PLUS

Ross Precision Computer
Richard Smith Hughes

Here is a complete copy of the 1918 advertisement that came with the Roy Kegerreis letter (July 21, 1918) and the manual, copyrighted 1919, which came with my Ross. Kegerreis purchased his Ross in *1921 (Smithsonian National Museum of American History Kenneth E. Behring Center)*.

My Ross after cleaning

The Ross Precision Computer is a new multiplier and divider of UNUSUAL PRECISION. It solves problems like 879.65 × 72.638 ÷ 74.769 = 854.58,—with an accuracy of 5 figures, i. e. to an ultimate accuracy of 1/1000 of 1%, or 1 in 100,000. It is 100 times as accurate as the slide-rule;—if a slide-rule were made 100 FEET long and graduated with spaces no greater than the ordinary 10-inch rule, it would still be less accurate than the Precision Computer.

Field it covers

A problem like:—

879.65 × 72.638 ÷ 74.769 = 854.58

could not be solved heretofore in a practical way. Logarithms require 4 searches in tables, 4 mental interpolations, a subtraction, an addition; and then the answer is worthless unless checked. Longhand is out of the question. An adding machine may do this in from 60 to 100 movements,—after months of practice in dexterity and an outlay of several hundred dollars. A slide-rule will never solve this in 1000 moves (except the first 2 or 3 figures).

The PRECISION COMPUTER solves this in half a minute, and CHECKS the answer. It requires only one movement more than the slide-rule, and is 100 times as accurate. It reads 4 figures exact, and the 5th figure by interpolation, like 5-place logarithms. It combines the directness of the slide-rule with the accuracy of 5-place interpolated logarithms, without the drawbacks of either.

Practical uses

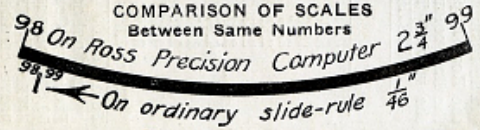
Many engineers use the Precision Computer as a graphic table of 5-place logs and anti-logs; also for figuring earthwork, monthly and final estimates, unit cost, payroll, for final design and reports, where an accuracy of at least 4 figures exact is desired. With a table of natural functions it is used for figuring traverses. The Precision Computer is intended primarily for NUMERICAL WORK OF HIGH PRECISION, for the field, office, laboratory and counting room.

See Scientific American; vol. CXIV, No. 3; Jan. 15, 1916.

96.3077.3

100 Times as Accurate as 10" Slide-Rule

COMPARISON OF SCALES
Between Same Numbers



Equivalent length of Precision Computer scale at 98-99 is therefore
10" x 2¾ ÷ 1/46 = 10" x 126 = 1260 Inches = 105 FEET.

Equivalent to Slide-Rule 100 Feet Long

Simple in Construction

The ROSS PRECISION COMPUTER consists of few and simple parts:

1 is the Dial; it carries a spiral scale of 25 continuous coils, and a scale of 400 equal parts around the rim.

2 is the Back-disk, with finger-slot through which the Dial may be turned.

3 is a stationary hair-line attached to the handle.

4 is a floating hair-line attached to the Back-disk.

5 is a clamp to lock the Back-disk when Dial alone is turned.

6 is a direct-reading, simplified slide-rule. It points to the proper answer-coil, checks the answer, and locates its decimal point. It may be used alone, without the Dial, to obtain approximate, 3-place answers instantly.

How it works

879.65 x 7.2638=?

Set 87965 under arm 3, clamp;
" 72638 " " 4.
Answer 6389.6 is under arm 3.

Slide checks answer—locates decimal.

Solves other problems as easily.

Condensed directions, with examples, are given on the handle, near the clamp, in sight of user. Detailed directions accompany each instrument.

Problems it solves

Multiplies—Divides
Gives Reciprocals
Solves Proportions
Handles constant multipliers
" " divisors
" " ratios
Reads 5-place logs and anti-logs
Solves exponential problems
Gives 3-place answers instantly

Solves expressions like $\frac{a \times b \times c \times d}{e \times f \times g \times h}$

With a table of natural functions many engineers use it for traverses; obtaining 5-place accuracy; that is, ⅛ inch in 1000 feet.

Commercial Rapid Computer

The Rapid Computer is made also for commercial use without any technical scales, but with scales for simple and compound interest, and scales (4) N, (5) M, (6) D. In this form it is used for office work, either to check your figures or for original calculation. It figures payroll, interest, discount, freight, profit and loss, pro-rating, compound interest, unit costs, foreign exchange; mensuration, weight,—in fact, any and every calculation involving multiplication and division in any form. It is so simple a child can use it.

Used and approved

"I like the Ross Rapid Computer, its theory and convenience of using; tried a number of traverse calculations—you have a very handy Computer—I feel certain that it will pay for itself in checking long-hand and logarithmic calculations."—Lumber Engineer.

"Have tested the Ross Rapid Computer, once on a circuitous traverse 2,800 feet long, to establish a 160-acre corner from a mile-post, and again on a closed polygon. The results were very satisfactory. The ingenious arrangement of the scales, as well as the mechanical execution, is very good. It is the simplicity of the Computer which impresses me. A study of its scales and some practice makes one appreciate how great a diversity of work can be done rapidly and with practical accuracy by using the Ross Rapid Computer."—..... , County Surveyor.

Mechanical Details

The Ross Rapid Computer is 8 inches in diameter, so that its number scales equal the lower scales of a slide-rule 20 inches long; but its trigonometric scales correspond to those of a slide-rule 30 to 40 inches long. Made of weather and wear proof celluloid, with a clamped, metal arm to lock settings. Packed in a strong sewed leather case, with full directions.

Price, with leather case and full directions,

$7.50 POSTPAID

This price represents basic, intrinsic value; therefore no fictitious discount can be allowed.

All Instruments Are Guaranteed

A students' model of the Rapid Computer is made, 6 inches in diameter, to fit the pocket. The scales and construction are similar to those of the 8-inch Computer, but it has no clamp on the arm. Price, with case and directions, $4.50, postpaid.

The 8-inch Rapid Computer is more accurate, easier to read, and has a clamp to lock the arm on any reading desired.

ACCURACY

The results of a coal analysis given below, show vividly the practicable accuracy of the Ross Rapid and Ross Precision Computers, compared to long-hand. Each weight in the first column, is divided by the total weight 29.80 pounds, to obtain its percentage of the whole. The sum of the percentages should, of course, add to 100.000%:

PERCENTAGES CALCULATED

WEIGHTS	By Rapid Computer	By Precision Computer	By Longhand 4 places	By Longhand 5 places
3.27	10.97	10.972	10.97	10.973
5.47	18.37	18.357	18.36	18.356
3.96	13.30	13.289	13.29	13.289
3.27	10.97	10.972	10.97	10.973
2.39	8.02	8.0203	8.02	8.020
2.31	7.755	7.7518	7.75	7.752
2.31	7.755	7.7518	7.75	7.752
1.67	5.61	5.6040	5.60	5.604
1.07	3.59	3.5907	3.59	3.591
1.08	3.626	3.6245	3.62	3.624
0.91	3.060	3.0535	3.05	3.054
0.54	1.815	1.8120	1.81	1.812
1.55	5.20	5.2012	5.20	5.201
Totals 29.80	100.04	99.9998	99.98	100.001

The final accuracy of the Rapid Computer averages 1/20%, 1 part in 2000; that of the Precision Computer, 2 in 1,000,000, happens to be much better than its claim of 1 in 50,000, because the minute differences counterbalance. The readings were made with very ordinary care. A capable calculator, with a knack at figures, could readily improve on these results; but there is seldom any need for improvement, because the Precision Computer figures more closely than the trained man, with skilled instruments, can measure his DATA.

PRECISION vs. RAPID COMPUTER

The Precision and Rapid Computers are rather distinct in character and application.

The Rapid Computer is intended for general work, where a GREAT VARIETY of technical, trigonometric and complex problems are to be handled; where extreme simplicity is desired, and where an accuracy of 1/20%, 1 part in 2000, is sufficient. It is amply accurate for ordinary calculations, because it will figure more closely than the ordinary man can measure his data.

The Precision Computer is intended primarily for PRECISE NUMERICAL CALCULATIONS, where an accuracy of 4 to 5 figures is indispensable, for which a slide-rule is wholly inadequate. It will figure more closely than the skilled man, with skilled instruments, can measure HIS data.

Because of the distinct features, many engineers use both Computers, one for precise work, the other for general use.

With combined orders for any two instruments at one time, in any combination, we allow as a premium, one Miniature Rapid-Computer. With three instruments in any combination, one Ross Vest-Pocket Slide-Rule.

The Miniature Rapid Computer

The Technical Rapid Computer is made also in miniature form, 3½ inches in diameter; of celluloid; scales protected by a durable, transparent coating. Equivalent to 10-inch polyphase duplex slide-rule; with complete trigonometric scales, squares, cubes, 360° protractor. The scales and numbering are necessarily small, as legible as seconds on an ordinary watch. Packed in soft leather case to fit vest-pocket, coat-pocket, any place. Sold only with the other Computers listed, as stated above.

Ross Vest-Pocket Slide-Rule

The Slide, which is shown attached to the Precision Computer, is also made separately. Simplified, 3½ inches long, with inverted scales that make it as effective as the upper scales of an ordinary 7-in. slide; silvered, bevel-grooved, all metal to last indefinitely; in stiff leather case to fit vest-pocket; a most convenient pocket piece for approximate numerical calculations. Sold only with the other Computers listed.

Some of Its Users

Used by Panama Canal Commission, New York Department of Public Works, Philadelphia Bureau of Tests, Cincinnati Water Works, Oakland Testing Department; by universities, county and private engineers throughout the United States and abroad; by the American Steel & Wire Co., Dupont Powder Works, General Electric Co. Repeat orders from many public departments, mining and industrial plants, and numerous others.

Opinion of Users

"I find the Precision Computer too useful to get along without, even for a few weeks."
—.....Dept. of Physics.

"Have had very good success in operating the Precision Computer, and for results requiring 4 or 5 significant figures, find it very rapid and accurate."—.....Supt. Power Co.

Mechanical Details

The Precision Computer is made of metal, to last indefinitely. There are no glass parts to break. The dial is also of metal, but its graduations are on a tinted facing especially easy on the eyes. Silvered, bevel-grooved, metal slide, hand-fitted. Nine inches diameter; weighs one pound. Precisely machined. Packed in fine sewed leather case, with full directions.

Price complete, with leather case and full directions,

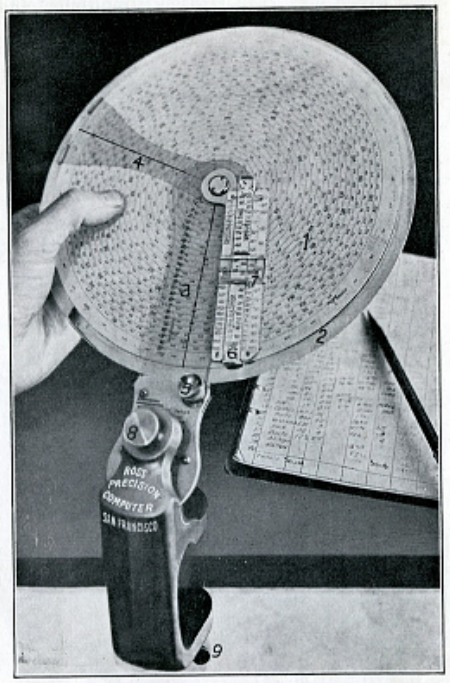
$20 POSTPAID

This price represents basic, intrinsic value; therefore no fictitious discount can be allowed.

All Instruments Are Guaranteed

If purchaser desires, the graduations will be engraved INTO the Dial, as on a compass or on a transit, without additional cost to the purchaser. These graduations are not as easy on the eyes, but may be preferred for unusually rough field use.

COMPUTER MFG. CO.,
25 California St., San Francisco



Use With One Hand

For greater accuracy and rigidity the Computer may be attached instantly and firmly to any desk-edge, by the Tilted Duplex Clamp. It permits fine settings to be made with great precision—with either the right, left, or both hands. Can be faced about in any direction convenient. A turn of Thumb-nut 8 releases the Computer, ready to put in your desk or valise, among your papers.

Clamp, finely japanned, polished nickel trimmings, solid, durable.

Price, parcel-post-paid $2.50

Tear off on this line

COMPUTER MFG. CO.

25 California Street · · San Francisco

1. ORDER BLANK. Please send me on approval How Many

.....ROSS PRECISION COMPUTERS.. .....

.....TILTED DUPLEX CLAMP.....

.....ROSS MERIDIOGRAPHS, Model 10 or 20?.....

.....ROSS RAPID COMPUTERS, 6 or 8-Inch?.....
Technical or Commercial?

I enclose (money order or check?).....

for $.....

If the instruments fail to do what is claimed for them, or prove otherwise unsatisfactory, I will return them in good condition within two weeks after their receipt, and my remittance is to be refunded in full.

My Name.....

Address .....

All Instruments Are Guaranteed

They will retain their accuracy. Defective parts will be replaced free of charge; duplicate parts at nominal price.

2. INFORMATION BLANK. I am interested in the

....., but would like to have further information with regard to:

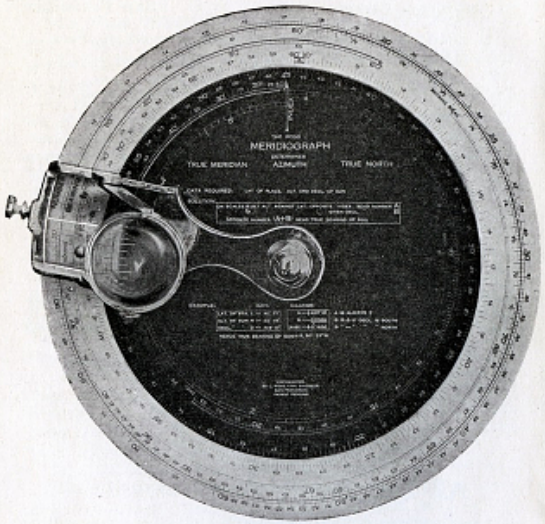
Please send Circulars also to:

Name .....

Address .....

.....

Do You Survey?



THE ROSS

MERIDI-O-GRAPH

Checks your meridian graphically.

A practicing civil engineer writes:

> "I have consumed $100 worth of time at night and exhausted all of my patience trying to get satisfactory results from Polaris observations; whilst with your Meridiograph I can refer every survey to the true meridian in a few minutes, with absolutely no loss of time in making observation."

See Engineering News; vol. 71, No. 9; Feb. 26, 1914.

It is a double 7-inch dial and fits your kit.
Price $7.50 and $25.00
Ask for Folder A31.

COMPUTER MFG. CO.
25 California Street - - San Francisco

THE ROSS RAPID COMPUTER multiplies and divides numbers instantly. It has two main features:

1. Simplicity.
2. Completeness.

Anyone who can read numbers can use this computer. It consists of two Dials and a clamped reading Arm. To multiply or divide: set your problem under the arm; an arrow automatically points to the answer, and another arrow points to the proof. It reads 3 to 4 significant figures, like:

$23.67 \times 8.62 = 204.0$, or $23.67 \div 8.62 = 2.746$.

It gives an average accuracy of 1/20 of 1%, 1 part in 2000.

Practical Uses

The Ross Rapid Computer may be used for figuring quantities, capacity, unit cost, earthwork and payroll; for design and construction, traverses, stadia, and all surveying problems; to figure R. R. curves, right and oblique triangles, squares, cubes, degrees, radians; public evaluation work; logarithmic and exponential problems.

Scales, complete, simple

Beginning with the outermost, the scales on the outside Dial are:

1. Degrees, 0° to 360°, for measuring angles;
2. Radians, 0 to 2π (6.283), for circular measure;
3. A scale of equal parts, 0 to 1000, to read logarithms;
4. Scale N, for reading the first number and answer.

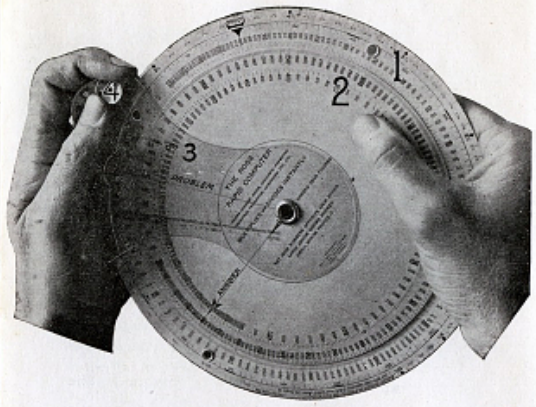
The scales on the inner Dial are:

5. Scale M, Multiplier;
6. Scale D, Divisor;
7, 8 and 9. FULL trigonometric scales: sines and cosines, tangents and cotangents, secants and cosecants,—ALL SIX functions, for ALL ANGLES from 0° to 90°.

10 and 11. Squares and cubes.

All scales are numbered plainly, like a calendar or time table, requiring no study; just pick up and use the Ross Rapid Computer.

See Engineering News; vol. 75, No. 21; May 25, 1916.



THE ROSS

RAPID COMPUTER

Problems it solves

Multiplies and divides;

Solves proportions;

Handles constant multipliers, constant divisors, constant dividends, and constant ratios;

Multiplies 3 numbers with a single setting;

Solves expressions like ab/cdef, without any blank movements, each movement is effective;

Gives logarithms and anti-logarithms;

Measures angles, in degrees and in radians;

Converts radians to degrees, and vice-versa;

Gives FULL trigonometric functions, without requiring to take (90° — the angle), or reciprocals;

Reads squares, cubes, square and cube roots;

Figures compound interest and exponential problems;

Solves traverses and stadia;

Solves triangles with a single setting;

Solves expressions like: abc; a/bc; ab tan x; a cos x; a sin x cos y; ab³√c; π/180 log a/bc, etc., etc.

Ross Manual
(brittle with age)

DIRECTIONS FOR USING
THE ROSS
PRECISION COMPUTER

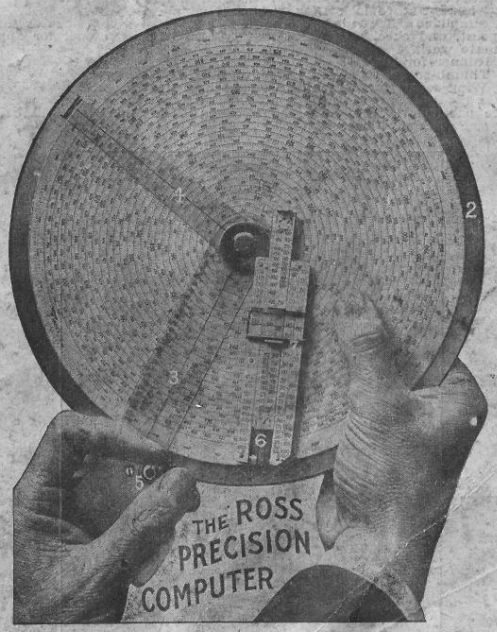


Fig. 1 shows PRECISION COMPUTER for Hand-use, and how to grip Thumb-nut 5 properly.

LIST OF CONTENTS

COMPUTER MFG. CO. SAN FRANCISCO

DESCRIPTION OF PARTS

Referring to the numbered parts in Figs. 1 and 2:—
1 is the Dial; it carries a Spiral scale of 25 **continuous** coils; its rim is divided into 4 quarters of 100 equal parts each.
2 is the Disk, with 3 finger-slots in back, for turning Dial 1.
3 is a stationary hair-line attached to handle, and called **Base.**
4 is a floating hair-line, rotating with Disk 2, and called **Float.**
5 is a Thumb-nut to lock Disk 2 when Dial alone is turned.
6 is a simplified Slide-rule. It shows proper answer-coil, locates decimal point, and checks answer. It may also be used alone, for approximate work.
7 is a Runner for Slide 6.
8 is a Thumb-screw to fasten Computer in Clamp.
9 is a Wing-screw for attaching Computer to desk.
On the back are natural trigonometric functions.
Note particularly the difference between **Disk** and **Dial**, and between **Base** and **Float.**

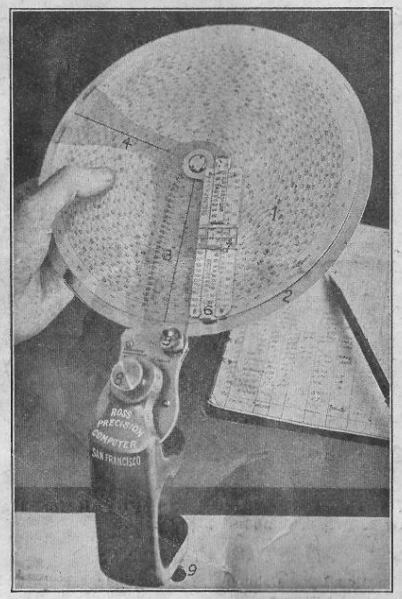


Fig. 2 shows the Precision Computer with DESK ATTACHMENT. It may then be operated with either or both hands.

MANIPULATION

For desk use, tighten Thumb-screw 8 **tightly,** face Computer in any direction convenient on your desk, and tighten Wing-screw 9. Turn Dial with either or both hands, to suit yourself.

For hand use, without Clamp, hold Computer as shown in Fig. 1, with first (index) finger over the handle, gripping Thumb-nut 5.

GENERAL

This permits locking and unlocking the Disk with a slight, almost unconscious, turn of the finger, **without using the right hand.**

Practice the following three simple movements for a few minutes.

1. Lock Disk and turn dial alone, gripping Dial through one of the three finger slots most convenient. Turn Dial the whole length of the slot, briskly, freely,—there is nothing to break. Turn it now a smaller amount; then turn very minutely, just a hair.

2. Unlock Disk; turn Disk and Dial together, gripping them together near the rim of Dial. Again turn them various amounts. Repeat alternately:—Lock, turn Dial; unlock, turn both.

3. Shift Slider, i. e., M D scales, also Runner 7, up and down. Do not put the Computer aside until you can handle it smoothly, easily, and in a way most convenient to yourself, so as to be able to set numbers quickly and accurately.

SCALES

A knowledge of the scales is the key to the Precision Computer. The whole Dial reads like Fig. 3; being able to read the numbers on Fig. 3, you can read the whole Dial without further study. All numbers on the Dial are 10 spaces apart, like seconds on a watch, **without exception.**

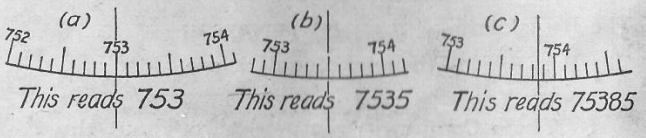


Fig. 3 shows an ENLARGED PORTION OF SPIRAL, and how to read on it 3, 4, or 5-place numbers.

Fig. 3c may stand for 75385, or $75.38½, or 7.5385%, or $7538.50, or 0.0075385, or 753 ft. 10 ins. (=753.85 ft. nearly) or for any number whose 5 significant figures are 7-5-3-8-5.

In setting a number disregard the decimal point. To set 2 or 20 or 0.02 or 200,000 use 200. To set 43.763 or 0.043763 or 437.630 or $43.76 1/3 set 437-63. In reading an answer read it as a series of figures, like 4-3-7-6-3, write it down as 43763; then point off decimal according to rules given later.

Set INDEX of Dial under Base, as in Fig. 4. Note that the numbers begin near center with 100, 101, 102, etc., increasing continuously toward the rim, to 998, 999, 1000 (INDEX), all 10 spaces apart, without exception. Check those readings that are given in Fig. 4, and read all other coils where Base-line cuts them. In every case, the first 3 figures are printed, the 4th figure is read by counting **full** spaces, for 5th figure interpolate **tenths** of last fractional space, where hair-line cuts it.

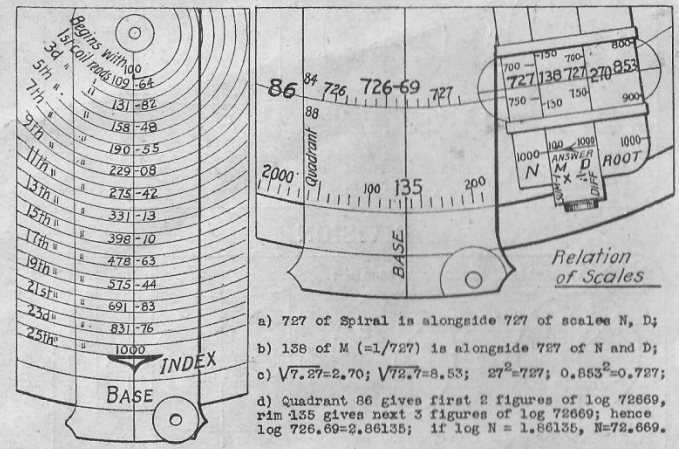
Set 72669 under Base, and Runner on 727 of scale N, as in Fig. 5. Note the relation of the auxiliary scales, as given in a), b), c), under Fig. 5.

On the Slide, scale N reads 100 to 1000; these numbers are alongside the corresponding numbers on the Spiral, and may be used as a key for finding numbers on Spiral quickly. Next is scale M, reciprocal to N; scale D like N, and last the ROOT scale.

To the left of the Base-line, on the transparent arm, the 25 coils are numbered 4, 8, 12, 16, etc., to 96, 100. These reference numbers are called

EXPLANATION

Quadrants, because each represents ¼ coil space, or ¼ turn of dial. Thus, a point 4½ coils from 100, the beginning of the spiral, is on Quadrant 18. Around the rim is a scale of equal parts reading 0 to 4000. These scales are used mainly for technical work, as shown in Fig. 5, also in cols. 11 and 12.



a) 727 of Spiral is alongside 727 of scales N, D;

b) 138 of M (=1/727) is alongside 727 of N and D;

c) $\sqrt{7.27}=2.70$; $\sqrt{72.7}=8.53$; $27^2=727$; $0.853^2=0.727$;

d) Quadrant 86 gives first 2 figures of log 72669, rim 135 gives next 3 figures of log 72669; hence log 726.69=2.86135; if log N = 1.86135, N=72.669.

Fig. 4 shows the beginning and end of Spiral, and gives 5-PLACE READINGS FOR PRACTICE.

Fig. 5 shows the RELATION OF ALL SCALES on the face of the Precision Computer.

You are advised not to go further until you have mastered the arrangement of scales, as given in Figs. 3, 4, 5.

SPEED AND ACCURACY

The Precision Computer will multiply, divide, or solve a proportion in about half a minute; setting a 5-place number should take 5 to 10 seconds, no more. If it takes longer it is due to misunderstanding the arrangement of the Spiral, as given in Figs. 4 and 5, or to unnecessary hunting for numbers.

Never hunt for numbers all over the Dial; bring the numbers to you. Keep your eye on the Base or Float only; do not let your eyes roam over the Dial.

The Base and Float correspond to the hands of a watch. To look for numbers away from these hair-lines is like trying to tell time on a watch, without looking at its hands. **Keep your eye on the hair-line,** and bring the number to you.

Thus, to set 3.4784 under Base-line, think of it as 347-84, grouping separately the first 3 and last 2 figures. Glance down the Base to the nearest coil; on one coil the number will be less than 347, on the next, more. **Stop and think** which is the shortest way to turn, remembering that the numbers run from left to right, just as on this printed page.

Turn the shortest way, with a big swing through the back finger slots; not mincingly, in jerks, but guaging the size of the swing by the difference between 347 and the nearest number that first happens to be under the Base.

Now turn Dial carefully to set the **next 2 figures** 84; that is, turn it

8.4 spaces beyond 347. It is a waste of time to count 1, 2, 3, 4, 5, 6, 7, 8 spaces. Take 347-50 and go 3.4 spaces beyond; better still, take 348-00 and go 1.6 spaces back. To set the last fractional 0.4 space, brace your fingers against the outer edge of the finger-slot in the back, or against edge of handle if you are turning Disk and Dial together. In estimating 0.4 space, estimate for accuracy both sides, 0.4 on one side, 0.6 on other side of hair-line.

HINTS FOR SPEED AND ACCURACY

1. Keep your eye on hair-line only, bring numbers to you.
2. Disregard decimal point in setting and reading numbers.
3. To set or read 3.4876 or 0.034876, think of it as 348-76.
4. To set 18¼ or 7 ft. 4 ins., convert to decimals; 182-50, 733-33.
5. To set 3.4870 take 348-50 and go 2 spaces forward; to set 3.4890 take 349-00 and go 1 space back.
6. In 5th place 5 is ½ space, 3 is scant 1/3, 2 is scant ¼ space.
7. To set 3/10 space estimate .3 on one and .7 on other side.

TWO-WAY READINGS

The Precision Computer Dial reads two ways:—

1. Along the hair-line; to locate the proper coil;
2. Across the hair-line, to fix the exact point on the coil.

Most precision instruments, tables, scales, are based on two-way readings. Thus, a micrometer reads hundredths along the stem, thousandths around the stem. On a typewriter, when a sheet of paper is inserted, it is first rolled up to the proper line, then shifted sideways to the exact point on that line. In the ordinary log table you first find the right line by the vertical margin numbers, then the proper number on that line by the top guide numbers. Even on a watch, the hour hand first gives the hour of day, then the minute hand gives the minute of the hour, while fractions of a minute are read by interpolation, or by the second hand.

Suppose these instruments were built primitively, with one-way readings, like the ordinary slide-rule; think how crude, cumbersome and limited in accuracy they would be. In the Precision Computer the two way readings permit a 100-foot slide-rule to be condensed into an 8-inch dial, with larger, simpler, uniformly decimal scales. Though it has 10,000 graduations, and reads by interpolation to 100,000,—any number can be found instantly, and set by about a quarter-turn of Dial.

Thus, to set any number, glance along the hair-line to the proper coil, and turn dial to the exact reading on that coil.

To work a problem, shift Slide to locate answer-coil; then solve on Dial, to locate exact answer on that coil. Since the Slide and Dial move independently of each other, it is immaterial which movement comes first.

BASIC DIAL MOVEMENTS

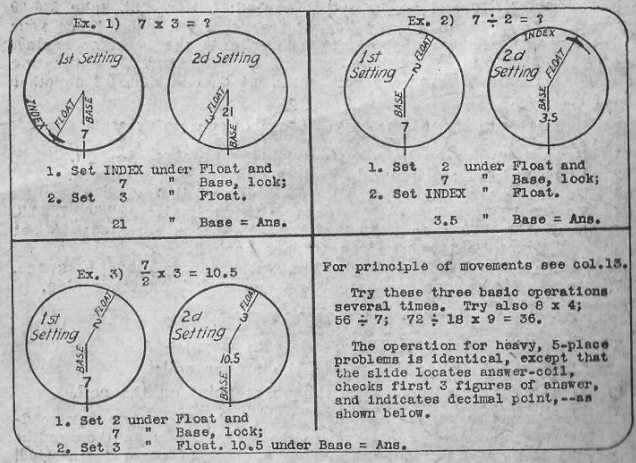
To multiply 7×3 on Dial, explained in full detail.

1. Set INDEX under Float, turn Disk and Dial together to set 7 (i. e. 700) under Base, lock;
2. Now turn Dial alone to bring 3 (i. e. 300) under Float.

Answer 21 (i. e. 210) is now under Base, just above middle. Slide locates answer-coil, as given below.

This operation is basic; repeat 7×3 several times until the movements become instinctive. The operation for division and proportion is identical, except that the numbers are set in different sequence, as shown below; but the **first setting is always made under the Float.**

HOW TO USE DIAL ALONE



1. Set INDEX under Float and 7 " Base, lock;
2. Set 3 " Float.
21 " Base = Ans.

1. Set 2 under Float and 7 " Base, lock;
2. Set INDEX " Float.
3.5 " Base = Ans.

1. Set 2 under Float and 7 " Base, lock;
2. Set 3 " Float. 10.5 under Base = Ans.

For principle of movements see col.13.

Try these three basic operations several times. Try also 8 x 4; 56 ÷ 7; 72 ÷ 18 x 9 = 36.

The operation for heavy, 5-place problems is identical, except that the slide locates answer-coil, checks first 3 figures of answer, and indicates decimal point,--as shown below.

Fig. 6 shows the BASIC DIAL MOVEMENTS for Multiplication, Division and Proportion. They are repeated on Handle of Computer for permanent Reminders.

In all 3 cases, Set Divisor first under Float.
For principle of movements see col. 13.

HOW TO USE SLIDE ALONE

To multiply, set your numbers opposite each other, on scales N and M, both under Runner 7. **To divide,** set them also opposite each other, but on scales N and D; D stands for Divisor. Each end of the MD scales has an arrow marked ANSWER; one of these two arrows always points to correct answer on scale N, while one end of scale N shows proof on scale M. Try 2×4; 3×4; 24÷2; 24÷3. Try also 48×3÷16=9; set 48×3, move Runner to ANSWER 144, and bring 16 of scale D under Runner; arrow shows answer 9 on scale N.

For other uses of Slide see column 12.

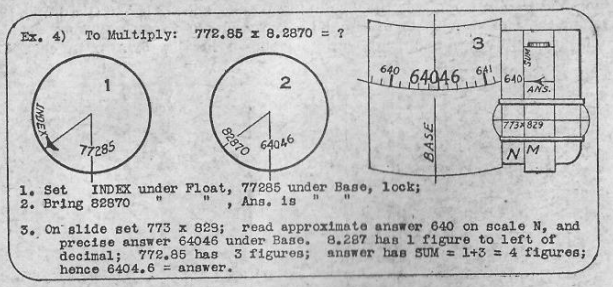
DECIMAL POINT INDICATORS

For multiplication, one end of scale M is marked SUM, the other SUM—1; for division, one end of scale D is marked DIFF, the other DIFF+1. These are decimal indicators. Count in your data the places to the left of their decimal points. Take their sum, sum—1, difference, or difference+1, as shown by indicators, point off that many places to the left of the decimal in the answer, as shown in Examples 4, 5, 6.

In counting places, 7623 has 4 places, 7.623 has 1 place, 0.7623 has 0 place, 0.007623 has —2 places, etc.

FUNDAMENTAL

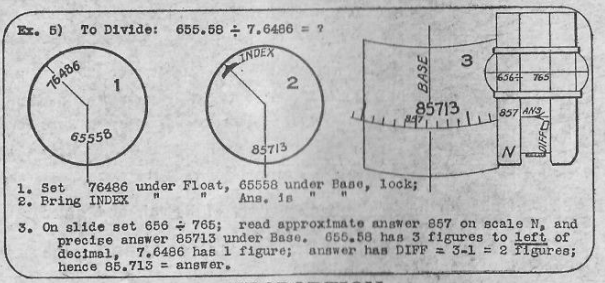
MULTIPLICATION



1. Set INDEX under Float, 77285 under Base, lock;
2. Bring 82870 " " , Ans. is " "

3. On slide set 773 x 829; read approximate answer 640 on scale N, and precise answer 64046 under Base. 8.287 has 1 figure to left of decimal; 772.85 has 3 figures; answer has SUM = 1+3 = 4 figures; hence 6404.6 = answer.

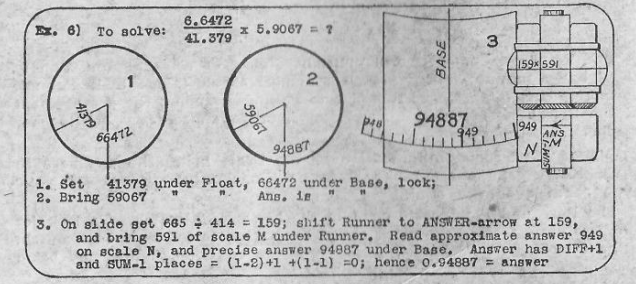
DIVISION



1. Set 76486 under Float, 65558 under Base, lock;
2. Bring INDEX " " Ans. is " "

3. On slide set 656 ÷ 765; read approximate answer 857 on scale N, and precise answer 85713 under Base. 655.58 has 3 figures to left of decimal, 7.6486 has 1 figure; answer has DIFF = 3-1 = 2 figures; hence 85.713 = answer.

PROPORTION



1. Set 41379 under Float, 66472 under Base, lock;
2. Bring 59067 " " Ans. is " "

3. On slide set 665 ÷ 414 = 159; shift Runner to ANSWER-arrow at 159, and bring 591 of scale M under Runner. Read approximate answer 949 on scale N, and precise answer 94887 under Base. Answer has DIFF+1 and SUM-1 places = (1-2)+1 +(1-1) =0; hence 0.94887 = answer

CONSTANTS, TABULAR WORK

Constants. For multiplying and dividing a long series of items by the same numbers, that is by one or two constants, the Precision Computer is particularly effective. Set the constants first, once for all, and lock; then a single turn of Dial solves each succeeding problem, while a shift of slide locates answer-coil and checks answer.

The answers can be read off as fast as an assistant can call off the items and write down the results, say 2 to 5 per minute.

This feature is of great value in figuring payroll when the rate of pay

EXAMPLES

is the same for many operatives, in figuring foreign exchange, in converting units, figuring series of percentages, in pro-rating, and in most heavy, tabular calculations. Ex. 7, 8, and 9 are typical problems; master them, then apply this principle to your own work.

CONSTANT MULTIPLIER

Ex. 7. To multiply each item in first column by the constant 77.285: Set INDEX under Float, 77285 under Base, lock; set Runner on 773 of scale N, as in Ex. 4, and do not shift Runner during operation; then continue:—

Set each item of your data					Arrow Shows Each Answer				
8.2870	under	Float,	829	of M under Runner;	640	on scale N,	640.46	under	Base;
7.5383	"	"	754	" " " "	583	" " "	582.60	"	"
4.6779	"	"	468	" " " "	362	" " "	361.53	"	"
9.6128	"	"	961	" " " "	743	" " "	742.93	"	"
2.6937	"	"	269	" " "	208	" " "	208.18	"	"
1.3674	"	"	137	" " " "	106	" " "	105.68	"	"

CONSTANT DIVISOR

Ex. 8. To divide each item in first column by total 76.486, in order to find what percentage of total each item represents:—Set constant Divisor 76486 under Float, INDEX under Base, lock. Set Runner on 131 of scale N (=1/765 of scale M, see Fig. 5), thus multiplying by 0.0131 instead of dividing by 76.5. Then continue:

Set each item of your data					Arrow Shows Each Answer				
6.5558	under	Float,	656	of M under Runner;	857	on scale N,	8.5713	under	Base;
6.5983	"	"	660	" " " "	863	" " "	8.6268	"	"
7.9726	"	"	797	" " " "	104	" " "	10.424	"	"
8.7934	"	"	879	" " " "	115	" " "	11.497	"	"
29.847	"	"	298	" " " "	390	" " "	39.023	"	"
16.719	"	"	167	" " " "	219	" " "	21.859	"	"

76.4861=sum of items Sum of percentages=100.001=proof

Here INDEX follows Divisor; in Ex. 5 Dividend follows Divisor; either method solves simple division. But with constant Divisor use method shown here, because only constants must be set before locking Disk.

CONSTANT RATIO or PRO RATING

Ex. 9. To distribute $664.72 among the items in first column, in proportion to each item. Their total is 41.3790, and the amounts are:—

$\frac{664.72}{41.379}\times 5.9067$; $\frac{664.72}{41.379}\times 6.4893$; etc., Set 41379 under Float, 66472 under Base, lock; on slide set 665÷414=161; set Runner on 161 of N; continue:—

Set each item of your data					Arrow Shows Each Answer				
5.9067	under	Float,	591	of M under Runner;	949	on scale N,	$94.89	under	Base;
6.4893	"	"	649	" " " "	104	" " "	104.25	"	"
3.6948	"	"	369	" " " "	594	" " "	59.35	"	"
14.5830	"	"	146	" " " "	234	" " "	234.27	"	"
7.4789	"	"	748	" " " "	120	" " "	120.14	"	"
3.2263	"	"	323	" " " "	518	" " "	51.82	"	"

41.3790=sum of items Sum of pro-rated amounts=664.72 =proof

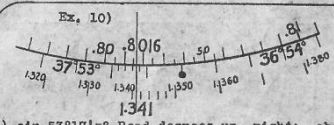
Here each item is multiplied by 66472÷41379. If it were required to divide each item by41379÷66472, the operation would, of course, be identical. Hence, to divide a series of items by a constant ratio, like 5/3, invert the ratio, and multiply by 3/5, exactly as above.

TRIGONOMETRIC SCALES

The Trigonometric Scales, on the back, form a 5-coil spiral, 18° to each coil; so that the subdivisions of all 5 coils are symmetrically over each other. The degrees are subdivided to 2'; they run both ways, up the coils and to the right for sine and tangent; down and to the left for cosine and cotangent. So 56° is marked 34°, because sin 56°=cos 34°. Above the degrees are sines and cosines, below are tangents and cotangents, as shown in diagram of Ex. 10. Key scales on the arm locate any number desired instantly; if desired angle is not in view turn scale the shortest way, or look in the next slot. When not in use the trigonometric arm is held under metal arm by its raised dome.

These scales are wholly independent of those on the face of the Computer. In solving problems, take the function from the back; write it against or over the corresponding angle in your table, formula or sketch. Then, as with plain numbers, use the face of the Computer.

NATURAL FUNCTIONS



Sin-cos are above the degrees, cos-cot " below " " ; both increase upward, to right.

Degrees, 0° to 90°, run both ways Upward, to right, for sin-tan, down, " left, " cos-cot.

a) sin 53°17'=? Read degrees up, right; above 53°17' read 0.8016 = answer;
b) cos 36°43'=? " " down, left; " 36°43' " 0.8016 = "
c) tan 53°17'=? " " up, right; below 53°17' " 1.341 = "
d) cot 36°43'=? " " down, left; " 36°43' " 1.341 = "

Likewise:

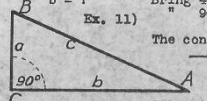
e) sin D=0.8016, D=? On sin-cos scale find .8016, below read right 53°17' Ans.
f) cos D=0.8016, D=? " " " " .8016, " " left 36°43' "
g) tan D=1.341, D=? " tan-cot " " 1.341, above " right 53°17' "
h) cot D=1.341, D=? " " " " 1.341, " " left 36°43' "

TRAVERSES, RIGHT TRIANGLES

Given: A = 24°53' On back read sin 24°53'=.4208; cos 24°53'=.9072;
c = 742.53 On face of Computer multiply side c by sin and cos.

Find: a = ? Set INDEX under Float, 742.53 under Base, lock;
b = ? Bring 4208 " " , 312.45 " " = side a, ans.
" 9072 " " , 673.72 " " = " b, "

Ex. 11)



The constant 742.53 is set only once; see Ex. 7.

On face divide sides a/b, to obtain tan A:-

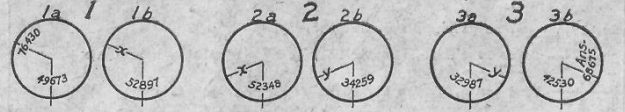
Given: a = 242.56 Set 546.93 under Float, 242.56 under Base, lock;
b = 546.93 Bring INDEX " " , 0.4435 " " = tan A

A = ? On back read .4435 = tan 23°55', above 23°55' read
c = ? sin = .4054. Then a/sinA = side c.

Ex. 12) Set 4054 under Float, 242.56 under Base, lock;
Bring INDEX " " , 598.32 " " = side c, ans.

CONTINUOUS MULT. AND DIV.

Ex. 13. $7643 \times \frac{52.897 \times 3425.9 \times 4.2530}{4967.3 \times 5234.8 \times 0.032987} = ?$



Begin by setting under Float first Multiplicand 7643; unlock and

1a) Turn Disk and Dial together, set under Base 1st Divisor 49673, lock;
b) " Dial alone ..... " " " " Multiplier 52897,
(Intermediate answer x=81.391 is now under Float), unlock;
2a) Turn Disk and Dial together, set under Base 2d Divisor 52348, lock;
b) " Dial alone ..... " " " " Multiplier 34259,
(Intermediate answer y=53.266 is now under Float), unlock;
3a) Turn Disk and Dial together, set under Base 3d Divisor 32987, lock;
b) " Dial alone ..... " " " " Multiplier 42530.

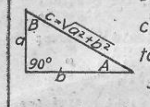
Final answer 6867.5 is now under Float.

After setting first Multiplicand, set a Divisor, then a Multiplier, alternately. If there is no alternate term, use 1, i. e., set INDEX, but **do not skip the movement.** The intermediate answer appears after setting each Multiplier; to find intermediate answer after a Divisor, multiply by 1. Each number in denominator is a divisor, as 5234.8, 0.032987. To find proper answer-coil and decimal point, use either of the following two methods:

1. Use slide successively, taking the numbers in any sequence. Note decimal indicators SUM, DIFF., etc., at each step.
2. Make the most obvious cancellations between numerators and denominators. This will always locate decimal, and minimize the slide operation.

SOLUTION OF TRIANGLES

Right



$a = b \cdot \tan A = c \cdot \sin A$

$b = a \cdot \cot A = c \cdot \cos A$

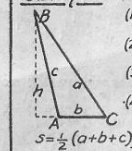
$c = \frac{a}{\sin A} = \frac{b}{\cos A}$

$\tan A = \cot B = \frac{\sin A}{\cos A}$

$\sin A = \cos B$

$\text{Area} = \frac{ab}{2} = \frac{a^2}{2 \tan A} = \frac{b^2}{2 \cdot \cot A} = \frac{c^2 \sin 2A}{4}$

Oblique



(1) $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

(2) $\frac{a-b}{a+b} = \frac{\tan \frac{1}{2}(A-B)}{\tan \frac{1}{2}(A+B)}$

(3) $c^2 = a^2 + b^2 - 2ab \cos C$

(4) $\cot \frac{A}{2} = \frac{s-a}{r}$, where

$s = \frac{1}{2}(a+b+c)$; $r = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}}$

$\text{Area} = \frac{bh}{2} = \frac{bc \cdot \sin A}{2} = \frac{b^2 \cdot \sin A \cdot \sin C}{2 \cdot \sin B}$

Given: Side and 2∠s, or 2 sides and angle opposite, use formula (1) twice;
" 2 sides and included angle, use formula (2) or (3), then (1);
" 3 sides, use formula (3) or (4), then (1).

Ex. 14 Read sinA, like Ex.10a; solve sinB = sinA $\frac{b}{a}$, like Ex.6;
Given a,b,A
Find B,C,c Read B, like Ex.10e; C=180°-(A+B); solve c=a$\frac{\sin C}{\sin A}$, like Ex.6.

Ex. 15 Write down (a+b), (a-b), $\frac{1}{2}(A+B)=90°-\frac{1}{2}C$; read cot $\frac{1}{2}C$, see Ex.10d
Given a,b,C
Find A,B,c Solve tan $\frac{1}{2}(A-B)=\cot\frac{1}{2}C\frac{a-b}{a+b}$, like Ex.6; read $\frac{1}{2}(A-B)$, like Ex. 10g

$A=\frac{1}{2}(A+B)+\frac{1}{2}(A-B)$; $B=\frac{1}{2}(A+B)-\frac{1}{2}(A-B)$; solve c = a$\frac{\sin C}{\sin A}$, like Ex.6.

Ex. 16 C = 180°-(A+B); read sin A, sin B, sin C, like Ex.10a;
Given a,A,B
Find b,c,C Solve b = a $\frac{\sin B}{\sin A}$, c = a $\frac{\sin C}{\sin A}$, setting ratio $\frac{a}{\sin A}$ only once, like Ex.9.

Ex. 17 Solve $r^2 = (s-a)\frac{(s-b)(s-c)}{s \times 1}$, like Ex. 13; do not read r^2, but
Given a,b,c
Find A,B,C halve the rim-reading to find r directly, as in Ex. 28;

solve cot $\frac{1}{2}A = \frac{s-a}{r}$; cot $\frac{1}{2}B = \frac{s-b}{r}$; cot $\frac{1}{2}C = \frac{s-c}{r}$; like Ex. 8;

read angles $\frac{1}{2}A$, $\frac{1}{2}B$, $\frac{1}{2}C$, like Ex.10h, and double them.

Ex. 18, areas, as given by formulae above:-

$\frac{1}{2}ab$------ Solve like Ex.6. Better halve side a mentally, solve $\frac{1}{2}a \times b$, like Ex. 4.

$\frac{a^2}{2 \tan A}$ Find tan A, double it, solve $\frac{a \times a}{2 \tan A}$, like Ex.6.

$\frac{c^2 \sin 2A}{4}$ Double A, read sin 2A, solve $\sin 2A \cdot \frac{c \times c}{4 \times 1}$, like Ex. 13.

$\frac{1}{2}bh$----- Calculate height h as in Ex. 11, then figure area like $\frac{1}{2}ab$ above

Ex. 19. General rule: Look up the natural function and solve like Ex. 4, 5 or 6. If your problem has a repeating factor, solve like Ex. 7, 8, or 9. If it is reducible to the form NM$\div$D, solve like Ex. 6.

The accuracy of the Trigonometric Functions is consistent with the accuracy of the angle scale, throughout. Ordinary tables, reading uniformly 4 or 5 places, have a variable accuracy, especially noticeable for angles of 1°, 2°, 88°, 89°, etc. This is somewhat remedied in tables, but not effectively, by jumping one place or by changing the interval near the end of the table.

Here the graphic functions and angles have obviously a consistent accuracy throughout. Since angles are not measured ordinarily closer than ¼ or ½ minute, these graphic functions meet amply practical requirements.

TECHNICAL

LOGARITHMS, EXPONENTS

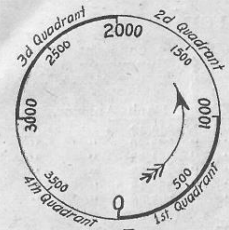


FIG. 7

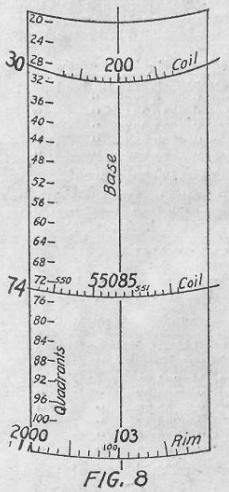


FIG. 8

Fig. 7 shows the RIM SCALE divided into 4 quarters, each reading 1000.

Fig. 8 shows how to read 5-place LOGS AND ANTI-LOGS. For any number under Base-line, Quadrant-scale to left gives first 2 figures of log, Rim-scale gives next 3 figures.

Ex. 20. Log 2=0.30103; log 200=2.30103.
Ex. 21. Log 5.5085=0.74103;
Log 0.055085=8.74103—10=—1.25897.

Do not interpolate second figure of 74 on Quadrant scale, but read 72, and note on rim to left of Base 2000, i. e. 2 quadrants, making 74 quadrants, or 0.74000.

Ex. 22. If log N=2.74103, N=? Divide mentally by 4 first 2 figures of given log, 74÷4=18, remainder=2, that is 2000; set 2103 of rim under Base, as shown in Fig. 8; alongside Quadrant 74 read answer 550.85.

The negative form of log 0.055085= —1.25897 may be found directly: In Fig. 8 read Quadrants up, for 76 read 24; on rim read backward from INDEX 1897; hence —1.25897=answer. Disregard actual numbering of rim, but use Quarter-points and 100-marks.

If log N=—3.25897, N=? 25÷4=6, remainder=1000 go back from INDEX 1897, and go up 26 quadrants, i. e. up to Quadrant 74; alongside it read answer 0.0055085.

EXPONENTIAL PROBLEMS

Ex.23 SQUARE ROOT: $\sqrt{2.8679} = ?$

Approximate: Set Runner on 286 of scale N;
Under Runner, on ROOT scale, read ans. 1.69

Precise:
Set 2.8679 under Base, read its log = 0.45 756
Under Base set half of this log, = 0.22 878
Under Base, opp. quad 22, read ans. = 1.6935

Ex.24 3/2 POWERS: $0.87393^{1.5} = ?$

Set 0.87393 under Base, read its log = 9.94 148
Take ½ of this log (19.94 148÷20) = 9.97 074
Add them = 9.91 222
Set 3222 on rim; opp. quad 91 read ans. = 0.8170

Ex.25 ROOTS: $\sqrt[1.497]{0.076452} = ?$

Set 0.076452 under Base, read its log = —1.11 662
On Dial set and read —1.11662 ÷ 1.497 = —0.74 590
Set —2590 on rim; opp. quad —74 read ans. = 0.17952

Ex.26 EXPONENTS: $7.2643^{0.793} \times 0.4563 = ?$

Set 0.4563 under Base, read its log = —0.34 075
On Dial set and read —0.34075 x 0.793 = —0.27 021
Set 7.2643 under Base, read its log = 0.86 119
Add, set 3098 on rim, read ans. 3.8993 0.59 098

Ex.27 MULT. and DIV. by LOGS: $7.2643 \times 0.53678 = ?$

Set 0.53678 under Base, read its log = 9.72 979
Set 7.2643 under Base, read its log = 0.86 119
Add, set 3098 on rim. Ans. = 3.8993 0.59 098

DETAILS

SQUARE ROOT

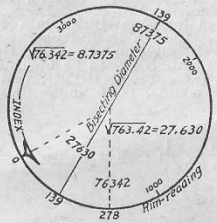
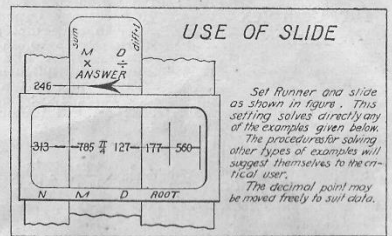


FIG. 9

Fig. 9 shows that the SQUARE ROOT of any number LIES on a diameter HALF WAY BETWEEN THAT NUMBER AND THE INDEX, on one or the other radius.



1	313 × 0.785 = 246	or 313 ÷ 12.7 = 24.6	Mult. or Div.
2	1/0.785 = 1.27	" 1/12.7 = 0.0785	Reciprocals
3	17.7² = 313	" 5.6² = 31.3	Squares
4	√313 = 17.7	" √3130 = 56	Square roots
5	7.85 × 17.7² = 24 0	" 7.85 × 5.6² = 24	Mult. with squares
6	π/4 × 17.7² = 246	" π/4 × 56² = 2460	(Given diameter of circle / To find its area
7	√(246/0.785) = 17.7	" √(246/0.0785) = 56	Sq. root of quotient
8	√(246 × 1.27) = 17.7	" √(24.6 × 0.785) = 5.6	" " " product
9	√(246/π/4) = 17.7	" √(24.6/π/4) = 5.6	(Given area of circle / To find its diameter
10	17.7³ = 5630	" ∛5630 = 17.7	(Not illustrated. Instead of 785 use 177 on scale M

Fig. 10 shows how to use SLIDE alone FOR VARIOUS PROBLEMS.

Ex. 28. $\sqrt{76.342}$=? Set 76342 under Base; take its approximate sq. root 8.73 on slide; note rim-reading 278, as in Fig. 9; bring 873 of Spiral under Base, and turn Dial slightly to set bisector 139 under Base; above it read exact sq. root 8.7375. See also Ex. 4 in Fig. 10.

Ex. 29. $\sqrt{763.42}$=27.630 lies on the other radius, as shown in Fig. 9.

To solve $\sqrt{abcd \div efg}$, find abcd÷efg as in Ex. 13; read answer not under Float, but on bisector, as above; this gives square root directly.

LOCATING DECIMAL POINT

The method of placing decimal by means of the Indicators on the Slide, has been explained in columns 6 and 7. The practical calculator will usually prefer to do it by common sense.

Read the answer on the dial, and write it down, as merely a series of figures, like 49673; then look at your problem; common sense will tell whether this stands for say $49.67 or $4.97 or $496.73. Cultivate the habit of seeing about what the answer will be, whether it is 16.38 or 163.8 yards. You will find this natural and easy.

In complex cases move decimal point in data, thus: 0.00213×0.0345=? Dial reads 73485. Shift decimal of first number so that it will lie between 1 and 10; here shift decimal 3 places to right, and to counterbalance shift decimal of second number 3 places to left, making the problem 2.13×0.0000345. Since 2×0.00003=0.00006, answer is obviously 0.000,073,485.

Again, 0.00213÷0.0345=? Dial reads 61738. Shift decimal point of Divisor so that Divisor will lie between 1 and 10. Here shift it 2 places to right, and to counterbalance do the same to Dividend, making problem read 0.213÷3.45=? Since .21÷3=.07, answer is obviously 0.061,738.

In general, leave decimal point alone, clear to the end; your problem will easily and readily suggest its location.

The answer may be located by noting the Quadrants of the data, without using the Slide. In multiplication add the data Quadrants; thus, 25×30; 25 is on quadrant 40, 30 is on quadrant 48, answer 750 is on quadrant 40+48=88.

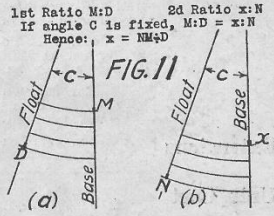
In division subtract quadrants; 300÷25; answer 12 is on quadrant 48—40=8.

If sum of quadrants is more than 100, drop 100; if difference is less than 0, add 100 to smaller quadrant.

PRINCIPLE OF DIAL MOVEMENTS

The ANGLE between ANY two numbers on the Spiral equals the angle betwen any two other numbers having the SAME RATIO,—and they are just as many coils apart.

Fig. 11 shows PRINCIPLE: Let Float and Base be set at any angle C apart, and LOCKED. Take any 2 numbers, D and M, on these lines, 3 coils apart. If Dial is now turned to bring any 2 other numbers N and x, under the hairlines, also 3 coils apart, then x/N=M/D.



Referring to Ex. 1, 2, 3, of Fig. 6, in column 6, multiplication and division are solved exactly like proportion: 7×3÷2, or N×M÷D, because:
Multiplication, 7×3, is merely 7×3÷1; use INDEX (1000) for 1;
Division, 7÷2, is merely 7×1÷2; use INDEX (1000) for 1;

In mult., 7×3; angle from 1 to 7=angle from 3 to x= 21, answer;
In division, 7÷2; angle from 2 to 7=angle from 1 to x= 3.5, answer;
In prop., 7÷2×3; angle from 2 to 7=angle from 3 to x=10.5, answer;
In general, N×M÷D; angle from D to M=angle from N to x=answer:

Therefore, always set the first, given, ratio and lock it; bring the third term under one hair-line, answer appears under the other; slide locates the proper coil. The proportion may be written D/M=N/x or D/N=M/x, or N/D=x/M, or M/D=x/N; it may likewise be set differently under the hair-lines, but the order of settings given in Ex. 1 to 6 is generally best, thus:—

1st ratio:—Set Divisor D under Float, Multiplicand M under Base, lock;
2d ratio:—Set Multiplier M under Float, Answer is now under Base; Slide locates coil, checks answer, indicates decimal.

If Multiplicand M is set first under Float, answer will appear under Float, as in Ex. 8.

PERSONAL ACCURACY

Users of graphic instruments occasionally form the habit of setting the last fractional space too "strong" or too "weak." Thus, for 348-57 they may set 348-57½ or 348-56½, or even 348-58, thus affecting, in the case of the Precision Computer, the 5th figure in the answer.

To detect and eliminate this tendency, try problems like 9×9, or 7×7, or 19.7×19.7=388.09; or 20.1×20.1=404.01. Try each several times. If the answer habitually reads too small, you are setting the data a fraction of a hair too weak; so exaggerate in the opposite direction; set the numbers too strong, as 9.0001, 7.0001, 197-01, 201-01, respectively,—and vice versa, until the answer reads just right. A bit of practice like this will give you the measure in your hand and eye of setting the last fractional hair just right, and will increase your accuracy and confidence in using the Computer. The effect of mis-setting is greatest when data near center of dial bring answer toward the rim; so be particularly careful then.

DECIMAL EQUIVALENTS

To convert Units to Doz., Ins. to Ft., Mos. to Yrs., Ft. B. M., etc.

Fraction	1/12	2/12	3/12	4/12	5/12	6/12	7/12	8/12	9/12	10/12	11/12
Decimal	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

To convert Ozs. to Lbs., Pints to Gals., 1/8's and 1/16's to decimals.

Fraction	1/16	1/8	3/16	5/16	3/8	7/16	9/16	5/8	11/16	13/16	15/16
Decimal	.0625	.1250	.1875	.3125	.3750	.4375	.5625	.6250	.6875	.8125	.9375

If any other fractional units recur frequently in your work, tabulate once for all their decimal equivalents, as above, and use these equivalents in future.

PRACTICAL

Payroll

Ex. 30. To find wages of operatives who worked 37¼, 41½, 44, 33¼ hours during the week, all at 72½c per hour: Set INDEX under Float, 725 under Base, lock; proceed as in Ex. 7. Set given hours under Float, read answer under Base; a single turn of Dial solves each problem.

Ex. 31. To find wages for same hours as in Ex. 30, but at $23.50 for 44-hour week: Set 440 under Float, 2350 under base, lock; proceed as in Ex. 9.

Ex. 32. To find wages for 24¼, 21½, 27¼ days, at $135 for 26-day month: Set 260 under Float, 135 under Base, proceed as in Ex. 9.

Extensions

Ex. 33. Solve like simple multiplication, Ex. 4. Fractional dozens, 1/16's, etc., etc., convert to decimals first; see col. 13. See also Ex. 34 to 36.

Unit Cost

Ex. 34. If 45 ft. 7 ins. belting cost $32.15, and duty is 12½% additional, what is total cost per foot?

Solve 32.15×1.125/45.583, as in Ex. 6. See. also col. 13.

Percentage

Ex. 35. $234.56 overhead on $1876.40=what percent? Divide 23456/18764, like Ex. 5.

Discount

Ex. 36. 17½% discount on $432.67=? Multiply 175×43267, like Ex. 4. **Net** amount may also be found by setting 825 (=100%—17.5%), as in Ex. 7. Constant 43267 is set only once. Combination discounts work like **Ex. 13.**

Simple Interest

Ex. 37. Interest on $1764 for 7 mos. 19 days, at 7¾%=? Solve: $\frac{1764\times 229 \text{ dys.}\times 7.75}{360 \quad \times 1}$=$86.97, like Ex. 13.

Compound Interest

But if you use 7¾% frequently, better find once for all value of 360÷7.75=46.450, then solve 1764×229÷46.450=$86.97, like Ex. 6.

Annuities

See Ex. 25 and 26. Special directions sent on request.

Inventory

Ex. 38. These usually require but simple multiplication, like Ex. 4; but if same conversion factor enters repeatedly set it only once, as in Ex. 7 or 8.

Quantities

Ex. 39. Simple units. At 8.324 lbs. per gallon, how many gallons in 5460 lbs? Solve like Ex. 5 if you have a single problem; for many items, with same conversion factor, follow Ex. 7 or 8.

Converting Units

Ex. 40. Compound units: like changing pounds per sq. inch into kilos per sq. cm., find the equivalent single conversion factor, by Ex. 6 or 13, then proceed as in Ex. 39.

Circles

Ex. 41. Circle constants, 3.1416, 3.1416÷4=.7854, 4÷3.1416=1.2732, 1÷3.1416=.31832, — are marked on the spiral at the exact points. Use these marks directly. To solve 0.7854×D×D write it D×D÷1.2732, and solve like Ex. 6.

Reciprocals

Ex. 42. To solve 1÷a=x follow Ex. 5: Set a under Float, INDEX under Base, lock; bring INDEX under Float, reciprocal x is under Base. See also Fig. 5 for approximate method.

In general, if INDEX is under Float, and any number N is under Base, then turning INDEX to Base brings reciprocal of N to Float. Try 1/2=0.5; 1/2.5=0.4.

Squares

Ex. 43. Multiply number by itself, like Ex. 4.

Cubes

Ex. 44. Write it $A\times\frac{A\times A}{1\times 1}$, solve like Ex. 13.

Sq. Root

Ex. 45. Set number under Base, halve rim-reading, read answer as in Ex. 28.

Cube Root

Ex. 46. Read log, take 1/3 of it; read corresponding answer as in Ex. 23.

APPLICATIONS

General Rules for Complex Problems

Ex. 47. a) Reduce your problem, if possible, to the form of a proportion NM÷D, and solve like Ex. 4, 5, or 6. If necessary cancel mentally small factors, like 2, 3, ½, ¼, to save dial movements.

b) If answer is to be used immediately as data for next operation, solve like Ex. 13, even if first operation is a simple multiplication or division, because this method brings answer under Float, ready to be operated on again. Thus, 3×4: Set 3 under Float, INDEX under Base, lock; bring 4 under Base, ans. 12 is under Float. Try 21÷7.

abc, $\frac{a}{bc}$, $\frac{1}{abc}$ Write them: $a\frac{b\times c}{1\times 1}$, $a\frac{1\times 1}{b\times c}$, $1\times\frac{1\times 1\times 1}{a\times b\times c}$; solve like Ex. 13.

MECHANICAL DETAILS

Each Computer is carefully centered and adjusted to turn with proper degree of tightness. Do not tamper with center unnecessarily. In case of accident, center may be opened or locked with a wire clip, or small nail.

The Slider can be tightened or loosened by springing the tongues under it, at each end of the plate. To adjust Runner, remove it, arch it slightly between your fingers, or spring the two sliding wings slightly with a pocket-knife.

If any part is damaged accidentally, or lost, it will be replaced on request, at a nominal price, or free of cost.

ACCURACY ADAPTABLE TO WORK

No answer can be more accurate than the Data. Thus, if a cubic foot of iron weighs 480 pounds with a variation of 1 pound above or below, every calculation involving this term 480 will have the first two figures in the answer correct, 3rd figure doubtful, 4th and subsequent figures, incorrect, useless, meaningless and misleading.

Therefore, suit the accuracy of your work to the accuracy of your data. The Precision Computer is adaptable to various degrees of accuracy, thus:

For 2-place work, as in rough estimates, say 2% accuracy, 1 part in 50, use slide alone, roughly. Thus, 4.6×720=3300; 0.0069÷0.38=0.18; 1500×590=880,000.

For 3-place work, as in approximate figuring, say 1/3% accuracy, 1 part in 300, use slide alone, but carefully, read both answer and proof. Thus, 4.62×723=3340; 0.00691÷0.473=0.0145; 2730×597=1,630,000.

For 4-place work, as in ordinary engineering work, say 1/50% accuracy, 1 part in 5000, use dial, reading to the nearest full space, without interpolating fractional spaces.

For 5-place work, as in precise calculations, or in extensions, say 1/500% accuracy, 1 part in 50,000, use Dial, interpolating with care the fractional spaces, as shown in previous examples.

Six-place work is not warranted by ordinary data. Nearly all practical problems depend on measurements which are seldom accurate to 5 or 6 places. But if, in some special case, an answer of more than 5 places is indispensable, it is obtainable by special methods, details of which will be sent on request.

By places are meant **significant figures,** irrespective of the decimal point. Thus, 7.623 or 0.0007623 or 76,230,000, all have 4 significant figures 7-6-2-3. Again, if 720 feet stands for 720 definite feet, with a doubt only in the tenths of feet, then it has 3 significant figures 7-2-0; but if it stands for 720 feet with a few feet more or less, then it has only two significant figures 7-2, the zero being merely an indication of the decimal