13. Removing and Reattaching the Cursor
of the School Commerce 0905

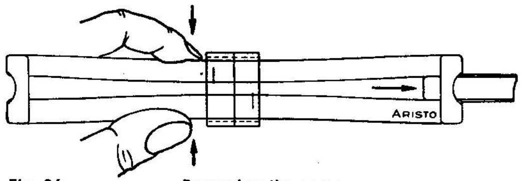


Fig. 34 **Removing the cursor**

With slide drawn well toward the right or left of the body, press the two body panels slightly together. The cursor can then be taken off or replaced. (Fig. 35).

Broken cursor springs can be easily exchanged, as shown in Fig. 34. For replacements apply to your dealer.

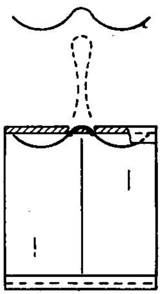


Fig. 35 **Inserting a Spring**

14. The C-Tablet
(Concerns ARISTO Commerce I and II only)

In amplification of the M scale the C-Tablet supplies the conversion factors between numerous British/US units and metric equivalents. Also the metric equivalents of the most commonly used fractions of an inch, as well as a table for changing shillings and pence to decimals of one £. A table of parities between the principal international currencies is also included. The C-Tablet will be found of all-round usefulness in many branches of business.

15. Treatment of the ARISTO Slide Rules

The instrument is a valuable calculating aid and deserves careful treatment. Scales and cursor should be protected from dirt and scratches, so that the reading accuracy may not suffer.

It is advisable to give the rule an occasional treatment with the special cleanser fluid DEPAROL, or with soap and water, followed by a dry polishing. Avoid chemical substances of any description as they are almost certain to spoil the scales.

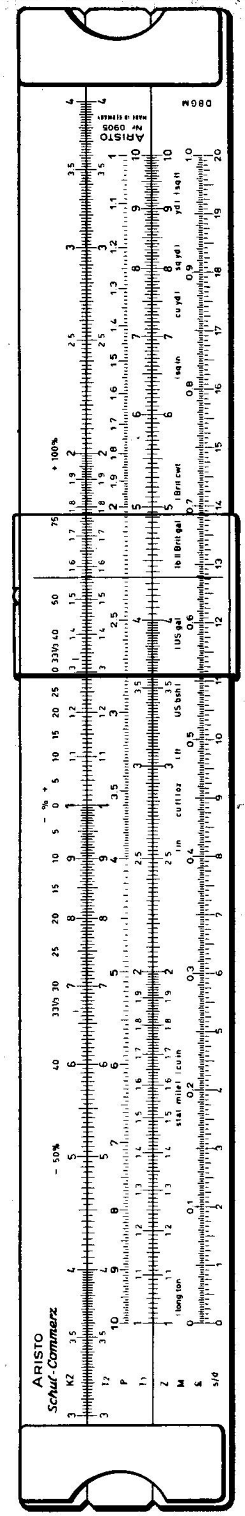
Do not leave the rule on heated surfaces such as radiators. Do not expose for a greater length of time to powerful sunlight. Deformations may occur in temperatures above 60° C (140° F). Rules so damaged will not be exchanged free of charge.

DENNERT & PAPE · ARISTO-WERKE
HAMBURG-GERMANY

HARVOZ-ROOS CORPORATION

ARISTO

COMMERCE



CONTENTS

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Slide Rules for Businessmen

So you have decided to do your daily figure work by slide rule and will want some briefing on its most efficient operation. All problems that take so much time and effort to work out in longhand and usually involve multiplication and/or division in one form or another are the strong point of the slide rule. But it is useless for addition and subtraction.

Always do simple arithmetic by mental process and use the calculating machine where the solution has to be strictly accurate to the last digit; but between the two lies the vast and varied domain of the slide rule where an accuracy to three or four digits is considered satisfactory, as in percentages, cost calculation, interest, statistics and in compiling price lists. The advantage of doing this work by slide rule is that, for each step in a computation, the problem itself and the answer appear clearly "written" on the slide rule and can be reviewed before proceeding, that its operation is noiseless and that it fits your pocket to be always on hand for instant use. The present instructions will show you the way to becoming a competent slide rule operator. It will not take you long to appreciate how easy it is to solve all your tedious calculations by short cut methods and without mental effort. The moment you have your problem straight in your mind, the solution requires no more than normal eye judgment and nimble fingers. The slide rule does the figure work for you — instantly and infallibly. Self-instruction takes no longer than learning to operate a typewriter or a calculating machine and is much easier than picking up shorthand.

These instructions cover the four business slide rules ARISTO-School Commerce, ARISTO-Commerce Pocket Size, ARISTO-Commerce I and ARISTO-Commerce II, whose most frequently used scales are similar in design. Differences in the layout and certain special scales will be explained in the respective chapters.

THE SLIDE RULE *ARISTO* SCHOOL COMMERCE 0905

1. The Scales

Percent Scale	For Problems involving Percentages	On Upper Body Panel
KZ	Fundamental Scale Displaced by 360	
T2	Fundamental Scale Displaced by 360	On Slide
P	Reciprocal Scale	
T1	Fundamental Scale	
Z	Fundamental Scale	On Lower Body Panel
M	Marks for Converting Brit./US Units to Metric Equivalents	
£ / s./d.	Scales for Changing s./d. to Decimals of 1 £	

Millimeter and Inch Scales on Back of Body.

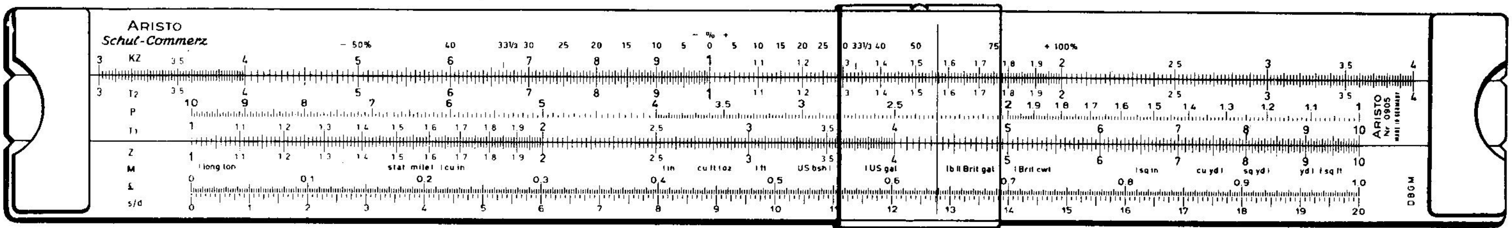

Fig. 1 Front Face of ARISTO School Commerce 0905

THE POCKET SLIDE RULE *ARISTO* COMMERCE 845

Millimeter Scale on Front Bevel, Inch Scale on Rear Face.

Percent Scale	For Problems involving Percentages	On Upper Body Panel
KZ	Fundamental Scale Displaced by 360	
T2	Fundamental Scale Displaced by 360	On Slide
P	Reciprocal Scale	
T1	Fundamental Scale	
Z	Fundamental Scale	On Lower Body Panel
M	Marks for Converting Brit./US Units to Metric Equivalents	

On Back of Slide:

£ / s./d. Scales for Changing s./d. to Decimals of 1£

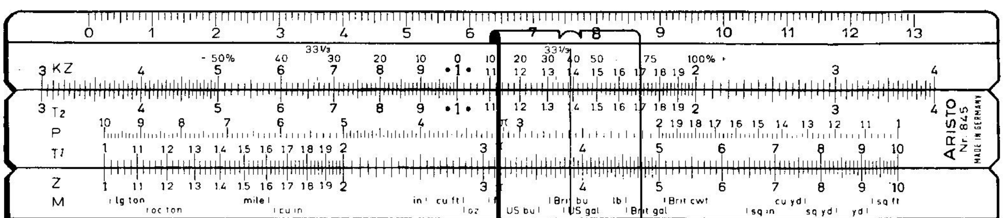

Fig. 2 Front Face of ARISTO Pocket Commerce 845

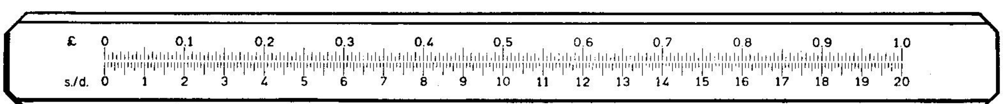

Fig. 3 Back of Slide of ARISTO Pocket Commerce 845

THE SLIDE RULE *ARISTO* COMMERCE I 955

Millimeter Scale on Bevel, Inch Scale on Rear Face		On Upper Body Panel
Percent Scale for Problems involving Percentages		
KZ	Fundamental Scale Displaced by 360	
T2	Fundamental Scale Displaced by 360	On Slide
P2	Reciprocal Scale of T2	
P1	Reciprocal Scale of T1	
T1	Fundamental Scale	
Z	Fundamental Scale	On Lower Body Panel
M	Marks for Converting Brit./US Units to Metric Equivalents	
£, s./d.	Scales for Changing s./d. to Decimals of 1 £	

The ARISTO Commerce I is accompanied by a C-Tablet.

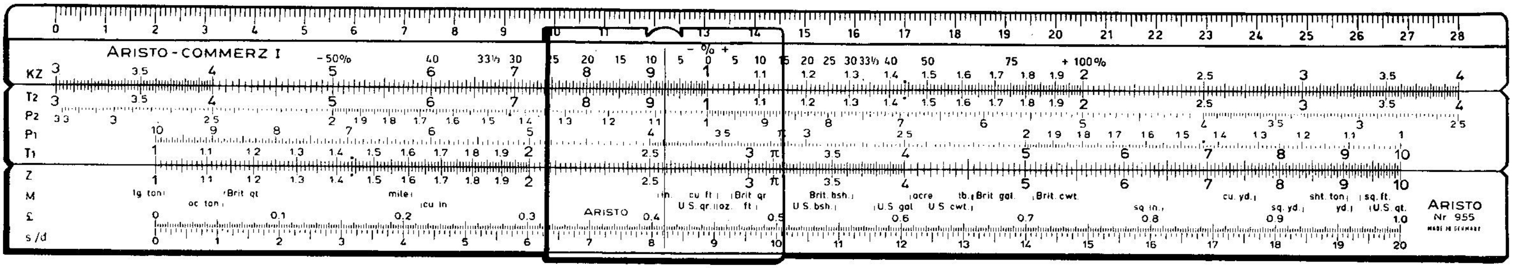

Fig. 4 Front Face of ARISTO Commerce I and II

THE SLIDE RULE *ARISTO* COMMERCE II 965

The Front Face of the ARISTO Commerce II is identical with that of the ARISTO Commerce I (see page 6).

ZZ3	Compound Interest Scale 2.6 to 30,000	On Back of Slide
ZZ2	Compound Interest Scale 1.1 to 2.8	
ZZ1	Compound Interest Scale 1.01 to 1.11	
ZZ%	%-Numeration to Simplify Settings on the ZZ1 Scale	
T_1	Fundamental Scale	

The ARISTO Commerce II is accompanied by a C-Tablet.

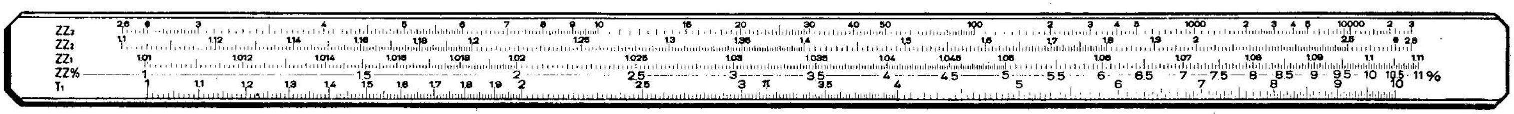

Fig. 5 Back of Slide of ARISTO Commerce II

2. Reading the Scales

Learn to read the slide rule scales fluently before embarking on actual problems. This is the most important preparatory exercise. Slide rule scales are not uniformly divided like ordinary linear scales but their intervals shrink progressively between the first and the terminal line. This makes it necessary to employ three systems of subdivision which you will at first find a bit difficult to read without hesitation.

For comparison take a look at an ordinary millimeter scale which you have no doubt often used for taking measurements. Note that each line of its subdivisions marks an advance of 1 mm, each fifth interval being emphasized by a slightly longer line, and that each tenth line bears its respective numeral. This makes such a scale easy to read at sight.

Fig. 6 Millimeter Scale

Looking over the Z or T1 scales of your rule, which may be aptly called the key scales of the entire system, you will find that the slide rule scales between 1 and 2 are similarly divided and numerated and that after 2 the system of division lines changes to a less elaborate pattern and from 4 to the terminal line the scales are still further condensed. This is necessary because, owing to the systematic contraction of the scale intervals between both extremes, crowding of the lines in the right hand region would render the scales illegible. Hence the three systems of graduation within each full length scale. These will be fully explained in this chapter for the 10″ model.

Now consider: The number 2 on a metric scale may be translated into terms of any of its possible decimal variates, such as 2 cm, 20 mm, 0.2 dm, 0.02 m, and so on. Similarly, too, the slide rule only takes account of significant figures in their proper order and leaves the placement of the decimal point to the computer when the final answer is obtained. To avoid confusion or omission of digits it is therefore good policy, both in setting and reading the scales, to think of and pronounce all numbers as sequences of digits. Thus: One-Three-Four, not One Hundred and Thirty-four.

Now for your first reading practice between 1 and 2 of the Z scale. Here the system of subdivision is similar to that of a millimeter scale, but different in so far as the intervals decrease in width from left to right and that the first line is not marked 0 but 1.

Fig. 7 Reading between 1 and 2

Set the cursor hairline to 1 and assume this number to represent 100. Then move the cursor slowly to the right, line-for-line, and recite: 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113 and so on (Fig. 7). Your very first move will probably cause you bewilderment. Why is the second line 1—0—1? Why the zero? Easy to comprehend if you look at the next printed numeral to the right of 1. It says 11 and, in our present case, therefore means 110. Hence the lines between the printed 1 (100) and 11 (110) represent the intermediate numbers viz. 101 to 109. This is where the novice often makes the mistake of overlooking the zero in the middle.

The hairline of the cursor is of such spiderthread fineness that it is easily adjusted within the space intercepted between two neighboring lines so as to divide this space accurately in two equal parts. More than that, the eye can also distinguish even smaller fractions right down to the tenths, after some experience. Let's now resume our reading practice with the foregoing remarks in mind. Suppose we had got as far as 131 or 1310, which is the same thing. Now nudge the cursor over slowly to where you estimate the place for the tenth part of the interval between the lines for 131 and 132 would be. That place would then be 1311. Another carefully gauged advance by one tenth: 1312; and another: 1313. And so on.

Be careful again, when locating numbers between one numerated line and the next line, that you do not omit any zero. Return the cursor to the line marked 13 (1300) and divide the next interval by estimate: 1301, 1302 etc. Be particularly watchful in the first interval after 1 (1000) and count off here: 1001, 1002, 1003 etc.

Let's now turn to the segment of the scale which comprises the numerals 2 to 4 in large print and which concerns all numbers beginning with the digits 2 or 3. Notice that the spacing has shrunk to such an extent that a division line could only be provided for each fifth of the distance to the next line for the second digit in the number and that only the lines for the sequences 2.5 and 3.5 are actually labeled in addition to 2 and 4 (See Fig. 8).

Fig. 8 Reading between 2 and 4

Align the cursor hair to 2 which would represent 200, as agreed upon. The next short line would then signify 202, followed by 204, 206, 208, 210, 212, 214 etc. In the middle of each interval we can place the uneven numbers easily by eyesight: 201, 203, 205, 207, 209, 211, 213 etc. Fig. 8 shows some specimen readings in this category.

In section three of the scale, dealing with numbers beginning with 4 up to 10 the intervals advance by five tenths. Hence, again as agreed upon, we can read off on the lines: 400, 405, 410, 415, 420, 425 and so on.

Fig. 9 Reading between 4 and 10

Intermediate values are obtained by visual estimate: In the middle between 400 and 405 we can locate 4025. A little to the left of this middle position we could place 402, and the same distance to the right would give us 403. So, conversely, in the next interval the middle place would be 4075 etc. Fig. 9 illustrates a series of such readings.

Like most beginners you will at first have some trouble in locating numbers on the scales correctly. You are therefore well advised to devote ample time to practicing settings of random examples by use of the cursor and later also with the index 1 of the slide scale. This applies to all other scales as well, since their system of division is the same. Once you can do this almost without thinking, the actual calculating process will present no major problems.

Pocket-size slide rules, being only half as long as the standard models, are naturally divided in less detail, but the system is basically the same. In the range 1—2 count off 102—104—106 etc. as Fig. 8 shows for the corresponding scale progression of a 10″ rule. For the range 2—5 take a look at Fig. 9 and count 200—205—210. . . . Between 5 and 10 read as shown in Fig. 7, viz. 500, 510, 520 . . .

The computations with which you are concerned in your daily work always involve multiplication or division in one form or another. With the slide rule this is done mechanically by adding or subtracting two segments of line. The basis of the process can be simply demonstrated with the aid of two ordinary millimeter rules by shifting one of them alongside the other.

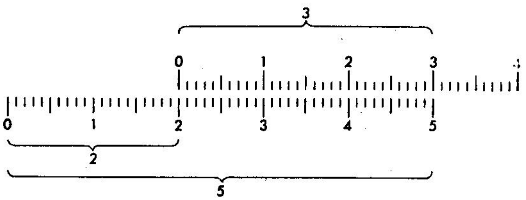

Fig. 10 Graphic Addition by use of two Linear Scales

Fig. 10 shows the example 2 + 3 = 5. Note how, by placing the tip of the upper rule opposite the value 2 of the lower rule, we can add any other length to this line segment 2 of the lower scale by reference to the upper scale. So, for instance, we find the sum of 2 + 3 = 5 on the lower scale under 3 of the upper scale. In the diagram we can also follow the addition 2 + 1 = 3 or 20 + 15 = 35, counting off in millimeters.

The process of subtraction, too, can be viewed on the diagram by simply reading in reversed order. To deduct the length 3 of the upper scale from 5 of the lower scale set 3 over 5 and find the remainder 2 under the tip of the upper scale on its companion.

On your slide rule, now, the scales are printed on a rigid frame, called the body, as well as on the slide which moves in it lengthwise to the body scales. The fundamental characteristic of the slide rule scales is that they are divisioned to logarithmic distances. By adding two segments of line with the slide rule we actually perform a multiplication and, analogously, subtraction achieves a division of the numbers involved.

3. Use of the Fundamental Scales

Our first practical experience will be confined to operations with the most important of all scales viz. Z and T1 and their transformed counterparts KZ and T2 which differ from them in so far as they "begin" with 1 (called the index) in the center. From here the graduation runs rightward to the end, breaks off and recommences at the left extreme, terminating at the index. The advantages of this quadruplicate set of scales will be explained as we go along.

4. Multiplication

(Adding two segments of scale)

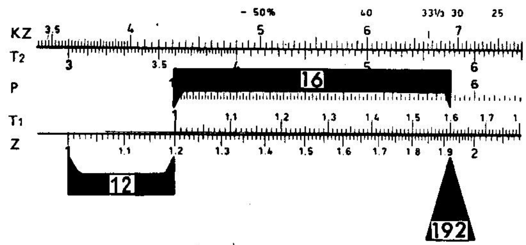

Fig. 11 12 × 16 = 192

When the tip of the T1 scale is placed over the value 12 on the Z scale and the cursor hairline made to coincide with 16 on T1 we have added two linear dimensions as demonstrated in Fig. 10. But, with respect to the numbers located on the scales we have performed their multiplication. The product 192 appears under the hairline on Z. The number of places in this answer is determined by rough approximation with such strongly rounded-off values as 10 × 20 = 200 for example.

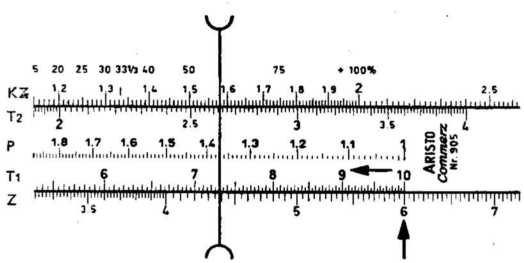

Fig. 12 6 × 7.3 = 43.8

Fig. 12 shows the start of a computation with the rear index 10 of the T1 scale when the procedure portrayed in Fig. 11 would fail because the result would lie beyond the end of the body scale. In this new form of setting the front part of the slide scale overhangs the tip of the body scale. Conceive now a duplicate of the Z scale preceding the original scale and you will realize that the left index of the slide would also coincide with 6 on this imaginary scale, as in a setting with the front index. With the cursor set to 7.3 of T1 read the product 43.8 on Z. From the foregoing we can deduce 1) that either index may be used for setting the multiplier, 2) that in each case some part of the scales will always be out of reading range and 3) that when readings are required in the unreadable range we have only to substitute one index for the other. This change of indexes is known as "resetting the slide".

5. Multiplication with Scales KZ and T2

Now glance at the T2 scale in Fig. 12 and note how its index 1 is invariably aligned to the same value on KZ to which the index 1 of T1 is aligned on Z. It follows that we can also begin the foregoing examples with the "upper scales" KZ/T2 and with advantage too. No more need to decide between two indexes for the first setting.

The scale combination KZ/T2 and Z/T1 may be regarded as one intercontinnous system displaying a limitless procession of equivalences having the same ratio. Whenever the point is reached where one pair fails to give the answer, the other pair takes over. No more "resetting the slide". The yellow-toned scales of the slide guard against taking the wrong track in switching back and forth within this scale assembly.

Let it be assumed that the abstract numerals in Fig. 12 have some denominate significance, such as 1 yard of a certain material sells for \$ 6.—. How much for 7.3 yards? With just one setting of the slide we can read the prices of this and as many further yardages as we may wish to ascertain. It is in the compiling of price lists and similar tabulations that the slide rule is particularly efficient, as Fig. 13 demonstrates.

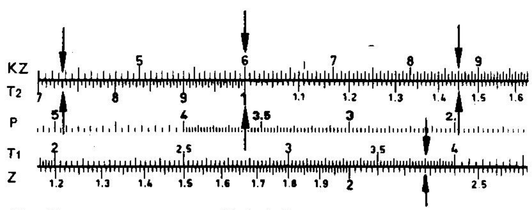

Fig. 13 Tabulation

When the quantities are set along the coloured scales T1 and T2 by successive moves of the cursor hairline, the prices are found on their respective companions Z and KZ. On comparison you will notice that within a wide range the same pairs of values are coupled together on both pairs of scales: The answer to the Fig. 13 problem can be read on both pairs of scales, but 6 × 3.8 = 22.80 is obtainable with the lower scales only and 6 × 14.5 = 87.0 with the upper scales. In any case you can always rely on finding your answers either on one or the other pair provided that you make the initial setting with that index which leaves about half of the slide length inside the rule. Even this stipulation can be disregarded by making it a rule to start all ordinary multiplications with the top scales.

Example:

Assume that a reduction of 17% on a price list goes into effect and it is required to find how much the reduction amounts to for each listed item. Draw the index of the T2 scale under 17 of KZ. For any list price on T2 or T1 you can now read the reduction on KZ or Z. 0.17 × 12 = 2.04; 0.17 × 17.65 = 3.00 etc.

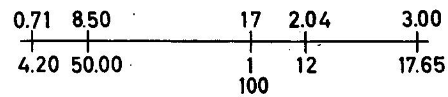

Fig. 14 Diagram of Scale Adjustment

Exercises:

8.75 × 6.35 = 55.6	0.39 × 22.7 = 8.85
1.07 × 9.72 = 10.40	0.39 × 52.5 = 20.48
0.75 × 32 = 24	54.3 × 12.4 = 673
0.87 × 0.76 = 0.661	2.58 × 14.75 = 38.06

6. Division

(Subtracting one segment of scale from another)

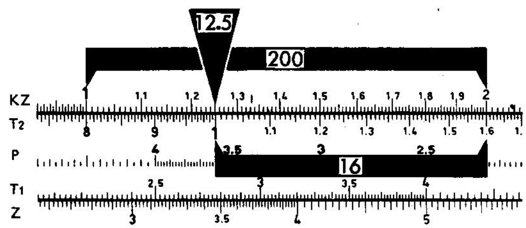

Fig. 15 200 ÷ 16 = 12.5 Roughly: 200 ÷ 20 = 10

The operation starts with the setting of 200 over 16. Do this by shifting the cursor to 200 on the KZ scale and then drawing 16 on the T2 scale under the hairline. The quotient is found above the index 1 of the T2 scale on KZ and simultaneously also under the index of T1 on Z. The advantage of starting with the upper scales is that here we can set the problem in the clear form of a fraction. The narrow joint separating the scales serves as the division line between dividend and divisor. Almost impossible to blunder into a wrong setting. Of course you can take your choice and use the lower scales.

Exercises: 4450 ÷ 835 = 5.33
47389 ÷ 34754 = 1.363
(reduced to three-digit numbers 474 ÷ 348)

A merchandise is quoted at \$ 26.80 per gross. How much per unit? 26.8 ÷ 144 = \$ 0.186. Special dot marks in the graduations of the models No. 955 and 965 make it easy to locate 144 instantly.

7. Multiplication and Division Combined

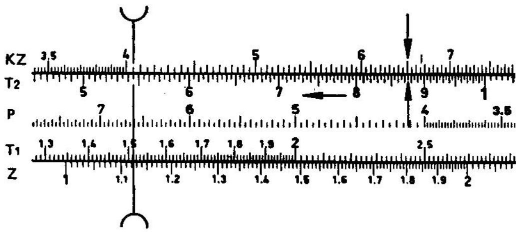

Fig. 16 $\quad \frac{6.5}{8.75} \times 5.45 = 4.05 \qquad$ Roughly: $\frac{7 \times 5}{9} \approx 4$

This type of calculation is probably the most frequent in everyday office routine.

First carry out the indicated division with the upper scales. Don't trouble to read the result — it's of no interest — but follow up with the multiplication by simply running the cursor over to 5.45 on T1 or T2. The answer 4.05 then appears under the hairline on the adjacent scales Z or KZ.

Application of a so-called rule-of-three problem in practice:

If 50 lbs. of a commodity are worth \$ 8.50
then 35 lbs. would work out at \$ 5.95

as derived from the notation $\frac{8.50 \times 35}{50} = 5.95$

When a problem contains several factors in both het numerator and the denominator, solve by alternate division and multiplication.

For Example:

$$\frac{6.5 \times 5.45}{8.75 \times 3.0} = 1.350$$

The first two steps are as shown in Fig. 16. The division by 3.0 is then performed by drawing 3 of the slide scale T1 or T2, respectively, under the hairline. The answer is found on the body scale opposite the slide index.

8. Proportion

While the above rule-of-three solution is the orthodox form given in textbooks on business arithmetic which usually deal with longhand computation exclusively, it is much better for slide rule work to formulate the problem in proportion form, thus:

$$\frac{\text{lbs.}}{\$} = \frac{50}{8.50} = \frac{35}{5.95} = \frac{42}{7.13} = \frac{100}{17.00} \text{ and so on.}$$

Note how in this fractional form of notation all price/weight relations stand out clearly and in logical order.

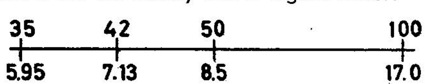

Fig. 17 Proportion

The known ratio in the problem is

50 lbs. are worth \$ 8.50

Set these values opposite each other. In the next step or steps you only have to be careful that you do not cross scales but keep strictly to the order in which you have arranged the original ratio. Observe how, with but one adjustment of the slide rule, you can read the answers to as many problems of the same weight/price relations as may be required by simple successive moves of the cursor.

By the way, whether you start with the ratio set 8.50 ÷ 50 or, the other way around, 50 ÷ 8.50, and whether you start with the scale pair KZ/T2 or Z/T1 is immaterial as long as you keep on the proper track in taking the readings.

9. Use of the Reciprocal Scale P

From your school days you will recall your first encounter with the reciprocal of a number. A pretentious word for what actually is quite a simple branch of arithmetic. In slide rule manipulation you will probably experience its first practical application. How useful and time-saving reciprocals are you will see:

The reciprocal of 5 (or 5 ÷ 1 in another form of notation) is 1 ÷ 5 = 0.2.
The reciprocal of 4 (or 4 ÷ 1 in another form of notation) is 1 ÷ 4 = 0.25.

Look at the slide scales labeled T1 and P or P1. Note how each number faces its reciprocal. Opposite 5 find 0.2 and opposite 4 read 0.25, naturally, as always in slide rule language, without revealing the decimal point. Similarly, the P2 scale of models 955 and 965 supplies the reciprocals of numbers on T2. The T and P scales are duplicates of each other, except that their graduations advance in opposite directions. The P scales count from right to left. Be careful! As a safeguard against reading errors the P scales are finished in green colour throughout or only the numeration is in green print.

The value of this arrangement is best explained by reference to the nature of common fractions

$$\frac{4}{5} \text{ gives the same as } 4 \times \frac{1}{5}$$

$$\text{and } 4 \times 5 \quad ,, \quad ,, \quad ,, \quad ,, \; 4 \div \frac{1}{5}$$

It follows that when the scale P1 (P) is used together with the scale Z (or scale P2 is used together with the scale KZ on Nos. 955 and 965) the effect is that the same mechanical operation involved in multiplication with T1/Z or T2/KZ in this case achieves a division and vice versa. It will not take you long to realize through practice how this, in slide rule work, often means fewer slide movements and greater accuracy, too. For better understanding of reciprocals at work consider that at the end of a division by slide rule the answer always appears opposite one of the indexes and the slide is therefore set in readiness for any subsequent multiplication. Thus, the P scales can simplify computations when there are several factors in the denominator or in the numerator.

Example 1: $\frac{15.3}{2.24 \times 5.3} = \frac{15.3}{2.24} \times \frac{1}{5.3} = 1.29$

Rough check for locating the decimal point: $\frac{15}{2 \times 5} = 1.5.$

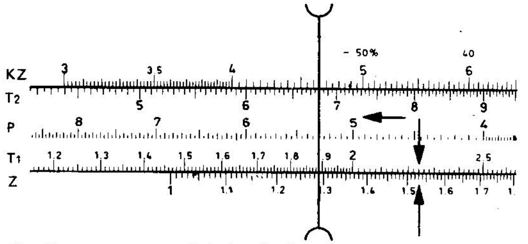

Fig. 18 Solution by P scale

In this case do the division $15.3 \div 2.24$ as usual, then multiply by 1/5.3 by setting the hairline to 5.3 on P or P1 resp. The answer is found under the hairline on Z. It is worth-while exercise for owners of the model 955 or 965 to repeat this example with the upper group of scales. Note how the answer 1.29 then also appears opposite 5.3 of P2 on KZ.

Example 2:

An export shipment consists of 13 cases each $2.3 \times 4.5 \times 6.3$ft. Find the cubic measurement. This is a simple case of multiplication with 4 factors $13 \times 2.3 \times 4.5 \times 6.3$ or written for the slide rule as follows

$$\frac{13}{1/2.3} \times \frac{4.5}{1/6.3} = 848 \text{ cu. ft.}$$

Thus the problem is now stated in the form of combined multiplication and division (Chapter 7) in which the two divisions are done with either P1 or P2. When the problem is changed to

$$13 \times 2.3 \times 2.5 \times 6.3 = 4.72$$

the above method seems inapplicable, because the factor 2.5 can only be set on the T2 scale. Here we have a case where the advantage of the models ARISTO Commerce I and II manifests itself by reason of their extra reciprocal scale P2 which operates in conjunction with KZ and T2. So, when the intermediate product of

$$13 \times 2.3 \times 2.5 = 74.7$$

appears on the KZ scale, the fourth factor 6.3 can be directly set with the P2 scale and the result 472 appears on KZ opposite the index of T2.

But owners of an ARISTO School Commerce or a pocket model (having only one reciprocal scale) can easily adapt such problems to the pattern of their scales. Resetting the slide is a trick that always works. In the changed problem simply draw the 1 of the T2 scale under the hairline and perform the multiplication by 6.3 as usual. It is also possible to solve with the reciprocal scale P by placing the factor 6.3 under the hairline, already located over 74.7 on KZ and reading the answer opposite 1 of P on the KZ scale. This latter form of solution, however, is only

recommended to those users who have learned all the ins and outs of slide rule technique.

In cases like the above it is much simpler to reverse the order of the factors 2.5 and 6.3 in order to avoid such difficulties altogether. After a little practical experience you will do this intuitively.

It is worth-while working out this example several times with changed settings and counting the number of movements involved. Do this first with the Z and T1 scales alone, then with Z, T1 and P combined, next with the upper group of scales and finally, with all scales together. This is a good way to acquire proficiency in the use of the various scales, to gain a clear insight into the procedures and a quick grasp of the easiest approach to the solution.

10. The Principle of Proportion Applied in Practice

10.1 Conversions Between British/US and Metric Units

The M scale contains a series of marks for converting weights and measurements expressed in British/US units to metric equivalents, and vice versa. These marks are labeled in abridged form. The following table gives the complete spelling and the unit conversion factors. (Commerce I and II supplemented by C-Tablet. See Chapter 14).

	1 lg. ton	(long ton)	= 1.016 t
**	1 oc. ton	(ocean ton)	= 1.1327 m^3
*	1 Brit. qt.	(quart)	= 1.1365 l
	1 mile	(statute mile)	= 1.609 km
	1 cu. in.	(cubic inch)	= 16.39 cm^3
	1 in.	(inch)	= 2.540 cm
*	1 U. S. qr.	(quarter)	= 0.2819 m^3
	1 cu. ft.	(cubic foot)	= 28.32 dm^3
	1 oz.	(ounze)	= 28.35 g
*	1 Brit. qr.	(quarter)	= 0.2909 m^3
	1 ft.	(foot)	= 30,48 cm
	1 U. S. bsh.	(bushel)	= 35.24 dm^3
**	1 Brit. bsh.	(bushel)	= 36.3687 dm^3
	1 U. S. gal.	(gallon)	= 3.785 l
*	1 acre		= 40.4684 a
*	1 U. S. cwt.	(hundredweight)	= 45.3592 kg
	1 lb.	(pound)	= 0.4536 kg
	1 Brit. gal.	(gallon)	= 4.546 l
	1 Brit. cwt.	(hundredweight)	= 50.80 kg
	1 sq. in.	(square inch)	= 6.45 cm^2
	1 cu. yd.	(cubic yard)	= 0.7646 m^3
	1 sq. yd.	(square yard)	= 0.8361 m^2
*	1 sht. ton.	(short ton)	= 0.9072 t
	1 yd.	(yard)	= 0.9144 m
	1 sq. ft.	(square foot)	= 0.0929 m^2
*	1 U. S. qt.	(quart)	= 0.9464 l

* Marks omitted on the School-Commerce and the pocket model.

** Marks omitted only on the School-Commerce.

When, for example, the cursor is set to the mark "ft.", scale Z gives the metric equivalent 30.48 cm.

Example 1:

To find the equivalent of 19 lbs. in kg.
The lb. mark represents the parity 1 lb. = 0.454 kg.
Hence 19 lbs. = 19 × 0.454 = 8.63 kg.

With the cursor hair over the "lb" mark and the index of T1 drawn into line your slide rule is now a conversion table for reading off any and all equivalences. This is so because you have set the ratio

$$\frac{1\ \text{lb.}}{0.454\ \text{kg}} \text{ hence opposite each other } \frac{19\ \text{lbs.}}{8.63\ \text{kg}}$$

and whatever further quantity relation you may wish to find. By reading in the inverse direction you can, of course, also convert kg to lbs. As you will see, the left index of Z is opposite 2.21 on T1, showing 1 kg equals 2.21 lbs., and so on.

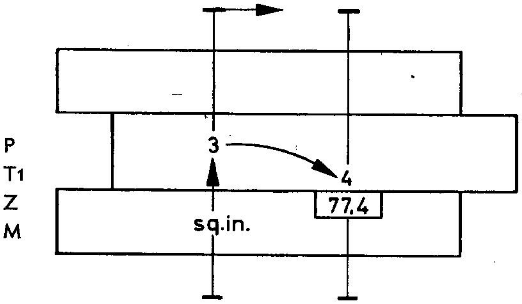

Fig. 19 3″ × 4″ = 77.4 cm²

Example 2:

Conversion of an area 3 in. × 4 in. to sq. cm. Since the M scale has a permanent mark for 1 sq. inch = 6.45 sq. cm, the solution is as shown in Fig. 19 3×4×6.45=77.4 sq. cm.

Here the reciprocal scale enters into the picture. Simply set 3 of the P scale to the "sq. in." mark. Under 4 of T1 then read 77.4 sq. cm.!

In the process of converting an area 3 cm × 4 cm to sq. in. it is a little more tricky to find the speediest solution because we only have a mark for converting sq. in. to sq. cm. The required factor for translating sq. cm. into sq. in. is the reciprocal value of the sq. in. mark. The formula is:

Area in sq. in. $= 3 \times 4 \times \frac{1}{\text{sq.in.mark}}$. The details of this equation stand out more clearly when written in proportion form:

$$\frac{3}{\text{sq. in. mark}} = \frac{\text{Area in sq. in.}}{4}$$

Fig. 20 outlines this solution.

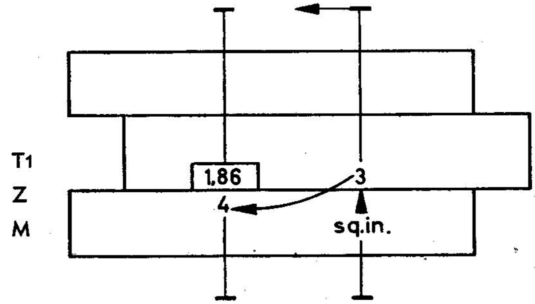

Fig. 20 3 cm × 4 cm = 1.86 sq. in.

10.2 Foreign Exchange

Conversions between two currencies are treated as problems in proportion or tabulations.

If the rate of exchange is given, as in US $ 1.— = DM 4,20, and the two values are set facing each other, the rule is in tabulating position for reading each and every amount of one currency in terms of the other.

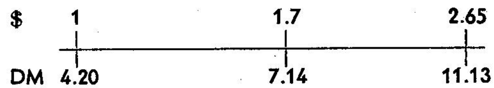

Fig. 21 Currency Conversions

The scales labeled £ and s./d. are used for converting amounts in shillings and pence to decimal fractions of 1 £. Facing each other there is the £ scale divided into decimal fractions of 1 £ and the s./d. scale divided into 20 parts for the shillings, each shilling interval beeing subdivided into 12 parts for the pence.

So, for instance:

£ 1.0 = s 20/—	s 18/8 = £ .934
£ .4 = s 8/—	s 9/3 = £ .4625
£ .425 = s 8/6	

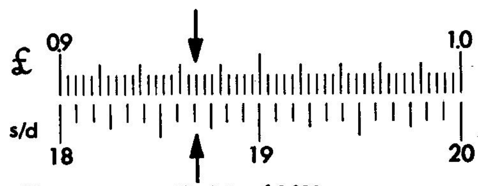

Fig. 22 18 s 8 d = £ 0.934

Example 1:

£ 16.10.— were changed and yielded Belg. Fr. 2312.—. What is the exchange rate for this transaction?

Convet to decimals £ 16.10.— = £ 16.5

$$\frac{\text{Belg. Fr.}}{£} = \frac{2312}{16.5} = \frac{140.10}{1} \quad £\,1 = \text{Belg. Fr. } 140.10$$

Example 2:

Scale M makes it easy to solve problems involving currencies as well as quantities or measurements in only one operation.

A certain commodity is quoted at £ 2.16.— per lb. How much then in DM per kg at exchange of £ 1.— = DM 11,75? First find the decimal equivalent of £ 2.16.0 = £ 2.80.

Set the cursor to the lb. mark and bring the exchange rate 11.75 under the hairline. The rule is now in the tabulating position £/lb.: DM/kg. So below 2.8 on KZ you instantly have the price DM 72,50 per 1 kg on the T2 scale. In this solution we have actually solved by working out

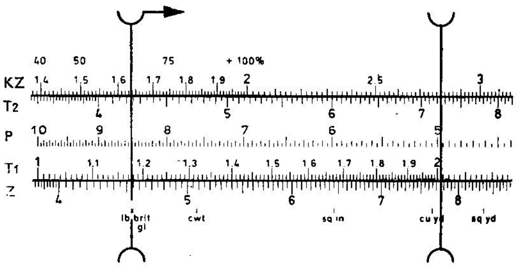

Fig. 23 $\frac{11.75}{\text{lb. mark}} = \frac{72.50}{2.8}$

$\frac{2.8 \times 11.75}{0.454} = 72.50$ but by use of the more practical proportion form

$$\frac{11.75}{\text{lb. mark}} = \frac{72.50}{2.8}$$

or, stated in formula form for all problems of this type:

$$\frac{\text{Exchange Rate}}{\text{Weight or Measurement M.}} = \frac{\text{Price in One Currency}}{\text{Price in the Other Currency}}$$

Example 3:

A certain grade of cocoa beans is offered at s 350/— per cwt. of 112 lbs. and the Sterling exchange is £ 1 = DM 11,75, i. e. s 1/— = DM 0,588. After aligning the mark Brit. cwt. to the exchange relation 0.588 read the price DM 405,50 per 100 kg opposite the given market price of s 350/—.

Note for those businessmen who can recall their college mathematics and know how to use logarithms: The £ scale may be regarded as a table of logarithms for reading the mantissas of numbers located on Z. Useful for raising numbers to any power and extracting roots to any index.

10.3 Percentages

A manufacturer offers his products to the trade at list prices less 45% discount. How much does the discount amount to on an item listed at $ 14.50 and what is the net price. The usual longhand approach to this problem is by reasoning that, if 1% is one hundredth part of the price, or 0.145, then 45% is 45 × 0.145 = 6.52. In slide rule work we again use the convenient proportion principle to formulate the problem:

$$\frac{\%}{\$} = \frac{100\%}{\$\,14.50} = \frac{45\%}{\$\,6.52}$$

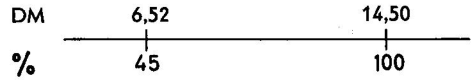

Fig. 24

Hence the net price is 14.50 less 6.52 = $ 7.98.

With the above type of setting we can also determine what percentage one value is of another. For percentages in business practice the slide rule answer is always adequate since the rates contain only a few digits.

10.4 Percentages Added and Deducted

Let's use the above simple problem once more to show how we can arrive at the final net price in only one operation i. e. without deduction of the discount amount from the gross price. Let's inversely apply this to finding the gross price after adding the same percentage of 45% to the net price. By the previous process we should have to find the amount of increase or decrease first and then make the respective addition or deduction. We can change this to a simple problem in multiplication by assigning 100% to the base value, adding or subtracting the percentage: 100 + 45 = 145 or 100 — 45 = 55. This means multiplying the base value by 1.45 or 0.55, to get the new value directly.

To make matter still more simple the KZ scale has percentage marks ranging from minus 50% to plus 100%. In our example set 14.50 on the T2 scale under 0%, then shift the cursor to — 45% and find 7.98 below this place on T2 (Fig. 25).

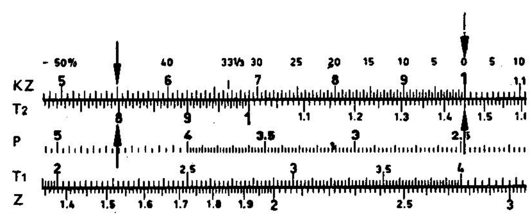

Fig. 25 $ 14.50 less 45% = $ 7.98

This is a short cut method for obtaining all net prices after deducting 45% from the list price because, if we make the setting: Index 1 of T2 below — 45% (that is list price

$ 100.— opposite net price $ 55.—) then all relations whatever of list price to net price can be read off by simply passing the cursor along the scales, e. g. $ 14.50 and $ 7.98, $ 20.— and $ 11.— (Fig. 26).

Very often list prices are subject to further special discounts and cash discounts, also discounts and advances mixed. In these cases it is best to use the scale T2 to reduce the various successive percentages to one final percent factor for multiplier. This method is recommended when

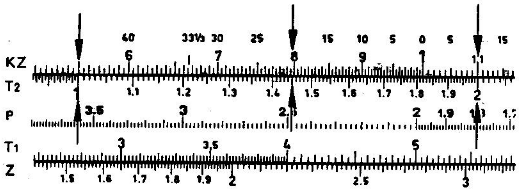

Fig. 26

many items have to be subjected to the same set of percentages. First take a look at the percent rates printed on the KZ scale above its normal graduation. Note how along the latter the intervals total 10% from one printed numeral to the next. So by counting off on the intervening lines you can easily locate each and every percentage besides those actually marked for convenience. This percentage-count is, of course, applicable to the other scales, particularly when using the T2 scale for the percentages as in the next example.

Let us now use the previous example but with an extra discount of 5% and 3% cash discount off the list price. Set the index of T2 under the list price $ 14.50 on KZ and with the cursor count leftward on the T2 scale until you have reached — 45%. This place is the line 55 and opposite the same you will find the value $ 7.98 on KZ. But you need not take any reading! Simply bring the index of T2 under the hairline and count off another 5 units leftward on T2 by use of the cursor, ignoring the answer again. Repeat drawing the index of T2 under the hairline and moving the cursor leftward, this time by 3 units. Your final answer $ 7.35 now appears on KZ. If you have to find the net prices corresponding to other gross prices in the list it is now only necessary to set the list price 14.50 under the value 7.35 so found and you have a table for the relation

$$\frac{\$\ 7.35}{\$\ 14.50} = \frac{\text{Net price}}{\text{List price}} = \frac{\$\ 14.10}{\$\ 27.80}\ \text{etc.}$$

Fig. 27

Note: The multiplier 0.507 appears over the index of scale T2.

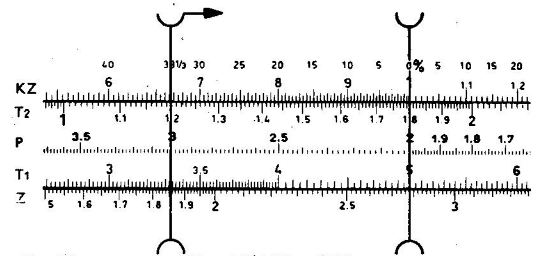

Fig. 28 ? less 33¹/₃% = $ 12.—

Another type of problem is that of determining the gross prices for articles on which a specified discount can be allowed to the trade to yield certain net prices to the seller.

Example:

An article must bring the seller $ 12.— net. Find the gross price at which it has to be invoiced to the trade subject to 33¹/₃% of discount (Fig. 28).

The known values are set: $ 12.— under minus 33¹/₃% mark. The gross price is found under the 0% mark and is $ 18.00. Reading the scales in reversed order would give $ 18.— less 33¹/₃% = $ 12.— as in the previous case. The profit added to the net price is 50% as can be checked by setting $ 12.— under the 0% mark and reading plus 50% over $ 18.—.

10.5 Percentages of Profit and Loss

In a manner similar to the above the margin of profit or loss in percents can be determined from the given cost and sale prices.

Example 1:

Goods bought for $ 7.— were sold for $ 8.75. Find the percentage of gross profit. In this case the purchase price is set below the 0% mark. Over 8.75 then read + 25%. If the selling price were $ 5.95 you would obtain the reading — 15%.

Example 2:

1750 cwt. of sugar were produced from 11,250 cwt. of beets. The yield is 15.55% as found by 11,250 cwt. = 100% (Fig. 29).

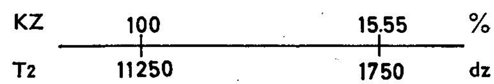

Fig. 29

11. Simple Interest

In business practice interest is usually computed on the basis of 360 days to a year or 30 days to a month. The graduations of the KZ and T2 scales are laterally displaced in respect of Z and T1 by the value 360. Over the index of Z and T1 you find the permanent setting 36 on KZ and T2.

This means that, whatever the value located in scales Z/T1 you can immediately read the result of its multiplication by 36, in slide rule practice also readable as 360, on scales KZ/T2. In the same manner by switching from KZ/T2 to Z/T1 the division by 360 is performed automatically. The advantage of this feature in interest computations will be appreciated after getting to the examples in this chapter

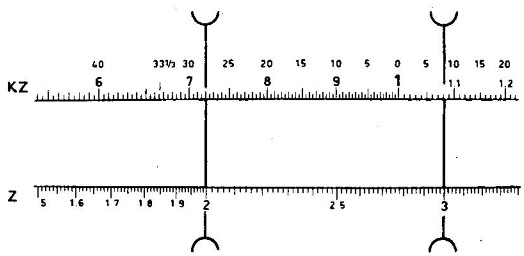

Fig. 30 $720 \div 360 = 2$ $108 \div 360 = 0.3$

In cases where the bankers' method of computing on the basis of 365 days to a year is prescribed a special cursor can be provided without change of the procedures explained hereunder.

This valuable feature in the set up of the scales saves one step in every interest computation which is easy to understand by taking a look at the well-known formula:

$$I = \frac{P \times i \times n}{100 \times 360}$$

where I = Interest
P = Principal
i = Rate of interest
n = Number of days

Example:

Find the interest on a principal of \$ 1800.— at 4% for 290 days.

Set the cursor to the principal \$ 1800.— on the KZ scale and draw the interest rate 4% on the reciprocal scale P or P1 resp. under the hairline. The latter movement already includes the division by 360 for all readings taken on KZ/T2, or, respectively, Z/T1 against the given number of days. Thus, by moving the cursor to 290 days on T1, the Z scale will answer: interest amount \$ 58.—. For 400 days you will get \$ 80.—. For 65 days simply switch to T2 and read the answer \$ 13.— on KZ.

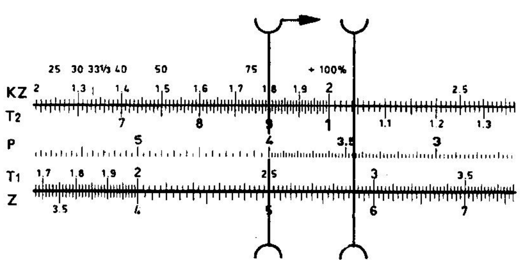

Fig. 31 $\frac{1800 \times 4 \times 290}{100 \times 360} = 58$

Analogously, too, the principal or the interest rate can be found by setting the respective pair of given values viz. Principal/Rate or Time/Interest Amount, opposite each other on the appropriate scales. When, for instance, the interest rate is to be found the computation starts with setting the number of days opposite the interest amount, the interest rate can be read on the P scale under the principal.

11.1 Bank Discount

The above discussed principles also apply in the discounting of bills or promissory notes which is merely another kind of interest computation. Interest is an additive quantity, discount is deductive. A bill for \$ 940.— maturing on Oct. 1st sold on Sept. 1st at discount rate of $4^1/_2$%. Find the proceeds.

The discount amount is found by the same process as that applied to interest. The cash value of the bill then is \$ 940.— less \$ 3.53 = \$ 936.47.

11.2 Compound Interest (only for No. 965)

An original principal P accumulates in a term of n years to a compound amount $S = P \times q^n$. In this equation q^n is called the growth factor derived from $q^n = \left(1 + \frac{i}{100}\right)^n$, where i is the rate of interest.

With the slide rule the growth factor can be read off directly for any percentage of i and any number of years n from the triple scale ZZ1, ZZ2, ZZ3 on the rear face of the slide. Turn the slide back to front. Locate on ZZ1 the value of $q = \left(1 + \frac{i}{100}\right)$ (which is the growth factor for the first year) and match it to the index 1 or 10 of Z. The growth factor q^n for any number of n years is determined by shifting the cursor to the respective term of years on the Z scale and taking the reading from ZZ. In order to make the first setting easier an auxiliary scale ZZ% is provided which shows the setting of $q = 1 + \frac{i}{100}$ for a variety of percentages i.

Since the growth factor q^n increases proportionately to any increase in the interest rate i and extension of the time interval n, it may have to be taken from either ZZ1, ZZ2 or ZZ3, depending on the magnitude of the given original figures. The ZZ scales are really not three separate scales but one continuous scale in three sections. The procedure is best explained by working out a few sample problems.

In the case of a 2% interest rate place 2 on the ZZ% scale $\left(\text{or } 1 + \frac{2}{100} = 1.02 \text{ on scale ZZ1}\right)$ over the left index of the Z scale. Now you can read off the growth factor on the ZZ1 scale for any number of years 1 to 5 on Z. To find this factor for more than 5 years reset the slide i. e. place the 2 of ZZ% over the right index. In this case we read the growth factor for 5 up to 10 years on ZZ2 because it is the extension of ZZ1. No alert computer would make the mistake of reading the wrong scale because he would there get a growth factor lower even than that for one year.

Example 1:
$i = 2\%$, $n = 2^1/_2$ years.
Growth factor $q^n = 1.0508$. The slide rule has solved automatically $1.02^{2.5} = 1.0508$.

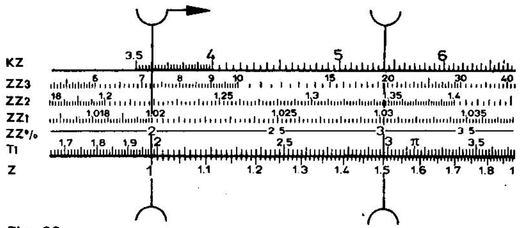

Fig. 32

Example 2:
$ 4500.— are invested at $3^1/_2\%$ annually compounded. Find the amount to which the principal accumulates in 8 years. Place 3.5 of ZZ% over the right index of Z. Shift the cursor to 8 on Z and read the growth factor $q^n = 1.035^8 = 1.317$ on ZZ2.
Hence the compound amount:
$S = P \times q^n = 4500 \times 1.317 =$ $ 5927.—. The indicated multiplication is of course carried out with the fundamental scales T1 and Z.
The growth factor may also be regarded as the ratio prevailing between the original principal and the compound amount. When found and thereafter set on the Z scale with the index of T1 scale we have achieved a table of equivalents for any further given capital invested at the same rate and for the same term.

Example 3:
$i = 4^1/_4\%$ and $n = 12$ years gives $q^{12} = 1.647$. The value 4.25 is not marked on the ZZ% scale, hence we must set 1.0425 of ZZ1 (Fig. 33).

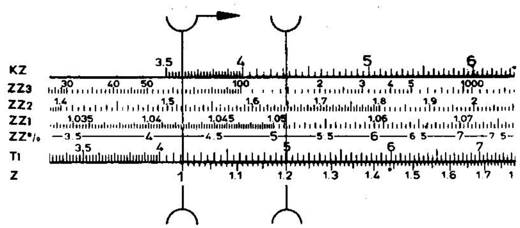

Fig. 33

12. Example of a Practical Business Calculation

Only simple examples have purposely been used in the preceeding text so that the learner may easily follow and check the steps to the final answer. We shall now review a practical example in order to demonstrate the versatility of the ARISTO Slide Rules in dealing with complex problems.

An export merchant has to work out a CIF-Angola quotation in Escudos per one gross of ball point pens, imitation jewellery, or whatever the article may be. The manufacturers' price list is in US $ per 100 units, FOB port of shipment, subject to 6% advance and 45% discount. To be included: 15% profit and agent's commission and 3.5% for CIF charges. The rate of exchange is $ 0.035 to 1 Escudo.

It would be senseless to work out the Escudo price separately for each of the required items. The fact is that at the end of the first of such calculations we could at once read the price in Escudos for a nominal list price of $ 1.—, which is then the basis price, and any other end price could also be instantly read, the slide rule being adjusted to tabulating position. This basis ratio (Dollars per 100 FOB: Escudos per gross CIF) is known as the "general multiplier".

The customary practice is to start with computing the general multiplier from an assumed list price of $ 1.—, as follows: $ 1.— plus 6% advance gives 1.06 in scale KZ. Deduct the 45% discount by placing 55 (100% less 45%) of the P scale (P1) under this value. Then over the front index 1 of the T1 scale (or 10 of the P scale) you find the net price on KZ. Don't bother to read this and all other intermediate results! Leave the slide undisturbed and move the cursor to 85 on P and find the answer on KZ (selling price including 15% profit and commission on the selling price). Add thereto 3.5% for CIF charges by placing the 1 of T1 under the cursor hair to 1.035 (100% plus 3.5%) on this same scale. This gives the between-price per 100 units under the hairline on KZ. Since the CIF price is required per gross (144 units) instead of 100 units, return the 1 of T1 to the hairline and then move the cursor along T1 to the value 144 to obtain the price per one gross in Dollars on KZ. Finally convert this figure into Escudos, dividing the same by 0.035 through drawing 35 of T2 under the hairline. The final answer 29.2 (Escudos 29.20 per gross CIF) is read on Z (and KZ) opposite the index 1 of T1 (and 1 of T2). The slide is now already in tabulating position and the Escudo price for each and every catalog item can be instantly read against the list price in Dollars.

$$\frac{\text{List Price US \$}}{\text{Selling Price Escudos}} = \frac{1}{29.2} = \frac{33.34}{973} = \frac{35.84}{1048} = \frac{37.26}{1089} = \frac{42.39}{1238} \text{ etc.}$$

A still more elegant form of solution is possible with the ARISTO Commerce I and II which contain an extra scale P2 as the reciprocal of T2. Since owners of these models will meanwhile have gained a clear insight into the advantages accruing from this feature, it will hardly be necessary to demonstrate the solution in detail, since they will easily find out how the answer can be obtained with fewer steps.