INSTRUCTION MANUAL FOR

EMBLEM SERIES

SLIDE RULE

PATTERN 1071

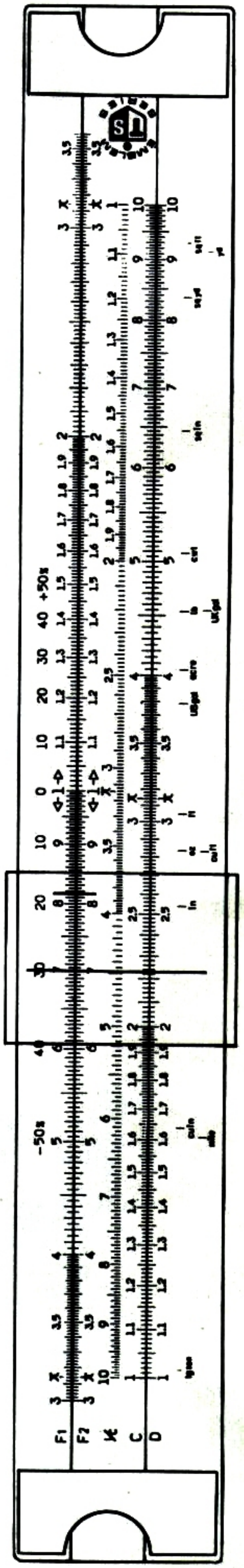
SCALE ARRANGEMENT OF THE EMBLEM COMMERCIAL RULE NO. 1071

Upper body panel: Scale of percentage Mark up or Discount
F_1 Fundamental scale folded at

Slide: F_2 Fundamental scale folded at
1/C Fundamental scale of reciprocals
C Fundamental scale

Lower body panel: D Fundamental scale
Range of gauge marks for conversion between Imperial and Metric units.

Back of rule: Conversion scale, Decimal £ to shillings and pence.



USING YOUR SLIDE RULE

Sect. 1

INTRODUCTION

You now have a new companion – soon you will want your rule with you whenever and wherever you have figure work to do. Two things to remember: first, the slide rule is essentially simple and easy to master; second, that it deserves reasonable care – don't leave it in full sunshine for hours or on a hot radiator. Simple common sense care will ensure a lifetimes service from the model you have.

Sect. 2

THE PARTS OF THE SLIDE RULE

The rule consists of three parts:

1. The stock or body.
2. The slide, which moves freely in a groove in the stock.
3. The cursor – a device to aid scale reading, which slides over the whole length of the stock. The face of the cursor has one or more hairlines scored into it, to simplify lining up or reading off values from the scales.

Sect. 3

HOLDING THE RULE PROPERLY

Good habits lead to good work. From the beginning, hold your rule properly. As the illustration shows, the slide can be moved easily by pressure and counter pressure at its ends, enabling you to adjust its position to a nicety. If you hold the rule with pressure on the edges of the stock, you will tend to clamp the slide in the groove and will not achieve the smooth, easy motion needed for accurate setting. When the slide has been set, the cursor is moved as needed by lightly holding it between the forefinger and thumb, being careful not to twist it. Fig. 1.

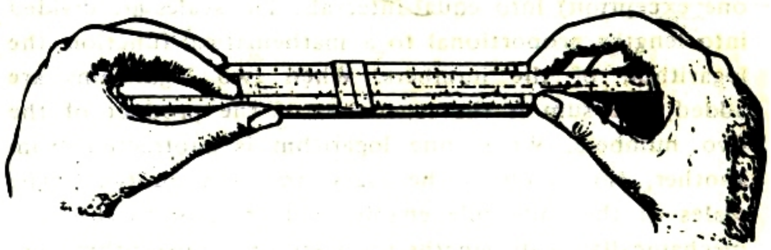


Fig. 1

Sect. 4

READING THE SCALES

The slide rule functions by adding – or subtracting – scale lengths, an activity made purely mechanical by the slide as it is moved to right or left in the stock. The whole art of slide rule competency lies in reading the scales and in this the key to proficiency is practice.

Whilst you may be familiar with logarithms, such knowledge is not essential to efficient slide rule manipulation. An understanding of the basis of the work will follow from an experiment you may care to make. Cut two strips of white card and draw on each a straight line of equal length. Carefully measure and number equal divisions or distances along each line – as shown in Fig. 2.

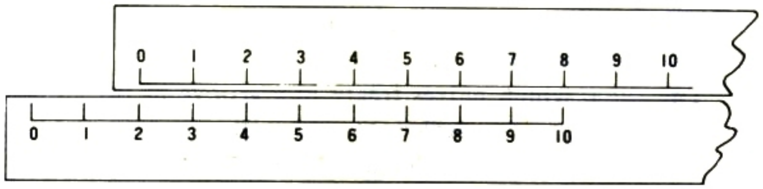


Fig. 2

Place the slips edge to edge. By sliding the uppermost scale so that its left hand end is opposite the figure 2 on the lower scale, you can read off the sums 2 + 3, 2 + 4, etc., by looking at the numbers on the lower scale immediately under the values 3, 4, etc., on the upper scale. Reversing the process of setting, i.e., by bringing a number on the upper scale, which you wish to subtract, over a number on the lower scale, the remainder can be read on the lower scale under the left hand end mark of the upper scale. Thus, you can mechanically add or subtract lengths of scale proportional to numbers and obtain sums or remainders, simply by adjusting the relative position of two identical scales.

The slide rule is not required to add or to subtract, however, and is not provided with scales divided (with one exception) into equal intervals. The scales are divided into lengths proportional to a mathematical function, the logarithm, of the numbers. When two logarithms are added, the sum is the logarithm of the product of the two numbers. When one logarithm is subtracted from another, the result is the logarithm of a quotient. The scales of the slide rule enable us to add or to subtract, mechanically, scale lengths proportional to logarithms and thus to achieve multiplication or division.

Sect. 5

RECOGNISING THE SCALES

Take up your slide rule and examine the scales on the face. You will note that each is identified by a letter. Reading from top to bottom, we have:

Percentage scale Folded scale F_1	on the upper panel of the stock
Folded scale F_2 Reciprocal scale 1/C Fundamental scale	on the slide
Fundamental scale D	on the lower panel of the stock

At the bottom of the lower panel, beneath the D scale, will be seen a series of gauge marks. The purpose of these, together with an explanation of all scales and examples of their use, will follow.

For the moment, you should ignore all scales other than scales C and D. These are known as the fundamental scales since all the rest are related to them. If you line up the scales, moving the slide if need be, so that the figure 1 at the left hand end of scale C is over 1 on scale D, you will see that scales C and D are identically divided and figured.

Before we examine the method of subdivision of the intervals on scales C/D, let us confirm by trial with simple numbers that scales C/D will multiply or divide numbers.

The left hand end of scales C/D is figured 1, 1.1, 1.2, ... etc. Between the figured graduations are shorter marks dividing each space into 10. supose we wish to multiply 1.3 x 1.2. Bring the mark 1 (which we shall in future call the left hand index, l.h.i.) of C immediately over the numbered graduation 1.3 on D. Next move the cursor until the hairline is over the figure 1.2 on scale C. Then, on scale D under the hairline we can read the product 1.56. (Figured mark 1.5 plus 6 of the smaller spaces). Fig. 3.

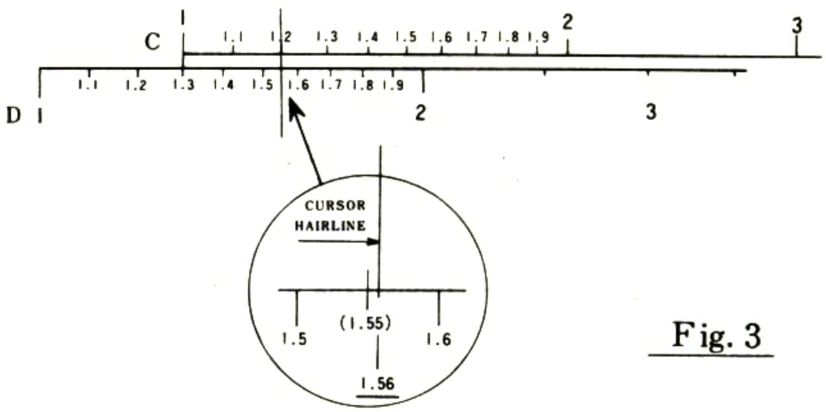


Fig. 3

We have obtained the value of the product 1.3 x 1.2 by adding to scale length 1.3 on D another scale length 1.2 on C and noting the value of the sum of the two lengths, i.e., 1.56 on scale D.

Clearly, the reverse process, setting length 1.2 on C over 1.56 on D, will permit us to subtract one length from the other and achieve division.

Sect. 6

PATTERN OF SCALE DIVISION

Scales C and D, between the larger figures 1 and 2, are divided into ten secondary intervals, numbered progressively. Each secondary interval is re-divided into ten parts. We can thus, by counting off these tertiary marks, obtain the second decimal place in a number – as in 1.56, Fig. 3. Finally, with practice, the third decimal place can be estimated visually, aided by the cursor hairline.

The main intervals 2 – 3, 3 – 4 are shorter than the interval 1 – 2 and the pattern of division is modified to avoid the confusion of marks too close together. The intervals 2 – 3, 3 – 4 are each divided into 10 secondary intervals – with a slightly longer line 2·5, 3·5. In turn these intervals are each divided, this time into five tertiary intervals – a short line marking a scale length of value 2 units in the second place. Thus, the even numbers 2, 4, 6, 8 are marked by lines. Halfway between any pair of such tertiary marks is the location of the odd numbers, 3 5 7 9. See figure 4.

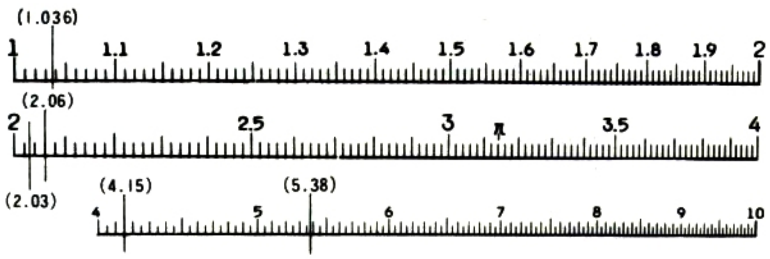


Fig. 4

In the remainder of the scale, 4 – 5, 5 – 6 to 9 – 10, a third method of subdivision is used. Ten secondary intervals are each divided into two parts and it follows that the marks represent the value 5 in the second decimal place. Further subdivision by eye (cursor aided) is obviously possible, even though the width of all intervals decreases progressively from left to right. Fig. 4 makes clear the setting of numbers in the range 2 – 4, 4 – 10.

Sect. 7

MULTIPLICATION AND DIVISION – SCALES C/D

The examples so far given have been simple illustrations of the pattern of scale graduation. The uses of the scales will follow from more typical examples of slide rule calculations.

First, however, it must be understood that the figures in the C/D scales are independent of the decimal point, although by tradition many makers put in the decimal point in the interval 1 – 2 on scales C/D (and, as in the present case, at graduations 2·5 and 3·5). However, make it your habit to read values as a simple sequence of digits e.g., read one-five-four and not one hundred and fiftyfour. Be especially careful when reading values in the range 1 -1·1 at the left hand end of scales C/D – do not omit the zero! See Fig. 4.

Locating the decimal point

'Standard Form' is the most certain method of locating the position of the decimal point in slide rule work. It is also most helpful in making approximations when doing any figure work.

Since, in the decimal system, we can multiply by 10 by simply moving the decimal point one place to the right, or by 100 by moving it two places to the right; divide by 10 by moving the decimal marker one place to the left and so on, we can always write any number, large or small, with a convenient number of digits to the left of the decimal point, adding a term to indicate the powers of 10 involved in the change of form. Thus, we can write 5793 in the form 5.793×10^3, or write 0.0136 as 1.36×10^{-2}.

Suppose we want to find the value of the expression:

$$\frac{5.34 \times 786.2 \times 18.7}{36 \times 483}$$

This would involve much counting up of decimal places, did we multiply and divide the terms as they stand. We might well be doubtful at the end – is our answer 10 or 100 times too big or too small? If we used the slide rule, we should not know where to put the decimal point.

Take out the 10's factor for each of the terms and re-write the expression as:

$$\frac{5.34 \times 7.862 \times 10^2 \times 1.87 \times 10}{3.6 \times 10 \times 4.83 \times 10^2}$$

Obviously, we can cancel the tens and leave a more simple expression:

$$\frac{5.34 \times 7.862 \times 1.87}{3.6 \times 4.83}$$

But how does this help? We now have terms with only one whole digit before the decimal point. We can quickly and easily obtain an approximate answer by rounding off the figures:

$$\frac{5 \times 8 \times 2}{4 \times 5} = 4$$

This tells us at once the order of magnitude of our answer and the decimal point can be placed with confidence. We will work out the problem on the slide rule in section 9.

Examples:

1 2.76 x 3.35 Approximation 3 x 3 = 9
 Set cursor to 276 on D
 Bring left hand index of C to cursor hairline
 Move cursor to 335 on C
 Under cursor hairline read 9246 on D
 The approx. solution was 9, so final answer is 9.246

2 0.38 x 21.4 Approximation $\frac{20 \times 4}{10} = 8$
 Set 38 on D (with cursor)
 Bring left hand index of C to hairline
 Move cursor to 214 on D
 Under hairline read 813 on D
 Approximation was 8, so final answer is 8.13

3 2.6 x 5.4 Approximation: 3 x 5 = 15
 Set cursor to 26 on D

At once we have an apparent difficulty. If we bring the left hand index of C to the cursor, we cannot then read the required product on C, because slide scale C projects beyond the end of scale D at the right hand end of the rule. The difficulty is solved quickly and easily: instead of using the left hand index 1 of C, we use the right hand index, 10, of scale C. Step 2 of our work is, then:

 Bring the right hand index of C under the hairline
 Move cursor to 54 on C
 Under hairline read product 1404 on D

The approximation was 15, so final answer is 14.04

What we have done is to imagine a second D scale running on from the left hand index ,1, of D on the rule.

Did this scale exist, it would be found that the left hand index of C would be over the mark 26 and the calculation would proceed as in examples 1 and 2. Changing the index in the way described must often be done, but, as you have seen, it does not affect the calculation.

Division

Since division is the reverse of multiplication, you have probably thought out – or guessed – the method to use in division on the slide rule. To divide, on scales C/D, set the divisor on C over the dividend on D and read the quotient under the index of C, on D. Having learnt that changing the index of the slide does not affect the process of multiplication, you may reason, correctly, that in division with scales C/D, one or other of the index marks will be over the quotient required and that there is never need to change the index when dividing.

Example

4 $\frac{4.37}{3.2}$ Approximation: $4\frac{1}{2}/3 = 1\frac{1}{2}$
 Cursor to 437 on D
 Bring 32 on C under hairline
 Under left hand index of C read 1365 on D
 Approximation was $1\frac{1}{2}$, so final result is 1.365

Sect. 8

COMBINED MULTIPLICATION AND DIVISION

Expressions of the type $\frac{a \times b \times c \times d}{e \times f \times g}$ often arise and are easy to solve with the slide rule. Two simple rules will help:

1. Divide and multiply alternately, beginning with division
2. Take the factors in their order of size, as is usually possible, to reduce slide movement.

Exmaple Find the value of $\frac{5.24 \times 7.86 \times 1.87}{3.6 \times 4.83}$

5. Cursor to 524 on D
 Bring 36 under hairline
 Cursor to 187 on C
 Bring 483 on C under hairline
 Cursor to 7682 on C
 Under hairline read 443 on D
 Appproximation (see section 7) was 5
 So final result is 4.43

Sect. 9

SCALE OF RECIPROCALS CI (1/C)

This scale, on the slide immediately above the C scale, is an exact counterpart of scale C, arranged so that its graduations and figuring progress from right to left. Thus, for any value x found on scale C, we have over it on scale CI the value 1/x. The CI scale is used to reduce movement of the slide, particularly during the computation of expressions with several factors, e.g., combined multiplication and division, as illustrated by example 5. If we have a multiplier, x, we can if convenient obtain a product xy by dividing the other factor, y, by 1/x, locating 1/x on scale CI.

Example   Find value of 718 x 0.202 x 6.75

6 First use scales C/D, as already explained.

Cursor to 718 on D
Bring r.h.i. of C to cursor
Move cursor to 202 on C
Bring l.h.i. of C to cursor
Move cursor to 675 on C
Under hairline read 980 on D

Observe that at the second step the slide was moved about $1\frac{1}{2}$ inches. At the third step it was moved about 3 inches, making a total slide movement of about $4\frac{1}{2}$ inches.

Now re-work the example, using scales C/D and CI, this time solving the problem in the form 718 ÷ 1/0.202 x 675

Cursor to 718 on D
Bring 202 on CI under the hairline
Cursor to 675 on C
Under hairline read 980 on D

This invoves one slide movement only, about $1\frac{1}{2}$ inches. The approximate result is found by separating the 10's factors –giving 7.18 x 2.02 x 6.75 x 10^{2-1} which is seen to be, approximately, (7 x 2 x 7) x 10, or 980.

The scale of reciprocals is particularly useful when we have a constant factor to be multiplied or divided by a series of factors.

Example

7 Tabulate values of:

65 x 18.3   65 x 11.2   65 x 64   65÷2.9

Locate 65 on D with cursor
Bring r.h.i. of C to cursor
Cursor to 183 on C, read 119 on D
Cursor to 65 on D
Bring 11.2 on CI under hairline, read 728 on D
Cursor to 64 on C, read 4160 on D
Cursor to 2.9 on CI, read 224 on D

The location of the decimal point follows by approximation.

Sect. 10

PROPORTIONS AND TABULATION

The utility of the slide rule is nowhere more clearly shown than when problems of ratio and proportion are involved. When we move the slide so that the left or right hand index of scale C stands opposite any value, say x, on scale D, we at once establish an infinite number of pairs of values C:D in the ratio 1:x.

If, then, we have a series of weights in pounds to convert to their equivalents in kilogrammes, all we need to do is to set the basic ratio – 1 lb = 0.456 kg in the form 1 (or 10) on scale C over 0.456 on D. Using the cursor only, we can read off as many equivalents (conversions) as we please, finding lb values on C and kg immediately beneath, on D. Conversely, if we started with kilogrammes and required equivalent weights in lb, we should use the cursor to locate kg values on D and read lb under the hairline on scale C.

It may be necessary to re-set the slide. As will be seen later, this can be avoided by the use of the folded scales.

Example: Tabulate the equivalents, using scales C/D.

Given:	1	3.84	5.62	7.15	8.35	12.95
Required: kg	0.456	1.75	2.56	3.26	3.81	5.9

The rule is set as shown in Fig. 5 . The cursor is then moved successively over the given values in lb and the equivalent in kg read from scale D, under the hairline.

Many types of arithmetic problem can be written in the form of a ratio or proportion.

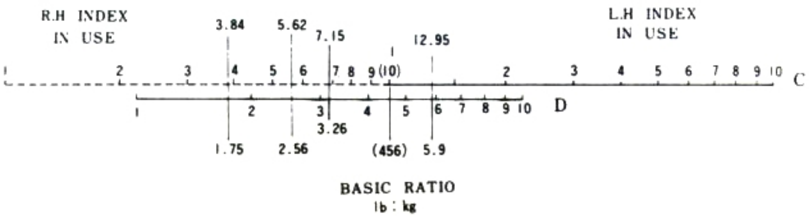


Fig. 5

Sect. 11

THE FOLDED SCALES, F_1, F_2

Scales F_1 and F_2 are identically divided and are, in fact, divided exactly as scales C and D. However, relative to the fundamental scales, F_1, F_2 are moved sideways by a distance equivalent to the scale length of π. The result is that we have on the left hand side of F_1, a counterpart of scale D between 3 and 10 (on D) and on the right hand side of F_1 the counterpart of the interval 1 to π of scale D. The value π on F_1 lines up with the left hand index of D and it follows that, because F_1 has been moved sideways – equivalent to moving the slide through the distance $(1 - \pi)$ on C, we can find by simple cursor movement the value π x x by bringing the cursor over x on D and reading the product π x under the hairline on F_1.

Convenient though this is, it is not the primary purpose of the folded scales. You will recall that sometimes, in multiplication, you found it necessary to change the slide index. The folded scales make such slide re-setting unnecessary.

At approximately the middle of scales F_1/F_2 is the centre index, 1. Suppose you have a series of values to be multiplied by 1.5. Bring the centre index 1 of scale F_2 under 1.5 on F_1 using scales C/D and, without moving the slide, find any product of 1.5 between 3 and 10, or 1 and 2.4, on scales F_1/F_2. In short, re-setting the slide need never bother you, if you begin your multiplication on scales F_1/F_2 and use these scales as the complements of scales C/D.

The utility of the folded scales is seen at once when dealing with problems involving several factors.

Example: $\frac{5.33 \times 0.735}{1.69}$ (Approx. 2.5)

If we set on scales C/D, for the first step, the division of 5.33 by 1.69, we at once find it necessary to re-set the slide to multiply by 0.735.
Set, instead, on F_1/F_2.

Bring 1.69 on F_2 under 5.33 on F_1
Cursor to 0.735 on C
Under hairline read 2.318 on D.

A further example: $\frac{5.78 \times 14.2}{0.386 \times \pi}$ (Approx. 70)

This is an interesting example. Check the following methods and note, in so doing, the total amount of slide movement for each process.

Method 1. Bring 386 on F_2 under 578 on F_1
(The intermediate result, which need not be read, appears on D under 1 on C and also on F_1 over the centre index of F_2)
Cursor to 142 on F_2
*Under hairline read 67.66 on D.

* Because any number on D is a value on F_1 divided by π.

Method 2. Bring index 1 of F_2 under 142 on F_1
Cursor to 578 on F_1
(Under hairline read result of division by on D)
Bring 386 on C under hairline
Read 67.66 on D under right hand index of C.

Method 3. Cursor to 142 on F_1
(Under hairline is 142 divided by π on D)
Bring 386 on C under hairline
Cursor to 578 on C
Read answer 67.66 on D under hairline.

These three solutions should teach you the value of the folded scales and also the benefits that flow from a careful inspection of a problem before setting the slide rule. So far as arithmetic is concerned, the order in which you take the factors is of no consequence. A proper choice of sequence can, with the aid of the folded scales, reduce significantly the amount of setting necessary.

Sect. 12

TABULATION, PROPORTIONS, RATIO – WITH FOLDED SCALES

You have noted the value of the slide rule in tabulating a series of pairs of numbers in a constant ratio or proporition. With scales C/D, slide re-setting was needed at times. Using scales C/D and F_1/F_2, and for preference beginning the work on the folded scales, one slide setting is enough and all pairs in the given ratio can be found with the cursor.

Example:

Yards.	1	1.3	2.2	3.7	6.8	7.4	11.6	14.6
Meters	0.914		2.01		6.21		10.6	13.34
		1.188		3.38		6.76		

Initial setting is 1 on F_2 under 0.914 on F_1. The cursor is then used to set yards on F_2 or C and the conversion read on F_1 or D, as convenient – the slide is not moved.

CONVERSION OF UNITS

The necessity to convert between British and Metric units of measurement is met by the provision, on your rule, of a series of gauge marks identified by English abbreviations and related to scale D. If the cursor is brought over the appropriate gauge mark the hairline will also lie over the conversion factor, on scale D. By setting the index of scale C to the hairline, the required ratio is set up. For example, over the gauge mark 1 mile is 1.61 (km), on scale D. If the index of C is now brought under the hairline, the equivalent in miles of any value in kilometers, read on C, is at once available on D – and vice versa.

Note: In certain cases, there is a difference between the British and the American unit of the same name e.g., Imp. gallon and U. S. gallon. Take care to use the appropriate gauge mark!

THE DECIMAL £ SCALE

On the back of the rule are two scales, fixed relative to each other. The upper scale is divided equally into 100 intervals, corresponding to the division of the £ into 100p. The lower scale is divided into shillings and pence. The scales enable you immediately to convert an amount in shillings and pence (old currency) to new pence as a decimal fraction of £1.

Sect. 13

SCALE FOR MARK UP AND DISCOUNT

Above the F_1 scale, centred at the index mark 1, is a scale running from centre to left, figured 0 to -50, and from centre to the right, figured 0 to +50%. The scale is referred to scale F_1.

The scale provides a ready means of reading the 'amount' when a known percentage discount or mark up is applied to a 'principal' sum.

Thus £80 + 15% = £92

Bring centre index 1 of F_2 under +15 of the percentage scale

Over 80 on F_2 read principal plus percentage, i.e. 92, on F_1.

£76 less a discount of 12½%.

Bring centre index of F_2 under -12½ on the percentage scale.

Over 76 on F_2 read 66.5 on F_1.

Sect. 14

AUXILIARY CURSOR LINE

If the main cursor line is moved to index 1 on D, then, with the slide in 'neutral' position – the index marks of scales C/D coincident- a short line on the cursor, to the right of the main hairline, will be seen over the folded scales F_1 and F_2.

The displacement of this line from the main ahirline is proportional to the value 36. If a value x is set on D with the main cursor line, we can read on F_1 the product 36x under the short auxiliary line.

The factor 36 is used to convert hours to second (1 hour = 3600 seconds). In financial calculations, it is common practice to reckon one year as 360 days and here the factor 36 is useful.

CONCLUSION

You have now explored all the scales on your rule and are aware of the wide ranging application of the scales to every-day problems in commercial work. Your task now is to use the rule as often as you can and to practise regularly so that, without difficulty, you set and read the scales accurately. Ten minutes each day for a few weeks will make you both efficient and really competent.

EMBLEM Rule Pattern 1071 was developed to solve, with the minimum of complication, the widest range of calculations arising in general commercial work. In special industries or in business in which calculations involving Compound Interest are frequent or technical problems must be solved, other patterns of rule will merit consideration. For example, with Compound Interest, Bill Discounting and like problems, a LogLog rule should be used. When proficient in the use of model 1071, you may feel that a more sophisticated pattern – by no means more difficult to use – would be of more help in your special area of interest. The chart on the inside of the back cover, giving details of the various scale arrangements available, will help you to make a good choice.

MEMO

MEMO

T/S EMBLEM CHART

		1051	1052	1053	1081	1091
		TUTOR	OLYMPIC	OLYMPIC LL	TECHLOG	EXECUTIVE
FRONT FACE		K DF	L K A	L K A	T_1 T_2 A	LL_{01} LL_{02} LL_{03} A
		CF CIF CI C	B CI C	B CI C	B BI CI C	B L K C
		D A	D S ST T	D S ST T	D P S ST	D LL_3 LL_2 LL_1
REVERSE FACE			CM	CM	LL_1 LL_2 LL_3 DF	T_2 T_1 ST DF
				S LL_2 LL_3	CF CIF CI C	CF CIF CI C
			INCH	INCH	D L K	D P S