STRAIGHT LINE ENGINEERING DIAGRAMS

MANIFOLD & POOLE

STRAIGHT LINE ENGINEERING DIAGRAMS

— BY —

MANIFOLD & POOLE

PUBLISHED BY

Technical Publishing Co.

604 MISSION ST. SAN FRANCISCO

CONTENTS

INTRODUCTION

Field engineers and others must frequently make rough and ready estimates for construction. They have neither time nor information available for careful calculation, yet the expenditure of large sums is based upon the accuracy of their estimates. This volume contains a number of computing diagrams giving rapid, approximate solutions of the common problems in the design and construction of electric power systems and similar undertakings.

Beginning with the design of foundations, arches and reinforced concrete walls, the strength and dimensions of all necessary material can be readily determined. Stadia readings can be quickly reduced, the capacity of pipes and flumes easily found, the economic size of pipe selected and the weight of material for wood-stave or steel pipe lines determined. Where steam is to be used the horse-power of different sized engines can be mechanically determined and the power transmitted by shafting, gearing and belting calculated. Electric wiring problems and those of pole line construction are worked simply and the comparative cost of power easily shown.

All this and more may be done without knowledge of mathematics by the simplest mechanical process; no hand book nor slide rule nor table of logarithms are necessary in any of the problems covered. Detailed explanation and typical examples are given on the page opposite each of the diagrams.

Rules for Operation

The pocket in the front cover contains a piece of clear celluloid on which is scribed a straight line. This is called the index and will be found convenient in the solution of the problem. Instead of this line, however, a string or straight edge can be used.

The diagrams are all solved in a similar manner, as follows: From a known point on any scale a line is carried to a known point on another scale, and where it cuts the remaining scales, which are to be read simultaneously as shown by arrow points, solutions are found. On several of the diagrams, it is necessary to revolve the index around a point as shown by a double arrow; this is easily accomplished by placing the point of a pencil over the inter-section of the index line and the turning scale. On several of the diagrams no arrow points are shown, in which case all scales are read simultaneously.

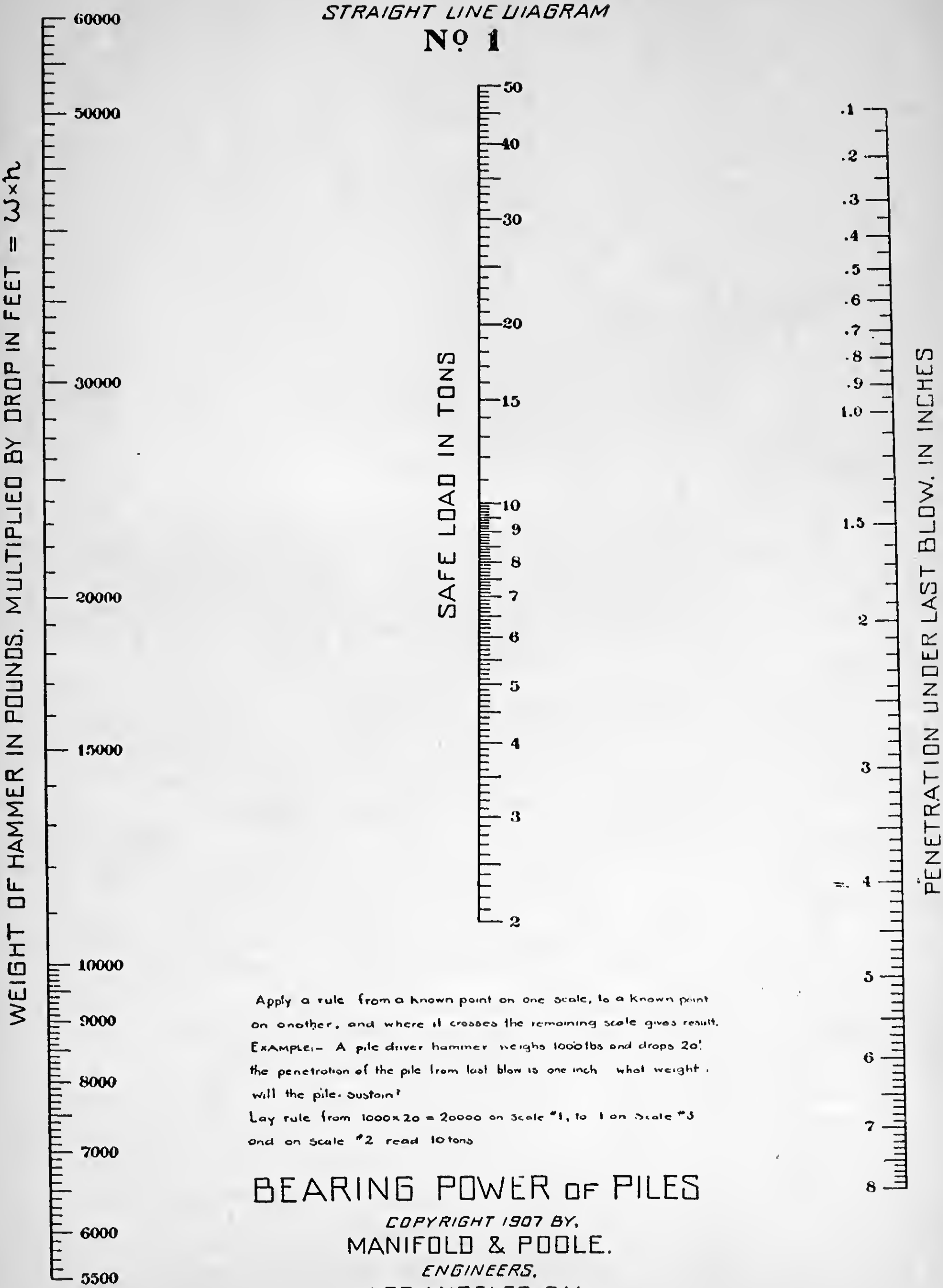
Explanation of Diagram No. 1

Bearing Power of Piles

This diagram indicates the safe load in tons that may be carried by either a timber or concrete pile, considered either as a column resting on a hard stratum or as being supported by the friction of the earth on its sides. It is assumed that the pile is driven by a hammer of known weight and fall which gives a measured penetration under the last or test blow which does not bounce. This blow should be on sound wood while the preceding penetrations have been decreasing at an approximately constant rate. The result is not reliable if there has been any crushing of the head, body or foot of the pile. The diagram consists of three scales, the first is laid off proportionately to the hammer weight and its fall, the second to the safe load in tons and the third to the penetration in inches under the last blow. A typical problem is solved on the diagram. The calculations are based on the generally accepted formula $P = \frac{2\,W\,h}{s + 1}$

STRAIGHT LINE DIAGRAM

No. 1



Apply a rule from a known point on one scale, to a known point on another, and where it crosses the remaining scale gives result.

EXAMPLE:– A pile driver hammer weighs 1000 lbs and drops 20'. the penetration of the pile from last blow is one inch what weight will the pile sustain?

Lay rule from 1000×20 = 20000 on Scale #1, to 1 on Scale #3 and on Scale #2 read 10 tons

BEARING POWER OF PILES

MANIFOLD & POOLE.

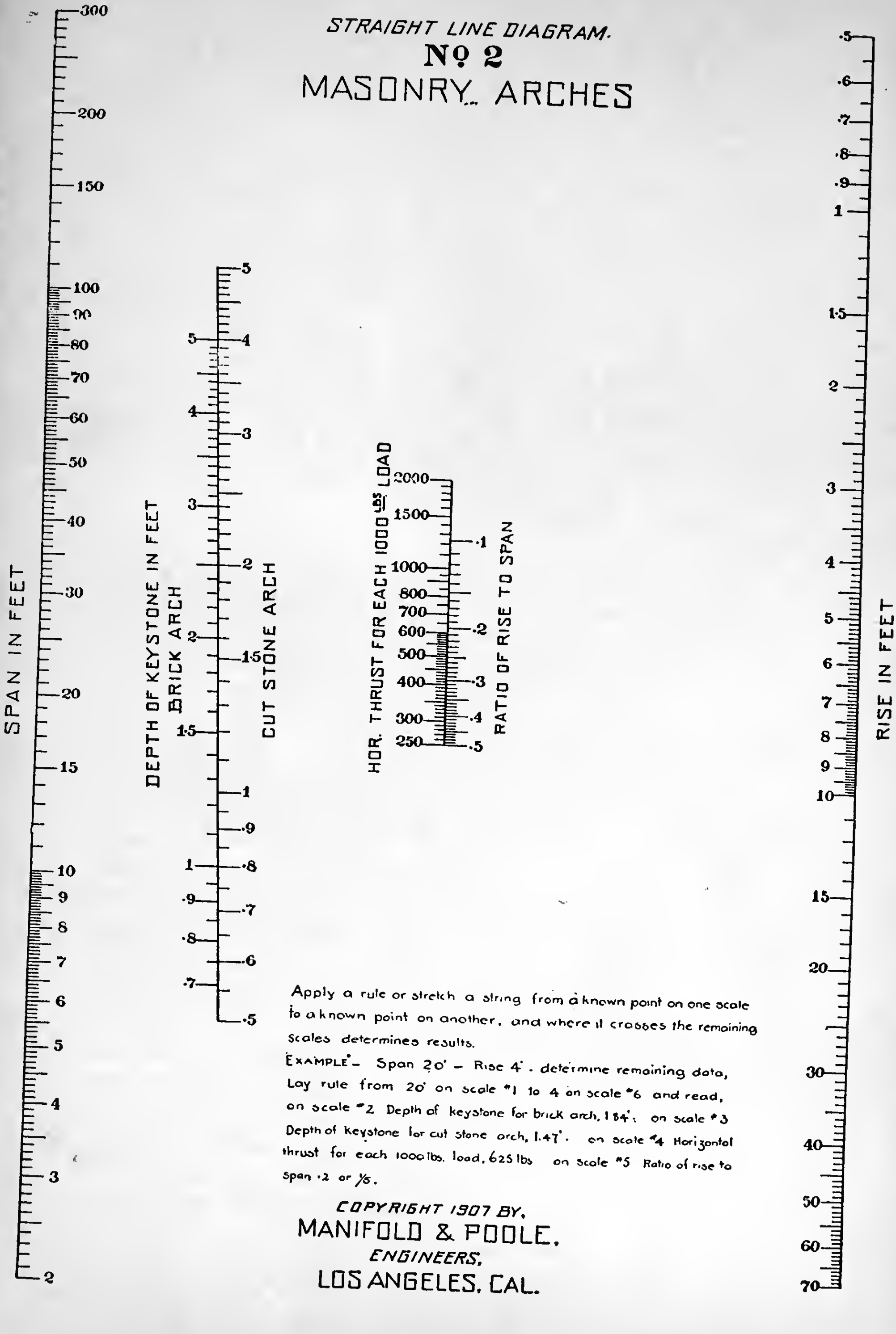
ENGINEERS,

LOS ANGELES, CAL.

Explanation of Diagram No. 2
Masonry Arches

This diagram shows the necessary depth of keystone for different spans and rises in masonry arches. The span is the horizontal distance between supports, the rise is the vertical distance between the lowest and highest point of the lower or concave surface of the arch. The ratio of span to rise also determines the horizontal thrust for each 1,000 pounds of load, which in turn determines the stability of the structure. The left scale is laid off for spans from 2 to 300 feet; the right scale for rises from .5 to 70 feet. The first intermediate scale shows the proper keystone depth for both brick and cut stone arches for different ratios of rise to span. The second intermediate scale shows the ensuing horizontal thrust. The method of procedure is outlined on the diagram.

STRAIGHT LINE DIAGRAM.
Nº 2
MASONRY ARCHES



Apply a rule or stretch a string from a known point on one scale to a known point on another, and where it crosses the remaining scales determines results.

EXAMPLE.— Span 20' — Rise 4'. determine remaining data, Lay rule from 20' on scale #1 to 4 on scale #6 and read, on scale #2 Depth of keystone for brick arch, 1.84'; on scale #3 Depth of keystone for cut stone arch, 1.47'. on scale #4 Horizontal thrust for each 1000 lbs. load, 625 lbs on scale #5 Ratio of rise to span .2 or 1/5.

MANIFOLD & POOLE.
ENGINEERS.
LOS ANGELES, CAL.

Explanation of Diagram No. 3

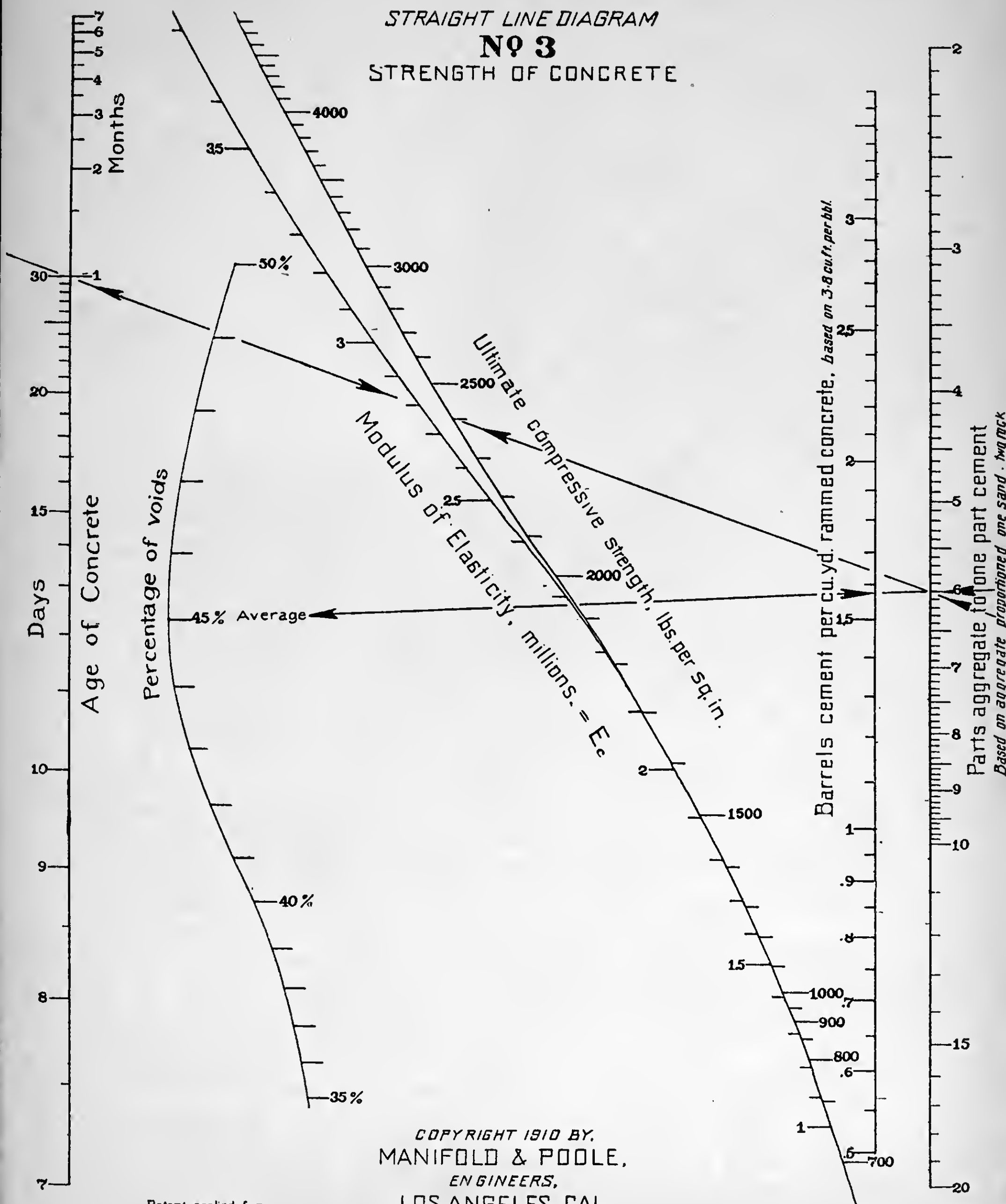
Strength of Concrete

This diagram indicates the strength and modulus of elasticity of concrete, made from Portland cement having various proportions and times of setting, also the barrels of cement required to the cubic yard of rammed concrete for different percentages of voids. The results, however, are approximate, as there is a wide variation due to quality of cement and aggregates. When possible, the cement should be tested and definite results obtained.

The term aggregate as used on the scales at the extreme right is the inert material and one part cement to six parts aggregate means one part cement, two parts sand and four parts broken rock.

Example: To find the strength and modulus of elasticity of a concrete mixed in the proportion of one part cement to six parts aggregate after setting one month; also barrels of cement required to make one cubic yard of rammed concrete.

Solution: Connect 1 on scale No. 2 to 6 on scale No. 7 and read modulus of elasticity, scale No. 4—2,800,000; and ultimate compressive strength scale No. 5—2,400 lbs. per sq. in. Then revolving index at intersecting with scale No. 7 and connecting to 45% on scale No. 3 read 1.58 barrels cement per cubic yard rammed concrete.


STRAIGHT LINE DIAGRAM
Nº 3
STRENGTH OF CONCRETE
Age of Concrete
Days
Months
Percentage of voids
45% Average
50%
40%
35%
Ultimate compressive strength, lbs. per sq. in.
Modulus of Elasticity, millions. = E_c
Barrels cement per cu. yd. rammed concrete, based on 3.8 cu. ft. per bbl.
Parts aggregate to one part cement
Based on aggregate proportioned one sand · two rock

Explanation of Diagram No. 4

Concrete Steel

This diagram and Nos. 5 and 6 give the economical percentage of steel to use in any beam or slab and the strength coefficient which are later used with diagram No. 7. Having obtained the modulus of elasticity for a certain concrete, either by the use of diagram No. 3 or from experiment, choose between Nos. 4, 5 and 6 the nearest corresponding modulus.

Example: The modulus of elasticity of a certain concrete is found to be 2,200,000 and the ultimate compressive strength 2,000 lb. per sq. in. and is to be reinforced with steel having an elastic limit of 40,000 lb. per sq. in. to find the percentage of steel required and coefficient of strength.

Solution: Connect 40,000, scale No. 1, to 2,000, scale No. 6, and find 1.03% reinforcement, scale No. 3, and coefficient $K = 340$, scale No. 5.

In some cases a beam is of a depth greater than the economic, and it is required to reinforce this beam to withstand its load. The coefficient K is found from diagram No. 7.

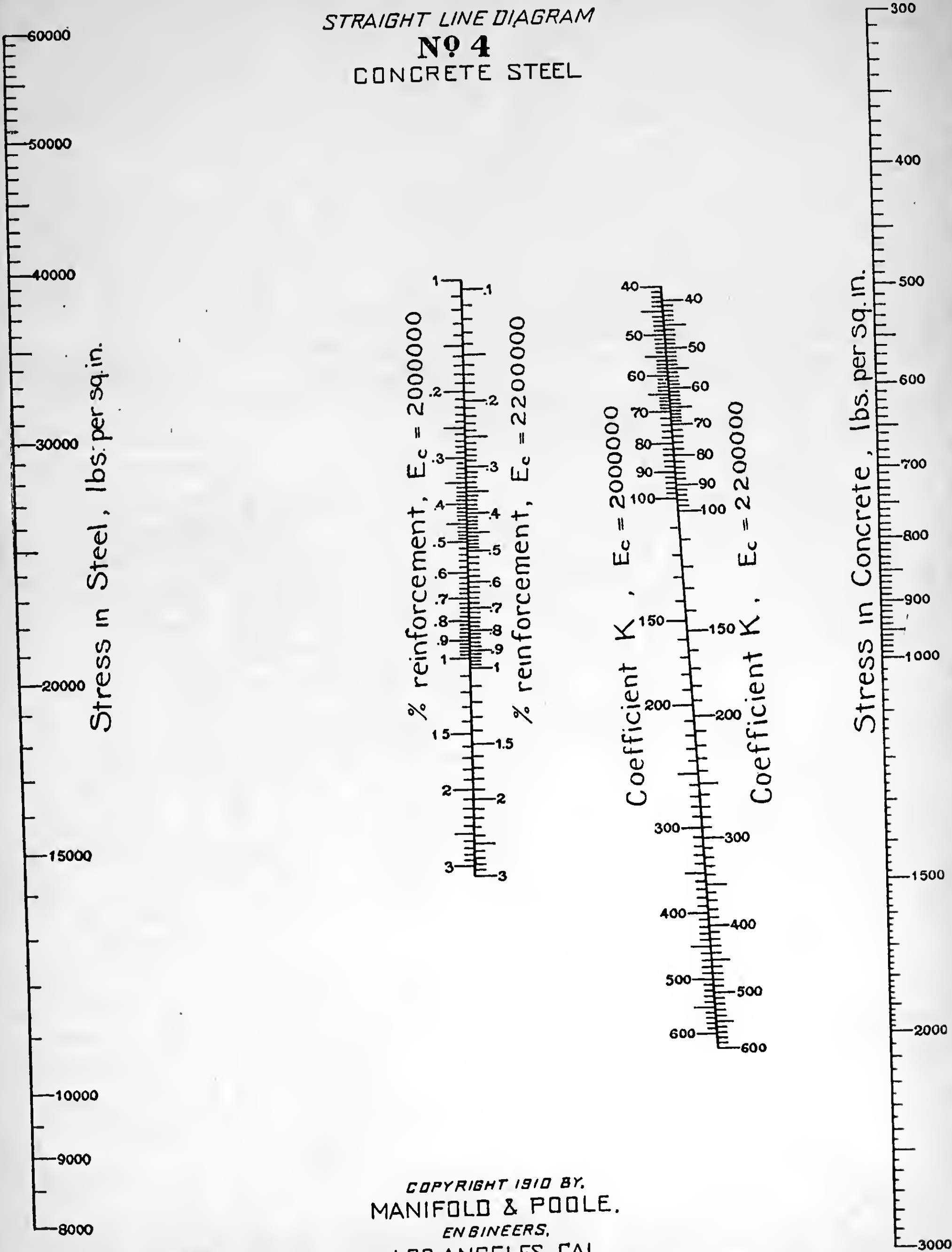
Example: It is found in a beam of a certain depth that the coefficient K equals 250; modulus of elasticity of the concrete 2,000,000; elastic limit of the steel being 38,000 lb. per sq. in. to find percentage of reinforcement and the stress in the concrete.

Solution: Connect 38,000, scale No. 1, to 250, scale No. 4, and find .79% reinforcement required, scale No. 2, and stress in concrete 1,570 lb. per sq. in., scale No. 6.

STRAIGHT LINE DIAGRAM

Nº 4

CONCRETE STEEL



Patent applied for

Explanation of Diagram No. 5

Concrete Steel

This diagram and Nos. 4 and 6 give the economical percentage of steel to use in any beam or slab and the strength coefficient, which are later used with diagram No. 7. Having obtained the modulus of elasticity for a certain concrete, either by the use of diagram No. 3 or from experiment, choose between Nos. 4, 5 and 6 the nearest corresponding modulus.

Example: The modulus of elasticity of a certain concrete is found to be 2,400,000 and the ultimate compressive strength 2,100 lb. per sq. in. and is to be reinforced with steel having an elastic limit of 40,000 lb. per sq. in. to find the percentage of steel required and coefficient of strength.

Solution: Connect 40,000, scale No. 1, to 2,100, scale No. 6, and find 1.03% reinforcement, scale No. 2, and coefficient K = 350, scale No. 4.

In some cases a beam is of a depth greater than the economic and it is required to reinforce this beam to withstand its load, the coefficient K is found from diagram No. 7.

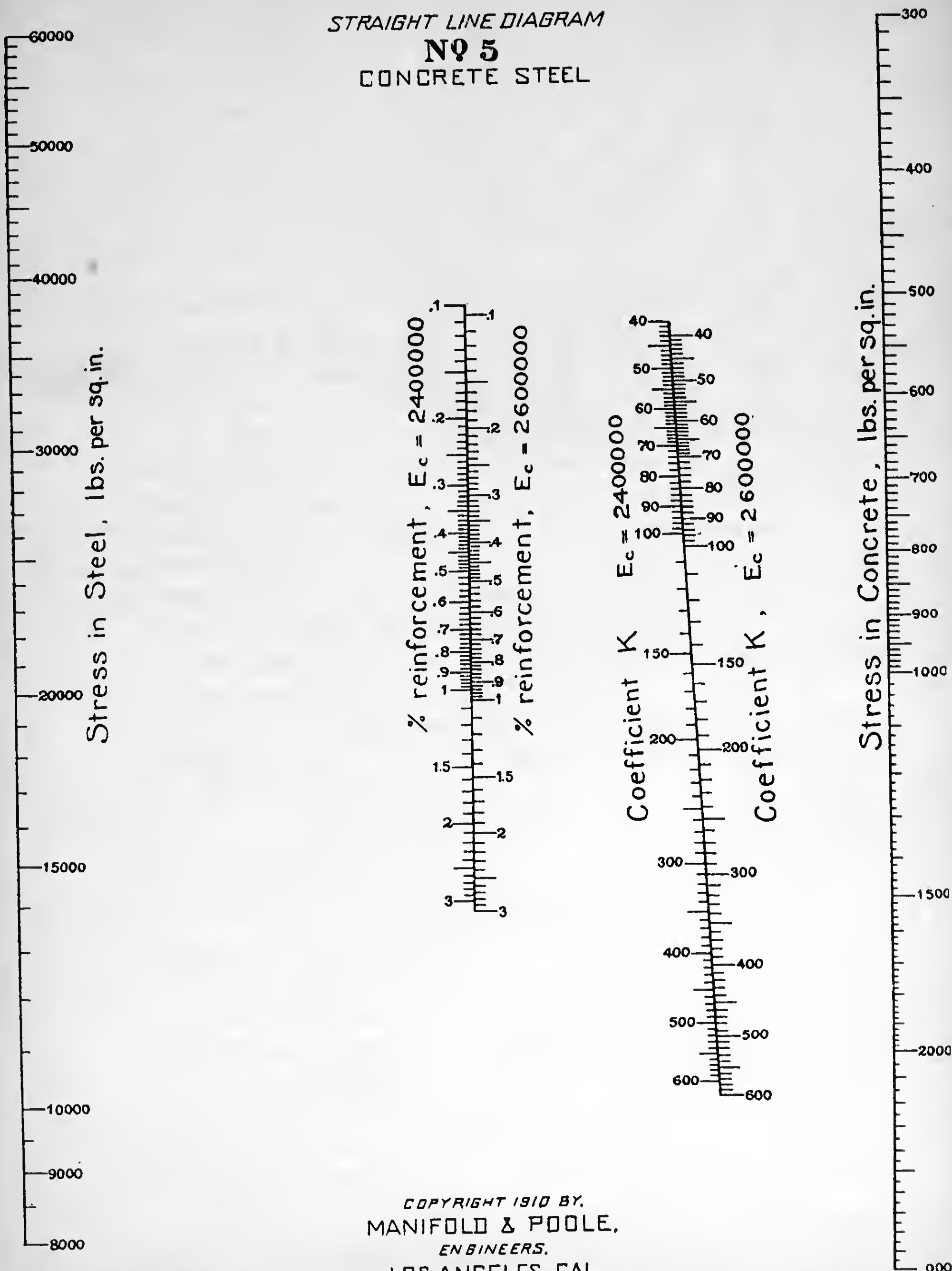
Example: It is found in a beam of a certain depth that the coefficient K equals 250; modulus of elasticity of the concrete 2,600,000; elastic limit of the steel being 38,000 lb. per sq. in. to find percentage of reinforcement and the stress in the concrete.

Solution: Connect 38,000, scale No. 1, to 250, scale No. 5, and find .74% reinforcement required, scale No. 3, and stress in concrete 1,680 lb. per sq. in, scale No. 6.

STRAIGHT LINE DIAGRAM

Nº 5

CONCRETE STEEL



Patent applied for

Explanation of Diagram No. 6

Concrete Steel

This diagram and Nos. 4 and 5 give the economical percentage of steel to use in any beam or slab and the strength coefficient, which are later used with diagram No. 7. Having obtained the modulus of elasticity for a certain concrete, either by the use of diagram No. 3 or from experiment, choose between Nos. 4, 5 and 6 the nearest corresponding modulus.

Example: The modulus of elasticity of a certain concrete is found to be 2,800,000 and the ultimate compressive strength 2,400 lb. per sq. in. and is to be reinforced with steel having an elastic limit of 50,000 lb. per sq. in. to find the percentage of steel required and coefficient of strength.

Solution: Connect 50,000, scale No. 1, to 2,400, scale No. 6, and find .82% reinforcement, scale No. 2 and coefficient $K = 360$, scale No. 4.

In some cases a beam is of a depth greater than the economic, and it is required to reinforce this beam to withstand its load. The coefficient K is found from diagram No. 7.

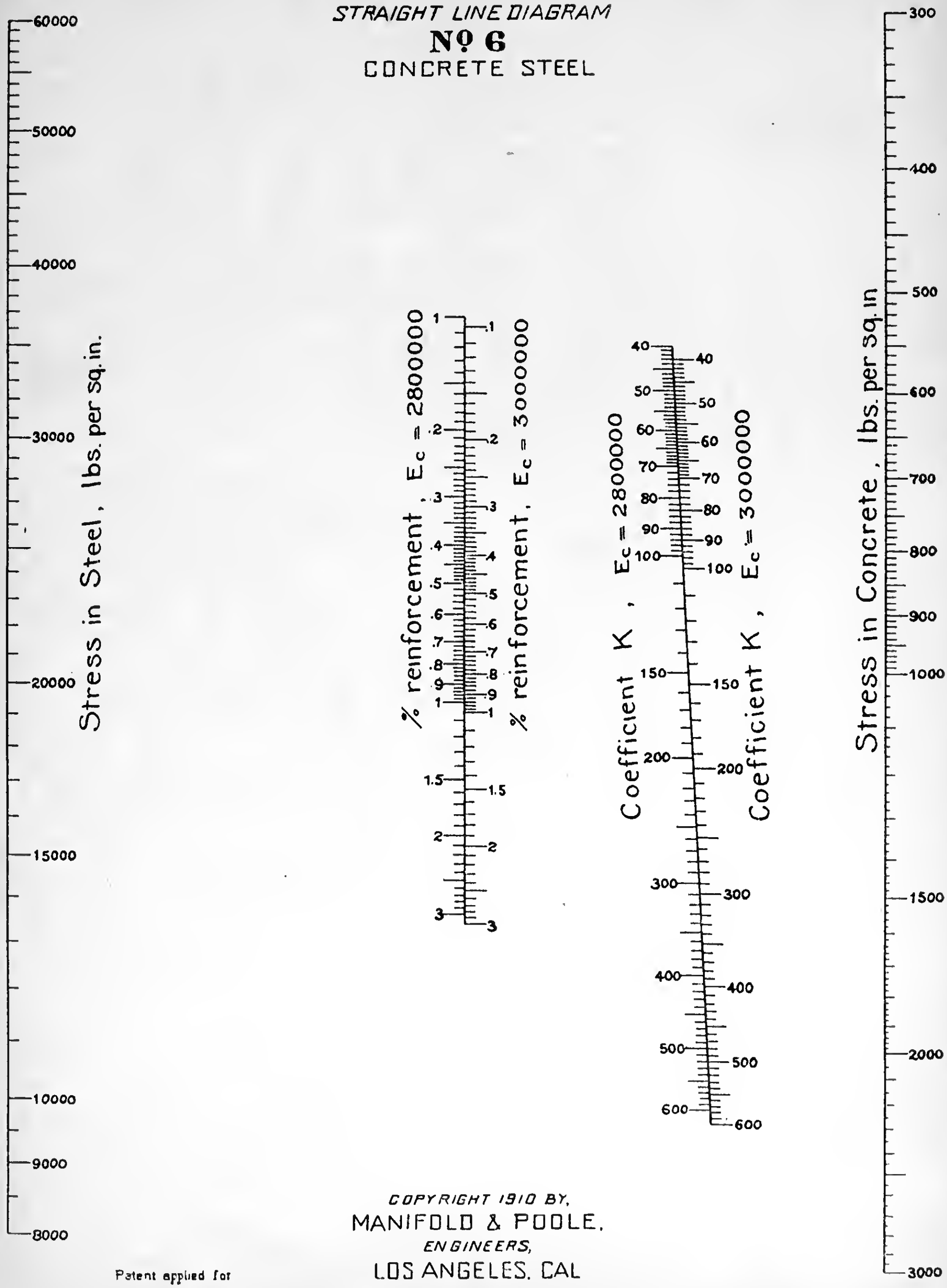
Example: It is found in a beam of a certain depth that the coefficient K equals 300; modulus of elasticity of the concrete 3,000,000; elastic limit of the steel being 38,000 lb. per sq. in. to find percentage of reinforcement and the stress in the concrete.

Solution: Connect 38000, scale No. 1, to 300, scale No. 5, and find .89% reinforcement required, scale No. 3, and stress in concrete 2,000 lb. per sq. in., scale No. 6.

STRAIGHT LINE DIAGRAM

Nº 6

CONCRETE STEEL



Patent applied for

Explanation of Diagram No. 7

Concrete Steel

This diagram determines the depth of concrete and cross section of steel required in a beam for a predetermined bending moment. The percentage of steel required and the coefficient of strength K are determined for any particular concrete and steel from diagrams 4, 5 or 6. The bending moment is next obtained from the load and span, and is multiplied by a suitable factor of safety and is then found on scales Nos. 4 or 5.

Example: The maximum bending moment per foot width in a certain concrete steel beam = 200,000 inch lb. The coefficient of strength K = 350 and the percentage of steel .5% to find the depth of the concrete above the steel and the cross section of the steel per ft. width of beam; factor of safety 3.

Solution: Connect 350 on scale No. 1 to 200000 × 3 f. s. = 600000 on scale No. 5 and find 12 in. depth of concrete above center of steel on scale No. 7; revolving on this point and connecting to .5 on scale No. 2 find .72 sq. in. steel per foot width.

In some cases the depth of a beam is greater than the economic, and it is required to reinforce this beam to withstand its load.

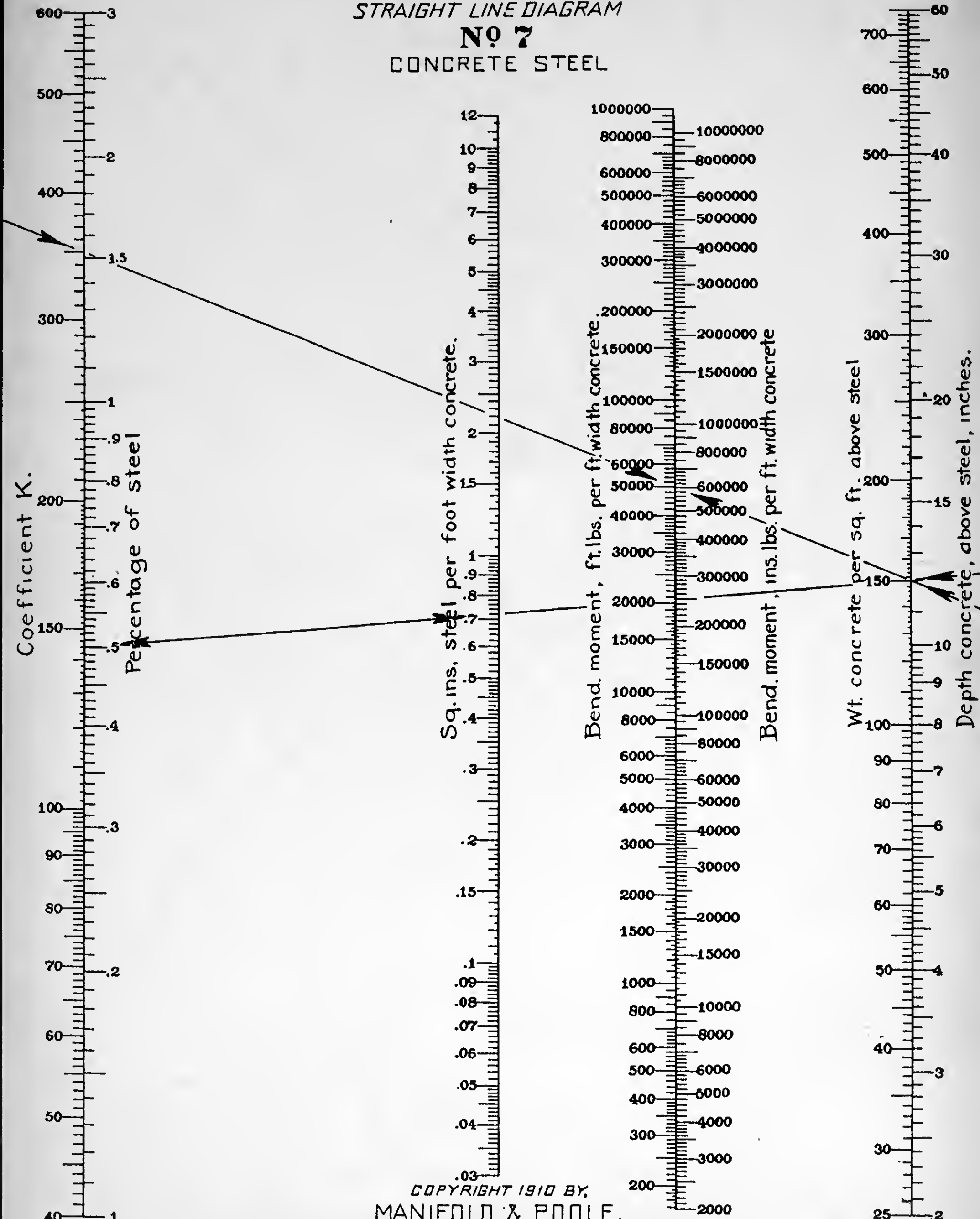
Example: The depth of a beam is 15 in. Maximum bending moment multiplied by a factor of safety is 50,000 ft. lb. to find the percentage and cross section of steel required, modulus of elasticity of the concrete being 2,400,000 and elastic limit of steel 30,000 lb. per sq. in.

Solution: Connect 15 on scale No. 7 to 50,000 on scale No. 4 and find 226 on scale No. 1. Turning now to diagram 5, connect 226 on scale No. 4 to 30,000 on scale No. 1 and find percentage of steel .88%, also find stress in concrete 1,430 lb. per sq. in. Returning again to diagram No. 7, connect .88 on scale No. 2 to 15 on scale No. 7 and find cross section of steel per foot width concrete 1.57 sq. in.

STRAIGHT LINE DIAGRAM

Nº 7

CONCRETE STEEL



Patent applied for

Explanation of Diagram No. 8

Concrete Steel

This diagram gives the spacing required for any size of bar.

Example: Assume that a certain slab requires 1.57 sq. in. of steel cross section per foot width; required distance center to center for ¾ in. sq. rods.

Solution: Connect 1.57 on scale No. 1 to ¾ on scale No. 6 and find 4.25 in. center to center on scale No. 3. Also on scale No. 4 find 2.8 bars per foot width of concrete.

Sq. ins. steel per foot width concrete
Wt. steel per foot, per ft. width concrete.
Patent applied for
STRAIGHT LINE DIAGRAM
No. 8
CONCRETE STEEL
Dis. c. to c. reinforcing bars
Number bars per foot width of concrete.
COPYRIGHT 1910 BY
MANIFOLD & POOLE,
ENGINEERS,
LOS ANGELES, CAL.
Dia. in inches, round steel bars, and Gage Nos.
Size Square Steel Bars, Ins.

Explanation of Diagram No. 9

Strength of Beams

This diagram gives the strength of beams. Scales of rounds, squares, I beams, channels and angles are to be projected horizontally on to scale No. 2, entitled Section Molulus.

Example: What uniformly distributed load will a 4 in. sq. steel bar support; span between supports 13 ft., max. fibre stress 15,000 lb. per sq. in.

Solution: Project 4 in. sq. horizontally to cut scale No. 2 at 10.7 and connect this point to 13 on scale No. 4, and find point 7.2 on scale No. 6; turning on this point connect to 15,000 on scale No. 3 and find 7,700 lb. on scale No. 5. This includes the weight of the bar itself, which is about 700 lb. The net weight therefore which can be supported is 7,700 — 700 = 7,000 lb.

Relative strength of beams:

Supported both ends, uniformly distributed load	= 1
" " " concentrated load at center	= 1/2
" " " " " " 1/3 span	= 9/16
" " " " " " 1/4 span	= 2/3
" " " " " " 1/5 span	= 25/32
" " " " " " 1/6 span	= 9/10
" " " " " " 1/7 span	= 49/48
" " " " " " 1/8 span	= 8/7
" " " " " " 1/9 span	= 81/64
" " " " " " 1/10 span	= 25/18
Fixed one end, uniformly loaded	= 1/5
" " " loaded at other	= 1/8
Firmly fixed both ends, loaded center	= 1
" " " " uniformly loaded	= 1 1/2

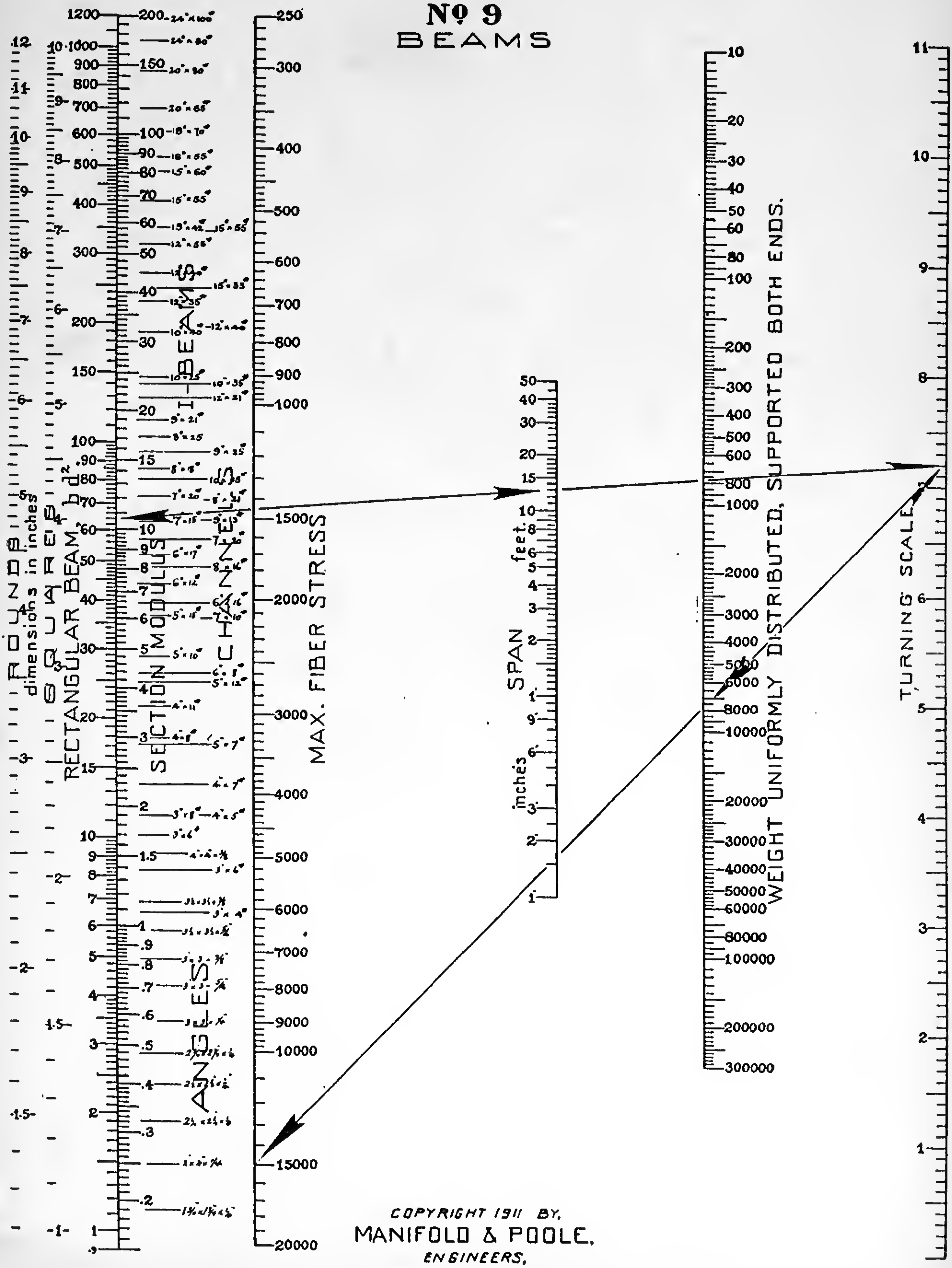
Example: What size of steel I beam supported at each end will be required to sustain a load of 18,000 lb. concentrated at a point 2 ft. from one support, span being 12 ft. and the maximum fibre stress 16,000 lb. per sq. in.

Solution: In this case the load is concentrated at 1/6 the span, and hence is equivalent to a uniformly distributed load of 18,000 divided by 9/10 = 20,000. Connect 16,000 on scale No. 3 to 20,000 on scale No. 5; find turning point 6 on scale No. 6 connecting to 12 on scale No. 4, find section modulus 24 on scale No. 2, which is about a 10 in. by 25 lb. beam.

Rolled Beam without lateral support:

Length of Beam	Proportion of greatest safe load
20 times flange width	Whole
20 to 30 " " "	9/10
30 to 40 " " "	8/10
40 to 50 " " "	7/10
50 to 60 " " "	6/10
60 to 70 " " "	5/10

STRAIGHT LINE DIAGRAM
Nº 9
BEAMS



Patent applied for

Explanation of Diagram No. 10
Direct Current Wiring

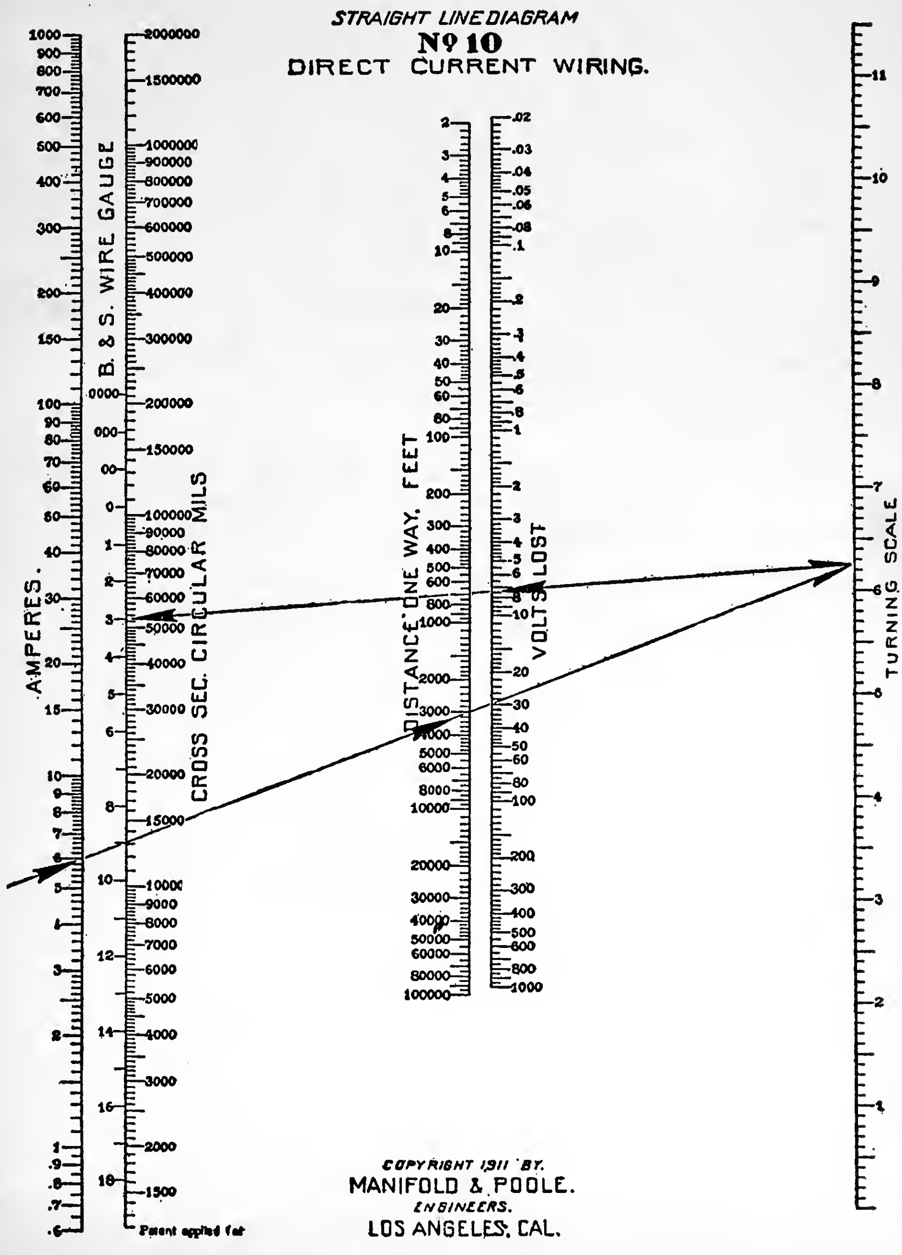
This diagram is intended for the calculation of the number of volts lost in transmitting a given number of amperes a given distance through a given sized wire. It incidentally shows the circular mil. cross section of the various wire sizes in the B. & S. gauge. It is based on the formula $A = 21.56\ L\ I \div$ volts lost.

The first, or left hand scale, is laid off from .6 to 1,000 amperes, the second according to the wire size in the B. & S. gauge, the third giving the corresponding cross section in circular mils., the fourth the distance in feet one way between points to be connected, the fifth the number of volts lost in the total length circuit (including return), and the sixth is a turning scale to carry forward the calculation.

The arrows show that in transmitting 6 amperes 3,000 ft. 7½ volts are lost using No. 3 wire, similarly 26 volts would be lost in using No. 8 wire, etc.

If it were required to find how many amperes that can be carried by No. 3 wire 3,000 feet between points with a volt loss of 7½, the operation is reversed, and the number of amperes (6) read on the first scale.

Similarly, if it were required to find how far 6 amperes can be carried with No. 3 wire and a loss of 7½ volts, the distance is read on the intermediate scale.



STRAIGHT LINE DIAGRAM
Nº 10
DIRECT CURRENT WIRING.
AMPERES.
B. & S. WIRE GAUGE
CROSS SEC. CIRCULAR MILS
DISTANCE ONE WAY, FEET
VOLTS LOST
TURNING SCALE
Patent applied for
COPYRIGHT 1911 BY.
MANIFOLD & POOLE.
ENGINEERS.
LOS ANGELES, CAL.

Explanation of Diagram No. 11
Pole Line Construction—Copper

This diagram gives the necessary deflection for copper wire at various spans and temperatures. Examples are indicated on the diagram.

Formulae employed are:

$$S = \frac{a^2 + 3b^2}{6a}; \quad l = \frac{2a^2 + 3b^2}{3b};$$

$$a = 3S - \sqrt{9S^2 - 3b^2}$$

where

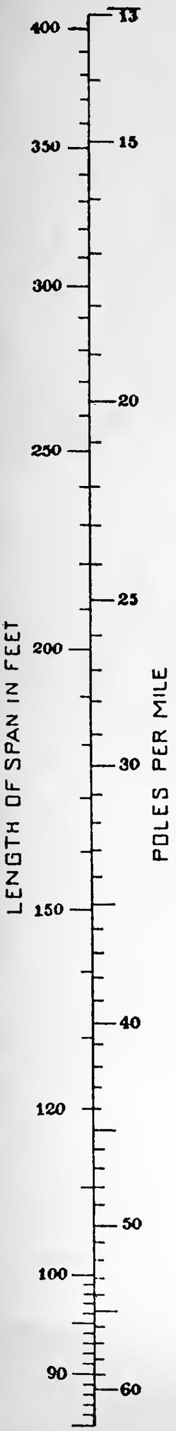
a = center deflection in feet
$2b$ = span in feet
$2l$ = length of conducter in span in feet
w = weight of conductor lb. per foot
s = elastic limit of conductor per sq. in. cross sec.
weight of 1 ft. of conductor, 1 sq. in. " "

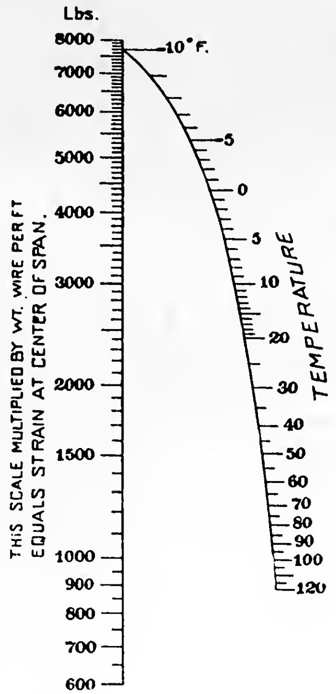
STRAIGHT LINE DIAGRAM

Nº 11

POLE LINE CONSTRUCTION

COPPER





This diagram is figured on a maximum strain of 30000 pounds per sq. in cross sec. of conductor, at -10°F. Apply a rule, or stretch a string, from a known point on one scale to a known point on another, and where it crosses the remaining scales determines results.

EXAMPLE Span of wire is 264, or 20 poles to the mile. Temperature 50°F Weight of conductor .32 lb per ft Lay rule from 264 scale 1, to 50 on scale 4, and find sag of wire 3.95' on scale 5, also read 2200 on scale 3, which multiplied by 32 gives 704 lbs strain in center of span

MANIFOLD & POOLE.

ENGINEERS,

LOS ANGELES, CAL.

Explanation of Diagram No. 12

Pole Line Construction

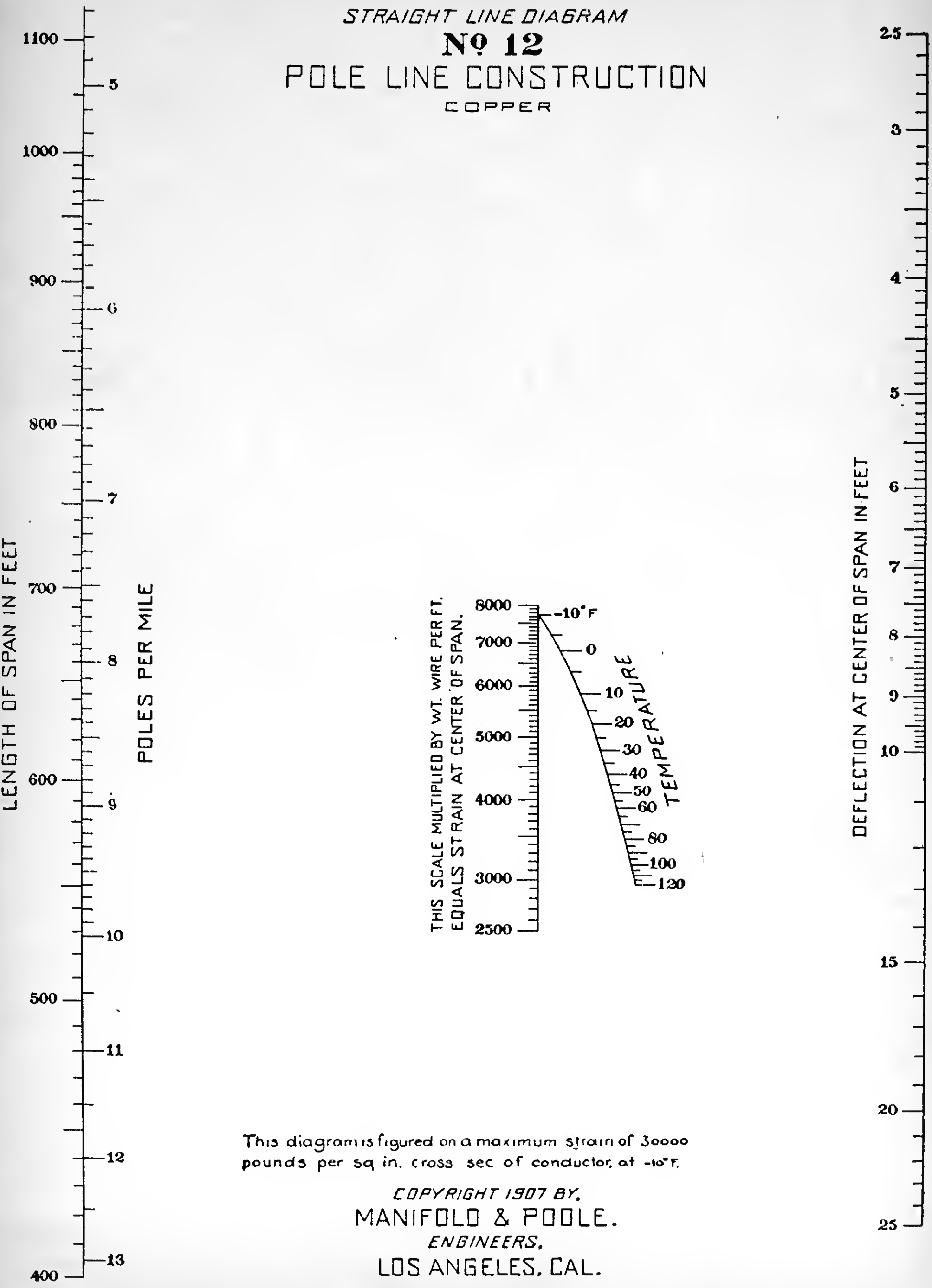
This diagram is a continuation of No. 11.

STRAIGHT LINE DIAGRAM

Nº 12

POLE LINE CONSTRUCTION

COPPER



This diagram is figured on a maximum strain of 30000 pounds per sq in. cross sec of conductor, at -10°F.

MANIFOLD & POOLE.

ENGINEERS,

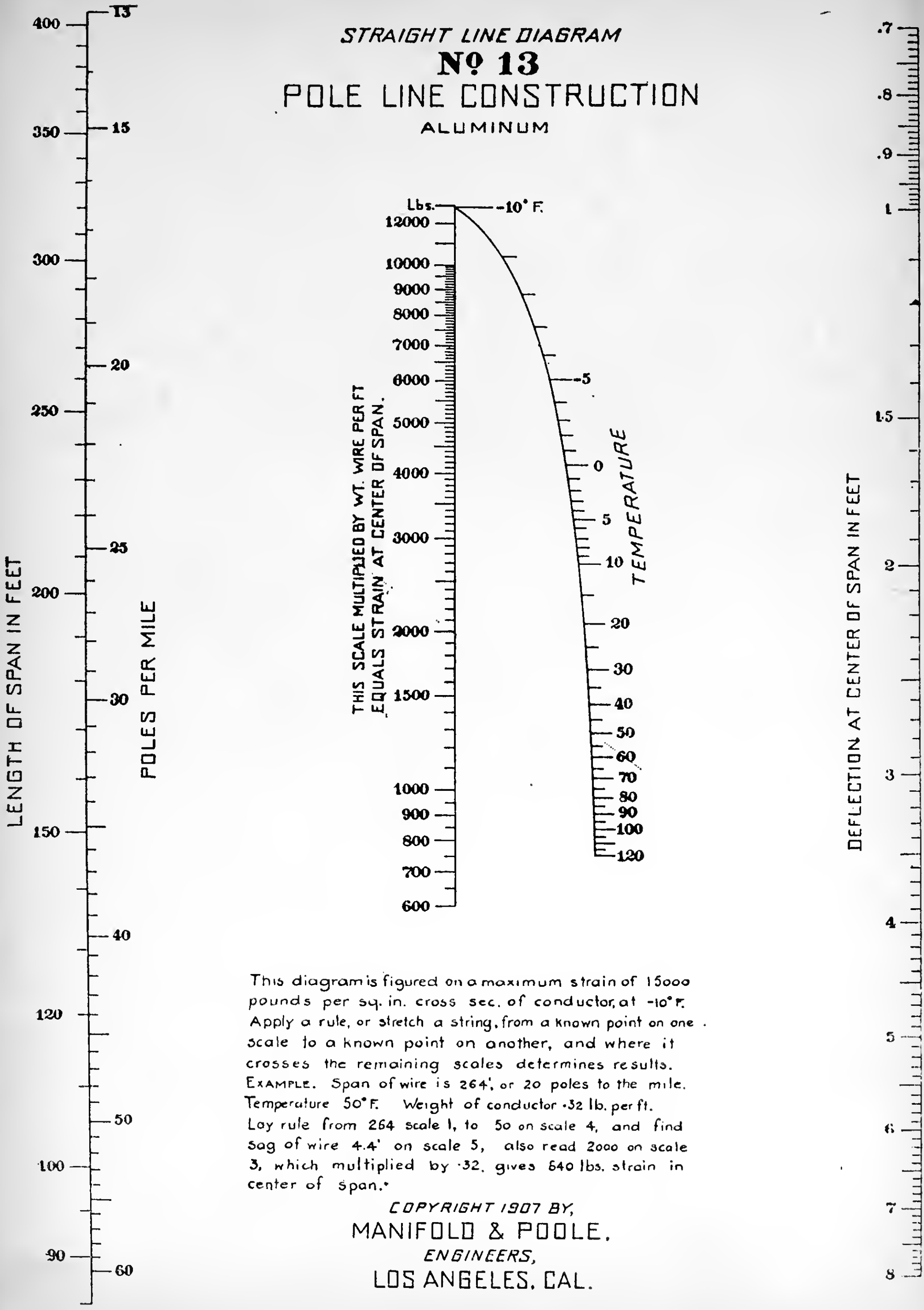
LOS ANGELES, CAL.

Explanation of Diagram No. 13

Pole Line Construction—Aluminum

This diagram is based on the same conditions as No. 11 and 12, except that aluminum is used instead of copper wire.

STRAIGHT LINE DIAGRAM
Nº 13
POLE LINE CONSTRUCTION
ALUMINUM



This diagram is figured on a maximum strain of 15000 pounds per sq. in. cross sec. of conductor, at -10° F. Apply a rule, or stretch a string, from a known point on one scale to a known point on another, and where it crosses the remaining scales determines results.

EXAMPLE. Span of wire is 264', or 20 poles to the mile. Temperature 50° F. Weight of conductor ·32 lb. per ft. Lay rule from 264 scale 1, to 50 on scale 4, and find sag of wire 4.4' on scale 5, also read 2000 on scale 3, which multiplied by ·32, gives 640 lbs. strain in center of span.

Explanation of Diagram No. 14

Electric Circuits

This diagram gives the relations existing between kilowatts, horse power, voltage and amperes in alternating current circuits, for either single or three-phase and various power factors.

Example: 150 k.w. or 200 h.p. is to be transmitted over a three-phase circuit, voltage 1,500, p.f. 80, to find the amperes.

Solution: Connect 150 on scale No. 1 to 1,500 on scale No. 5 and find 100 on scale No. 7, revolving on this point and connecting to 80 on scale No. 4, find 73 amperes on scale No. 6.

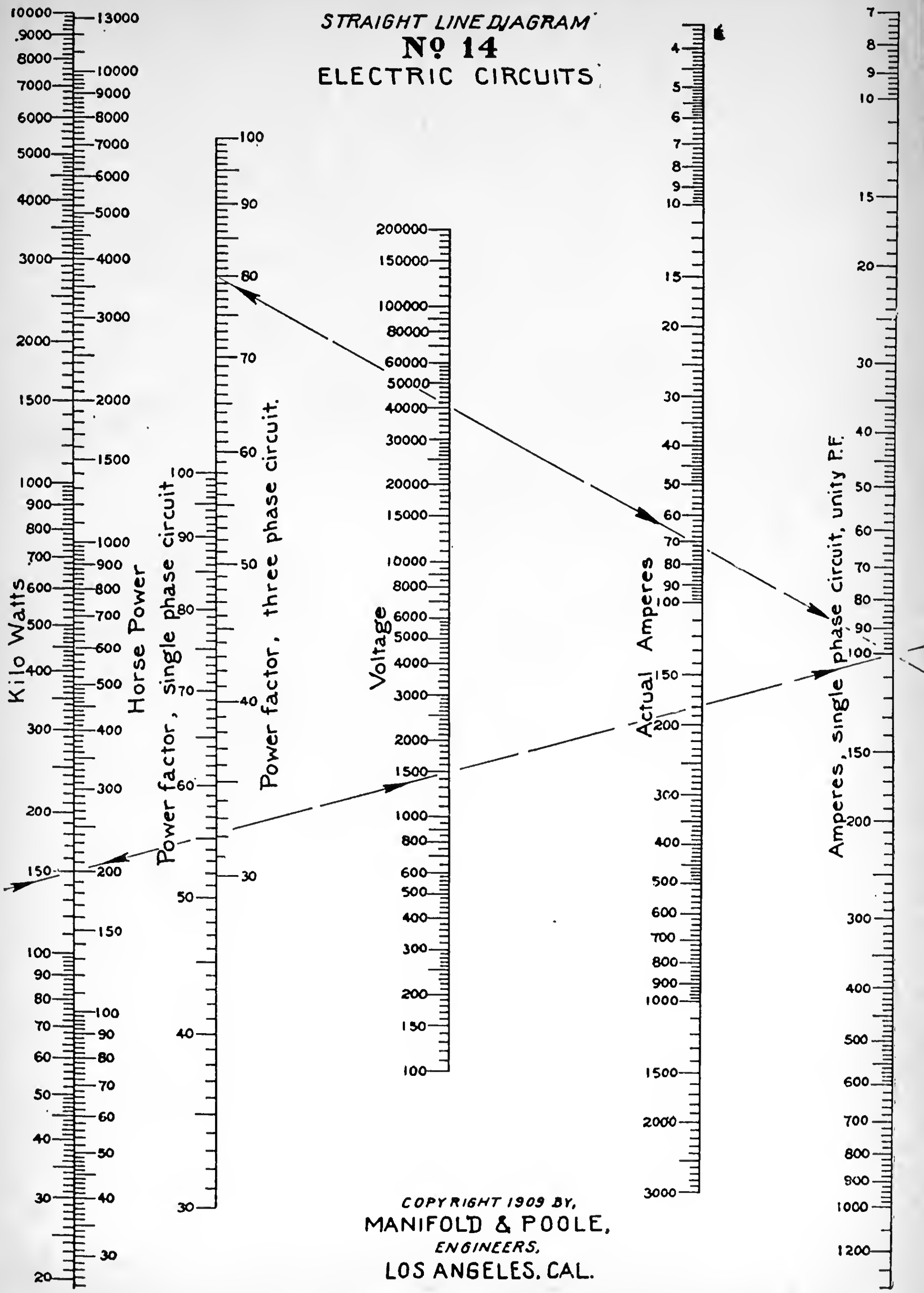
Example: Suppose the power factor is 70, single-phase circuit, 200 actual amperes, 2,200 volts; what horse power is being transmitted?

Solution: Connect 70 on scale No. 3 to 200 on scale No. 6 and revolve index at point where it cuts scale No. 7 through 2200 on scale No. 5, and find 420 h.p. on scale No. 2.

STRAIGHT LINE DIAGRAM

Nº 14

ELECTRIC CIRCUITS



Explanation of Diagram No. 15
Power Transmission Lines

This diagram determines the size of copper wire required for transmission of power, using 60 cycle alternating current; the amperes here used are the actual amperes for determination of which see diagram No. 14.

Example: Required the drop in voltage per mile of a three phase circuit carrying 50 amperes, size wire OO B. & S., distance between wire 72 in.

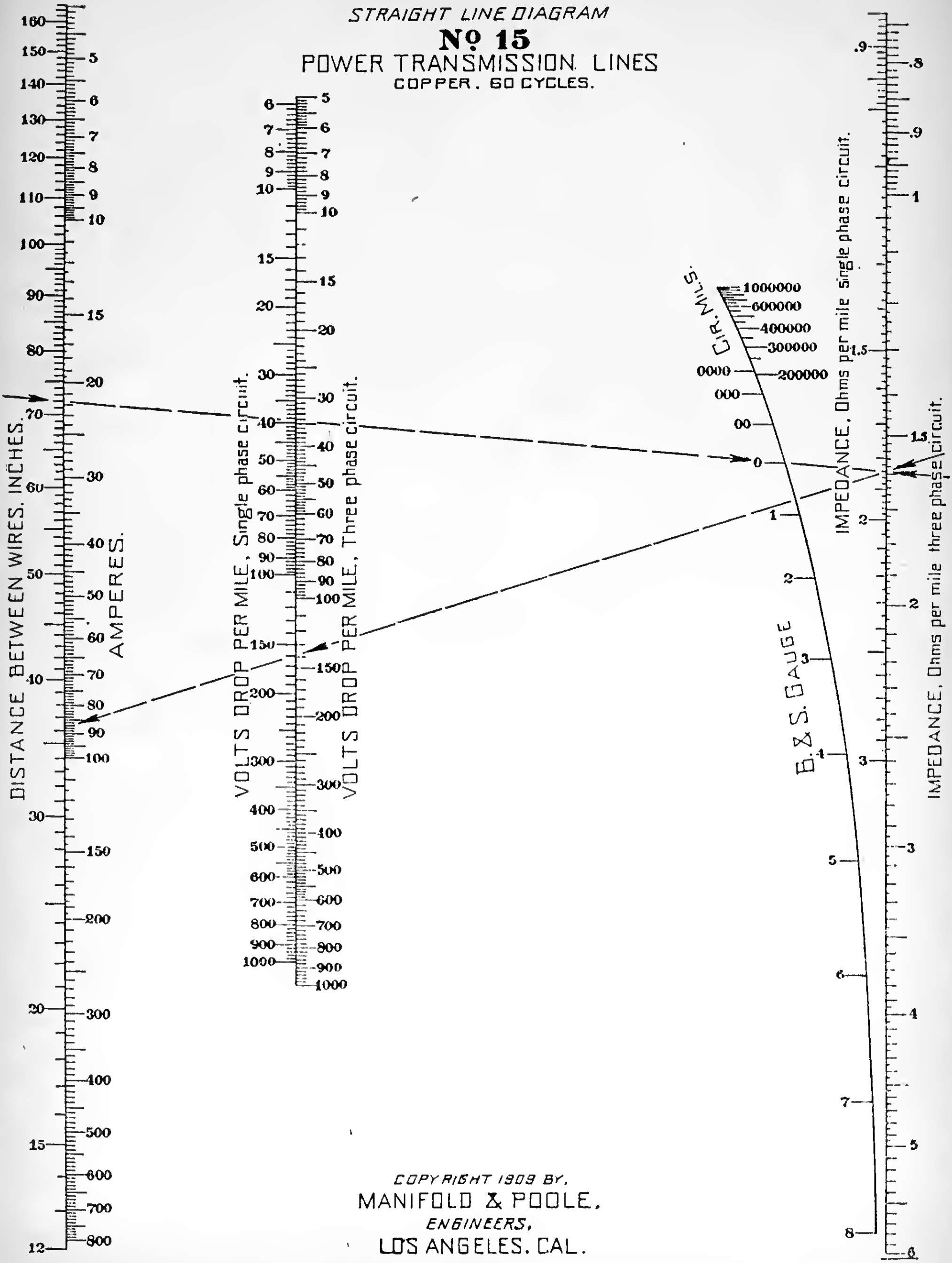
Solution: From 72 on scale No. 1 connect index line to OO on scale No. 5 and where it cuts No. 8 put point of lead pencil over intersection and revolve the index to 50 on scale No. 2. Then the drop in volts per mile scale No. 4 = 74.

STRAIGHT LINE DIAGRAM

Nº 15

POWER TRANSMISSION LINES

COPPER. 60 CYCLES.



Explanation of Diagram No. 16
Comparative Cost of Power

This diagram shows cost of fuel per month per horse power in various kinds of engines and the price per kilowatt hour that electricity can be sold to compete with same. In this diagram all that is necessary is to follow along any of the horizontal lines.

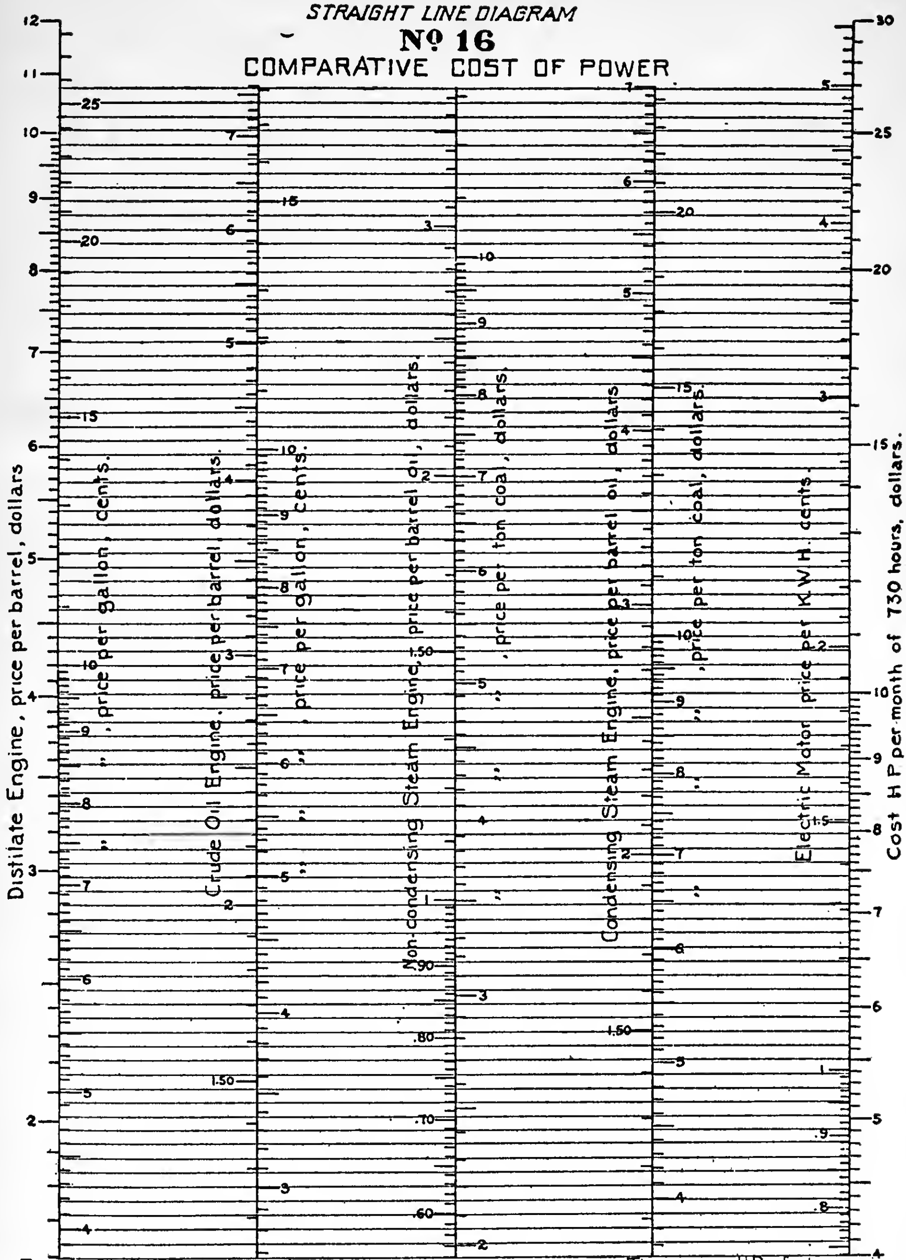
Example: The price of distillate for use in an engine in a certain locality is $4.00 per barrel. What is the cost per h.p. per month of 730 hours, and at what price per k.w. hr. must an electric company sell to meet this competition?

Solution: From 4 on scale No. 1 follow across horizontally and find cost horse power per month, scale No. 10 = $9.95, and price per k.w. hr., scale No. 9 — 1.84 cents.

STRAIGHT LINE DIAGRAM

No. 16

COMPARATIVE COST OF POWER



The cost per H.P. is for fuel only and does not include labor, water, maintenance or interest. The fuel cost is usually from 30% to 60% of total cost.

MANIFOLD & POOLE
ENGINEERS,
LOS ANGELES, CAL.

The cost per H.P. of steam engines is for average conditions, and may vary 20% more or less according to type engine used.

Explanation of Diagram No. 17
Steam Hoists

This diagram solves problems in hoisting and haulage up inclines; 30 lb. per ton rolling friction is allowed.

Example 1: Engine 30 in. x 60 in. drum 6 ft. in diameter, to find the load that can be taken up a 3 per cent grade?

Solution: Connect point 30 on scale No. 3 to point 60 on scale No. 8, place point of pencil over intersection of index line with scale No. 11 and revolve line to cut scale No. 5 at point 6, then read 31,000 on scale No. 10, which is the load in pounds that could be hoisted from a vertical shaft; place point of pencil over this last intersection and revolve index to cut scale No. 2 at point 3 and read 680,000 on scale No. 6, which is the weight that can be hauled up a 3 per cent grade.

Example 2: Suppose it is required to raise 20,000 pounds, vertical shaft, rope speed 1,500 ft. per min. drum 8 feet diameter, required the size of engine?

Solution: Connect 8 on scale No. 5 to 20000 on scale No. 10, and find point 500000 on scale No. 11, next connect 8 on scale No. 5 to 1500 on scale No. 7 and find 60 on scale No. 8, put point of pencil over this intersection and revolve index to point 500000 on scale No. 11 previously found, the index line will now cut scale No. 3 at about 27¾, so the engine required would be 28 in. x 60 in.

Example 3: Although diagram No. 17 is made for steam hoists, it can be used for any hoist having the horse power and the r.p.m. of the drum shaft. Suppose an electric hoist, 50 h.p. motor, diameter of drum 4 feet, revs. of drum shaft 60 per min. To find the load that can be raised vertically?

Solution: There is no 50 on the horse power scale, but by taking 500 and dividing the result by 10 the result may be found.

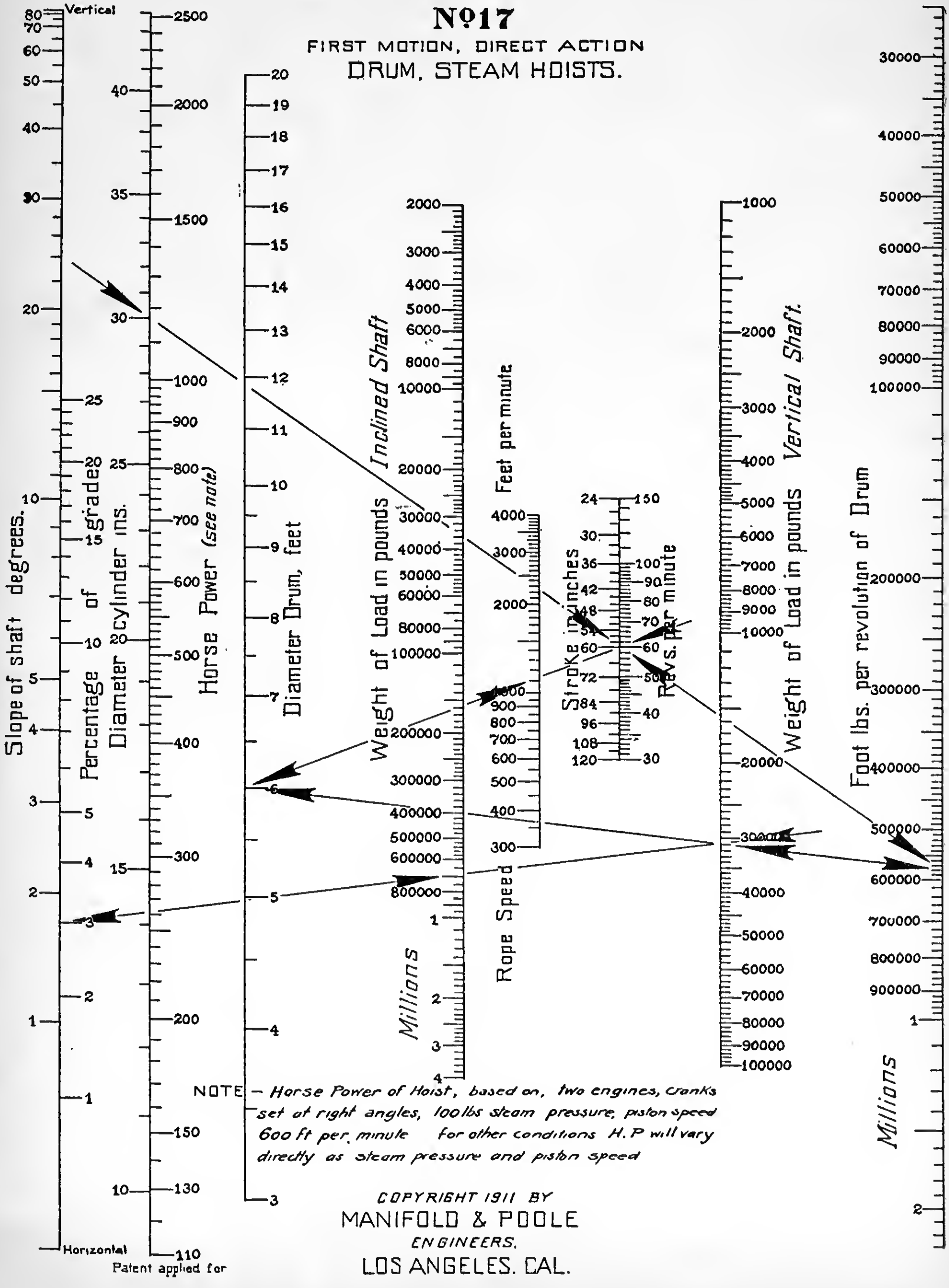
Connect 500 on scale No. 4 to 60 on scale No. 9, place point of pencil on point of intersection with scale No. 11, revolve index to point 4 on scale No. 5, and read 20000 on scale No. 10, the weight that can be raised at this speed is therefore 2,000 lb. The rope speed in this case is found by connecting 4 on scale No. 5 to 60 on scale No. 9 and find 750 on scale No. 7.

STRAIGHT LINE DIAGRAM

Nº17

FIRST MOTION, DIRECT ACTION

DRUM, STEAM HOISTS.



NOTE — *Horse Power of Hoist, based on, two engines, cranks set at right angles, 100 lbs steam pressure, piston speed 600 ft per minute for other conditions H. P will vary directly as steam pressure and piston speed*

MANIFOLD & POOLE

ENGINEERS.

LOS ANGELES. CAL.

Explanation of Diagram No. 18

Steam Engines

This diagram gives the horse power of steam engines. The mean effective pressure in any cylinder is best obtained by using an indicator. The diagram, however, gives a method of approximating the mean effective pressure which can be used in certain cases.

Example: Find the horse power of a 20 in. x 36 in. engine 100 r.p.m. 48½ lbs. M.E.P.

Solution: Connect 100 on scale No. 10 to 36 on scale No. 5, and find piston speed 600 on scale No. 1, turning on this point and connecting to 20 on scale No. 6 and find horse power per lb. M.E.P. 5.71 on scale No. 11; turning on this point connect to 48.5 on scale No. 2 and find h.p. 277 on scale No. 7.

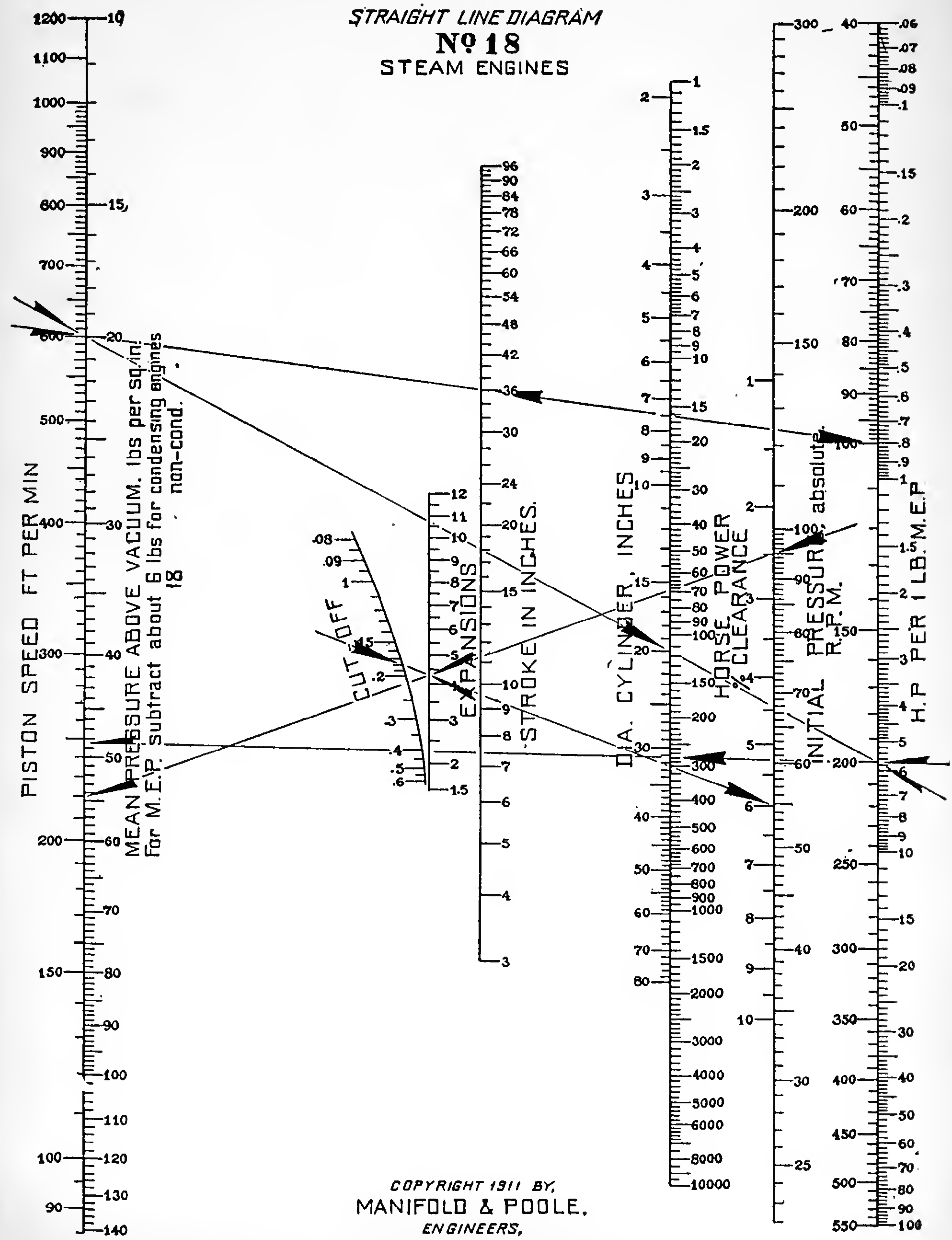
Example 2: A cylinder has 6 per cent clearance. The cut off is at .18 of the stroke, find the number of expansions and the mean pressure above vacuum when the steam pressure is 95 lb. absolute.

Solution: Connect 6 on scale No. 8 to .18 on scale No. 3 and find 4.25 expansions; turning on this point, connect to 95 on scale No. 9 and find 54.5 mean pressure above vacuum on scale No. 2.

STRAIGHT LINE DIAGRAM

Nº 18

STEAM ENGINES



Patent applied for

Explanation of Diagram No. 19

Economic Size of Pipe

This diagram gives the economic diameter of pressure pipe to be used in development of hydraulic power. The formula used is as follows:

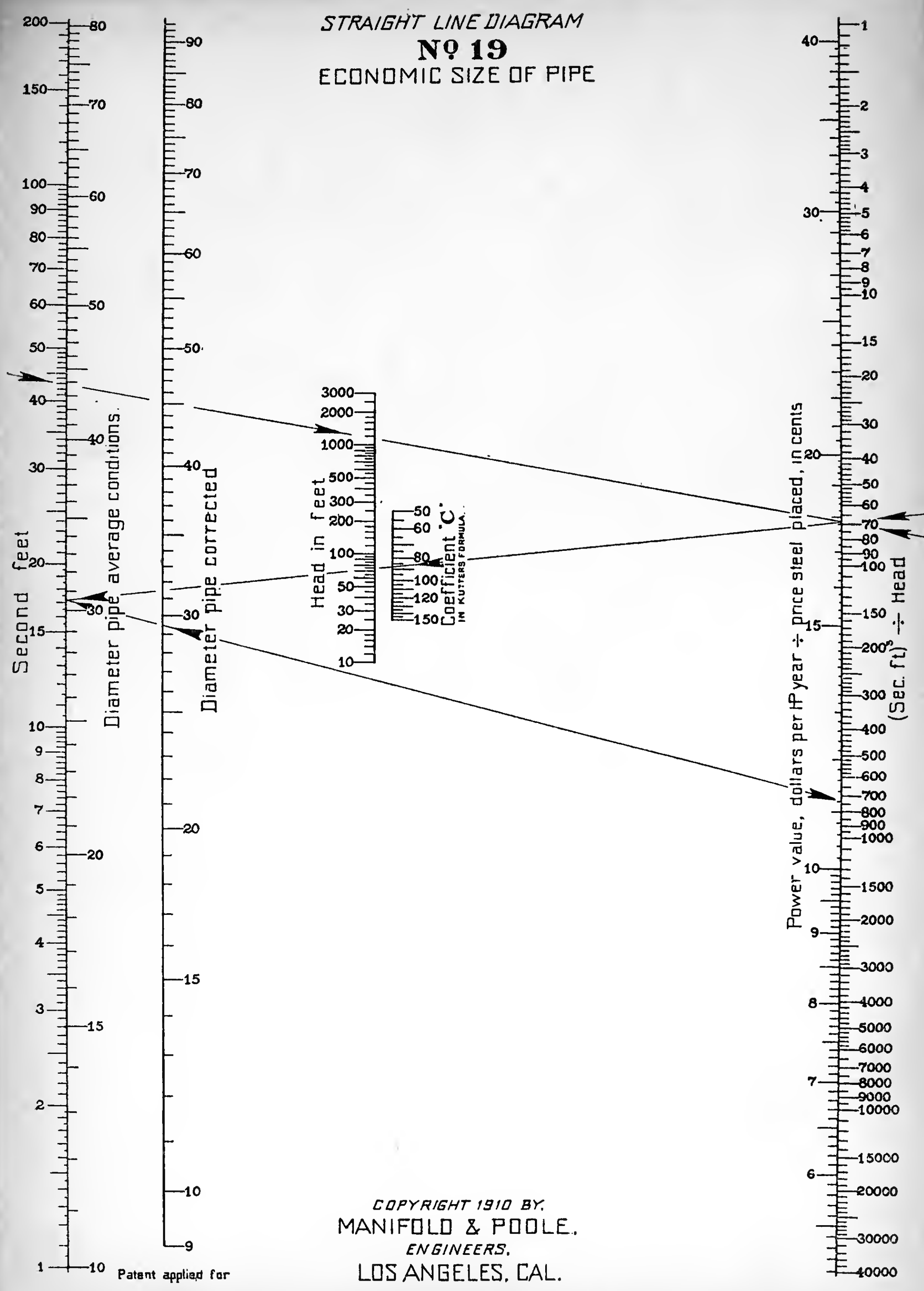
$$d = 5.0059 \left(\frac{q^3}{c^2 h}\right)^{\frac{1}{7}}$$

in which

q = quantity water in second feet
h = head in feet
c = constant in Kutter's formula.

The constant 5.0059 is based on steel in place 7c per pound, and cost of horse power $100 per annum, and hence varies as the annual horse power cost ÷ the price of steel.

Examples are indicated by arrow point on diagram.


STRAIGHT LINE DIAGRAM
Nº 19
ECONOMIC SIZE OF PIPE
Second feet
Diameter pipe average conditions.
Diameter pipe corrected
Head in feet
Coefficient 'C' in Kutters formula.
Power value, dollars per HP year ÷ price steel placed, in cents
(Sec. ft)^3 ÷ Head
Patent applied for
COPYRIGHT 1910 BY.
MANIFOLD & POOLE.
ENGINEERS.
LOS ANGELES, CAL.

Explanation of Diagram No. 20

Flow of Water in Small Pipes

This diagram gives the flow and friction losses for small piping, such as standard iron and steel screwed piping and casing, for sizes from an ⅛ in. upwards. The miner's inch here given is 1/50 second foot or 50 miner's inches equal one second foot.

Example: If 10 gallons per minute are forced through a 1¼ in. standard pipe, what is the friction loss per 1,000 ft.?

Solution: Connect 10 on scale No. 1 to 1¼ on scale No. 4 and find 30 on scale No. 5.

It will be observed that 1¼ standard pipe is 1.38 in. actually in diameter, by comparing scales Nos. 2 and 3 and that the velocity in pipe is 2.15 ft. per second, found on scale No. 6.

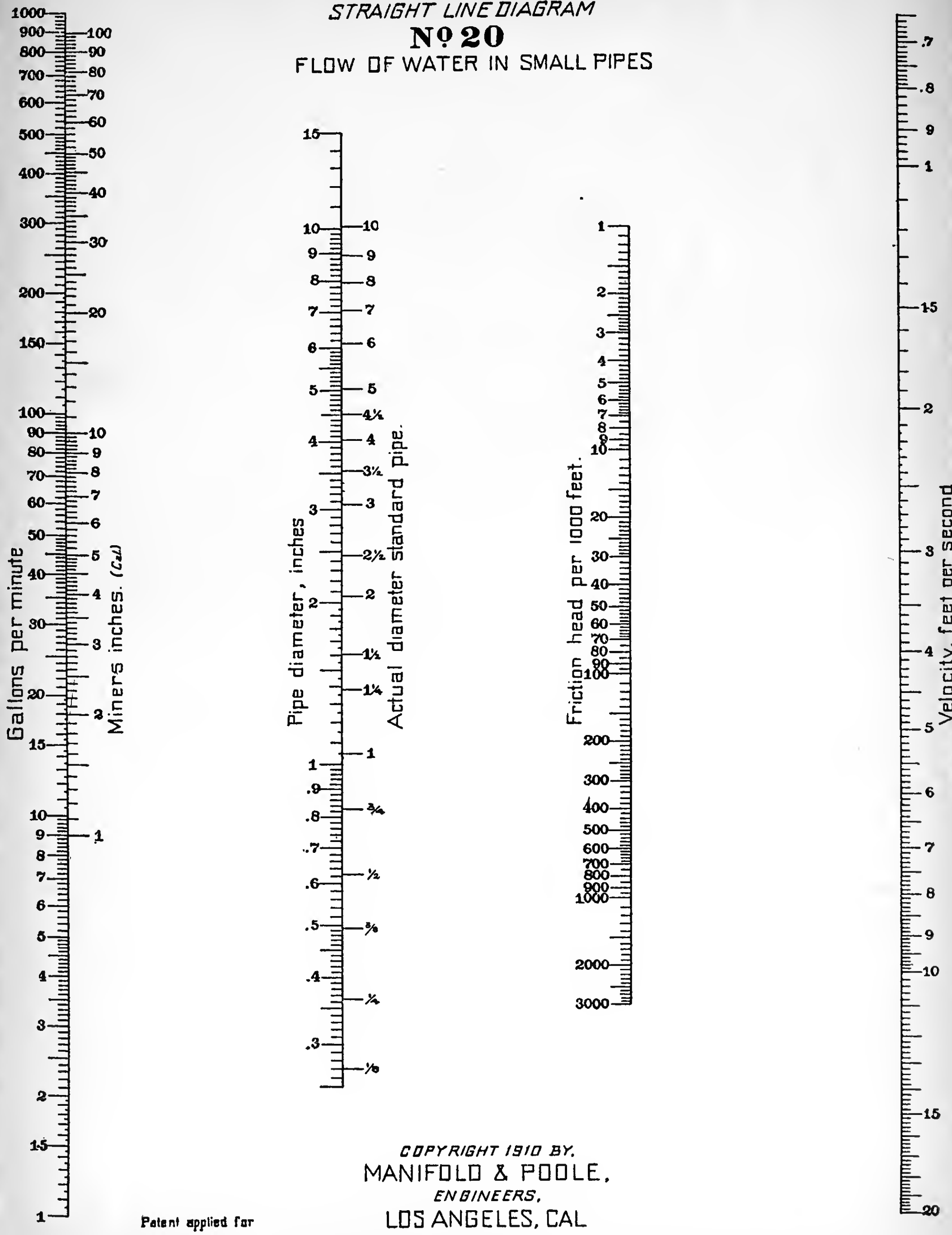
Example: 2 miner's inches have to be conveyed in a pipe with grade of 20 ft. per 1,000; what pipe must be used?

Solution: Connect 2 on scale No. 2 to 20 on scale No. 5 and find diameter 1.87 in. on scale No. 3, hence use 2 in. pipe.

STRAIGHT LINE DIAGRAM

№ 20

FLOW OF WATER IN SMALL PIPES



Patent applied for

Explanation of Diagram No. 21
Canals in Earth

This diagram is used for preliminary estimating and is figured for the case where depth = bottom width = sq. root cross section divided by 2.5 and slopes of sides 1½ to 1.

The formula used is $V = C R^{.67} S^{.5}$ in which V = Velocity, C = Constant, in this case 59. R = hydraulic radius; S = slope.

The miner's inch here given is equal to 1/40 second ft. or 40 miner's inches = 1 sec. ft.

Example: What dimensions and fall per mile must be given a canal to carry 100 second ft. at a velocity of 2 feet per second?

Solution: Connect 100, scale No. 1, to 2, scale No. 7, and find fall per mile, scale No. 6 = 1.7 ft.

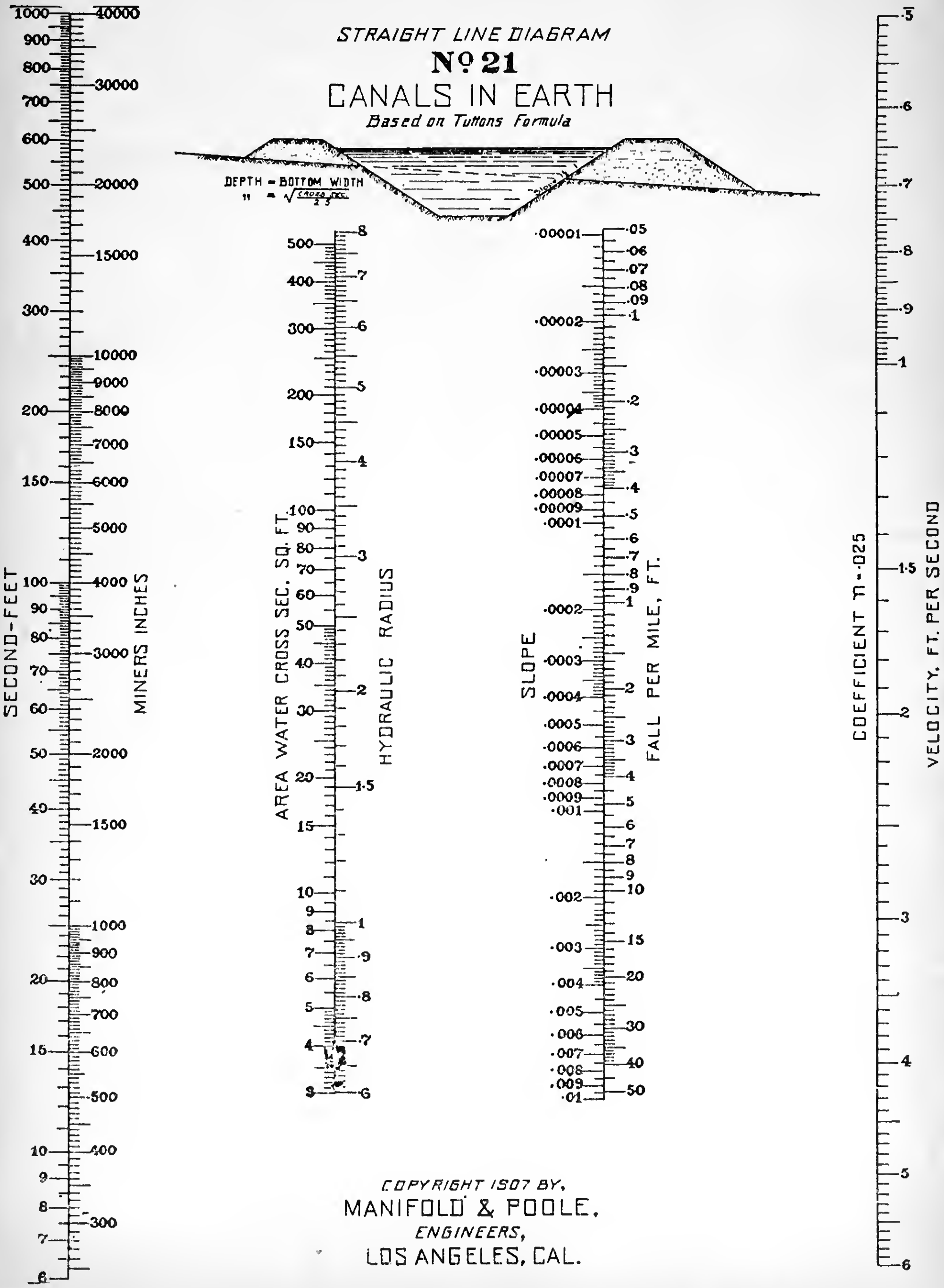
Also find cross section of water, scale No. 3 = 50 sq. ft. and insert in above formula gives depth = sq. root of 20 = 4.47 ft. Bottom width = 4.47, surface of water = 4 x 4.47 = 17.88 ft.

STRAIGHT LINE DIAGRAM

Nº 21

CANALS IN EARTH

Based on Tuttons Formula



MANIFOLD & POOLE,

ENGINEERS,

LOS ANGELES, CAL.

Explanation of Diagram No. 22

Water Power

This diagram shows the horse power which can be generated from the given quantity of water dropping a certain number of feet. Also the horse power required to raise a given quantity of water a certain number of feet. The miner's inch here given is equal to 1/50 second foot or 50 miner's inches = 1 second ft.

The example indicated on the diagram shows that 24 second ft. or 1,200 miner's inches falling through a vertical height of 100 ft. will generate to 273 h.p. or 204 k.w. theoretically, and at 70 per cent efficiency equals 191 horse power or 143 k.w.

Example: If it is required to lift the above water through the same total head of 100 ft., the efficiency of the pumps being 60 per cent, required horse power.

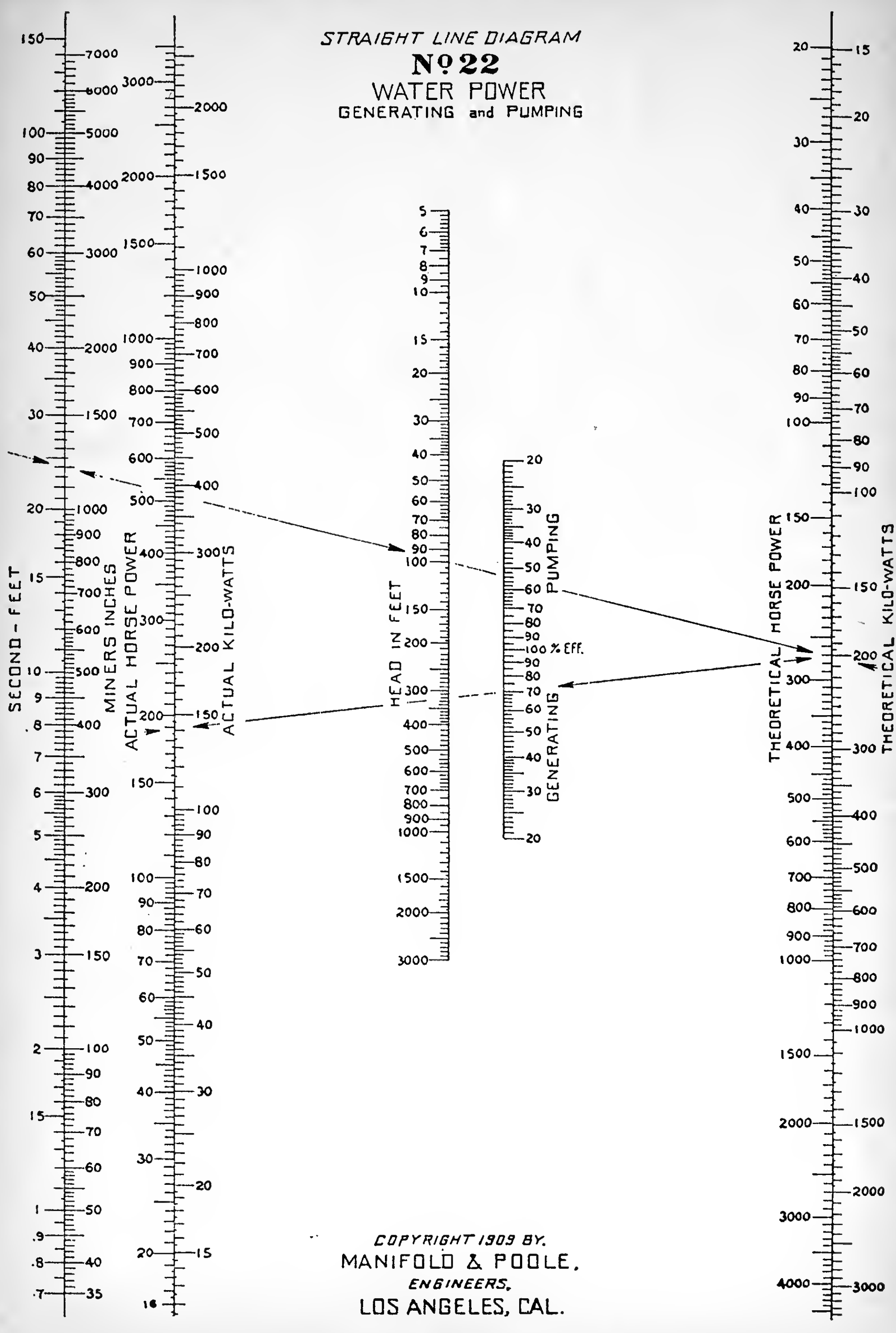
Solution: The theoretical horse power will be the same as before, 273 on scale No. 7, connecting this point to 60 pumping on scale No. 6, find actual h.p. required 455 on scale No. 3.

STRAIGHT LINE DIAGRAM

Nº 22

WATER POWER

GENERATING and PUMPING



MANIFOLD & POOLE.
ENGINEERS.
LOS ANGELES, CAL.

Explanation of Diagram No. 23

Steel Pipe Line

This diagram is used for estimating the thickness and weight of riveted steel pressure pipe.

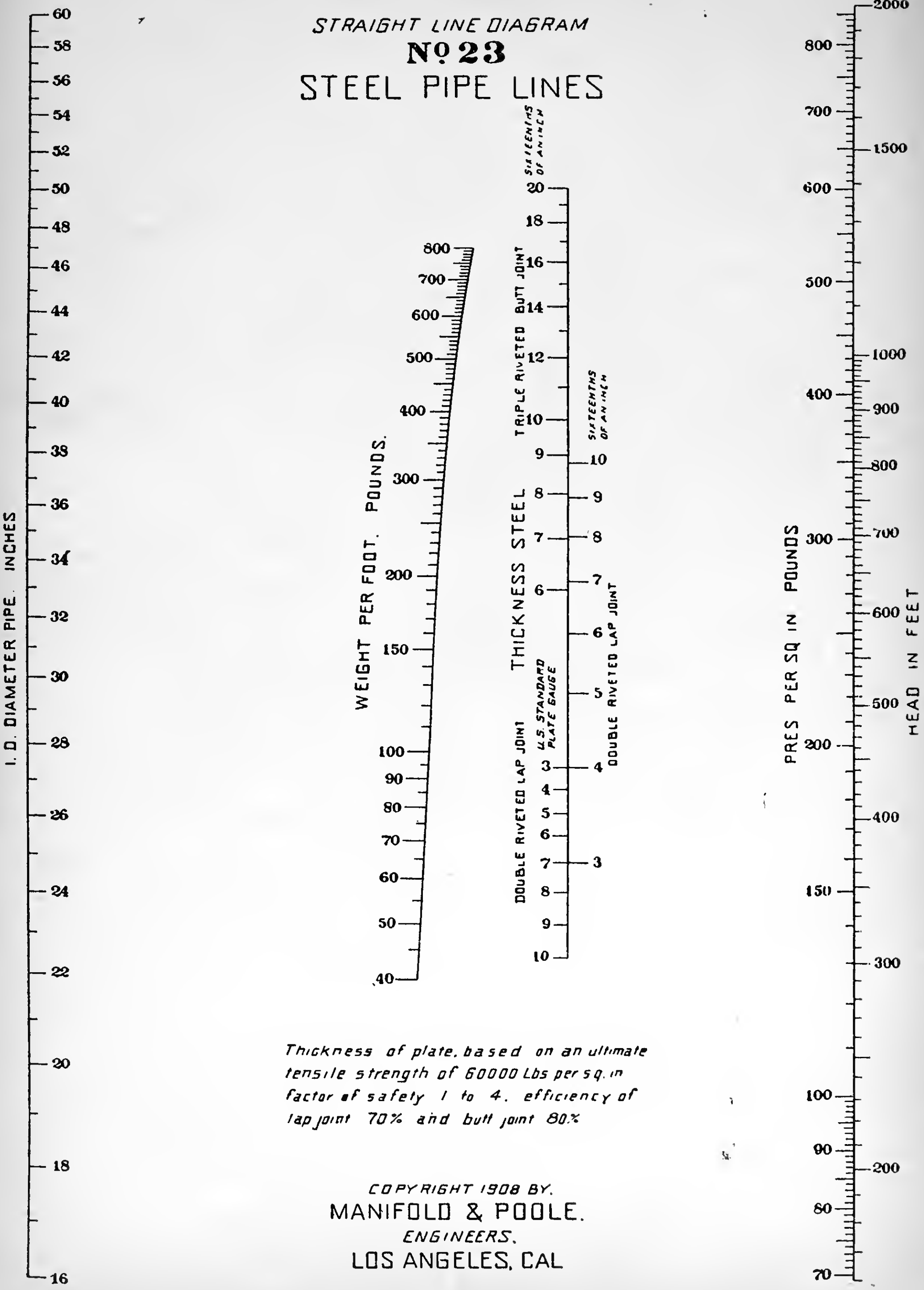
Example: What is the weight per ft. of 36 in. lap riveted pipe ½ in. thick and what head will it sustain with factor of safety 4?

Solution: Connect 36 on scale No. 1 to 8 on scale No. 4 and find weight per foot, scale No. 2 = 243 lb. and head in feet scale No. 6 = 672.

STRAIGHT LINE DIAGRAM

Nº 23

STEEL PIPE LINES



Thickness of plate, based on an ultimate tensile strength of 60000 Lbs per sq. in factor of safety 1 to 4. efficiency of lap joint 70% and butt joint 80%

Explanation of Diagram No. 24

Flow of Water in Pipes

Coefficient $n = .009$ for metal pipe absolutely smooth and straight; coefficient $n = .01$ for cast iron and welded steel pipe in good condition.

This diagram gives the loss in friction in pipes of diameter from 4 in. to 150 in., when carrying various quantities of water. The miner's inch here given is equal to 1/40 second foot or 40 miner's inches = 1 sec. ft.

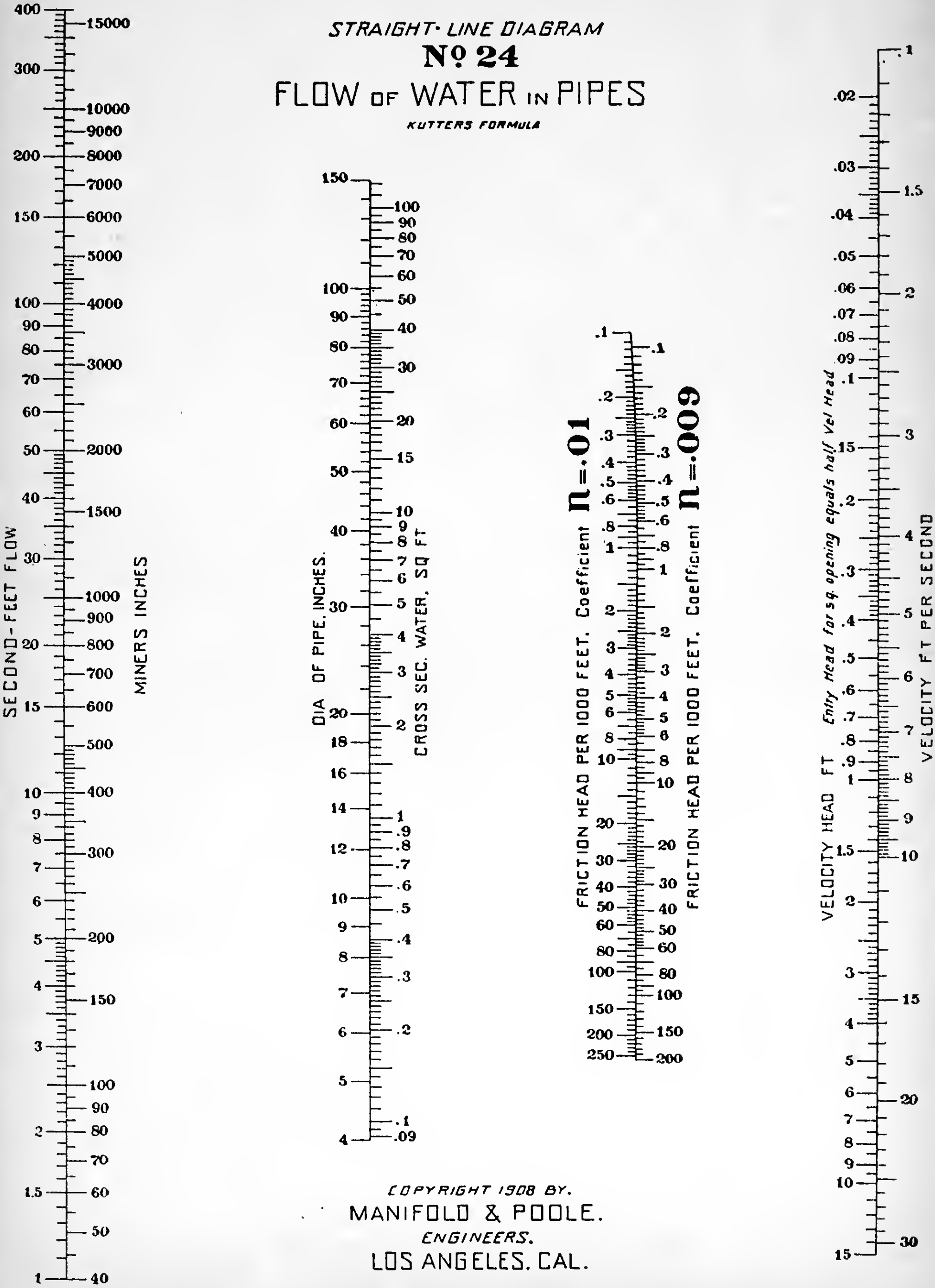
Example 1: It is required to determine the diameter of a cast iron pipe to carry 10 second ft. or 400 miner's inches of water, when laid on a grade of 2 ft. per 1,000. Coefficient $n = .01$.

Solution: Connect 10 on scale No. 1 to 2 on scale No. 5 and find diameter of pipe 21½ in. on scale No. 3; also the velocity of the water equals 4 ft. per sec. and the velocity head .25 ft. and entry head .125 ft.

Example 2: If diameter of above pipe is increased to 24 in. how much water will flow at same grade? **Answer**—13½ sec. ft.

Example 3: At what grade would a 24 in. pipe have to be laid to carry 10 sec. ft. coefficient $n = .01$ as above? **Answer**—1.1 ft. per 1,000.

STRAIGHT-LINE DIAGRAM
Nº 24
FLOW OF WATER IN PIPES
KUTTERS FORMULA



MANIFOLD & POOLE.
ENGINEERS.
LOS ANGELES, CAL.

Explanation of Diagram No. 25

Flow of Water in Pipes

Coefficient $n = .011$, for steel pipe carefully coated inside with asphaltum in good alignment.

Coefficient $n = .012$, for wood-stave pipe in good condition made of first-class lumber carefully milled.

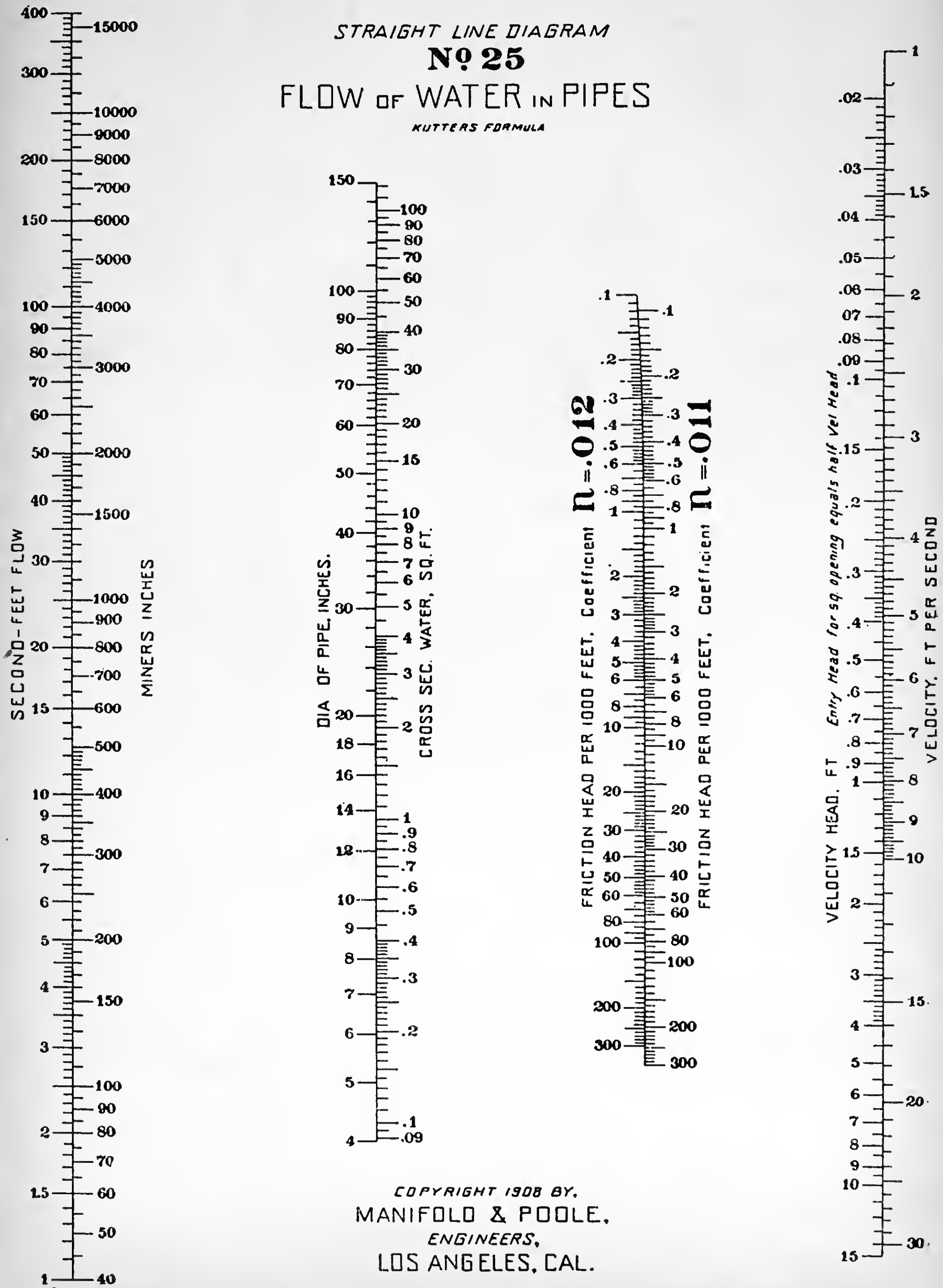
This diagram gives loss in friction in pipe of diameter 4 in. to 150 in. when carrying various quantities of water.

See diagram No. 24 for example illustrating method of working.

STRAIGHT LINE DIAGRAM

№ 25
FLOW OF WATER IN PIPES

KUTTERS FORMULA



Explanation of Diagram No. 26

Flow of Water in Pipes

Coefficient $n = .013$ for wood-stave pipe

Coefficient $n = .014$ for light steel riveted pipe

This diagram gives loss in friction in pipe of diameter 4 in. to 150 in. when carrying various quantities of water.

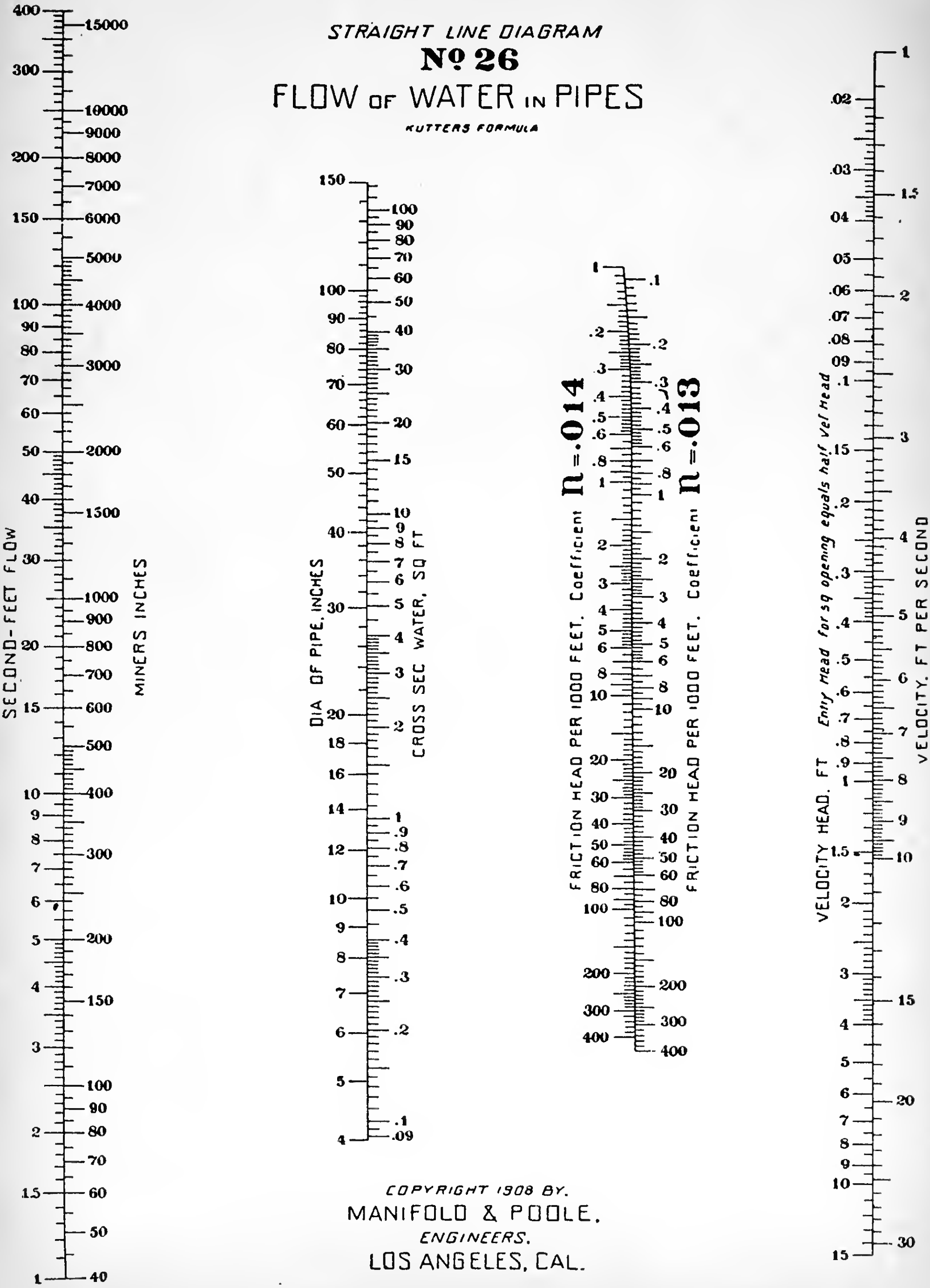
See diagram No. 24 for examples illustrating method of working.

STRAIGHT LINE DIAGRAM

Nº 26

FLOW OF WATER IN PIPES

KUTTERS FORMULA



MANIFOLD & POOLE.

ENGINEERS.

LOS ANGELES, CAL.

Explanation of Diagram No. 27
Flow of Water in Pipes

Coefficient $n = .015$ for lap-riveted steel pipe up to $\frac{3}{8}$ in. thick.

Coefficient $n = .016$ for lap-riveted steel pipe from $\frac{3}{8}$ in. thick and up.

This diagram gives loss in friction in pipe of diameter 4 in to 150 in. when carrying various quantities of water.

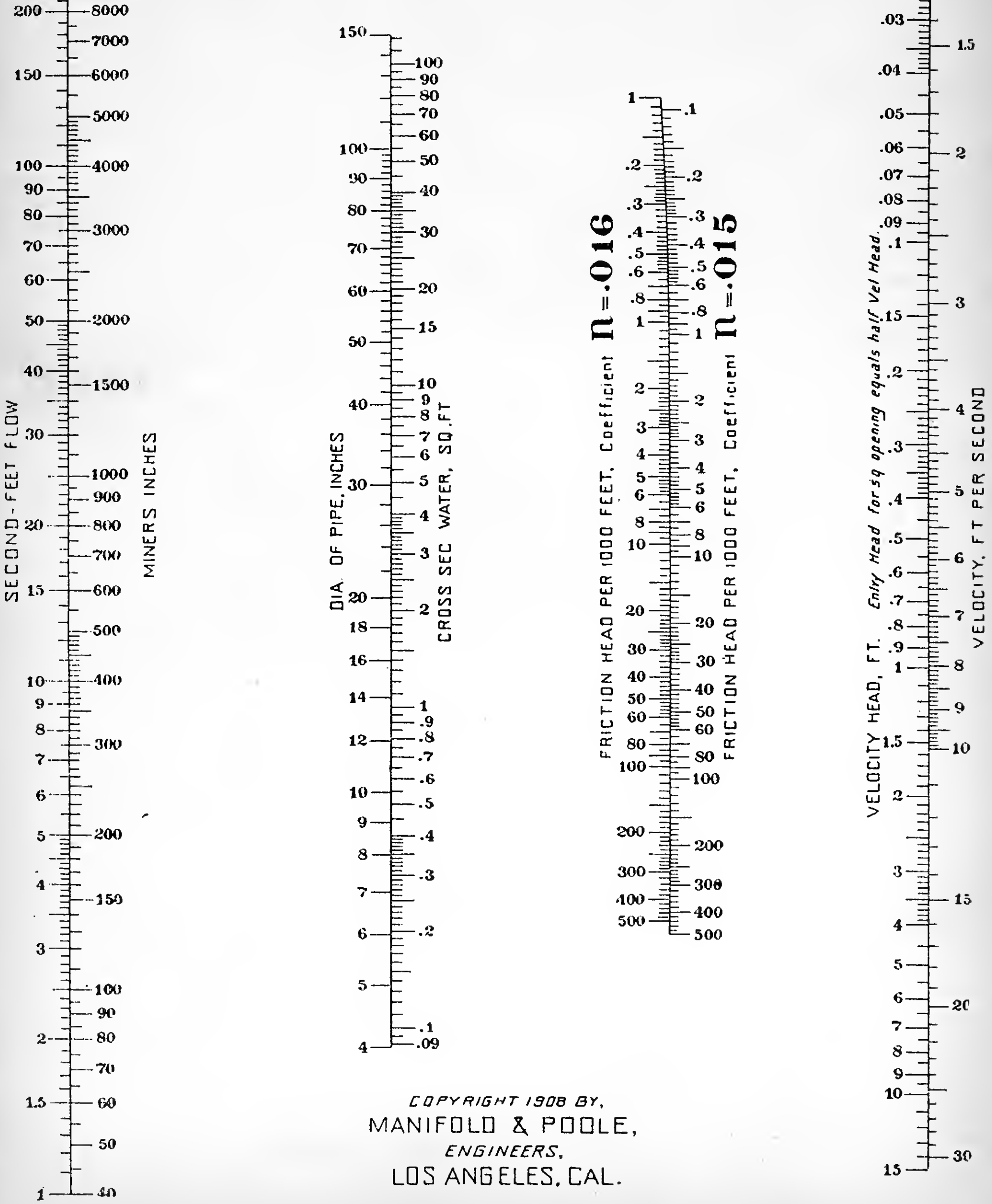
See diagram No. 24 for examples illustrating method of working.

STRAIGHT LINE DIAGRAM

Nº 27

FLOW OF WATER IN PIPES

KUTTERS FORMULA



MANIFOLD & POOLE,
ENGINEERS,
LOS ANGELES, CAL.

Explanation of Diagram No. 28

Flow of Water in Pipes

Coefficient $n = .017$ for triple riveted butt-joint steel pipe up to $\frac{5}{8}$ in thick.

Coefficient $n = .018$ for triple riveted butt-joint steel pipe from $\frac{5}{8}$ in. thick and up.

This diagram gives loss in friction in pipe of diameter 4 in. to 150 in. when carrying various quantities of water.

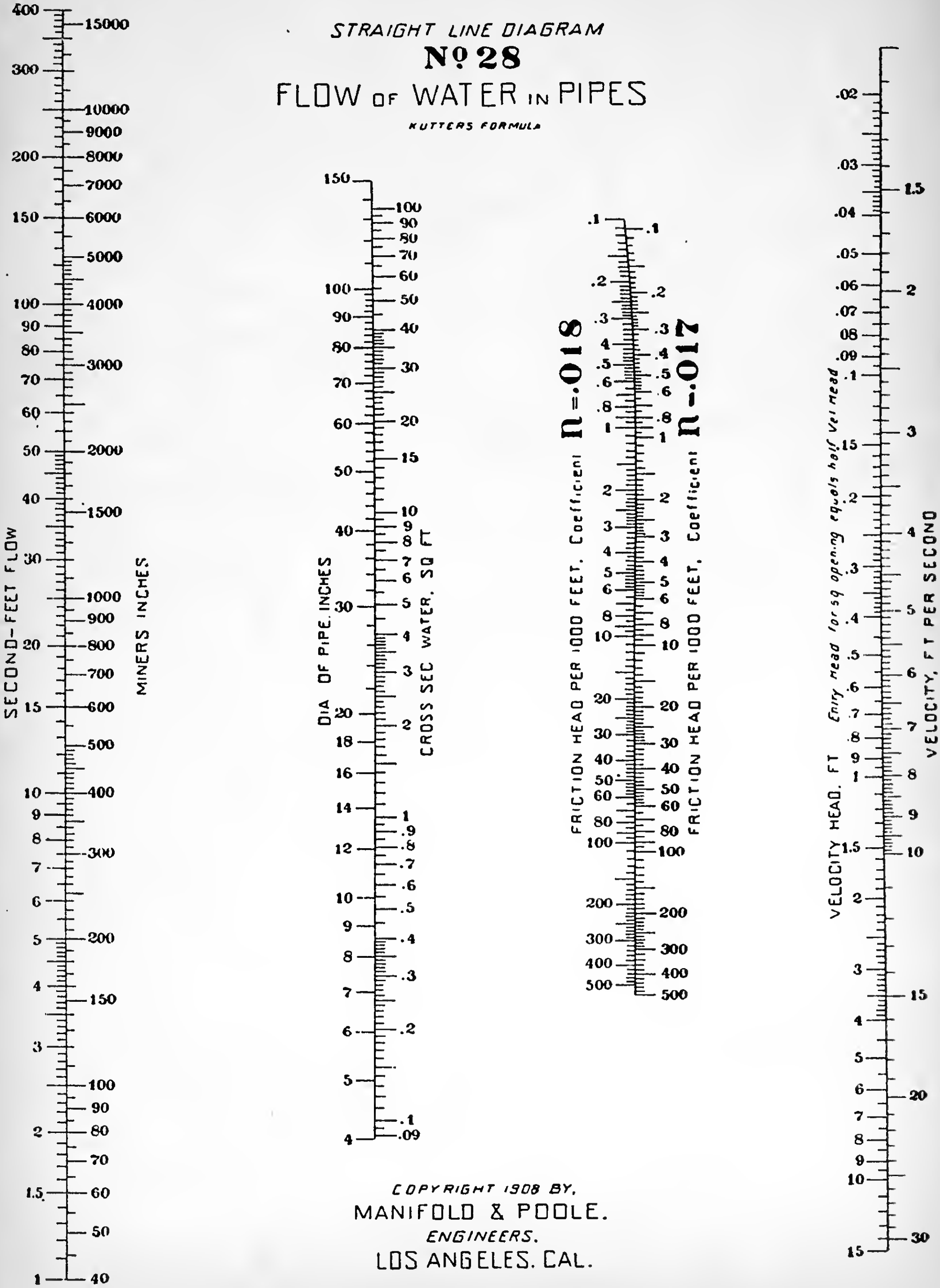
See diagram No. 24 for examples illustrating method of working.

STRAIGHT LINE DIAGRAM

Nº 28

FLOW OF WATER IN PIPES

KUTTERS FORMULA



MANIFOLD & POOLE.

ENGINEERS.

LOS ANGELES. CAL.

Explanation of Diagram No. 29
Flow of Water in Pipes

Coefficient $n = .019$ for heavy lap-joint steel pipe in poor condition.

Coefficient $n = .02$ for heavy butt-joint steel pipe in poor condition.

This diagram gives loss in friction in pipe of diameter 4 in. to 150 in. when carrying various quantities of water.

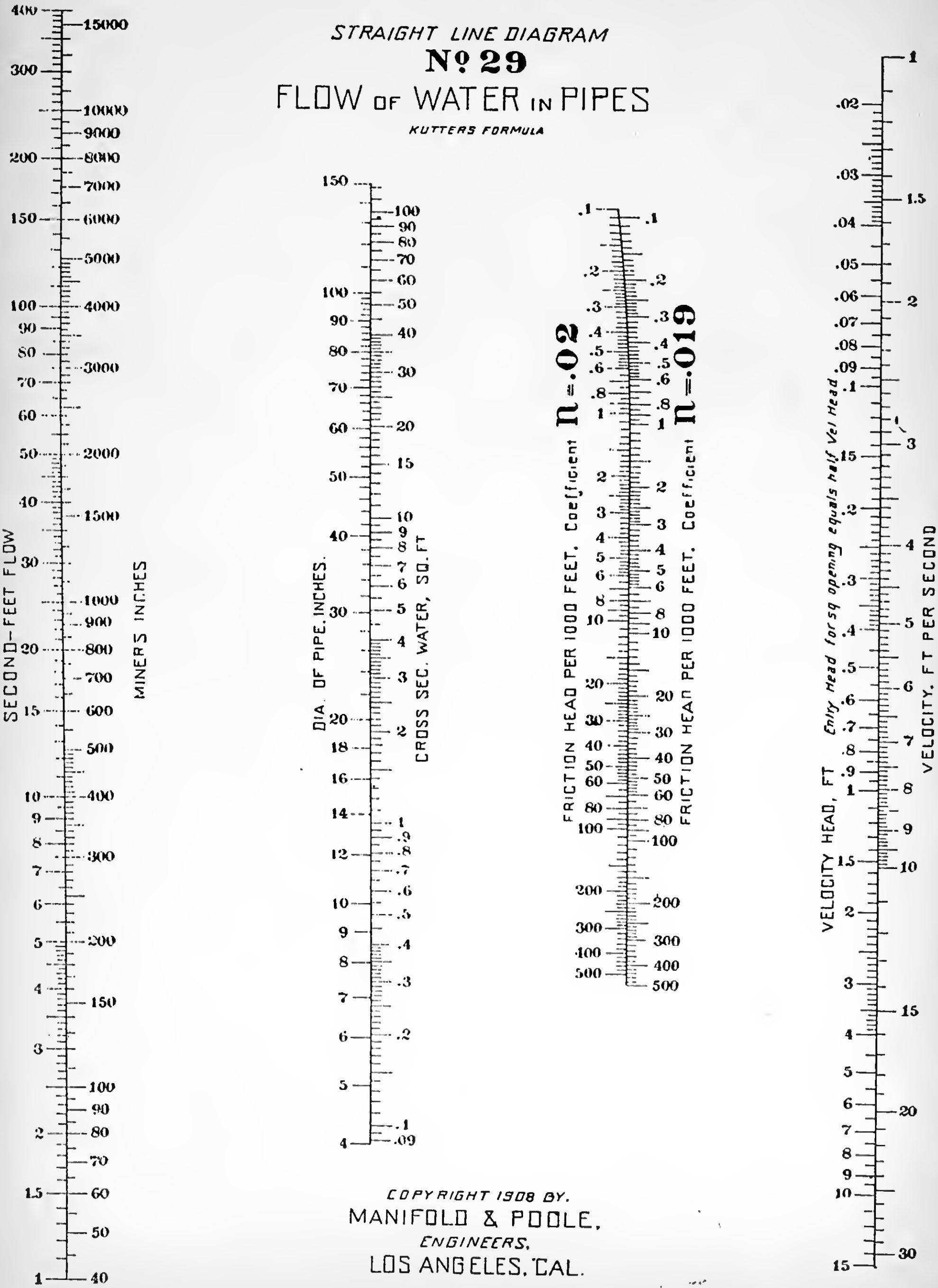
See diagram No. 24 for examples illustrating method of working.

STRAIGHT LINE DIAGRAM

Nº 29

FLOW OF WATER IN PIPES

KUTTERS FORMULA



Explanation of Diagram No. 30
Wood-Stave Pipe Lines

This diagram is used for designing wood-stave pipe and estimating quantities of material required. Scale No. 1 is the outside diameter which has to be taken when calculating the bands required, as the pressure extends to the outside. The size and number of staves required are found directly on scale No. 2. For instance a 48 in. diameter pipe would be 51 in. outside diameter and would require 29 staves; as the staves are from 2 in. x 6 in. stock, there will be required 29 ft. of lumber per ft. of pipe.

A tensile strength of 60,000 lb. per sq. in. is assumed for the steel in the bands, with a factor of safety of 4. Swelling of the wood is assumed at 100 lb. per sq. in.

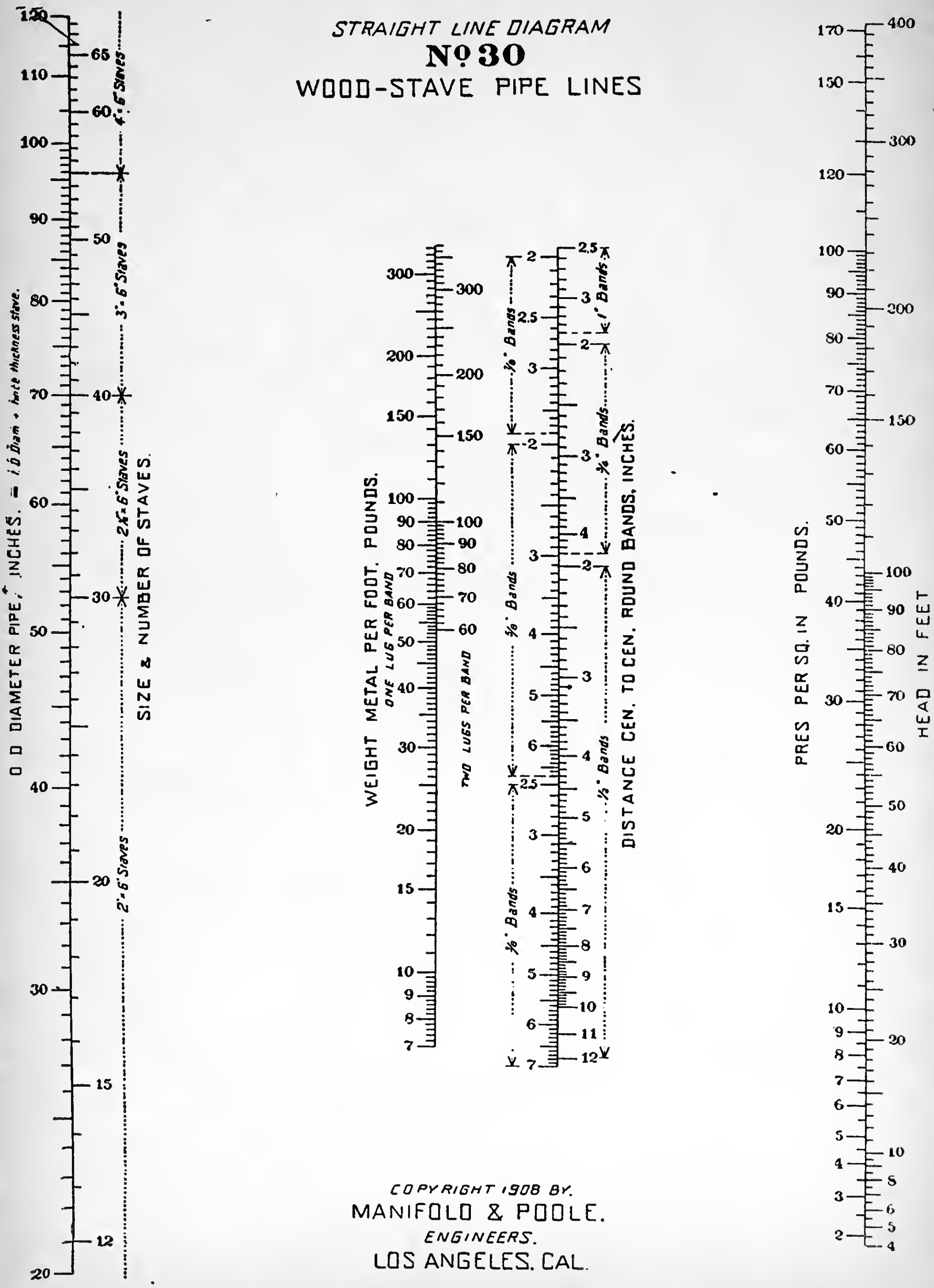
Example: A wood-stave pipe is 48 in. diameter inside or 51 in. outside; find the distance between center of ⅝ in. bands to sustain 48 ft. head, and the weight of the metal contained in bands and shoes per foot of pipe.

Solution: Connect 51 on scale No. 1 to 48 on scale No. 8 and read 5.9 in. on scale No. 5, distance center to center, and 36 lb. on scale No. 3. If the bands were of ½ in. round, the distance center to center would be 3.8 in., as found on scale No. 6.

STRAIGHT LINE DIAGRAM

Nº 30

WOOD-STAVE PIPE LINES



MANIFOLD & POOLE.

ENGINEERS.

LOS ANGELES, CAL.

Explanation of Diagram No. 31

Flow of Water Over Sharp-Edged Weirs

This diagram solves Bazin's formula for the discharge per foot in length over sharp-edged vertical weirs, without end contraction.

Examples: Find quantity of water flowing over a weir 10 ft. high, 10 ft. wide, depth water over weir 3 ft.

Solution: Connect 3, scale No. 1, to 10, scale No. 3, and find second feet per foot of weir, scale No. 2 = 17.5 second ft.

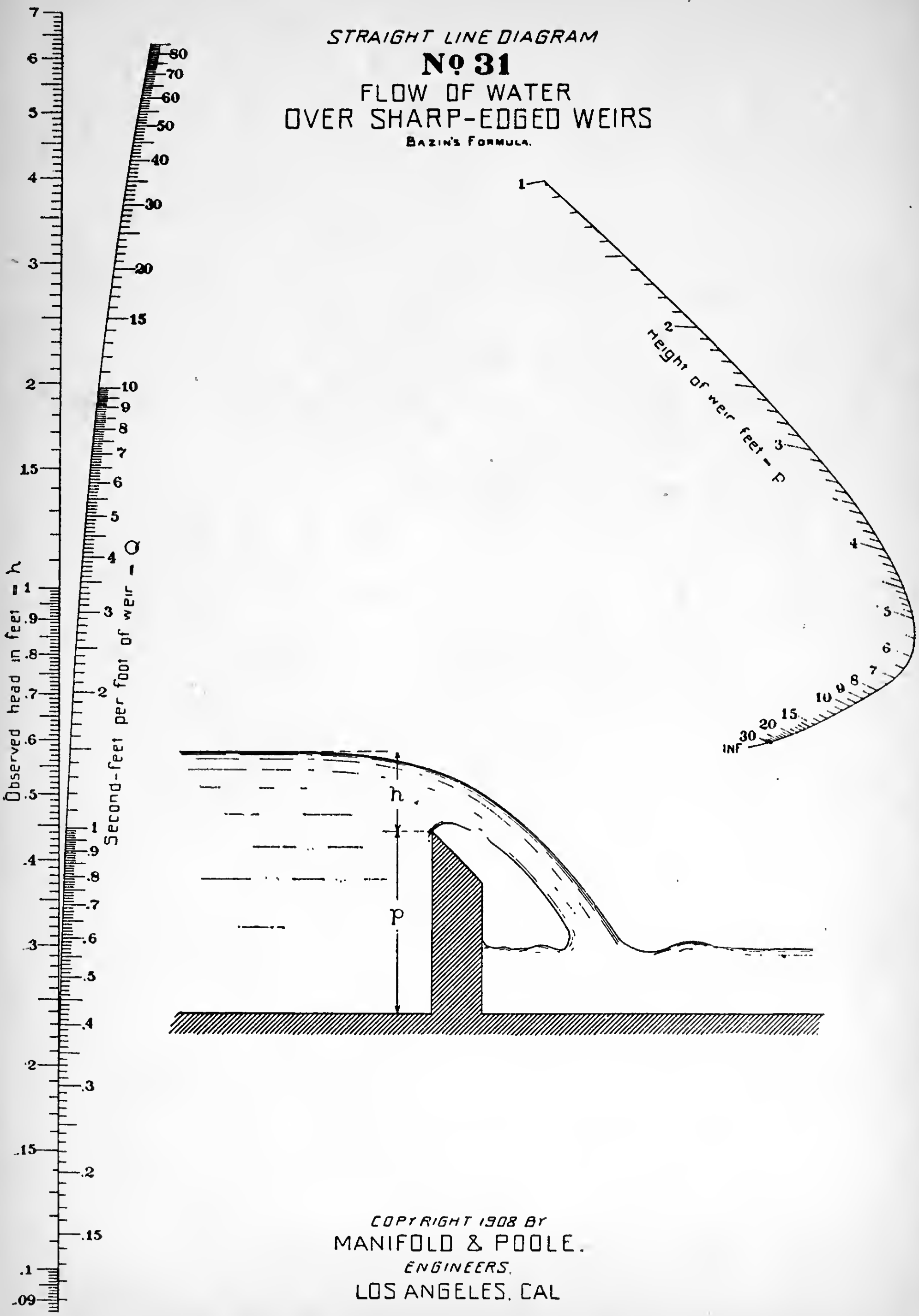
17.5 multiplied by 10 ft. = 175 second feet.

STRAIGHT LINE DIAGRAM

Nº 31

FLOW OF WATER OVER SHARP-EDGED WEIRS

BAZIN'S FORMULA.



ENGINEERS.
LOS ANGELES, CAL

Explanation of Diagram No. 32

Flow of Water in Canals and Flumes

This diagram is based on Kutter's formula.

In designing a canal or flume, first determine the value for coefficient n and turn to the proper diagram based on this coefficient as found on scales Nos. 3 or 4; then assume a proportion of depth to bottom width and slopes of sides and find the section and depth constants from the table, which are used as follows: Scale No. 1 is second feet flow multiplied by section constant; hydraulic radius as found on scale No. 2 multiplied by depth constant equals depth of water in feet.

For plaster in neat cement, planed lumber, glazed surface $n = .010$

Plaster one part cement, three parts sand, $n = .011$

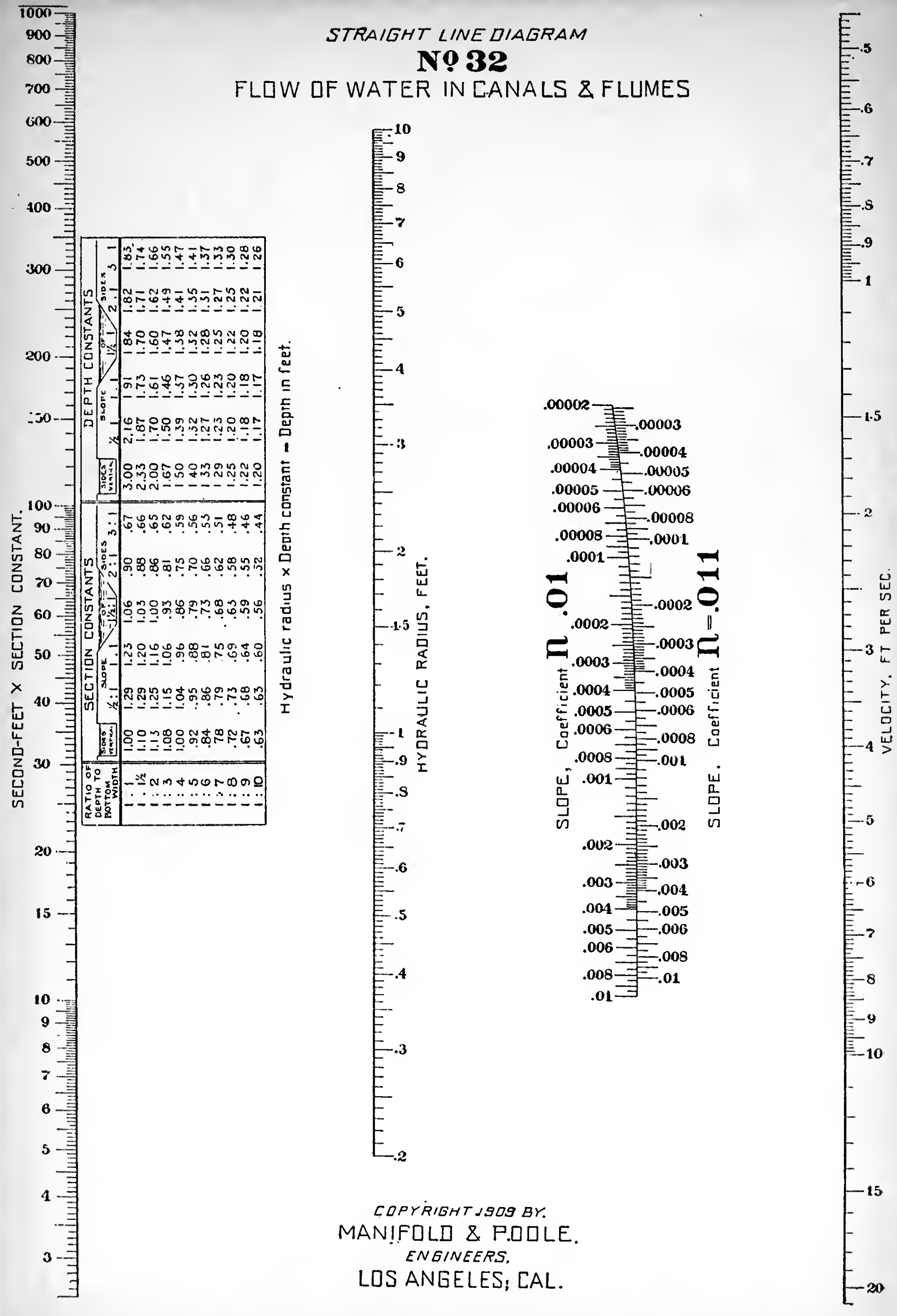
Example: A canal to carry 100 second feet and constructed in earth has to be designed. Slope of sides 2:1. Ratio depth to bottom width 1:2. Velocity to be 2.5 ft. per second, to find the dimension of the canal and slope on which it will have to run.

Solution: Turn to diagram No. 36 in which the canal is assumed of average conditions and $n = .025$. By examining the table, find section constant .86 and depth constant 1.62. Connect $100 \times .86 = 86$ on scale No. 1 to 2.5 on scale No. 5 and read .0008 on scale No. 4, which is the slope that must be given to the canal, and also read 1.95 on scale No. 2, the hydraulic radius which multiplied by the depth constant 1.62 equals 3.16 ft. depth of water. As the ratio of depth to bottom width equals 1:2, bottom width equals $2 \times 3.16 = 6.32$. And as the slope of the sides is 2:1, the surface of the water will be found 18.96 wide.

STRAIGHT LINE DIAGRAM

Nº 32

FLOW OF WATER IN CANALS & FLUMES



RATIO OF DEPTH TO BOTTOM WIDTH	SECTION CONSTANTS: SIDES VERTICAL	SLOPE OF SIDES ½:1	1:1	1½:1	2:1	3:1	DEPTH CONSTANTS: SIDES VERTICAL	SLOPE OF SIDES ½:1	1:1	1½:1	2:1	3:1
1 : 1	1.00	1.29	1.23	1.06	.90	.67	3.00	2.16	1.91	1.84	1.82	1.83
1 : 1½	1.10	1.29	1.20	1.03	.88	.66	2.33	1.87	1.73	1.70	1.71	1.74
1 : 2	1.13	1.25	1.16	1.00	.86	.65	2.00	1.70	1.61	1.60	1.62	1.66
1 : 3	1.08	1.15	1.06	.93	.81	.62	1.67	1.50	1.46	1.47	1.49	1.55
1 : 4	1.00	1.04	.96	.86	.75	.59	1.50	1.39	1.37	1.38	1.41	1.47
1 : 5	.92	.95	.88	.79	.70	.56	1.40	1.32	1.30	1.32	1.35	1.41
1 : 6	.84	.86	.81	.73	.66	.53	1.33	1.27	1.26	1.28	1.31	1.37
1 : 7	.78	.79	.75	.68	.62	.51	1.29	1.23	1.23	1.25	1.27	1.33
1 : 8	.72	.73	.69	.63	.58	.48	1.25	1.20	1.20	1.22	1.25	1.30
1 : 9	.67	.68	.64	.59	.55	.46	1.22	1.18	1.18	1.20	1.22	1.28
1 : 10	.63	.63	.60	.56	.52	.44	1.20	1.17	1.17	1.18	1.21	1.26

Hydraulic radius × Depth constant = Depth in feet.

MANIFOLD & POOLE.
ENGINEERS,
LOS ANGELES; CAL.

Explanation of Diagram No. 33.

Flow of Water in Canals and Flumes

$n = .012$ for unplaned lumber in good order

$n = .013$ for ashlar or good brick work.

For full explanation and examples of working see diagram No. 32.

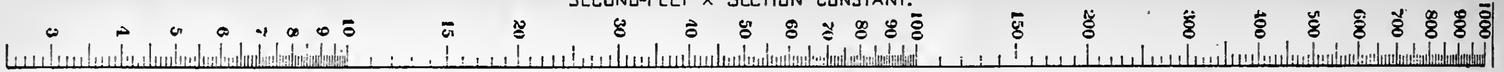
Example 2: A flume 8 ft. 6 in. wide by 6 ft. 3 in. high, with sides perpendicular, built of planed lumber, well fitted and having a slope of .0004; required the velocity of the water and how much it will carry.

Solution: Assume that the water line is at 6 in. from top of side, giving depth of water 5 ft. 9 in. The ratio of depth to bottom width will be nearly 1:1½. The section constant equals 1.10 and depth constant 2.33. Assuming that coefficient $n = .01$, since hydraulic radius = depth in ft. divided by depth constant, hence connect 5.75 ft divided by 2.33 = 2.46 on scale No. 2 to .0004 on scale No. 3 and read velocity 5.4 on scale No. 5 and second ft. multiplied by section constant equals 293 on scale No. 1. Hence second ft. flow equals 293 divided by 1.1 = 266 second ft.

STRAIGHT LINE DIAGRAM

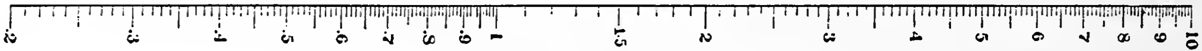
Nº 33

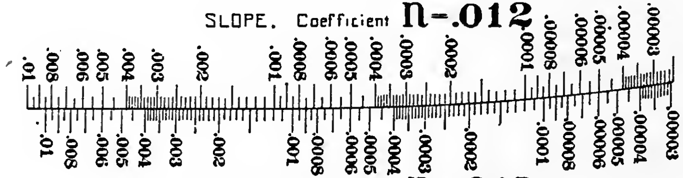
FLOW OF WATER IN CANALS & FLUMES



RATIO OF DEPTH TO BOTTOM WIDTH	SECTION CONSTANTS: SIDES VERTICAL	SLOPE ½ : 1	1 : 1	OF 1½ : 1	SIDES 2 : 1	3 : 1	DEPTH CONSTANTS: SIDES VERTICAL	SLOPE ½ : 1	1 : 1	OF 1½ : 1	SIDES 2 : 1	3 : 1
1 : 1	1.00	1.29	1.23	1.06	.90	67	3.00	2.16	1.91	1.84	1.82	1.83
1 : 1½	1.10	1.29	1.20	1.03	.88	.66	2.33	1.87	1.73	1.70	1.71	1.74
1 : 2	1.13	1.25	1.16	1.00	.86	.65	2 00	1.70	1.61	1.60	1.62	1.66
1 : 3	1.08	1.15	1.06	.93	.81	.62	1 67	1.50	1.46	1.47	1.49	1.55
1 : 4	1.00	1.04	.96	.86	.75	.59	1.50	1.39	1.37	1.38	1.41	1.47
1 : 5	92	.95	.88	.79	.70	.56	1.40	1.32	1.30	1.32	1.35	1.41
1 : 6	.84	.86	.81	.73	.66	.53	1.33	1.27	1.26	1.28	1.31	1.37
1 : 7	.78	.79	.75	.68	.62	.51	1 29	1.23	1.23	1.25	1.27	1.33
1 : 8	.72	.73	.69	.63	.58	.48	1.25	1.20	1.20	1.22	1.25	1.30
1 : 9	.67	.68	.64	.59	.55	.46	1.22	1.18	1.18	1.20	1.22	1.28
1 : 10	.63	.63	.60	.56	.52	.44	1.20	1.17	1 17	1.18	1.21	1.26

Hydraulic radius × Depth constant = Depth in feet.





MANIFOLD & POOLE,
ENGINEERS,
LOS ANGELES, CAL.

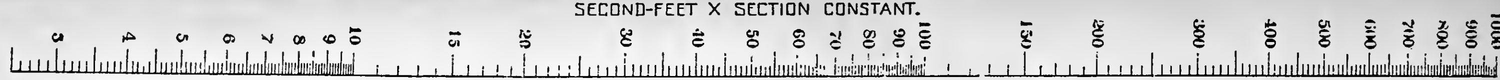
Explanation of Diagram No. 34.

Flow of Water in Canals and Flumes

$n = .014$ for canvas lined flumes supported by wood

$n = .015$ for well dressed stone work, iron, wood or cement in imperfect condition.

For full explanation and examples of working see diagram No. 32.



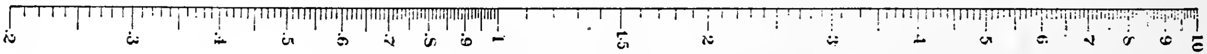
RATIO OF DEPTH TO BOTTOM WIDTH	SECTION CONSTANTS: Sides vertical	Slope of sides ½:1	1:1	1½:1	2:1	3:1	DEPTH CONSTANTS: Sides vertical	Slope of sides ½:1	1:1	1½:1	2:1	3:1
1 : 1	1.00	1.29	1.23	1.06	.90	.67	3.00	2.16	1.91	1.84	1.82	1.83
1 : 1½	1.10	1.29	1.20	1.03	.88	.66	2.33	1.87	1.73	1.70	1.71	1.74
1 : 2	1.13	1.25	1.16	1.00	.86	.65	2.00	1.70	1.61	1.60	1.62	1.66
1 : 3	1.08	1.15	1.06	.93	.81	.62	1.67	1.50	1.46	1.47	1.49	1.55
1 : 4	1.00	1.04	.96	.86	.75	.59	1.50	1.39	1.37	1.38	1.41	1.47
1 : 5	.92	.95	.88	.79	.70	.56	1.40	1.32	1.30	1.32	1.35	1.41
1 : 6	.84	.86	.81	.73	.66	.53	1.33	1.27	1.26	1.28	1.31	1.37
1 : 7	.78	.79	.75	.68	.62	.51	1.29	1.23	1.23	1.25	1.27	1.33
1 : 8	.72	.73	.69	.63	.58	.48	1.25	1.20	1.20	1.22	1.25	1.30
1 : 9	.67	.68	.64	.59	.55	.46	1.22	1.18	1.18	1.20	1.22	1.28
1 : 10	.63	.63	.60	.56	.52	.44	1.20	1.17	1.17	1.18	1.21	1.26

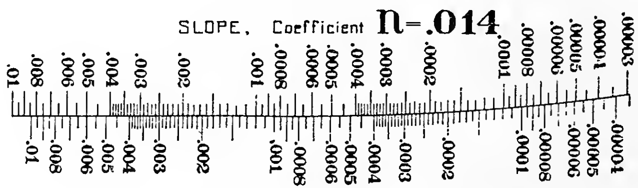
Hydraulic radius × Depth constant = Depth in feet.

STRAIGHT LINE DIAGRAM

Nº 34

FLOW OF WATER IN CANALS & FLUMES





MANIFOLD & POOLE,
ENGINEERS,
LOS ANGELES, CAL.

Explanation of Diagram No. 35

Flow of Water in Canals and Flumes

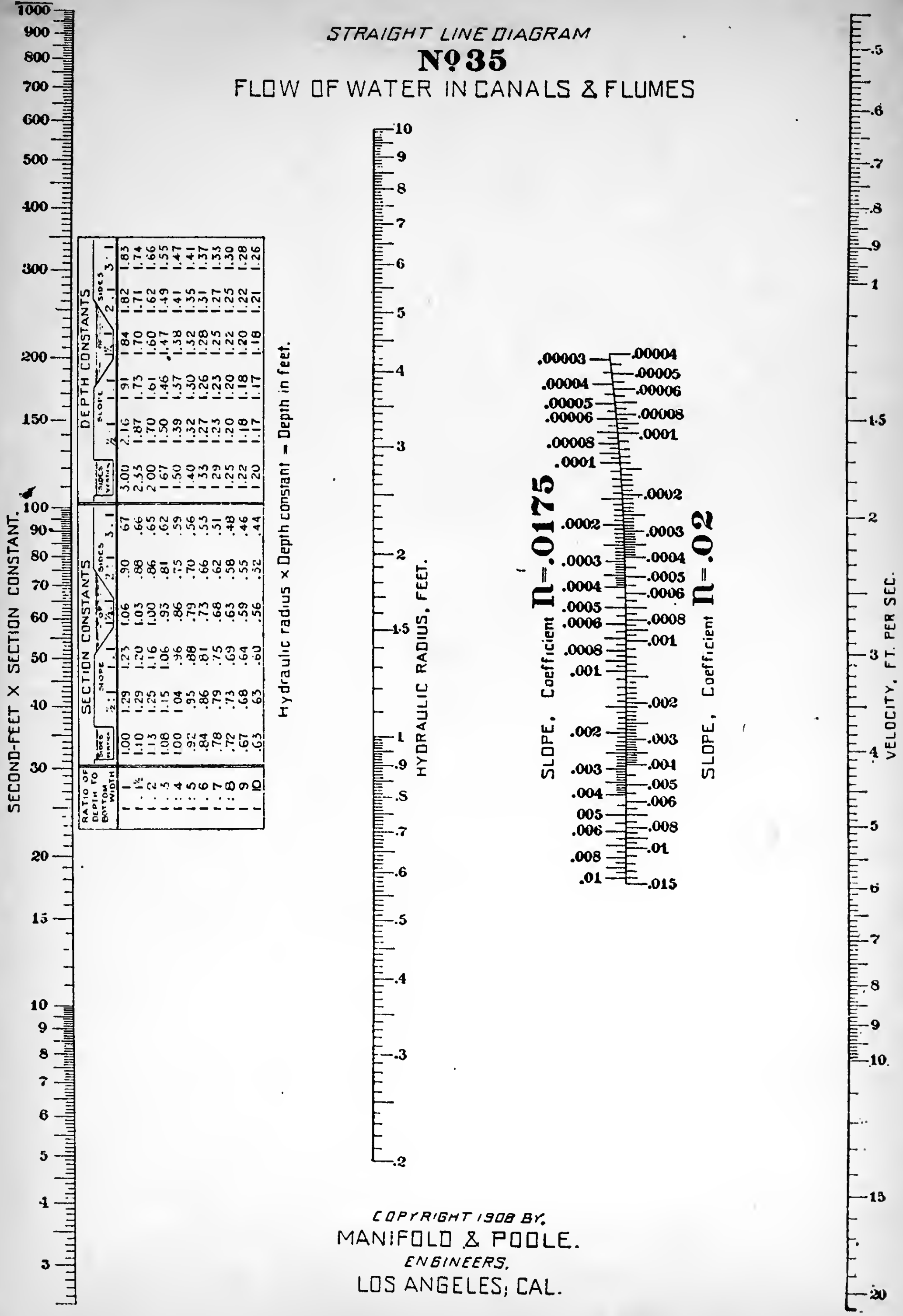
$n = .0175$ for rubble

$n = .02$ for canals in very fine gravel in perfect order.

STRAIGHT LINE DIAGRAM

Nº 35

FLOW OF WATER IN CANALS & FLUMES



RATIO OF DEPTH TO BOTTOM WIDTH	SECTION CONSTANTS						DEPTH CONSTANTS					
SLOPE OF SIDES	Sides vertical	½:1	1:1	1½:1	2:1	3:1	Sides vertical	½:1	1:1	1½:1	2:1	3:1
1 : 1	1.00	1.29	1.23	1.06	.90	.67	3.00	2.16	1.91	1.84	1.82	1.83
1 : 1½	1.10	1.29	1.20	1.03	.88	.66	2.53	1.87	1.73	1.70	1.71	1.74
1 : 2	1.13	1.25	1.16	1.00	.86	.65	2.00	1.70	1.61	1.60	1.62	1.66
1 : 3	1.08	1.15	1.06	.93	.81	.62	1.67	1.50	1.46	1.47	1.49	1.55
1 : 4	1.00	1.04	.96	.86	.75	.59	1.50	1.39	1.37	1.38	1.41	1.47
1 : 5	.92	.95	.88	.79	.70	.56	1.40	1.32	1.30	1.32	1.35	1.41
1 : 6	.84	.86	.81	.73	.66	.53	1.33	1.27	1.26	1.28	1.31	1.37
1 : 7	.78	.79	.75	.68	.62	.51	1.29	1.23	1.23	1.25	1.27	1.33
1 : 8	.72	.73	.69	.63	.58	.48	1.25	1.20	1.20	1.22	1.25	1.30
1 : 9	.67	.68	.64	.59	.55	.46	1.22	1.18	1.18	1.20	1.22	1.28
1 : 10	.63	.63	.60	.56	.52	.44	1.20	1.17	1.17	1.18	1.21	1.26

Hydraulic radius × Depth constant = Depth in feet.

Explanation of Diagram No. 36

Flow of Water in Canals and Flumes

$n = .0225$ for canals in earth better than average conditions

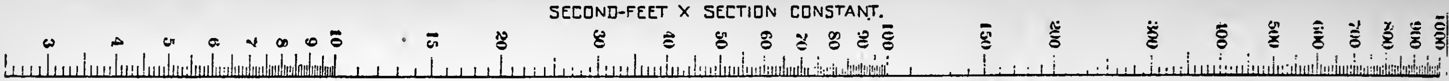
$n = .025$ for canals in earth with average conditions.

For full explanation and method of working see diagram No. 32.

STRAIGHT LINE DIAGRAM

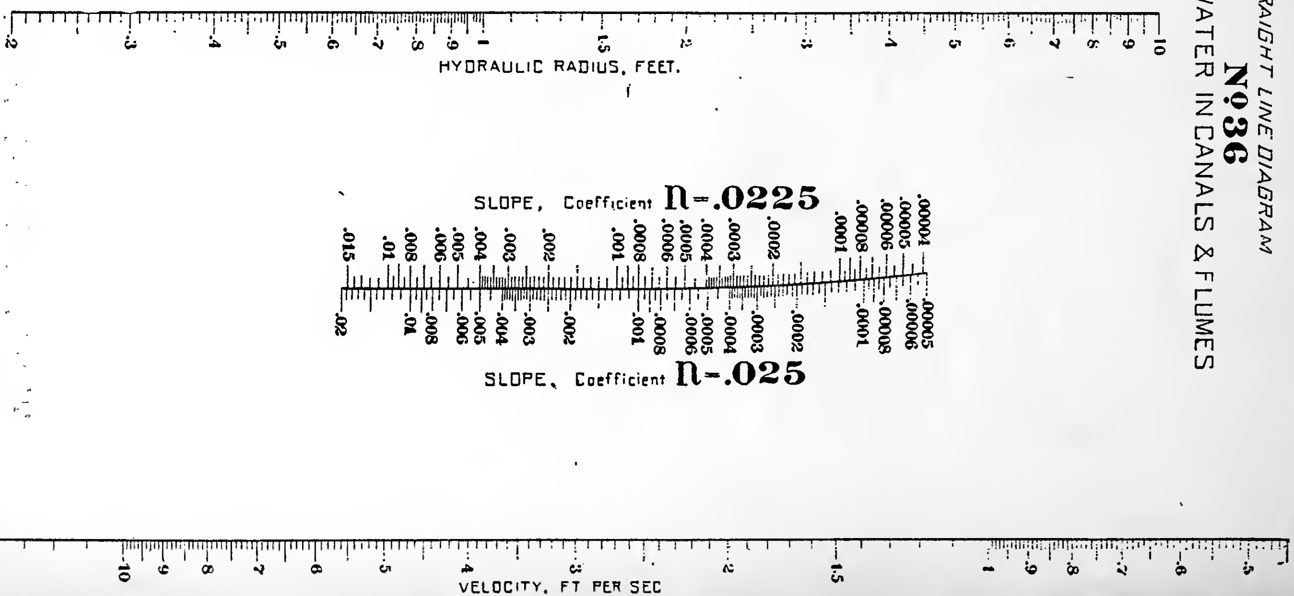
No. 36

FLOW OF WATER IN CANALS & FLUMES



RATIO OF DEPTH TO BOTTOM WIDTH	SECTION CONSTANTS: SIDES VERTICAL	SLOPE OF SIDES ½ : 1	1 : 1	1½ : 1	2 : 1	3 : 1	DEPTH CONSTANTS: SIDES VERTICAL	SLOPE OF SIDES ½ : 1	1 : 1	1½ : 1	2 : 1	3 : 1
1 : 1	1.00	1.29	1.25	1.06	.90	.67	3.00	2.16	1.91	1.84	1.82	1.63
1 : 1½	1.10	1.29	1.20	1.03	.88	.66	2.33	1.87	1.73	1.70	1.71	1.74
1 : 2	1.13	1.25	1.16	1.00	.86	.65	2.00	1.70	1.61	1.60	1.62	1.66
1 : 3	1.08	1.15	1.06	.93	.81	.62	1.67	1.50	1.46	1.47	1.49	1.55
1 : 4	1.00	1.04	.96	.86	.75	.59	1.50	1.39	1.37	1.38	1.41	1.47
1 : 5	.92	.95	.88	.79	.70	.56	1.40	1.32	1.30	1.32	1.35	1.41
1 : 6	.84	.86	.81	.73	.66	.53	1.33	1.27	1.26	1.28	1.31	1.37
1 : 7	.78	.79	.75	.68	.62	.51	1.29	1.23	1.23	1.25	1.27	1.33
1 : 8	.72	.73	.69	.63	.58	.48	1.25	1.20	1.20	1.22	1.25	1.30
1 : 9	.67	.68	.64	.59	.55	.46	1.22	1.18	1.18	1.20	1.22	1.28
1 : 10	.63	.63	.60	.56	.52	.44	1.20	1.17	1.17	1.18	1.21	1.26

Hydraulic radius × Depth constant = Depth in feet



Explanation of Diagram No. 37

Flow of Water in Canals and Flumes

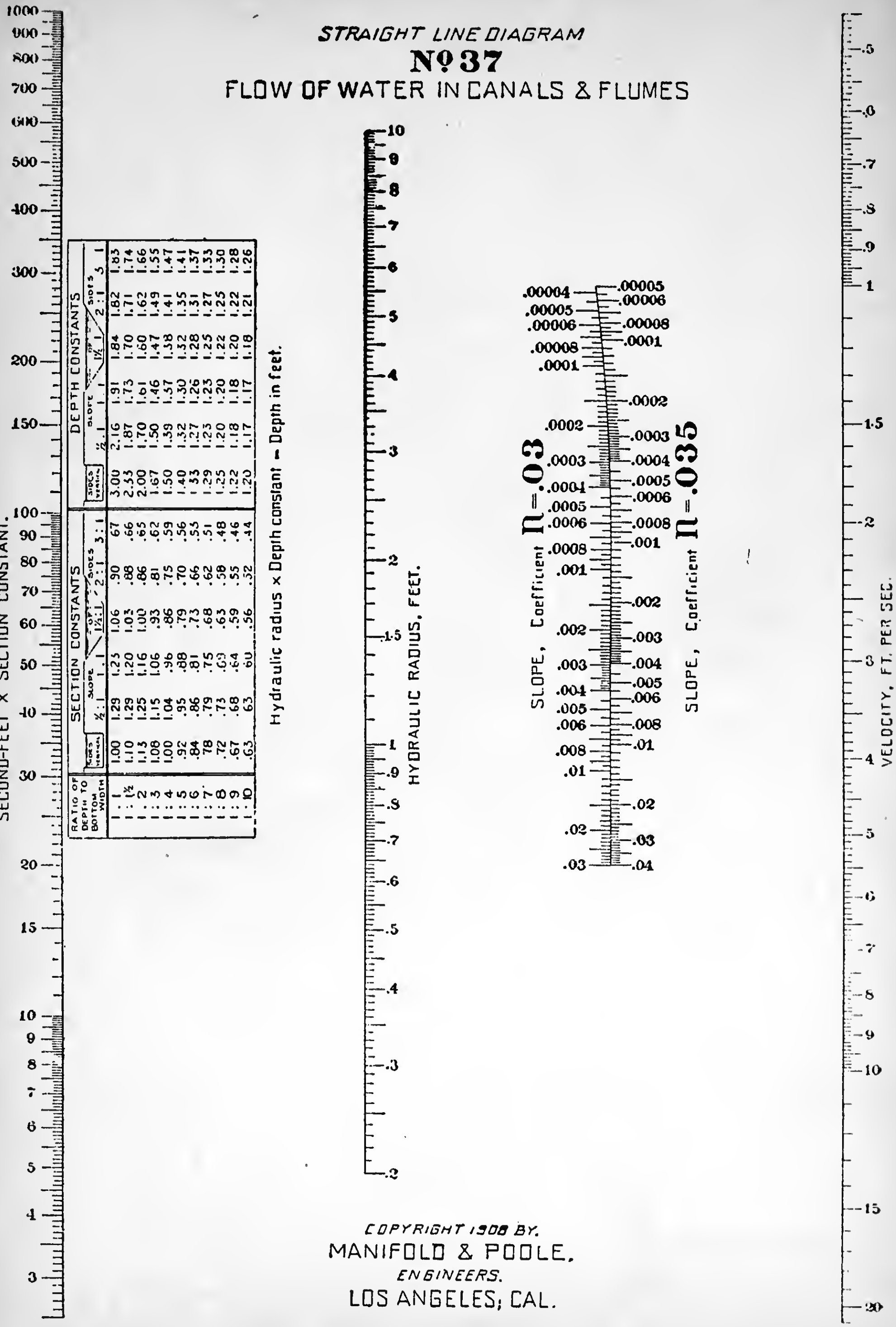
$n = .030$ for canals in earth below average conditions

$n = .035$ for canals and rivers in bad order.

STRAIGHT LINE DIAGRAM

Nº 37

FLOW OF WATER IN CANALS & FLUMES



Ratio of depth to bottom width	Section constants: Sides vertical	Section constants: Slope of sides ½:1	1:1	1½:1	2:1	3:1	Depth constants: Sides vertical	Depth constants: Slope of sides ½:1	1:1	1½:1	2:1	3:1
1 : 1	1.00	1.29	1.25	1.06	.90	.67	3.00	2.16	1.91	1.84	1.82	1.83
1 : 1½	1.10	1.29	1.20	1.03	.88	.66	2.53	1.87	1.73	1.70	1.71	1.74
1 : 2	1.13	1.25	1.16	1.00	.86	.65	2.00	1.70	1.61	1.60	1.62	1.66
1 : 3	1.08	1.15	1.06	.93	.81	.62	1.67	1.50	1.46	1.47	1.49	1.55
1 : 4	1.00	1.04	.96	.86	.75	.59	1.50	1.39	1.37	1.38	1.41	1.47
1 : 5	.92	.95	.88	.79	.70	.56	1.40	1.32	1.30	1.32	1.35	1.41
1 : 6	.84	.86	.81	.73	.66	.53	1.33	1.27	1.26	1.28	1.31	1.37
1 : 7	.78	.79	.75	.68	.62	.51	1.29	1.23	1.23	1.25	1.27	1.33
1 : 8	.72	.73	.69	.63	.58	.48	1.25	1.20	1.20	1.22	1.25	1.30
1 : 9	.67	.68	.64	.59	.55	.46	1.22	1.18	1.18	1.20	1.22	1.28
1 : 10	.63	.63	.60	.56	.52	.44	1.20	1.17	1.17	1.18	1.21	1.26

Hydraulic radius × Depth constant = Depth in feet.

Explanation of Diagram No. 38
Water Measurements

This diagram gives corresponding measurements for various methods of measuring water. To solve problems merely follow along any of the horizontal lines.

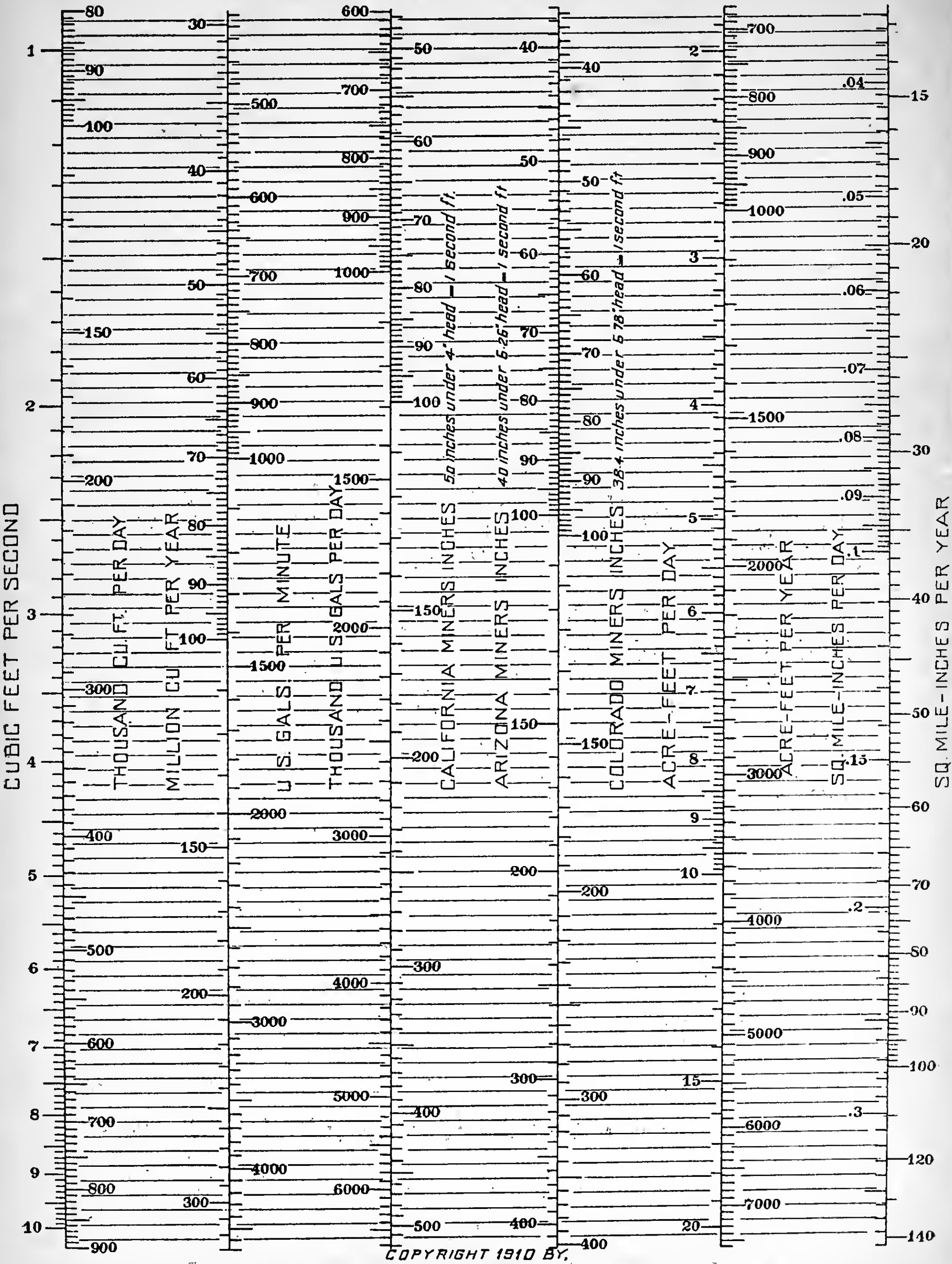
Example: To find how many acre feet per year is required to maintain a flow of 30 second feet.

Solution: From 3 on scale No. 1 follow along horizontal line to acre feet per year, scale No. 10 = 2,200, and multiply result by 10; hence 2,200 X 10 = 22,000 acre feet will give 30 second feet for a year.

STRAIGHT LINE DIAGRAM

No. 38

WATER MEASUREMENTS



MANIFOLD & POOLE,

ENGINEERS.

LOS ANGELES, CAL.

Patent applied for

Explanation of Diagrams Nos. 39, 40, 41
Stadia Measurements

These diagrams are used in stadia surveying and solve equation:

$c = 100\ s \cos^2 a + (f + c); \quad d = L \tan a$

in which

c = horizontal distance
s = space intercepted on vertical rod
a = vertical angle of inclination of telescope
c = distance from axis to object glass
f = focal distance.

To the horizontal distance found in the diagram f plus c must be added, which will be a constant for any instrument.

For distances less than 100 ft., take the diagram giving 10 times the distance and divide answer by ten.

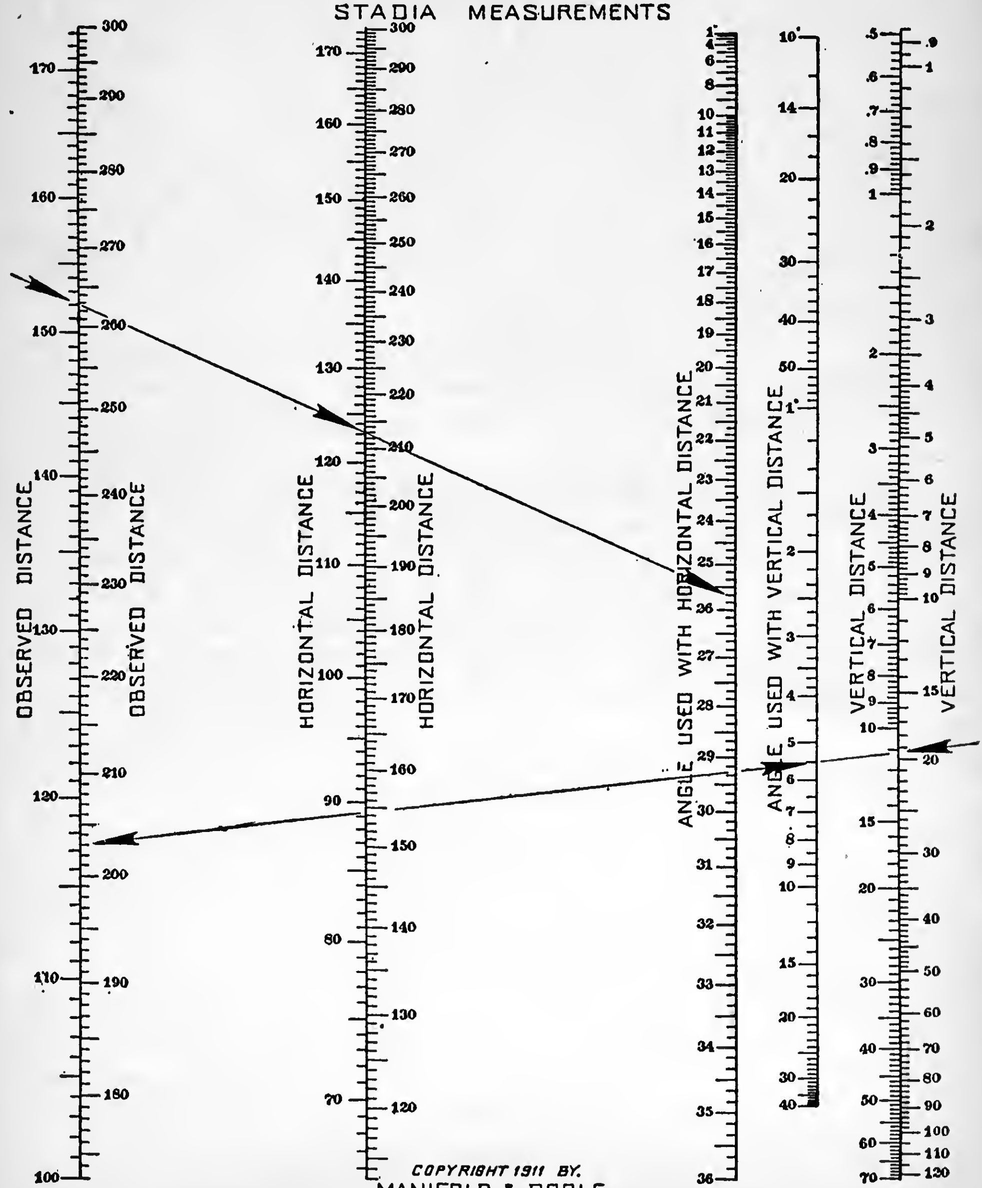
Examples indicated on diagram No. 39 by arrow points will illustrate method of obtaining results on Nos. 40 and 41 also. Here, the observed distance is 152, the vertical angle is 25 deg. 45 min. and the horizontal distance found 123.3 ft., to which should be added (f plus c).

Also the lower set of arrow points give the observed distance 203 ft., the vertical angle 5 deg. 30 min. and vertical distance is found to be 19.4 ft.

STRAIGHT LINE DIAGRAM

Nº 39

STADIA MEASUREMENTS



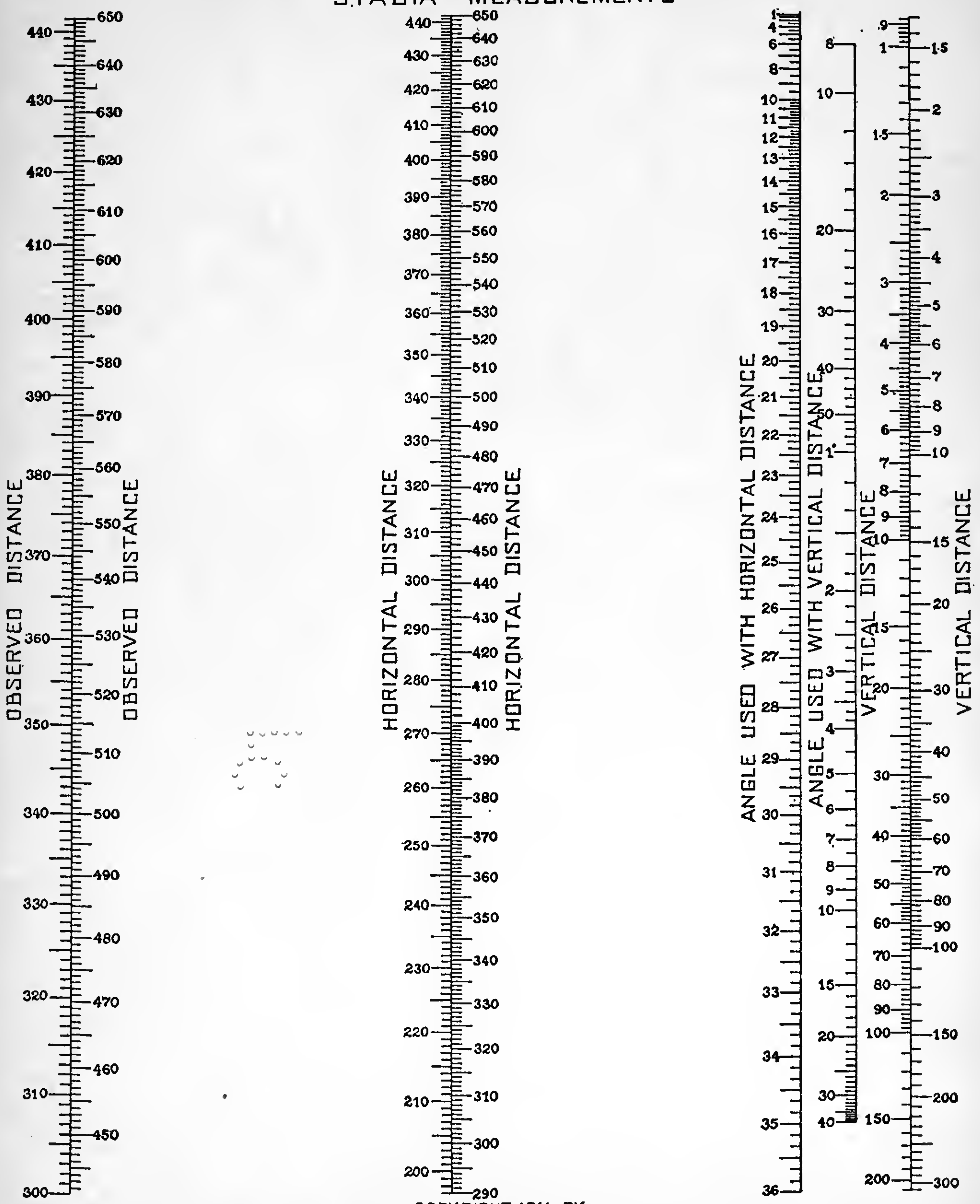
Patent applied for

Diagram No. 40 Is a Continuation of No. 39

STRAIGHT LINE DIAGRAM

Nº 40

STADIA MEASUREMENTS



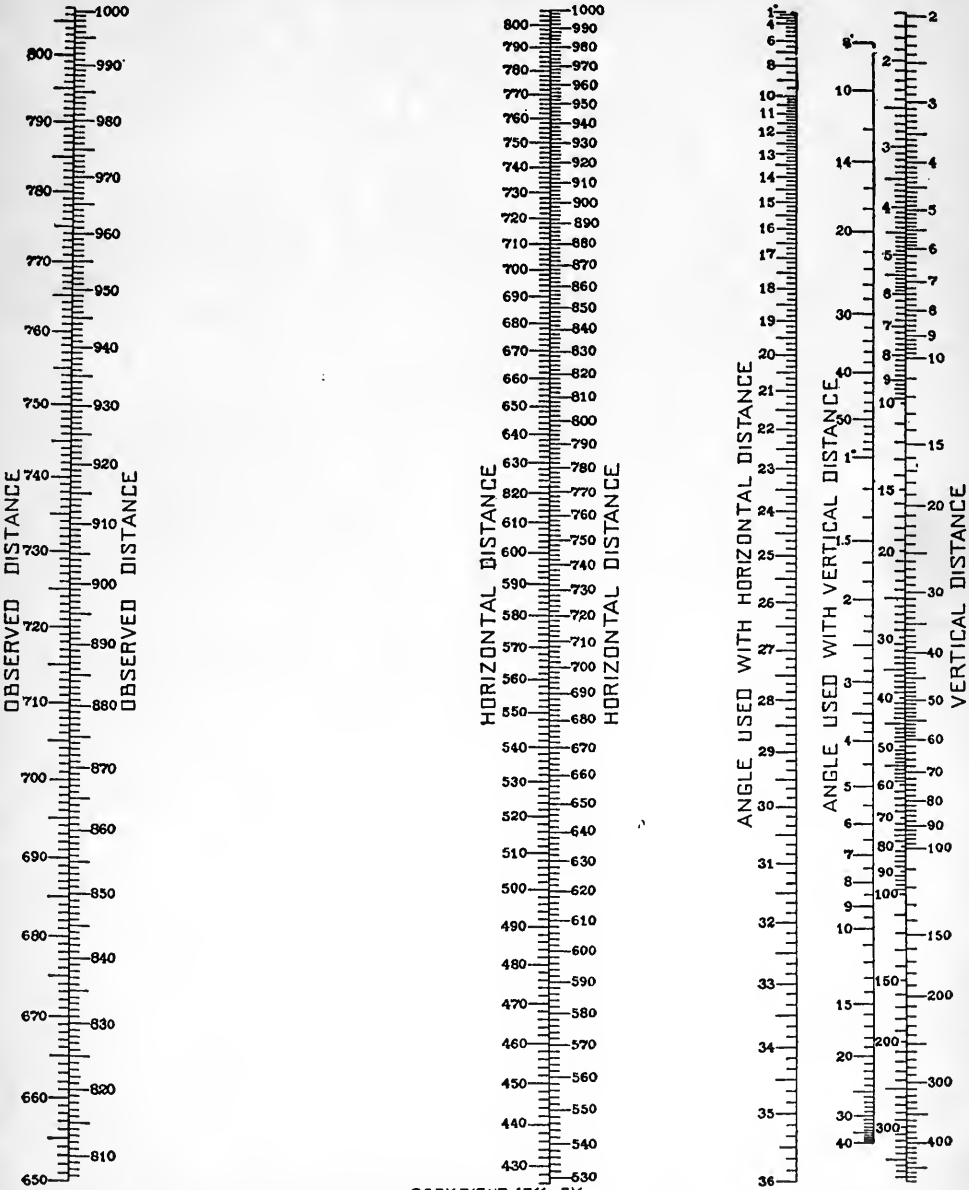
Patent applied for

Diagram No. 41 Is a Continuation of Nos. 39 and 40

STRAIGHT LINE DIAGRAM

Nº 41

STADIA MEASUREMENTS



Patent applied for

Explanation of Diagram No. 42

Shafting

This diagram determines the power that can be transmitted by steel shafting of various diameters and spacings of bearings.

Example: It is required to transmit 100 h.p. at 100 r.p.m. with cold rolled shaft as prime mover, between the bearings, 8 ft. span.

Solution: From 100 on scale No. 1 run through 100 on scale No. 5 and find 5250 on scale No. 9, which is the torque in ft. lb. Revolving on this point and connecting to cold rolled steel prime mover on scale No. 4, find size of shaft 4⅝″ on scale No. 7; revolving on this point connect to 8 on scale No. 2, and find 5400 on scale No. 6, which gives the max. total bending moment including weight of shaft and pulleys, pull of belt, etc., which can be applied to shaft for this spacing, so that the max. deflection of shaft shall not exceed 1/80 in. per ft.

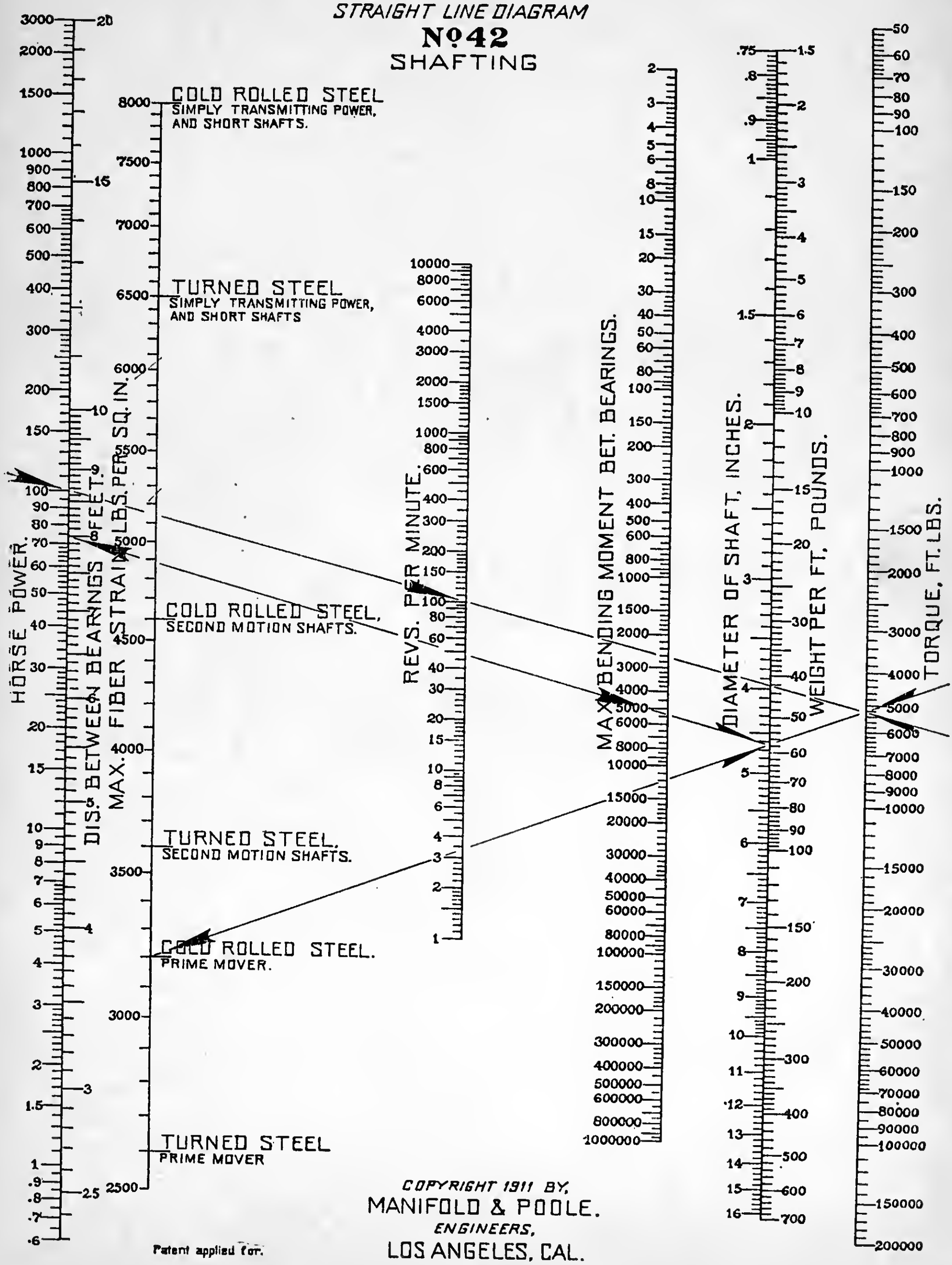
Should the total bending moment be 8,000 ft. lb. with same spacing of bearings, connect 8 on scale No. 2 to 8000 on scale No. 6, and find size of shaft as 5.3 in. diameter on scale No. 7.

In looking over this diagram, we also find that scale No. 3 gives the corresponding maximum fibre strain, at which shafts indicated on scale No. 4 will work.

Also scale No. 8 gives weight of shafts per ft. in lbs. corresponding to diameter given on scale No. 7.

STRAIGHT LINE DIAGRAM

Nº42
SHAFTING



Patent applied for.

Explanation of Diagram No. 43

Gearing

This diagram gives a simple and rapid method of computing gearing problems.

Example: A cast iron gear has the following dimensions: Pitch 1½ in., face 4½ in., number of teeth 30, diameter pitch circle 14.32 in. What is the strength of the teeth and what horse power will it transmit at 222 r.p.m.?

Solution: Multiply the diameter 14.32 X 222 = 3179; from this point on scale No. 8, run to 1.5 on scale No. 2, and find strength of rack tooth on scale No. 4 equal to 1500 lb.; revolve index on this intersection and connect to 30 on scale No. 6, and find strength of gear tooth 1220 on scale No. 5; revolve on this intersection and connect again to 3179 on scale No. 8, and find horse power 31 on scale No. 1.

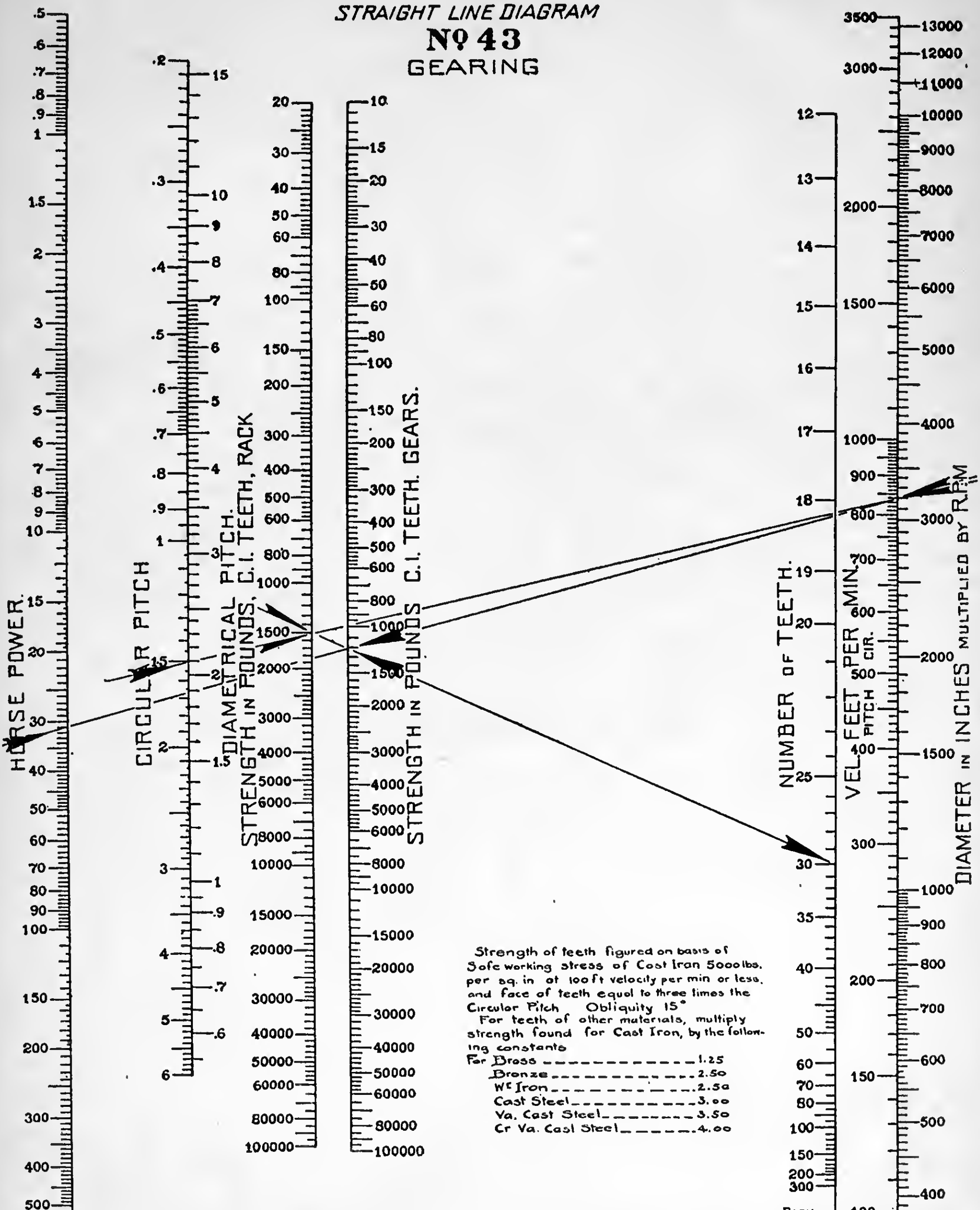
Had the face of this gear been only 3 in. the h.p. would have been proportionately reduced, and would equal 31 X 3 divided by 4½, equal to 20 2/3.

It will be noticed by inspection of scales 2 and 3 that 1½ circular pitch is very nearly equivalent to 2.1 diametrical pitch. The exact figure is 2.0944. Also by inspection of scales Nos. 7 and 8, the diameter in inches multiplied by r.p.m. = 3179 as above, is equivalent to a velocity of pitch circle of 835 ft. per min.

Making the angle of obliquity 20 degrees instead of 15 degrees adds about 15 per cent to the strength of the gear.

STRAIGHT LINE DIAGRAM

Nº 43
GEARING



Strength of teeth figured on basis of Safe working stress of Cast Iron 5000 lbs. per sq. in at 100 ft velocity per min or less, and face of teeth equal to three times the Circular Pitch. Obliquity 15°

For teeth of other materials, multiply strength found for Cast Iron, by the following constants

For Brass	1.25
Bronze	2.50
Wt Iron	2.50
Cast Steel	3.00
Va. Cast Steel	3.50
Cr Va. Cast Steel	4.00

Patent applied for

Explanation of Diagram No. 44

Belting

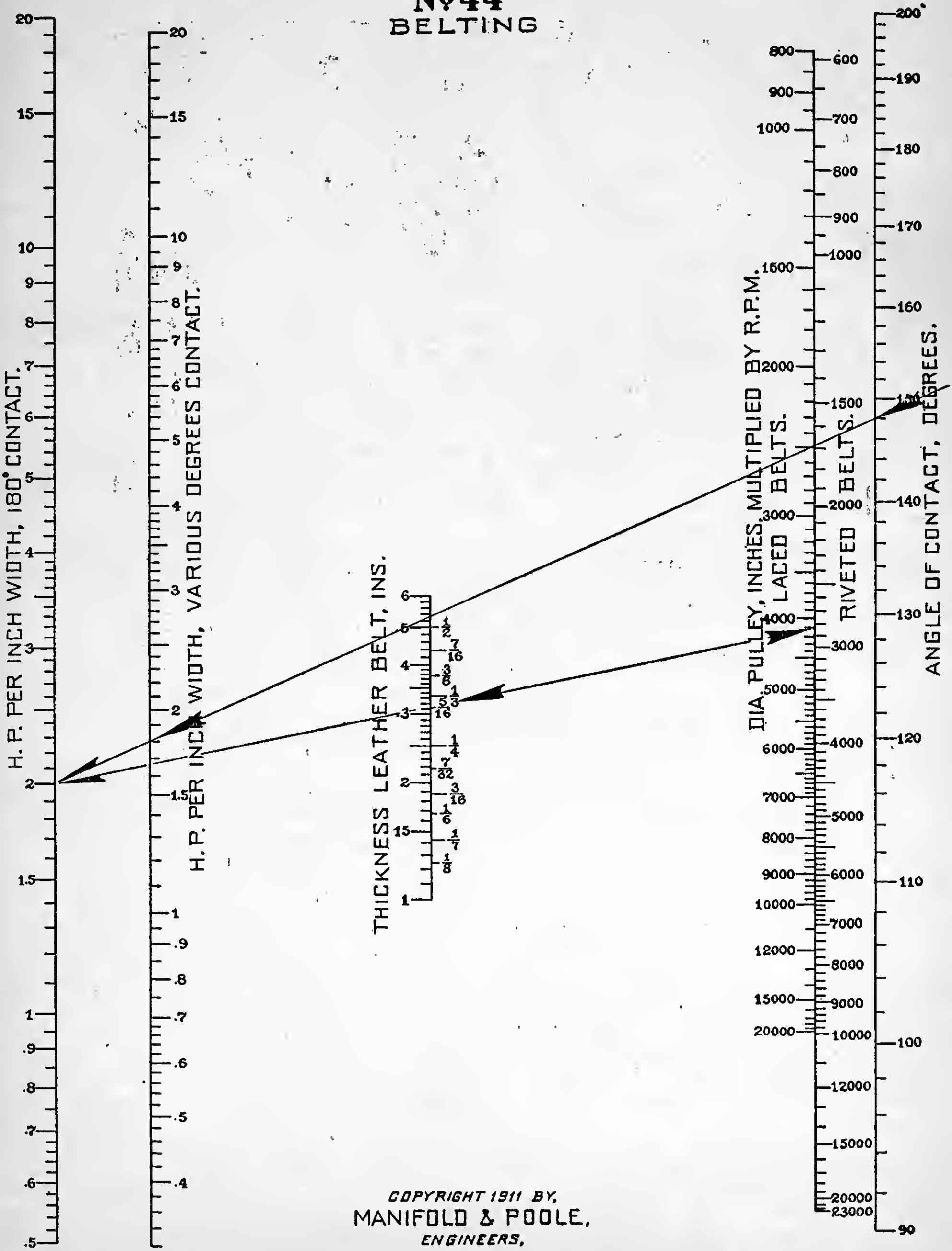
This diagram gives a simple and rapid method of computing belting problems.

Example: How many h.p. will a belt 5/16 in. thick and 10 in. wide transmit to a pulley 20 in. diameter, running 205 r.p.m.? Laced belt.

Solution: Multiply 20 in. diameter of pulley by 205 r.p.m. = 4100; then from 4100 on scale No. 5 run to 5/16 on scale No. 4, and find on scale No. 1 h.p. per inch of belt 2; multiply by the width of belt 2 X 10 = 20 h.p. Should the angle of contact be 148 degrees, from 2 as found on scale No. 1, run to 148 on scale No. 7 and find 1.8 on scale No. 2, which multiplies by the width 1.8 X 10 = 18 h.p.

STRAIGHT LINE DIAGRAM

Nº 44
BELTING



Patent applied for.

APPENDIX

Resuscitation From Electric Shock *

Electric shock is simply a case of suspended animation due to lack of circulation, a sort of "stunning" of the heart and lungs. The method employed in reviving a person shocked is the same as that in case of drowning except that the lungs need not be drained of water. Furthermore the person suffering from electric shock often swallows the tongue, sometimes a great hindrance to the life savers. This same process should be employed in cases of gas asphyxiation. Its most important features are promptness and continuity of performance.

1. Chop wires with hatchet on block of wood, or pull man from circuit by coat-tail or loose clothing, not by his shoes for they have dangerous nails. Clothes next to his body are not insulators on account

Fig. 1. Arms compressing the chest at lower ribs to expel the air—limbs extended. (see Fifth note of paper)

* These directions are taken from "The Life Hazard and Resuscitation in Electrical Engineering" by Clem A. Copeland, which contains information of value to all electrical workers.

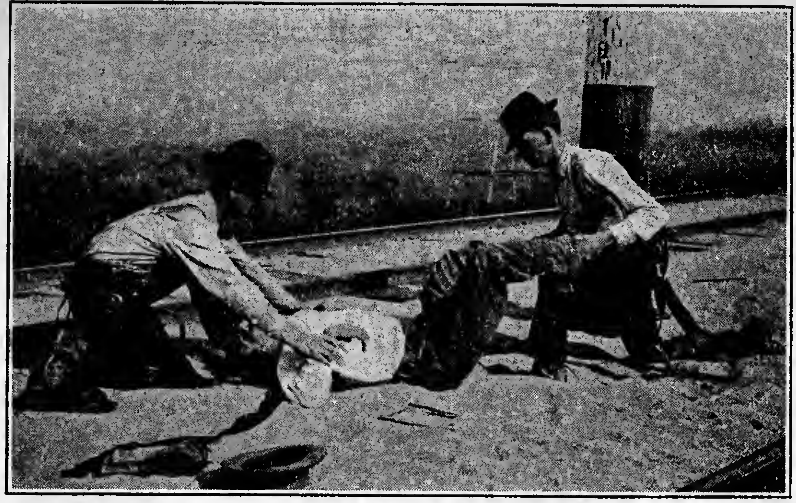


Fig. 2. Arms being extended back over the head in the plane of the body (see Fifth note of paper) and knees being pressed up towards the breast (see Eleventh note of paper)

of perspiration, so look out and don't get shocked yourself.

2. Tear off any obstructions around throat, as collars or handkerchief, shoulder braces or suspenders, and loosen clothing. Don't expose the breast any more than necessary. The body heat should be conserved as much as possible to help circulation.

3. Put him in such a position that his head is lower than is feet, if possible and handy.

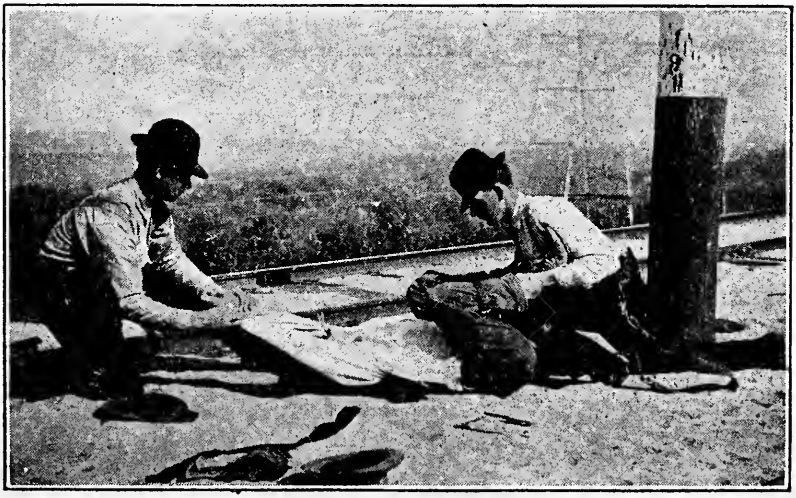


Fig. 3. Arms fully extended over head, knees up to breast

4. If you are the only one present to resuscitate the man, don't send for any one, or anything, but do it yourself quickly, and don't get "rattled." Lay man on his back and commence resuscitation method immediately, right where he falls, and don't let any one remove him to new location. Every fraction of a minute is valuable; one does not know what second life may become extinct.

5. Compress the chest at the lower ribs, then extend arms back over the head in the plane of the body and then bring them down forward over the chest and compress the chest again, repeating the process deliberately about sixteen times per minute to simulate natural breathing.

6. You should hear air freely issuing from throat when ribs are compressed. If not throat is probably plugged with tongue. Stop long enough to force open mouth with pliers or stick of wood (not your fingers, you may be bitten and delayed). Then pull tongue out a ways with handkerchief or pliers, using a pin, safety pin or piece of wrapping wire to hold it out, then commence resuscitation method.

N. B. (a) Don't put fingers in mouth unless it is blocked open.

N. B. (b) Rigidity or resistance to the resuscitation method is a good sign.

N. B. (c) Vomiting is also a good sign but you will have to clean out throat a little with fingers or it may obstruct breathing. You might have to turn man over on face for an instant and lift up waist of body to drain his throat. Return to resuscitation as soon as possible.

7. If there is one other man present get him to roll up a coat and put it between the shoulders. If a coat is not handy take a block of wood or a flat stone, but don't let him interrupt your resuscitation method.

8. Also get him to force open his mouth and draw his tongue out a little ways, as explained in sixth note above, keeping throat clear. While he is doing this use the alternative method shown in Fig. 5. With the fingers spread out wide grasping the lower chest and with the base of the hand on the diaphragm deliberately and powerfully press inward and upward toward the heart and then slowly release the pressure.

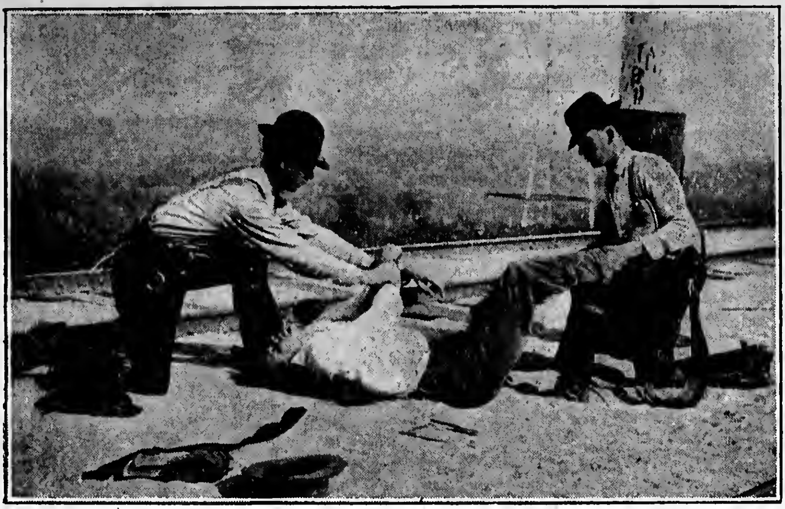


Fig. 4. Arms being brought down forward over the chest

This is repeated deliberately sixteen times per minute to duplicate breathing. Elevate the feet if possible.

9. Then also get him to run to nearest house if not more than half a block away and get blankets to cover him with so as to conserve heat of body. Warm weather may be uncomfortable to those working but is favorable to the man shocked.

If shocked in freezing or snowing weather it may be advisable to take him into a warm house if very near by, in violation to fourth note or instruction above.

10. If there are two present to help, send one for a

Fig. 5. Alternative method

doctor with an oxygen tank if possible. Do not send for the emergency wagon until he shows signs of life.

11. Have one of your helpers lift up legs, bend them at the knees and press the knees up towards the breast, then bring them back down and straighten them out. Perform this in unison with the resuscitation method so that the knees follow the arms back and forth.

12. Don't give up working, no matter how long, unless eyeball is soft. Compare your own eye ball with the injured man's. He may revive in five minutes or several hours, usually from one to four hours.

13. Don't try to administer whisky or water or anything else until the man is revived and stands or sits up.

TREATMENT FOR BURNS

1. If clothes are on fire smother flames with your coat, a blanket, or roll person over and over in dust or dirt.

2. If burn is very severe use heroic treatment of lowering patient into bath tub of lukewarm water by means of a sheet, allowing him to remain about half an hour. Remove only the clothing which does not touch the burn, then proceed as below:

The following applies to any case of burn, slight or severe:

3. Cut away clothing around burn. Should the patch of clothing stick to the burn don't try to peel it off. If possible immerse burned spot with patch in limewater for a half hour or so. If not, bathe it in limewater for some time longer. If no limewater is at hand use baking soda water in the same way.

4. If the burn is severe send for a physician as soon as the above is accomplished.

5. If physician is not obtainable or burn is slight, follow limewater treatment by the following:

Dry off the burned place by delicate touches of absorbent cotton, but don't try to remove the patch of clothing if it still sticks to the burn. Then bathe the burn thoroughly in an emulsion of half and half limewater and raw linseed oil made by violently shaking them together in a bottle.

If limewater is not at hand use raw linseed oil alone, and if this is not handy use olive or sweet oil or