CASTELL

SLIDE RULE 1/28

"Super-Business"

INSTRUCTIONS

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A New Commercial Slide-Rule Makes its Bow.

The "Business Model" of our Commercial Slide-Rule has awakened such widespread enthusiasm that it would be superfluous to set out in detail the manifold advantages which it offers or the reasons why it has been found necessary to provide the business-man with an instrument of this nature. For the progressively minded man of affairs it has become just as natural a part of his equipment as the Rietz rule for the engineer, craftsman and building expert.

The prejudices of those who felt that such a mysterious device could be mastered by none but the scientifically trained have long been overcome. Similarly, we are no longer faced with the problem of deciding which is to be preferred — the calculating-machine or the slide-rule. Each has its place, and any business-man who fails to avail himself of these most efficient instruments in order to make his task easier will soon come to see that their absence is a handicap.

The CASTELL 1/28 ("Super-Business") incorporates all the advantages of Model 1/22 ("Business"). In addition, however, it offers a number of further advantages which are worthy of note and which will prove particularly valuable to the business-man in the industrial sphere. Details will be given at a suitable point in this introductory booklet.

How Can a Calculating Rule Really Calculate?

To the uninitiated this appears to be something of a mystery. In reality, however, it is perfectly simple. Let us first of all consider the following facts:-

(1) The Slide Rule is divided up by "graduations". We are already familiar with such graduations. They are found on the barometer, the thermometer and the ordinary ruler as well. There is, however, a difference. The divisions formed by the graduation-marks hitherto known to us are all equal. Every centimetre, for instance, is divided into 10 mm, each of which is exactly the same size as the next. On the Slide Rule, however, the divisions become smaller as the numbers get bigger (that is to say, as we move from left to right along the main scales). (The problem of why this is so need not trouble us here. Let us merely mention in passing that it is governed by the laws of logarithmic calculation. A knowledge of these laws is of no interest to the practical user of the Slide Rule).

(2) Calculations can be made on an ordinary ruler as well. Fig. 1 shows two exactly similar rulers laid side by side in order to add 3.5 to 4.5 (= 8). The upper ruler has been displaced by the distance required for its initial gra-

duation-mark to come to rest above the "3.5" on the lower ruler. The answer ("8") can then be found on the lower ruler, underneath the "4.5" on the upper ruler.

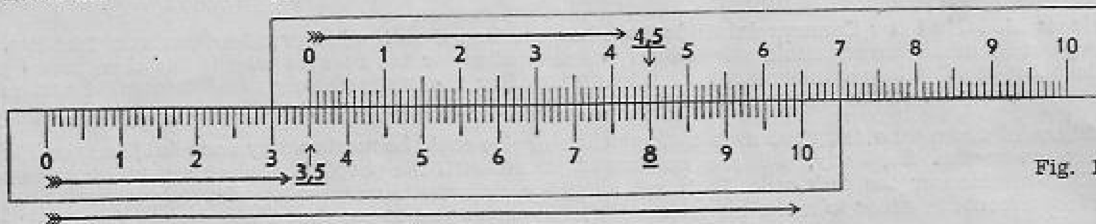


Fig. 1

Subtraction is carried out by the converse process. These possible methods of making calculations with ordinary rulers, however, are never used in practice, as the answers in such cases are arrived at far more quickly by simple mental arithmetic.

(3) The Slide Rule, too, consists of graduated parts, adjustable in relation to one another, as described above, and having additional properties enabling the user to multiply by using the process mentioned in connection with addition and to divide by using the converse process.

A Preliminary Summary of the Slide-Rule and its Elements

Of what does our Slide Rule consist and how is it divided up?

As a rough and ready description, we may say that it can be divided into three parts without "violence" (see Fig. 2):-

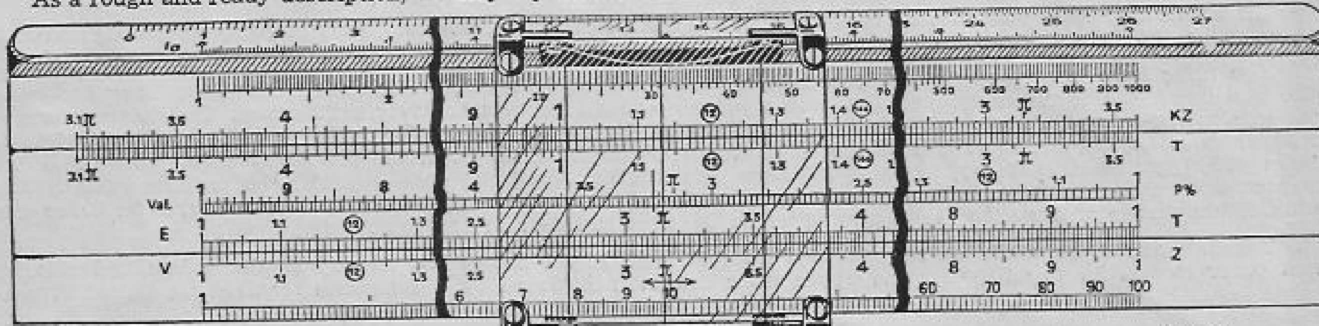


Fig. 2

(1) The **framework**, which we grasp when we pick the Slide Rule up or the **body of the Slide Rule.**

(2) The **slide**, which slides in the grooves of the body.

(3) The **cursor:** a metal-framed glass plate covering the entire width of the Rule and the Slide together.

The body of the rule and the slide are **graduated** as follows:-

(1) A scale in black graduations along the lower groove of the body (marked Int. at the right-hand end and S. P. at the left-hand end). It begins on the left with 1 and goes asfar as 10, which, however, is also written as "1." We term this scale the "lower body" and abbreviate it to **D.**

(2) A scale in red graduations along the lower edge of the Slide (marked D on the right and P. P. on the left). It coincides exactly with the scale **D** and is termed "lower slide-scale", abbreviated to **C.**

(3) A scale in green along the centre of the Slide. This also coincides with **D** and **C** but runs in the opposite direction. We call the "centre slide-scale" **Cr.** It is marked "Val" at the beginning and "R %" at the end.

(4) A scale in red along the upper edge of the Slide — the "upper slide scale", abbreviated to **B** and marked D at the right-hand end. It begins on the left with 3.1, reaching the value 10 in the middle, where it starts again at 1, and ends on the right at 3.6.

(5) A scale in black along the upper groove of the body — the "upper body scale", or **A.** This coincides with **B**, and is marked "P" at the beginning and Int. at the end. The CASTELL 1/28 also has a number of subsidiary graduations which will be explained later on.

The ABC of Slide-Rule Calculations

There is no help for it: we must start just like schoolboys learning their ABC. For all that, we shall master it somewhat more quickly than they do. We have already seen that the distances between the graduation-marks become smaller as the numbers grow, i. e. that they are not all equal. Between 1 and 2 we can see this quite clearly. They then appear to get bigger again, but only because their significance has changed. Let us pass right on to the details, taking a Slide Rule with a graduated length of 25 cm as our basis.

Division D 1 — D 2: Here we find 10 big subdivisions the ends of which are marked 1.1, 1.2, 1.3 and so on, up to 1.9. Each of these subdivisions in its turn is divided into **ten** sub-sections, but these are not marked with figures. There is no difficulty in mastering their significance.

First of all let us bear carefully in mind the fact that as a general principle the Slide Rule shows all numbers **without a decimal point.** This means that we only read off the series of actual numbers, that is to say, not 1.1, but 11 — for which, however, we do not say "eleven", but "one-one". It can just as easily stand for 0.11, 11, 110, 1100 and so forth. It will be best if we always read off three digits. Fig. 3 shows a portion of the scale, with all values marked. We can now read off the entire series from 1 to 2 without difficulty. It is most important never to overlook the noughts in the second position. Let us therefore never confuse 102 with 120 (or with 12). So the numbers to be read off are: 100, 101, 102 . . . to 197, 198, 199,200.

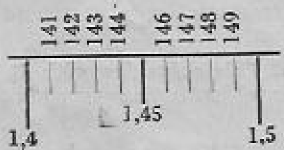
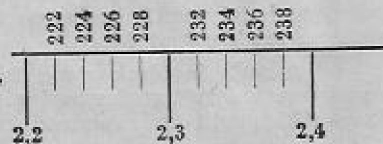


Fig. 3

Fig. 4



Division 2 — 4: When counting from 199 onwards we immediately notice that after 200 something has "changed". The graduation jumps as it were, the spaces suddenly becoming wider. The object is to guard against the confusion which might arise from overnarrow spaces. Between 2 and 4, in fact, the mark only appears for every second number. We thus count as follows: 200, 202, 204, etc. Every fifth mark is prolonged. It allows the "tens" (210, 220, etc.) to stand out. The "halves" (250, 350) are made still more conspicuous. Fig. 4 shows a portion of the scale with all values.

Division 4—10: If we read off 398, 400 . . . and then want to continue, we are for a moment at a loss. With a little thought, however, we understand what has happened: it is only every 5th number that has been given a mark. Every 2nd mark, representing the "tens", is somewhat prolonged, while the "halves" (450, 550, etc.) are made still more conspicuous (see Fig. 5).

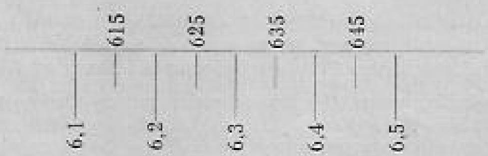


Fig. 5

But What Happens if . . . .

. . . we require values which have no mark on the scale? Here are some typical examples:

(1) We wish to set the cursor to 135.5. For 135 there is mark. The next mark represents 136. The central point between the two marks will give the value required.

(2) For 223. After 2 the first small mark following the two larger ones is 222. With the next we pass right on to 224. So here again 223 is the central point between the two marks, and we can easily judge its position with the naked eye.

(3) 450, 451, 452, 453, 454. Here the "centrefinding method" lets us down. So let us consider what has to be done. The next mark after 450 has the value 455. The "half-way value" would be 452.5. For 453 we set the cursor a little to the right of this position, and for 452 a little to the left. 451 is a tiny distance beyond the mark for 450, while 454 is found just before 455.

At this point we have to perform quite a variety of setting and reading-off exercises. Do not go on to the next chapter until you have thoroughly mastered these fundamental principles. These operations naturally call for patience and perseverance. This new knowledge, like any other kind of new knowledge, is governed by the motto **"Practice makes perfect"**.

The Basic Divisions

Constructing a Table

Let us start right away with an interesting method of calculation known as the Rule of Three. It is widely used in commerce and can be solved with the Slide Rule in a manner which is little short of astonishing. By way of an initial example: For a distance of 60 Km. we have calculated transport-costs of 4.75 $. What will the cost be for 47 Km?

The answer is found on the Slide Rule when the two figures which "belong together" have been placed one above the other on two scales moving alongside each other. The quest on of **which** numbers belong together **cannot** be answered by the Slide Rule. We must ascertain this ourselves, but if we have any arithmetical ability at all this will present no difficulty. In this case the numbers which belong together are 60 Km. and $ 4.75. We therefore set the cursor-line to **D** 60 and move the slide to the right until 475 is under the cursor-line, so that its exact position is above the 60. Fig. 6 shows the Slide Rule in this position.

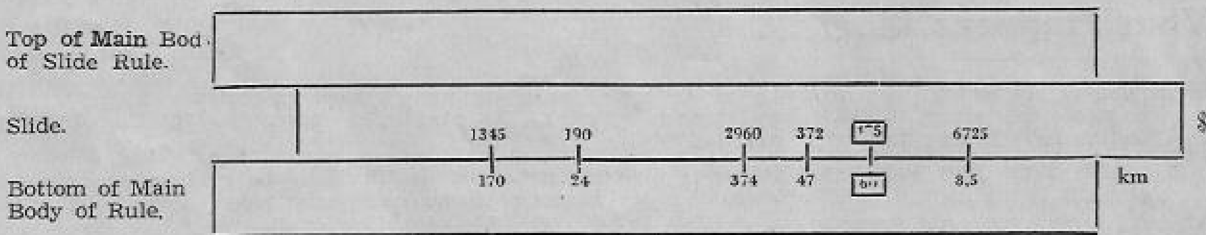


Fig. 6

If we first find the "kilometre-figure" 47 on the fixed scale **D**, then above it, on the movable scale **C**, we find the series of digits 3-7-2, which means that the transport-costs for a distance of 47 Km. are $ 3.72.

The surprising thing is that with this **one** operation of setting the Slide Rule to the "key factor" of the problem (i. e. a cost of $ 4.75 for a distance of 60 Km.) we answer **all** other questions at the same time. With our one setting we have formed a **table**, in which the kilometres appear on the body of the Slide Rule while the respective costs are found on the slide (Fig. 6). All we have to do is to read off the figures and add in the decimal point. Above 170 we find the series of digits 1345; that is to say, for a distance of 170 Km. the cost is \$ 13.45. In just the same way we find that the cost is \$ 1.90 for Km. 24, \$ 29.60 for Km. 374 and 67¼ cents for 8.5 Km. It is easy to find the right position for the decimal point, for the cost is always less than one-tenth of the number of kilometres.

A second example: 65 grammes of a certain drug cost \$ 2.59. We require to set the Slide Rule to a "table" showing the cost of any other weight of the same drug in grammes.

Once again we find the one number of the "key factor" on the main body of the Slide Rule — say, the weight; we then move the cursor to 65 and move the slide along until the number 259 appears above it (Fig. 7). The body of the Slide Rule then shows the weights and the slide the respective prices. We can read off the answer immediately: 70 gr. cost \$ 2.79, 350 gr. cost \$ 13.95. Conversely: for \$ 20 we find we have 502 gr., while for \$ 1.50 the amount is not quite 38 gr. — to be exact, 37.6 gr.

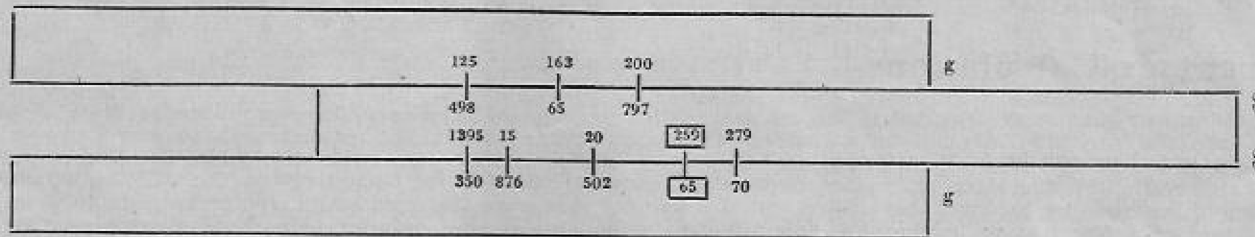


Fig. 7

The price of 125 gr. cannot be found at once, as the graduation to the right only goes as far as 100 gr. As soon as the lower graduations on the CASTELL Slide Rule 1/28 seem to fail us, we look for the answer on the upper scale. The weights are shown not merely by the "lower main-body scale" **D** but also by the upper one, and it is not only the lower slide-scale **C** which shows the respective prices, but also the one at the top. We therefore find the 125 gr. on the upper main-body scale **A**, which gives us — below it, on the upper slide-scale **B** — the price of \$ 4.98. In just the same way we find the price of \$ 7.97 for 200 gr. and an amount of 163 gr. for an outlay of \$ 6.50.

The lower and upper scales thus constitute an inseparable whole: as soon as one has set either the lower or the upper part of the Slide Rule to the "key factor" in a problem involving the Rule of Three, one finds the answer to **every** question. One merely has to make sure that not more than half the length of the slide is projecting outside the body of the Slide Rule. We thus have the following "law":

To construct a table, set scales C and D or A and B to its key-factor. All the correlative values of the table will then be found, one below the other, on the upper and lower scales. During this operation, over half the length of the slide must always be inside the main body of the Slide Rule.

Further examples for exercise in proportion:

1 metre of material costs Kr. 1.65. Place 165 above 1 (on the left). The table has now been constructed. We can read off the amounts of 1.6 metres for an outlay of Kr. 2.64, 3.5 metres for Kr. 5.78, 7.15 metres for Kr. 11.80 (to be read off from the top).

14 gallons are 53 litres. We place 14 above 53 and find: 100 litres are 26.4 gallons, 125 litres are 33 gallons, 157 litres are 41.5 gallons — or conversely, that 51 gallons are 193 litres and that 75 gallons are 284 litres.

75 English pounds are 34 kilogrammes. We place 34 above 75 and find that 53 lbs. are 24 Kgs., 30 lbs. are 13.6 Kgs., 140 lbs. are 63.5 Kgs., and conversely that 72.5 Kgs. are 160 lbs. and that 127 Kgs. are 280 lbs.

Percentage-Calculations

The business-man very frequently has to deal with percentage-calculations. These are likewise "rule of three" calculations and can therefore best be solved by the construction of tables. Let us start with an easy example.

We wish to find 68% of £ 735. Although we only require this one answer, we make up a table. The "key factor" is: £ 735 are 100 %. We therefore place the number 100 above **D** 735 (the right-hand "1" in Fig. 8). The percentages are then shown on the two movable scales and the sums of money on the fixed scales, and underneath 68 % we find the amount of £ 500. It may be that the necessity for finding this percentage arises out of an advance estimate and

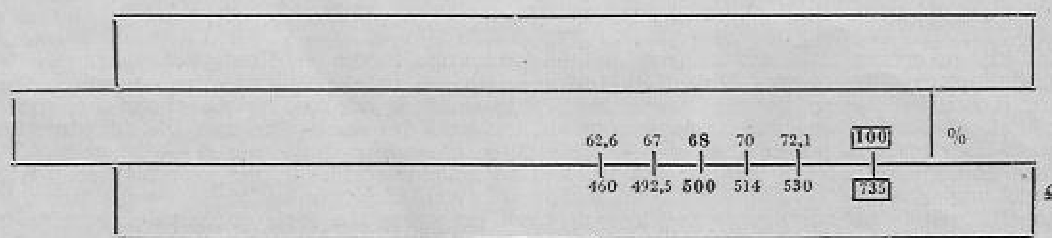


Fig. 8

that it is desirable to take into account certain other percentages in its vicinity. We can immediately read off £ 514 for 70 %, £ 492·50 (£ 492.10 s.) for 67 % and (conversely) 62.6 % for £ 460 and 72.1 % for £ 530.

If we cast glance along the scales, we see that from the lower graduations we can read off percentages from about 14 % to 100 %. Those under 14 % must be read off from the upper graduations.

A price-list is to be altered on the basis of a $6\frac{3}{4}$ % increase in all prices. To determine the "key factor" we must understand that £ 100 is now equivalent to £ 106·75. These two numbers must thus be placed together — say, by moving the left-hand **"1"** (**C** 1) (representing 100) until it is above **D** 10 675 (Fig. 9). The movable scales then show the old prices while the rigid scales show the new, increased prices. An article formerly costing £ 3 now costs £ 3·2 (£ 3. 4 s. 0 d.), one which formerly cost £ 3. 10 s (£ 3·5) now costs £ 3·74 (£ 3. 14 s. 10 d.), one formerly priced at £ 4. 10 s. (£ 4·5) is now priced at £ 4·8 (£ 4. 16 s. 0 d.) 4 s. 6 d is now priced 4·8 s. (4 s. $9\frac{1}{2}$ d.) and for £ 7·5 an amount of £ 8 is now shown.

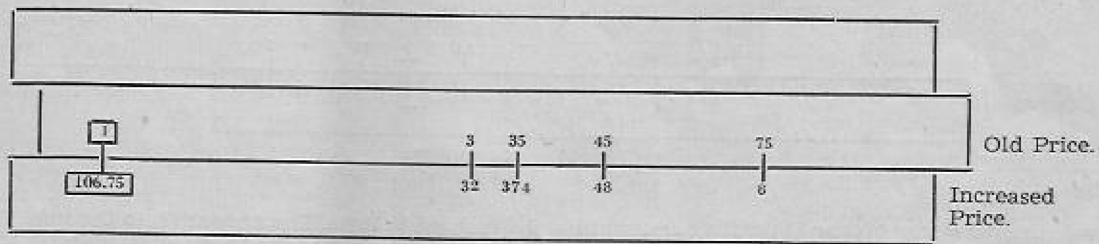


Fig. 9

A reference-leaflet is now to be made out from a certain price-lists, showing all prices reduced by $14\frac{1}{2}$ %. The "key factor" is: $ 100 equals $ 85.50. We therefore place the right-hand "1" **C** 10 (representing 100) above **D** 855 and read off $ 3.42 for $ 4, $ 2.91 for $ 3.40 and $ 1.54 in place of $ 1.80.

Let us suppose that we have a basic price of DM 66.50. Various percentages are to be added and deducted. Key-factor: DM 66.50 = 100 %. The middle "1" on the upper scale **B**, representing 100, is placed below **A** 665. A supplement of 3 % gives DM 68.50, since it is the series of digits 6-8-5 that appears above **B** 103 (= 100 % + 3 %). A supplement of $10\frac{1}{2}$ % gives DM 73.50, as may be seen above **B** 110.5 (= 100 % + 10.5 %). A deduction of $7\frac{1}{2}$ % gives DM 61.50, for this is the amount which appears above **B** 92.50 (= 100 % — 7.5 %), while a 15 % deduction gives DM 56.50, as may be seen above **B 85.**

Multiplication

We will begin our explanatory note with the simple multiplication-sum 2×3. As we know, the task is to place the scales **next to each other.** We therefore push the slide to the right until the "1" on the lower slide-scale (**C** 1) is above the "2" on the "lower main-body scale" (**D** 2). If we then move the cursor until it is over the "3" of the lower slide-scale (**C** 3), we find the result (2 × 3 = 6) below it (Fig. 10).

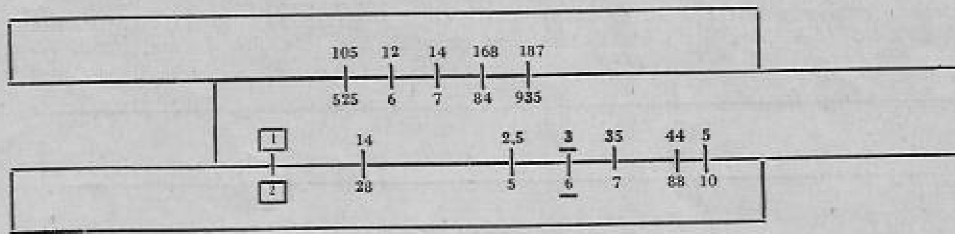


Fig. 10

A valuable property of the Slide Rule is immediately brought to light. The answer (8) to the sum "2 × 4" can be read off without readjustment. The main cursor line is now moved to the "4" of the lower slide-scale (**C** 4). The "8" is found underneath it. We also find, without moving the slide any further, that:

2 × 14 = 28, 2 × 2·5 = 5, 2 × 0·35 = 0·7, 2 × 440 = 880 and 2 × 4·85 = 9·7.

At first it appears that one can only read off the values as far as 2 × 5 = 10, since the graduation does not extend any farther to the right. If we take a look at the upper scales, however, we see that all the sums still to be solved can be found here. If we look for the "6" (**B** 6) we find the answer to the sum "2 × 6" (= 12) above it. The second multiplication-factor is thus invariably to be found on the scale of the **slide**, the result being always on the scale of the **main body** of the Slide Rule.

Find the following results in the same way: 2 × 70 = 140, 2 × 0·84 = 1·68, 2 × 9·35 = 18·7 and 2 × 525 = 1050.

Setting the Slide Rule for a multiplication sum of which one factor is 2 is this equivalent to forming a table which provides the answers to **all** multiplication sums involving this factor. Against any desired number on the scale of the slide we find its double on the main-body graduation.

Examples: $14 \times 1{\cdot}5 = 21$. $134 \times 2{\cdot}76 = 370$. $3{\cdot}07 \times 2{\cdot}28 = 7$. $213 \times 0{\cdot}258 = 55$. $2{\cdot}08 \times 31 = 64{\cdot}5$ $1{\cdot}28 \times 0{\cdot}68 = 0{\cdot}87$.
$2^3/_4$ metres at \$ 1·80 each costs \$ 4·95. 1·28 metres at \$ 5·90 each costs \$ 7·55.

Although this certainly enables the user to carry out a large number of sums in multiplication, it still seems as though there are certain problems which **cannot** be solved in this way. If we wish to multiply 4 by 6, for instance, we are unsuccessful, because we cannot take any reading underneath the "6". We are no nearer the goal if we tackle it from the "6 × 4 angle". The only way is to **extend** our system of multiplication. We now place the **right-hand** instead of the **left-hand** "1" above the "4". We can then read off the result (24) under the "6". (Fig. 11).

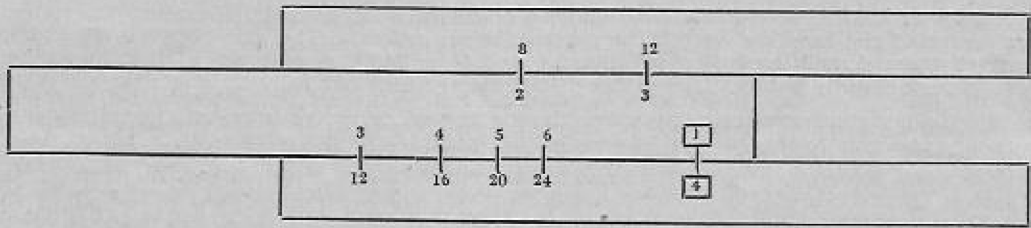


Fig. 11

These two methods of adjusting the instrument for multiplication-purposes may be summaried in **one single** rule:-

> **If two numbers are to be multiplied together, find one number on the lower "main-body scale", place the left-hand or the right-hand "1" of the lower slide-scale over it, find the other number on one of the scales of the slide and read off the result below or above it.**

Whether we select the left-hand or the right-hand "1" depends on the problem to be solved. What must be borne in mind is that the slide must at all times lie within the main body of the Slide Rule to the extent of more than half its length.

The **one** sum $4 \times 6 = 24$ once again results in the formation of a table for **all** multiplication-sums with the factor 4. By utilising the upper scales we find the following answers: $4 \times 2 = 8$, $4 \times 3 = 12$, $4 \times 4 = 16$ and $4 \times 5 = 20$ (Fig. 11).

We are now in a position to solve **any** problem in multiplication.

Examples:

14.43 × 0·418 = 6·03.	Estimate: About half of 14.		
838 × 3·13 = 2620.	"	800 × 3 = 2400.	
0.498 × 0·207 = 0·103.	"	0·5 × 0·2 = 0·10	
1579 × 0·0469 = 74.	"	1600 × 1/20 = 80.	

The beginner usually makes his approximate estimates too difficult for himself. He attempts, in fact, to get the result more or less correct This, however, is not the purpose of an estimate. The sole object is to make sure that the decimal point is correctly placed, with confusion between 1.4 and 14 or 140, for example, so that in our rough estimates we may round our figures off **quite boldly.** This makes it not merely easy but fully adequate for the purpose.

With problems arising in actual commercial practice the making of estimates is quite unnecessary, as in such cases one can never be in any doubt as to the position of the decimal point.

Multiplication of Three Numbers

Commercial practice often involves problems requiring the product of **three** numbers. Such problems can, of course, be solved simply by multiplying the first two numbers together and then multiplying the result by the third number. On these lines, the sum "2×3×5" (= 30) would be carried out by multiplying 2×3 in the way we already know, but the result of this would not be read off; we simply have to **retain** it by means of the line on the cursor, in order to place the right-hand "1" above it. It is thus not necessary to **read off** the intermediate result.

That the slide has to be moved **twice** when carrying out this sum will strike the reader as only too natural: are not **two** problems involved? For all that, the answer to this double multiplication sum can in many cases be found by **one single** movement of the slide. All we have to do is to utilise the green-coloured **internal** graduation of the slide **(Cr).** Let us use the sum "2×3×5" to explain the process (Fig. 12).

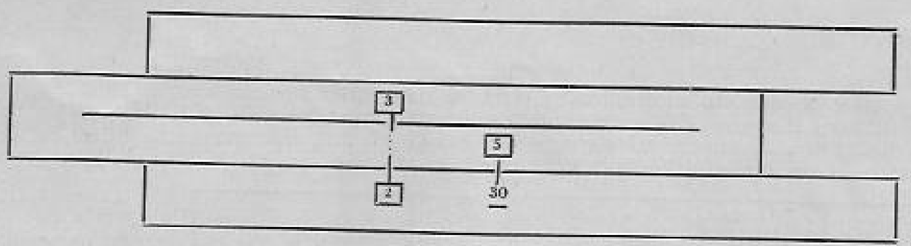


Fig. 12

We first of all find the figure 2 on the lower main-body graduation (**D** 2), place the figure 3 of the central slide graduation (**Cr** 3) immediately above it (for which purpose the line on the cursor must be used) and then find the figure 5 on the lower slide-graduation (**C** 5), the answer (30) appearing below it.

With this multiplication system likewise, the upper graduations must be used where necessary. Let us suppose we have to find the product of 2, 25 and 15. We place point **Cr** 25 above point **D** 2. Nothing can be read off under **C** 15, but a reading can be taken above **B** 15, where we find on **A** the digits 7—5, which in this case stand for 750. We find the answer in **one** movement, provided we bear in mind that not more than half the length of the slide may be drawn out of the main body of the Slide Rule.

The rule for the multiplication of three numbers is thus as follows:

Find the first number on D, place the second number (on Cr) above it, find the third number on one of the slide-graduations (C or B) and read off the answer, below or above it, on the main-body graduation (D or A).

Examples:

44.5 × 3.08 × 1.64 = 225.	Estimate: 50 × 3 × 1.5 = .225.
0.627 × 333 × 7.05 = 1472.	„ 0.5 × 350 × 7 = 1225.
36.7 × 4.77 × 6.34 = 1110.	„ 40 × 5 × 6 = 1200.

This very convenient method cannot always be used; if the figures do not lend themselves to it at all well, two separate multiplication-sums have to be carried out, the slide being readjusted accordingly.

Division

Division is the opposite process to multiplication; the method used for dividing is thus the reverse of that used for multiplying. We will take the sum 8 : 4 = 2 as an easy initial example. We find the "8" on the lower main-body graduation (**D** 8) and the "4" on the lower slide-graduation (**C** 4), placing one above the other as shown in Fig. 13. We then read off the result (2) underneath the index figure 1 (**C** 1).

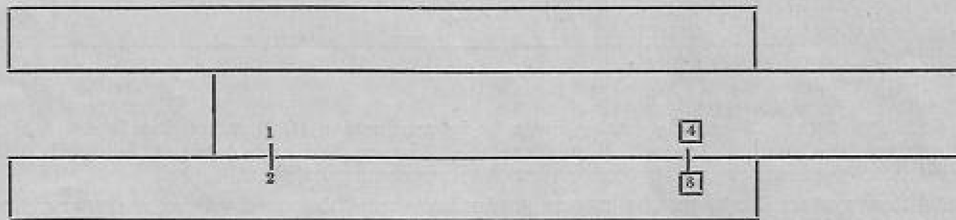


Fig. 13

We will use a second example to show that the position may sometimes be different. Let the sum to be solved be 180 : 30 (= 6). We place **C** 3 above **D** 18 (Fig. 14); in this case we cannot take any reading under **C** 1, but the answer

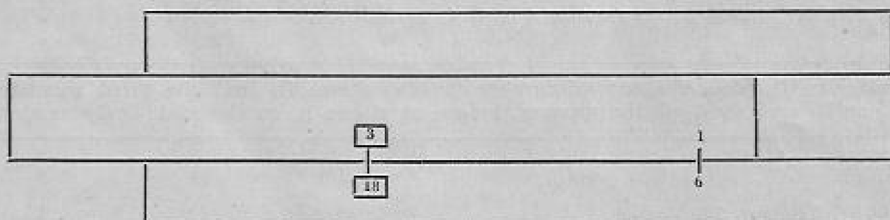


Fig. 14

can be read off under **C** 10. Here we find the answer (6). **It is thus of no importance whether the reading is taken under the left-hand "1" or under the right-hand "1".**

We thus have the following rule for division:

Find the divisior (denominator) on C (or B), the dividend (numerator) on D (or A) and read the quotient on D (or A)in line with the left-hand or right-hand "1" of C (or the centre 1 of B).

Examples:	36.4	:	2.46	= 14.8.	0.561 :	54.8	=	0.01024.
	23500	:	53.2	= 442.	0.353 :	0.434	=	0.814
	631	:	0.468	= 1348.	109	: 1725	=	0.0632.

Computation of Interest

The computation of **annual** interest involves no special calculations. It consists of simple percentage calculations such as those with which we have already dealt. In most cases, however, one requires to find the interest for a number of **days.** The "SUPER-BUSINESS" slide rule is specially arranged to solve such problems. On the left-hand and on the right-hand edge we find certain letters — P, Int., D and R %. These mean that from the scales so marked we are to read off the capital, the interest, the number of days and the percentage-rate. Hence we have the following rule:

Find the capital in all cases on scale A use the short cursor line to place the percentage-rate (on scale Cr) underneath it, find the number of days on scale B or C and find the interest immediately above or below it on the black scale.

Examples: Calculate the interest due in 35 days on £ 115 at 3 %.

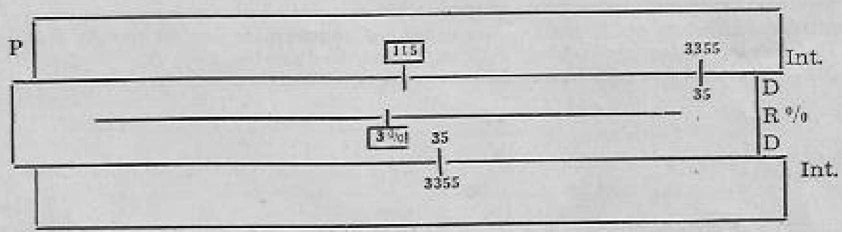


Fig. 15

Bring the main cursor line at point "A 115" (Fig. 15) and **Cr** 3 under the short cursor line; on Days-scales we look for 35 and find that it appears twice, once at the bottom and once again at the top, to the extreme right. We find the series of digits 3355 below it in the first case and above it in the second place. Here this can only signify £ 0.3355, or 6 s $8^1/_2$ d.

In general the interest will be found with **one** adjustment of the slide. It may happen, however, that the slide has to be "readjusted".

Calculate the interest due in 28 days on £ 308 at $4^1/_2$ %.

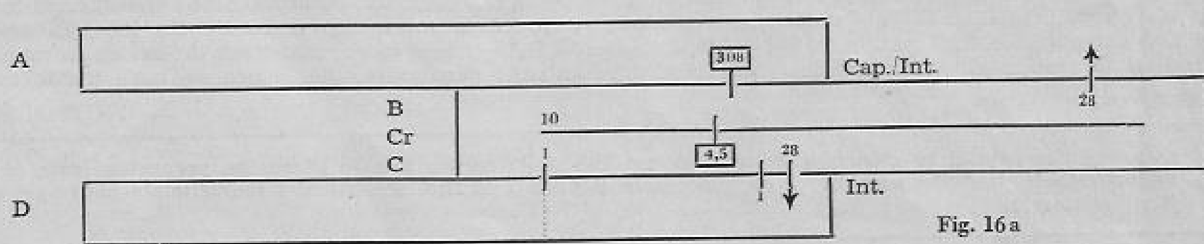


Fig. 16a

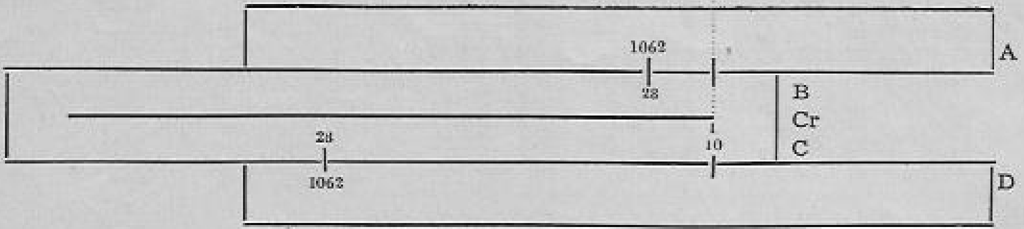


Fig. 16 b

The value 308 is only found on A to the extreme right. Set the main cursor line to it and bring 4.5 on **Cr** under the short cursor line (Fig. 16a). We then find the number of days "outside", to the right, on **C**, so that no reading can be taken below it. Nor can any reading be taken at the top. This problem can only be solved by **"readjusting"** the slide. This must be done by pushing it to the left (or to the right, as the case may be) until beginning and end are interchanged. The cursor-line is therefore placed on the left-hand end of the slide, which is then moved to the left until its right-hand end comes to rest underneath the cursor-line (Fig. 16 b). We can now take a reading both above 28 and below 28, and find the series of digits 1062. The interest sought is thus £ 1.062 or £ 1. 1 s. 4 d.

Let us note:

The slide is readjusted by "marking the place" for one end of the slide with the line on the cursor and then placing the other end of the slide underneath the cursor-line.

To avoid the re-setting, multiply or divide one of the factors by 2 and for compensation divide resp. multiply the result by 2.

In the foregoing examples the rate per cent is based on a year of 365 days. Should it be necessary to calculate the interest when the rate is given for a year of 360 days, as is the case in many countries, the method is the same, but the rate is set under the main cursor line, instead of under the short line.

Examples: —

Make the following interest-calculations:

				for 360 days	for 365 days
$ 4645	(principal)	at $5^1/_2$ %	in 207 days	= $ 146.90	$ 144.80 (interest).
$ 6473	„	at 5 %	in 173 „	= $ 155.50	$ 153.40 „
$ 489	„	at $5^3/_4$ %	in 203 „	= $ 15.86	$ 15.64 „
$ 5824	„	at $6^1/_4$ %	in 225 „	= $ 227.50	$ 224.40 „

$ 628 (principal)	at 5¼ % in 84 days	= $ 7.69	$ 7.59 (interest).
$ 67536 „	at 4½ % in 139 „	= $ 1174.—	$ 1157.35 „
$ 64085 „	at 4¾ % in 112 „	= $ 947.—	$ 934.06 „
$ 4019 „	at 2½ % in 179 „	= $ 49.96	$ 49.26 „
$ 15318 „	at 3½ % in 72 „	= $ 107.20	$ 105.93 „
$ 54317 „	at 6 % in 23 „	= $ 208.21	$ 205.37 „
$ 46075 „	at 2 % in 149 „	= $ 381.40	$ 376.23 „

Inverse Proportions

Problems involving inverse proportions occur less frequently than the normal problems involving the "rule of three", but here again the Slide-Rule enables us to perform the necessary calculation. All we need to do is to combine the green scale **Cr** with the black scale **D.**

We require 43 yards of a material having a width of 60 inches. It happens, however, to be 90 inches wide. What length does one require?

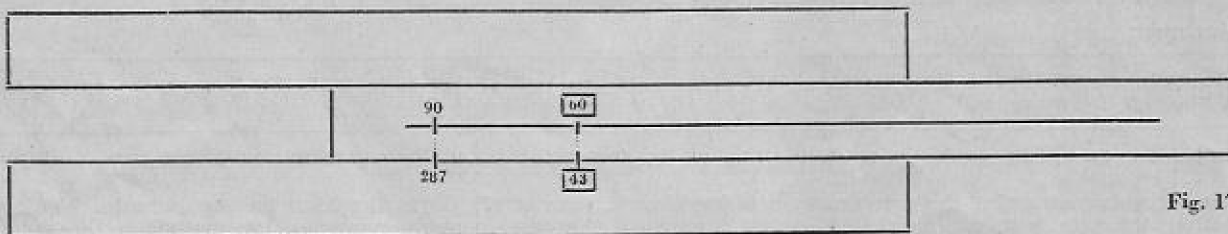


Fig. 17

We find 43 on **D**, placing 60 (on **Cr**) above it. We then find the length required — 28·7 yards — under 90 on **Cr** (Fig. 17).

With a speed of 24 feet per second we require a time of 2·5 minutes. What is the alteration in the time required when the speed is increased to 27·5 feet?

We find 24 on **D**, placing point **Cr** 25 above it; the new period (2·18 minutes) is then found on **Cr**, above D 2-7-5.

Costing

Costing invariably consists of a percentage-calculation in which increases and deductions often have to be made in stages, i. e. in several consecutive operations. To assist the memory the left-hand ends of the **C** and **D** scales are marked "P. P." (purchase-price) and "S. P." (selling-price) respectively. A few typical examples are set out below.

(1) Purchase price £ 23. 10 s. 0 d. Selling price £ 35. What profit has been made on the **selling**-price? Here the **selling** price must naturally be treated as 100 %. We therefore place the right-hand "1" (100 %) of **C** above D 35 and read off, above **D** 23·5, the value 6-7-1, which stands for 67·1 %. Since the purchase price is 67·1 % of the selling price, the profit on the selling price is 32·9 %.

(2) If we wish to find out what profit has been made on the **purchase** price, with the same figures as above, then we must treat the sum of £ 23·5 as 100 % placing the left-hand "1" of the **C** scale above **D** 235. The value shown on **C**, above **D** 35, is then 149, indicating that the selling price is 149 % of the purchase price. The profit on the **purchase** price is thus 49 %.

(3) Starting from the purchase price £ 23·5 we wish to compare a number of different selling prices and the profits thereby made on the purchase price. Set the Slide Rule as in Example 2. If we wish to make a profit of 60 %, then the selling price £ 37·6 (£ 37. 12 s. 0 d.) is under **C** 160; if a profit of only 20 % is required, then the selling price £ 28·2 may be found under **C** 120.

(4) If we take a fixed selling price £ 35 as our starting-point in order to examine a number of possibilities as regards profit, then we keep to the position to which we set the Slide Rule in Example 1. If we wish to make a profit of 40 % on the selling price, we must obtain the goods from the supplier for as little as £ 21, for this is the price which we find under **C** 60 (100 % — 40 %). If we are satisfied with a profit of 30 %, the purchase price may be increased to £ 24·5, as this is the amount read off under **C** 70.

(5) We find that the selling price is £ 4. 4 s. 0 d. and know that the seller is basing his operations on a profit of 35 % on the cost price (which is unknown to us). What is this cost price? The "key factor" is: £ 4·2 = 135 % of the cost price. **C** 135 is placed above **D** 42; we then find, under the left-hand "1" of **C** (= 100 %) a cost price of £ 3·11.

(6) A supplier sells his goods at £ 26. 12 s. 0 d. He knows that his customers are in the habit of selling them at a profit of 30 % on the selling price. What is the resulting retail price? Key-factor: £ 26·6 = 70 %. If we place **C** 70 above **D** 266, then we find, under **C** 100 (right-hand "1"), a retail price of £ 38.

Unit percentage

(1) A costing operation usually runs as follows: one starts with a purchase price; for example, £ 4. 9 s. 0 d. = £ 4·45. Petty charges of 7½ % and business expenses of 17 % have to be added, and a profit of 38 % is desired.

C 1 (= 100 %) is placed above **D** 1075, since the first supplement brings £ 100 up to £ 107·5. The line on the cursor is then placed above **C** 117, thus adding the 17 %, and the slide pushed to the right until its "1" (100 %) comes to rest under the cursor-line, the latter then being placed over 138 in order to add the 38 %. It now shows the series of digits 1736 on **D** and this means that to add the three percentages in succession is tantamount to making an increase of 73·6 % (or multiplying the basic price by 1·736) in one single operation. This number is know as the **unit percentage.** If we now place **C** 1 under the cursor-line, i. e. above **D** 1736, we form a table in which all numbers are multiplied by this value. On the red scale we have the purchase prices and on the black the selling prices. Without any further movement of the slide we read off the following figures: £ 7·72 for £ 4·45, £ 10 for £ 5·76, £ 10·70 for £ 6·16 (to be read off at the top!) and £ 15·10 for £ 8·70.

(2) From a list-price of 13 s. 9 d. we wish to grant the retailer a reduction of 6½ %, a rebate of 23 % and a discount of 2 %. What is the actual price which he has to pay?

B 1 (to be found in the middle and to be regarded as 100 %) is placed under **A** 935, as the first deduction brings 100 s. down to 93·5 s. The cursor is then placed over **B** 77, in order to deduct the 23 % rebate, after which **B** 1 is again placed under the line on the cursor and the latter then placed on **B** 98. Above it, on **A**, we find the series of digits 705, i. e. to deduct all three percentages successively is the same as deducting 29·5 % in one operation, or multiplying all the numbers by the unit percentage 0.705. If **B** 1 is then placed under the line on the cursor, i. e. under **A** 705, the conversion-table is completed: the red scales show the list-prices, the black the real prices, and we take the following readings: 9 s. 8½ d. (9·7 s.) paid instead of 13 s. 9 d. (13·75 s.), 8 s. 3 d. (8·25 s.) instead of 11 s. 8½ d. (11·7 s.) and 5 s. 3 d. (5·25 s.) instead of 7 s. 5½ d. (7·45 s.).

Let the reader think out for himself why we should not start with the right-hand **C** 1 above **D** 1375.

On this aspect of the use of the Slide Rule we advise the reader to set himself a good number of exercises from his own sphere of work. It is in such calculations as these that the great advantages offered by the Slide Rule are shown most clearly.

Calculation of Compound Interest

Let us now pull the slide right out and reinsert it into the Slide Rule so that its reverse side faces upwards. We find it bears three different scales. From the two graduated lines at the top we obtain the so-called interest-factors, which then enable us to continue our calculations on the main scales. For this purpose the **C** scale is reproduced on the back of the Slide.

Example: What is the sum to which £ 415 increases in 10 years at 4 % compound interest?

Above 4 % we find that the back of the slide gives the value 1·48. This is the interest-factor by which £ 415 has to be multiplied. We carry out this calculation on the main scales and obtain a figure of £ 614.

Example: £ 3150 has been running for 10 years at compound interest and has grown to £ 4550. What was the rate of interest?

We first of all have to ascertain the interest-factor required. We therefore divide 4550 by 3150 on the front of the slide, obtaining the quotient of 1·445. By finding this value on the back of the slide we obtain the rate of interest, which is $3^3/_4$ %.

In these instances the number of years was always 10, but the compound-interest division can also give us the interest-factor for any other number of years. While the problems described in the foregoing could even be solved without turning the slide over, the following calculations cannot be performed without reversing it in this way.

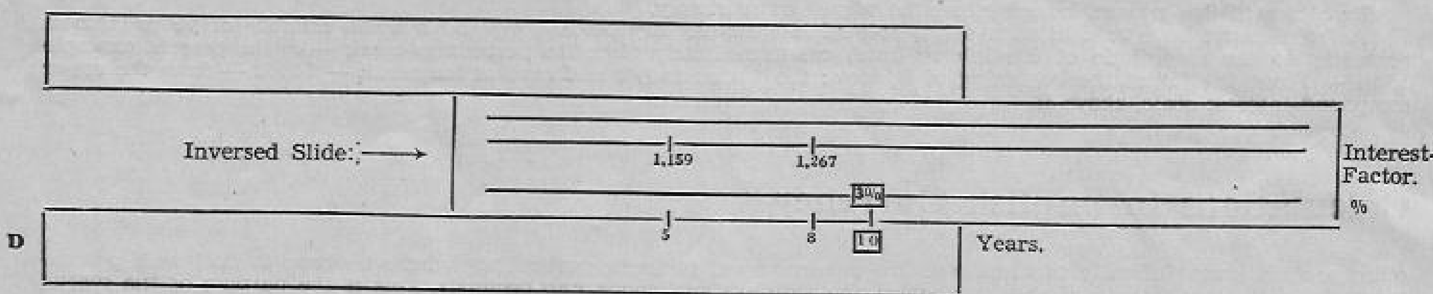


Fig. 18

If we want to find the interest-factor for 3 % and 8 years, we place the sign 3 % above the 10 on the **D** scale (Fig.18). This immediately gives us a table of interest-factors for 3 % and all periods. Above **D** 8 we find the desired interest-factor to be 1·267. For 5 years it is 1·159, for 7 years 1·230, for 6 years 1·194.

If the interest-factor for $3\frac{1}{2}$ % and 13 years is required, we place the sign $3\frac{1}{2}$ % above the beginning (1) of the **D** scale — for this can also be read as 10. The required factor — 1·564 — is then found above **D** 13. Here again we have a complete table, from which we may take the further readings 1·619 for 14 years, 1·675 for 15 years, and so on.

Example: The sum of £ 285 has grown in 15 years to £ 532. On what rate of interest was this based?

We first of all divide 532 by 285 on the main scales, obtaining the quotient of 1·876. This is the interest-factor for 15 years. Using the back of the slide, we now place the number 1.867 above **D** 15. The factor for 10 years is now found above **D** 10 (the beginning of the scale) and is seen to be 1.516, the rate of interest being $4\frac{1}{4}$ %.

The answer cannot in every case be directly obtained by the method shown here.

Example: Find the interest-factor for 3 years at 2.5 %.

If, in this case, we place point "2.5 %" above the "1" of the **D** scale, we can only find the interest factors for 4 years (= 1·1038). Having set the Slide Rule as far as this stage, we overcome the difficulty by using the cursor to "retain" the **vertical red** mark (above 1·1) which appears on the slide to the left and by then moving the slide to the left until the right-hand red vertical mark (likewise above 1·1, but on the **upper** scale) comes to rest underneath the cursor-line. The cursor is now set to **D** 3, and we can read off the interest-factor — 1·0768 — from the upper scale, above it.

Problems of this nature, however, can be solved more simply.

As soon as we have to deal with a low rate of interest (usually below 3 %) and a small number of years (2 to 4, according to the magnitude of the interest-rate) we immediately place the percentage-mark — in the present example 2·5 % — above the "1" at the beginning of **D**, move the cursor to **D** 3 and read of the result — 1·0768 — from the **upper** compound-interest scale, above it.

Calculations in English Currency

often present great difficulty to those who are unaccustomed to them, particularly where we have to deal with percentages. In such cases it is advisable to convert the shillings and pence into decimals. This is the purpose of the special graduations appearing on the lower vertical edge of the Slide Rule. Further explanation is hardly necessary.

Additional Information for the Business-Man whose Work is of a Technical Nature

This brings us nearly to the end. The information which remains to be given chiefly concerns the „technical" business-man, dealing as it does with additional scales of which he will be main user. First of all, there is the

Square Scale

We find this under **D**. It is exactly the same graduation as the one which the technician finds (duplicated) on the upper part of his Slide Rule. If we pass on from **D** to **S**, we can take readings of "squares". Under **D** 4, for example, we find the value 16 on graduation **S**, while under **D** 2.7 we find the series of digits 729. (Answer: 7.29).

Square roots can be read off by proceeding from **S** to **D**. Here it is important to bear in mind that a distinction must be drawn between the left half of the **S** graduation (1—10) and the right half (10—100).

It is certainly not a matter of indifference whether we set the Slide Rule to find the square root of 5.8 at **S** as 5.8 (obtaining the answer 2.408, which is arithmetically correct) or find it opposite **S** 58, which gives 7.61, this being the square root of 58.

We must keep to the following rule, which is easily remembered:

The numbers of which the square roots are required must always be set at **S** according to the way in which the numbers are actually written: 9 (on the left) to find the root of 9 and 90 (on the right) for the root of 90. In the case of numbers which do not lie between 1 and 100 we cut off 2, 4 or 6 (etc.) "places" in each case, or add the appropriate number of noughts, thus obtaining the value required, e. g.—

$$\sqrt{3600} = \sqrt{36} \times \sqrt{100} = 60$$

$$\sqrt{0.0074} = \sqrt{74} : \sqrt{10000} = 8.6 : 100 = 0.086$$

$$\sqrt{486924} = \sqrt{48.6924} \times \sqrt{10000} \text{ etc.}$$

Cube Scale

On the upper edge of the main body of the Slide Rule we find the Cube Scale, which falls into three equal sections (1—10, 10—100, 100—1000). It is used in conjunction with **D** or **C** as the case may be. Above **D** 2 we obtain the value 8 from the **Cu** scale, 27 appearing above **D** 3, etc.

By the converse process we obtain cube roots. Here again we must take care to see that the numbers of which the roots are required are selected in the correct range of figures. Numbers above 1000 or below 1 must be reduced in each case by 3, 6 or 9 digits, etc., or extended by a similar number of digits, in order to obtain an appropriate value within the 1—1000 range, e. g. —

$$\sqrt[3]{9000} = \sqrt[3]{9} \times \sqrt[3]{1000}$$ etc. (cf. detailed explanation given on square roots).

It should be mentioned in passing that by proceeding from **Cu** to **S** or vice versa powers of $\frac{2}{3}$ and $\frac{3}{2}$ respectively are obtained, e. g. —

$$4^{\frac{2}{3}} = 2{,}52 \qquad 4^{\frac{3}{2}} = 8.$$

Logarithmic Scale (L)

This is to be found on the upper inclined edge of the Slide' Rule. It gives us the mantissae of the Briggs logarithms, and we shall find it of use in many difficult kinds of calculation of less frequent occurrence. The Slide Rule is set to the numbers concerned on the **D** scale, the mantissae being read off from the **L** scale.

Example: log 3 = 0·4771.

Conversely, of course, the number can be obtained when we know the logarithm.

Example: 2·4183 = log 262.

We find 4183 on **L** (since the characteristic 2 is merely a guide to the number of digits in front of the decimal point and is therefore disregarded). By the rules with which we are already familiar, the answer must consist of a number of three digits.

Constants

These are values which are frequently used and which are made to stand out in our graduations. On our Slide Rule we find the following:

12, for calculations in "dozens" (marked with a circle).
144, for calculations in "grosses" (marked with a circle).
π = 3.1416 (for calculations in connection with circles).

On the **S** scale we also find the reciprocal of π, $\frac{1}{\pi}$, = 0.3183, this being marked **M**.

The Cursor

In addition to the main line the cursor has two further full-length marks to the left and right, the distance between each one of them and the main line being 1·128 and designated as "C". These are used for calculating circular and cross-sectional areas, which the technician finds by the formula

$$A\ (\text{Area}) = \frac{\text{diameter}}{C}$$

Example: What is the cross-sectional area of a trunk with a diameter of 28·2 in.? We set the main line of the cursor to 28·2 on **D** and find on **S**, under the left-hand ancillary mark, the figures 624, which signifies 624 sq. in.