal<br>Gauge                                | Painted                         | Galvanized                          | Painted   | Galvanized<br>Painted   |   | Galvanized   | Painted  | Galvanized  | Painted             | Galvanized  | Painted | Galvanized   | Painted    | Galvanized   |
| 29<br>28<br>27<br>26<br>25<br>24<br>23<br>21<br>20<br>18<br>16<br>14 | 71<br>78<br>85<br>99<br>113<br> | 81<br>88<br>95<br>102<br>116<br>130 | 71<br>78<br>85<br>99<br>113<br>127<br>141<br>155<br>169 | 81<br>88<br>95<br>102<br>116<br>130<br>144<br>158<br>172<br>186 | 68<br>75<br>82<br>95<br>109<br>122<br>136<br>149<br>163<br>216<br>270 | 77<br>84<br>91<br>98<br>111<br>125<br>138<br>151<br>165<br>178<br>232<br>286 | 68<br>75<br>82<br>95<br>109<br>122<br>136<br>149<br>163<br>216<br>270<br>338<br>472<br>607 | 77<br>84<br>91<br>98<br>111<br>125<br>138<br>151<br>165<br>178<br>232<br>286<br>353<br>488<br>623 | $\frac{342}{478}$   | 78<br>85<br>92<br>99<br>113<br>126<br>140<br>153<br>167<br>181<br>235<br>290<br>358<br>494<br>631 |         | 77<br>84<br>91<br>98<br>111<br>125<br>138<br>151<br>165<br>178<br>232<br>286<br>353<br>488 | 269<br>336 | 77<br>84<br>91<br>97<br>111<br>124<br>137<br>151<br>164<br>178<br>231<br>285<br>352<br>486 |

# TABLE 14

# Number of Corrugated Iron and Steel Sheets in One Square (100 Square Feet)

|   | Length of Sheet,<br>Inches | tions. Width (flat) 28 Inches. | 2½-Inch Corruga-<br>tions. Width<br>(flat) 28 Inches.<br>Width (after cor-<br>rugating) 26<br>Inches | tions. Width<br>(flat) 28 Inches. |
|---|----------------------------|--------------------------------|--|-----------------------------------|
| • | 72                         | 7.692                          | 7.692  | 8.000                             |
|   | 84                         | 6.593                          | 6.593  | 6.857                             |
|   | 96                         | 5.769                          | 5.769  | 6.000                             |
|   | 108                        | 5.128                          | 5.128  | 5.333                             |
|   | 120                        | 4.616                          | 4.616  | 4.800                             |

## TABLE 15

# Spacing of Supports for Corrugated Sheets

| Nos. 16 and 18 |                   |
|----------------|-------------------|
| Nos. 20 and 22 | 4 to 5 feet apart |
| No. 24         | 2 to 4 feet apart |
| No. 28         | 2 feet apart.     |

#### TABLE 16

# Comparison of Standard Gauges for Wire and Sheet Metal

Diameter or Thickness in Decimals of an Inch

| Number<br>of Gauge | United State<br>Gauge for<br>Sheet and<br>Plate Iron<br>and Steel | American<br>or Brown<br>& Sharpe<br>Wire-Gauge | Stube          | John A.<br>Roebling's<br>Sons Co.<br>Wire-<br>Gauge | British<br>Imperial<br>or English<br>Standard<br>Wire-Gauge | Wire-          |                  |
|--------------------|---|--|----------------|---|---|----------------|------------------|
| 0000000            | 0.5   |  |                | 0.4900  | 0.500   |                |                  |
| .000000            | 0.46875   | 0.580000                                       |                | 0.4615  | 0.464   |                |                  |
| 00000              | 0.4375  | 0.516500                                       | 0.500          | 0.4305  | 0.432   | 0.450          |                  |
| 0000               | 0.40625   | 0.460000                                       | 0.454          | 0.3938  | 0.400   | 0.400          | : : : : : : :    |
| 000                | 0.375   | 0.409642                                       | 0.425          | 0.3625  | 0.372   | 0.360          | 0.0315           |
| 00                 | 0.34375   | 0.364796                                       | 0.380          | 0.3310  | 0.348   | 0.330          | 0.0447           |
| . 0                | 0.3125  | 0.324861                                       | 0.340          | 0.3065  | 0.324   | 0.305          | 0.0578           |
| ' 1                | 0.2825  | 0.289297                                       | 0.300          | 0.2830  |   | 0.285          | 0.0710           |
| 2<br>3             | 0.265625  | 0.257627                                       | 0.284          | 0.2625  |   | 0.265          | 0.0842           |
| 3<br>4             | 0.25  | 0.229423                                       | 0.259          | 0.2437<br>0.2253                                    | 0.252<br>0.232  | 0.245<br>0.225 | 0.0973<br>0.1105 |
| 5                  | 0.234375  | 0.204307<br>0.181940                           | 0.238<br>0.220 | 0.2233  | 0.232   | 0.205          | 0.1236           |
| 6                  | 0.21875<br>0.203125   | 0.162023                                       | 0.220          | 0.2070  | 0.192   | 0.190          | 0.1368           |
| 7                  | 0.203123  | 0.102023                                       | 0.180          | 0.1770  | 0.176   | 0.175          | 0.1500           |
| 8                  | 0.171875  | 0.128490                                       | 0.165          | 0.1620  | 0.160   | 0.160          | 0.1631           |
| 9                  | 0.15625   | 0.114423                                       | 0.148          | 0.1483  | 0.144   | 0.145          | 0.1763           |
| 10                 | 0.140625  | 0.101897                                       | 0.134          | 0.1350  | 0.128   | 0.130          | 0.1894           |
| ii                 | 0.125   | 0.090742                                       | 0.120          | 0.1205  | 0.116   | 0.1175         | 0.2026           |
| 12                 | 0.109375  | 0.080808                                       | 0.109          | 0.1055  |   | 0.105          | 0.2158           |
| 13                 | 0.09375   | 0.071962                                       | 0.095          | 0.0915  | 0.092   | 0.0925         | 0.2289           |
| 14                 | 0.078125  | 0.064084                                       | 0.083          | 0.0800  | 0.080   | 0.0806         | 0.2421           |
| 15                 | 0.0703125   | 0.057068                                       | 0.072          | 0.0720  | 0.072   | 0.070          | 0.2552           |
| 16                 | 0.0625  | 0.050821                                       | 0.065          | 0.0625  | 0.064   | 0.061          | 0.2684           |
| 17                 | 0.05625   | 0.045257                                       | 0.058          | 0.0540  | 0.056   | 0.0525         | 0.2816           |
| 18                 | 0.05  | 0.040303                                       | 0.049          | 0.0475  |   | 0.045          | 0.2947           |
| 19                 | 0.04375   | 0.035890                                       | 0.042          | 0.0410  | 0.040   | 0.040          | 0.3079           |
| 20                 | 0.0375  | 0.031961                                       | 0.035          | 0.0348  |   | 0.035          | 0.3210           |
| 21                 | 0.034375  | 0.028462                                       | 0.032          | 0.03175   | 0.032   | 0.031          | 0.3342           |
| 22                 | 0.03125   | 0.025346                                       | 0.028          | 0.0286  |   | 0.028          | 0.3474           |
| 23                 | 0.028125  | 0.022572                                       | 0.025          | 0.0258  |   | 0.025          | 0.3605           |
| 24                 | 0.025   | 0.020101                                       | 0.022          | 0.230   |   | 0.0225         | 0.3737<br>0.3868 |
| 25                 | 0.021875  | 0.017900                                       | 0.020          | 0.0204  |   | 0.020          | 0.4000           |
| 26                 | 0.01875   | 0.015941<br>0.014195                           | 0.018<br>0.016 | 0.0181<br>0.0173                                    |   | 0.018<br>0.017 | 0.4132           |
| 27<br>28           | 0.0171875<br>0.015625   | 0.014195                                       | 0.014          | 0.0173  |   | 0.016          | 0.4263           |
| 29                 | 0.013023  | 0.012041                                       | 0.014          | 0.0150  |   | 0.015          | 0.4395           |
| 30                 | 0.0125  | 0.011237                                       | 0.013          | 0.0140  |   | 0.014          | 0.4526           |
| 31                 | 0.0123  | 0.008928                                       | 0.012          | 0.0132  |   | 0.013          | 0.4658           |
| 32                 | 0.01015625  |  | 0.009          | 0.0132  |   | 0.012          | 0.4790           |
| 33                 | 0.009375  | 0.007080                                       | 0.008          | 0.0118  |   | 0.011          | 0.4921           |
| 34                 | 0.00859375  |  | 0.007          | 0.0104  |   | 0.010          | 0.5053           |
| 35                 | 0.0078125   | 0.005615                                       | 0.005          | 0.0095  |   | 0.0095         | 0.5184           |
| 36                 | 0.00703125  | 0.005000                                       | 0.004          | 0.0090  |   | 0.009          | 0.5316           |
| 37                 | 0.00664062  |  |                | 0.0085  |   | 0.0085         | 0.5448           |
| 38                 | 0.00625   | 0.003965                                       |                | 0.0080  |   | 0.008          | 0.5579           |
| 39                 |   | 0.003531                                       |                | 0.0075  |   | 0.0075         | 0.5711           |
| 40                 |   | 0.003144                                       |                | 0.0070  |   | 0.007          | 0.5842           |

As there are many gauges in use differing from each other, and even the thicknesses of a certain specified gauge, as the Birmingham, are not assumed the same by all manufacturers, orders for sheets and wires should always state the weight per square foot, or the thickness in thousandthe of an inch.

TABLE 17

Weight of Sheets of Wrought Iron, Steel, Copper and Brass Per Square Foot in Pounds

| American<br>or B. & S.<br>Gauge         | Thickness<br>in Inches | Iron                                     | Steel                   | Copper                  | Brass               |
|---|------------------------|--|-------------------------|-------------------------|---------------------|
| 0000                                    | .46                    | 18.46                                    | 18.70                   | 20.84                   | 19.69               |
| 000                                     | .4096                  | 16.44                                    | 16.66                   | 18.56                   | 17.53               |
| 00                                      | .3648                  | 14.64                                    | 14.83                   | 16.53                   | 15.61               |
| 0                                       | .3249                  | 13.04                                    | 13.21                   | 14.72                   | 13.90               |
| 1                                       | .2893                  | 11.61                                    | 11.76                   | 13.11                   | 12.38               |
| <b>2</b>                                | .2576                  | 10.34                                    | 10.48                   | 11.67                   | 11.03               |
| 3                                       | .2294                  | 9.21                                     | 9.33                    | 10.39                   | 9.82                |
| 4                                       | .2043                  | 8.20                                     | 8.31                    | 9.26                    | 8.74                |
| , <b>5</b>                              | .1319                  | 7.30                                     | 7.40                    | 8.24                    | 7.79                |
| 6                                       | .1620                  | 6.50                                     | 6.59                    | 7.34                    | 6.93                |
| 7                                       | . 1443                 | 5.79                                     | 5.87                    | 6.54                    | 6.18                |
| 8                                       | .1285                  | 5.16                                     | 5.22                    | $\bf 5.82$              | 5.50                |
| 9                                       | .1144                  | 4.59                                     | 4.65                    | 5.18                    | 4.90                |
| 10                                      | .1019                  | 4.09                                     | 4.14                    | 4.62                    | 4.36                |
| 11                                      | .0907                  | 3.64                                     | 3.69                    | 4.11                    | 3.88                |
| 12                                      | .0808                  | 3.24                                     | 3.29                    | 3.66                    | 3.46                |
| 13                                      | .0720                  | 2.89                                     | 2.93                    | 3.26                    | 3.08                |
| 14                                      | .0641                  | 2.57                                     | 2.61                    | $\frac{2.90}{2.50}$     | 2.74                |
| 15                                      | .0571                  | 2.29                                     | 2.32                    | 2.59                    | 2.44                |
| . 16                                    | .0508                  | 2.04                                     | 2.07                    | 2.30                    | 2.18                |
| 17                                      | .0453                  | 1.82                                     | 1.84                    | 2.05                    | 1.94                |
| 18<br>19                                | .0403                  | 1.62                                     | 1.64                    | 1.83                    | 1.73                |
| 20                                      | .0359<br>.032 <b>0</b> | $\frac{1.44}{1.28}$                      | $\substack{1.46\\1.30}$ | $rac{1.63}{1.45}$      | 1.54                |
|   |                        |  |                         |                         | 1.37                |
| $\begin{array}{c} 21 \\ 22 \end{array}$ | $.0285 \\ .0253$       | $egin{array}{c} 1.14 \ 1.02 \end{array}$ | $\frac{1.16}{1.03}$     | 1.29                    | 1.22                |
| $\frac{22}{23}$                         | .0233 $.0226$          | .906                                     | .918                    | $\substack{1.15\\1.02}$ | $\frac{1.08}{.966}$ |
| $\frac{23}{24}$                         | .0220                  | .807                                     | .817                    | .911                    | .860                |
| $\mathbf{\tilde{25}}$                   | .0179                  | .718                                     | .728                    | .811                    | .766                |
| 26                                      | .0159                  | .640                                     | .648                    | .722                    | .682                |
| 07                                      | .0139                  | .570                                     | .577                    | .643                    | .608                |
| , 27<br>28                              | .0126                  | .507                                     | .514                    | .573                    | .541                |
| 29                                      | .0113                  | .452                                     | .458                    | .510                    | .482                |
| 30                                      | .0100                  | .402                                     | .408                    | .454                    | .429                |
| 31                                      | .0089                  | .358                                     | .363                    | .404                    | .382                |
| 32                                      | .0080                  | .319                                     | .323                    | .360                    | .340                |
| 33                                      | .0071                  | .284                                     | .288                    | .321                    | .303                |
| 34                                      | .0063                  | .253                                     | .256                    | .286                    | .270                |
| 35                                      | .0056                  | .225                                     | .228                    | .254                    | .240                |
|   |                        |  |                         |                         |                     |

TABLE 18
Weights of Steel, Wrought Iron, Brass and
Copper Plates

|             |              | F 1   |       |                               |               |
|-------------|--------------|-------|-------|-------------------------------|---------------|
| Number      | Thickness    |       |       | r Stubs' Gaug<br>bs. per Foot | e             |
| of<br>Gauge | in Inches -  | Steel | Iron  | Brass                         | Copper        |
| 0000        | . 454        | 18.52 | 18.16 | 19.431                        | 20.556        |
| 000         | .425         | 17.34 | 17.00 | 18.190                        | 19.253        |
| 00          | .380         | 15.30 | 15.20 | 16.264                        | 17.214        |
| 0           | .340         | 13.87 | 13.60 | 14.552                        | 15.402        |
| 1           | . 300        | 12.24 | 12.00 | 12.840                        | 13.590        |
| 2           | . <b>284</b> | 11.59 | 11.36 | 12.155                        | 12.865        |
| 3           | . 259        | 10.57 | 10.36 | 11.085                        | 11.733        |
| 4           | .238         | 9.71  | 9.52  | 10.186                        | 10.781        |
| 5           | . 220        | 8.98  | 8.80  | 9.416                         | 9.966         |
| 6           | . <b>203</b> | 8.28  | 8.12  | 8.689                         | 9.196         |
| 7           | .180         | 7.34  | 7.20  | 7.704                         | 8.154         |
| 8           | .165         | 6.73  | 6.60  | 7.062                         | 7.475         |
| 9           | .148         | 6.04  | 5.92  | 6.334                         | 6.704         |
| 10          | .134         | 5.47  | 5.36  | 5.735                         | 6.070         |
| 11          | . 120        | 4.90  | 4.80  | 5.137                         | 5.436         |
| 12          | . 109        | 5.45  | 4.36  | 4.667                         | 4.938         |
| 13          | .095         | 3.88  | 3.80  | 4.066                         | 4.303         |
| 14          | .083         | 3.39  | 3.32  | 3.552                         | 3.769         |
| 15          | .072         | 2.94  | 2.88  | 3.081                         | 3.262         |
| 16          | .065         | 2.65  | 2.60  | 2.782                         | 2.945         |
| 17          | .058         | 2.37  | 2.32  | 2.482                         | 2.627         |
| 18          | .049         | 2.00  | 1.96  | 2.097                         | 2.220         |
| 19          | .042         | 1.71  | 1.68  | 1.797                         | 1.902         |
| 20          | .035         | 1.43  | 1.40  | 1.498                         | 1.585         |
| 21          | .032         | 1.31  | 1.28  | 1.369                         | 1.450         |
| 22          | .028         | 1.14  | 1.12  | 1.198                         | 1.270         |
| 23          | .025         | 1.02  | 1.10  | 1.070                         | 1.132         |
| 24          | .022         | .898  | .88   | .941                          | . <b>9</b> 97 |
| 25          | .020         | .816  | .80   | .856                          | . 906         |
| 26          | .018         | .734  | .72   | .770                          | .815          |
| 27          | .016         | . 653 | .64   | .685                          | .725          |
| 28          | .014         | . 571 | . 56  | . <b>59</b> 9                 | .634          |
| 29          | .013         | . 530 | .52   | . 5 <b>5</b> 6                | . <b>5</b> 89 |
| 30          | .012         | .490  | .48   | .514                          | . 544         |
| 31          | .010         | .408  | .40   | .428                          | . <b>45</b> 3 |
| 32          | .009         | .367  | .36   | .385                          | .408          |
| 33          | .008         | .326  | .32   | .342                          | .362          |
| 34          | .007         | . 286 | .28   | . 2996                        | 317           |
| 35          | .005         | . 204 | .20   | .214                          | .227          |
| 36          | .004         | . 163 | .16   | .171                          | .181          |

Table 19 Net Weight Per Box Bright Tin Plates in Pounds

|       |               | ٠       |          |                 |        | _           |      |      |            |          |      |      |                 |      |            |            |      |      |      |             |      |             |             |      |                |                |      |
|-------|---------------|---------|----------|-----------------|--------|-------------|------|------|------------|----------|------|------|-----------------|------|------------|------------|------|------|------|-------------|------|-------------|-------------|------|----------------|----------------|------|
|       |               | XXX     |          | ß               |        |             | 196  | 196  | 392        | 88<br>88 | 169  | 333  | 370             | 202  | <b>202</b> | 386<br>236 | 236  | 274  | 274  | 315         | 358  | 405         | 227         | 253  | 28<br>28<br>28 | 60<br>80<br>80 | 330  |
|       |               | IXXXI   |          | 8               |        |             | 176  | 176  | 352        | 251      | 152  | 304  | 333             | 181  | 181        | 212        | 212  | 246  | 246  | <b>583</b>  | 325  | 363         | <b>₹</b>    | 227  | 251            | 277            | 304  |
|       |               | IXXI    |          | 21              |        | ST          | 156  | 156  | 312        | 223      | 135  | 270  | 295             | 160  | 160        | 188        | 188  | 218  | 218  | 251         | 285  | 355         | <b>3</b> 8  | 201  | 223            | 246            | 270  |
|       | sheets.       | X       |          | 83              | í      | n Pounc     | 135  | 135  | 220        | 193      | 117  | 234  | 255             | 139  | 139        | 163        | 163  | 189  | 189  | 217         | 247  | 279         | .156        | 174  | 193            | 213            | 234  |
|       | 112           | IXL     |          | 287%            | :      | ecified i   | 128  | 128  | 256        | 183      | 111  | 222  | 242             | 132  | 132        | 154        | 154  | 179  | 179  | <b>50</b> 6 | 234  | 264         | 148         | 165  | 183            | 202            | 221  |
| )     | $4 \times 20$ | IC      |          | ස               | ;      | Sizes Sr    | 107  | 107  | 214        | 153      | 35   | 184  | 202             | 110  | 110        | 129        | 129  | 150  | 150  | 172         | 196  | 221         | 124         | 138  | 153            | 169            | 184  |
|       | s; or, 1      | 100 lb. |          | 31              | •      | Pox of      | 100  | 100  | 200<br>200 | 143      | 98   | 172  | 189             | 103  | 103        | 121        | 121  | 140  | 140  | 191         | 183  | <b>50</b> 6 | 116         | 129  | 143            | 158            | 172  |
| ;     | sheets        | 95 lb.  |          | $31\frac{1}{2}$ | ,      | ight per    | 95   | 95   | 190        | 136      | 83   | 164  | 179             | 86   | 86         | 115        | 115  | 133  | 133  | 153         | 174  | 196         | <b>1</b> 10 | 122  | 136            | 150            | 164  |
| 11811 | 14, 225       | 90 lb.  |          | 32              | i      | Me<br> <br> | 8    | 8    | 180        | 129      | 28   | 156  | 170             | ස    | 63         | 100        | 109  | 126  | 126  | 145         | 165  | 186         | 104         | 116  | 129            | 142            | 156  |
| בני א | x 01          | 85 lb.  |          | 33              |        |             | 82   | 85   | 170        | 121      | 73   | 147  | 161             | 87   | 82         | 103        | 103  | 119  | 119  | 137         | 155  | 175         | 86          | 110  | 121            | 134            | 147  |
| 7     | Basis         | 80 lb.  |          | 34              |        |             | 8    | 8    | 160        | 114      | 69   | 138  | 151             | 8    | 83         | 26         | 26   | 112  | 112  | 129         | 146  | 165         | 93          | 103  | 114            | 126            | 138  |
| LABLE |               | :       | ire      | :               | heets  | er Box.     | 225  | 112  | 112        | 225      | 225  | 225  | 225             | 225  | 112        | 225        | 112  | 225  | 112  | 225         | 225  | 225         | 112         | 112  | 112            | 112            | 112  |
|       |               | e term  | s Iron W | ige No          | ر<br>ج | S.          | x 14 | x 20 | × 28       | x 20     | x 11 | x 22 | × 23            | x 12 | x 24       | x 13       | x 26 | x 14 | × 28 | x 15        | x 16 | x 17        | x 18        | x 19 | × 20           | x 21           | x 22 |
|       |               | Trad    | Stub     | gar             | Size   | Sheet       | 10   | 14   | R          | 10       | 11   | 11   | $11\frac{1}{2}$ | 12   | 12         | 13         | 13   | 14   | 14   | 15          | 16   | 17          | 18          | 19   | ಜ              | 21             | 55   |

| Pounds |
|--------|
| .되     |
| Plates |
| Tin    |
| Bright |
| Box    |
| Per    |
| Weight |
| Net    |
| (panu  |
| Conti  |
| )      |
| Ξ,     |
| TABLE  |

| 2                   |             | Т           | H.         | E              | N    | E               | W      | T       | 'II'       | VS   | M    | ľ    | ΓF         | ľS         | 3 ]        | HE    | £L       | P              | Eŀ        | Z           |        |        |            |              |     |
|---------------------|-------------|-------------|------------|----------------|------|-----------------|--------|---------|------------|------|------|------|------------|------------|------------|-------|----------|----------------|-----------|-------------|--------|--------|------------|--------------|-----|
|                     | 196         |             | 370        | \$             | 472  | 183             | 202    | 202     | 8          | 216  | 220  | 224  |            |            |            |       |          | 0              | spunc     | r box.      | 224    | 8      | 168        |              |     |
|                     | 176         |             | 333<br>333 | 362            | 424  | 165             | 182    | 182     | 185        | 194  | 197  | 201  | 273        | No. 23     | 162        | 162   | 241      | $20 \times 4$  | eets Poun | box. per    |        | 62     | 62         |              |     |
|                     | 156         |             | 295        | 321            | 377  | 147             | 191    | 191     | <u>1</u> 5 | 172  | 176  | 178  |            |            |            | 142   |          |                | Š         | per         |        |        |            |              |     |
| sheets.             | 135         | n Pound     | 255        | 278            | 326  | 127             | 139    | 139     | 142        | 149  | 152  | 154  | 203<br>206 | No. 25     | 122        | 122   | 181      | 28             | Pounds    | per box.    |        |        |            | 224          |     |
| 112                 | 128         | pecified i  | 242        | 263            | 306  | 120             | 132    | 132     | 134        | 141  | 144  | 146  | 198        |            |            |       |          | 20 x           | Sheets    | er box.     | 112    | 128    | 150        | 180          | 777 |
| 14 x 20,            | 107         | Sizes Speci | 202        | 220            | 258  | 100             | 110    | 110     | 112        | 118  | 120  | 122  | 166        | 0. 28      | 95         | \$    | 140      |                |           | _           |        |        |            |              |     |
| ; or, 1.            | 100         | Box of §    | 189        | 204            | 241  | \$              | 103    | 103     | 105        | 110  | 113  | 114  | 155        | Z          |            |       | :        | 8              | Pounds    | per box     | 107    | 112    | 112        | 112          | 1   |
| 14, 225 sheets; or, | 92          | ight per    | 179        | 195            | 229  | 68              | 86     | 86      | 100        | 105  | 107  | 109  | 147        |            |            |       |          | 14.            | Sheets    | per box.    | 112    | 128    | 150<br>251 | 180 112      | 777 |
| 14, 225             | <b>6</b> 6  | We          | 170        | 185            | 217  | 8               | 88     | 63      | 95         | 8    | 101  | 103  | 140        |            |            |       |          |                | Pounds    | box.        |        |        |            |              |     |
| x oi                | 85          |             | 191        | 175            | 205  | 8               | 8      | 88      | 68         | 94   | 95   | 62   | 132        | ates       |            |       |          | $10 \times 14$ |           | -           |        |        | Ξ          | 112          | •   |
| Basis               | 8           |             | 151        | 164            | 193  | 22              | 8      | 88      | <b>%</b>   | 8    | 8    | 91   | 124        | age D P    |            |       |          | 2              | Sheets    | per box.    |        |        | ල<br>ල     | 8 4<br>9 6   | >   |
|                     | t, pounds   | r Box.      | 112        | 112            | 112  | 112             | 124    | 130     | 112        | 112  | 112  | 112  | 112        | Wire Gan   | 8          | 50    | 200      |                |           | ind Tin.    |        |        |            |              |     |
|                     | ght per box | ets. per    | 23         | x 24           | x 26 | x 191%          | x 1834 | x 191/2 | x 21       | x 22 | x 21 | x 20 | x 31       | roximate V | (x 17D 10  | x 25D | x 21D 10 |                |           | gers Iron a | 30 W G | 32 W G | 34 W G     | დ<br>გ<br>88 |     |
|                     | Weig        | Sheets.     | 23         | <del>7</del> 7 | 28   | $13\frac{1}{2}$ | 14     | 14      | 14         | 14   | 15   | 16   | 14         | App        | $12^{1/2}$ | 17    | 15       |                |           | Tags        | Š.     | ġ;     | o c        | Š            |     |

TABLE 20

# Weights of Standard Galvanized Sheets

| Gauge |       | Lb.<br>Per<br>Sq. Ft. | Gauge | Oz.<br>Per<br>Sq. Ft. | Lb.<br>Per<br>Sq. Ft. | Gauge | Os.<br>Per<br>Sq. Ft. | Lb.<br>Per<br>Sq. Ft. | Gauge | Os.<br>Per<br>Sq. Ft. | Lb.<br>Per<br>Sq. Ft. |
|-------|-------|-----------------------|-------|-----------------------|-----------------------|-------|-----------------------|-----------------------|-------|-----------------------|-----------------------|
| 8     | 112.5 | 7.031                 | 15    | 47.5                  | 2.969                 | 22    | 22.5                  | 1.406                 | 29    | 11.5                  | 0.719                 |
| 9     | 102.5 | 6.406                 | 16    | 42.5                  | 2.656                 | 23    | 20.5                  | 1.281                 | 30    | 10.5                  | . 656                 |
| 10    | 92.5  | 5.781                 | 17    | 38.5                  | 2.406                 | 24    | 18.5                  | 1.156                 | 31    | 9.5                   | .594                  |
| 11    | 82.5  | 5.156                 | 18    | 34.5                  | 2.156                 | 25    | 16.5                  | 1.031                 | 32    | 9.0                   | . 563                 |
| 12    | 72.5  | 4.531                 | 19    | 30.5                  | 1.906                 | 26    | 14.5                  | 0.906                 | 33    | 8.5                   | . 531                 |
| 13    | 62.5  | 3.906                 | 20    | 26.5                  | 1.656                 | 27    | 13.5                  | . 844                 | 34    | 8.0                   | . 500                 |
| 14    | 52.5  | 3.281                 | 21    | 24.5                  | 1.531                 | 28    | 12.5                  | .781                  |       |                       |                       |

TABLE 21

#### Ordinary Dimensions of Galvanized Sheets

| Widths         | 40  | 38  | 36  | 34  | 32  | 30    | 28  | 26  | 24  | 22  | 20  |
|----------------|-----|-----|-----|-----|-----|-------|-----|-----|-----|-----|-----|
| Gauges.        |     |     |     |     | L   | ength | ıs. |     |     |     |     |
| No. 14         |     |     | 96  | 96  | 96  | 96    | 96  | 96  | 96  | 96  | 96  |
| Nos. 16 to 22  | 120 | 120 | 120 | 120 | 120 | 120   | 120 | 120 | 120 | 120 | 120 |
| Nos. 23 and 24 | 96  | 96  | 96  | 96  | 108 | 120   | 120 | 120 | 120 | 108 | 108 |
| Nos. 25 to 28  |     |     | 96  | 96  | 108 | 120   | 120 | 120 | 120 | 108 | 108 |
| Nos. 29 and 30 |     |     |     |     |     | 96    | 96  | 96  | 96  |     |     |

# TABLE 22

# Weights and Sizes of Sheet Lead

The thickness of lead is in common determined or understood by the weight, the unit being that of a square or superficial foot; a square foot 1/16 of an inch thick weighs four pounds.

| 12   | Ounce | Lead | is | .013       | Inch | Thick | 8  | Pound | Lead | is | 1/8 | Inch | Thick |
|------|-------|------|----|------------|------|-------|----|-------|------|----|-----|------|-------|
| 1    | Pound | "    | "  | 48         | 4    | 4     | 10 | ĸ     | u    | "  | 32  | "    | u     |
| 11/2 | u     | "    | "  | ¥3         | 4    | "     | 12 | u     | α    | "  | 16  | "    | u     |
| 2    | "     | "    | "  | 32         | 4    | 4     | 14 | u     | u    | "  | 372 | "    | 4     |
| 21/2 | æ     | "    | u  | 1<br>2x    | "    | u     | 16 | "     | u    | "  | 1/4 | a    | "     |
| 3    | 4     | "    | æ  | eg.        | 4    | "     | 20 | 4     | ű    | Œ  | 16  | u    | "     |
| 4    | a     | "    | u  | 78         | u    | æ     | 24 | u     | "    | u  | 3/8 | u    | "     |
| 5    | "     | "    | "  | 5 <u>.</u> | 4    | 4     | 32 | "     | "    | 4  | 1/2 | 4    | "     |
| 6    | *     | u    | "  | 32         | u    | "     | 60 | u     | u    | 4  | 1   | u    | "     |
| 7    | #     | u    | 4  | 7.         | "    | 4     |    |       |      |    |     |      |       |

TABLE 23

# Standard Weights and Gauges of Tin Plate

| Trade<br>Term |    | Wt.<br>Per<br>Sq.<br>Ft.<br>Lbs. | Wt.<br>of Box<br>14 ×<br>20 in.,<br>Lbs. | Trade   | Near-<br>est<br>Wire<br>Gauge<br>No. | Wt.<br>Per<br>Sq.<br>Ft.<br>Lbs. | Wt.<br>of Bex<br>14 ×<br>20 in.,<br>Lbs. | Trade                  | Near-<br>est<br>Wire<br>Gauge<br>No. | Wt.<br>Per<br>Sq.<br>Ft.<br>Lbs. | Wt.<br>of Box<br>14 ×<br>20 in,<br>Lbs. |
|---------------|----|----------------------------------|--|---------|--------------------------------------|----------------------------------|--|------------------------|--------------------------------------|----------------------------------|---|
| 55 lb.        | 38 | 0.252                            | 55                                       | 100 lb. | 301/2                                | 0.459                            | 100                                      | 3XL                    | 26                                   | 0.771                            | 168                                     |
| 60 "          | 37 | . 275                            | 60                                       | IC      | 30                                   | .491                             | 107                                      | $\mathbf{D}\mathbf{X}$ | 26                                   | . 826                            | 180                                     |
| 65 "          | 36 | . 298                            | 65                                       | 118 lb. | 29                                   | . 542                            | 118                                      | 4X                     | 25                                   | . 895                            | 195                                     |
| 70 "          | 35 | .321                             | 70                                       | IX      | 28                                   | .619                             | 135                                      | 4XL                    | 25                                   | .863                             | 188                                     |
| 75 "          | 34 | .344                             | 75                                       | IXL     | 28                                   | .588                             | 128                                      | D2X                    | 24                                   | .964                             | 210                                     |
| 80 "          | 33 | .367                             | 80                                       | DC      | 28                                   | .638                             | 139                                      | D3X                    | 23                                   | 1.102                            | 240                                     |
| 85 "          | 32 | .390                             | 85                                       | 2X      | 27                                   | .711                             | 155                                      | D4X                    | 22                                   | 1.239                            | 270                                     |
| 90 "          | 31 | .413                             | 90                                       | 2XL     | 27                                   | .679                             | 148                                      |                        |                                      |                                  |   |
| 95 4          | 31 | .436                             | 95                                       | 3X      | 26                                   | .803                             |  | ••••                   |                                      |                                  | ••••                                    |

# TABLE 24

# Specifications for Tin and Terne Plate

| Ma           | terial Des  | ired  | Rejected if Less Than   |   |   |  |  |
|--------------|---|---|---|---|---|--|--|
| Tin<br>Plate | No. 1<br>Terne  | No. 2<br>Terne  | Tin<br>Plate  | No. 1<br>Terne  | No. 2<br>Terne  |  |  |
|              |   |   |   |   |   |  |  |
| 00           | 26  | 16  |   |   |   |  |  |
| 0            | 74  | 84  |   |   |   |  |  |
| 0.023        | 0.046   | 0.023   | 0.0183  | 0.0413  | 0.083   |  |  |
|              |   |   |   |   |   |  |  |
| 0.496        | 0.519   | 0.496   | 0.468   | 0.490   | 0.468   |  |  |
| . 625        | .648  | . 625   | . 590   | .612  | . 590   |  |  |
| .716         | . 739   | .716  | . 676   | . 699   | . 676   |  |  |
| .808         | .831  | .808  | .763  | .787  | .763  |  |  |
| .900         | .925  | .900  | .850  | .874  | .850  |  |  |
|              | Tin Plate  00 0 0 0.023  0.496     .625     .716     .808 | Tin No. 1<br>Plate Terne.  00 26<br>0 74<br>0.023 0.046  0.496 0.519<br>.625 .648<br>.716 .739<br>.808 .831 | Plate         Terne         Terne           00         26         16           0         74         84           0.023         0.046         0.023           0.496         0.519         0.496           .625         .648         .625           .716         .739         .716           .808         .831         .808 | Tin Plate         No. 1 Terne         No. 2 Terne         Tin Plate           00         26         16            0         74         84            0.023         0.046         0.023         0.0183           0.496         0.519         0.496         0.468           .625         .648         .625         .590           .716         .739         .716         .676           .808         .831         .808         .763 | Tin Plate         No. 1 Terne         No. 2 Terne         Tin Plate         No. 1 Terne           00         26         16             0         74         84             0.023         0.046         0.023         0.0183         0.0413           0.496         0.519         0.496         0.468         0.490           .625         .648         .625         .590         .612           .716         .739         .716         .676         .699           .808         .831         .808         .763         .787 |  |  |

## TABLE 25

# Weight of Terne Plates

TERNE PLATES, or Roofing Tin, are coated with an alloy of tin and lead. In the "U. S. Eagle, N.M." brand the alloy is 32% tin, 68% lead. The weight per 112 sheets of this brand before and after coating is as follows:

| IC 14 x 20                | IC 20 x 28       | IX 14 x 20     | IX 20 x 28     |
|---------------------------|------------------|----------------|----------------|
| Black plates 95 to 100 lb | . 190 to 200 lb. | 125 to 130 lb. | 250 to 260 lb. |
| After coating 115 to 120  | 230 to 240       | 145 to 150     | 290 to 300     |

Terne plates are made in two thicknesses: 1C, in which the iron body weighs about 50 lb. per 100 sq. ft., and IX, in which it weighs 62½ lb. per 100 sq. ft. The IC grade is preferred for roofing, while the IX grade is used for spouts, valleys, gutters, and flashings. The standard weight of 14 x 20 in. IC plates is 107 lb. per base-box, and of 14 x 20 in. IX plate 135 lb.

Long terne sheets are made in gauges, Nos. 14 to 32, from 10 to 40 in. wide and up to 12 in. long. They are made in five grades with coatings of 8, 12, 15, 20, and 25 lb.

A box of 112 sheets 14 x 20 in. will cover approximately 192 sq. ft. of roof, flat seam, or 583 sheets 1,000 sq. ft. For standing seam roofing a sheet 20 x 28 in. will cover 475 sq. in. or 303 sheets per 1,000 sq. ft. A box of 112 sheets 20 x 28 in. will cover approximately 366 sq. ft.

The common sizes of tin plates are  $10 \times 14$  in. and multiples of that measure. The sizes most generally used are  $14 \times 20$  and  $20 \times 28$  in.

#### TABLE 26

#### Thickness and Weight Per Sq. Foot of Sheet Tin

| 1 lb. tin is <sup>1</sup> / <sub>40</sub> inch thick | 31/2     | lb. tin is | 1/11 inch thick                         |
|--|----------|------------|---|
| $1\frac{1}{2}$ lb. tin is $\frac{1}{21}$ inch thick  | 4        | lb. tin is | <sup>1</sup> / <sub>10</sub> inch thick |
| 2 lb. tin is $\frac{1}{20}$ inch thick               | 41/2     | lb. tin is | 1/9 inch thick                          |
| $2\frac{1}{2}$ lb. tin is $\frac{1}{16}$ inch thick  | 5        | lb. tin is | 1/8 inch thick                          |
| 3 lb. tin is $\frac{1}{18}$ inch thick               | 10       | lb. tin is | 1/4 inch thick                          |
| 20 lb. tin is !                                      | 1/2 inch | thick      |   |

# TABLE 27

# Pure Block-Tin Pipe

|  | Calibre   | Weight<br>Per Ft.<br>Oz.                 | Calibre  | Weig<br>per<br>Lbs. | Ft.                            |
|--|---|--|--|---------------------|--------------------------------|
| 1/8 inch<br>1/4 #<br>1/4 #<br>1/4 #<br>1/4 #<br>1/8 #<br>1/2 # | extra strong<br>double extra strong<br>double extra strong<br>extra strong<br>double extra strong<br>strong | . 5<br>: 6<br>: 6½<br>: 6<br>: 8<br>: 6½ | 1/2 inch double extra strong. 5/4 " extra strong. 5/4 " double extra strong. 5/4 " extra strong. 1 " extra strong. 1 " double extra strong. 1 double extra strong. | 1                   | 15<br>9<br>14<br>11<br>14<br>4 |

TABLE 28

# Weight of Round Zinc Rods Per Lineal Foot

| 3/8 | inch | diameter |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | . 33 | pounds     |
|-----|------|----------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|------|------------|
| 1,3 | "    | u        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | .58  | • <b>"</b> |
| 5%  | "    | 4        | • | Ī |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | .90  | u          |
| 3%  | "    | 4        | • |   |   |   | - | - | - |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 1.30 | u          |
| 7%  | "    | u        |   |   | - | - | - | • | - | - | - | - | - | - | - | - | - |   | _ |   |   |   |   |   | - | 1 78 | "          |
| 1 8 | "    | u        | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | 2 32 | u          |

TABLE 29

## Weights of Aluminum Sheets

| Stubs'<br>Gauge | Thickness<br>in Decimal | Weight in         | Pounds of         | Aluminum          | of Same           | Thickness         |
|-----------------|-------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| (Nearest)       | Parts of<br>1 Inch      | Sheets<br>14 x 48 | Sheets<br>24 x 48 | Sheets<br>30 x 60 | Sheets<br>36 x 72 | Sheets<br>48 x 72 |
| 35              | .00537                  | 0.35              | 0.61              | 0.96              | 1.38              | 1.83              |
| 33              | .00806                  | 0.53              | 0.92              | 1.43              | 2.06              | 2.75              |
| 31              | .0107                   | 0.71              | 1.22              | 1.91              | 2.75              | 3.66              |
| 29              | .0134                   | 0.89              | 1.53              | 2.38              | 3.43              | 4.57              |
| 27              | .0161                   | 1.07              | 1.83              | 2.86              | 4.12              | 5.49              |
| 26              | .0188                   | 1.25              | 2.14              | 3.33              | 4.80              | 6.40              |
| 24              | .0215                   | 1.42              | 2.44              | 3.81              | 5. <b>49</b>      | 7.32              |
| 23              | .0242                   | 1.60              | 2.75              | 4.29              | 6.17              | 8.23              |
| 22              | . 0269                  | 1.78              | 3.05              | 4.76              | 6.86              | 9.14              |
| 21              | .0322                   | 2.14              | 3.66              | 5.72              | 8.23              | 11.00             |
| 19              | . 0430                  | 2.85              | 4.88              | 7.62              | 11.00             | 14.70             |
| 18              | . 0538                  | 3.56              | 6.10              | 9.52              | 13.75             | 18.30             |
| 16              | .0645                   | 4.27              | 7.32              | 11.45             | 16.50             | 22.00             |
| 15              | . 0754                  | 4.98              | 8.53              | 13.35             | 19.20             | <b>25</b> .60     |
| 14              | . 0860                  | 5.69              | 9.75              | 15.30             | 21.95             | <b>29</b> .30     |
| 13              | . 095                   |                   | 10.70             | 16.80             | 24.10             | 32.00             |
| 12              | . 109                   |                   | 12.40             | 19.20             | 27.75             | <b>37</b> .20     |
| 11              | . 120                   |                   | 13.60             | 21.35             | 30.50             | 40.85             |
| 10              | . 134                   |                   | 15.30             | 23.80             | 34.20             | 45.70             |
| 9               | .148                    |                   | 16.80             | 26.20             | 37.80             | 50.30             |
| 8<br>7          | . 165                   |                   | 18.60             | 29.30             | 42.10             | <b>56</b> .10     |
|                 | . 180                   |                   | 20.40             | 32.00             | 46.00             | 61.30             |
| 6               | . 203                   |                   | 23.00             | 36.00             | 51.80             | <b>69.20</b>      |
| 5               | . 220                   |                   | 25.00             | 39.00             | 56.10             | 75.00             |
| 4               | . 238                   |                   | 27.00             | 42.10             | 60.70             | 81.10             |
| 8               | . 259                   |                   | 29.30             | 46.00             | 66.10             | 88.10             |
| 2               | . 284                   |                   | 32.20             | 50.30             | 72.50             | 96.60             |
| 1               | .300                    |                   | 34.00             | 53.10             | 76.50             | 102.20            |
| 0               | .340                    |                   | 38.60             | 60.40             | 86. <b>90</b>     | 116.00            |
| _               |                         |                   |                   |                   |                   |                   |

One ounce per square foot aluminum sheet is 0.0044 inch thick and corresponds to about No. 37 B. & S. gauge.

Rolled Aluminum has a specific gravity of 2.72. One cubic foot weighs 196<sup>510</sup>/<sub>1000</sub> pounds. One square foot of one inch thick weighs 14<sup>128</sup>/<sub>1000</sub> pounds.

# Thickness and Weights of Sheet Zinc

|   | ěě   | <u>ښ</u>  |  |
|---|--|---|--|
|   | 딞  | 8   |  |
|   | _  | 3   |  |
|   | 8  | 2.6   |  |
|   | 13   | .25   |  |
|   | _  | 92  |  |
|   | =  | 22  |  |
|   | 11   | .90 1.05 1.20 1.35 1.50 1.68 1.87 2.06 2.25 2.62 3.00 3.3 |  |
|   | 9  | 88  |  |
|   | Ä  | -   |  |
|   | 12   | 1.50  |  |
|   | 4  | 35  |  |
|   | _  | 1.  |  |
|   | 13   | 1.2   |  |
|   | 9  | 05  |  |
| , | _  | ) <b>1</b> .  |  |
| • | Ħ  | Ğ.  |  |
|   | 2  | .75   |  |
|   | _  | 2   |  |
|   | •  | .67   |  |
|   | •  | 9.  |  |
|   | -  | .52   |  |
|   | -  | ~:  |  |
|   | 9  | .45   |  |
|   | 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 2 | .30 .37 .45   |  |
|   | 4  | 30  |  |
|   |  |   |  |
|   | H Gauge N                                      | Weight, per 34.<br>Ft. in Lbs.<br>Thickness in            |  |
|   | Me   | Tr.   |  |

37 93

Ins. Approx

Sq. Ft. per Sheet Sheet Size of §

APPROXIMATE WEIGHT PER SHEET to 15 are the same as U. S. Standard Nos. 20 to 28. Sizes 8

 $008 \quad 010 \quad 012 \quad 014 \quad 016 \quad 018 \quad 020 \quad 024 \quad 028 \quad 032 \quad 036 \quad 040 \quad 045 \quad 050 \quad 055 \quad 060 \quad 070 \quad 080 \quad 080$ 

42.7 48.9 6 46.8 25.5 5 55.2 2 59.7 6 55.2 2 59.7 6 55.3 2 59.7 6 55.3 2 59.7 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 55.4 20.2 6 56.4 20.2 25. 52. 6 52. 6 52. 6 52. 6 52. 8 52. 8 53. 8 54. 8 31.3 33.6 36.1 38.5 441. 55.6 55.6 55.6 55.7 59.1 286.2 28.33.33.35.4 4.33.33.33.35.4 5.53.33.33.33.35.35.4 70.99.4 70.90.4 70.90.4 70.90.4 70.90.4 70.90.4 70.90.4 70.90.4 70.9 - 6 43.2 48.2 47. 53.8 5 18.9 22.5 22.5 23.5 26.9 32.4 36.4 36.5 တာ့ က မာ 18. 20.3 10.9 11.8 12.6 13.4 8.4 9.1 9.8 10.5 11.2 12. 14.1 16.2 12.5 13.4 14.9 12.2 14. 10.9 7.3 8.5 9.1 9.7 6.3 6.9 7.4 7.9 8.4 8.4 9.5 10.8 11.2 10.6 11.0 11.6 12.9 12.6 5.6 6.5 6.5 7.8 8.7 8.7 8.9 9.9 9.9 110.6 111.9 × 1. × × 6 14. 115.2 116.3 117.5 118.7 11 

No. 18 and heavier. Boxes average about 500 pounds. No. 17. 3 4 ŝ Casks average about 600 pounds each.

TABLE 31

# Weight of Aluminum Sheets

| B.&S                                 | 6. B. & S. | Corre-     | Weight        | B. & S. | B.&S.    | Corre-     | Weight        |
|--------------------------------------|------------|------------|---------------|---------|----------|------------|---------------|
| Gauge                                | e Gauge    | sponding   | Per           | Gauge   | Gauge    | sponding   | Per           |
| No.                                  | Decimal    | Fractional | Sq. Ft.       | No.     | Decimal  | Fractional | Sq. Ft.       |
|                                      | Parts of   | Part of    | Alumin-       |         | Parts of | Part of    | Alumin-       |
|                                      | an Inch    | an Inch    | um, Lbs.      |         | an Inch  | an Inch    | um, Lbs.      |
| 0000                                 | .460       | 15/32      | 6.406         | 20      | .032     | 1/32       | .445          |
| 000                                  | .410       | ·.         | 5.704         | 21      | .028     | i.         | . 396         |
| 00                                   | . 365      | 3/8        | 5.080         | 22      | .025     |            | . 353         |
| 0                                    | . 325      | 21/64      | 4.524         | 23      | .023     |            | .314          |
| ī                                    | . 289      | 9/32       | 4.029         | 24      | .020     |            | . 280         |
| 2                                    | . 258      | 1/4        | 3.588         | 25      | .018     |            | . 249         |
| 3                                    | . 229      | 15/64      | 3.195         | 26      | .016     | 1/64       | . 222         |
| 4                                    | . 204      | 13/64      | 2.845         | 27      | .014     |            | . 197         |
| 2<br>3<br>4<br>5<br>6<br>7<br>8<br>9 | . 182      | 3/16       | 2.534         | 28      | .013     |            | . 176         |
| 6                                    | . 162      | 5/32       | 2.256         | 29      | .011     |            | . 157         |
| 7                                    | . 144      | 9/64       | 2.009         | 30      | .010     |            | . 140         |
| 8                                    | . 128      | 1/8        | 1.789         | 31      | .009     |            | .124          |
|                                      | . 114      | 7/64       | 1.594         | 32      | .00795   |            | .1107         |
| 10                                   | . 102      |            | 1.418         | 33      | .00708   |            | .0985         |
| 11                                   | .091       | 3/32       | 1.264         | 34      | .0063    |            | .0877         |
| 12                                   | .081       | 5/64       | 1.126         | 35      | .0056    |            | .0782         |
| 13                                   | .072       |            | 1.002         | 36      | .005     |            | .0 <b>696</b> |
| 14                                   | .064       | 1/16       | . 8 <b>92</b> | 37      | .00445   |            | .0620         |
| 15                                   | .057       |            | . 795         | 38      | .00396   |            | .00 <b>52</b> |
| 16                                   | . 051      |            | .708          | 39      | . 00353  |            | .0491         |
| 17                                   | .045       | 3/64       | .6 <b>3</b> 0 | 40      | .00314   |            | .0438         |
| 18                                   | . 040      |            | . 561         | 41      | .0028    |            |               |
| . 19                                 | .036       |            | . 500         | 42      | .00249   |            |               |
| _                                    |            |            |               |         |          |            |               |

To obtain the weight of aluminum in bars, sheets, etc., divide the weight of similar pieces of copper by 3.3, brass by 3.1 and steel by 2.9.

TABLE 32 Weights of Aluminum and Brass Sheets

| Stubs'<br>Gauge<br>Nearest<br>No.                        |   | Per Sq. Ft.<br>Junces   | Stubs'<br>Gauge<br>Nearest                    | Weight Per Sq. Ft.<br>in Ounces  |  |  |  |
|--|---|---|---|--|--|--|--|
|  | Brass   | Aluminum  | No.   | Brass  | Aluminum   |  |  |
| 35<br>33<br>31<br>29<br>27<br>26<br>24<br>25<br>21<br>19 | 3.424<br>5.472<br>6.846<br>8.896<br>10.96<br>12.32<br>15.05<br>17.12<br>19.20<br>21.92<br>22.880<br>33.60 | 1. 22<br>1. 83<br>2. 44<br>3. 05<br>3. 60<br>4. 27<br>4. 88<br>5. 49<br>6. 10<br>7. 32<br>9. 75<br>12. 20 | 13<br>12<br>11<br>10<br>9<br>8<br>7<br>6<br>5 | 65.05<br>74.67<br>82.19<br>91.76<br>101.34<br>112.99<br>123.26<br>139.02<br>150.65<br>163.04<br>177.44<br>194.48 | 21. 35<br>24. 70<br>27. 15<br>30. 50<br>33. 55<br>37. 50<br>40. 85<br>46. 00<br>50. 00<br>53. 95<br>64. 30<br>67. 95 |  |  |
| 16<br>15<br>14   | 44.48<br>49.28<br>56.83   | 14.65<br>17.10<br>19.50   | 0   | 205.44<br>232.83   | 77.10  |  |  |

TABLE 33

| Weight   | of | Square | and  | Round | Aluminum           | Bars |
|----------|----|--------|------|-------|--------------------|------|
| TTOLEARC | V. |        | ou c |       | <b>Lyingimieni</b> | Lars |

| Thick-<br>ness,<br>Side,<br>or Dia.  | Square<br>Bars,<br>1 Ft.<br>Long                     | Round<br>Bars,<br>1 Ft.<br>Long                      | Thick-<br>ness,<br>Side,<br>or Dia. | Bars,<br>1 Ft.   | Round<br>Bars,<br>1 Ft.<br>Long                                | Thick-<br>ness,<br>Side,<br>or Dia.          | Bars,<br>1 Ft.                                | Round<br>Bars,<br>1 Ft.<br>Long                                    |
|--|--|--|-------------------------------------|--|--|--|---|--|
| In. to 1/8 to 1/4 to 1/ | Lb.<br>0.004<br>.018<br>.041<br>.672<br>.114<br>.163 | Lb.<br>0.003<br>.014<br>.032<br>.057<br>.089<br>.128 | In. %4                              | Lb.<br>0.652<br>.766<br>.888<br>1.019<br>1.159<br>1.309<br>1.467 | Lb.<br>0.516<br>.601<br>.697<br>.900<br>.911<br>1.028<br>1.152 | In.<br>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | Lb. 2.396 2.609 2.831 8.062 3.302 3.550 3.810 | Lb.<br>1.882<br>2.049<br>2.223<br>2.405<br>2.593<br>2.789<br>2.992 |
| 12.44  | .222<br>.290<br>.367<br>.453                         | .227<br>.288<br>.356                                 | 1 % 1 % 1 % 1 % 1 % 1 %             | 1.635<br>1.812<br>1.997<br>2.192                                 | 1.132<br>1.284<br>1.423<br>1.569<br>1.722                      | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1        | 4.075<br>4.352<br>4.638                       | 3.202<br>3.417<br>3.642  |

TABLE 34

# Weight of Sheet Copper

| Stubs<br>Gaug<br>Neare<br>No. | e in Decimal<br>st Parts of |     | Sheets<br>14 x 48,<br>Weight<br>in Lbs. | Sheets<br>24 x 48,<br>Weight<br>in Lbs. | Sheets<br>30 x 60,<br>Weight<br>in Lbs. | Sheets<br>36 x 72,<br>Weight<br>in Lbs. | Sheets<br>48 x 72,<br>Weight<br>in Lbs. |
|-------------------------------|-----------------------------|-----|---|---|---|---|---|
| 35                            | .00537                      | 4   | 1.16                                    | 2                                       | 3.12                                    | 4.50                                    | 6                                       |
| 88                            | .00806                      | 6   | 1.75                                    | 3                                       | 4.68                                    | 6.75                                    | 9                                       |
| 31                            | .0107                       | 8   | 2.03                                    |   | 6.25                                    | 9                                       | 12                                      |
| 29                            | .0134                       | 10  | 2.91                                    | . 4<br>5<br>6                           | 7.81                                    | 11.25                                   | 15                                      |
| 27                            | .0161                       | 12  | 3.50                                    | 6                                       | 9.37                                    | 13.50                                   | 18                                      |
| 26                            | .0188                       | 14  | 4.08                                    | 7                                       | 10.93                                   | 15.75                                   | 21                                      |
| 24                            | .0215                       | 16  | 4.66                                    | 8                                       | 12.50                                   | 18                                      | 24                                      |
| 23                            | .0242                       | 18  | 5.25                                    | 9                                       | 14.06                                   | 20.25                                   | 27                                      |
| 22                            | .0269                       | 20  | 5.83                                    | 10                                      | 15.62                                   | 22.50                                   | 30                                      |
| 21                            | .0322                       | 24  | 7                                       | 12                                      | 18.75                                   | 27                                      | 36                                      |
| 19                            | .0430                       | 32  | 9.33                                    | 16                                      | 25                                      | 36                                      | 48                                      |
| 18                            | .0538                       | 40  | 11.66                                   | 20                                      | 31.25                                   | <b>4</b> 5                              | 60                                      |
| 16                            | .0645                       | 48  | 14                                      | 24                                      | <b>37.5</b> 0                           | 54                                      | 72                                      |
| 15                            | .0754                       | 56  | 16.33                                   | 28                                      | 43.75                                   | 63                                      | 84                                      |
| 14                            | .0860                       | 64  | 18.66                                   | 32                                      | 50                                      | 72                                      | 96                                      |
| 13                            | .095                        | 70  |   | 35                                      | 55                                      | 79                                      | 105                                     |
| 12                            | .109                        | 81  |   | 401/2                                   | 63                                      | 91                                      | 122                                     |
| 11                            |                             | 89  |   | 441/2                                   | 70                                      | 100                                     | 134                                     |
| 10                            |                             | 100 |   | 50                                      | <b>78</b>                               | 112                                     | 150                                     |
| 9                             |                             | 110 |   | <b>5</b> 5                              | 86                                      | 124                                     | 165                                     |
| 8                             | .165                        | 123 |   | 61                                      | 96                                      | 138                                     | 184                                     |
| 7                             | .180                        | 134 |   | 67                                      | 105                                     | 151                                     | 201                                     |
| 6                             | .203                        | 151 |   | 751/2                                   | 118                                     | 170                                     | 227                                     |
| . 5                           | .220                        | 164 |   | 82                                      | 128                                     | 184                                     | 246                                     |
| 4                             | .238                        | 177 |   | 8814                                    | 138                                     | 199                                     | 266                                     |
| . 3                           |                             | 193 |   | 96                                      | 151                                     | 217                                     | 289                                     |
| 2                             |                             | 211 |   | 1051/2                                  | 165                                     | 238                                     | 317                                     |
| 1                             |                             | 223 |   | 1111/2                                  | 174                                     | 251                                     | 335                                     |
| 0                             | .340                        | 253 |   | $126\frac{1}{2}$                        | 198                                     | 285                                     | 380                                     |

U .04U 203 ..... 120½ 198 285 380 Official table adopted by the Association of Copper Manufacturers of the United States.

Rolled copper has specific gravity of 8.93. One cubic foot weighs 558<sup>105</sup>/1000 pounds. One square foot, of 1 inch thick, weighs 46<sup>20</sup>/100 pounds.

| s of Sheets and Bars of Lead, Copper and Brass |  |
|--|--|
| E Lead,  |  |
| Bars of  |  |
| ts and   |  |
| of Shee  |  |
| Weights  |  |
| LABLE 35                                       |  |

| Thickness Or Or Diameter, 1/36 1/36 1/32 1/32 1/4 1/4 1/4 1/1/6 1/6 1/6 1/6 1/6 1/6 1/6 1/6 1/6 1  |              |
|--|--------------|
| Round Bars 1 Ft. Long. 1 Long. |              |
| Brass Square Bars 1 Ft. Long. 1 Long.  |              |
| Sheets Per Sq. Per 1.36 1.36 1.36 1.36 1.36 1.36 1.36 1.36   |              |
| Round Bars 1 Pt. Long, Lb. 1000 1000 1000 1000 1000 1000 1000 10   |              |
| Copper—Square Bars 1 Pr. Long. Lb. 1 Copper—1 Co |              |
| Sheets Per 1   |              |
| Round Bars 1 Pt. Long, Lb. 6004 0 0015 0 001 | , table tire |
| Lead Square Bars 1 Ft. Long, Lb. 1 Co. 1 Lb. 1 Co. 1 C | nevagor: 100 |
| Sheets States St | o within o   |
| Thickness or Diameter, Inches Inches 1/16 3/32 3/32 3/16 1/32 3/16 1/2 1/2 1/2 1/2 1/2 1/2 1/2 1/2 1/2 1/2   |              |

Table 36
Approximate Weight Per Lineal Foot o

# Approximate Weight Per Lineal Foot of Rectangular or Flat Copper and Brass Bars

| Size,<br>Inch  | Copper<br>Lbs.   | Brass<br>Lbs.   | Size,<br>Inch   | Copper<br>Lbs.  | Brass<br>Lbs.  |
|--|--|---|---|---|--|
|  | . 12<br>. 15<br>. 18<br>. 21<br>. 24<br>. 30<br>. 36<br>. 24<br>. 30<br>. 36 |   | Inch  16 × 2  14 × 1/2  14 × 5/8  14 × 3/4  14 × 1/8  14 × 11/4  14 × 11/4  14 × 11/6   | 1.44<br>.48<br>.60<br>.72<br>.84<br>.97<br>1.20<br>1.44<br>1.68<br>1.93 |  |
| 18 × 18<br>18 × 114<br>18 × 114<br>18 × 134<br>18 × 2<br>318 × 12  | .42<br>.48<br>.60<br>.72<br>.84  | .399<br>.456<br>.570<br>.684<br>.798                  | $\frac{3}{8} \times 1$<br>$\frac{3}{8} \times 1\frac{1}{4}$<br>$\frac{3}{8} \times 1\frac{1}{2}$                                      | 1.44<br>1.80<br>2.16<br>2.52<br>2.88<br>3.24                            | 1.368<br>1.710<br>2.052<br>2.394<br>2.736<br>3.078                   |
| $\frac{16}{16} \times \frac{1}{2}$ $\frac{16}{16} \times \frac{5}{8}$ $\frac{16}{16} \times \frac{3}{4}$ $\frac{16}{16} \times 1$ $\frac{1}{3}$ $\frac{16}{16} \times 1$ $\frac{1}{4}$ $\frac{1}{3}$ $\frac{1}{16} \times 1$ $\frac{3}{16} \times 1$ $\frac{3}{16} \times 1$ $\frac{3}{16} \times 1$ | .36<br>.45<br>.54<br>.63<br>.72<br>.90<br>1.08<br>1.26                       | .342<br>.427<br>.513<br>.598<br>.684<br>.855<br>1.026 | 3/8 × 2 1/4<br>3/8 × 2 1/4<br>3/8 × × 2 1/4<br>1/2 × 1 1/4<br>1/2 × 1 1/4<br>1/2 × 2 1/4<br>1/2 × 2 1/4<br>1/2 × 2 1/4<br>1/2 × 2 1/4 | 3.60<br>1.93<br>2.41<br>2.89<br>3.37<br>3.86<br>4.34<br>4.82            | 3.420<br>1.833<br>2.289<br>2.745<br>3.201<br>3.667<br>4.123<br>4.579 |

TABLE 37

# Weight Per Foot of Lead Pipe

| Inside<br>Diam- |        | ok-            |        | x.         |        | A          | •          | 3       | ٠.         | 2       | Ę   |            | For       | un-     |
|-----------------|--------|----------------|--------|------------|--------|------------|------------|---------|------------|---------|-----|------------|-----------|---------|
| eter,<br>Inches | Lb.    | Oz.            | Lb.    | ong<br>Oz. | Lb.    | ong<br>Oz. | Med<br>Lb. | Oz.     | Lig<br>Lb. | Oz.     | Lb. | ght<br>Oz. | ta<br>Lb. | Oz.     |
| 3/8             | 1      | 12             | 1      | 8          | 1      | 4          | 1          | 0       | 0          | 12      | 0   | 10         | 1         | 7       |
| 1/2             | . 3    | ö              | 2      | Ö          | i      | iż         | i          | 4       | 1          | 13<br>0 | Ö   | 12         | Ġ.        | . 9     |
| 5/8<br>3/4      | 3<br>4 | $\frac{8}{12}$ | 2<br>3 | 12<br>8    | 2<br>3 | 8          | 2<br>2     | 0<br>4  | 1          | 8<br>12 | 1   | 0<br>4     | 0         | 12<br>0 |
| 114             | 6<br>6 | 0<br>12        | 4<br>5 | 12<br>12   | 4      | 0<br>12    | 3          | 4<br>12 | 2          | 8       | 2   | 8          | 1 2       | 8       |
| 1 1/2<br>13/4   | , š    | 8              | 7<br>8 | 8          | 6      | 8          | 5          | Õ       | 4          | 4       | 3   | 8          | 3         | ŏ       |
| 2               | iĭ     | 12             | 9      | õ          | 8      | ŏ          | 7          | ŏ       | 6          | ö       | 4   | 12         |           |         |

Table 38
Weight Per Foot of Seamless Brass Tubes

| A.W.G                           | . 2     | 4      | 6        | 8      | 10     | 12      | 14           | 16     | 18      | 20      | 22           | 24    |
|---------------------------------|---------|--------|----------|--------|--------|---------|--------------|--------|---------|---------|--------------|-------|
| Wall.*                          | .2576   | . 204  | 3 .162   | . 1285 | .1019  | .0808   | .0641        | .0508  | . 0403  | .0320   | .0253        | .0201 |
| Diam.                           | t       |        |          |        |        |         |              |        |         |         |              |       |
| 1/8                             |         |        | <b>.</b> |        |        |         |              |        |         | 0.034   | 0.0290       |       |
| 18                              |         |        |          |        |        |         | 0.092        | .080   | .069    | .058    | .048         | . 039 |
| 1/4                             |         |        |          |        |        | 0.158   | . 138        |        | .098    | .081    | .066         | .053  |
| 16                              |         |        |          |        | . 248  | .217    | . 184        | . 154  | .127    | . 104   | .084         | .068  |
| 3/8<br>1/2<br>5/8<br>3/4<br>7/8 |         |        |          | 0.376  |        | .275    | . 231        | . 191  | . 156   | .127    | . 103        | . 083 |
| 1/2                             |         |        | . 0.634  |        |        | .392    | . 323        | .264   | 214     | .173    | . 139        | . 112 |
| 5∕8                             | 1.10    | 0.994  |          |        | . 617  | . 509   | .416         | .338   | . 273   | .219    | . 176        | . 141 |
| 3/4                             | 1.47    | 1.29   | 1.10     | . 934  |        | . 626   | . 509        | .411   | .331    | .266    | .213         | .170  |
| 7∕8                             | 1.84    | 1.59   | 1.34     | 1.12   | .911   | . 743   | . 601        | .485   | .389    | .312    | .249         | . 199 |
| 1                               | 2.21    | 1.88   | 1.57     | 1.31   | 1.06   | .859    | . 694        | . 558  | .448    | . 358   | .286         | .228  |
| 11/8                            | 2.59    | 2.18   | 1.81     | 1.49   | 1.21   | .976    | . 787        | . 632  | . 506   | .404    | . <b>322</b> | . 257 |
| 11/8<br>11/4                    | 2.96    | 2.47   | 2.04     | 1.68   | 1.35   | 1.09    | .879         | . 705  | . 564   | . 450   | .359         | . 286 |
| 13/8                            | 3.33    | 2.77   | 2.27     | 1.86   | 1.50   | 1.21    | . 972        | .779   | . 622   | . 497   | .396         | .315  |
| 11/2                            | 3.70    | 3.06   | 2.51     | 2.05   | 1.65   | 1.33    | 1.06         | .852   | . 681   | . 543   | .432         | .344  |
| 13/4                            | 4.45    | 3.65   | 2.98     | 2.42   | 1.94   | 1.56    | 1.25         | . 999  | .797    | . 635   | .506         | .402  |
| 2                               | 5.19    | 4.24   | 3.45     | 2.79   | 2.24   | 1.79    | 1.44         | 1.15   | .914    | .728    | .579         | .460  |
| 21/4                            | 5.94    | 4.84   | 3.91     | 3.16   | 2.53   | 2.03    | 1.62         | 1.29   | 1.03    | .820    | .652         | . 519 |
| 21/2                            | 6.68    | 5.43   | 4.38     | 3.54   | 2.83   | 2.26    | 1.81         | 1.44   | 1.15    | .913    | .722         | .577  |
| 234                             | 7.43    | 6.02   | 4.85     | 3.91   | 3.12   | 2.50    | 1.99         | 1.59   | 1.26    | 1.01    | .799         | . 635 |
| 3                               | 8.17    | 6.61   | 5.32     | 4.28   | 3.42   | 2.73    | 2.18         | 1.73   | 1.38    | 1.10    | .872         | . 693 |
| 31/4                            | 8.92    | 7.20   | 5.79     | 4.65   | 3.71   | 2.96    | 2.36         | 1.88   | 1.50    | 1.19    | .946         | .751  |
| 312                             | 9.66    | 7.79   | 6.26     | 5.02   | 4.01   | 3.20    | 2.55         |        | 1.61    |         | 1.02         | .809  |
| 334                             |         | 8.38   | 6.73     | 5.39   | 4.30   | 3.43    | 2.73         |        | 1.73    |         | 1.09         | .867  |
|                                 | 11.2    | 8.97   | 7.19     | 5.77   | 4.60   |         | 2.92         | 2.32   | 1.85    |         | 1.17         | .926  |
| 41/4                            |         | 9.56   | 7.66     | 6.14   | 4.89   | 3.90    | 3.10         |        | 1.96    |         | 1.24         | .984  |
| 41/2                            |         | 10.2   | 8.13     | 6.51   | 5.19   |         | 3.29         |        | 2.08    |         |              | .04   |
| 434                             |         | 10.7   | 8.60     | 6.88   | 5.48   |         | 3.47         |        | 2.20    |         |              | .10   |
|                                 |         | 11.3   | 9.07     | 7.25   | 5.78   |         | 3.66         |        | 2.31    |         |              | .16   |
| 51/4                            |         | 11.9   | 9.54     | 7.62   | 6.07   |         | 3.85         |        | 2.43    | 1.93    |              | . 10  |
| 51/2                            |         |        | 10.0     | 8.00   | 6.36   | 5.07    | 4.03         |        |         | 2.02    | • • • •      |       |
| 534                             |         | 13.1   | 10.5     | 8.37   | 6.66   | 5.30    | 4.22         |        |         | 2.11    |              | • • • |
| 6                               |         | 13.7   | 10.9     | 8.74   | 6.95   | 5.53    | 4.40         |        |         | 2.21    | • • • •      |       |
| 61/4                            |         | 14.3   | 11.4     | 9.11   | 7.25   |         | 4.59         |        |         |         |              | • • • |
| 61/2                            |         |        | 11.9     | 9.48   | 7.54   |         | 4.77         |        | 3.01    | • • • • | • • • •      | • • • |
|                                 |         |        | 12.3     | 9.85   | 7.84   |         |              | 3.19   |         | • • • • | • • • •      | • • • |
| 63/4                            |         |        |          |        |        |         | 4.96<br>5.14 |        | • • • • | • • • • | • • • • •    |       |
|                                 |         |        |          | 10.2   | 8.13   |         |              | 4.09   | • • • • | • • • • | • • • •      | • • • |
| 71/4                            |         |        |          | 10.6   |        |         |              | 4.23   | • • • • | • • • • | • • • •      | • • • |
| 71/2                            | 21.0    |        |          | 11.0   | 8.72   |         | 5.51         | 4.38   | • • • • | • • • • | • • • •      | • • • |
| 73/4                            |         |        |          | 11.3   | 9.02   |         | 5.70         | 4.53   | • • • • | • • • • | • • • •      | • • • |
|                                 |         |        |          | 11.7   | 9.31   |         | 5.88         | 4.67   | • • • • | • • • • | • • • •      | • • • |
| 814                             |         | 19.0   |          | 12.1   | 9.61   |         | 6.07         | 4.82   | • • • • |         | • • • •      | • • • |
| 81/2                            |         |        | 15.6     | 12.5   | 9.90   | 7.87    | 6.25         | 4.97   | • • • • | • • • • | • • • • •    |       |
| 83/4                            |         |        |          |        |        |         |              | 5.12   | • • • • |         |              |       |
| 9 :                             | 26.1    | 20.8   | 16.6     | 13.2   | 10.5   | 8.34    | 6.63         | 5.26   |         |         |              | • • • |
| * Th                            | ickness | in inc | hoa      |        | † Outs | ide dia | meter        | inches |         |         |              |       |

\* Thickness in inches. † Outside diameter, inches. Seamless brass tubes are made from  $\frac{1}{2}$  in. to 1 in. outside diameter, varying by  $\frac{1}{2}$  in., and from  $\frac{1}{2}$  in. to 1 in. outside diameter, varying by  $\frac{1}{2}$  in., and in all gauges from No. 2 to No. 24 A.W.G. within the limits of the above table. To determine the weight per foot of a tube of a given inside diameter, add to the weights given above, the weights given below, under the corresponding gauge numbers.

A.W.G. 2 4 6 8 10 12 14 16 18 20 22 24 26 Lb. per ft. 1.54 .966 6.07 3.82 .240 .151 .095 .060 .038 .024 .015 .009 .0059 For copper tubing add 6% to the weights given above.

TABLE 39

#### Weight of Lead Wire Per Lineal Foot in Pounds

| Diameter in<br>Brown & Sharpe Gauge | Correspond-<br>ing Decimal<br>Equivalent | Correspond-<br>ing Fractional<br>Equivalent |                 |
|-------------------------------------|--|---|-----------------|
| No. 6                               | . 16202                                  | 5 (F)                                       | 10              |
| No. 8                               | . 12849                                  | $\frac{1}{8}$ (F)                           | $15\frac{1}{2}$ |
| No. 10                              | . 10189                                  | 7 (S)                                       | 25              |
| No. 11                              | .09074                                   | $\frac{8}{32}$ (S)                          | 31              |
| No. 12                              | .08081                                   | 54 (F)                                      | 40              |
| No. 13                              | .07196                                   | 84 (S)                                      | 50              |
| No. 14                              | . 06408                                  | $\frac{1}{16}$ (F)                          | $62\frac{1}{2}$ |
| No. 15                              | . 05706                                  | $\frac{1}{16}$ (S)                          | 77              |
| No. 16                              | .05082                                   | 3 (F)                                       | 100             |
| No. 17                              | .04525                                   | $\frac{3}{64}$ (S)                          | 125             |
| No. 18                              | . 0403                                   | $\frac{3}{64}$ (S)                          | 166             |
| No. 19                              | . 03589                                  | $\frac{1}{82}$ (F)                          | 200             |
| No. 20                              | .03196                                   | 32  | 250             |
| No. 21                              | .02846                                   | 36  | 332             |
| No. 22                              | .02535                                   | 40  | 400             |
| No. 23                              | .02257                                   | 44  | 510             |

Note.—Sizes above No. 6 B. & S. gauge increase by  $\frac{1}{32}$  of an inch. (F) = Full. (S) = Scant.

TABLE 40

# Weights of Wrought Iron, Copper and Lead Pipe

| Thick.<br>Inch. | Wrought<br>Iron | Copper | Lead  | Thick.<br>Inch | Wrought<br>Iron | Copper | Lead  |
|-----------------|-----------------|--------|-------|----------------|-----------------|--------|-------|
| 1-32            | .326            | .38    | .483  | 5-32           | 1.627           | 1.90   | 2.417 |
| 1-16            | .653            | .76    | .967  | 3-16           | 1.950           | 2.28   | 2.900 |
| 3-32            | .976            | 1.14   | 1.450 | 7-32           | 2.277           | 2.66   | 3.383 |
| 1-8             | 1.300           | 1.52   | 1.933 | 1-40           | 2.600           | 3.04   | 3.867 |

Rule: To the interior diameter of the pipe, in inches, add the thickness of the metal; multiply the sum by the decimal number opposite the required thickness and under the metal's name; also by the length of the pipe in feet; and the product is the weight of the pipe in pounds.

1. Required the weight of a copper pipe whose interior diameter is  $2\frac{1}{2}$  in., its length 20 ft., and the metal  $\frac{1}{8}$  in, in thickness.

 $2.25 + .125 = 2.375 \times 1.52 \times 20 = 72.2$  lbs.

TABLE 41

Quantity of Tin for Roofs

Standing Seam

| Sur-         |           | Flat     | Saam    |     |     |        | 5       | tandin  | g Sea   | m     |       |             |
|--------------|-----------|----------|---------|-----|-----|--------|---------|---------|---------|-------|-------|-------------|
| face         |           | I lat    |         |     |     | Single | Lock    | :       | • ]     | Doubl | e Loc | k           |
| of           | Ed        | ged      | Ed      | ged | 34. | ·In.   |         | Īn.     |         | ·In.  | 1-    | Īn.         |
| Roof         | 1/4       | In.      | 3/8     | ln. | Se  | am     | Se      | am      | Se      | am    |       | am          |
| to be        |           |          |         |     |     |        |         |         |         |       |       |             |
| Cov-<br>ered | 14<br>x   | 20<br>x  | 14<br>x | 20  | 14  | 20 x   | 14<br>x | 20<br>x | 14<br>x | 20    | 14    | 20          |
| ered         | 20        | 28       | 20      | 28  | 20  | 28     | 20      | 28      | 20      | 28    | 20    | 28          |
|              |           |          |         |     |     |        |         |         |         |       |       |             |
| Sq. Ft.      | S         | S        | S       | S   | S   | Ş      | S       | S       | S       | S     | S     | S           |
| 10           | 6         | 3        | 6       | 3   | 7   | 4      | 7       | 4       | 7       | 4     | 7     | 4           |
| 11           | 7         | 4        | 7       | 4   | 7   | 4      | 8       | 4       | 8       | 4     | 8     | 4           |
| 12           | 7         | 4        | 8       | 4   | 8   | 4      | 8       | 4       | 8       | 4     | 8     | 4           |
| 13           | 8         | 4        | 8       | 4   | 9   | 4      | 9       | 5       | 9       | 4     | 9     | 5<br>5<br>5 |
| 14           | 9         | 4        | 9       | 4   | 9   | 5      | 10      | 5       | 10.     | 5     | 10    | 5           |
| 15           | 9         | 5        | 9       | 5   | 10  | 5      | 10      | 5       | 10      | 5     | 10    | 5           |
| 16           | 10        | 5        | 10      | 5   | 11  | 5      | 11      | 5       | 11      | 5     | 11    | 6           |
| 17           | 10        | 5        | 11      | 5   | 11  | 6      | 12      | 6       | 11      | 6     | 12    | 6           |
| 18           | 11        | .6       | 11      | 6   | 12  | 6      | 12      | 6       | 12      | 6     | 12    | 6           |
| 19           | 12        | 6        | 12      | 6   | 12  | 6      | 13      | 6       | 13      | 6     | 13    | 6<br>7      |
| 20           | 12        | 6        | 12      | 6   | 13  | 7      | 13      | 7       | 13      | 7     | 14    | 7           |
| 21           | 13        | 6        | 13      | 6   | 14  | 7      | 14      | 7       | 14      | 7     | 14    | 7           |
| 22           | 13        | 7        | 14      | 7   | 14  | 7      | 15      | 7       | 15      | 7     | 15    | 7           |
| 23           | 14        | 7        | 14      | 7   | 15  | 7      | 15      | 8       | 15      | 8     | 16    | 8           |
| 24           | 14        | 7        | 15      | 7   | 16  | 8      | 16      | 8       | 16      | 8     | 16    | 8           |
| 25           | 15        | 8        | 15      | 8   | 16  | 8      | 17      | 8       | 17      | 8     | 17    | 8           |
| <b>2</b> 6   | 16        | 8        | 16      | 8   | 17  | 8      | 17      | 9       | 17      | 8     | 18    | 9           |
| 27           | 16        | 8        | 16      | 8   | 18  | 9      | 18      | 9       | 18      | 9     | 18    | 9           |
| 28           | 17        | 8        | 17      | 8   | 18  | 9      | 19      | 9       | 19      | 9     | 19    | 9           |
| 29           | 17        | 9        | 18      | 9   | 19  | 9      | 19      | 10      | 19      | 9     | 20    | 10          |
| 30           | 18        | 9        | 18      | 9   | 19  | 10     | 20      | 10      | 20      | 10    | 20    | 10          |
| 31           | 19        | 9        | 19      | 9   | 20  | 10     | 21      | 10      | 21      | 10    | 21    | 10          |
| 32           | 19        | 9        | 19      | 10  | 21  | 10     | 21      | 10      | 21      | 10    | 22    | 11          |
| 33           | 20        | 10       | 20      | 10  | 21  | 10     | 22      | 11      | 22      | 11    | 22    | 11          |
| 34           | 20        | 10       | 21      | 10  | 22  | 11     | 23      | 11      | 22      | 11    | 23    | 11          |
| 35           | 21        | 10       | 21      | 10  | 23  | 11     | 23      | 11      | 23      | 11    | 24    | 11          |
| 36           | 21        | 11       | 22      | 11  | 23  | 11     | 24      | 12      | 24      | 11    | 24    | 12          |
| 37           | 22        | 11       | 22      | 11  | 24  | 12     | 24      | 12      | 24      | 12    | 25    | 12          |
| 38           | 23        | 11       | 23      | 11  | 24  | 12     | 25      | 12      | 25      | 12    | 26    | 12          |
| 39           | 23        | 11       | 24      | 12  | 25  | 12     | 26      | 13      | 26      | 12    | 26    | 13          |
| 40           | 24        | 12       | 24      | 12  | 26  | 13     | 26      | 13      | 26      | 13    | 27    | 13          |
| 41           | 24        | 12       | 25      | 12  | 26  | 13     | 27      | 13      | 27      | 13    | 28    | 13          |
| 42           | 25        | 12       | 25      | 12  | 27  | 13     | 28      | 14      | 28      | 13    | 28    | 14          |
| 43           | 26        | 13       | 26      | 13  | 28  | 13     | 28      | 14      | 28      | 14    | 29    | 14          |
| 44           | 26        | 13       | 27      | 13  | 28  | 14     | 29      | 14      | 29      | 14    | 30    | 14          |
| 45           | 27        | 13       | 27      | 13  | 29  | 14     | 30      | 14      | 30      | 14    | 30    | 15          |
| 46           | 27        | 13       | 28      | 14  | 29  | 14     | 30      | 15      | 30      | 15    | 31    | 15          |
| 47           | 28        | 14       | 28      | 14  | 30  | 15     | 31      | 15      | 31      | 15    | 32    | 15          |
| 48           | 28        | 14       | 29      | 14  | 31  | 15     | 32      | 15      | 31      | 15    | 32    | 16          |
| 49           | 29        | 14       | 30      | 14  | 31  | 15     | 32      | 16      | 32      | 15    | 33    | 16<br>16    |
| 50           | 30        | 15       | 30      | 15  | 32  | 16     | 33      | 16      | 33      | 16    | 34    | 16<br>17    |
| 51           | 30        | 15       | 31      | 15  | 33  | 16     | 34      | 16      | 33      | 16    | 34    | 17          |
| 52           | 31        | 15<br>15 | 31      | 15  | 33  | 16     | 34      | 17      | 34      | 16    | 35    | 17          |
| 53           | 31        |          | 32      | 16  | 34  | 16     | 35      | 17      | 35      | 17    | 36    | 17          |
| <b>54</b>    | <b>32</b> | 16       | 32      | 16  | 35  | 17     | 36      | 17      | 35      | 17    | 36    | 17          |

# TABLE 41 (Continued)

# Quantity of Tin for Roofs

|               |          | <b></b> .  | _         |                 |          |           | St       | andin     | g Sea    | ım              |          |                 |
|---------------|----------|------------|-----------|-----------------|----------|-----------|----------|-----------|----------|-----------------|----------|-----------------|
| Sur-<br>face  |          |            | Seam      |                 |          | Şingle    | Lock     |           |          | Doubl           |          |                 |
| of<br>Roof    |          | ged<br>In. |           | ged<br>In.      | Se       | In.<br>am |          | In.<br>am | Se       | ·In.<br>am      |          | ln.<br>am       |
| to be<br>Cov- | 14       | 20         | 14        | 20              | 14       | 20        | 14       | 20        | 14       | 20              | 14       | 20              |
| ered          | X        | x          | x         | x               | x        | x         | x        | x         | x        | x               | x        | x               |
|               | 20       | 28         | 20        | 28              | 20       | 28        | 20       | 28        | 20       | 28              | 20       | 28              |
| Sq. Ft.       | . s      | s          | s         | s               | S        | s         | s        | S         | S        | s               | S        | s               |
| 55            | 33       | 16         | 33        | 16              | 35       | 17        | 36       | 18        | 36       | 17              | 37       | 18              |
| 56            | 33       | 16         | 34        | 16              | 36       | 17        | 37       | 18        | 37       | 18              | 38       | 18              |
| 57            | 34       | 16         | 34        | 17              | 36       | 18        | 37       | 18        | 37       | 18              | 38       | 18              |
| 58            | 34       | 17         | 35        | 17              | 37       | 18        | 38       | 19        | 38       | 18              | 39       | 19              |
| 59            | 35       | 17         | . 35      | 17              | 38       | 18        | 39       | 19        | 39       | 19              | 40       | 19              |
| 60            | 35       | 17         | 36        | 18              | 38       | 19        | 39       | 19        | 39       | 19              | 40       | 19              |
| 61<br>62      | 36       | 18         | 37        | 18              | 39       | 19        | 40       | 19        | 40       | 19              | 41       | 20              |
| 63            | 37<br>37 | 18<br>18   | 37<br>38  | 18<br>18        | 40       | 19        | 41<br>41 | 20<br>20  | 41       | 19              | 42       | 20              |
| 64            | 38       | 18         | 38        | 19              | 40<br>41 | 20<br>20  | 42       | 20        | 41<br>42 | 20<br>20        | 42<br>43 | $\frac{20}{21}$ |
| 65            | 38       | 19         | 39        | 19              | 41       | 20        | 43       | 21        | 42       | 20              | 44       | 21              |
| 66            | 39       | 19         | 40        | 19              | 42       | 20        | 43       | 21        | 43       | 21              | 44       | 21              |
| 67            | 40       | 19         | 40        | 20              | 43       | 21        | 44       | 21        | 44       | 21              | 45       | 22              |
| 68            | 40       | 20         | 41        | 20              | 43       | 21        | 45       | 22        | 44       | 21              | 46       | 22              |
| 69            | 41       | 20         | 41        | 20              | 44       | 21        | 45       | 22        | 45       | 22              | 46       | 22              |
| 70            | 41       | 20         | 42        | 20              | 45       | 22        | 46       | 22        | 46       | 22              | 47       | 22              |
| 71            | 42       | 20         | 43        | 21              | 45       | 22        | 47       | 23        | 46       | 22              | 48       | 23              |
| 72            | 42       | 21         | 43        | 21              | 46       | 22        | 47       | 23        | 47       | 22              | 48       | 23              |
| <b>7</b> 3    | 43       | 21         | 44        | 21              | 46       | 23        | 48       | 23        | 48       | 23              | 49       | 23              |
| 74            | 44       | 21         | 44        | 22              | 47       | 23        | 48       | 23        | 48       | 23              | 50       | 24              |
| <b>7</b> 5    | 44       | 22         | 45        | 22              | 48       | 23        | 49       | 24        | 49       | 23              | 50       | 24              |
| <b>7</b> 6    | 45       | 22         | 46        | 22              | 48       | 23        | 50       | 24        | 50       | 24              | 51       | 24              |
| 77            | 45       | 22         | 46        | 22              | 49       | 24        | 50       | 24        | 50       | 24              | 52       | 25              |
| <b>7</b> 8    | 46       | 22         | 47        | 23              | 50       | 24        | 51       | 25        | 51       | 24              | 52       | 25              |
| <b>79</b>     | 47       | 23         | 47        | 23              | 50       | 24        | 52       | 25        | 52       | 25              | 53       | 25              |
| 80            | 47       | 23         | 48        | 23              | 51       | 25        | 52       | 25        | 52       | 25              | 54       | 26              |
| 81            | 48       | 23         | 48        | 23              | 52       | 25        | 53       | 26        | 53       | 25              | 54       | 26              |
| 82<br>83      | 48<br>49 | 24<br>24   | 49<br>50  | $\frac{24}{24}$ | 52<br>53 | 25<br>26  | 54<br>54 | 26<br>26  | 53<br>54 | $\frac{26}{26}$ | 55<br>56 | 26<br>27        |
| 84            | 49       | 24         | 50<br>50  | 24<br>24        | 53       | 26        | 55       | 20<br>27  | 55       | 26<br>26        | 56       | 27              |
| 85            | 50       | 24         | 51        | 25              | 54       | 26        | 56       | 27        | 55       | 26              | 57       | 27              |
| 86            | 51       | 25         | 51        | 25              | 55       | 26        | 56       | 27        | 56       | 27              | 58       | 28              |
| 87            | 51       | 25         | 52        | 25              | 55       | 27        | 57       | 28        | 57       | 27              | 58       | 28              |
| 88            | 52       | 25         | 53        | 25              | 56       | 27        | 58       | 28        | 57       | 27              | 59       | 28              |
| 89            | 52       | 26         | 53        | 26              | 57       | 27        | 58       | 28        | 58       | 28              | 60       | 28              |
| 90            | 53       | 26         | 54        | 26              | 57       | 28        | 59       | 28        | 59       | 28              | 60       | 29              |
| 91            | 54       | 26         | 54        | 26              | 58       | 28        | 60       | 29        | 59       | 28              | 61       | 29              |
| 92            | 54       | 26         | 55        | 27              | 58       | 28        | 60       | 29        | 60       | 29              | 62       | 29              |
| 93            | 55       | 27         | 56        | 27              | 59       | 29        | 61       | 29        | 61       | 29              | 62       | 30              |
| 94            | 55       | 27         | 56        | 27              | 60       | 29        | 61       | 30        | 61       | 29              | 63       | 30              |
| 95            | 56       | 27         | 57        | 27              | 60       | 29        | 62       | 30        | 62       | 30              | 64       | 30              |
| 96            | 56       | 27         | 57        | 28              | 61       | 29        | 63       | 30        | 62       | 30              | 64       | 31              |
| 97            | 57       | 28         | 58        | 28              | 62       | 30        | 63       | 31        | 63       | 30              | 65       | 31              |
| 98            | 58       | 28         | 59        | 28              | 62       | 30        | 64       | 31        | 64       | 30              | 66       | 31              |
| 99            | 58       | 28         | <b>59</b> | 29              | 63       | 30        | 65       | 31        | 64       | 31              | 66       | 32              |

# TABLE 41 (Continued) Quantity of Tin for Roofs

# TABLE 41 (Continued) Quantity of Tin for Roofs Standing Sean

| Surface  | Single  | Lock   |  | Double  | Lock   |   |
|--|---|--|--|---|--|---|
| of Roof<br>to be   | 1-In. S   |  | 3/4-In   | . Seam  | 1-In.  | Seam  |
| Covered  | 14 x 20   | 20 x 28  | 14 x 20  | 20 x 28   | 14 x 20  | 20 x 28   |
| or Root to be Covered  |   |  |  |   |  |   |
| 4400<br>4500<br>4600<br>4700<br>4800<br>4900<br>5000<br>6000<br>7000<br>8000<br>9000 | 25 53<br>26 6<br>26 71<br>27 24<br>27 89<br>28 42<br>28 106<br>34 83<br>40 59<br>46 36<br>52 12<br>57 100 | 12 23<br>12 54<br>12 85<br>13 4<br>13 35<br>13 67<br>13 98<br>16 72<br>19 47<br>22 21<br>24 108<br>27 83 | 25 42<br>25 107<br>26 59<br>27 76<br>28 29<br>28 29<br>28 93<br>34 67<br>40 41<br>46 15<br>51 101<br>57 74 | 12 0<br>12 31<br>12 61<br>12 92<br>13 10<br>13 41<br>13 72<br>16 41<br>19 10<br>21 92<br>24 61<br>27 31 | 26 12<br>26 79<br>27 33<br>27 100<br>28 54<br>29 9<br>29 75<br>35 67<br>41 60<br>47 52<br>53 45<br>59 37 | 12 39<br>12 71<br>12 102<br>13 22<br>13 53<br>13 84<br>14 4<br>16 94<br>19 72<br>22 51<br>25 29 |

#### Basis of Calculation

#### Flat Seams

One table is calculated on a basis of 1/4-inch edges on 14 x 20 and 20 x 28 sheets, consuming about 1 inch, covering a space 13 x 19 and 19 x 27 inches and exposing a surface of 247 and 513 square inches respectively.

The other table is calculated on a basis of 3%-inch edges on 14 x 20 and 20 x 28 sheets, consuming 11% inches, covering a space 127% x 187% and 187% x 267% inches and exposing a surface of 243 1/64 and 507 17/64 square inches respectively.

#### Standing Seam, Single Lock

This table is calculated on the basis of \%-inch single lock cross seams, consuming 1\% inches of tin and covering 228 17/32 square inches when edged I and 1\% inches and giving a finished seam \%-inch high, and covering 222 3/32 square inches when edged 1\% and 1\% inches and giving a finished seam I inch high, with 14 x 20 tin. With 20 x 28 tin edged in the same way with a \%-inch finished seam 477 1/32 square inches are covered, and with a I-inch finished seam 463 19/32 square inches are covered.

#### Standing Seam, Double Lock

This table is calculated on the basis of the amount of tin consumed by double lock machines, which is I 7/16 inches by measurement for cross seams and covering 222 63/64 square inches when edged I and I¼ inches and giving a finished seam ¾ inch high, and covering 216-45/64 square inches when edged I¼ and I½ inches, giving a finished seam I inch high, with I4 x 20 tin. With 20 x 28 tin edged in the same way with a ¾-inch finished seam 47I 3I/64 square inches are covered, and with a I-inch finished seam 458 I3/64 square inches are covered.

#### Directions for Use

Look for the number of squares nearest the required surface. Note the quantity of tin opposite in the column for the kind of roof to be put on, whether it be ½ inch or ¾ inch Flat Seam or ¾ inch or I inch Standing Seam, Single Lock or Double Lock, and set down the amount. Then, in the same manner, determine the quantity of tin for the odd feet and add this to the former amount. Reduce the sheets to boxes by dividing by 112.

#### Flat Seam Example

How much 14 x 20 tin edged 1/4 inch covering 13 x 19 will be required to cover a roof of 4,665 square feet Flat Seam?

First look for 4,600 square feet (=46 squares) and set down the quantity opposite, thus:

23 boxes 107 sheets

Then for 65 square feet and set down.. 38 sheets

Making a total of......23 boxes 145 sheets which is equal to 24 boxes 33 sheets.

#### Single Lock Standing Seam Example

How much 14 x 20 tin will be required to cover a roof of 3,752 square feet with single lock cross seams and 1-inch standing seams?

First look for 3,700 square feet (=37 squares) and set down the quantity opposite, thus:

21 boxes 48 sheets

. Then for 52 square feet and set down.. 34 sheets

Making a total of...... 21 boxes 82 sheets

#### Double Lock Standing Seam Example

How much 20 x 28 tin will be required to cover a roof of 2,987 square feet with double lock cross seams and 34-inch standing seams?

First look for 2,900 square feet (=29 squares) and set down the quantity opposite, thus:

| down the quantity opposite, thus:   | 7 boxes 102 sheets |
|---|--------------------|
| Then look for 87 square feet and set  | 27 sheets          |
| Making a total of  Dividing 129 by 112, they are found box and 17 sheets, which added to 7 bo give a total of | to be equal to I   |

#### TABLE 42

#### Weight of Skylight Glass

The glass used in the majority of cases for skylight work is either rough or ribbed skylight glass and can be had with or without the wire mesh. No two lists agree on the weights of this material, but the following table of Kidder's is as correct as possible to make a table of weights, and will be found useful in computing the loads on skylight bars and the like.

Thickness in inches.  $\frac{1}{8} \frac{3}{16} \frac{1}{4} \frac{3}{8} \frac{1}{2} \frac{5}{8} \frac{3}{4} \frac{1}{1}$ Weight in pounds..  $2 \frac{2}{2} \frac{3}{2} \frac{3}{2} \frac{5}{5} \frac{7}{8} \frac{3}{2} \frac{10}{12} \frac{12}{2}$ 

#### TABLE 43

## Skylight Glass Required for One Square of Roof

| Dimensions, inches    | 15 × 60 | 20 × 100 | 94 × 156 |
|-----------------------|---------|----------|----------|
| Thickness, inches     | 6.246   | 13.880   | 101.768  |
| Weight per square, lb | 350     | 500      | 700      |

No allowance has been made in the above figures for lap. If ordinary window-glass is used, single thick glass (about  $\frac{1}{12}$  inch) will weigh about 82 lb. per square, and double thick glass (about  $\frac{1}{12}$  inch) will weigh about 164 lb. per square, no allowance being made for lap. A box of ordinary window-glass contains as nearly 50 square feet as the size of the panes will admit. Panes of, any size are made to order by the manufacturers, but a great variety of sizes are usually kept in stock, ranging from 6  $\times$  8 inches to 36  $\times$  60 inches.

TABLE 44
Tin in Rolls, or Gutter-Strips

| W7: Jak          | Wii Jaha     | 117: dab.       |        | 187: JAN.      |
|------------------|--------------|-----------------|--------|----------------|
| Number of sheets | required per | linear foot for | 20 and | 28-inch widths |
|                  |              |                 |        |                |

| Feet        | Wi                                   | dths                       | Feet | Wi | dths | Feet | Wi | dths | Feet  | W     | idths |
|-------------|--------------------------------------|----------------------------|------|----|------|------|----|------|-------|-------|-------|
| reet        | 20                                   | 28                         | reet | 20 | 28   | reet | 20 | 28   | reet  | 20    | 28    |
| 1           | 1                                    | 1                          | 35   | 16 | 23   | 69   | 31 | 44   | 200   | 89    | 128   |
| 2           | 1                                    | 2                          | 36   | 16 | 23   | 70   | 32 | 45   | 300   | 134   | 192   |
| 3<br>4      | 2<br>2<br>3<br>3<br>4<br>4<br>5<br>5 | 2<br>2<br>3                | 37   | 17 | 24   | 71   | 32 | 45   | 400   | 178   | 256   |
| 4           | 2                                    | 3                          | 38   | 17 | 24   | 72   | 32 | 46   | 500   | 223   | 320   |
| 5           | 3                                    | 4                          | 39   | 18 | 25   | 73   | 33 | 47   | 600   | 267   | 384   |
| 5<br>6<br>7 | 3                                    | 4<br>4<br>5<br>5<br>6<br>7 | 40   | 18 | 26   | 74   | 33 | 47   | 700   | 312   | 444   |
| 7           | 4                                    | 5                          | 41   | 19 | 27   | 75   | 34 | 48   | 800   | 356   | 512   |
| 8           | 4                                    | 5                          | 42   | 19 | 27   | 76   | 34 | 48   | 900   | 401   | 576   |
| 8           | 4                                    | 6                          | 43   | 20 | 28   | 77   | 35 | 49   | 1.000 | 445   | 640   |
| 10          | 5                                    | 7                          | 44   | 20 | 28   | 78   | 35 | 50   | 1,100 | 495   | 704   |
| 11          | 5                                    | 7                          | 45   | 20 | 29   | 79   | 36 | 50   | 1,200 | 540   | 768   |
| 12          | 6                                    | 8                          | , 46 | 21 | 29   | 80   | 36 | 51   | 1,300 | 585   | 832   |
| 13          | 6                                    | 8                          | 47   | 21 | 30   | 81   | 36 | 52   | 1,400 | 630   | 896   |
| 14          | 7                                    | 9                          | 48   | 22 | 31   | 82   | 37 | 52   | 1,500 | 675   | 960 ~ |
| 15          | 7                                    | 10                         | 49   | 22 | 31   | 83   | 37 | 53   | 1,600 | 720   | 1,024 |
| 16<br>17    | 8                                    | 11                         | 50   | 23 | 32   | 84   | 38 | 54   | 1,700 | 765   | 1,088 |
| 17          | 8                                    | 11                         | 51   | 23 | 33   | 85   | 38 | 54   | 1,800 | 810   | 1.152 |
| 18          | 8                                    | 12                         | 52   | 24 | 33   | 86   | 39 | 55   | 1,900 | 855   | 1,216 |
| 19          | 9                                    | 12                         | 53   | 24 | 34   | 87   | 39 | 55   | 2,000 | 900   | 1,280 |
| 20          | 9                                    | 13                         | 54   | 24 | 34   | 88   | 40 | 56   | 2,100 | 945   | 1,344 |
| 21          | 10                                   | 14                         | 55   | 25 | 35   | 89   | 40 | 57   | 2,200 | 900   | 1,408 |
| 22          | 10                                   | 14                         | 56   | 25 | 36   | 90   | 40 | 57   | 2,300 | 1,035 | 1,472 |
| 23          | 11                                   | 15                         | 57   | 26 | 36   | 91   | 41 | 58   | 2,400 | 1,080 | 1,536 |
| 24          | 11                                   | 16                         | 58   | 26 | 37   | 92   | 41 | 59   | 2,500 | 1,135 | 1,600 |
| 25          | 12                                   | 16                         | 59   | 27 | 38   | 93   | 42 | 59   | 2,600 | 1,170 | 1,664 |
| 26          | 12                                   | 17                         | 60   | 27 | 38   | 94   | 42 | 60   | 2.700 | 1,215 | 1,738 |
| 27          | 12                                   | 18                         | 61   | 28 | 39   | 95   | 43 | 61   | 2,800 | 1.260 | 1.792 |
| 28          | 13                                   | 18                         | 62   | 28 | 40   | 96   | 43 | 62   | 2,900 | 1,305 | 1.856 |
| 29          | 13                                   | 19                         | 63   | 28 | 40   | 97   | 44 | 62   | 3,000 | 1,350 | 1,920 |
| 30          | 14                                   | 19                         | 64   | 29 | 41   | 98   | 44 | 63   | 3,100 | 1,395 | 1,984 |
| 31          | 14                                   | 20                         | 65   | 29 | 41   | 99   | 44 | 64   | 3,200 | 1,440 | 2,048 |
| 32          | 15                                   | 21                         | 66   | 30 | 42   | 100  | 45 | 64   | 3,300 | 1,485 | 2,112 |
| 33          | 15                                   | 21                         | 67   | 30 | 43   |      |    |      | 3,400 | 1,530 | 2,176 |
| 34          | 16                                   | 22                         | 68   | 31 | 43   |      |    |      | 3,500 | 1,575 | 2,240 |

112 sheets in 28-in. roll cover 175 lin. ft. 112 sheets in 20-in. roll cover 248 lin. ft. 112 sheets in 14-in. roll cover 350 lin. ft. 112 sheets in 10-in. roll cover 496 lin. ft.

This table enables tin roofers to tell how many sheets to lock together to cover any desired length. For example: How many 20 x 28-inch sheets shall be locked together to "knock out" a gutter strip 65 feet long, 28 inches wide.

Now, if the strip is to be 28 inches wide it means that the sheets are to be edged on the 28-inch sides so that from turned edge to turned edge will be approximately 19 inches and it will then take 41 times this dimension to make 65 feet; so referring to first column locate 65 feet,

read across to column under 28-inch width and find 41, meaning 41 sheets are required. Supposing the strip is to be 20 inches wide, which would mean that the edges are to be turned on the 20-inch sides, so that there will be about 27 inches from turned edge to turned edge and the 20-inch wide column directs that 29 sheets be locked together for 65 feet length.

Table 45

Angles of Roofs as Commonly Used

| Proportion of<br>Rise to | An       | gle  | Length of<br>Rafter to | Propor-<br>tion of<br>Rise to | An       | gle      | Length of<br>Rafter to |
|--------------------------|----------|------|------------------------|-------------------------------|----------|----------|------------------------|
| Span                     | Deg.     | Min. | Rise                   | Span                          | Deg.     | Min.     | Rise                   |
| 1/2                      | 45<br>33 | 4i   | 1.4142<br>1.8028       | 1/4<br>1/5                    | 26<br>21 | 34<br>48 | 2.2361<br>2.6926       |
| $\frac{1}{2\sqrt{3}}$    | 30       | ••   | 2.0000                 | ···<br>1/6                    | 18       | 26       | 3.1623                 |

TABLE 46

## Number of Flat Head Copper Rivets to Pound

| Discussion of Chauda |              | Lengt               | h Measur            | red Under           | Head        |             |
|----------------------|--------------|---------------------|---------------------|---------------------|-------------|-------------|
| Diameter of Shank    | 3/4          | 1                   | 11/4                | 13/8                | 11/2        | 2           |
| 1/4<br>1/5<br>1/2    | 48<br>26<br> | 36<br>24<br>17<br>9 | 32<br>21<br>15<br>8 | 30<br>17<br>13<br>7 | <br>12<br>6 | <br>10<br>5 |

TABLE 47

# Number and Weight of Cedar and Pine Shingles Per Square of One Hundred Square Feet

| Length,                                | Assumed                    | or  | Number<br>of Shin-<br>gles Per                | Wei<br>Per S                                  |   | Number<br>of Nails<br>Per                                   | Weight<br>of Nails<br>Per                            |
|--|----------------------------|---|---|---|---|---|--|
| In.                                    | width,<br>In.              | Gauge,<br>In.   | Square  | Cedar,<br>Lb.                                 | Pine,<br>Lb.                                  | Square  | Square,<br>Lb.                                       |
| 14<br>15<br>16<br>18<br>20<br>22<br>24 | 4<br>4<br>4<br>4<br>4<br>4 | 4<br>4 <sup>1</sup> / <sub>2</sub><br>5<br>5 <sup>1</sup> / <sub>2</sub><br>6<br>6 <sup>1</sup> / <sub>2</sub><br>7 | 900<br>800<br>720<br>655<br>600<br>554<br>515 | 210<br>200<br>192<br>197<br>200<br>203<br>206 | 233<br>222<br>213<br>218<br>222<br>226<br>229 | 1,800<br>1,600<br>1,440<br>1,310<br>1,200<br>1,108<br>1,030 | 4.50<br>4.00<br>3.60<br>3.28<br>3.00<br>2.77<br>2.58 |

# Weights of Hot Air Pipe in Pounds

| Sizes in Inches   | 7 In.        | 8 In.                                   | 9 In.   | 10 In.            | 12 In.       | 14 In.           | 16 In.   | 18 In.  | 20 In. |
|---|--------------|---|---------|-------------------|--------------|------------------|----------|---|--------|
| Hot air pipe per foot,— IC. IX.   | 1 34<br>1 34 | 1.4<br>1.7                              | 12.5    | 11.5              | 11.7         | $2\frac{15}{14}$ | 5₹       | . 200<br>. 300<br>. 400   |        |
| Hot air elbows,— 3 piece, IC  | 84,          | 78;                                     | 77.     | 13%               | 27%          | :                | :        | :   | :      |
| 4 piece, IX   | 1%           | 21<br>874                               | 4%      | 22%               | 27%          | 37.              | 37%      | 51%   | 63%    |
| Hot air angles,—<br>45° IC<br>45° IX.                                     | % ::         | e 15%                                   | 138%    | 1,4%              | 17:          | 12:              | 23%      | :<br>:<br>:   | 35%    |
| npers   | Z :42        | 200                                     | 12/2/21 | % <sup>4</sup> 7% | 1,2%         | :47.             | :4%;     | :88   | 27.5   |
| Galvanized iron pipe,— Per foot   | 13/2         | 78/8/                                   | 200     | 22.74.47.         | 32%          | 314<br>412<br>2  | 30 to 00 | 4 7 1 1 5 7 1 1 5 7 1 1 5 7 1 7 1 1 5 7 1 1 5 7 1 1 5 7 1 1 1 1 | 918    |
| Angles, 45<br>Angles, 22/2<br>Smoke pipe dampers<br>Safety thimbles       | 1277         | 1 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | %4. 4.  | 12 2              | 10012        | on : :           |          |   |        |
| Top bonnet collarsSide bonnet collarsPitch bonnet collarsCold air collars | %/4/% :      | -1-1/2% :                               | 72%     | 70,4%             | ₩ <u>1</u> : | 13: 27:          | ; N ; W  | 23: 24: 24:   | 37:    |

TABLE 49

# Table Showing Number of Star Brand Brass Escutcheon Pins to the Pound

|     | Length Measured under the Head |      |      |      |      |     |   |      |      |             |     |
|-----|--------------------------------|------|------|------|------|-----|---|------|------|-------------|-----|
| No. | 1/4                            | 3/8  | ⅓    | 5∕8  | 3/4  | 1∕8 | 1 | 11/4 | 11/2 | 1%          | 2   |
| 12  |                                |      |      |      |      |     |   |      | 212  | 192         | 170 |
| 13  |                                |      |      |      |      |     |   |      |      | 229         | 220 |
| 14  |                                |      |      |      |      | 692 |   |      |      | 320         | 272 |
| 15  |                                |      |      |      |      |     |   |      | 580  | 432         | 400 |
| 16  |                                |      |      |      |      |     |   |      | 592  | <b>578</b>  | 464 |
| 17  |                                |      |      |      |      |     |   |      | 800  | <b>64</b> 0 |     |
| 18  |                                |      |      |      |      |     |   |      |      |             |     |
| 19  |                                |      |      |      |      |     |   |      |      |             |     |
| 20  | 9932                           | 8419 | 6374 | 5500 | 4155 |     |   |      | •    |             |     |

#### TABLE 50

#### Oval Head Copper Braziers' Rivets

Length Measured under the Head

| Numbers                  | 1  | 2<br>17 | 3        | 4<br>11 | 5  | 6<br>%   | 7<br>1 | 8 | 9 | 10    |
|--------------------------|----|---------|----------|---------|----|----------|--------|---|---|-------|
| Number to pound. 160 148 | 66 | 49      | 37<br>37 | 28      | 23 | 19<br>19 | 13     | 8 | 6 | 1 1/4 |

TABLE 51 '

# Approximate Dimensions of Tinners' Rivets

| Size   | Length  | Diameter,<br>Wire<br>Gauge                         | Size      | Length                                 | Diameter,<br>Wire<br>Gauge             |
|--|---|--|-----------|--|--|
| 8 oz.<br>10 "<br>12 "<br>14 "<br>1 lb.<br>11 "<br>1 2 "<br>1 3 4 "<br>2 2 4 "<br>3 " | 52144 15 4 5 15 6 7 5 6 5 7 6 6 7 6 | No. 13¼ 13 12¼ 12 12 11 12 11 10 10 10 19 19 18 14 | 3½ lbs. 4 | ************************************** | No. 8 4 764 4 6 8 444 4 44 4 3 4 2 4 1 |

TABLE 52

#### Oval Head Rivets and Burs to the Pound

| Length Measured under the Head |     |     |     |     |     |     |     |     |     |     |       |      |       |
|--------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|------|-------|
| No.                            | 1/4 | 16  | 3∕8 | 176 | 1/2 | ₩.  | 5∕8 | 34  | 1∕8 | 1   | 1 1/8 | 11/4 | Burs. |
| 9                              | 317 | 270 | 254 | 220 | 206 | 193 | 189 | 165 | 138 | 116 | 107   | 101  | 600   |

TABLE 53

#### Size of Conductor Pipes

| 31/2 | in. | Trough, | up | to | 12        | ft. | long;    | use | <b>2</b> | in. | Conductor | Pipe |
|------|-----|---------|----|----|-----------|-----|----------|-----|----------|-----|-----------|------|
| 31/2 | "   | u       | 12 | to | 25        | "   | u        | u   | 3        | u   | u         | u    |
| 4    | α   | æ       | 25 | to | 35        | æ   | «        | u   | 3        | u   | "         | u    |
| 5    | a   | u       | 35 | to | 45        | u   | Œ        | u   | 4        | u   | "         | æ    |
| 6    | u   | u       | 45 | to | <b>55</b> | "   | <b>"</b> | "   | 5        | и   | "         | u    |
| 7    | u   | u       | 55 | to | 65        | ű   | «        | u   | 6        | "   | "         | æ    |
| 8    | u   | u       | 65 | to | 75        | ĸ   | α        | •   | 7        | α   | u         | "    |

## TABLE 54

#### Weight of Tiles

Flat tiles  $6\frac{1}{4} \times 10\frac{1}{2} \times \frac{5}{8}$  in. weigh from 1,480 to 1,850 lb. per square of roof (100 square feet), the lap being one-half the length of the tile.

Tiles with grooves and fillets weigh from 740 to 925 lbs. per square of roof.

Pan-tiles  $14\frac{1}{2} \times 10\frac{1}{2}$  laid 10 in. to the weather weigh 850 lbs. per square.

Sheet-Metal Tiles. Roofing-tiles stamped from sheet steel, plain or galvanized, and also from sheet copper, in imitation of clay tiles, are made by several manufacturers and have been extensively used for factories and buildings of secondary importance. The first cost of these tiles, except those made of copper, is much less than that of clay tiles and they do not require as heavy roof-framing. Tin or galvanized-iron tiles, however, must be painted every few years, so that for a long period of years they probably cost as much as clay tiles and more than slate.

#### TABLE 55

# Approximate Weight of Roof Coverings Per Square in Pounds

Weight in

| Material  | Lbs. per Square<br>of Roof |
|---|----------------------------|
| Ash sheathing, 1 inch thick   | 500                        |
| Copper, 16 ounce, standing seam   | 150                        |
| Felt and asphalt, without sheathing   | 150                        |
| Felt and gravel, without sheathing  |                            |
| Glass with skylight frame $\frac{3}{16}$ inch to $\frac{1}{2}$ inch the                       |                            |
| Hemlock sheathing, 1 inch thick   |                            |
| Iron, corrugated, No. 20, without sheathing   |                            |
| Iron, galvanized, flat  |                            |
| Lath and plaster ceiling (ordinary)   | 600 to 800                 |
| Lead, about 1/8 inch thick  | 600 to 800                 |
| Maple sheathing, 1 inch thick   |                            |
| Mackite, 1 inch thick, with plaster   |                            |
| Neponset roofing felt, 2 layers   | 50                         |
| Oak sheathing, I inch thick   | 500                        |
| Slate, ¼ inch thick   | 900                        |
| Slate, $\frac{3}{16}$ inch thick  | 675                        |
| Slate, 1/8 inch thick   | 450                        |
| Shingles, 6 inches $\times$ 18 inches, 6 inches to the  |                            |
| Sheet iron, $\frac{1}{16}$ inch thick   |                            |
| Sheet iron, $\frac{1}{16}$ inch thick, with laths   | 400                        |
| Spruce sheathing, 1 inch thick  | 250                        |
| Slag roofing, four-ply  | 400                        |
| Tiles (plain) $10\frac{1}{2}$ inches $\times$ $6\frac{1}{4}$ inches $\times$ $\frac{5}{8}$ in | ches, 51/2                 |
| inches to weather   | 1800                       |
| Tiles (Spanish) $14\frac{1}{2}$ inches $\times$ $10\frac{1}{2}$ inches, $7\frac{1}{2}$        | inches to                  |
| weather   | 850                        |
| Tiles, plain with mortar  | 2000 to 3000               |
| Terne plate (tin), IC, without sheathing  | 50                         |
| Terne plate (tin), IX, without sheathing  |                            |
| White pine sheathing, 1 inch thick  |                            |
| Yellow pine sheathing, 1 inch thick   | 400                        |

#### TABLE 56

#### Weight of Metal Shingles

Metal shingles weigh from 80 to 90 pounds per square of 100 feet, depending on the shape of the shingle and the weight of the metal.

Table 57

# Number of Slates, and Pounds of Nails to 100 Square Feet of Roof 3-inch Lap

| Sizes of Slates  | Exposed<br>When Laid | Number to<br>a Square | Weights o                                  |                 |
|--|----------------------|-----------------------|--|-----------------|
| Inches   | Inches               |                       | Lb.  | Oz.             |
| $14 \times 24$   | 101/2                | 98                    | (1   | 6               |
| $12 \times 24$   | $10\frac{1}{2}$      | 115                   | 1  | . 10            |
| $12 \times 22$   | 91/2                 | 126                   | 1 ارب                                      | 12              |
| $11 \times 22$   | $9^{1/2}$            | 138                   | $4d \begin{cases} \frac{1}{1} \end{cases}$ | 15              |
| $11 \times 20$   | $8^{1/2}$            | 155                   | 2  | 0               |
| $10 \times 20$   | $81\sqrt{5}$         | 170                   | $\begin{bmatrix} 2 \\ 2 \end{bmatrix}$     | 6               |
| $12 \times 18$   | $7\frac{1}{2}$       | 160                   |  | 13              |
| $10 \times 18$   | $7\frac{1}{2}$       | 192                   | $1\bar{2}$                                 | 3               |
| $9 \times 18$  | 71%                  | 214                   | 1<br>2<br>2<br>2<br>2<br>2<br>3            | 7               |
| $1\overset{\circ}{2}\overset{\circ}{\times}\overset{\circ}{1}\overset{\circ}{6}$ | 61%                  | 185                   | 15   | $\frac{7}{2}$ . |
| $10 \times 16$   | 61%                  | <b>222</b>            | 12   | 8               |
| $\stackrel{\sim}{9} \times \stackrel{\sim}{16}$                                  | 61/2                 | 247                   | 1 3  | ŏ               |
| $\overset{\circ}{8}\overset{\wedge}{\times}\overset{10}{16}$                     | $6\frac{1}{2}$       | $\frac{23}{277}$      | $3d \stackrel{\downarrow}{\downarrow} 3$   | 2               |
| $10 \times 14$   | $\frac{51}{2}$       | 262                   | $3d \begin{Bmatrix} 3 \\ 3 \end{Bmatrix}$  | õ               |
| _ ` ` `  | 4 =                  |                       | 3  | •               |
|  | $\frac{51}{2}$       | 328                   |  | 12              |
| $7 \times 14$  | $\frac{51}{2}$       | 375                   | 4  | 4               |
| $8 \times 12$  | 41/2                 | 400                   | 4<br>  5                                   | 9               |
| $7 \times 12$  | $4\frac{1}{2}$       | 457                   | 5  | 3               |
| $6 \times 12$  | $4\frac{1}{2}$       | 534                   | (6   | 1               |

TABLE 58

#### Weight of Slate Per Square of Roof in Pounds

| Length     | Thickness of Slate, Inches |     |     |      |      |      |      |      |  |  |  |  |
|------------|----------------------------|-----|-----|------|------|------|------|------|--|--|--|--|
| Slate, In. | 1/8                        | 18  | 1/4 | 3/8  | 1/2  | 5/8  | 3/4  | 1    |  |  |  |  |
| 12         | 483                        | 724 | 967 | 1450 | 1936 | 2419 | 2902 | 3872 |  |  |  |  |
| 14         | 460                        | 688 | 920 | 1379 | 1842 | 2301 | 2760 | 3683 |  |  |  |  |
| 16         | 445                        | 667 | 890 | 1336 | 1784 | 2229 | 2670 | 3567 |  |  |  |  |
| 18         | 434                        | 650 | 869 | 1303 | 1740 | 2174 | 2607 | 3480 |  |  |  |  |
| 20         | 425                        | 637 | 851 | 1276 | 1704 | 2129 | 2553 | 3408 |  |  |  |  |
| 22         | 418                        | 626 | 836 | 1254 | 1675 | 2093 | 2508 | 3350 |  |  |  |  |
| 24         | 412                        | 617 | 825 | 1238 | 1653 | 2066 | 2478 | 3306 |  |  |  |  |
| 26         | 407                        | 610 | 815 | 1222 | 1631 | 2039 | 2445 | 3263 |  |  |  |  |

(1 cu. ft. slate = 175 lbs.) The cost of slate varies with the size, color and quality. The medium sizes cost the most, and those of the larger and smaller sizes the least. Special prices are quoted for special sizes. The larger sizes make the cheapest roofs. Red slates cost from 60 to 150% more than black slates. The green slates are more expensive than the black with the exception of the Maine and Peach Bottom varieties.

#### TABLE 59

# Sizes of Tinware in the Form of Frustum of a Cone

| Pans  |           | Druggists' and Liquor<br>Dealers' Measures  |  |  |  |  |  |
|---|-----------|---|--|--|--|--|--|
| Size of Top of Bo 20 qt. 19½ in. 13 16 4 184 4 114 14 4 1514 4 94 10 4 143 4 11 6 4 123 4 9 2 9 6 6 3 pt. 8½ 4 554 1 6¼ 4 Pie 9 77½ |           | Diam. Diam.  Size of Top of Bot. Height  5 gal. 8 in 13½ in 12¾ in.  2 " 6 " 10½ " 3¾ « 8¾ " 7½ «  1 " 3½ " 6¾ " 6 « 1  1 " 3½ " 6¾ " 6 « 1  1 qt. 2½ " 5¼ " 4½ « 1  1 pt. 2 " 4 " 4 « 1  1 " 1¼ " 3¾ « 3¾ « 3½ « 1 |  |  |  |  |  |
| Dish Kettles a  | nd Pails  | . Measures  |  |  |  |  |  |
| Diam. Diam. Size of Top of Bo 14 qt. 13 in. 9 in. 10 " 11½" 7 6 " 9¼" 5½ 2 " 6½" 4  |           | Diam. Diam.  Size of Top of Bot. Height  1 gal. 5½ in. 6½ in. 9½ in.  1 qt. 3½ " 4½ " 8½ "  1 pt. 2½ " 3¾ " 4¼ "  1½ " 2½ " 3¾ " 4¼ "  1½ " 3½ " 3¾ " 4¼ "  |  |  |  |  |  |
| Coffee Po   | ots       | Dippers   |  |  |  |  |  |
| Diam. Diam. Size of Top of Bo 1 gal. 4 in. 7 in. 3 qt. 3½ 6 6   | t. Height | Diam. Diam. Size of Top of Bot. Height 1/2 gal. 61/2 in. 4 in. 4 in. 1 pt. 41/4 " 33/4 " 23/4 "   |  |  |  |  |  |

#### Wash Bowls

|                 | Diam.  | Diam.   |        |
|-----------------|--------|---------|--------|
| Size            | of Top | of Bot. | Height |
| Large wash bowl |        | 5¾ in.  | 5 in.  |
| Small wash bowl |        | 516 "   | 3% *   |
| Milk strainer   |        | 51/2 "  | 31/2   |

#### Table 60

#### Dimensions for Liquid Measures

1 Pint 1 Quart 1 Gallon 2 Gallon 3 Gallon 5 Gallon

Diam. of top, inches... 2 2½ 3¾ 6 7 8

Diam of bottom inches 4 5½ 8¾ 1014 1114 1214

| Height, inches   | 4 | 4 1/8 | 71/2 | 83/8 | 101%      | 1232                     |
|--|---|-------|------|------|-----------|--------------------------|
| A gill contains 7.22 cu. in<br>A quart contains 57.75 cu |   |       |      |      | ains 28.8 | 37 cu. in.<br>31 cu. in. |

#### TABLE 61

# Pine Shingles

The figures below give the weight of shingles required to cover one square of a common gable roof. For hip roofs add 5 per cent.

| Inches exposed to weather             | 4   | 41/2        | 5   | 51/2             | 6   |
|---------------------------------------|-----|-------------|-----|------------------|-----|
| Number of shingles per square of roof | 900 | 80 <b>0</b> | 720 | $65\overline{5}$ | 600 |
| Weight of shingles per square, lb     | 216 | 192         | 173 | 157              | 144 |

TABLE 62

#### Capacity of Cans One Inch Deep in U. S. Gallons

| Diam.    | •              | 1/10           | <b>2</b> / <sub>10</sub> | 3/10           | 4/10           | 5/10           | 6/10           | 7/10           | 8/10           | 9/10           |
|----------|----------------|----------------|--------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 3        | .03            | .03            | .03                      | .03            | .03            | .04            | .04            | .04            | .04            | .05            |
| Ă        | .05            | .05            | .05                      | .05            | .06            | .06            | .07            | .07            | .07            | .08            |
| 5        | .08            | .08            | .08                      | .08            | .09            | .10            | .10            | .11            | .11            | .11            |
| Ğ        | .12            | . 12           | .12                      | .13            | .13            | .14            | .14            | . 15           | .15            | . 15           |
| 7        | .16            | .17            | .17                      | .18            | .18            | .19            | . 19           | .20            | .20            | .21            |
| 8        | .21            | . 22           | . 22                     | .23            | .23            | .24            | .25            | .25            | .26            | .26            |
| 9        | .27            | .28            | . 28                     | . 29           | .30            | .30            | .31            | .31            | .32            | .33            |
| 10       | .34            | .34            | .35                      | .36            | .36            | .37            | .38            | .38            | .39            | .40            |
| 11       | .41            | .41            | .42                      | .43            | .44            | . 44           | .45            | .46            | .47            | .48            |
| 12       | .48            | .49            | .50                      | .51            | .52            | .53            | . 53           | .54            | . 55           | . 56           |
| 13       | .57            | . 58           | . 59                     | . 60           | .60            | . 61           | . 62           | . 63           | .64            | . 65           |
| 14       | .66            | . 67           | . 68                     | . 69           | .70            | .71            | .72            | .73            | .74            | .75            |
| 15       | .76            | .77            | .78                      | .79            | .80            | .81            | .82            | .83            | .84            | .85            |
| 16       | .87            | .88            | .89                      | .90_           | .91            | .92            | . 93           | .94            | .95            | .97            |
| 17       | .98            | .99            | 1.005                    | 1.017          | 1.028          | 1.040          | 1.051          | 1.063          | 1.075          | 1.086          |
| 18       | 1.101          | 1.113          | 1.125                    | 1.138          | 1.150          | 1.162          | 1.170          | 1.187          | 1.200          | 1.211          |
| 19       | 1.227          | 1.240          | 1.253                    | 1.266          | 1.279          | 1.292          | 1.304          | 1.317          | 1.330          | 1.343          |
| 20       | 1.360          | 1.373          | 1.385                    | 1.400          | 1.414          | 1.428          | 1.441          | 1.455          | 1.478          | 1.482          |
| 21<br>22 | 1.499          | 1.513          | 1.527                    | 1.542          | 1.556          | 1.570          | 1.585          | 1.600          | 1.612          | 1.630          |
| 23       | 1.645          | 1.660          | 1.675                    | 1.696          | 1.705          | 1.720          | 1.735          | 1.750          | 1.770          | 1.780          |
| 24       | 1.798          | 1.814          | 1.830                    | 1.845          | 1.861          | 1.876          | 1.892          | 1.908          | 1.923          | 1.940          |
| 25       | 1.958          | 1.974          | 1.991                    | 2.007<br>2.176 | 2.023<br>2.193 | 2.040<br>2.120 | 2.056<br>2.227 | 2.072<br>2.244 | 2.096          | 2.105          |
| 26       | 2.125          | 2.142<br>2.316 | 2.159<br>2.333           | 2.351          | 2.193          | 2.120          | 2.404          | 2.422          | 2.261<br>2.440 | 2.280          |
| 27       | 2.298<br>2.478 | 2.496          | 2.515                    | 2.533          | 2.552          | 2.570          | 2.588          | 2.607          | 2.440          | 2.460<br>2.643 |
| 28       | 2.665          | 2.684          | 2.703                    | 2.722          | 2.741          | 2.764          | 2.780          | 2.800          | 2.820          | 2.836          |
| 29       | 2.859          | 2.879          | 2.898                    | 2.918          | 2.938          | 2.704          | 2.977          | 2.997          | 3.017          | 3.036          |
| 30       | 3.060          | 3.080          | 3.100                    | 3.121          | 3.141          | 3.162          | 3.182          | 3.202          | 3.223          | 3.245          |
| 31       | 3.267          | 3.288          | 3.309                    | 3.330          | 3.351          | 3.372          | 3.393          | 3.414          | 3.436          | 3.457          |
| 32       | 3.481          | 3.503          | 3.524                    | 3.543          | 3.568          | 3.590          | 3.612          | 3.633          | 3.655          | 3.589          |
| 32       | 3.702          | 3.725          | 3.747                    | 3.773          | 3.795          | 3.814          | 3.837          | 3.860          | 3.882          | 3.904          |
| 34       | 3.930          | 3.953          | 3.976                    | 4.003          | 4.022          | 4.046          | 4.070          | 4.092          | 4.115          | 4.140          |
| 35       | 4.165          | 4.188          | 4.212                    | 4.236          | 4.260          | 4.284          | 4.307          | 4.331          | 4.355          | 4.380          |
| 36       | 4.406          | 4.430          | 4.455                    | 4.483          | 4.503          | 4.528          | 4.553          | 4.577          | 4.602          | 4.626          |
| 37       | 4.654          | 4.679          | 4.704                    | 4.730          | 4.755          | 4.780          | 4.805          | 4.834          | 4.855          | 4.880          |
| 38       | 4.909          | 4.935          | 4.961                    | 4.987          | 5.012          | 5.038          | 5.064          | 5.090          | 5.120          | 5.142          |
| 39       | 5.171          | 5.197          | 5.224                    | 5.250          | 5.277          | 5.304          | 5.330          | 5.357          | 5.383          | 5.410          |
| 40       | 5.440          | 5.467          | 5.491                    | 5.521          | 5.548          | 5.576          | 5.603          | 5.630          | 5.657          | 5.684          |
|          |                |                |                          |                |                |                |                |                |                |                |

## Use of the Table

Required the contents of a vessel, diameter  $6^{7}/_{10}$  inches, depth 10 inches.

By the table a vessel 1 inch deep and  $6^7/_{10}$  inches diameter contains .15 (hundredths) gallon, then .15  $\times$  10 = 1.50, or 1 gallon and 2 quarts.

Required the contents of a can, diameter  $19^8/_{10}$  inches, depth 30 inches.

By the table a vessel I inch deep and  $19^8/_{10}$  inches diameter contains I gallon and .33 (hundredths), then  $1.33 \times 30 = 39.90$ , or nearly 40 gallons.

Required the depth of a can whose diameter is  $12^2/_{10}$  inches, to contain 16 gallons.

By the table a vessel I inch deep and  $12^2/_{10}$  inches diameter contains .50 (hundredths) gallon, then  $16 \div .50 = 32$  inches, the depth required.

#### Number of Barrels in Cisterns and Tanks

The following table shows the number of barrels (31½ gallons) contained in cisterns of various diameters, from 5 to 30 feet, and of depths ranging from 5 to 20 feet.

To use the table, find the required depth in the side column, and then follow along the line to the column which has the required diameter at the top. Thus, with a cistern 6 feet deep and 16 feet in diameter, we find 6 in the second line, and then follow along until column 16 is reached, when we find that the contents is 286.5 barrels.

For tanks that are tapering the diameter may be measured four-tenths from large end.

TABLE 63

Capacity of Cisterns and Tanks in Barrels

| C           | capac            | ity of           | Cis            | terns            | and              | Tan              | ks in            | Barre            | els                     |
|-------------|------------------|------------------|----------------|------------------|------------------|------------------|------------------|------------------|-------------------------|
| Depth       | 1                | -                |                | D                | iameter i        | n Feet           |                  |                  |                         |
| Feet        | 5                | 6                | 7              | 8                | 9                | 10               | 11               | 12               | 13                      |
| 5           | 23.3             | 33.6             | 45.7           | 59.7             | 75.5             | 93.5             |                  | 134.3            | 157.6                   |
| 6           | 28.0             | 40.3             | 54.8           | 71.7             | 90.6             | 111.9            | 9 135.4          | 161.1            | 189.1                   |
| 7           | 32.7             | 47.0             | 64.0           | 83.6             | 105.7            | 130.             | 8 158.0          | 188.0            | 220.6                   |
| 8<br>9      | 37.3<br>42.0     | 53.7<br>60.4     | 73.1<br>82.2   | 95.5<br>107.4    | 120.9<br>136.0   | 149.5<br>167.5   |                  | 214.8            | 252.1<br>283.7          |
| 10          | 46.7             | 67.1             | 91.4           | 119.4            | 151.1            | 186.             |                  | 241.7<br>268.6   | 200.7<br>315.9          |
| 11          | 51.3             | 73.9             | 100.5          | 131.3            | 166.2            | 205.             | 248.2            | 295.4            | 315.2<br>346.7          |
| 12          | 56.0             | 80.6             | 109.7          | 143.2            | 181.3            | 223.8            | 270.8            | 322.3            | 378.2                   |
| 13          | 60.7             | 87.3             | 118.8          | 155.2<br>167.1   | 196.4            | 242.4            | £ 293.4          | 349.1            | 409 7                   |
| 14          | 65.3             | 94.0             | 127.9          | 167.1            | 211.5            | 261.             |                  | 376.0            | 441.3<br>472.8<br>504.3 |
| 15          | 70.0             | 100.7            | 137.1          | 179.0            | 226.6            | 289.8            |                  | 402.8            | 472.8                   |
| 16<br>17    | 74.7             | 107.4            | 146.2<br>155.4 | 191.0<br>202.9   | 241.7            | 298.4            |                  | 429.7            | 504.3<br>535.8          |
| 18          | 79.3<br>84.0     | 114.1<br>120.9   | 164.5          | 214.8            | 256.8<br>272.0   | 317.0<br>335.7   |                  | 456.6<br>483.4   | 567.3                   |
| 19          | 88.7             | 127.6            | 173.6          | 226.8            | 287.0            | 354.             | 3 428.8          | 510.3            | 598.0                   |
| 20          | 93.3             | 134.3            | 182.8          | 238.7            | 302.1            | 373.0            |                  | 537.1            | 630.4                   |
| Depth<br>in |                  |                  |                | Dia              | meter in         | Feet             |                  |                  |                         |
| Feet        | 14               | 15               | 16             | 17               | 18               | 19               | 20               | 21               | 22                      |
| 5           | 182.8            | 209.8            | 238.7          | 269.5            | 302.1            | 336.6            | 3 373.0          | 411.2            | 451.3                   |
| 6           | 219.3            | 251.8            | 286.5          | 323.4            | 362.6            | 404.0            |                  | 493.5            | 541.6                   |
| 7           | 255.9            | 293.7            | 334.2          | 377.3            | 423.0            | 471.3            |                  | 575.7            | 631.9                   |
| 8           | 292.4            | 335.7<br>377.7   | 382.0          | 431.2            | 483.4            | 538.6            |                  | 658.0            | 722.1                   |
| 9<br>10     | 329.0            |                  | 429.7          | 485.1            | 543.8            | 605.9            |                  | 740.2            | 812.4                   |
| 11          | 365.5<br>402.1   | 419.6<br>461.6   | 477.4<br>525.2 | 539.0<br>592.9   | 604.3<br>667.7   | 673.3<br>740.6   |                  | 822.5<br>904.7   | 902.7<br>992.9          |
| 12          | 438.6            | 503.5            | 572.9          | 646.8            | 725.1            | 807.9            | 895.2            | 987.0            | 1083.2                  |
| 13          | 475.2            | 545.5            | 620.7          | 700.7            | 785.5            | 875.2            | 969.8            | 1069.2           | 1173.5                  |
| 14          | 511.8            | 587.5            | 668.2          | 754.6            | 846.6            | 942.6            | 1044.4           | 1151.5           | 1263.7                  |
| 15          | 548.3            | 629.4            | 716.2          | 808.5            | 906.0            | 1009.9           | 1119.0           | 1233.7           | 1354.0                  |
| 16          | 584.9            | 671.4            | 773.9          | 862.4            | 966.8            | 1077.2           | 1193.6           | 1315.9           | 1444.3                  |
| 17<br>18    | 621.4<br>658.0   | 713.4            | 811.6<br>859.4 | $916.3 \\ 970.2$ | 1027.2           | 1144.6           |                  | 1398.2<br>1480.4 | 1534.5                  |
| 18<br>19    | 694.5            | 755.3<br>797.3   | 907.1          | 1024.1           | 1087.7<br>1148.1 | 1211.9<br>1279.2 |                  | 1562.7           | 1624.8<br>1715.1        |
| 20          | 731.1            | 839.3            | 954.9          | 1078.0           | 1208.5           | 1346.5           |                  | 1644.9           | 1805.3                  |
| Depth       | .01.1            | 555.5            | 002.0          |                  | meter in         |                  |                  | 2012.0           | 2000.0                  |
| in<br>Feet  | 23               | 24               | 25             | 2                | 6                | 27               | 28               | 29               | 30                      |
| 5           | 493.3            | 537.1            | 582            | 9 62             | 0.4              | 679.8            | 731.1            | 784.2            | 839.3                   |
| 6           | 592.0            | 644.5            | 699            |                  |                  | 15.8             | 877.3            | 941.1            | 1007.1                  |
| 7           | 690.6            | 752.0            |                | 9 88             | 2.5              | 51.7             | 1023.5           | 1097.9           | 1175.0                  |
| Š           | 789.3            | 859.4            |                |                  | 8.6 10           | 87.7             | 1169.7           | 1254.8           | 1342.8                  |
| 9           | 887.9            | 966.8            | 1049           |                  | 4.7 12           | 23.6             | 1316.0           | 1411.6           | 1510.7                  |
| 10          | 986.6            | 1074.2           | 1165           | 6 126            | 0.8 13           | 59.6             |                  | 1568.2           | 1678.5                  |
| 11          | 1085.2           | 1181.7           | 1282           | 2 138            |                  | 95.6             | 1608.7           | 1723.0           | 1846.4                  |
| 12<br>13    | 1183.9           | 1289.1<br>1396.5 | 1398<br>1515   | 7 151            | 2.9 It           | 31.5<br>67.5     | 1754.6<br>1900.8 | 1882.2<br>2039.0 | 2014.2°<br>2182.0       |
| 14          | 1282.6<br>1381.2 | 1503.9           | 1631           |                  | 7.U 17           | 07.5             | 2047.1           | 2195.9           | 2343.9                  |
| 15          | 1479.9           | 16M.4            | 1748           |                  |                  | 39.4             | 2193.3           | 2352.7           | 2517.8                  |
| 16          | 1578.5           | 1718.8           | 1865           | 0 201            | 7.2 21           | 75.4             | 2339.5           | 2509.6           | 2685.6                  |
| 17          | 1677.2           | 1826.2           | 1981           | 6 214            | 3.3 23           | 311.3            | 2485.7           | 2666.4           | 2853.5                  |
| 18          | 1775.9           | 1933.6           | 2098           |                  | 9.4 24           | 47.3             | 2631.9           | 2823.3           | 3021.3                  |
| 19          | 1874.5           | 2041.1           | 2214           |                  |                  | 83.2             | 2778.1           | 2980.1           | 3189.2                  |
| 20          | 1973.2           | 2148.5           | 2321           | . 2 252          | 1.5 27           | 19.2             | 2924.4           | 3137.0           | 3357.0                  |

#### Capacity of Cylinders in United States Gallons

Table 65 gives the capacity in United States gallons (231 cubic inches) of cylindrical vessels from 1 to 72 inches in depth and from 4 to 72 inches in diameter. Table 64 will be found useful in reducing the decimal parts of a gallon to gills, pints and quarts. A very few words will suffice to explain the use of the tables, and perhaps the simplest method of doing so is to apply it to a practical case. Suppose, for instance, it is desired to find the dimensions of a cylinder holding 27 gallons. Running down the column headed 19, we find the number 27.0028, and following the line across, we come to the number 22; hence a cylinder 19 inches in diameter and 22 inches deep will hold 27 gallons and .0028 gallon. Turning to Table 64 we find a gill is equal to .03125 gallon, so that the capacity of the cylinder in question is about 1/10 gill more than 27 gallons.

Again, if it is desired to find the depth of a 15-inch cylinder that shall hold 27 gallons, we run down the column headed 15 till we come to the number 27.54, and following the line across we find the depth to be 36 inches. The decimal .54 we find, on consulting Table 64, is equivalent to between 1 and 2 pints; therefore a 15-inch cylinder 36 inches deep will hold between 1 and 2 pints more than 27 gallons. Similarly, to find the diameter of a cylinder 15 inches deep that shall hold 27 gallons, we run across the line opposite 15 till we come to the number 26.976, under the column headed 23. The decimal part, accord-

ing to Table 64, is equivalent to between 31 gills and I gallon, so the capacity of a cylinder 15 inches deep and 23 inches diameter is about 1/2 gill less than 27 gallons. Where it is desired to find the capacity of a cylinder both dimensions of which are given, it is only necessary to run down the column headed with the diameter till we come to the line across from the given depth, where the number found will be the capacity of the cylinder in gallons. To illustrate: What is the capacity of a cylinder 20 inches deep and 32 inches in diameter? Consulting Table 65 in the manner described, we find the number 100.966, the decimal part of which, according to Table 64, is about 31 gills, or 3 quarts, I pint and 3 gills; the given cylinder, therefore, holding 100 gallons, 3 quarts, 1 pint and 3 gills. These examples, we think, fully illustrate the uses of the tables, and serve to show their wide application to the determination of the capacities and dimensions of cylindrical vessels.

TABLE 64

# The Decimal Equivalents of the Fractional Parts of a Gallon

| 0.03125 of a gallon | =  | 1    | gill  | 0.53125 of a gallon = 17 gills               |
|---------------------|----|------|-------|--|
| 0.06250 of a gallon | =  | 1/2  | pint  | $0.56250$ of a gallon = $4\frac{1}{2}$ pints |
| 0.09375 of a gallon | =  | 3    | gills | 0.59375 of a gallon = 19 gills               |
| 0.12500 of a gallon | =  | 1    | pint  | 0.62500 of a gallon = 5 pints                |
| 0.15625 of a gallon | =  | 5    | gills | 0.65625 of a gallon = 21 gills               |
| 0.18750 of a gallon |    | 11/2 | pints | $0.68750$ of a gallon = $5\frac{1}{2}$ pints |
| 0.21875 of a gallon |    |      | gills | 0.71875 of a gallon = 23 gills               |
| 0.25000 of a gallon |    |      | quart | 0.75000 of a gallon = 3 quarts               |
| 0.28125 of a gallon |    |      | gills | 0.78125 of a gallon = $25$ gills             |
| 0.31250 of a gallon |    |      | pints | $0.81250$ of a gallon = $6\frac{1}{2}$ pints |
| 0.34375 of a gallon |    |      | gills | 0.84375 of a gallon = 27 gills               |
| 0.37500 of a gallon |    |      | pints | 0.87500 of a gallon = 7 pints                |
| 0.40625 of a gallon |    |      | gills | 0.90625 of a gallon = 29 gills               |
| 0.43750 of a gallon |    |      | pints | $0.93750$ of a gallon = $7\frac{1}{2}$ pints |
| 0.46875 of a gallon | == | 15   | gills | 0.96875 of a gallon = 31 gills               |
| 0.50000 of a gallon |    |      |       | 1.00000 of a gallon = 1 gallon               |
|                     |    |      | -     |  |

TABLE 65
Capacity of Cylinders in United States Gallons

| Depth.      | Diameter in Inches |       |        |         |         |                |  |  |  |  |  |  |
|-------------|--------------------|-------|--------|---------|---------|----------------|--|--|--|--|--|--|
| Inches      | 4                  | 5     | 6      | 7       | 8 .     | 9              |  |  |  |  |  |  |
| 1           | .0544              | .085  | .1224  | .1666   | .2176   | . 2754         |  |  |  |  |  |  |
| 2           | . 1088             | . 170 | .2448  | .3332   | .4352   | . 5508         |  |  |  |  |  |  |
| 3           | . 1632             | . 255 | .3672  | .4998   | .6528   | . 8262         |  |  |  |  |  |  |
| 4           | .2176              | . 340 | .4896  | .6664   | .8704   | 1.1016         |  |  |  |  |  |  |
| , 5         | . 2720             | .425  | .6120  | .8330   | 1.0880  | 1.3770         |  |  |  |  |  |  |
| 6           | .3264              | .510  | .7344  | .9996   | 1.3056  | 1.6524         |  |  |  |  |  |  |
| 7           | .3808              | . 595 | .8568  | 1.1662  | 1.5232  | 1.9278         |  |  |  |  |  |  |
| 8           | .4352              | . 680 | .9792  | 1.3328  | 1.7408  | 2.2023         |  |  |  |  |  |  |
| 9           | . 4896             | .765  | 1.1016 | 1.4994  | 1.9584  | 2.4780         |  |  |  |  |  |  |
| 10          | .5440              | .850  | 1.2240 | 1.6660  | 2.1760  | 2.7546         |  |  |  |  |  |  |
| 11          | .5984              | .935  | 1.3464 | 1.8326  | 2.3936  | 3.0294         |  |  |  |  |  |  |
| 12          | .6528              | 1.020 | 1.4688 | 1.9992  | 2.6112  | 3.3048         |  |  |  |  |  |  |
| 13          | .7072              | 1.105 | 1.5912 | 2.1658  | 2.8288  | 3.5802         |  |  |  |  |  |  |
| 14          | . 7616             | 1.190 | 1.7136 | 2.3324  | 3.0464  | 3.8556         |  |  |  |  |  |  |
| 15          | .8160              | 1.275 | 1.8360 | 2.4990  | 3.2640  | 4.1310         |  |  |  |  |  |  |
| 16          | .8704              | 1.360 | 1.9584 | 2.6656  | 3.4816  | 4.4064         |  |  |  |  |  |  |
| 17          | .9248              | 1.445 | 2.0808 | 2.8322  | 3.6992  | 4.6818         |  |  |  |  |  |  |
| 18          | .9792              | 1.530 | 2.2032 | 2.9988  | 3.9168  | 4.9572         |  |  |  |  |  |  |
| 19          | 1.0336             | 1.615 | 2.3256 | 3.1654  | 4.1344  | 5.2326         |  |  |  |  |  |  |
| 20          | 1.0880             | 1.707 | 2.4480 | 3.3320  | 4.3520  | 5.5080         |  |  |  |  |  |  |
| 21          | 1.1424             | 1.785 | 2.5704 | 3.4986  | 4.5696  | 5.7834         |  |  |  |  |  |  |
| 22          | 1.1968             | 1.870 | 2.6928 | 3.6652  | 4.7872  | 6.0588         |  |  |  |  |  |  |
| 23          | 1.2512             | 1.955 | 2.8152 | 3.8318  | 5.0048  | 6.3342         |  |  |  |  |  |  |
| 24          | 1.3056             | 2.040 | 2.9376 | 3.9984  | 5.2224  | 6.6096         |  |  |  |  |  |  |
| 25          | 1.3600             | 2.125 | 3.0600 | 4.1650  | 5.4400  | 6.8850         |  |  |  |  |  |  |
| 26          | 1.4144             | 2.210 | 3.1824 | 4.3316  | 5.6576  | 7.1604         |  |  |  |  |  |  |
| 27          | 1.4688             | 2.295 | 3.3048 | 4.4982  | 5.8752  | <b>7</b> .4358 |  |  |  |  |  |  |
| <b>28</b> . | 1.5232             | 2.380 | 3.4272 | 4.6648  | 6.0928  | 7.7112         |  |  |  |  |  |  |
| 29          | 1.5776             | 2.465 | 3.5496 | 4.8314  | 6.3104  | 7.9866         |  |  |  |  |  |  |
| 30          | 1.6320             | 2.550 | 3.6720 | 4.9980  | 6.5280  | 8.2620         |  |  |  |  |  |  |
| 81          | 1.6864             | 2.635 | 3.7944 | 5.1646  | 6.7456  | 8.5374         |  |  |  |  |  |  |
| 32          | 1.7408             | 2.720 | 3.9168 | 5.3312  | 6.9632  | 8.8128         |  |  |  |  |  |  |
| 83          | 1.7952             | 2.805 | 4.0392 | 5.4978  | 7.1808  | 9.0882         |  |  |  |  |  |  |
| 34          | 1.8496             | 2.890 | 4.1616 | 5.6644  | 7.3984  | 9.3636         |  |  |  |  |  |  |
| 35          | 1.9040             | 2.975 | 4.2840 | 5.8310  | 7.6160  | 9.0390         |  |  |  |  |  |  |
| 36          | 1.9584             | 3.060 | 4.4064 | 5.9976  | 7.8336  | 9.9144         |  |  |  |  |  |  |
| 40          | 2.1760             | 3.400 | 4.8960 | 6.6640  | 8.7040  | 11.0160        |  |  |  |  |  |  |
| 44          | 2.3936             | 3.740 | 5.3856 | 7.3304  | 9.5744  | 12.1176        |  |  |  |  |  |  |
| 48          | 2.6112             | 4.080 | 5.8752 | 7.9968  | 10.4448 | 13.2192        |  |  |  |  |  |  |
| 54<br>60    | 2.9376             | 4.590 | 6.6096 | 8.9964  | 11.7504 | 14.8716        |  |  |  |  |  |  |
| 60<br>78    | 3.2640             | 5.100 | 7.3440 | 9.9960  | 13.0560 | 16.5240        |  |  |  |  |  |  |
| 72          | 3.9168             | 6.120 | 8.8128 | 11.9952 | 15.6672 | 19.8288        |  |  |  |  |  |  |

Table 65 (Continued)

# Capacity of Cylinders in United States Gallons

| Depth,   |       |         | Diameter | in Inches |         |                    |
|----------|-------|---------|----------|-----------|---------|--------------------|
| Inches   | 10    | 11      | 12       | 13        | 14      | 15                 |
| 1        | .34   | .4114   | .4896    | . 5746    | . 6664  | .765               |
| 2        | . 68  | .8228   | .9792    | 1.1492    | 1.3328  | 1.530              |
| 3        | 1.02  | 1.2342  | 1.4688   | 1.7238    | 1.9992  | 2.295              |
| 4        | 1.36  | 1.6456  | 1.9584   | 2.2984    | 2.6656  | 3.060              |
| 5        | 1.70  | 2.0570  | 2.4480   | 2.8730    | 3.3320  | 3.825              |
| 6        | 2.04  | 2.4684  | 2.9376   | 3.4476    | 3.9984  | 4.590              |
| 7        | 2.38  | 2.8798  | 3.4272   | 4.0222    | 4.6648  | 5.355              |
| 8        | 2.72  | 3.2912  | 3.9168   | 4.5968    | 5.3312  | 6.120              |
| 9        | 3.06  | 3.7026  | 4.4064   | 5.1714    | 5.9976  | 6.885              |
| 10       | 3.40  | 4.1140  | 4.8960   | 5.7460    | 6.6640  | 7.650              |
| 11       | 3.74  | 4.5254  | 5.3856   | 6.3206    | 7.3304  | 8.415              |
| 12       | 4.08  | 4.9368  | 5.8752   | 6.8952    | 7.9968  | 9.180              |
| 18       | 4.42  | 5.3482  | 6.3648   | 7.4698    | 8.6632  | 9.945              |
| 14       | 4.76  | 5.7596  | 6.8544   | 8.0444    | 9.3296  | 10.710             |
| 15       | 5.10  | 6.1710  | 7.3440   | 8.6190    | 9.9960  | 11.475             |
| 16.      | 5.44  | 6.5824  | 7.8336   | 9.1936    | 10.6624 | 12.240             |
| 17       | 5.78  | 6.9938  | 8.3232   | 9.7682    | 11.3288 | 13.005             |
| 18       | 6.12  | 7.4052  | 8.8128   | 10.3428   | 11.9952 | 13.770             |
| 19       | 6.46  | 7.8166  | 9.3024   | 10.9174   | 12.6616 | 14.535             |
| 20       | 6.80  | 8.2280  | 9.7920   | 11.4920   | 13.3280 | 15.300             |
| 21       | 7.14  | 8.6394  | 10.2816  | 12.0666   | 13.9944 | 16.065             |
| 22       | 7.48  | 9.0508  | 10.7712  | 12.6412   | 14.6608 | 16.830             |
| 28       | 7.82  | 9.4622  | 11.2608  | 13.2158   | 15.3272 | 17.595             |
| 24       | 8.16  | 9.8736  | 11.7504  | 13.7904   | 15.9936 | 18.360             |
| 25       | 8.50  | 10.2850 | 12.2400  | 14.3650   | 16.6600 | 19.125             |
| 26       | 8.84  | 10.6964 | 12.7296  | 14.9396   | 17.3264 | 19.890             |
| 27       | 9.18  | 11.1078 | 13.2192  | 15.5142   | 17.9928 | 20.655             |
| 28       | 9.52  | 11.5192 | 13.7088  | 16.0888   | 18.6592 | 21.420             |
| 29<br>30 | 9.86  | 11.8306 | 14.1984  | 16.6634   | 19.3256 | $22.185 \\ 22.950$ |
| 30       | 10.20 | 12.3420 | 14.6880  | 17.2380   | 19.9920 | 22.930             |
| 31       | 10,54 | 12.7534 | 15.1776  | 17.8126   | 20.6584 | 23.715             |
| 32       | 10.88 | 13.1648 | 15.6672  | 18.3872   | 21.3248 | 24.480             |
| 33       | 11.22 | 13.5762 | 16.1568  | 18.9618   | 21.9912 | 25.245             |
| 34       | 11.56 | 13.9876 | 16.6464  | 19.5364   | 22.6576 | 26.010             |
| 35       | 11.90 | 14.3998 | 17.1360  | 20.1110   | 23.3240 | 26.775             |
| 36       | 12.24 | 14.8104 | 17.6256  | 20.6856   | 23.9904 | 27.540             |
| 40       | 13,60 | 16.4560 | 19.5840  | 22.9840   | 26.6560 | 30.600             |
| 44       | 14.96 | 18.1016 | 21.5424  | 25.2824   | 29.3216 | 33.660             |
| 48       | 16.32 | 19.7472 | 23.5008  | 27.5808   | 31.9872 | 36.720             |
| 54       | 18.36 | 22.2156 | 26.4384  | 31.0284   | 35.9856 | 41.310             |
| 60       | 20.40 | 24.6840 | 29.3760  | 34.4760   | 39.9840 | 45.900             |
| 72       | 24.48 | 29.6208 | 35.2512  | 41.3712   | 47.9808 | 55.080             |

## Table 65 (Continued)

## Capacity of Cylinders in United States Gallons

| D45              | Diameter in Inches |         |         |                  |               |                          |  |  |  |  |  |  |
|------------------|--------------------|---------|---------|------------------|---------------|--------------------------|--|--|--|--|--|--|
| Depth,<br>Inches | 16                 | 17      | 16      | 19               | 20            | 21                       |  |  |  |  |  |  |
| 1                | .8704              | .9826   | 1.1016  | 1.2274           | 1.36          | 1 . 4094                 |  |  |  |  |  |  |
| 2                | 1.7408             | 1.9652  | 2.2032  | 2.4548           | 2.72          | 2.9988                   |  |  |  |  |  |  |
| 8                | 2.6112             | 2.9478  | 3.3048  | 3.6822           | 4.08          | 4 . 4082                 |  |  |  |  |  |  |
| 4                | 3.4816             | 3.9304  | 4.4064  | 4.9096           | 5.44          | 5.9 <b>97</b> 6          |  |  |  |  |  |  |
| . 2              | 4.3520             | 4.9130  | 5.5080  | 6.1370           | 6.80          | 7.4970                   |  |  |  |  |  |  |
| 6                | 5.2224             | 5.8956  | 6.6096  | 7.3644           | 8.16          | 8.9964                   |  |  |  |  |  |  |
| 7                | 6.0928             | 6.8782  | 7.7112  | 8.5918           | 9.52          | 10.4958                  |  |  |  |  |  |  |
| 8                | 6.9632             | 7.8608  | 8.8128  | 9.8192           | 10.88         | 11.9952                  |  |  |  |  |  |  |
| 9                | 7.8336             | 8.8434  | 9.9144  | 11.0466          | 12.24         | 13 . <b>49</b> 46        |  |  |  |  |  |  |
| 10               | 8.7040             | 9.8260  | 11.0160 | 12.2740          | 13.60         | 14.9 <b>94</b> 0         |  |  |  |  |  |  |
| 11               | 9.5744             | 10.8086 | 12.1176 | 13.5014          | 14.96         | 16. <b>493</b> 4         |  |  |  |  |  |  |
| 12               | 10.4448            | 11.7912 | 13.2192 | 14.7288          | 16.32         | 17. <b>992</b> 8         |  |  |  |  |  |  |
| 13               | 11.3152            | 12.7738 | 14.3208 | 15.9562          | 17.68         | 19.4922                  |  |  |  |  |  |  |
| 14               | 12.1856            | 13.7564 | 15.4224 | 17.1636          | 19.04         | 20.9916                  |  |  |  |  |  |  |
| 15               | 13.0560            | 14.7390 | 16.5240 | 18.4110          | 20.40         | 22.4910                  |  |  |  |  |  |  |
| 16               | 13.9264            | 15.7216 | 17.6256 | 19.6384          | 21.76         | 23.9 <b>904</b>          |  |  |  |  |  |  |
| 17               | 14.7968            | 16.7042 | 18.7272 | 20.8658          | 23.12         | 25.4 <b>89</b> 8         |  |  |  |  |  |  |
| 18               | 15.6672            | 17.6868 | 19.8288 | 22.0932          | 24.48         | 26.9 <b>89</b> 2         |  |  |  |  |  |  |
| 19               | 16.5376            | 18.6694 | 20.9304 | 23.3206          | <b>25</b> .84 | 28.4 <del>88</del> 6     |  |  |  |  |  |  |
| 20               | 17.4080            | 19.6520 | 22.0320 | 24.5480          | 27.20         | 29.9680                  |  |  |  |  |  |  |
| 21               | 18.2784            | 20.6346 | 23.1336 | 25.7754          | 28.56         | 31.4874                  |  |  |  |  |  |  |
| 22               | 19.1488            | 21.6172 | 24.2352 | 27.0028          | <b>29.92</b>  | 32.9868                  |  |  |  |  |  |  |
| 28               | 20.0192            | 22.5998 | 25.3368 | 28.2302          | 31.28         | 34.4862                  |  |  |  |  |  |  |
| 24               | 20.8896            | 23.5824 | 26.4384 | 29.4576          | 32.64         | 35.9856                  |  |  |  |  |  |  |
| 25               | 21.7600            | 24.5650 | 27.5400 | 30.6850          | 34.00         | 37.4850                  |  |  |  |  |  |  |
| 26               | 22.6304            | 25.5476 | 28.6416 | 31.9124          | 35.36         | 38.9844                  |  |  |  |  |  |  |
| 27               | 23.5008            | 26.5302 | 29.7432 | 33.1398          | 36.72         | 40.4838                  |  |  |  |  |  |  |
| 28               | 24.3712            | 27.5128 | 30.8448 | 34.3672          | 38.08         | 41.9832                  |  |  |  |  |  |  |
| 29               | 25.2416            | 28.4954 | 31.9464 | 35.5946          | 39.44         | 43.4826                  |  |  |  |  |  |  |
| 30               | 26.1120            | 29.4780 | 33.0480 | 40.8220          | 40.80         | 44.9820                  |  |  |  |  |  |  |
| 81               | 26.9824            | 30.4606 | 34.1496 | 38.0494          | 42.16         | 46.4814                  |  |  |  |  |  |  |
| 82               | 27.8528            | 31.4432 | 35.2512 | 39.2768          | 43.52         | 47.9808                  |  |  |  |  |  |  |
| 88               | 28.7232            | 32.4258 | 36.3528 | 40.5042          | 44.88         | 49.4802                  |  |  |  |  |  |  |
| 84               | 29.5936            | 33.4084 | 37.4544 | 41.7316          | 46.14         | 50.9796                  |  |  |  |  |  |  |
| 35 ·             | 30.4640            | 34.3910 | 38.5560 | 42.9590          | 47.60         | <b>52.479</b> 0          |  |  |  |  |  |  |
| 86               | 31.3344            | 35.3736 | 39.6576 | 44.1864          | 48.96         | 53.9784                  |  |  |  |  |  |  |
| 40               | 34.8160            | 39.3040 | 44.0640 | 49.0960          | 54.40         | <b>59</b> . <b>976</b> 0 |  |  |  |  |  |  |
| 44               | 38.2976            | 43.2344 | 48.4704 | 54.0056          | <b>59.84</b>  | 65.9736                  |  |  |  |  |  |  |
| 48               | 41.7792            | 47.1648 | 52.8768 | 58.9152          | 65.28         | 71.9712                  |  |  |  |  |  |  |
| 54               | 47.0016            | 53.0604 | 59.4864 | 66. <b>479</b> 6 | 73.44         | 80.9676                  |  |  |  |  |  |  |
| 60               | 52.2240            | 58.9560 | 66.0960 | 73.6440          | 81.60         | 89.9640                  |  |  |  |  |  |  |
| 72               | 62.6688            | 70.7472 | 79.3151 | 88. <b>3728</b>  | 97.92         | 107.9570                 |  |  |  |  |  |  |
|                  |                    |         |         |                  |               |                          |  |  |  |  |  |  |

Table 65 (Continued)

# Capacity of Cylinders in United States Gallons

| 2         3.2912         3.5972         3.9168         4.5968         5.3312           3         4.9368         5.3958         5.8752         6.8952         7.9968           4         6.5824         7.1944         7.8336         9.1936         10.6624           5         8.2280         8.9930         9.7920         11.4920         13.3280           6         9.8736         10.7916         11.7504         13.7904         15.9936           7         11.5192         12.5902         13.7089         16.0888         18.6592           8         13.1648         14.3888         15.6672         18.3872         21.3248           9         14.8104         16.1874         17.6256         20.6856         23.9904           10         16.4560         17.9860         19.5840         22.9840         26.6560           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.5008         27.5808         31.9872           13         21.3928         23.3818         25.4592         29.8792         34.6528           14         23.0384         25.1804         27.4176 <th>5 .45</th> <th colspan="11">Diameter in Inches</th>  | 5 .45 | Diameter in Inches |          |          |          |                  |  |  |  |  |  |  |
|---|-------|--------------------|----------|----------|----------|------------------|--|--|--|--|--|--|
| 2         3.2912         3.5972         3.9168         4.5968         5.3128           3         4.9368         5.3958         5.8752         6.8952         7.9968           4         6.5824         7.1944         7.8336         9.1936         10.6624           5         8.2280         8.9930         9.7920         11.4920         13.3826           6         9.8736         10.7916         11.7504         13.7904         15.9936           7         11.5192         12.5902         13.7089         16.0888         18.6592           8         13.1648         14.3888         15.6672         18.3872         21.3248           9         14.8104         16.1874         17.6256         20.6856         23.9904           10         16.4560         17.9860         19.5840         22.9840         26.6560           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.5008         27.5808         31.9872           13         21.3928         23.3818         25.4592         29.8792         34.6528           14         23.0384         25.1804         27.4176 <th></th> <th>22</th> <th>23</th> <th>24</th> <th>26</th> <th>28</th>  |       | 22                 | 23       | 24       | 26       | 28               |  |  |  |  |  |  |
| 8         4.9368         5.3958         5.8752         6.8952         7.9948           4         6.5824         7.1944         7.8336         9.1936         10.6624           5         8.2280         8.9930         9.7920         11.4920         13.3286           6         9.8736         10.7916         11.7504         13.7904         15.9936           7         11.5192         12.5902         13.7089         16.0888         18.6592           8         13.1648         14.3838         15.6672         18.3872         21.3248           9         14.8104         16.1874         17.6256         20.6856         23.9904           10         16.4560         17.9860         19.5840         22.9840         26.6560           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.5008         27.5808         31.9872           13         21.3928         23.3818         25.4592         29.8792         34.6528           14         23.0384         25.1804         27.4176         32.1776         37.3184           15         24.6840         26.9790         29.37  | 1     | 1.6456             |          |          | 2.2984   | 2.6656           |  |  |  |  |  |  |
| 4         6.5824         7.1944         7.8336         9.1936         10.6624           5         8.2280         8.9930         9.7920         11.4920         13.3286           6         9.8736         10.7916         11.7504         13.7904         15.9936           7         11.5192         12.5902         13.7089         16.0888         18.6592           8         13.1648         14.3888         15.6672         18.3872         21.3248           9         14.8104         16.1874         17.6256         20.6856         23.9904           10         16.4560         17.9860         19.5840         22.9840         26.6560           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.5008         27.5808         31.9872           13         21.3328         23.3818         25.4592         29.8792         34.6522           14         23.0384         25.1804         27.4176         32.1776         37.3184           15         24.6840         26.9790         29.3760         34.4760         39.9840           16         26.3296         28.7776 <td< td=""><td>2</td><td>3.2912</td><td>3.5972</td><td>3.9168</td><td>4.5968</td><td>5.3312</td></td<>               | 2     | 3.2912             | 3.5972   | 3.9168   | 4.5968   | 5.3312           |  |  |  |  |  |  |
| 8         2280         8.9930         9.7920         11.4920         13.3286           6         9.8736         10.7916         11.7504         13.7904         15.9936           7         11.5192         12.5902         13.7089         16.0888         18.6592           8         13.1648         14.3888         15.6672         18.3872         21.3248           9         14.8104         16.1874         17.6256         20.6856         23.9904           10         16.4560         17.9860         19.5840         22.9840         26.6560           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.5008         27.5808         31.9872           13         21.3928         23.3818         25.4592         29.8792         34.6528           14         23.0384         25.1804         27.4176         32.1776         37.3184           15         24.6840         26.0790         29.3760         34.4760         39.9846           16         26.3296         28.7776         31.3344         36.7741         42.6596           17         27.9752         30.5762   |       | 4.9368             |          |          |          | 7.9968           |  |  |  |  |  |  |
| 6         9.8736         10.7916         11.7504         13.7904         15.9936           7         11.5192         12.5902         13.7089         16.0888         18.6592           8         13.1648         14.3838         15.6672         18.3872         21.3248           9         14.8104         16.1874         17.6256         20.6856         23.9904           10         16.4560         17.9860         19.5840         22.9840         26.6560           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.5008         27.5808         31.9872           13         21.3928         23.3818         25.4592         29.8792         34.6528           14         23.0384         25.1804         27.4176         32.1776         37.3184           15         24.6840         26.9790         29.3760         34.4760         39.9846           16         26.3296         28.7776         31.3344         36.7741         42.6596           16         26.3296         32.748         35.2512         41.3712         47.9808           17         27.9752         30.5762  | 4     | 6.5824             |          |          |          |                  |  |  |  |  |  |  |
| 7         11.5192         12.5902         13.7089         16.0888         18.6592           8         13.1648         14.3888         15.6672         18.3872         21.3248           9         14.8104         16.1874         17.6256         20.6856         23.9904           10         16.4560         17.9860         19.5840         22.9840         26.6560           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.5008         27.5808         31.9872           13         21.3928         23.3818         25.4592         29.8792         34.6528           14         23.0384         25.1804         27.4176         32.1776         37.3184           15         24.6840         26.0790         29.3760         34.4760         39.9840           16         26.3296         28.7776         31.3344         36.7741         42.6564           17         27.9752         30.5762         33.2928         39.0728         45.3152           18         29.6208         32.3748         35.2512         41.3712         47.9808           19         31.2664         34.1734   |       |                    |          |          |          |                  |  |  |  |  |  |  |
| 8         13.1648         14.3888         15.6672         18.3872         21.3248           9         14.8104         16.1874         17.6256         20.6856         23.9904           10         16.4560         17.9860         19.5840         22.9840         26.6560           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.3508         27.5808         31.9872           13         21.3928         23.3818         25.4502         29.8792         34.6528           14         23.0384         25.1804         27.4176         32.1776         37.3184           16         24.6840         26.0790         29.3760         34.4760         39.9846           17         27.9752         30.5762         33.2928         39.0728         45.3152           17         27.9752         30.5762         33.2928         39.0728         45.3152           18         29.6208         32.3748         35.2512         41.3712         47.9808           19         31.2664         34.1734         37.2096         43.6696         50.6464           20         32.9120         35.9720  |       | 9.8736             |          |          |          |                  |  |  |  |  |  |  |
| 9         14.8104         16.1874         17.6256         20.6856         23.9904           10         16.4560         17.9860         19.5840         22.9840         26.6566           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.5008         27.5808         31.9872           13         21.3928         23.3818         25.4592         29.8792         34.6528           14         23.0384         25.1804         27.4176         32.1776         37.3184           15         24.6840         26.9790         29.3760         34.4760         39.9840           16         26.3296         28.7776         31.3344         36.7741         42.6596           17         27.9752         30.5762         33.2928         39.0728         45.3152           18         29.6208         32.3748         35.2512         41.3712         47.9808           20         32.9120         35.9720         39.1680         45.9680         53.3122           21         34.5576         37.7706         41.1264         48.2664         55.9776           22         36.2032         39.5692 <td>7</td> <td></td> <td></td> <td></td> <td></td> <td>18.6592</td>                                     | 7     |                    |          |          |          | 18.6592          |  |  |  |  |  |  |
| 10         16.4560         17.9860         19.5840         22.9840         26.6560           11         18.1016         19.7846         21.5424         25.2824         29.3216           12         19.7472         21.5832         23.5008         27.5808         31.9872           13         21.3928         23.3818         25.4592         29.8792         34.6528           14         23.0384         25.1804         27.4176         32.1776         37.3184           15         24.6840         26.9790         29.3760         34.4760         39.9840           16         26.3296         28.7776         31.3344         36.7741         42.6596           17         27.9752         30.5762         33.3928         39.0728         45.3152           18         29.6208         32.3748         35.2512         41.3712         47.9808           19         31.2664         34.1734         37.2096         43.6696         50.6464           20         32.9120         35.9720         39.1680         45.9680         53.3120           21         34.5576         37.7706         41.1264         48.2664         55.9756           23         36.2032         39.5692 <td>8</td> <td>13.1648</td> <td></td> <td></td> <td></td> <td></td>                                    | 8     | 13.1648            |          |          |          |                  |  |  |  |  |  |  |
| 11       18.1016       19.7846       21.5424       25.2824       29.3216         12       19.7472       21.5832       23.5008       27.5808       31.9872         13       21.3928       23.3818       25.4592       29.8792       34.6528         14       23.0384       25.1804       27.4176       32.1776       37.3184         15       24.6840       26.0790       29.3760       34.4760       39.9846         16       26.3296       28.7776       31.3344       36.7741       42.6596         17       27.9752       30.5762       33.2928       39.0728       45.3152         18       29.6208       32.3748       35.2512       41.3712       47.9808         19       31.2664       34.1734       37.2096       43.6696       50.6464         20       32.9120       35.9720       39.1680       45.9680       53.3120         21       34.5576       37.7706       41.1264       48.2664       55.9776         22       36.2032       39.5692       43.0848       50.5648       58.6432         23       37.8488       41.3678       45.0432       52.332       61.3088         24       39.4944 <td< td=""><td>9</td><td>14.8104</td><td>16.1874</td><td></td><td>20.6856</td><td>23.9904</td></td<>   | 9     | 14.8104            | 16.1874  |          | 20.6856  | 23.9904          |  |  |  |  |  |  |
| 12       19,7472       21,5832       23,5008       27,5808       31,9872         13       21,3928       23,3818       25,4592       29,8792       34,6528         14       23,0384       25,1804       27,4176       32,1776       37,3184         15       24,6840       26,9790       29,3760       34,4760       39,9840         16       26,3296       28,7776       31,3344       36,7741       42,6596         17       27,9752       30,5762       33,2928       39,0728       45,3152         18       29,6208       32,3748       35,2512       41,3712       47,9808         19       31,2664       34,1734       37,2096       43,6696       50,6464         20       32,9120       35,9720       39,1680       45,9680       53,3120         21       34,5576       37,7706       41,1264       48,2664       55,9776         22       36,2032       39,5692       43,0848       50,5648       58,6432         23       37,8488       41,3678       45,0432       52,332       61,3088         24       39,4944       43,1664       47,0016       45,1660       63,974         25       41,1400   | 10    | 16.4560            | 17.9860  |          | 22.9840  | 26.6560          |  |  |  |  |  |  |
| 13         21.3928         23.3818         25.4592         29.8792         34.6528           14         23.0384         25.1804         27.4176         32.1776         37.3184           16         24.6840         26.0790         29.3760         34.4760         39.9846           16         26.3296         28.7776         31.3344         36.7741         42.6596           17         27.9752         30.5762         33.2928         39.0728         45.3152           18         29.6208         32.3748         35.2512         41.3712         47.9808           19         31.2664         34.1734         37.2096         43.6696         50.6464           20         32.9120         35.9720         39.1680         45.9680         53.3120           21         34.5576         37.7706         41.1264         48.2664         55.9776           22         36.2032         39.5692         43.0848         50.5648         58.6432           23         37.8488         41.3678         45.0432         52.332         61.3088           24         39.4944         43.1664         47.0016         55.1616         63.9744           25         41.1400         44.9650 <td>11</td> <td>18.1016</td> <td>19.7846</td> <td>21.5424</td> <td></td> <td>29.3216</td>               | 11    | 18.1016            | 19.7846  | 21.5424  |          | 29.3216          |  |  |  |  |  |  |
| 14         23.0384         25.1804         27.4176         32.1776         37.3184           16         24.6840         26.0790         29.3760         34.4760         39.9846           16         26.3296         28.7776         31.3344         36.7741         42.6506           17         27.9752         30.5762         33.2928         39.0728         45.3152           18         29.6208         32.3748         35.2512         41.3712         47.9806           20         32.9120         35.9720         39.1680         45.9680         53.3120           21         34.5576         37.7706         41.1264         48.2664         55.9776           22         36.2032         39.5692         43.0848         50.5648         58.6432           23         37.8488         41.3678         45.0432         52.832         61.3088           24         39.4944         43.1664         47.0016         57.4600         66.6400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608 <td>12</td> <td>19.7472</td> <td></td> <td>23.5008</td> <td>27.5808</td> <td>31.9872</td>               | 12    | 19.7472            |          | 23.5008  | 27.5808  | 31.9872          |  |  |  |  |  |  |
| 16         24.6840         26.9790         29.3760         34.4760         39.9840           16         26.3296         28.7776         31.3344         36.7741         42.6596           17         27.9752         30.5762         33.2928         39.0728         45.3152           18         29.6208         32.3748         35.2512         41.3712         47.9808           19         31.2664         34.1734         37.2096         43.6696         50.6464           20         32.9120         35.9720         39.1680         45.9680         53.3120           21         34.5576         37.7706         41.1264         48.2664         55.9776           22         36.2032         39.5692         43.0848         50.5648         58.6432           23         37.8488         41.3678         45.0432         52.532         61.3088           24         39.4944         43.1664         47.0016         57.4600         66.400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608  | 13    | 21.3928            | 23.3818  | 25.4592  | 29.8792  | 34.6528          |  |  |  |  |  |  |
| 16         26.3296         28.7776         31.3344         36.7741         42.6506           17         27.9752         30.5762         33.2928         39.0728         45.3152           18         29.6208         32.3748         35.2512         41.3712         47.9808           19         31.2664         34.1734         37.2096         43.6696         50.6464           20         32.9120         35.9720         39.1680         45.9680         53.3120           21         34.5576         37.7706         41.1264         48.2664         55.9776           22         36.2032         39.5692         43.0848         50.5648         58.6432           23         37.8488         41.3678         45.0432         52.332         61.3088           24         39.4944         43.1664         47.0016         55.1616         63.9744           25         41.1400         44.9650         48.9600         57.4600         66.6400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608 <td>14</td> <td>23.0384</td> <td>25.1804</td> <td>27.4176</td> <td>32.1776</td> <td>37.3184</td>        | 14    | 23.0384            | 25.1804  | 27.4176  | 32.1776  | 37.3184          |  |  |  |  |  |  |
| 17         27.9752         30.5762         33.2928         39.0728         45.3152           18         29.6208         32.3748         35.2512         41.3712         47.9806           19         31.2664         34.1734         37.2906         43.6996         50.6464           20         32.9120         35.9720         39.1680         45.9680         53.3120           21         34.5576         37.7706         41.1264         48.2664         55.9776           22         36.2032         39.5692         43.0848         50.5648         58.6432           23         37.8488         41.3678         45.0432         52.832         61.3088           24         39.4944         43.1664         47.0016         55.1616         63.9744           25         41.1400         44.9650         48.9600         57.4600         66.6400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594 <td>15</td> <td>24.6840</td> <td>26.9790</td> <td>29.3760</td> <td>34.4760</td> <td>39.9840</td>        | 15    | 24.6840            | 26.9790  | 29.3760  | 34.4760  | 39.9840          |  |  |  |  |  |  |
| 18         29.6208         32.3748         35.2512         41.3712         47.9808           19         31.2664         34.1734         37.2096         43.6696         50.6464           20         32.9120         35.9720         39.1680         45.9680         53.3120           21         34.5576         37.7706         41.1264         48.2664         55.9776           22         36.2032         39.5692         43.0848         50.5648         58.6432           23         37.8488         41.3678         45.0432         52.532         61.3088           24         39.4944         43.1664         47.0016         55.1616         63.9744           25         41.1400         44.9650         48.9600         57.4600         66.400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.6536         77.3024           30         49.3680         53.9580  | 16    | 26.3296            | 28.7776  | 31.3344  | 36.7741  | 42.6596          |  |  |  |  |  |  |
| 19         31.2664         34.1734         37.2096         43.6696         50.6464           20         32.9120         35.9720         39.1680         45.9680         53.3120           21         34.5576         37.7706         41.1264         48.2664         55.9776           22         36.2032         39.5692         43.0848         50.5648         58.6432           23         37.8488         41.3678         45.0432         52.832         61.3088           24         39.4944         43.1664         47.0016         55.1616         63.9744           26         41.1400         44.9650         48.9600         57.4600         66.6400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.536         77.9024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566  | 17    | 27.9752            | 30.5762  | 33.2928  | 39.0728  | 45.3152          |  |  |  |  |  |  |
| 20         32.9120         35.9720         39.1680         45.9680         53.3120           21         34.5576         37.7706         41.1264         48.2664         55.9776           22         36.2032         39.5692         43.0848         50.5648         58.6432           23         37.8488         41.3678         45.0432         52.8322         61.3084           24         39.4944         43.1664         47.0016         55.1616         63.9744           25         41.1400         44.9650         48.9600         57.4600         66.6400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.6536         77.3024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552 <td>18</td> <td>29.6208</td> <td>32.3748</td> <td>35.2512</td> <td>41.3712</td> <td>47.9808</td>       | 18    | 29.6208            | 32.3748  | 35.2512  | 41.3712  | 47.9808          |  |  |  |  |  |  |
| 21       34.5576       37.7706       41.1264       48.2664       55.9776         22       36.2032       39.5692       43.0848       50.5648       58.6432         23       37.8488       41.3678       45.0432       52.5332       61.3088         24       39.4944       43.1664       47.0016       55.1616       63.9744         25       41.1400       44.9650       48.9600       57.4600       66.6400         26       42.7856       46.7636       50.9184       59.8584       69.3056         27       44.4312       48.5622       52.8768       62.0568       71.9712         28       46.0768       50.3608       54.8352       64.3552       74.6368         29       47.7224       52.1594       56.7936       66.6536       77.3024         30       49.3680       53.9580       58.7520       68.9520       79.9680         31       51.0136       55.7566       60.7104       71.2504       82.6336         32       52.6592       57.5552       62.6688       73.5482       85.2992         33       54.3048       59.3538       64.6272       75.8472       87.9648         34       55.9504 <t< td=""><td>19</td><td>31.2664</td><td>34.1734</td><td>37.2096</td><td>43.6696</td><td>50.6464</td></t<>  | 19    | 31.2664            | 34.1734  | 37.2096  | 43.6696  | 50.6464          |  |  |  |  |  |  |
| 22         36.2032         39.5692         43.0848         50.5648         58.6432           23         37.8488         41.3678         45.0432         52.532         61.3088           24         39.4944         43.1664         47.0016         55.1616         63.9744           25         41.1400         44.9650         48.9600         57.4600         66.6400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.6536         77.3024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5488         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524 <td>20</td> <td>32.9120</td> <td>35.9720</td> <td>39.1680</td> <td>45.9680</td> <td>53.3120</td>        | 20    | 32.9120            | 35.9720  | 39.1680  | 45.9680  | 53.3120          |  |  |  |  |  |  |
| 23         37.8488         41.3678         45.0432         52.5332         61.3088           24         39.4944         43.1664         47.0016         55.1616         63.9744           25         41.1400         44.9650         48.9600         57.4600         66.6400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.6536         77.3024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5488         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510 <td>21</td> <td>34.5576</td> <td>37.7706</td> <td>41.1264</td> <td>48.2664</td> <td>55.9776</td>       | 21    | 34.5576            | 37.7706  | 41.1264  | 48.2664  | 55.9776          |  |  |  |  |  |  |
| 24         39.4944         43.1664         47.0016         55.1616         63.9744           26         41.1400         44.9650         48.9600         57.4600         66.6400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.636         77.3024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5488         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2960           36         59.2416         64.7496 <td>22</td> <td>36.2032</td> <td></td> <td>43.0848</td> <td>50.5648</td> <td>58.6432</td>               | 22    | 36.2032            |          | 43.0848  | 50.5648  | 58.6432          |  |  |  |  |  |  |
| 26         41.1400         44.9650         48.9600         57.4600         66.6400           26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.6536         77.3024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5482         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2966           36         59.2416         64.7496         70.5024         82.7424         95.9616           40         65.8240         71.9440 <td>23</td> <td></td> <td>41.3678</td> <td></td> <td></td> <td>61.3088</td>                            | 23    |                    | 41.3678  |          |          | 61.3088          |  |  |  |  |  |  |
| 26         42.7856         46.7636         50.9184         59.8584         69.3056           27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.6536         77.3024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5488         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2960           36         59.2416         64.7496         70.5024         82.7424         95.9616           40         65.8240         71.9440         78.3360         91.9360         106.6244           41         72.4064         79.1384 </td <td>24</td> <td>39.4944</td> <td>43.1664</td> <td>47.0016</td> <td>£5.1616</td> <td>63.9744</td> | 24    | 39.4944            | 43.1664  | 47.0016  | £5.1616  | 63.9744          |  |  |  |  |  |  |
| 27         44.4312         48.5622         52.8768         62.0568         71.9712           28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.6536         77.3024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5488         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2960           36         59.2416         64.7496         70.5024         82.7424         95.9614           40         65.8240         71.9440         78.3360         91.9360         106.6240           44         72.4064         79.1384         86.1096         101.1300         117.2860           45         78.9888         86.3328   | 25    | 41.1400            | 44.9650  | 48.9600  | 57.4600  | 66.6400          |  |  |  |  |  |  |
| 28         46.0768         50.3608         54.8352         64.3552         74.6368           29         47.7224         52.1594         56.7936         66.6536         77.3024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5488         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2966           36         59.2416         64.7496         70.5024         82.7424         95.9616           40         65.8240         71.9440         78.3360         91.9360         106.6240           44         72.4064         79.1384         86.1696         101.1300         117.2860           48         78.9888         86.3328         94.0032         110.3230         127.9490           54         88.8624         97.12   | 26    | 42.7856            | 46.7636  | 50.9184  | 59.8584  | 69. <b>3</b> 056 |  |  |  |  |  |  |
| 29         47.7224         52.1594         56.7936         66.6536         77.3024           30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5488         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2960           36         59.2416         64.7496         70.5024         82.7424         95.9616           40         65.8240         71.9440         78.3360         91.9360         106.6246           44         72.4064         79.1384         86.1696         101.1300         117.2860           48         78.9888         86.3328         94.0032         110.3230         127.9490           54         88.8624         97.1244         105.7540         124.1140         143.9420           60         98.73360         1   | 27    | 44.4312            | 48.5622  | 52.8768  | 62.0568  | 71.9712          |  |  |  |  |  |  |
| 30         49.3680         53.9580         58.7520         68.9520         79.9680           31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5488         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2960           36         59.2416         64.7406         70.5024         82.7424         95.9616           40         65.8240         71.9440         78.3360         91.9360         106.6240           44         72.4064         79.1384         86.1696         101.1300         117.2860           45         78.9888         86.3328         94.0032         110.3230         127.9440           46         88.8624         97.1244         105.7540         124.1140         143.9420           50         98.73360         107.9160         117.5040         137.9040         159.9360  | 28    | 46.0768            | 50.3608  | 54.8352  | 64.3552  | 74 . 6368        |  |  |  |  |  |  |
| 31         51.0136         55.7566         60.7104         71.2504         82.6336           32         52.6592         57.5552         62.6688         73.5488         85.2992           33         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2966           36         59.2416         64.7496         70.5024         82.7424         95.9616           40         65.8240         71.9440         78.3360         91.9360         106.6240           44         72.4064         79.1384         86.1696         101.1300         117.2860           48         78.9888         86.3328         94.0032         110.3230         127.9490           54         88.8624         97.1244         105.7540         124.1140         143.9420           60         98.7360         107.9160         117.5040         137.9040         159.9360  | 29    |                    | 52.1594  |          |          | 77.3024          |  |  |  |  |  |  |
| 32         52,6592         57,5552         62,6688         73,5488         85,2992           33         54,3048         59,3538         64,6272         75,8472         87,9648           34         55,9504         61,1524         66,5856         78,1456         90,6304           35         57,5960         62,9510         68,5440         80,4440         93,2960           36         59,2416         64,7496         70,5024         82,7424         95,9616           40         65,8240         71,9440         78,3360         91,9360         106,6246           44         72,4064         79,1384         86,1696         101,1300         117,2860           45         78,9888         86,3328         94,0032         110,3230         127,9490           54         88,8624         97,1244         105,7540         124,1140         143,9420           60         98,7360         107,9160         117,5040         137,9040         159,9360   | 30    | 49.3680            | 53.9580  | 58.7520  | 68.9520  | <b>7</b> 9.9680  |  |  |  |  |  |  |
| 35         54.3048         59.3538         64.6272         75.8472         87.9648           34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2960           36         59.2416         64.7496         70.5024         82.7424         95.9616           40         65.8240         71.9440         78.3360         91.9360         106.6240           44         72.4064         79.1384         86.1696         101.1300         117.2860           48         78.9888         86.3328         94.0032         110.3230         127.9490           54         88.8624         97.1244         105.7540         124.1140         143.9420           60         98.7360         107.9160         117.5040         137.9040         159.9360  | 31    |                    |          |          |          | 82.6336          |  |  |  |  |  |  |
| 34         55.9504         61.1524         66.5856         78.1456         90.6304           35         57.5960         62.9510         68.5440         80.4440         93.2966           36         59.2416         64.7496         70.5024         82.7424         95.9616           40         65.8240         71.9440         78.3360         91.9360         106.6240           44         72.4064         79.1384         86.1696         101.1300         117.2860           48         78.9888         86.3328         94.0032         110.3230         127.9490           54         88.8624         97.1244         105.7540         124.1140         143.9420           60         98.7360         107.9160         117.5040         137.9040         159.9360   | 32    |                    |          |          |          |                  |  |  |  |  |  |  |
| 35         57.5960         62.9510         68.5440         80.4440         93.2960           36         59.2416         64.7496         70.5024         82.7424         95.9616           40         65.8240         71.9440         78.3360         91.9360         106.6246           44         72.4064         79.1384         86.1696         101.1300         117.2860           45         78.9888         86.3328         94.0032         110.3230         127.9490           54         88.8624         97.1244         105.7540         124.1140         143.9420           60         98.7360         107.9160         117.5040         137.9040         159.9360  | 33    | 54.3048            |          |          |          |                  |  |  |  |  |  |  |
| 36         59.216         64.7496         70.5024         82.7424         95.9616           40         65.8240         71.9440         78.3360         91.9360         106.6240           44         72.4064         79.1384         86.1696         101.1300         117.2866           48         78.9888         86.3328         94.0032         110.3230         127.9490           54         88.8624         97.1244         105.7540         124.1140         143.9420           60         98.7360         107.9160         117.5040         137.9040         159.9360  | 34    | 55.9504            | 61.1524  | 66.5856  | 78.1456  | 90.6304          |  |  |  |  |  |  |
| 40         65.8240         71.9440         78.3360         91.9360         106.6240           44         72.4064         79.1384         86.1696         101.1300         117.2860           48         78.9888         86.3328         94.0032         110.3230         127.9490           54         88.8624         97.1244         105.7540         124.1140         143.9420           60         98.7360         107.9160         117.5040         137.9040         159.9360  | 35    | 57.5960            | 62.9510  | 68.5440  |          | 93.2960          |  |  |  |  |  |  |
| 44     72.4064     79.1384     86.1696     101.1300     117.2860       45     78.9888     86.3328     94.0032     110.3230     127.9490       54     88.8624     97.1244     105.7540     124.1140     143.9420       60     98.7360     107.9160     117.5040     137.9040     159.9360  | 36    | 59.2416            | 64.7496  |          |          | 95.9616          |  |  |  |  |  |  |
| 48     78.9888     86.3328     94.0032     110.3230     127.9490       54     88.8624     97.1244     105.7540     124.1140     143.9420       60     98.7360     107.9160     117.5040     137.9040     159.9360   | 40    | 65.8240            | 71.9440  |          |          | 106.6240         |  |  |  |  |  |  |
| <b>54</b> 88.8624 97.1244 105.7540 124.1140 143.9420 <b>60</b> 98.7360 107.9160 117.5040 137.9040 159.9860  | 44    | 72.4064            | 79.1384  | 86.1696  | 101.1300 | 117.2860         |  |  |  |  |  |  |
| <b>60</b> 98.7360 107.9160 117.5040 137.9040 159.9360   | 48    | 78.9888            | 86.3328  |          | 110.3230 | 127.9490         |  |  |  |  |  |  |
|   | 54    | 88.8624            | 97.1244  |          | 124.1140 | 143.9420         |  |  |  |  |  |  |
| <b>72</b> 118.4830 129.4990 141.0050 165.4850 191.9230  |       | 98.7360            | 107.9160 |          |          | 159.9360         |  |  |  |  |  |  |
|   | 72    | 118.4830           | 129.4990 | 141.0050 | 165.4850 | 191.9230         |  |  |  |  |  |  |

72

220.32

Table 65 (Continued)

#### Capacity of Cylinders in United States Gallons

Diameter in Inches Depth. 30 82 34 36 40 Inches 1 3.06 3.4816 3.9304 4.4064 5.44 2 6.12 6.9632 7.8608 8.8128 10.88 3 9.18 10.4448 11.7912 13.2192 16.32 17.6256 12.24 13.9264 15.7216 21.76 5 15.30 17.4080 19.6520 22.5320 27.20 18.36 20.8896 23.5824 26.4384 32.64 7 21.42 24.3712 27.5128 30.8448 38.08 31.4432 35.2512 43.52 8 24.48 27.8528 27.54 31.3344 35.3736 39.6576 48.96 10 30.60 34.8160 39.3040 44.0640 54.40 11 38.2976 43.2344 48.4704 59.84 33.66 12 36.72 41.7792 47.1648 52.8768 65.2857.2832 70.72 13 39.78 45.2608 51.0952 48.7424 55.0256 61.6896 76.16 14 42.84 15 45.90 52.2240 58.9560 66.0960 81.60 16 48.96 55.7056 62.8864 70.5024 87.04 17 52.02 59.1872 66.8168 74.9088 92.48 70.7472 79.3152 97.92 18 55.08 62.6688 83.7216 19 66.1504 74.6776 103.36 58.14 20 61.20 69.6320 78.6080 88.1280 108.80 21 64.26 73.1136 82.5384 92.5344 114.24 96.9408 22 67.32 76.5952 86.4688 119.68 23 70.38 80.0768 90.3992 101.3470 125.12 83.5584 94.3296 105.7540 130.56 24 73.44 98.2600 76.50 87.0400 110.1600 136.00 25 114.5660 79.56 90.5216 102.1900 141.44 26 118.9730 27 82.62 94.0032 106.1210 146.88 28 85.68 97.4848 110.0510 123.3790 152.32 127.7860 157.76 29 88.74 100.9660 113.9820 163.20 117.9120 132.1920 20 91.80 100.4480 168.64 81 94.86 107.9300 121.8420 136.5980 141.0050 174.08 32 97.92 111.4110 125.7730 145.4110 179.52 33 100.98 114.8930 129.7030 84 104.04 118.3740 133.6440 149.8180 184.96 190.40 35 107.10 121.8560 137.5640 154.2240 195.84 36 125.3380 141.4944 158.6300 110.16 157.2160 176.2560 217.60 40 122.04 139.2640 44 172.9380 193.8820 239.36 134.64 153.1900 261.12 48 167.1170 188.6590 211.5070 146.88 237.9460 293.76 54 165.24 188.0060 212.2420 264.3840 60 183.60 208.8960 235.8240 326.40

NOTE.—This table on heavy cardboard 11 × 14 ins., eyeletted, \$0.25.

282.9890

317.2610

391.68

250.6750

Table 65 (Continued)

# Capacity of Cylinders in United States Gallons

Diameter in Inches

| Denth            |          |                  |                 |        |                |
|------------------|----------|------------------|-----------------|--------|----------------|
| Depth,<br>Inches | 44       | 48               | 54              | 60     | 72             |
| 1                | 6.5824   | 7.8336           | 9.9144          | 12.24  | 17.6256        |
| 2                | 13.1648  | 15.6672          | 19.8288         | 24.48  | 35.2512        |
| . 3              | 19.7472  | 23.5008          | 29.7432         | 36.72  | <b>52.8768</b> |
| 4                | 26.3296  | 31.3344          | 39.6576         | 44.96  | 70.5024        |
| 5                | 32.9120  | 39.1680          | 49.5720 -       | 61.20  | 88.1280        |
| 6                | 39.4944  | 47.0016          | <b>59.4</b> 864 | 73.44  | 105.7540       |
| 7                | 46.0768  | 54.8352          | 69.4008         | 85.68  | 123.3790       |
| 8                | 52.6592  | 62.6688          | 79.3152         | 97.92  | 141.0050       |
| 9                | 59.2416  | 70.5024          | 89.2296         | 110.16 | 158.6300       |
| 10               | 65.8240  | 78.3360          | 99.1440         | 122.40 | 176.2560       |
| 11               | 72.4064  | 86.1696          | 109.0580        | 134.64 | 193.8820       |
| 12               | 78.9888  | 94.0032          | 118.9730        | 146.88 | 211.5070       |
| 13               | 85.5712  | 101.837 <b>0</b> | 128.8870        | 159.12 | 229.1330       |
| 14               | 92.1536  | 109.6700         | 138.8020        | 171.36 | 246.7580       |
| 15               | 98.7360  | 117.5040         | 148.7160        | 183.60 | 264.3840       |
| 16               | 105.3180 | 125.3380         | 158.6300        | 195.84 | 282.0100       |
| 17               | 111.9010 | 133.1710         | 168.5450        | 208.08 | 299.6350       |
| 18               | 118.1830 | 141.0050         | 178.4590        | 220.32 | 317.2610       |
| 19               | 125.0660 | 148.8380         | 188.3740        | 232.56 | 334.8860       |
| 20               | 131.6480 | 156.6720         | 198.2880        | 244.80 | 352.5120       |
| 21               | 138.2300 | 164.5060         | 208.2020        | 257.04 | 370.1380       |
| 22               | 144.8130 | 172.3390         | 218.1170        | 269.28 | 387.7630       |
| 23               | 151.3950 | 180.1730         | 228.0310        | 281.52 | 405.3890       |
| 24               | 157.9780 | 188.0060         | 237.9460        | 293.76 | 423.0140       |
| 25               | 164.5600 | 195.8400         | 247.8600        | 306.00 | 440.6400       |
| 26               | 171.1420 | 203.6740         | 257.7740        | 318.24 | 458.2660       |
| 27               | 177.7250 | 211.5070         | 267.6890        | 330.48 | 475.8910       |
| 28               | 184.3070 | 219.3410         | 277.6030        | 342.72 | 493.5170       |
| 29               | 190.8900 | 227.1740         | 287.5180        | 354.96 | 511.1420       |
| 30               | 197.4720 | 235.0080         | 297.4320        | 367.20 | 528.7680       |
| 31               | 204.0540 | 242.8420         | 307.3460        | 379.44 | 546.3940       |
| 32               | 210.6370 | 250.6750         | 317.2610        | 391.68 | 564.0190       |
| 33               | 217.2190 | 258.5090         | 327.1750        | 403.92 | 581.6450       |
| 34               | 223.8020 | 266.3420         | 337.0900        | 416.16 | 599.2700       |
| 35               | 230.3840 | 274.1760         | 347.0040        | 428.40 | 616.8960       |
| 36               | 236.9660 | 282.0100         | 356.9180        | 440.64 | 634.5220       |
| 40               | 263.2960 | 313.3440         | 396.5760        | 489.60 | 705.0240       |
| 44               | 289.6260 | 344.6780         | 436.2340        | 538.56 | 775.5260       |
| 48               | 315.9550 | 376.0130         | 475.8910        | 587.52 | 846.0290       |
| 54               | 355.4500 | 423.0140         | 535.3780        | 660.96 | 951.7820       |
| 60               | 394.9440 | 470.0160         | 594.8640        | 734.40 | 1057.5400      |
| 72               | 473.9330 | 564.0190         | 713.8370        | 881.28 | 1269.0400      |
|                  |          |                  |                 |        |                |

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Table 65 (Continued)

#### Capacity of Cylinders in United States Gallons

| Depth | Diameter in Feet |       |       |               |       |        |        |        |  |  |  |
|-------|------------------|-------|-------|---------------|-------|--------|--------|--------|--|--|--|
| Feet  | 5                | 6     | 7.    | 8 •           |       | 10     | 11     | 12     |  |  |  |
| 5     | 735              | 1,060 | 1,440 | 1,875         | 2,380 | 2,925  | 3,550  | 4,23   |  |  |  |
| 6     | 881              | 1,270 | 1,728 | 2,250         | 2,855 | 3,510  | 4,260  | 5,08   |  |  |  |
| 7     | 1,028            | 1,480 | 2,016 | 2,625         | 3,330 | 4,095  | 4,970  | 5,93   |  |  |  |
| 8     | 1,175            | 1,690 | 2,304 | 3,000         | 3,805 | 4,680  | 5,680  | 6,77   |  |  |  |
| •     | 1,322            | 1,900 | 2,592 | 3,375         | 4,280 | 5,265  | 6,390  | 7,62   |  |  |  |
| 10    | 1,469            | 2,110 | 2,880 | 3,750         | 4,755 | 5,850  | 7,100  | 8,47   |  |  |  |
| 11    | 1,616            | 2,320 | 3,168 | 4,125         | 5,250 | 6,435  | 7,810  | 9,319  |  |  |  |
| 12    | 1,762            | 2,530 | 3,456 | 4,500         | 5,705 | 7,020  | 8,520  | 10,160 |  |  |  |
| 18    | 1,909            | 2,740 | 3,744 | 4,875         | 6,180 | 7,605  | 9,230  | 11,01  |  |  |  |
| 14    | 2,056            | 2,950 | 4,032 | 5,250         | 6,655 | 8,190  | 9,940  | 11,86  |  |  |  |
| 15    | 2,203            | 3,160 | 4,320 | 5,6 <b>25</b> | 7,130 | 8,775  | 10,650 | 12,70  |  |  |  |
| 16    | 2,356            | 3,370 | 4,608 | 6,000         | 7,605 | 9,360  | 11,360 | 13,55  |  |  |  |
| 17    | 2,497            | 3,580 | 4,896 | 6,375         | 8,080 | 9,945  | 12,070 | 14,40  |  |  |  |
| 18    | 2,644            | 3,790 | 5,184 | 6,750         | 8,535 | 10,530 | 12,780 | 15,24  |  |  |  |
| 19    | 2,791            | 4,000 | 5,472 | 7,125         | 9,010 | 11,115 | 13,490 | 16,09  |  |  |  |
| 20    | 2.938            | 4.210 | 5,760 | 7,500         | 9.490 | 11,700 | 14.200 | 16.94  |  |  |  |

|   | Depth      |        |        | T      | Jiameter | in Feet |        |        |        |
|---|------------|--------|--------|--------|----------|---------|--------|--------|--------|
|   | in<br>Feet | 13     | 14     | 15     | 16       | 18      | 20     | 22     | 24     |
| • | 5 ,        | 4,960  | 5,765  | 6,698  | 7,520    | 9,516   | 11,750 | 14,215 | 16,918 |
|   | 6          | 5,952  | 6,918  | 8,038  | 9,024    | 11,419  | 14,100 | 17,059 | 20,302 |
|   | 7          | 6,944  | 8,071  | 9,378  | 10,528   | 13,322  | 16,450 | 19,902 | 23,680 |
|   | 8          | 7,936  | 9,224  | 10,718 | 12,032   | 15,225  | 18,800 | 22,745 | 27,070 |
|   | •          | 8,928  | 10,377 | 12,058 | 13,536   | 17,128  | 21,150 | 25,588 | 30,454 |
|   | 10         | 9,920  | 11,530 | 13,398 | 15,050   | 19,031  | 23,500 | 28,431 | 33,838 |
|   | 11         | 10,913 | 12,683 | 14,738 | 16,544   | 20,934  | 25,850 | 31,274 | 37,222 |
|   | 12         | 11,904 | 13,836 | 16,078 | 18,048   | 22,837  | 28,200 | 34,117 | 40,606 |
|   | 13         | 12,896 | 14,989 | 17,418 | 19,552   | 24,740  | 30,550 | 36,960 | 43,990 |
|   | 14         | 13,888 | 16,142 | 18,758 | 21,056   | 26,643  | 32,900 | 39,803 | 47,374 |
|   | 15         | 14,880 | 17,295 | 20,098 | 22,260   | 28,546  | 35,250 | 42,646 | 50,758 |
|   | 16         | 15,872 | 18,448 | 21,438 | 26,064   | 30,449  | 37,600 | 45,489 | 54,142 |
|   | 17         | 16,864 | 19,601 | 22,778 | 25,568   | 32,352  | 39,950 | 48,332 | 57,520 |
|   | 18         | 17,856 | 20,754 | 24,118 | 27,072   | 34,255  | 42,300 | 51,175 | 60,910 |
|   | 19         | 18,848 | 21,907 | 25,458 | 28,576   | 36,158  | 44,650 | 54,018 | 64,294 |
|   | 20         | 19,840 | 23,060 | 26,798 | 30,080   | 38,062  | 47,000 | 56,861 | 67,678 |
|   |            |        |        |        |          |         |        |        |        |

Diameter in Fost

To find the number of gallons in a tank of unequal diameter multiply the inside bottom diameter in inches by the inside top diameter in inches, then this product by 34: point off four figures and the result will be the average number of gallons to one inch in depth of the tank.

TABLE 66

# Number of U. S. Gallons in Rectangular Tanks One Foot in Depth

| Width      | Length of Tank in Feet |      |         |        |           |        |          |          |        |        |        |        |
|------------|------------------------|------|---------|--------|-----------|--------|----------|----------|--------|--------|--------|--------|
| Feet       | 2                      | 2    | . 5     | 3      | 3.5       | 4      | 4.5      | 5        | 5.5    | 6      | 6.5    | 7      |
| 2          | 29.92                  | 37   | .40 4   | 4.88   | 52.30     | 3 59.8 | 67.32    |          |        |        |        | 104.73 |
| 2.5        |                        | 46   | .75 5   |        |           |        |          |          |        |        |        | 130.91 |
| 3          |                        |      |         |        | 78.54     |        |          |          |        |        |        | 157.09 |
| 3.5        |                        |      |         |        | 91.64     |        | 117.82   |          |        |        |        |        |
| 4          |                        |      |         |        |           |        |          |          |        |        |        | 209.45 |
| 4.5        |                        |      |         |        |           |        | . 151.48 |          |        |        |        |        |
| 5          |                        |      |         |        |           |        |          | 187.01   |        |        |        |        |
| 5.5        |                        |      |         |        |           |        |          |          |        | 246.86 |        |        |
| 6          |                        |      |         |        |           |        |          |          |        | 269.30 | 291.74 | 314.18 |
| 6.5        |                        |      |         |        |           |        |          |          |        |        | 316.05 | 340.36 |
| 7          |                        |      | · · · · |        | • • • • • |        |          |          |        |        | •••••  | 366.54 |
| Width      | 1                      |      |         |        |           | Len    | gth of T | ank in l | Feet   |        |        |        |
| in<br>Feet | 7.                     | .5   |         |        | 8.5       | 9      | 9.5      | 10       | 10.5   | 11     | 11.5   | 12     |
| 2          | 112                    | .21  | 119.0   | 39 .13 | 27.17     | 134.65 | 142_13   | 149.61   | 157.09 | 164.57 | 172.05 | 179.53 |
| 2.5        | 140                    | . 26 | 149.0   | 81 1   | 8.96      | 168.31 | 177.66   | 187.01   | 196.36 | 205.71 | 215.06 | 224.41 |
| 3          | 168                    | .31  | 179.    | 53 19  | 0.75      | 202.97 | 213.19   | 224.41   | 235.63 | 246.86 | 258.07 | 269.30 |
| 3.5        | 196                    | . 36 | 209.4   | 15 22  | 2.54      | 235.63 | 248.73   | 261.82   | 274.90 | 288.00 | 301.09 | 314.18 |
| 4          | 224                    | .41  | 239.3   | 37 2   | 4.34      | 269.30 | 284.26   | 299.22   | 314.18 | 329.14 | 344.10 | 359.06 |
| 4.5        | <b>2</b> 52            | .47  | 269.3   | 30 28  | 6.13      | 302.96 | 319.79   | 336.62   | 353.45 | 370.28 | 387.11 | 403.94 |
| 5          | 280                    | . 52 | 299.2   | 22 31  | 7.92      | 336.62 | 355.32   | 374.03   | 392.72 | 411.43 | 430.13 | 448.83 |
| 5.5        | 308                    | . 57 | 329.1   | [4 34  | 9.71      | 370.28 | 390.85   | 411.43   | 432.00 | 452.57 | 473.14 | 493.71 |
| 6          | 336                    | . 62 | 359.0   | 6 38   | 31.50     | 403.94 | 426.39   | 448.83   | 471.27 | 493.71 | 516.15 | 538.59 |
| 6.5        | 364                    | . 67 | 388.9   | 98 41  | 3.30      | 437.60 | 461.92   | 486.23   | 510.54 | 534.85 | 559.16 | 583.47 |
| 7          | 392                    | .72  | 418.9   | 1 44   | 5.09      | 471.27 | 497.45   | 523.64   | 549.81 | 575.99 | 602.18 | 628.36 |
| 7.5        | 420                    | .78  | 448.8   | 33 47  | 6.88      | 504.93 | 532.98   | 561.04   | 589.08 | 617.14 | 645.19 | 673.24 |
| 8          |                        |      | 478.    | 75 50  | 8.67      | 538.59 | 568.51   | 598.44   | 628.36 | 658.28 | 688.20 | 718.12 |
| 8.5        |                        |      |         | 54     | 10.46     | 572.25 | 604.05   | 635.84   | 667.63 | 699.42 | 731.21 | 763.00 |
| 9          |                        |      |         |        |           | 605.92 | 639.58   | 673.25   | 706.90 | 740.56 | 774.23 | 807.89 |
| 9.5        |                        |      |         |        |           |        | 675.11   | 710.65   | 746.17 | 781.71 | 817.24 | 852.77 |
| 10         |                        |      |         |        |           |        |          | 748.05   | 785.45 | 822.86 | 860.26 | 897.66 |
| 10.5       |                        |      |         |        |           |        |          |          |        |        |        | 942.56 |
| 11         |                        |      |         |        |           |        |          |          |        | 905.14 |        | 987.43 |
| 11.5       |                        |      |         |        |           |        |          |          |        |        | 989.29 | 1032.3 |
| 12         |                        |      |         |        |           |        |          |          |        |        |        | 1077.2 |

Example.—To find number of gallons in a rectangular tank that is 7.5 feet by 10 feet, the water being 4 feet deep: Look in extreme left-hand column for 7.5, and opposite to this in column headed 10 read 561.04, which being multiplied by 4, the depth of water in the tank, gives 2244.2, the number of gallons required.

Table 67
Capacity of Cylinders in Imperial Gallons

Diameter in Inches

| Depth,<br>Inches | 4      | 5      |       |               |         |                |         |
|------------------|--------|--------|-------|---------------|---------|----------------|---------|
| Inches           |        | •      | 6     | 7             | 8       | 9              | 10      |
| 1                | .0453  | .0708  | .102  | . 1388        | .1814   | .2295          | . 2833  |
| 2                | .0906  | .1416  | .204  | .2776         | .3628   | .4590          | . 5666  |
| 8                | . 1359 | .2124  | .306  | .4164         | .5442   | .6885          | . 8499  |
| 4                | .1812  | .2832  | .408  | .5552         | .7256   | .9180          | 1.1332  |
| 5                | .2265  | .3540  | .510  | . 6940        | .9070   | 1.1475         | 1.4165  |
| 6                | .2718  | .4248  | .612  | .83 <b>28</b> | 1.0884  | 1.3770         | 1.6998  |
| 7                | .3171  | .4956  | .714  | .9716         | 1.1698  | 1.6065         | 1.9831  |
| 8                | .3624  | . 5664 | .816  | 1.1104        | 1.4512  | 1.8360         | 2.2664  |
| 9                | .4077  | .6372  | .918  | 1.2492        | 1.6326  | 2.0655         | 2.5497  |
| 10               | .4530  | .7080  | 1.020 | 1.3880        | 1.8140  | 2.2050         | 2.8330  |
| 11               | .4983  | .7788  | 1.122 | 1.5268        | 1.9954  | 2.5245         | 3.1163  |
| 12               | . 5436 | .8496  | 1.224 | 1.6656        | 2.1768  | 2.7540         | 3.3996  |
| 13               | .5889  | .9204  | 1.326 | 1.8044        | 2.3582  | 2.9835         | 3.6829  |
| 14               | .6342  | .9912  | 1.428 | 1.9432        | 2.3396  | 3.2130         | 3.9662  |
| 15               | .6795  | 1.0620 | 1.530 | 2.0820        | 2.7210  | 3.4425         | 4.2495  |
| 16               | .7248  | 1.1328 | 1.632 | 2.2208        | 2.9024  | 3.6720         | 4.5328  |
| 17               | .7701  | 1.2036 | 1.734 | 2.3596        | 3.0838  | 3.9015         | 4.8161  |
| 18               | .8154  | 1.2744 | 1.836 | 2.4984        | 3.2652  | 4.1310         | 5.0994  |
| 19               | .8607  | 1.3452 | 1.938 | 2.6372        | 3.4466  | 4.3605         | 5.3827  |
| 20               | .9060  | 1.4160 | 2.040 | 2.7760        | 3.6280  | 4.5900         | 5.6660  |
| 21               | .9513  | 1.4868 | 2.142 | 2.9148        | 3.5094  | 4.8195         | 5.9493  |
| 22               | .9966  | 1.5576 | 2.244 | 3.0536        | 3.9908  | 5.0490         | 6.2326  |
| 28               | 1.0419 | 1.6284 | 2.346 | 3.1924        | 4.1722  | 5. <b>2785</b> | 6.5159  |
| 24               | 1.0872 | 1.6992 | 2.448 | 3.3312        | 4.3536  | 5.5080         | 6.7992  |
| 25               | 1.1325 | 1.7700 | 2.550 | 3.4700        | 4.5350  | 5.7375         | 7.0825  |
| 26               | 1.1778 | 1.8408 | 2.652 | 3.6088        | 4.7164  | 5.9670         | 7.3658  |
| 27               | 1.2231 | 1.9116 | 2.754 | 3.7476        | 4.8978  | 6.1965         | 7.6491  |
| 28               | 1.2684 | 1.9824 | 2.856 | 3.8864        | 4.6792  | 6.4260         | 7.9324  |
| 29               | 1.3137 | 2.0532 | 2.958 | 4.0252        | 5.2606  | 6.6555         | 8.3057  |
| 30               | 1.3590 | 2.1240 | 3.060 | 4.1640        | 5.4420  | 6.8850         | 8.4990  |
| 31               | 1.4043 | 2.1948 | 3.162 | 4.3028        | 5.6234  | 7.1145         | 8.7823  |
| 32               | 1.4496 | 2.2656 | 3.264 | 4.4416        | 5.8048  | 7.3440         | 9.0656  |
| 33               | 1.4949 | 2.3364 | 3.366 | 4.5804        | 5.9862  | 7.5735         | 9.3489  |
| 34               | 1.5402 | 2.4072 | 3.468 | 4.7192        | 6.1676  | 7.8030         | 9.6322  |
| 35               | 1.5855 | 2.4780 | 3.570 | 4.8580        | 6.3490  | 8.0325         | 9.9155  |
| 36               | 1.6308 | 2.5488 | 3.672 | 4.9968        | 6.5304  | 8.2620         | 10.1988 |
| 40               | 1.8120 | 2.8320 | 4.080 | 5.5520        | 7.2560  | 9.1800         | 11.3320 |
| 44               | 1.9932 | 3.1152 | 4.489 | 6.1072        | 7.9816  | 10.0980        | 12 4652 |
| 48               | 2.1744 | 3.3984 | 4.896 | 6.6624        | 8.7072  | 11.0160        | 13 5984 |
| 54               | 2.4462 | 3.8232 | 5.508 | 7.4952        | 9.7956  | 12.3930        | 15.2982 |
| 60               | 2.7180 | 4.2480 | 6.120 | 8.3280        | 10.8840 | 13.7700        | 16.2980 |
| 72               | 3.2616 | 5.0976 | 7.344 | 9.9936        | 13.0608 | 16.5240        | 20.3976 |

This table gives number of Imperial gallons (277.274 inches) in cylindrical vessels from 1 to 72 inches in depth and from 4 to 72 inches in diameter.

TABLE 67 (Continued)

#### Capacity of Cylinders in Imperial Gallons

| Depth,     |         | Diameter in Inches |         |         |         |         |  |  |  |  |  |
|------------|---------|--------------------|---------|---------|---------|---------|--|--|--|--|--|
| Inches     | 11      | 12                 | 18      | 14      | 15      | 16      |  |  |  |  |  |
| 1          | .3428   | .4080              | .4788   | . 5553  | .6375   | .7253   |  |  |  |  |  |
| 2          | .6856   | .8160              | .9576   | 1.1106  | 1.2750  | 1.4506  |  |  |  |  |  |
| 3          | 1.0284  | 1.2240             | 1.4364  | 1.6659  | 2.0125  | 2.1759  |  |  |  |  |  |
| 4          | 1.3712  | 1.6320             | 1.9152  | 2.2212  | 2.5500  | 2.9012  |  |  |  |  |  |
| 5          | 1.7140  | 2.0400             | 2.3940  | 2.7765  | 3.1875  | 3.6265  |  |  |  |  |  |
| . <b>6</b> | 2.0568  | 2.4480             | 2.8728  | 3.3318  | 3.8250  | 4.3518  |  |  |  |  |  |
| 7          | 2.3996  | 2.8560             | 3.3516  | 3.8871  | 4.3625  | 5.0771  |  |  |  |  |  |
| 8          | 2.7424  | 3.2640             | 3.8304  | 4.4424  | 5.1000  | 5.8024  |  |  |  |  |  |
| 9          | 3.0852  | 3.6720             | 4.3092  | 4.9977  | 5.7375  | 6.5277  |  |  |  |  |  |
| 10         | 3.4280  | 4.0800             | 4.7880  | 5.5530  | 6.3750  | 7.2530  |  |  |  |  |  |
| 11         | 3.7708  | 4.4880             | 5.2668  | 6.1083  | 7.0125  | 7.9783  |  |  |  |  |  |
| 12         | 4.1136  | 4.8960             | 5.7456  | 6.6636  | 7.6500  | 8.7036  |  |  |  |  |  |
| 13         | 4.4564  | 5.3040             | 6.2244  | 7.2189  | 8.2875  | 9.4289  |  |  |  |  |  |
| 14         | 4.7992  | 5.7120             | 6.7032  | 7.7742  | 8.7250  | 10.1542 |  |  |  |  |  |
| 15         | 5.1420  | 6.1200             | 7.1820  | 8.3295  | 9.5625  | 10.8795 |  |  |  |  |  |
| 16         | 5.4848  | 6.5280             | 7.6608  | 8.8848  | 10.2000 | 11.6048 |  |  |  |  |  |
| 17         | 5.8276  | 6.9360             | 8.1396  | 9.4401  | 10.8375 | 12.3301 |  |  |  |  |  |
| 18         | 6.1704  | 7.3440             | 8.6184  | 9.9954  | 11.4750 | 13.0554 |  |  |  |  |  |
| 19         | 6.5132  | 7.7520             | 9.0972  | 10.5507 | 12.1125 | 13.7807 |  |  |  |  |  |
| 20         | 6.8560  | 8.1600             | 9.5760  | 11.1060 | 12.7500 | 14.5060 |  |  |  |  |  |
| 21         | 7.1988  | 8.5680             | 10.0548 | 11.6613 | 13.0875 | 15.2313 |  |  |  |  |  |
| 22         | 7.5416  | 8.9760             | 10.5336 | 12.2166 | 14.0250 | 15.9566 |  |  |  |  |  |
| 23         | 7.8844  | 9.3840             | 11.0124 | 12.7719 | 14.6625 | 16.6819 |  |  |  |  |  |
| 24         | 8.2272  | 9.7920             | 11.4912 | 13.3272 | 15.3000 | 17.4072 |  |  |  |  |  |
| 25         | 8.5700  | 10.2000            | 11.9700 | 13.8825 | 15.9375 | 18.1325 |  |  |  |  |  |
| 26         | 8.9128  | 10.6080            | 12.4488 | 14.4378 | 16.5750 | 18.8578 |  |  |  |  |  |
| 27         | 9.2556  | 11.0160            | 12.9276 | 14.9931 | 17.2125 | 19.5831 |  |  |  |  |  |
| 28         | 9.5984  | 11.4240            | 13.4064 | 15.5484 | 17.4500 | 20.3084 |  |  |  |  |  |
| 29         | 9.9412  | 11.8320            | 13.8852 | 16.1037 | 18.4875 | 21.0337 |  |  |  |  |  |
| 30         | 10.2840 | 12.2400            | 14.3640 | 16.6590 | 20.1250 | 21.7590 |  |  |  |  |  |
| 81         | 10.6268 | 12.6480            | 14.8428 | 17.2143 | 19.7625 | 22.4843 |  |  |  |  |  |
| 32         | 10.9696 | 13.0560            | 15.3216 | 17.7696 | 20.4000 | 23.2096 |  |  |  |  |  |
| 33         | 11.3124 | 13.4640            | 15.8004 | 18.3249 | 21.0375 | 23.9349 |  |  |  |  |  |
| 34         | 11.6552 | 13.8720            | 16.2792 | 18.8802 | 21.6750 | 24.6602 |  |  |  |  |  |
| 35         | 11.9980 | 14.2800            | 16.7580 | 19.4355 | 21.8125 | 25.3855 |  |  |  |  |  |
| 86         | 12.3408 | 14.6880            | 17.2368 | 19.9908 | 22.9500 | 26.1108 |  |  |  |  |  |
| 40         | 13.7120 | 16.3200            | 19.1520 | 22.2120 | 25.5000 | 29.0120 |  |  |  |  |  |
| 44         | 15.0832 | 17.9520            | 21.0672 | 24.4332 | 28.0500 | 31.9132 |  |  |  |  |  |
| 48         | 16.4544 | 19.5840            | 22.9824 | 26.6544 | 30.6000 | 34.8144 |  |  |  |  |  |
| 54         | 18.5112 | 22.0320            | 25.8552 | 29.9862 | 34.4250 | 39.1702 |  |  |  |  |  |
| . 60       | 20.5680 | 24.4800            | 28.7280 | 33.3180 | 38.2500 | 43.5180 |  |  |  |  |  |
| 72         | 24.6816 | 29.3760            | 34.4736 | 39.9816 | 45.9000 | 52.2216 |  |  |  |  |  |

This table gives the number of Imperial gallons (277.274 inches) in cylindrical vessels from 1 to 62 inches in depth and from 4 to 72 inches in diameter

#### Table 67 (Continued)

#### Capacity of Cylinders in Imperial Gallons

|                  |         | •              |          | •         |                |                |
|------------------|---------|----------------|----------|-----------|----------------|----------------|
| Depth,<br>Inches |         |                | Diameter | in Inches |                |                |
|                  | 17      | 18             | 19       | 20        | 21             | 24             |
| 1                | .8188   | .9180          | 1.0228   | 1.1333    | 1.2495         | 1.632          |
| 2                | 1.6376  | 1.8360         | 2.0456   | 2.2666    | 2.4990         | 3.264          |
| 3                | 2.4564  | 2.7540         | 3.0684   | 3.3999    | 3.7485         | 4.986          |
| 4                | 3.2752  | 3.6720         | 4.0912   | 4.5332    | 4.9980         | 6.528          |
| 5                | 4.0940  | 4.5900         | 5.1140   | 5.6665    | 6.2475         | 8.160          |
| 6                | 4.9128  | 5.5080         | 6.1368   | 6.7998    | 7.4970         | 9.792          |
| 7                | 5.7316  | 6.4260         | 7.1596   | 7.9331    | 8.7465         | 11.424         |
| 8                | 6.5504  | 7.3440         | 8.1824   | 9.0664    | 9.9960         | 13.056         |
| •                | 7.3692  | 8.2620         | 9.2052   | 10.1997   | 11.2455        | 14.688         |
| 10               | 8.1880  | 9.1800         | 10.2280  | 11.3330   | 12.4950        | 16.320         |
| 11               | 9.0068  | 10.0980        | 11.2518  | 12.4663   | 13.7445        | 17.952         |
| 12               | 9.8256  | 11.0160        | 12.2736  | 13.5996   | <b>14.9940</b> | 19.584         |
| 13               | 10.6444 | 11.9340        | 13.2964  | 14.7329   | 16.2435        | 21.216         |
| 14               | 11.4632 | 12.8520        | 14.3192  | 15.8662   | 17.4930        | 22.848         |
| 15               | 12.2820 | 13.7700        | 15.3420  | 16.9995   | 18.7425        | 24.480         |
| 16               | 13.1008 | 14.6880        | 16.3648  | 18.1328   | 19.9920        | 26.112         |
| 17               | 13.9196 | 15.6060        | 17.3876  | 19.2661   | 21.2415        | 27. <b>744</b> |
| 18               | 14.7384 | 16.5240        | 18.4104  | 20.3994   | 22.4910        | 29.376         |
| 19               | 15.5572 | 17.4420        | 19.4332  | 21.5327   | 23.7405        | 31.008         |
| 20               | 16.3760 | 18.3600        | 20.4560  | 22.6660   | 24.9900        | 32.640         |
| 21               | 17.1948 | 19.2780        | 21.4788  | 23.7993   | 26.2395        | 34.272         |
| 22               | 18.0136 | 20.1960        | 22.5036  | 24.9326   | 27.4890        | 35.904         |
| 23               | 18.8324 | 21.1140        | 23.5244  | 26.0659   | <b>28.7385</b> | 37.536         |
| 24               | 19.6512 | 22.0320        | 24.5472  | 27.1992   | 29.9880        | <b>39</b> .168 |
| 25               | 20.4700 | 22.9500        | 25.5700  | 28.3325   | 31.2375        | 40.800         |
| 26               | 21.2888 | 23.8680        | 26.5928  | 29.4658   | 32.4870        | 42.432         |
| 27               | 22.1076 | 24.7860        | 27.6156  | 30.5991   | 33.7365        | 44.064         |
| 28               | 22.9264 | <b>25.7040</b> | 28.6384  | 31.7324   | 34.9860        | 45.696         |
| 29               | 23.7452 | 26.6220        | 29.6612  | 32.8657   | 36.2355        | 47.328         |
| 30               | 24.5640 | 27.5400        | 30.6840  | 33.9990   | 37.4850        | 48.960         |
| 31               | 25.3828 | 28.4580        | 31.7068  | 35.1323   | 38.7345        | 50.592         |
| 32               | 26.2016 | 29.3760        | 32.7296  | 36.2656   | 39.9840        | 52.224         |
| 33               | 27.0204 | 30.2940        | 33.7554  | 37.3989   | 41.2335        | 53.85β         |
| 34               | 27.8392 | 31.2120        | 34.7752  | 38.5322   | 42.4830        | 55.488         |
| 35               | 28.6580 | 32.1300        | 35.7980  | 39.6655   | 43.7325        | 57.120         |
| 36               | 29.4768 | 33.0480        | 36 8208  | 40.7988   | 44.9820        | 58.752         |
| 40               | 32.7520 | 36.7200        | 40.9120  | 45.3320   | 49.9800        | 65.280         |
| 44               | 36.0272 | 40.3920        | 45.0072  | 49.8652   | 54.9780        | 71.808         |
| 48               | 39.3024 | 44.0640        | 45.0944  | 54.6384   | 59.9760        | 78.336         |
| 54               | 44.2152 | 49.5720        | 55.2312  | 61.1982   | 67.4730        | 88.128         |
| 60               | 49.1280 | 55.0800        | 61.3680  | 67.9980   | 74.9700        | 97.920         |
| 72               | 58.9536 | 66.0960        | 73.6416  | 81.5976   | 89.9640        | 117.504        |
|                  |         |                |          |           |                |                |

This table gives the number of Imperial gallons (277.274 inches) in cylindrical vessels from 1 to 72 inches in depth and from 4 to 72 inches in diameter.

#### USEFUL TABLES

## Table 67 (Continued)

# Capacity of Cylinders in Imperial Gallons

Diameter in Inches

| Depth,<br>Inches | 30            | 36      | 40                | 48                 | 60             | 72                 |
|------------------|---------------|---------|-------------------|--------------------|----------------|--------------------|
| 1                | 2.55          | 3.672   | 4.5333            | 6.528              | 10.2           | 14.688             |
| 2                | 5.10          | 7.344   | 9.0666            | 13.056             | 20.4           | 29.376             |
| 3                | 7.65          | 11.016  | 13.5999           | 19.584             | 30.6           | 44.064             |
| 4                | 10.20         | 14.688  | 18.1332           | 26.112             | 40.8           | 58.752             |
| 5                | <b>12</b> .75 | 18.360  | 22.6665           | 32.640             | 51.0           | 73.440             |
| 6                | 15.30         | 22.032  | 27.1998           | 39.168             | 61,2           | 88.128             |
| 7                | 17.85         | 25.704  | 31.7331           | 45.696             | 71.4           | • 102.816          |
| 8                | 20.40         | 29.376  | 36.2664           | 52.224             | 81.6           | 117.504            |
| 9                | 22.95         | 33.048  | 40.7997           | 58.752             | 91.8           | 132.192            |
| 10               | 25.50         | 36.720  | 45.3330           | 65.280             | 102.0          | 146.880            |
| 11               | 28.05         | 40.392  | 49.8663           | 71.808             | 112.2          | 161.568            |
| 12               | 30.60         | 44.064  | 54.3996           | 78.336             | 122.4          | 176.256            |
| 18               | 33.15         | 47.736  | 58.9329           | 84.864             | 132.6          | 190.944<br>205.632 |
| 14               | 35.70         | 51.408  | 63.4662           | 91.382             | 142.8          | 205.632            |
| 15               | 38.25         | 55.080  | 67.9995           | 97.920             | 153.0          |                    |
| 16               | 40.80         | 58.752  | 72.5328           | 104.448            | 163.2          | 235.008<br>249.696 |
| 17               | 43.35         | 62.424  | 77.0661           | 110.976            | 173.4<br>183.6 | 264.384            |
| 18               | 45.90         | 66.096  | 81.5994           | 117.504<br>124.032 | 193.8          | 279.072            |
| 19 •             | 48.45         | 69.768  | 86.1327           | 130.560            | 204.0          | 293.760            |
| 20               | 51.00         | 73.440  | 90.6660           | 130.500            | 204.0          | 293.100            |
| 21               | 53.55         | 77.112  | 95.1999           | 137.088            | 214.2          | 308.448            |
| 22               | 56.10         | 80.784  | 99.7326           | 143.616            | 224.4          | 323.136            |
| 23               | 58.65         | 84.456  | 104.2659          | 150.144            | 234.6          | 337.824            |
| 24               | 61.20         | 88.128  | 108.7992          | 156.672            | 244.8          | 352.512            |
| 25               | 63.75         | 91.800  | 113.3325          | 163.200            | 255.0          | 367.200            |
| 26               | 66.30         | 95.472  | 117.8658          | 169.728            | 265.2          | 381.888            |
| 27               | 68.85         | 99.144  | 122.3991          | 176.256            | 275.4          | 396.576            |
| 28               | 71.40         | 102.816 | 126.9324          | 182.784            | 285.6          | 411.264            |
| 29               | 73.95         | 106.488 | 131.4657          | 189.312            | 295.8          | 425.952            |
| 30               | <b>7</b> 6.50 | 110.160 | 135.9990          | 195.840            | 306.0          | 440.640            |
| 31               | 79.05         | 113.832 | 140.5326          | 202.368            | 316.2          | 455.328            |
| 32               | 81.60         | 117.504 | 145.0656          | 208.896            | 326.4          | 470.016            |
| 38               | 84.15         | 121.176 | 149.5989          | 215.424            | 336.6          | 484.704            |
| 34               | 86.70         | 124.848 | 154.1322          | 221.952            | 346.8          | 499.392            |
| 35               | 89.25         | 128.520 | 158.6655          | 228.480            | 357.0          | 514.080            |
| 36               | 91.80         | 132.192 | 163.1988          | 235.008            | 367.2          | 528.768            |
| 40               | 102.00        | 146.880 | 181.3320          | 261.120            | 408.0          | 587.520            |
| 44               | 112.20        | 161.568 | 199.4652          | 287.232            | 448.8          | 646.272            |
| 48               | 122.40        | 176.256 | 217.5984          | 313.344            | 489.6          | 705.024            |
| 54               | 137.70        | 198.288 | 244.2982          | 352.512            | 550.0          | 793.152            |
| 60               | 153.00        | 220.320 | 271.9980          | 391.680            | 612.0          | 881.280            |
| 72               | 183.60        | 264.384 | 326.39 <b>7</b> 6 | 470.016            | 734.4          | 1057.536           |

This table gives the number of Imperial gallons (277.274 inches) in cylindrical vessels from 1 to 72 inches in depth and from 4 to 72 inches in diameter.

#### TABLE 68

#### Diameters, Areas and Circumferences of Circles

To find the capacity of any cylindrical measure, from I inch diameter to 30 inches, take the inside diameter of the measure in inches, and multiply the area in the table which corresponds to the diameter by the depth in inches, and divide the products, if gills are required, by 7.2135; if pints, by 28.875; if quarts, by 57.75; if gallons, by 231.

If bushels are required (say in a tierce or barrel, after the mean diameter is obtained), multiply as above, and divide the product by 2150.42.

Calling the diameters feet the areas are feet,—then, if a ship's water tank, steam boiler, etc., is 51/8, or any number of feet and parts of feet in diameter, find the area in the table which corresponds in inches, multiply it by the length in feet, and multiply this result by the number of gallons in a cubic foot (7.4805), and the product is the answer in gallons. In any case where there are more figures in the divisor than in the dividend, add ciphers.

Any of the areas in inches, multiplied by .052, or the areas in feet multiplied by 7.48, the product is the numbers of gallons at I foot in depth.

Any of the areas in feet, multiplied by .03704, the product equals the number of cubic yards at I foot in depth.

| Diam.,<br>Ins. | Circum.,<br>Ins. | Area,<br>Sq. Ins. | Diam.,<br>Ins. | Circum.,<br>Ins. | Area,<br>Sq. Ins. | Diam.,<br>Ins. | Circum.,<br>Ins. | Area,<br>Sq. Ins. |
|----------------|------------------|-------------------|----------------|------------------|-------------------|----------------|------------------|-------------------|
| 16             | 372              | .0030             | 7/8            | 23/4             | . 6013            | 23/8           | 73/8             | 4.430             |
| 1/8            | 13               | .0122             | 18             | 214              | . 6903            | 21/2           | 73/4             | 4.908             |
| 16             | 19               | .0276             | 1              | 31/8             | .7854             | 25/8           | 81/4             | 5.412             |
| 1/4            | 35               | .0490             | 11/8           | 31/2             | .9940             | 23/4           | 85/8             | 5.939             |
| 16             | 31               | .0767             | 11/4           | 31/8             | 1.227             | 21/8           | 9                | 6.491             |
| 3/8            | 1 1              | .1104             | 13/8           | 41/4             | 1.484             | 3              | 93/8             | 7.068             |
| 76             | 13/8             | .1503             | 11/2           | 45/8             | 1.767             | 31/8           | 93/4             | 7.669             |
| 1/2            | 1,               | .1963             | 15/8           | 51/8             | 2.074             | 31/4           | 101/4            | 8.295             |
| 16             | 135              | .2485             | 13/4           | 51/2             | 2.405             | 33/8           | 105%             | 8.946             |
| 5/8            | 131              | .3068             | 17/8           | 57/8             | 2.761             | 31/2           | . 11             | 9.621             |
| 11             | 252              | .3712             | 2              | 61/4             | 3.141             | 35/8           | 113%             | 10.320            |
| 3/4            | 211              | .4417             | 21/8           | 65/8             | 3.546             | 33/4           | 113/4            | 11.044            |
| 11             | 216              | .5185             | 21/4           | 7                | 3.976             | 37/8           | 121/8            | 11.793            |

Table 68 (Continued)

# Diameters, Areas and Circumferences of Circles

| Diam.,<br>Ins. | Cir.,<br>Ft. In   | Area,<br>s. Sq. Ins.                                      | Area,<br>Sq. Ft. | Diam.,<br>Ins.  | Cir.,<br>Ft. Ins.  | Area,<br>Sq. Ins.  | Area.<br>Sq. Ft. |
|----------------|---|---|------------------|-----------------|--|--------------------|------------------|
| *****          | 1 0. 111  |   |                  |                 |  |                    |                  |
| 4 in.          | 1 0   | <b>12.566</b>   | .0879            | 1012            | 2 87/8   | 86.590             | .6061            |
| 41/6           | i 07  | 8 13.364  | .0935            | 105/8           | 2 93%  | 88.664             | .6206            |
| 414            | 1 19  | 14.186  | .0993            | 1034            | 2 98%  | 90.762             | . 6353           |
| 43/            | 1 19  | 15.033  | . 1052           | 10 7/8          | 2 101/8  | 92.855             | . 6499           |
| 41.5           | 1 2   | 8 15.904  | .1113            | 11 in.          | 2 101/2  | 95.033             | .6652            |
| 45/8           | 1 2   | <b>4</b> 16.800   | .1176            | 111/8           | 2 954<br>2 100 8<br>2 100 8<br>2 111 4<br>3 00 8<br>3 00 8<br>3 00 8<br>3 11 4<br>3 21 8<br>3 21 8<br>3 3 3 4<br>3 4 8<br>3 3 4 4 8<br>3 3 4 4 8 | 97.205             | . 6874           |
| 48/4           | 1 27  | <b>7</b> 17.720   | .1240            | 111/4           | 2 111/4  | 99.402             | . 6958           |
| 47/8           | 1 3   | 4 18.665  | .1306            | 113/8           | 2 1134   | 101 . 623          | .7143            |
| 5 in.          | 1 35  | § 19.635  | .1374            | 111/2           | 3 01/8   | 103.869            | .7290            |
| 51/8           | 1 4   | <b>8</b> 20.629   | . 1444           | 11%             | 3 0½<br>3 0½   | 106.139            | .7429            |
| 2.73           | 1 41  | 21.647  | .1515            | 11%             | 3 0/8  | 108.434            | .7590            |
| 3%8<br>51      | 1 5   | 22.690<br>23.758  | .1588<br>.1663   | 11½<br>12 in.   | 3 11/4<br>3 15/8   | 110.753            | .7752<br>.7916   |
| 552            | 1 55  |   | .1739            | 121/8           | 3 2 3  | 113.097<br>115.466 |                  |
| 58             | 1 6   | 25.967  | .1817            | 1214            | 3 21/  | 117.859            | .8082<br>.8250   |
| 572            | 1 63  | √s 27.108   | .1897            | 123%            | 3 21/2<br>3 27/8   | 120.276            | .8419            |
| 6 in.          | 1 63  | 28.274  | .1979            | 1213            | 3 314  | 122.718            | .8590            |
| 61/6           |   |   | .2062            | 125%            | 3 334  | 125.185            | .8762            |
| 614            | 1 75  | 30.679  | .2147            | 1234            | 3 4  | 127.676            | .8937            |
| 682            | ī š   | 31.919  | .2234            | $12\frac{7}{8}$ | 3 4%   | 130 . 192          | .9113            |
| 61/2           | 1 8<br>1 8 <sup>3</sup>   | <b>33.183</b>   | .2322            | 13 in.          | 3 434  | 132.732            | .9291            |
| 65 Z           | 1 8%  | 4 34.471  | .2412            | 131/8           | 3 51/4   | 135.297            | .9470            |
| 684            | 1 93  | <b>35.784</b>   | .2504            | 1314            | 3 5 1 5 1 1 1  | 137.886            | .9642            |
| 67⁄8           | 1 91  | <b>∕</b> 2 37.122   | .2598            | $13\frac{3}{8}$ | 3 6  | 140.500            | . 9835           |
| 7 in.          | 1 10  | 38.484  | .2693            | 131/2           | 3 638<br>3 654<br>3 718<br>3 778<br>3 778<br>3 838<br>3 834<br>3 912   | 143.139            | 1.0019           |
| 71/8           | 1 103   | <b>§</b> 39.871   | .2791            | 135/8           | 3 634  | 145.802            | 1.0206           |
| 71/4           | 1 103   | 41.282  | .2889            | 1334            | 3 71/8   | 148.489            | 1.0294           |
| 73/8           | 1 111   |   | .2990            | 137/8           | 3 712<br>3 778   | 151.201            | 1.0584           |
| 753            | 1 111   | 44.178  | .3092            | 14 in.<br>141/6 | 3 7/8  | 153.938            | 1.0775           |
| 73.8           | 1 117<br>2 03   |   | .3196<br>.3299   | 141/4           | 3 83 8<br>3 83 4   | 156.699<br>159.485 | 1.0968           |
| 772            | 2 03  | 47.173<br>4 47.707  | .3409            | 143%            | 3 91/8   | 162.295            | 1.1193<br>1.1360 |
| 8 in.          | 2 13  | \$ 50.265   | .3518            | 1413            | 3 016  | 165.130            | 1.1569           |
| 814            | 2 ii  | 51.848  | .3629            | 145%            | 3 912<br>3 978   | 167.989            | 1.1749           |
| 812            | 2 i7  |   | .3741            | 1434            | 3 978<br>3 1014<br>3 1034<br>3 1118  | 170.873            | 1.1961           |
| 83.6           | 2 2í  | 4 55.088  | .3856            | 147/8           | 3 1037   | 173.782            | 1.2164           |
| 81/2           | 2 21<br>2 25  | 8 56.745  | .3972            | 15 in.          | 3 10 <sup>3</sup> 4<br>3 11 <sup>1</sup> / <sub>8</sub>  | 176.715            | 1.2370           |
| 85/R           | 2 3   | 58.426  | .4089            | $15\frac{1}{8}$ | 3 11½<br>3 11½   | 179.672            | 1.2577           |
| 834            | 2 33<br>2 37  | <b>60.132</b>   | .4209            | 151/4           | 3 117/8  | 182.654            | 1.2785           |
| 81/8           | 2 37  | <b>61.862</b>   | .4330            | 153/8           | 4 01/4   | 185.661            | 1.2996           |
| 9 in.          | 2 41  | 4 63.617  | . 4453           | 151/2           | 4 0 1/8  | 188.692            | 1.3208           |
| 91/8           | 2 45  | 8 65.396  | .4517            | 155/8           | 4 1  | 191.748            | 1.3422           |
| 91/4           | 2 5   | 67.200  | .4704            | 1534            | 4 11/2   | 194.828            | 1.3637           |
| 93/8           | 2 53  | 69.029  | .4832            | $15\frac{7}{8}$ | 4 17/8   | 197.933            | 1.3855           |
| 91/2           | 2 53  | $\begin{array}{ccc} 4 & 70.882 \\ 4 & 72.759 \end{array}$ | .4961            | 16 in.          | 4 21/4   | 201.062            | 1.4074           |
| 03.2           | 2 61<br>2 67  | 4 72.759<br>4 74.662                                      | .5093<br>.5226   | 16½<br>16¼      | 4 25/8<br>4 3  | 204.216<br>207.394 | 1.4295<br>1.4517 |
| 072            | 2 7   | 8 74.002<br>76.588  | .5361            | 163/8           | 4 33%  | 210.597            | 1.4741           |
| 19 in.         | 2 73  | 4 78.540  | .5497            | 161/2           | 4 3 3 4  | 213.825            | 1.4967           |
| 101/8          | 2 73<br>2 73  | 80.515  | .5636            | 165%            | 4 414  | 217.077            | 1.5195           |
| 1014           | 1 117<br>2 0 0 3<br>2 1 1 4<br>2 2 1 2 1<br>2 2 2 2 2 3<br>3 2 2 4 4 1<br>2 2 2 5 5<br>3 2 2 6 3<br>2 2 2 5 5<br>3 2 2 2 2 8 8 1<br>2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 | 82.516  | .5776            | 1684            | 4 45%  | 220.353            | 1.5424           |
| 103/8          | 2 81  | 84.540  | .5917            | 1678            | 4 5  | 223.654            | 1.5655           |
|                | -,  | -   |                  | . •             |  |                    |                  |

# Table 68 (Continued)

# Diameters, Areas and Circumferences of Circles

| Diam.,<br>Ins.                         | Ft.              | ir.,<br>Ins.   | Area,<br>Sq. Ins.  | Area,<br>Sq. Ft. | Pt.                             | iam.,<br>Ins.                 | Ci<br>Ft.   | r.,<br>Ins.          | Area,<br>Sq. Ins.  | Area.<br>Sq. Ft.     |
|--|------------------|--|--------------------|------------------|---------------------------------|-------------------------------|-------------|----------------------|--------------------|----------------------|
| 17 in.                                 | 4                | 53/8   | 226.980            | 1.5888           | 2                               | 0                             | 6           | 33/6                 | 452.290            | 3.1418               |
| 171/8                                  | 4                | 53/4   | 230.330            | 1.6123           | 2                               | 01/4                          | 6           | 41/8                 | 461.864            | 3.2075               |
| 1714                                   | 4                | 61/8   | 233.705            | 1.6359           | 2                               | 01/2                          | 6           | 47/8                 | 471.436            | 3.2731               |
| $17\frac{3}{8}$                        | 4                | 61.5   | 237.104            | 1.6597           | 2                               | 03/4                          | 6           | 53/4                 | 481.106            | 3.3410               |
| 1712                                   | 4                | 67/8   | 240.528            | 1.6836           | 2                               | 1                             | 6           | 61/2                 | 490.875            | 3.4081               |
| 175 8                                  | 4                | 73/8   | 243.977            | 1.7078           | 2                               | 11/4                          | 6           | 71/4                 | 500.741            | 3.4775               |
| 1734                                   | 4                | 734  | 247.450            | 1.7321           | 2                               | 11/2                          | 6           | 81/8                 | 510.706            | 3.5468               |
| 177/8                                  | 4                | 81/8   | 250.947            | 1.7566           | 2                               | 1%                            | 6           | 87/8                 | 520.769            | 3.6101               |
| 18 in.<br>181/2                        | 4                | 81/2<br>87/8   | 254.469            | 1.7812<br>1.8061 | 2                               | 21/4                          | 6<br>6      | 95/8<br>101/2        | 530.930<br>541.189 | 3.6870<br>3.7583     |
| 1017                                   | 4                | 914  | 258.016<br>261.587 | 1.8311           | 2                               | $\frac{2}{2}\frac{7}{2}$      | 6           | 111/4                | 551.547            | 3.8302               |
| 18 <sup>1</sup> 4<br>18 <sup>3</sup> 8 | 4                | 934  | 265.182            | 1.8562           | 2<br>2<br>2<br>2<br>2<br>2<br>2 | 93/                           | 7           | 0                    | 562.002            | 3.9042               |
| 1812                                   | 4                | 101/8  | 268.803            | 1.8816           | 2                               | 3                             | 7           | 03/4                 | 572.556            | 3.9761               |
| 185/8                                  | 4                | 1013   | 272.447            | 1.9071           | 2                               | 31/4                          | 7           | 15%                  | 583.208            | 4.0500               |
| 183                                    | 4                | 10 <sup>1</sup> / <sub>2</sub><br>10 <sup>7</sup> / <sub>8</sub> | 276.117            | 1.9328           | 2                               | 31/2                          | 7           | 23/8                 | 593.958            | 4.1241               |
| 187/8                                  | 4                | 1114   | 279.811            | 1.9586           | 2                               | 344                           | 7           | 31/6                 | 604.807            | 4.2000               |
| 19 in.                                 | 4                | 115/8  | 283.529            | 1.9847           | 2                               | 4                             | 7<br>7      | 37%                  | 615.753            | 4.2760               |
| 191/8                                  | 5                | 0  | 287.272            | 1.9941           | 2                               | 41/4                          | 7           | 4%                   | 626.798            | 4.3521               |
| 1914                                   | 5                | $0\frac{1}{2}$   | 291.039            | 2.0371           | 2<br>2<br>2<br>2<br>2<br>2      | 41/2                          | 7           | 51/2                 | 637.941            | 4.4302               |
| 193/8                                  | 5                | 07/8   | 294.831            | 2.0637           | 2                               | 43/4                          | 7           | 61/4                 | 649.182            | 4.5083               |
| $19\frac{1}{2}$                        | 5                | 1:4  | 298.648            | 2.0904           | 2                               | 5                             | 7           | 7                    | 660.521            | 4.5861               |
| 195/8                                  | 5                | 15/8   | 302.489            | 2.1172           | 2                               | $5\frac{1}{4}$                | 7           | 7½<br>85%            | 671.958            | 4.6665               |
| 1934                                   | 5                | 2  | 306.355            | 2.1443           | 2                               | $5\frac{1}{2}$                | 7           | 89/8                 | 683.494            | 4.7467               |
| 197⁄8<br><b>20</b> in.                 | 5                | 23/8   | 310.245            | 2.1716           | 2                               | 534                           | 7           | 91/2                 | 695.128            | 4 . 8274<br>4 . 9081 |
| 20 in.<br>201/8                        | 5<br>5           | 27/8<br>31/4   | 314.160<br>318.099 | 2.1990<br>2.2265 | <b>2</b><br>2                   | 614                           | 7<br>7      | 10¼<br>11            | 706.860<br>718.690 | 4.9901               |
| 2014                                   | 5                | 35/8   | 322.063            | 2.2543           | 2                               | 61                            | 7           | 1134                 | 730.618            | 5.0731               |
| 203/8                                  | 5                | 4  | 326.051            | 2.2822           | 2                               | $\substack{61 \ 2 \\ 63 \ 4}$ | 8           | 05/8                 | 742.644            | 5.1573               |
| 2013                                   | 5                | 43%  | 330.064            | 2.3103           | 2                               | 7                             |             | 13/8                 | 754.769            | 5.2278               |
| 20%                                    | 5<br>5<br>5<br>5 | 43/8<br>43/4   | 334.101            | 2.3386           | $\frac{2}{2}$                   | 71/4                          | 8<br>8<br>8 | 21%                  | 766.992            | 5.3264               |
| 2034                                   | 5                | 51/6   | 338.163            | 2.3670           | 2                               | 71.2                          | 8           | 21/8<br>27/8<br>33/4 | 779.313            | 5.4112               |
| 2078                                   | 5                | 51/2   | 342.250            | 2.5956           | 2                               | 71.2<br>73.4                  | 8           | 384                  | 791.732            | 5.4982               |
| 21 in.                                 | 5                | Ð'∕8   | 346.361            | 2.4244           | 2                               | 8                             | 8           | 41/2                 | 804.249            | 5.5850               |
| 211/8                                  | 5                | 63/8   | 350.497            | 2.4533           | 2                               | 814                           | 8           | 41/2<br>53/8         | 816. <b>8</b> 65   | 5.6729               |
| 2114                                   | 5                | 63/4   | 354.657            | 2.4824           | 2                               | 812                           | 8           | 61/8<br>67/8         | 829.578            | 5.7 <b>6</b> 01      |
| 2138                                   | 5                | 71/8   | 358.841            | 2.5117           | 2                               | 834                           | 8           | 67/8                 | 842.390            | 5.8491               |
| 211/2                                  | 5                | 71/2   | 363.051            | 2.5412           | 2                               | 9                             | 8           | 75/8                 | 855.300            | 5.9398               |
| 215 8                                  | 5                | 71/8   | 367.284            | 2.5708           | 2                               | 914                           | 8           | 81/2                 | 868.308            | 6.0291               |
| 2134<br>2176                           | 5                | 81/4   | 371.543            | 2.6007           | ž                               | 91 2                          | 8           | 914                  | 881.415            | 6.1201               |
| T1/.0                                  | 5                | $\frac{834}{918}$  | 375.826<br>380.133 | 2.6306<br>2.6608 | 2<br>2<br>2<br>2                | 934<br>10                     | 8           | 10<br>10¾            | 894.619<br>907.922 | 6.2129<br>6.3051     |
| 22 in.<br>221/8                        | 5                | 91/2   | 384 . 465          | 2.6691           | 5                               | 101/4                         | 8           | 111/2                | 921.323            | 6.3981               |
| 2214                                   | 5<br>5           | 97/8   | 388.822            | 2.7016           | 2<br>2<br>2<br>2                | 101/2                         | ŷ           | 03/8                 | 934.822            | 6.4911               |
| 223%                                   | 5                | 1014   | 393.203            | 2.7224           | 2                               | 1034                          | ğ           | 11%                  | 948.419            | 6.5863               |
| 2213                                   | 5                | 105/8  | 397.608            | 2.7632           | 2                               | ii                            | ğ           | 11/8<br>17/8         | 962.115            | 6.6815               |
| 225 %                                  | 5                | ii   | 402.038            | 2.7980           | 2                               | 111/4                         | ğ           | 28/4                 | 975.908            | 6.7772               |
| 2234                                   | 5                | 111/2  | 406.493            | 2.8054           | 2                               | $11^{1/2}$                    | 9           | 31/2<br>41/4         | 989.800            | 6.8738               |
| 2278                                   | 5                | $11\frac{7}{8}$  | 410.972            | 2.8658           | 2                               | 113/4                         | 9           | 41/4                 | 1003.79            | 6.9701               |
| 23 in.                                 | 6                | 01/4   | 415.476            | 2.8903           | 3                               | 0                             | 9           | 5                    | 1017.87            | 7.0688               |
| 231/8                                  | 6                | 05/8   | 420.004            | 2.9100           | 3                               | 01/4                          | 9           |                      | 1032.06            | 7.1671               |
| 231/4                                  | 6                | 1  | 424.557            | 2.9518           | 3                               | $0\frac{1}{2}$                | 9           | 65/8                 | 1046.35            | 7.2664               |
| 233/8                                  | 6                | 13/8   | 429.135            | 2.9937           | 3                               | 034                           | 9           | 71/2                 | 1060.73            | 7.3662               |
| 231/2                                  | 6                | 13/4   | 433.737            | 3.0129           | 3                               | 1                             | 9           |                      | 1075.21            | 7.4661               |
| 23%                                    | 6                | 21/4   | 438.363            | 3.0261           | 3                               | 11/4                          | 9           | 9                    | 1089.79            | 7.5671               |
| $\frac{23\frac{3}{4}}{23\frac{7}{8}}$  | B                | 25/8<br>3  | 443.014<br>447.690 | 3.0722<br>3.1081 | 3                               | $\frac{11}{13}$               | 9           |                      | 1104.46<br>1119.24 | 7.6691<br>7.7791     |
| Note                                   | ,'7              | -  | ble on he          |                  | -                               |                               | -           |                      | eyeletted          |                      |
| 71015                                  | ··               | · wro (a   | OII HE             | was corn         | Joan                            | ,                             | ✓ 13        | ,                    | cherented          | , 40.60.             |

TABLE 68 (Continued)

# Diameters, Areas and Circumferences of Circles

|                  | am.,                                |          | ir.,   | Area,                    |    | rea,                           |               | iam.,          |          | Cir <u>.</u> ,                        | Area,              | Area,              |
|------------------|-------------------------------------|----------|--|--------------------------|----|--------------------------------|---------------|----------------|----------|---------------------------------------|--------------------|--------------------|
| Ft.              | Ins.                                | Ft.      | Ins.   | Sq. Ins.                 | Sq | ı. Ft.                         | Ft.           | . Ins.         | Ft.      | Ins.                                  | Sq. Ins.           | Sq. Ft.            |
| 3 .              | 2                                   | 9        | 113/8  | 1134.12                  |    | .8681                          | 4             | 4.             | 13       | 73/8                                  | 2123.72            | 14.748             |
| 3<br>3           | $\frac{2\frac{1}{4}}{2\frac{1}{2}}$ | 10       | 01/8   | 1149.09                  |    | . 9791                         | 4             | 41/4           | 13<br>13 | 81/8                                  | 2144.19<br>2164.75 | 14.890             |
| 3                | 23/                                 | 10<br>10 | $0\frac{7}{8}$ $1\frac{3}{4}$                                    | 1164.16<br>1179.32       |    | .0846<br>.1891                 | 4             | 41/2           | 13       | 87/8<br>93/4                          | 2185.42            | 15.033<br>15.176   |
| š                | 3                                   | iŏ       | 21/2   | 1194.59                  |    | 2951                           | 4             | 5 -            | 13       | 101/2                                 | 2206.18            | 15.320             |
| 3                | 31/4                                | 10       | 314  | 1209.95                  |    | 4026                           | 4             | 5              | 13       | 1114                                  | 2227.05            | 15.465             |
| 3                | 31/2                                | 10       | 4  | 1225.42                  |    | .5791                          | 4             | $\frac{51}{2}$ | 14       | 0                                     | 2248.01            | 15.611             |
| 3<br><b>3</b>    | 33/4                                | 10       | 47/8   | 1240.98                  |    | .6171                          | 4             | 53/4           | 14       | 07/8                                  | 2269.06            | 15.757             |
| 3                | 41/4                                | 10<br>10 | 55/8<br>68/8   | 1256.64<br>1272.39       |    | .7269<br>.8361                 | 4             | 61/4           | 14<br>14 | $\frac{15}{8}$ $\frac{23}{8}$         | 2290.22<br>2311.48 | 15.904<br>16.051   |
| š                | 413                                 | 10       | 714  | 1288.25                  |    | .9462                          | 4             | 612            | 14       | 314                                   | 2332.83            | 16.200             |
| 3<br>3           | 43/4                                | 10       | 8  | 1304.20                  |    | .0561                          | 4             | 63.4           | 14       | 4                                     | 2354.28            | 16.349             |
| 3                | 5                                   | 10       | 88/4   | 1320.25                  |    | . 1686                         | 4             | 7              | 14       | 48/4                                  | 2375.83            | 16.498             |
| 3                | 51/4                                | 10       | 91/2   | 1336.40                  |    | .2112                          | 4             | 71/4           | 14       | 5½<br>63/8                            | 2397.48            | 16.649             |
| 3<br>3           | 5½<br>5¾                            | 10<br>10 | 10 <sup>8</sup> / <sub>8</sub><br>11 <sup>1</sup> / <sub>8</sub> | 1352.65<br>1369.00       |    | . 3936<br>. 5061               | 4             | 73/4           | 14<br>14 | 71/8                                  | 2419.22<br>2441.07 | 16.800<br>16.951   |
| š                | 6                                   | 10       | 11%  | 1385.44                  |    | 6212                           | 4             | 174            | 14       | 71%                                   | 2463.01            | 17.104             |
| 3                | 61/4                                | īĭ       | 084  | 1401.98                  |    | 7364                           | 4             | 81/4           | 14       | 85%                                   | 2485.05            | 17.256             |
| 3                | 61/2                                | 11       | 11/2   | 1418.62                  |    | .8518                          | 4             | 81/2           | 14       | 91/2                                  | 2507.19            | 17.411             |
| 3                | 63/4                                | 11       | 21/4   | 1435.36                  |    | .9671                          | 4             | 83/4           | 14       | 101/4                                 | 2529.42            | 17.565             |
| 3                | 7<br>7¼                             | 11<br>11 | $\frac{3}{3\frac{7}{8}}$   | 1452.20<br>1469.14       |    | . 084<br>. 202                 | 4             | 91/4           | 14<br>14 | 11<br>111/8                           | 2551.76<br>2574.19 | 17.720 ·<br>17.876 |
| 3                | 71/2                                | ii       | 45/8   | 1486.17                  |    | . 320                          | 4             | 91/2           | 15       | 05/8                                  | 2596.72            | 18.033             |
| 3                | 73/4                                | īī       | 53%  | 1503.30                  |    | . 439                          | 4             | 984            | 15       | 13/8                                  | 2619.35            | 18.189             |
|                  | 8                                   | 11       | $6\frac{1}{4}$   | 1530.53                  |    | . 559                          | 4             | 10             | 15       | 914                                   | 2642.08            | 18.347             |
| 3                | 81/4                                | 11       | 7.   | 1537.86                  |    | . 679                          | 4             | 101/4          | 15       | 27/8                                  | 2664.91            | 18.506             |
| 3                | 81/2                                | 11<br>11 | $\frac{73}{4}$ $8\frac{1}{2}$                                    | 1555.28<br>1572.81       |    | . 800<br>. 922                 | 4             | 101/2          | 15<br>15 | 33/4                                  | 2687.83<br>2710.85 | 18.665<br>18.825   |
| 3                | 974                                 | ii       | 98/8   | 1590.43                  |    | .044                           | 4             | 10¾<br>11      | 15       | 41.2<br>51.4                          | 2733.97            | 18.825<br>18.965   |
| 3 .              | 91/4                                | îî       | 101/6  | 1608.15                  |    | . 167                          | â             | 111/4          | 15       | 618                                   | 2757.19            | 19.147             |
| 3                | 91/2                                | 11       | 107/8  | 1625.97                  |    | .291                           | 4             | 111/2          | 15       | 61/8                                  | 2780.51            | 19.309             |
| 3<br><b>3</b>    | 93/                                 | 11       | 1134   | 1643.89                  |    | . 415                          | 4             | 113/4          | 15       | 734                                   | 2803.92            | 19.471             |
| 3                | 10<br>10¼                           | 12<br>12 | 0½<br>1¼   | 1661.90<br>1680.02       |    | . 534<br>. 666                 | <b>5</b><br>5 | 01/4           | 15<br>15 | $\frac{81}{2}$                        | 2827.44<br>2851.05 | 19.635             |
| š                | 101/2                               | 12       | 2  | 1698.23                  |    | .793                           | 5             | 01/2           | 15       | 10                                    | 2874.76            | 19.798<br>19.963   |
| 3<br>3<br>3<br>3 | 1034                                | 12       | 25/8   | 1716.54                  |    | .920                           | ĕ             | 03/4           | 15       | 1034                                  | 2898.56            | 20.128             |
| 3                | 11                                  | 12       | 31/8   | 1734.94                  |    | .048                           | 5             | 1              | 15       | 115/8                                 | 2922.47            | 20.294             |
| 3                | 111/4                               | 12       | 45/8   | 1753.45                  |    | . 176                          | 5             | 11/4           | 16       | 03/8                                  | 2946.47            | 20.461             |
| 3                | 1114                                | 12<br>12 | 5½<br>6  | 1772.05<br>1790.76       |    | . <b>3</b> 05<br>. <b>4</b> 35 | 5<br>5        | 1½<br>1¾       | 16<br>16 | 11/4<br>17/8                          | 2970.57<br>2994.77 | 20.629             |
| Ĭ                | 0 4                                 | 12       | 63/4   | 1809.56                  |    | .566                           | 5             | 2 4            | 16       | 23,4                                  | 3019.07            | 20.797<br>20.965   |
| 4                | 01/4                                | 12       | 71/2   | 1828.46                  |    | . 697                          | 5             | 21/4           | 16       | $3i_2^*$                              | 3043.47            | 21.135             |
| 4                | $0\frac{1}{2}$                      | 12       | 83/8   | 1847.45                  |    | . 829                          | 5             | 21/2           | 16       | 41/4                                  | 3067.96            | 21.305             |
| 4                | 0%                                  | 12       | 91/8   | 1866.55                  |    | .962                           | 5             | 23/4           | 16       | 51/8                                  | 3092.56            | 21.476             |
| 4                | 11/4                                | 12<br>12 | 97/8<br>105/8  | 1885.74<br>1905.03       |    | . 095<br>. 229                 | 5<br>5        | 3<br>31/4      | 16<br>16 | 57/8                                  | 3117.25<br>3142.04 | 21.647             |
| 4                | 11/2                                | 12       | 111/2  | 1924.42                  |    | . 304                          | 5             | $\frac{31}{2}$ | 16       | $\frac{6!4}{7!2}$                     | 3166.92            | 21.819<br>21.992   |
| 4                | 134                                 | 13       | 014  | 1943.91                  |    | .499                           | 5             | 334            | 16       | 814                                   | 3191.91            | 22.166             |
| 4                | 2                                   | 13       | 1  | 1963.50                  |    | . 635                          | 5             | 4              | 16       | 9                                     | 3216.99            | 22.333             |
| 4                | 21/4                                | 13       | 17/8   | 1983.18                  |    | .772                           | 5             | 41/4           | 16       | 934                                   | 3242.17            | 22.515             |
| 4                | 21/2<br>28/4                        | 13<br>13 | 21/2   | 2002.96<br>2022.84       |    | . 909<br>. 0 <b>47</b>         | 5<br>5        | 41/2           | 16<br>16 | $\frac{10^{5}}{8}$ $\frac{11^{3}}{8}$ | 3267:46            | 22.621             |
| 4                | 3                                   | 13       | 41/4   | 2042.82                  |    | .186                           | 5             | 5              | 17       | 01/8                                  | 3292.83<br>3318.31 | 22.866<br>23.043   |
| Ã.               | 31/4                                | 13       | 5  | 2062.90                  |    | .325                           | 5             | 51/4           | 17       | 078                                   | 3343.88            | 23.221             |
| 4                | 31/2<br>33/4                        | 13       | 53/4   | 2083.07                  | 14 | . 465                          | 5             | 51/2<br>53/4   | 17       | 13/4                                  | 3369.56            | 23.330             |
| 4                |                                     | 13       | $6\frac{1}{2}$   | <b>21</b> 03 . <b>35</b> |    | . 606                          | Š             |                | 17       | 21/2                                  | 3395.33            | 23.578             |
| No               | TE.                                 | This     | table  | on, hea                  | vy | cardbo                         | ard           | 11 X           | 14       | ins.,                                 | eyeletted,         | \$0.25.            |

## TABLE 68 (Continued)

## Diameters, Areas and Circumferences of Circles

|                         | Diam.,<br>. Ins.                | Ft.        | ir.,<br>Ins.                  | Area,<br>Sq. Ins.  | Area,<br>Sq. Ft. |                | iam.,<br>Ins.  |          | ir.,<br>Ins.                        | Area,<br>Sq. Ins.  | Area,<br>Sq. Ft.   |
|-------------------------|---------------------------------|------------|-------------------------------|--------------------|------------------|----------------|--|----------|-------------------------------------|--------------------|--------------------|
| 5                       | 6                               | 17         | 35/8                          | 3421.20            | 23.758           | 6              | . 8  | 20       | 111/4                               | 5026.26            | 34.900             |
| 5                       | 61/4                            | 17         | 41/8                          | 3447.16            | 23.938           | 6              | 81/4   | 21       | 01/8                                | 5058. <b>02</b>    | 35.125             |
| 5                       | 61/2                            | 17         | 43/8                          | 3473.23            | 24.119           | 6              | 81/2   | 21       | 01/6                                | 5089.58            | 35.344             |
| 5<br>5                  | 63/4<br>7                       | 17<br>17   | 57%                           | 3499.39            | 24.301           | 6              | 83/4   | 21       | 15/6                                | 5121.24            | 35.564             |
| 5                       | 71/4                            | 17         | 61/2                          | 3525.26<br>3552.01 | 24.483<br>24.666 | 6<br>6         | 9<br>9¼  | 21<br>21 | 23/8<br>31/4                        | 5153.00<br>5184.86 | 35.784             |
| 5                       | 71/2                            | 17         | 8                             | 3578.47            | 24.850           | 6              | 91/2   | 21       | 4                                   | 5216.82            | 36.006<br>36.227   |
| 5                       | 73/4                            | 17         | 83/4                          | 3605.03            | 25.034           | 6              | 984  | 21       | 43/4                                | 5248.87            | 36.450             |
| 5                       | 8.                              | 17         | 95/8                          | 3631.68            | 25.220           | 6              | 10   | 21       | 51/6                                | 5281.02            | 36:674             |
| 5<br>5<br>5<br>5<br>5   | 81/4                            | 17<br>17   | 103/8                         | 3658.44<br>3685.29 | 25.405           | 6              | 101/4  | 21       | 63/8                                | 5313.27            | 36.897             |
| 5                       | 81/2<br>88/4                    | 17         | 11½<br>11½                    | 3712.24            | 25.592<br>25.779 | 6<br>6         | 10 <sup>1</sup> / <sub>2</sub><br>10 <sup>3</sup> / <sub>4</sub> | 21<br>21 | 71/8<br>71/8                        | 5345.62<br>5378.07 | 37.122             |
| 5                       | 9´*                             | 18         | 03/4                          | 3739.28            | 25.964           | 6              | 11   | 21       | 834                                 | 5410.62            | 37.347<br>37.573   |
| 5<br>5<br>5<br><b>5</b> | 91/4                            | 18         | $\frac{11}{2}$ $\frac{21}{4}$ | 3766.43            | 26.155           | 6              | 111/4  | 21       | 91/6                                | 5443.26            | 37.700             |
| 5                       | 91/2                            | 18         | 21/4                          | 3793.67            | 26.344           | 6              | 111/2  | 21       | 101/4                               | 5476.00            | 38.027             |
| ē                       | 934<br>10                       | 18<br>18   | 31/8<br>37/8                  | 3821.02<br>3848.46 | 26.534           | 6<br><b>7</b>  | 1134   | 21       | 11                                  | 5508.84            | 38.256             |
|                         | 101/4                           | 18         | 43/8                          | 3875.99            | 26.725<br>26.916 | 7              | 1  | 21<br>22 | 117/8<br>3                          | • • • • • •        | 38.4846            |
| 5<br>5<br>5<br>5        | 101/2                           | 18         | 51/2                          | 3903.63            | 27.108           | 7              | 2  | 22       | 6½                                  |                    | 39.4060<br>40.3388 |
| 5                       | $10\frac{1}{2}$ $10\frac{3}{4}$ | 18         | 51/2<br>61/4                  | 3931.36            | 27.301           | 7<br>7         | 3  | 22       | 914                                 |                    | 41.2825            |
| 5                       | 11                              | 18         | 7                             | 3959.20            | 27.494           | 7              | 4  | 23       | 03/8                                |                    | 42.2367            |
| ð                       | 111/4                           | 18         | 73/4                          | 3987.13            | 27.688           | 7              | 5  | 23       | 21/8                                | • • • • •          | 43.2022            |
| 5<br>5<br><b>6</b>      | 111/2                           | 18<br>18   | 85/8<br>93/8                  | 4015.16<br>4043.28 | 27.883<br>28.078 | 7              | 6  | 23<br>23 | 63/4                                | • • • • •          | 44.1787            |
| ĕ                       | 0 4                             | 18         | 101/8                         | 4071.51            | 28.274           | 7              | 8  | 24       | 11/8                                | • • • • • •        | 45.1656<br>46.1638 |
| 6                       | 01/4                            | 18         | 101/8                         | 4099.83            | 28.471           | 7              | ğ  | 24       | 41/8                                |                    | 47.1730            |
| 6                       | 01/2                            | 18         | $11\frac{3}{4}$               | 4128.25            | 28.663           | 7              | 10   | 24       | 71/4                                |                    | 48.1926            |
| 6                       | 08/4<br>1                       | 19         | $0^{1/2}_{1/4}$               | 4156.77            | 28.866           | 7              | 11   | 24       | 103/8                               |                    | 49.2236            |
| 6                       | 11/4                            | 19<br>19   | 21/8                          | 4185.39<br>4214.11 | 29.064<br>29.264 | <b>8</b><br>8  | 0<br>1   | 25<br>25 | 11/2<br>45/8                        | • • • • • •        | 50.2656            |
| 6                       | 11/2                            | 19         | $2\frac{7}{8}$                | 4242.92            | 29.466           | 8              | 2  | 25       | 77/8                                | • • • • • •        | 51.6178<br>52.3816 |
| 6                       | 13/4                            | 19         | 35/6                          | 4271.83            | 29.665           | 8              | 3  | 25       | 11                                  |                    | 53.4562            |
| 6                       | 2                               | 19         | 41/2                          | 4300.85            | 29.867           | 8              | 4  | 26       | 21/8                                |                    | 54.5412            |
| 6<br>6                  | $\frac{214}{212}$               | 19<br>19   | $\frac{5\frac{1}{4}}{6}$      | 4329.95            | 30.069           | 8              | 5  | 26       | 514                                 | • • • • •          | 55.6377            |
| 6                       | 284                             | 19         | 63/4                          | 4359.16<br>4388.47 | 30.271<br>30.475 | 8              | 6<br>7   | 26<br>26 | 83/8<br>111/8                       | • • • • •          | 56.7451<br>57.8628 |
| 6                       | 3 *                             | 19         | 75%                           | 4417.87            | 30.619           | 8              | 8  | 27       | 234                                 | • • • • • •        | 58.9920            |
| 6                       | 31/4                            | 19         | 83/8                          | 4447.37            | 30.884           | 8              | 9  | 27       | 534                                 |                    | 60.1321            |
| 6                       | 31/2                            | 19         | 91/8                          | 4476.97            | 31.090           | 8              | 10   | 27       | 9                                   |                    | 61.2826            |
| 6<br><b>6</b>           | 33/4                            | 19<br>19   | 97/8<br>103/4                 | 4506.67<br>4536.47 | 31.296<br>31.503 | 8<br>9         | 11   | 28       | 01/8                                | • • • • •          | 62.4445            |
| 6                       | 41/4                            | 19         | 111/2                         | 4566.36            | 31.710           | 9              | 0<br>1   | 28<br>28 | $\frac{3\frac{1}{4}}{6\frac{3}{8}}$ | • • • • • •        | 63.6174<br>64.8006 |
| 6                       | 41/2                            | 20         | 01/4                          | 4596.35            | 31.919           | ğ              | 2  | 28       | 91/2                                | • • • • • •        | 65.9951            |
| 6                       | 43/4                            | 20         | 11/6                          | 4626.44            | 32.114           | 9              | 3  | 29       | 05/8                                |                    | 67.2007            |
| 6                       | 5                               | 20         | 17%                           | 4656.63            | 32.337           | 9              | 4  | 29       | 33/4                                | • • • • •          | 68.4166            |
| 6<br>6                  | 51/4<br>51/6                    | 20<br>20   | 25/8                          | 4686.92<br>4717.30 | 32.548<br>32.759 | 9              | 5<br>6   | 29<br>29 | 7<br>10½                            | • • • • •          | 69.6440            |
| 6                       | 51/2<br>53/4                    | 20         | 31/8<br>41/4                  | 4747.79            | 32.970           | 9              | 7  | 30       | 11/4                                | • • • • •          | 70.8823<br>72.1309 |
| 6                       | 6                               | 20         | 5                             | 4778.37            | 33.183           | ğ              | 8  | 30       | 43%                                 |                    | 73.3910            |
| 6                       | 61/4                            | 20         | 584                           | 4809.05            | 33.396           | 9              | 9  | 30       | 71/9                                |                    | <b>74</b> .6620    |
| 6                       | 61/2                            | 20         | 61/2                          | 4839.83            | 33.619           | 9              | 10   | 30       | 115/8                               | • • • • •          | 75.9433            |
| 6                       | 68/4<br>7                       | 20<br>20   | 73/8<br>81/8                  | 4870.70<br>4901.68 | 33.824<br>34.039 | 9<br><b>10</b> | 11<br>0  | 31<br>31 | 13/4<br>5                           | • • • • • •        | 77.2362            |
| 6                       | 71/4                            | 20         | 87/8                          | 4932.75            | 34.255           | 10             | ĭ  | 31       | 81/8                                |                    | 78.5400<br>79.8540 |
| 6                       | 71/2<br>73/4                    | 20         | 934                           | 4963.92            | 34.471           | 10             | 2  | 31       | 1114                                |                    | 81.1795            |
| 6                       |                                 | <b>2</b> 0 | $10\frac{1}{2}$               | 4995.19            | 34.688           | 10             | 3  | 32       | 23/8                                |                    | 82.5190            |
| Ņ                       | OTE.—                           | This       | table                         | on heav            | y cardbo         | ard            | 11 ×   | 14       | ins., e                             | eyeletted,         | \$0.25.            |

Table 68 (Continued)

## Diameters. Areas and Circumferences of Circles

|          | am                              | , cc 1 3, | 1110               | as and C             |          | 41111            |           | 3 01                                | · CII CICS           |
|----------|---------------------------------|-----------|--------------------|----------------------|----------|------------------|-----------|-------------------------------------|----------------------|
| Dia      | m.,                             | _ 0       | Ъr.,               | Area.,               | Dia      | вm.,             | Ci        | r.,                                 | Area,                |
| Ft.      | Ins.                            | Ft.       | ir.,<br>Ins.       | Sq. Ft.              | Ft.      | Ins.             | Ft.       | r.,<br>Ins.                         | Sq. Ft.              |
|          |                                 |           |                    |                      |          |                  |           | 107/                                | 100 0515             |
| 10       | 4                               | 32        | 51/2               | 83.8627              | 15       | 3                | 47        | 107/8                               | 182.6545             |
| 10       | 5                               | 32        | 85/8               | 85.2211              | 15       | 4                | 48        | 21/2                                | 184 . 6555           |
| 10       | 6<br>7                          | 32        | 118/4              | 86:5903              | 15       | 5<br>6           | 48        | 51/8                                | 186.6684             |
| 10<br>10 | 8                               | 33<br>33  | 27/8<br>61/8       | 87.9697              | 15<br>15 | 7                | 48<br>48, | 81/4<br>113/8                       | 188.6923<br>190.7260 |
| 10       | 9                               | 33        | 914                | 89.3668<br>90.7627   | 15       | 8                | 49        | 25/8                                | 192 7716             |
| 10       | 10                              | 34        | 03%                | 92.1749              | 15       | 9                | 49        | 534                                 | 194.8282             |
| 10       | ii                              | 34        | 31/2               | 93.5986              | 15       | 10               | 49        | 87/8                                | 196.8946             |
| ii       | Ô                               | 34        | 65/8               | 95.0334              | 15       | iĭ               | 50        | ŏ´°                                 | 198.9730             |
| 11       | ĭ                               | 34        | 984                | 96.4783              | 16       | Õ                | 50        | 31/8                                | 201.0624             |
| ii       |                                 | 35        | 07/8               | 97.9347              | 16       | ì                | 50        | 61/4                                | 203.1615             |
| 11       | 2<br>3<br>4<br>5                | 35        | 41/8               | 99.4021              | 16       | 2                | 50        | 95/8                                | 205.2726             |
| 11       | 4                               | 35        | 71/4               | 100.8797             | 16       | 2<br>3<br>4      | 51        | 01/2                                | 207.3946             |
| 11       | 5                               | 35        | 105/8              | 102.3689             | 16       | 4                | 51        | 33/4                                | 209.5264             |
| 11       | 6                               | 36        | 11/2               | 103.8601             | 16       | 5<br>6           | 51        | $6\frac{1}{2}$                      | 211.6703             |
| 11       | 7                               | 36        | 41/2               | 105.3794             | 16       | 6                | 51        | 10                                  | 213.8251             |
| 11       | 8                               | 36        | 73/4               | 106.9013             | 16       | 7                | 52        | 11/8                                | 215.9896             |
| 11       | 9                               | 36        | 107/8              | 108.4342             | 16       | 8                | 52        | 41/4                                | 218.1662             |
| 11       | 10                              | 37        | 21/4               | 109.9772             | 16       | 9                | 52        | 73/8                                | 220.3537             |
| 11       | 11                              | 37        | 51/4               | 111.5319             | 16       | 10               | 52        | 101/2                               | 222.5510             |
| 12       | ,                               | 37        | 83/8               | 113.0976             | 16       | 11               | 53        | 15/8                                | 224.7603             |
| 12<br>12 | 1                               | 37        | 111/2              | 114.6732             | 17       | <b>0</b><br>1    | 53        | 4½<br>8                             | 226.9806             |
| 12       | 2<br>3<br>4                     | 38<br>38  | 25/8<br>53/4       | 116.2607<br>117.8590 | 17<br>17 | 2                | 53<br>53  | 111/8                               | 229.2105<br>231.4625 |
| 12       | 3                               | 38        | 81/8               | 119.4674             | 17       | 3                | 54        | 21/8                                | 233.7055             |
| 12       | 5                               | 39        | 0 8                | 121.0876             | 17       | 4                | 54        | 53/8                                | 235.9682             |
| 12       | 6                               | 39        | 31/4               | 122.7187             | 17       | 5                | 54        | 81/2                                | 238.2430             |
| 12       | 7                               | 39        | 63/8               | 124.3593             | 17       | 6                | 54        | 115%                                | 240.5287             |
| 12       | 8                               | 39        | 91/2               | 126.0127             | 17       | 6<br>7           | 55        | 27/8                                | 242.8241             |
| 12       | ğ                               | 40        | 05/8               | 127.6765             | 17       | 8                | 55        | 6                                   | 245.1316             |
| 12       | 10                              | 40        | 334                | 129.3504             | 17       | 9                | 55        | 91/8                                | 247.4500             |
| 12       | ii                              | 40        | 67/8               | 131.0369             | 17       | 10               | 56        | 01/4                                | 249.7781             |
| 13       | 0                               | 40        | 10                 | 132.7326             | 17       | 11               | 56        | 31/2                                | 252.1184             |
| 13       | 1                               | 41        | 11/8               | 134.4391             | 18       | 0                | 56        | $6\frac{1}{2}$                      | 254.4696             |
| 13       | 1<br>2<br>3<br>4<br>5<br>6<br>7 | 41        | 48/8               | 136.1574             | 18       | 1                | 56        | 95/8                                | 256.8303             |
| 13       | 3                               | 41        | 71/0               | 137.8867             | 18       | ~ <mark>2</mark> | 57        | 07/8                                | 259.2033             |
| 13       | 4                               | 41        | 105/8              | 139.6260             | 18       | 3                | 57        | 4                                   | 261.5872             |
| 13       | 5                               | 42        | 15/8               | 141.3771             | 18       | 4                | 57        | 71/8                                | 263.9807             |
| 13       | 9                               | 42        | 4.78               | 143.1391<br>144.9111 | 18       | 5<br>6           | 57        | 10½<br>13%                          | 266.3864<br>268.8031 |
| 13<br>13 | 8                               | 42<br>42  | 8<br>11½           | 146.6949             | 18<br>18 | 7                | 58<br>58  | 13/8<br>41/2                        | 271.2293             |
| 13       | ş                               | 43        | $\frac{1178}{214}$ | 148.4896             | 18       | 8                | 58        | 75/8                                | 273.6678             |
| 13       | 10                              | 43        | $\frac{274}{512}$  | 150.2943             | 18       | 9                | 58        | 1034                                | 276.1171             |
| 13       | 11                              | 43        | 85/8               | 152.1109             | 18       | 10               | 59        | 2                                   | 278.5761             |
| 14       | Ö                               | 43        | 1134               | 153.9484             | 18       | ii               | 59        | 51/8                                | 281.0472             |
| 14       | i                               | 44        | $2\frac{7}{8}$     | 155.7758             | 19       | Ö                | 59        | 81/4                                | 283.5294             |
| 14       | 2                               | 44        | 6                  | 157.6250             | 19       | 1                | 59        | $11\frac{3}{8}$                     | 286.0210             |
| 14       | 3<br>4                          | 44        | 91/8               | 159.4852             | 19       | 2                | 60        | 21/2                                | 288 5249             |
| 14       | 4                               | 45        | 01/4               | 161.3553             | 19       | 3                | 60        | 55/8                                | 291 3970             |
| 14       | 5                               | 45        | $3\frac{1}{2}$     | 163.2373             | 19       | 4                | 60        | 834                                 | 293.5641             |
| 14       | 6<br>7                          | 45        | 65/8               | 165.1303             | 19       | 5                | 60        | 111/9                               | 296.1107             |
| 14       | 7                               | 45        | 934                | 167.0331             | 19       | 6                | 61        | 31/8                                | 298.6483             |
| 14       | 8                               | 46        | 01/8               | 168.9479             | 19       | 7                | 61        | 614                                 | 301.2054             |
| 14       | 9                               | 46        | 71/                | 170.8735             | 19       | 8 ·<br>9         | 61<br>62  | 91/2                                | 303.7747<br>306.3550 |
| 14       | 10                              | 46        | 111/8              | 172.8091             | 19       | 10               | 62        | $\frac{0\frac{1}{2}}{3\frac{5}{8}}$ | 308.9448             |
| 14       | 11                              | 46<br>47  | 111/4              | 174.7565<br>176.7150 | 19<br>19 | 11               | 62        | 63/4                                | 311.5469             |
| 15<br>15 | 0<br>1                          | 47<br>47  | 11/2<br>45/8       | 178.6832             | 20       | 11               | 62        | 97/8                                | 314.1600             |
| 15       | 2                               | 47        | 734                | 180.6624             |          | •                | -         | 0/8                                 | <b>011.1000</b>      |
|          |                                 |           |                    | heavy cardbo         | ard 1    | 11 🗸             | 14 inc    | evele                               | tted. \$0.25         |
| 141      | J.E.—.                          | ruis car  | DIE OIL            | incavy cardio        |          | - ^              |           | 2,010                               |                      |

#### Table 69

## Long or Linear Measure

| 12   | inches    |  | = 1 foot    |
|------|-----------|--|-------------|
| 3    | feet,     | or 36 inches   | = 1 yard    |
| 51/2 | yards,    | or 198 ins., or 16½ ft.                                | = 1 rod     |
| 40   |           | or 7,920 ins., or 660 ft., or 220 yds.                 | = 1 furlong |
| 8    | furlongs, | or 6,330 ins., or 5,280 ft., or 1,760 yds. or 320 rods | = 1 mile    |

#### Measures in Occasional Use

| 1,000 | mils | = 1 inch             |   | ins.           |            | l span        |
|-------|------|----------------------|---|----------------|------------|---------------|
| 3     | ins. | = 1 palm<br>= 1 hand |   | ft.            | <b>=</b> 1 | military pace |
| 4     | ins. | = 1 hand             | 2 | yds., or 6 ft. | <b>=</b> 1 | fathom        |

#### TABLE 70

## Square Measure for Surface

| 1           | sq. in.    |                                   | -         | 1.2732 circular inches |
|-------------|------------|-----------------------------------|-----------|------------------------|
| 144         | sq. ins.,  | or 183.35 cir. ins.               |           | l square foot          |
| 9           | sq. ft.,   | or 1,296 sq. ins.                 |           | l square yard          |
| 100         | sq. ft.    |                                   | <b>**</b> | l square               |
| 301/4       |            | or 272¼ sq. ft.                   |           | l square rod           |
| 40          |            | or 1,210 sq. yds.                 | =         | l square rood          |
| 4           | sq. roods, | or 10 sq. chains, or 160 sq. rods |           |                        |
|             | or 4,84    | 0 sq. yds., or 43,560 sq. ft.     |           | l acre                 |
| <b>64</b> 0 | acres, one | section, or 27,878,400 sq. ft.    | =         | l square mile          |
|             |            |                                   |           |                        |

One square inch = 1.2732 circular inches. An acre = a square whose side is 208.71 feet.

## TABLE 71

## Liquid Measure

| 4      | gills    | or 16 fluid ounces  | = 1 pint         |
|--------|----------|---------------------|------------------|
| 4<br>2 | pints    | or 8 gills          | = 1 quart        |
| 4      | quarts.  | or 128 fluid ounces | = 1 gallon       |
| 311/2  | gallons  |                     | = 1 barrel       |
|        | gallons  |                     | = 1 tierce       |
| 63     | gallons, | or 2 barrels        | = 1 hogshead     |
|        |          | or 2 tierces        | = 1 puncheon     |
| 126    |          | or 2 hogsheads      | = 1 pipe or butt |
| 2      | pipes.   | or 3 puncheons      | = I tun          |

A gallon of water at 62° F. weighs 8.3356 pounds. The U. S. gallon contains 231 cubic inches. A measure six inches high and seven inches in diameter will hold almost a gallon, or one 6 inches high by 3½ inches in diameter one quart; or one three inches high and three and one-half inches in diameter will hold one pint. The British Imperial gallon contains 277.274 cubic inches or 1.20032 U. S. gallons.

#### Dry Measure

| 2 pints, or 67.2 cu. ins.     | = 1 quart  |
|-------------------------------|------------|
| 4 quarts, or 268.8 cu. ins.   | = 1 gallon |
| 2 gallons, or 8 quarts        | = 1 peck   |
| 4 pecks. or 2,150,42 cu. ins. | = 1 bushel |

The standard U. S. bushel is the Winchester bushel which is in cylinder form 18½ inches diameter and 8 inches deep. The British Imperial bushel equals 8 Imperial gallons or 2218.192 cubic inches. Eight Imperial bushels equal one British quarter.

The following measures are sanctioned by custom or law:

| 32 lbs. oats 45 lbs. timothy seed 48 lbs. barley 50 lbs. indian meal 56 lbs. rye 56 lbs. Indian corn 60 lbs. wheat 60 lbs. potatoes 60 lbs. clover seed | = 1 bushel<br>= 1 "<br>= 1 "<br>= 1 "<br>= 1 "<br>= 1 "<br>= 1 "<br>= 1 " | 56 lbs. butter 100 lbs. meal or flour 100 lbs. grain or flour 100 lbs. dry fish 100 lbs. nails 196 lbs. flour 200 lbs. beef or pork 280 lbs. salt N. Y. 280 lbs. lime | = 1 firkin<br>= 1 sack<br>= 1 cental<br>= 1 quintal<br>= 1 cask<br>= 1 barrel<br>= 1 "<br>= 1 " |
|---|---|---|---|
| 80 lbs. lime  | = 1 "   | 400 lbs. Portland cement  | = 1 "   |

## TABLE 73

#### Cubic Measure—Measures of Volume

#### TABLE 74

## Apothecaries' Fluid Measure

In the U. S. a fluid ounce is the 128th part of a U. S. gallon, or 1.805 cubic inches. It contains 456.3 grains of water at 39° F. In Great Britain the fluid ounce is 1.732 cubic inches and contains 1 ounce avoirdupois, or 437.5 grains of water at 62° F.

## Avoirdupois or Commercial Weight

```
27.343 grains
16 drachms,
                                                 = 1 drachm
                             or 437.5 grains = 1 ounce, oz.
                            or 7,000 grains = 1 pound, lb.
= 1 quarter, qr.
or 112 pounds = 1 hundredweight, cwt.
      16 ounces,
      28 pounds
      4 quarters, or 112 poun
20 hundredweight, or 2,240 lb.
                                                 = 1 gross or long ton
                                                 = 1 net or short ton
   2,000 pounds
2,204.6 pounds
                                                 = 1 metric ton
      14 pounds
                                                 = 1 stone
     100 pounds
                                                 = 1 quintal
```

The drachm, quarter, hundredweight, stone and quintal are now seldom used in the United States.

## TABLE 76

## Troy Weight

| 04                     |                 | _ 1                   |
|------------------------|-----------------|-----------------------|
| 24 grains              |                 | = 1 pennyweight, dwt. |
| 20 pennyweights,       | or 480 grains   | = 1 ounce, oz.        |
| 12 ounces.             | or 5,760 grains | = 1 pound, lb.        |
|                        | O1 0,100 B.u    | - 40 T                |
| 1 U. S. cent           |                 | = 48 T. grains        |
| 1 U. S. nickel         |                 | = 77.16 T. grains     |
| 1 U. S. dime,          | silver          | = 38.58 T. grains     |
| 1 U. S. quarter dollar | . silver        | = 96.45 T. grains     |
| 1 U. S. half dollar,   | silver          | = 192 T. grains       |
| 1 U. S. dollar.        | silver          | = 412.5 T. grains     |
| 1 U. S. dollar.        | gold            | = 25.8 T. grains      |
| 1 U. S. quarter eagle, |                 | = 64.5 T. grains      |
| 1 U. S. half eagle,    | \$5, gold       | = 129 T. grains       |
| 1 U. S. eagle,         | \$10, gold      | = 258 T. grains       |
|                        |                 |                       |
| 1 U. S. double eagle,  | \$20, gold      | = 516 T. grains       |

Troy weight is used for weighing gold and silver. The grain is the same as Avoirdupois, Troy, and Apothecaries' weights. A carat, for weighing diamonds = 3.168 grains = 0.200 gramme. In gold it indicates the fineness and means 1/24 part: Thus 18 carats fine is 18/24 gold and 6/24 alloy.

## TABLE 77

## Apothecaries' Weight

| 20 grains                  | = 1 scruple    | Э |
|----------------------------|----------------|---|
| 3 scruples, or 60 grains   | = 1 drachm     | 3 |
| 8 drachms, or 480 grains   | = 1 ounce, oz. | 3 |
| 12 ounces, or 5,760 grains | = 1 pound, lb. | _ |

## Metric and U. S. Equivalent Measures

## Measures of Length

| French  | British and U.S.  |
|---|---|
| 1 meter 0.3048 meter 1 centimeter 2.54 centimeters 1 millimeter 25.4 millimeters 1 kilometers 1 kilometer 1.60935 kilometers 1 myriameter | = 39.37 inches, or 3.28083 feet, or 1.09361 yds.<br>= 1 foot<br>= 0.3937 inch<br>= 1 inch<br>= 0.03937 inch, or about ½ inch<br>= 1 inch<br>= 1,093.61 yards, or 0.62137 mile<br>= 1 mile<br>= 6.2137 miles |
|   | ****  |

## Table 79

## Square or Surface Measure

| French                    | British and U.S.                        |
|---------------------------|---|
| 1 sq. meter               | = 10.7639 sq. feet, or 1.196 sq. yards  |
| 0.836 sq. meter           | = 1 sq. yard                            |
| 0.0920 sq. meter          | = 1 sq. foot                            |
| 1 sq. centimeter          | = 0.15500 sq. inch                      |
| 6.452 sq. centimeters     | = 1 sq. inch                            |
| 1 sq. cemtimeter          | = 0.00155 sq. inch $= 1.973$ circ. mils |
| 645.2 sq. cemtimeters     | = 1 sq. inch                            |
| 1 centiare = 1 sq. meter  | = 10.764 sq. feet, or 1.196 sq. yards   |
| 1 are, or 1 sq. decameter | = 1,076.41 sq. feet, or 119.6 sq. yards |
| 1 hectare, or 100 ares    | = 107.641  sq. feet  = 2.4711  acres    |
| 1 sq. kilometer           | = 0.386109  sq. miles = 247.11  acres   |
| 1 sq. myriameter          | = 38.6109 sq. miles                     |

## TABLE 80

## Cubic or Volume Measure

| French                           | British and U.S.                           |
|----------------------------------|--|
| 1 cu. meter                      | = 35.314 cu. feet, or 1.308 cu. yards      |
| 0.7645 cu. meter                 | = 1 cu. yard                               |
| 0.02832 cu. meter                | = 1 cu. foot                               |
| 1 cu. decimeter                  | = 61.0234 cu. inches, or 0.035314 cu. foot |
| 28.32 cu. decimeters             | = 1 cu. foot                               |
| 1 cu. centimeter                 | = 0.061 cu. inch                           |
| 16.387 cu. centimeters           | = 1 cu. inch                               |
| 1 cu. centimeter = 1 milliliter  | = 0.061 cu. inch                           |
| 1 deciliter                      | = 6.102 cu. inches                         |
| 1 liter = 1 cu. decimeter        | = 61.0234 cu. inches = 1.05671 qts, U. S.  |
| 1 hectoliter or decistere        | = 3.5314 cu. feet $= 2.8375$ bu., U.S.     |
| 1 stere, kiloliter, or cu. meter | = 1.308 cu. yards $= 28.37$ bu., U. S.     |

## Liquid and Dry Measures

The liter is the primary unit of measures of capacity, and is a cube, each of whose edges is a tenth of a meter in length.

The hectoliter is the unit in measuring large quantities of grain, fruits, roots and liquids.

```
      10 mikiliters (ml)
      = 1 centiliter (cl)
      = 0.338 fluid ounce

      10 decnititers
      = 1 liter (l)
      = 0.845 liquid gill

      10 deciliters
      = 1 liter (l)
      = 1.0567 liquid quarts

      10 decaliters
      = 1 decaliter
      = 2.6417 gallons

      10 decaliters
      = 1 hectoliter (h)
      = 2 bushels, 3.35 pecks

      10 hectoliters
      = 28 bushels, 1½ pecks
```

A centiliter is about ½3 of a fluid ounce; a liter is about 1 1/18 liquid quarts, or 9/10 of a dry quart; a hectoliter is about 25% bushels; and a kiloliter is one cubic meter, or stere.

#### TABLE 82

#### Weights

The gram is the primary unit of weights, and is the weight in a vacuum of a cubic centimeter of distilled water at the temperature of 39.2° F.

```
10 milligrams (mg) = 1 centigram (cg) =
                                                 0.1543 troy grain
                                               1.543 troy grains
1.5432 troy grains
15.432 troy grains
0.3527 avoirdupois ounce
3.5274 avoirdupois ounces
2.2046 avoirdupois pounds
                  = 1 decigram (dg) =
10 centigrams
10 decigrams
                    = 1 gram (g)
10 grams
10 decagrams
                     = 1 decagram
                     = 1 hectogram
10 hectograms
10 kilograms
                     = 1 kilogram (kg) =
                                                22.046 avoirdupois pounds
                     = 1 myriagram
10 myriagrams
                     = 1 quintal (q)
                                               220.46 avoirdupois pounds
                                    10 quintals
                     = 1 tonneau (t)
 1 kilogram per kilometer
 1 pound per thousand feet
                                   = 1.4882 kilograms per kilometer
 1 kilogram per sq. millimeter
                                     = 1.423 pounds per sq. inch
 1 pound per sq. inch
                                     = 0.000743 kilogram per sq. millimeter
```

The gram is used in weighing gold, jewels, letters and small quantities of things. The kilogram, or, for brevity, kilo, is used by grocers; and the tonneau, or metric ton, is used in finding the weight of very heavy articles.

A gram is about 15½ grains troy; the kilo about 2½ pounds avoirdupois; and the metric ton, about 2,205 pounds.

A kilo is the weight of a liter of water at its greatest density; and the metric ton, of a cubic meter of water.

Metric numbers are written with the decimal point (.) at the right of the figures denoting the unit; thus the expression, 15 meters 3 centimeters, is written, 15.03 m.

When metric numbers are expressed by figures, the part of the expression at the left of the decimal point is read as the number of the unit, and the part at the right, if any, as a number of the lowest denomination indicated, or as a decimal part of the unit; thus, 46.525 m is read 46 meters and 525 millimeters, or 46 and 525 thousandths meters.

In writing and reading metric numbers, according as the scale is 10, 100 or 1,000, each denomination should be allowed one, two or three orders of figures.

Table 83

Comparison of U. S. and Foreign Weights and

Measures

|              | Avoirdupois V<br>Name U. |          |           |             |          |           |
|--------------|--------------------------|----------|-----------|-------------|----------|-----------|
| Austria      | Pfund                    | 1.234    | Eimer     | 14 . 95     | Nutze.   | 1.745     |
| Bremen       | Pfund                    | L.099    | Stubcher  | 1851        | Scheffel | 2 . 103   |
| Buenos Ay's  | Libra1                   | 1.0127   | Frasco.   | 627         | Fanega   | 3.894     |
| China        | Catty                    | L.3333   |           |             | Sei      | 3.472     |
| Cuba         | Libra                    | 1.0119   | Arroba    | 4 . 1       | Fanega   | 3.124     |
| Denmark      | Pund                     | l . 1025 | Pott      | 255         | Fonda.   | 3.948     |
| England      | Pound !                  | ١.       | Imp. Gal  | 11 1.2003   | Imp. Bu  | ish1.0315 |
| France       | Kilo                     | 2.2046   | Liter     | 2642        | Hectoli  | ter2.838  |
| Hamburg      | Pfund                    | 1.0683   | Ohm       | 48.278      | Fass     | 1.56      |
| Japan        | Monme                    | 3.858    | Masa      | 459         |          |           |
| Mexico       | Libra                    | L.0119   | Frasco.   | 4           |          | 1.547     |
| Nor. & Swdn  | . Skalpund               | .937     | Kamea.    | 662         |          |           |
| Papal States | Libra                    | .7475    | Barile (w | v'e).15.412 |          | 836       |
| Portugal     | Libra                    | 1.0119   | Almude.   | 4.422       |          | e393      |
| Russia       | Fuat                     | 1.097    |           | 3.249       |          | rt5.956   |
| Turkey       | Oke                      | 2.834    |           |             |          | 1.001     |

TABLE 84

## Decimal Equivalents of the Fractional Parts of an Inch

| Fractions                         | Decimals 1                      | Aillimeter                    | Fractions                            | ١                                       | Decimals                        | Millimeter                    |
|-----------------------------------|---------------------------------|-------------------------------|--------------------------------------|---|---------------------------------|-------------------------------|
| 1/64 inch = 2/64 " = 3/64 " =     | 0.015625<br>0.03125<br>0.046875 | 0.3968<br>0.7937<br>1.1906    | 33/64 inch<br>34/64 "<br>35/64 "     | =                                       | 0.515625<br>0.53125<br>0.546875 | 13.0966<br>13.4934<br>13.8903 |
| 1/16 " = 5/64 " = 6/64 " =        | 0.0625<br>0.078125              | 1.5875<br>1.9843<br>2.3812    | <b>9/16 "</b> 37/64 "                | =                                       | 0.5625<br>0.578125<br>0.59375   | 14.2872<br>14.6841<br>15.0809 |
| 7/64 " = 1/8 " =                  | 0.109375<br>0.125               | 2.7780<br>3.1749              | 39/64 "<br><b>5/8</b> "              | =                                       | 0.609375<br>0.625               | 15.4778<br>15.8747            |
| 10/64 " =<br>11/64 " =            | 0.15625<br>0.171875             | 3.5718<br>3.9686<br>4.3655    | 42/64 "<br>43/64 "                   | =                                       | 0.640625<br>0.65625<br>0.671875 | 16.2715<br>16.6684<br>17.0653 |
| 13/64 " =<br>14/64 " =            | 0.1875<br>0.203125<br>0.21875   | 4.7624<br>5.1592<br>5.5561    | 11/16 "<br>45/64 "<br>46/64 "        | ======================================= | 0.6875<br>0.703125<br>0.71875   | 17.4621<br>17.8590<br>18.2559 |
| 1/4 " = 17/64 " =                 |                                 | 5.9530<br>6.3498<br>6.7467    | 47/64 "<br><b>3/4</b> "<br>49/64 "   | =                                       | 0.734375<br>0.750<br>0.765625   | 18.6527<br>19.0496<br>19.4465 |
| 18/64 " = 19/64 " = 5/16 " =      | 0.3125                          | 7.1436<br>7.5404<br>7.9373    | 50/64 "<br>51/64 "<br><b>13/16</b> " | =                                       | 0.78125<br>0.796875<br>0.8125   | 19.8433<br>20.2402<br>20.6371 |
| 21/64 " = 22/64 " = 23/64 " =     | 0.35375<br>0.359375             | 8.3342<br>8.7310<br>9.1279    | 53/64 "<br>54/64 "<br>55/64 "        | =                                       | 0.828125<br>0.84375<br>0.859375 | 21.0339<br>21.4308<br>21.8277 |
| 3/8 " =<br>25/64 " =<br>26/64 " = | 0.390625<br>0.40625             | 9.5248<br>9.9216<br>10.3185   | 7/8 "<br>57/64 "<br>58/64 "          | =                                       | 0.875<br>0.890625<br>0.90625    | 22.2245<br>22.6214<br>23.0183 |
| 27/64 " = 7/16 " = 29/64 " =      | 0.4375<br>0.453125              | 10.7154<br>11.1122<br>11.5091 | 59/64 "<br>15/16 "<br>61/64 "        | =                                       | 0.921875<br>0.9375<br>0.953125  | 23.4151<br>23.8120<br>24.2089 |
| 30/64 " = 31/64 " = 1/2 " =       | 0.484375                        | 11.9060<br>12.3029<br>12.6997 | 62/64 "<br>63/64 "<br>1 "            | =                                       | 0.96875<br>0.983275<br>1.000    | 24.6057<br>25.0057<br>25.3995 |

TABLE 85

# Inches and Fractions Expressed in Decimals of One Foot

| Inches | 0    | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   |
|--------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0      |      |      |      |      |      |      |      |      |      | 7500 |      |      |
| 1/8    | 0104 | 0938 | 1771 | 2604 | 3438 | 4271 | 5104 | 5938 | 6771 | 7604 | 8438 | 9271 |
| 1/4    | 0208 | 1042 | 1875 | 2708 | 3542 | 4375 | 5208 | 6042 | 6875 | 7708 | 8542 | 9375 |
| 3/8    | 0313 | 1146 | 1979 | 2813 | 3646 | 4479 | 5313 | 6146 | 6979 | 7813 | 8646 | 9479 |
| 1/2    | 0417 | 1250 | 2083 | 2917 | 3750 | 4583 | 5417 | 6250 | 7083 | 7917 | 8750 | 9583 |
| 5/8    | 0521 | 1354 | 2188 | 3021 | 3854 | 4688 | 5521 | 6354 | 7188 | 8021 | 8854 | 9688 |
| 3/4    | 0625 | 1458 | 2292 | 3125 | 3958 | 4792 | 5625 | 6458 | 7292 | 8125 | 8958 | 9792 |
| 7/8    |      |      |      |      |      |      |      |      |      | 8229 |      |      |

Table 86

# Weights of Various Substances Per Cubic Foot in Pounds

| Material             | Cubic  | ht per<br>Foot,<br>bs. | Material   | Cubic  | ht per<br>Foot,<br>bs. |
|----------------------|--------|------------------------|--|--------|------------------------|
| Aluminum             | 162 to | 166.5                  | Iron:  |        |                        |
| Antimony             |        | 421.6                  | Cast   |        | 450.                   |
| Ashes                | 37 to  | 43.                    | Wrought  |        | 480.                   |
| Asphaltum            |        | 87.                    | Lead   |        | 709.7                  |
| Bismuth              |        | 612.4                  | Lime, quick, in bulk   | 50 to  | 60.                    |
| Brass:               |        |                        | Limestone  | 140 to | 185.                   |
| Cast                 |        | 504                    | Magnesia, Carbonate  |        | 150.                   |
| Copper + Zinc        |        |                        | Magnesium  |        | 109.                   |
| 80 20)               |        | 536.3                  | Manganese  |        | <b>499</b> .           |
| 70 30                |        | 523.8                  | Marble   | 160 to | 180.                   |
| 00 40 (              |        | 521.3                  | Masonry:   |        |                        |
| 50 \ 50              |        | 511.4                  | Dry rubble   | 140 to | 160.                   |
| Brick:               |        |                        | Dressed  | 140 to | 180.                   |
| Soft                 |        | 100.                   | Mercury $\begin{cases} 32^{\circ} \dots \\ 60^{\circ} \dots \end{cases}$   |        | 848.6                  |
| Common               |        | 112.                   | Mercury { 60°  |        | 846.8                  |
| Hard                 |        | 125.                   | $ \frac{\text{Mercury}}{60^{\circ} \dots} \begin{cases} \frac{32^{\circ}}{60^{\circ} \dots} \\ 212^{\circ} \dots \end{cases} $ |        | 834.4                  |
| Pressed              | 135 to | 150.                   | Mica   | 175 to | 183.                   |
| Fire                 | 140 to | 150.                   | Mortar   | 90 to  | 100.                   |
| Sand-lime            |        | 136.                   | Mud, soft flowing  | 104 to | 120.                   |
| Brickwork in—        |        |                        | Nickel   |        | <b>548.7</b>           |
| Mortar               |        | 100.                   | Pitch  |        | 72.                    |
| Cement               |        | 112.                   | Plaster of Paris   | 93 to  |                        |
| Bronze:              |        |                        | Platinum   |        | 1347.0                 |
| Cop., 95 to 80 \     |        | 552                    | Potassium  |        | 53.9                   |
| Tin 5 to 20 \}       |        |                        | Quartz   |        | 165.                   |
| Cadmium              |        | 539.                   | Rosin  |        | <b>69</b> .            |
| Calcium              |        | 98.5                   | Salt:  |        | 4.5                    |
| Cement:              |        |                        | Coarse, N. Y   |        | 45.                    |
| American, Rosendale  | 3      | 56.                    | Fine, Liverpool  | 00.4-  | 49                     |
| Louisville, Portland | •••    | 50.                    | Sand   | 90 to  | 110.                   |
| loose                | 90 to  | 92.                    | * wet  | 118 to | 129 .<br>150 .         |
| in barrel            |        | 115.                   | Sandstone  | 140 to | 655.1                  |
| Chromium             | 100 4- | 311.8                  | Silver   | 170 to | 180.                   |
| Clay                 | 120 to | 150.<br>533.1          | Slate  | 110 10 | 100.                   |
| Cobalt               | 100 4- |                        | Snow:  | 5 to   | 12.                    |
| Concrete             | 120 to | 155.552.               | Freshly-fallen   | 15 to  | 50.                    |
| Copper               |        | 332.                   | Moistened<br>Soapstone   | 166 to | 175.                   |
| Earth:               | 72 to  | 80.                    | Sodium   | 100 10 | 60.5                   |
| Loose                | 90 to  | 110.                   | Steel  |        | 489.6                  |
| Rammed               | 90 10  | 250.                   | Stone:   |        | 400.0                  |
| Emery                | 156 to | 172.                   | Various  | 135 to | 200.                   |
| Glass                | 180 to | 196.                   | Crushed  | 100 00 | 100.                   |
| flint                |        |                        | Tar  |        | 62.                    |
| Gneiss }             | 160 to | <b>17</b> 0.           | Tile   | 110 to |                        |
| Granice)             |        |                        | Tin  |        | 458.3                  |
| Gold, pure:          | 1200 0 | to 1204                | Titanium   |        | 330.5                  |
| Hammered             |        | 1217                   | Trap Rock  | 170 to |                        |
| Gravel               | 100 to | 120.                   | Tungsten   |        | 1078.7                 |
| Gypsum               | 130 to | 150.                   | Water:   |        |                        |
| Hornblende           | 200 to | 220.                   | Distilled at 60° F.  |        | 62.35                  |
| Ice                  | 55 to  | 57.                    | Sea  |        | 64.08                  |
| Iridium              |        | 1396.                  | Zinc   |        | 436.5                  |
|                      |        |                        |  |        |                        |

## Weight of Liquids Per Gallon

| 1 Gallon   | Lbs.                                 | 1 Gallon   | Lbs.                                 |
|--|--------------------------------------|--|--------------------------------------|
| Acid, Nitric Acid, Sulphuric Acid, Muriatic Alcohol, Commerce Alcohol, Proof Spirit Naphtha Oil, Linseed | 15.42<br>10.<br>6.74<br>7.94<br>7.08 | Oil of Turpentine. Oil, Whale Petroleum Vinegar Salt Water Tar Distilled Water | 7.25<br>7.35<br>8.43<br>8.59<br>8.43 |

#### Table 88

## Weight of Water

| I     | cubic inchis equ               | ial to | .03617     | pound.         |
|-------|--------------------------------|--------|------------|----------------|
| I 2   | cubic inchesis equ             | ial to | ·434       | pound.         |
| 1     | cubic footis equ               | ıal to | 62.5       | pounds.        |
| 1     | cubic footis equ               | ıal to | 7.50       | U. S. gallons. |
| т.8   | cubic feetis equ               | ıal to | 112.00     | pounds.        |
| 35.84 | cubic feetis equ               | ial to | 2240.00    | pounds.        |
| 1     | cylindrical inis equ           | ıal to | .02842     | pound.         |
| I 2   | cylindrical insis equ          | ıal to | .341       | pound.         |
| I     | cylindrical ftis equ           | ial to | 49.10      | pounds.        |
| I     | cylindrical ftis equ           | ial to | 6.00       | U. S. gallons. |
| 2.282 | cylindrical ftis equ           | ial to | 112.00     | pounds.        |
| 45.64 | cylindrical ftis equ           | ıal to | 2240.00    | pounds.        |
| 13.43 | U. S. gallonsis equ            | ıal to | 112.00     | pounds.        |
| 268.8 | U. S. gallonsis equ            | ial to | 2240.00    | pounds.        |
| (     | enter of pressure is at two-th | irds o | lepth from | surface.       |

## TABLE 89

## Pressure of Water Per Square Inch, Due to Different Heads, from 1 to 250 Feet

| Head | Pressure in Lbs. | Head | Pressure in Lbs. | Head | Pressure in Lbs. |
|------|------------------|------|------------------|------|------------------|
| 1    | 4335             | 19   | 8.237            | 37   | 16.04            |
| 2    | .8670            | 20   | 8.670            | 38   | 16.47            |
| 3    | 1.300            | 21   | 9.104            | 39   | 16.91            |
| 4    | 1.734            | 22   | 9.537            | 40   | 17.34            |
| 5    | 2.167            | 23   | 9.971            | 50   | 21.67            |
| 6    | 2.601            | 24   | 10.40            | 100  | 43.35            |
| 7    | 3.035            | 25   | 10.84            | 110  | 47.68            |
| 8    | 3.408            | 26   | 11.27            | 120  | 52.02            |
| 9    | 3.902            | 27   | 11.70            | 130  | 56.36            |
| 10   | 4.335            | 28   | 12.14            | 140  | 60.69            |
|      | 4.768            | 29   | 12.57            | 150  | 65.03            |
| 11   |                  |      |                  |      |                  |
| 12   | 5.202            | 30   | 13.00            | 160  | 69.36            |
| 13   | 5.636            | 31   | 13.44            | 170  | <b>73.70</b>     |
| 14   | 6.069            | 32   | 13.87            | 180  | 78.03            |
| 15   | 6.503            | 33   | 14.31            | 190  | 82.36            |
| 16   | 6.936            | 34   | 14.74            | 200  | 86.70            |
| 17   | 7.370            | 35   | 15.17            | 225  | 97.41            |
| 18   | 7.803            | 36   | 15.60            | 250  | 108.37           |
| 10   | 1.000            | 90   | 10.00            | 200  | 100.01           |

TABLE 90

## Strength and Weight of Rope

Specifications of the United States Navy, June, 1910

| Circum         | 1 Diameters          | Manila hem              | p, plain laid             | American hemp, tarred, plain laid, three stands |                           |  |
|----------------|----------------------|-------------------------|---------------------------|---|---------------------------|--|
| ferences<br>in | es in                | Weights<br>lbs. per ft. | Breaking-<br>loads<br>lb. | Weights<br>lbs. per ft.                         | Breaking-<br>loads<br>lb. |  |
| 3/4            | 0.24                 | 0.02                    | 700                       | 0.051   | 750                       |  |
| 1 1            | 0.32                 | 0.033                   | 1,000                     | 0.06  | 1,060                     |  |
| 11/4           | 0.40                 | 0.05                    | 1,800                     | 0.067   | 1,670                     |  |
| $1\frac{1}{2}$ |                      | 0.083                   | 2,500                     | 0.083   | 2,340                     |  |
| $1\frac{3}{4}$ | 0.56                 | 0.10                    | 3,000                     | 0.105   | 3,325                     |  |
| <b>2</b>       | 0.64                 | 0.14                    | 4,000                     | 0.16  | 3,955                     |  |
| $2\frac{1}{4}$ | 0.72                 | 0.17                    | 5,000                     | 0.21  | 4,720                     |  |
| $2\frac{1}{2}$ | 0.80                 | 0.21                    | 5,500                     | 0.26  | 5,770                     |  |
| $2\frac{3}{4}$ | 0.87                 | 0.26                    | 6,600                     | 0.32  | 7,000                     |  |
| 3              | 0.95                 | 0.305                   | 7,800                     | 0.37  | 8,400                     |  |
| 31/4           | 1.03                 | 0.36                    | 9,200                     | 0.44  | 9,800                     |  |
| 31/2           | 1.16                 | 0.42                    | 10,500                    | 0.51  | 11,200                    |  |
| $3\frac{3}{4}$ | 1.19                 | 0.47                    | 12,200                    | 0.59  | 13,000                    |  |
| . 4            | 1.27                 | 0.54                    | 13,700                    | 0.67  | 14,550                    |  |
| 4½<br>5        | 1.43                 | 0.67                    | 17,400                    |   |                           |  |
| 5              | 1.59                 | 0.83                    | 21,800                    |   |                           |  |
| $5\frac{1}{2}$ | 1.75                 | 1.00                    | 27,700                    |   |                           |  |
| 6              | 1.90                 | 1.21                    | 31,000                    |   |                           |  |
| . <b>7</b>     | <b>2</b> . <b>22</b> | 1.63                    | 36,200                    |   |                           |  |
| . 8            | <b>2</b> . <b>54</b> | 2.17                    | 47,300                    |   |                           |  |
| 9              | 2.87                 | 2.70                    | 60,000                    |   |                           |  |
| 10             | 3.14                 | 3.33                    | <b>74,20</b> 0            |   |                           |  |

Manila-hemp rope is made in three strands and in sizes up to 3 inches in circumference; four strands are used for sizes larger than 3 inches in circumference.

#### Working-Load

The Working-Load for slow-speed derrick and hoisting-service is usually taken at one-seventh the Breaking-Load. This makes some allowance for the loss of strength at splices and connections. The deterioration of rope exposed to the weather is very rapid.

## Boiling Point of Acid, Oil, Water, Etc., at Atmospheric Pressure 14.7 lb. Per Sq. Inch

| 1                            | Degrees<br>F. | •                               | Degrees<br>F.  |
|------------------------------|---------------|---------------------------------|----------------|
| Alcohol                      | 173           | Mercury                         | . 676 ·        |
| Aniline                      | 363<br>146    | Naphthaline                     | . 248          |
| Average sea-water<br>Benzine | 213.2<br>176  | Oil of turpentine<br>Phosphorus | . 315<br>. 554 |
| Bromine                      | 145<br>118    | Saturated brine                 | . 226          |
| Chloroform                   | 140<br>100    | Sulphuric acid                  | . 590          |
| Ether, sulphuric             | 597           | Water<br>Wood spirit            | . 212<br>. 150 |

The boiling-points of liquids increase as the pressure increases.

#### TABLE 92

## Melting Points of Various Materials

| Degrees<br>F.   | Degrees<br>F.                            |
|---|--|
| Acetic acid 113 Alloy, 1½ tin, 1 lead 334, 367† Alluminum 1157*, 1214† Antimony 1150, 1169† Bismuth 504 to 507 Brass melts at 1873 Bronze 1692 Bromine - 9.5 Cadmium 442 Carbonic acid 102 Cast iron: White 1922, 2075† Gray 2012 to 2786, 2228* Copper 1929*, 1943† Gold 1913*, 1947† Hyponitric acid 16 Ice 32 Iodine 225 Iridium 4280 Lead 618*, 620t Magnesium 1200 Margaric acid 131 to 140 Mercury -39, 38† Molybdenum 4622 NaCl, common salt 1472† | Palladium                                |
| Nickel         2600†           Nitro-glycerine         45   | Wrought iron 2732 to 2912, 2737*<br>Zinc |

The figures given above are by Clark (on the authority of Pouillet, Claudel, and Wilson), except those marked \*, which are given by Prof. Roberts-Austen, those marked -, which are from H. von Wartenberg, and those marked †, which are given by Dr. J. A. Harker.

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