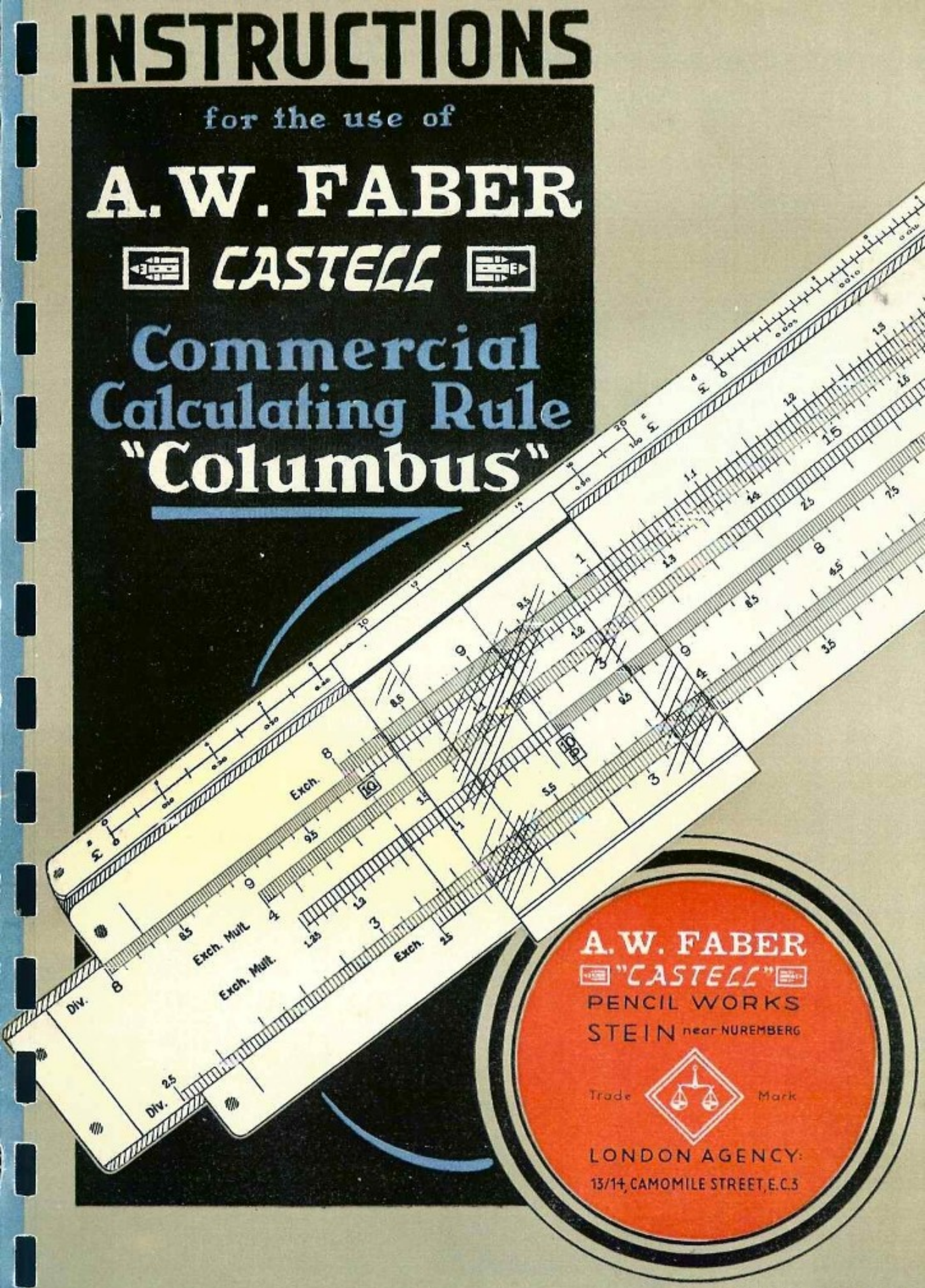
INSTRUCTIONS

for the use of

A.W. FABER

CASTELL

Commercial Calculating Rule "Columbus"



A.W. FABER
"CASTELL"
PENCIL WORKS
STEIN near NUREMBERG

Trade Mark

LONDON AGENCY:
13/14, CAMOMILE STREET, E.C.3

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INSTRUCTIONS

FOR THE USE OF

A. W. FABER "CASTELL"

COMMERCIAL CALCULATING RULE "COLUMBUS"

(SYSTEM ROHRBERG)

No. 342

A. W. FABER

CASTELL PENCIL WORKS, Ltd.

— Established 1761 —

STEIN near Nuremberg.

LONDON AGENCY:

13/14, Camomile Street, E. C. 3.

Printed in Bavaria.

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THE

A. W. FABER

COMMERCIAL CALCULATING RULE "COLUMBUS"

SYSTEM ROHRBERG.

PREFACE.

Practical men have found the calculating rule of the greatest assistance in carrying out almost all mathematical operations; its use allows complicated problems to be solved in a remarkably short time. Once the instrument is thoroughly understood, which does not take long, very accurate results will be obtained without the risk of error common to the ordinary methods of calculating. Almost the only mistakes which are possible in these results are those caused by inaccurate or careless setting, but since the time spent on these settings is so short, great care may be taken and still leave a large margin. Practice and a sound knowledge of the scales are the foundation of all successful slide rule operation.

Up to the present no great use has been made of the slide rule for commercial calculations. This is largely due to the fact that slide rules have been designed for technical calculations, and so carry a number of scales which could not be applied to commercial work. The main scales of the technical slide rule, in the hands of an expert operator, could be used for commercial calculations, but they would not be so convenient as scales specially designed for that purpose.

The **A. W. FABER** Slide Rule "Columbus", System Rohrberg, has been developed expressly for commercial work; owing to the double scales a high degree of accuracy is possible without making the rule an inconvenient length; a separate scale has been provided for multiplication, so that multiplication and division

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may be worked in the same way on different scales, thus preventing any confusion between the two processes. In addition to multiplication and division, this slide rule will be found particularly useful in calculating proportion, percentages, interest, foreign exchanges, discount, etc., and for quickly checking and correcting results obtained by other means.

While many commercial calculations are fully explained in this instruction book, it must be understood that these do not cover all the possibilities of this slide rule, but, having mastered the methods used, the operator will find no difficulty in solving any commercial problem.

INTRODUCTION.

The slide rule scales are simply tables of common logarithms in which a length represents the logarithm of the number marked at the end of it; the length from 1 to 2 is proportional to the logarithm of 2; the length from 1 to 3 is proportional to the logarithm of 3; and the length from 1 to 4 is proportional to the logarithm of 4. This applies to all graduations on the slide and rule faces.

The common logarithm of a number is the index of the power to which 10 must be raised in order to equal the given number. This is so since the base of the common logarithm is 10.

Let the number be 100, then the index of 10 must be 2, since $10^2 = 100$, and so the common logarithm of 100 will be 2. In the same way, the logarithm of 10 is 1, since $10^1 = 10$, and the logarithm of 1 is 0, since $10^0 = 1$. For a number above 10 and under 100, the logarithm must be above 1 and under 2, which means that part of it will be a fraction. For example, the logarithm of 20, called log 20, is 1·301. The fractional part of a logarithm ⟨0·301 in this case⟩ is known as the mantissa, while the integral part is called the characteristic. For all numbers having the same significant figures the mantissa is the same;

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log 2 = 0·301, log 20 = 1·301, log 200 = 2·301, and log 2000 = 3·301. The characteristic alone changes.

As the slide rule graduations may represent all numbers having the same significant figures at the same point on the scale, they only give the mantissa portion of the logarithm. For instance, 3, 30, 300, 3000, etc. or 0·3, 0·03, 0·003, etc. must all be taken on the graduation marked 3.

The addition of the logarithm of two numbers gives the logarithm of their product; so that by adding two lengths measured from the slide rule scales, we obtain the product of the two numbers to which these lengths relate.

Division is carried out by subtracting the logarithm of the divisor from the logarithm of the dividend. This is done on the slide rule by subtracting one length from the other.

The arrangement of a scale on the slide against a scale on the rule body enables us to do these additions and subtractions in a very convenient manner by simply moving the slide.

CONSTRUCTION OF THE A. W. FABER CALCULATING RULE "COLUMBUS"

SYSTEM ROHRBERG.

This rule, which is $15^1/_8$ inches long and just under 2 inches wide, consists of three parts: the stock or body, the slide, and the cursor.

The body is made from well-seasoned wood in two parts, each part being grooved to take the tongue of the slide and the guide on the cursor frame. These wooden pieces are reinforced along their centres by strips of metal which prevent warping due to climatic changes. The two parts of the body are joined by spring steel plates so arranged that they exert an even pressure on the slide, thus holding it steady in any position.

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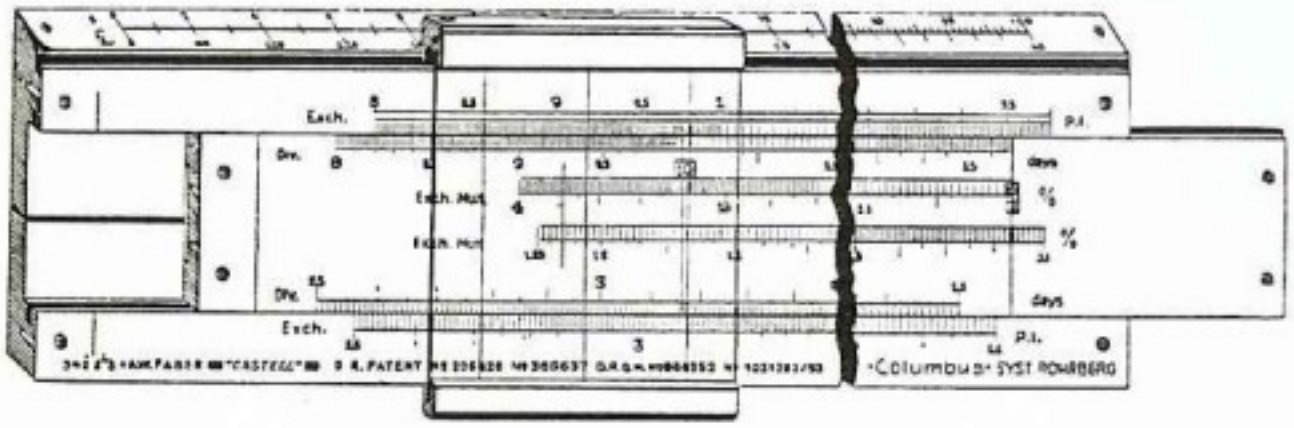
The slide is a strip of wood also reinforced by metal and having a tongue formed along each side. These tongues accurately fit the grooves in the rule body.

The cursor consists of a piece of glass carried on an aluminium frame. It is held over the rule face by means of the grooves along the outside edges of the rule body, and it may be moved over the whole length of the rule face. Four fine lines — two red and two black — are engraved across the glass.

The rule body and slide have been faced with white celluloid upon which the scales have been engraved with mathematical precision.



THE SCALES.

This slide rule carries three scales upon its face, which, to conform as nearly as possible to the usual practice, may be designated A, B, and C; A on the body of the rule, and B and C on the slide. These three scales are each divided into two parts, with a short overlapping portion. Looking at the face of the slide rule, we see that the A scale starts at 0·8 and continues to 3·6 on the upper part of the rule body, while the other half, from 2·5 to 11, will be found on the lower face of the rule body. The B scale, marked "Div" at the left hand end, is on the outer edges of the slide face. Its graduations are exactly the same as those on the A scale although commencing further to the left. Along the centre of the slide, the C scale, marked "Mult", has been engraved in two parts, the first extending from 1 to 4, and

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the second from 3·2 to 12·5. It will be noticed that this scale runs in the reverse direction to the A and B scales, it starts with the highest value to the extreme left of the lower portion and decreases to smallest number, 1, on the right of the upper part.

While the limits given are the numbers as marked on the slide rule scales, they may be, in certain cases, the numbers as actually shown or they may be any numbers having the same significant figures. For instance, the graduation marked 8 would be 0·08, 0·8, 8, 80, 800, 8000, etc., and the one at 11 may be used for 0·011, 0·11, 1·1, 11, 110, 1100, etc. As this applies to all the graduations on the scales, it is only possible to explain the relationship between the various division lines.

In reading the A or B scale and taking the first figure on the upper scale as 8, we find 8·5, 9, 9·5, 10 ⟨1⟩, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 ⟨2⟩, 25, 30 ⟨3⟩, and 35 marked in figures on the upper scale. On the lower scale, we get 25, 30 ⟨3⟩, 35, 40 ⟨4⟩, 45, and so on to 100 ⟨marked 10 on the A scale and 10 Q on B⟩. The last graduation on the right will now be 110. Between 8 and 10 on the upper A or B scale the two large spaces are each divided into ten smaller ones, every one of these is now equal to 0·1; so, reading on the longer lines, we get 8, 8·1, 8·2, 8·3, 8·4, 8·5, 8·6, etc. to 10. These spaces are again divided into five, each equal to 0·02 in this case. By reading the first line after 8, we get 8·02, then 8·04, 8·06, 8·08, and 8·1 ⟨the first long line after 8⟩; after 8·1 the first small division line will now be 8·12, followed by 8·14, 8·16, 8·18, 8·2, and so on. From 10 to 20 each large space, now representing one unit, is divided into ten smaller ones which are again subdivided into two. Consequently the first line immediately after 10 is 10·05, the next line is 10·1, then 10·15, 10·2, 10·25, 10·3, 10·35, 10·4, 10·45, 10·5 ⟨a long line⟩. This order is continued as far as 20, each space being 0·05 greater than the one before. At 20 the spacing changes, and the distance from 20 to 50 is marked at each unit by a long line. Thus, reading on the long lines, we get 21, 22, 23, 24, 25, 26,

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27, 28, 29, 30, and so on to 50. Each of these spaces, bounded by the long lines, is divided into ten smaller spaces by short lines, every fifth line being of intermediate length. On these short lines the readings will be 20·1 ⟨the first line after 20⟩, 20·2, 20·3, 20·4, 20·5, 20·6, 20·7, 20·8, 20·9, 21, and so on to 50. Taking the spacing between 50 and 60 as an example of the division of the scales from 50 to 100, we see that it is divided into ten parts each equal to 1, and these in turn are divided into five spaces each equal to 0·2. After 100 every long line shows 1, and the short ones give the halves or 0·5. It will be noticed that the graduations marked 1 and 10 on A are 1 Q and 10 Q on B. These are called the indices of B, while 1 and 10 on A are the indices of A.

If the first graduation on the upper A or B scale is taken as 0·8, each space will have one tenth the value given in the last paragraph. We should then read 0·8, 0·802, 0·804, 0·806, 0·808, 0·81 for the first five division lines immediately after 8. After 1, we should get 1·005, 1·01, 1·015, 1·02, 1·025, 1·03, and so on. Following 1·2 we should read 1·205, 1·21, 1·215, 1·22, 1·225, etc. From 2 we should get 2·01, 2·02, 2·03, 2·04, 2·05, 2·06, 2·07, 2·08, 2·09, 2·1. Instead of 8 we might take the first graduation as 80, when we should get 80·2, 80·4, 80·6, 80·8, 81; and 100·5, 101, 101·5, 102, 102·5, 103, etc. Whatever we call these graduations, we read the same significant figures at the same place on the scales and move the decimal point to the right or left as required.

From the foregoing, the C scale should not be difficult to understand, but, since the increase is from right to left, considerable care is required in reading. If the line at the extreme right is taken as 1 ⟨this point is marked 1 P in red⟩ the next short line will be 1·005, and the second graduation will be 1·01, then 1·015, 1·02, 1·025, 1·03, 1·035, 1·04, 1·045, 1·05; this order continues as far as 2. From 2 to 5 the increase is 0·01 per graduation, and after 5 it is 0·02 up to 10 ⟨10 P⟩. From 10 to 12·5 each graduation represents 0·05. As on the A and B scales, these values may be increased ten, a hundred, a thousand times or more.

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For instance, should the position of a number like 10,600 be required on scale C, it may be found on the upper or lower part of the scale. In the first case, the graduation marked 1 P would be 10,000 and, counting the longer lines towards 11,000 ⟨1·1⟩, we find the required position on the sixth, since each of these spaces now equals 100. On the lower C scale 10,600 would be on the sixth large division line after 10 P. Had the number been 10,650, it would have been found on the short graduation immediately after the position given for 10,600.

On all three scales there are marks at 0·4536 and 2·53995. The former is used when turning pounds into kilogrammes or vice versa, the latter when converting inches to centimetres or centimetres to inches.

The cursor is a great help in finding values which do not fall exactly on the division lines or in reading between the different scales. It may be set so that its line shows a half or a quarter of the space between any two graduations, or even smaller parts on some portions of the scales. When graduations on the B or C scale are to be set to points on the A scale, the cursor line is put over the latter and the slide is moved so as to bring the required graduation under the cursor line. In this way the setting may be easily and accurately made. The centre cursor line should be used for all ordinary calculations, care being taken not to confuse it with the red lines or the short black line. The slide rule should be held so that the light falls perpendicularly to its length, as only then can the cursor line be accurately set over the division line. When the light comes from the side a shadow will be cast alongside of the graduation, thus causing the latter to appear broader than it really is.

In calculations involving movements of the slide, the rule is conveniently held with the thumb and second finger against its edges while the first finger is applied to the end of the slide for the purpose of pushing or steadying it; the slide is held by its edges in the other hand. It is helpful if the tip of the first finger

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or thumb of the hand holding the slide touches the rule body when the setting is being completed. Considerable practice is needed before the setting can be done efficiently.

Three additional scales will be found on the upper edge of the rule body; the first is for converting shillings to decimals of a pound; the second for converting pence to decimals of a pound; and the third gives the percentage relationship between cost and selling prices.

On the first scale each shilling up to 20 will be found alongside of the corresponding decimal of a pound. For instance, 6 s. is £ 0·3, 11 s. is £ 0·55, £ 0·75 is 15 s., £ 0·35 is 7 s.

On the second scale the pence do not coincide with the decimals of a pound at all points, and so it becomes necessary to take the nearest graduation or to estimate the distance from the nearest graduation for an accurate answer. It is seen that 6 d. is £ 0·025, 1 d. is £ 0·0042, 4 d. is £ 0·0167, 11 d. is 0·046, and 3 d. is £ 0·0125. In converting £ 7. 8 s. 3 d. to pounds and decimals of a pound both scales are used, and the answer is seen to be £ 7 + £ 0·4 + £ 0·0125 = £ 7·4125.

EXAMPLE. £ 11. 13 s. 7 d. = £ 11 + £ 0·65 + £ 0·029 = £ 11·679.

The shillings and pence are found separately on their respective scales and added together for the answer, which is £ 11·679.

EXAMPLES.

£ 37. 5 s. 2 d. = £ 37 + £ 0·25 + £ 0·0083 = £ 37·2583.
£ 247. 7 s. 8 d. = £ 247 + £ 0·35 + £ 0·0333 = £ 247·3833.

To find the shillings and pence from their decimal equivalent of a pound the above procedure is reversed; part of the decimal will be found on the shilling scale, and the remainder will be found on the pence scale.

EXAMPLES.

£ 17·384 = £ 17 + £ 0·35 + £ 0·034 = £ 17. 7 s. 8 d.
£ 148·796 = £ 148 + £ 0·75 + £ 0·046 = £ 148. 15 s. 11 d.
£ 34·204 = £ 34 + £ 0·2 + £ 0·004 = £ 34. 4 s. 1 d.
£ 65·008 = £ 65 + £ 0.0 + £ 0·008 = £ 65. 0 s. 2 d.

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In the last example, the decimal being less than 0·05, there will be no shillings.

The third scale will be understood from the letters P. P. ⟨purchase price⟩ and S. P. ⟨selling price⟩. From the scale it is seen that 25% profit on the purchase price is 20% on the selling price; and 100% on the purchase price is 50% on the selling price. For instance, an article costing £40 is sold for £80. The profit on the purchase price is 100% and on the selling price 50%.

MULTIPLICATION.

For multiplication on this slide rule either the A and B or the A and C scales may be used, but, since the latter are more convenient for this purpose, they will be considered first.

To find the product of two numbers using the A and C scales, set one factor on C to the other on A, and read the answer on A in line with 1 P or 10 P, whichever is available.

The factors may be on adjacent A and C scales, such as both top or both bottom scales, or they may be on opposite scales, such as one top and one bottom. In the first case, the answer will be read on the A scale adjacent to 1 P or 10 P, while in the second case the product will be found on the A scale furthest from 1 P or 10 P. It will be helpful to note carefully that 10 P is 10 on the lower scale and 1 P is 1 on the upper scale. Therefore, to find the product of two factors on adjacent A and C scales, we must read on the A scale adjacent to 10 P ⟨lower A⟩ or adjacent to 1 P ⟨upper A⟩. While if the factors are on opposite scales, the product must be read on the opposite A scale in each case, below 1 P or above 10 P. This may be summed up in the following rule:

RULE. If we set the factors on adjacent scales we read on the adjacent scale; if we set the factors on opposite scales we read on the opposite scale.

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The above rule holds for all calculations on this slide rule.

EXAMPLE. Multiply 24 by 2.

Put the centre cursor line over 24 on the upper A scale, draw the slide out until 2 on C comes under it, and since the factors were set on adjacent scales, read the product, 48, on A below 10 P.

EXAMPLE. Multiply 85 by 31.

Set the cursor over 85 on the upper A scale, bring 31 on the upper C scale under it, and read the product, 2635, on the upper A scale against 1 P.

These factors were set on adjacent scales, and as 1 P is on the upper C scale, the product must be on the upper A scale. Should there be any difficulty in placing the decimal point in the last example, a rough mental calculation, such as 90×30, indicates that the answer will be about 2700.

EXAMPLE. Multiply 1·907 by 18·87.

Set the cursor line over 1·907 on the upper A scale ⟨this position is between the first two division lines directly after 1·9⟩, move the slide until 18·87 on the upper C scale comes under the cursor line, and read the answer, 36, against 10 P on the lower A scale. This answer will also be found above 1 P.

In the last example, we set the factors on adjacent scales and so must read the answer on the A scale nearest to the index used

EXAMPLE. Multiply 425 by 12.

Set the cursor line over 425 on the lower A scale, bring 12 on the upper C scale to it, and, since opposite scales were used, read 51, the significant figures in the answer, on the lower A scale under 1 P. A rough calculation ⟨400×12⟩ shows that the answer will be 5100.

Occasionally it may be helpful to move the decimal points in the factors so as to leave one figure to the left of each. The

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approximate product will then be apparent, and the decimal point in the answer may be adjusted to compensate for the previous movement. For instance, 456×789 could be taken as 4·56× 7·89×100×100. The hundreds do not come into the slide rule calculation, but simply show that the decimal point must be moved four places to the right in the answer. In estimating the answer, we may find the product of 4×8, from which the answer is seen to be about 32×10,000. By setting 7·89 on C to 4·56 on A, we read 35·98 against 10 P on the lower A scale; moving the decimal point four places to the left, we obtain the answer, 359,800. We cannot read closer than this, but the difference between the result found on the slide rule and the exact product is only 16. This shifting of the decimal point need not actually be done as the factors can be considered as consisting of units and decimals, the number of places being counted at the end of the calculation.

EXAMPLE. Multiply 316 by 85.

Set 85 on C against 316 on A, and read the significant figures, 2686, against the red line P. To estimate the number of digits, this example may be taken as 3×9×1000, which shows that the answer is approximately 27,000. The required product is, therefore, 26,860.

EXAMPLE. Multiply 9·58 by 13·37.

Bring 13·37 on C to 9·58 on A, and since opposite scales are used, read the product, 128·1, above 10 P on the upper A scale.

In most cases three figures can be found directly from the graduations, but the fourth must sometimes be estimated from the position occupied by the cursor line in the spaces. This can be done with considerable accuracy after a little practice. The last figure in a product of four digits can be always found by inspection of the factors.

EXAMPLE. Multiply 84 by 78.

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The reading under 10 P is 655, and from the factors the last figure is seen to be 2, so the answer is 6552.

EXAMPLE. Multiply 25,947 by 642.

As we cannot be certain of the position of the fifth figure on the scale, it may be omitted and the fourth increased by 1 ⟨since the fifth figure is over 5⟩. The problem is then 25,950×642. The reading above 10 P gives the significant figures 1666. A rough mental estimate, such as 3×6×1,000,000, shows that the answer contains eight figures, and, therefore, it is 16,660,000. The exact product is 16,657,974.

As the decimal point has no place in slide rule calculations, it will be apparent that decimals are multiplied in exactly the same way as whole numbers. They may be, if preferred, first changed to whole numbers.

EXAMPLE. Multiply 2·478 by 0·437.

We read the significant figures in the product, 1083, in the usual manner. In estimating the number of digits in the answer, we may take the second factor as 0·5 and the answer as approximately half the first factor. The product is, therefore, 1·083.

EXAMPLE. Multiply 0·468 by 0·0243.

This may be changed to $\frac{4{\cdot}68 \times 2{\cdot}43}{1000}$.

Setting 2·43 on C to 4·68 on A, we read 11·37 over 10 P; moving the decimal point three places to the left, as shown by the denominator, we obtain 0·01137, the required answer.

The method already explained for multiplication of two factors can be applied to any number of factors; the cursor line is left over the product of the first two factors; the third factor on C is brought under it and the cursor is moved over the second product against 1 P or 10 P; the fourth factor on C is brought under the cursor line, and the cursor is moved over the third product. This may be continued for any number of factors without

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reading the intermediate products. It is, however, necessary to notice whether each product comes on the upper or lower A scale so that the position of the final answer may be clear. When the number of figures in the answer is unknown, it may be found by a rough multiplication.

EXAMPLE. $8{\cdot}4 \times 1{\cdot}62 \times 9{\cdot}36 \times 4{\cdot}68 = 596.$

Put the cursor over 8·4 on A, bring 1·62 on C to it, and move the cursor over 10 P. The first product is on the upper scale. Set 9·36 on C under the cursor, and move the latter over 10 P. The product is again on the upper scale. Bring 4.68 on C under the cursor line, move the cursor over 1 P, and read the answer, 596, on the lower A scale.

In the above example it would have been very simple to estimate the sizes of the various products as the calculation progressed and to fix the position of the decimal point at once in the final answer. For instance, for the first product the cursor line is over 1361. Obviously this must be 13·61. The second reading is 1274, and since $13{\cdot}61 \times 9{\cdot}36$ is about 130, the second product is 127·4. The figures in the final product are 596, and as this must be about 120×5, the answer is 596.

The method used in fixing the position of the decimal point is a matter for individual choice. These questions seldom arise in practical work, as familiarity with the particular type of calculation used in his business will indicate to the operator approximately what size of answer he should get, and should he obtain one ten times or one tenth this the error will be obvious.

EXAMPLE. $72 \times 0{\cdot}025 \times 14{\cdot}46 \times 368 = 9580.$

Set 0·025 on C to 72 on A, move the cursor over 10 P ⟨since opposite scales are used the product will be on the upper A scale⟩, the first product is 1·8. Bring 368 under the cursor line, and read about 662 under 10 P. Bring 14·46 to this point and read the answer, 9580, under 1 P.

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EXERCISES.

$117{\cdot}3 \times 5{\cdot}862 = 687{\cdot}6.$
$257{\cdot}6 \times 804{\cdot}9 = 207{,}300.$
$90{\cdot}47 \times 22{\cdot}86 = 2068.$
$142{\cdot}7 \times 7{\cdot}864 = 1122$
$19{\cdot}38 \times 54{\cdot}93 = 1065.$
$42{\cdot}73 \times 1{\cdot}807 = 77{\cdot}21.$
$17{\cdot}36 \times 30{\cdot}48 = 529.$

$14{\cdot}72 \times 0{\cdot}5873 = 8{\cdot}645.$
$2{\cdot}679 \times 0{\cdot}07358 = 0{\cdot}197.$
$1937 \times 0{\cdot}4736 = 917{\cdot}4.$
$17{\cdot}36 \times 0{\cdot}3472 = 6{\cdot}03.$
$47{\cdot}38 \times 192{\cdot}8 = 9135.$
$48{\cdot}46 \times 7{\cdot}365 = 356{\cdot}9.$
$273{\cdot}6 \times 45{\cdot}72 = 12{,}510.$

$49{\cdot}25 \times 0{\cdot}1265 \times 368{\cdot}1 \times 0{\cdot}5242 = 1202.$
$746{\cdot}3 \times 0{\cdot}0046 \times 86{\cdot}3 \times 2{\cdot}846 = 843.$
$2{\cdot}222 \times 1{\cdot}487 \times 9{\cdot}79 \times 78{\cdot}25 = 2531.$
$273{\cdot}8 \times 92{\cdot}45 \times 0{\cdot}0086 \times 0{\cdot}0324 = 7{\cdot}05.$
$1129 \times 0{\cdot}000068 \times 7246 \times 4821 = 2{,}682{,}000.$
$14{\cdot}72 \times 96{\cdot}41 \times 0{\cdot}004231 \times 3{\cdot}624 = 21{\cdot}76.$

DIVISION.

The A and B scales are used for the solution of problems in division as well as for combined multiplication and division.

By setting the divisor on B in line with the dividend on A, we find the quotient on A against 1 Q or 10 Q. These points are 1 and 10 on the B scale, and Q indicates that quotients are to be read against them. As is the case with P on the C scale, the point 1 Q is on the upper B scale and 10 Q is on the lower. The answers to problems in division are found on the A scale in accordance with the following rule:

RULE. If we set the divisor and dividend on adjacent scales we read the quotient on the adjacent scale; if we set the divisor and dividend on opposite scales we read the quotient on the opposite scale.

As before the adjacent or opposite scale refers to the A scale nearest to or furthest from the B scale on which 1 Q or 10 Q is situated. For instance, the upper A scale would be an adjacent

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scale to 1 Q but an opposite scale to 10 Q, while the lower A scale would be adjacent to 10 Q and opposite to 1 Q.

EXAMPLE. Divide 28 by 2.

Set the centre cursor line over 28 on A, bring 2 on B under it, and, if the upper A scale was used in setting, read the quotient, 14, above 1 Q ⟨adjacent scales⟩, or if 28 was taken on the lower A scale, read above 10 Q ⟨opposite scales⟩.

EXAMPLE. Divide 45 by 5.

Set the cursor over 45 on A, put 5 on B under it, and read 9 on A over 1 Q or under 10 Q, since in each case this will be the adjacent scale.

EXAMPLE. Divide 48 by 4.

Set the cursor over 48 on the lower A scale, move the slide until 4 on B comes under the cursor line, and read 12 on the upper A scale above 1 Q. This setting was made on adjacent scales, and so the quotient must be read on a scale adjacent to 1 Q.

EXAMPLE. Divide 245 by 17·5.

Set 17·5 on B to 245 on A, move the cursor over 1 Q, and, since adjacent scales are used, read the quotient, 14, on the upper A scale under the cursor line.

EXAMPLE. Divide 1922 by 1887.

Place the cursor line over 1922 on the upper A scale, set 1887 on the B scale to it, and read the quotient, 1·019, on A above 1 Q. This reading will also be found below 10 Q.

The quotients will be easier to read if the cursor is moved over Q and the reading taken under the cursor line.

EXAMPLE. Divide 176·8 by 44·67.

Since a lower and an upper scale are used, the answer, 3·958, is read below 1 Q.

EXAMPLE. Divide 47·36 by 183·4.

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Setting 183·4 on B to 47·36 on A and moving the cursor over 1 Q, we read the quotient, 0·2582, on the lower A scale under the cursor line.

EXAMPLE. Divide 67·38 by 315·9.

Bringing 315·9 on B to 67·38 on A, we obtain the answer, 0·2133, on A above 1 Q.

In the last example there are two settings that give this result, depending on whether the upper or lower B scale is used, and in either case the answer is found on the upper A scale.

A little consideration will show where the decimal point should be placed in these answers. The last example, for the purpose of estimating the size of the quotient, could be taken as $6 \div 30$, which shows that the answer is about 0·2. The shifting of the decimal point the same number of places in the dividend and divisor does not, of course, alter the value, but it frequently causes the problem to assume a more convenient form for rough mental calculation.

EXAMPLE. At a rate of exchange of 20·11 convert 175·50 marks to pounds sterling.

Set the cursor over 175·5 on the upper A scale, bring 20·11 on B to it, and read £ 8·727 on A below 10 Q. From the decimal scales for pence and shillings this is seen to be £ 8. 14 s. $6^1/_2$ d.

EXAMPLE. Find the number of pounds sterling in 225 dollars when the rate of exchange is 4·62.

Put the cursor line over 225 on A, bring 4·62 under it, move the cursor over 1 Q, and read £ 48·7 on the lower A scale. This is £ 48. 14 s. 0 d.

A divisor that consists of a number of terms need not be multiplied out before dividing it into the dividend; the simplest way is to bring the first term on B to the dividend on A, move the cursor over the quotient against Q, put the second term of the divisor on B under the cursor, move the cursor over the second quotient, and so on. In this way the final quotient will be found without the necessity of reading at any of the inter-

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mediate stages. As in multiplication, we must notice the scales upon which the separate quotients are in order to find the answer at the end of the calculation, except, of course, when the approximate answer is known; we should, in the latter case, see from the approximate figures whether to read on the upper or lower A scale.

EXAMPLE. $\dfrac{645}{267 \times 986}$.

Put the cursor over 645 on the lower A scale, set 267 under it, move the cursor over 10 Q, bring 986 under the cursor line, and read the significant figures, 245, above 10 Q. From a rough calculation, such as

$$\frac{6{\cdot}5}{2{\cdot}5 \times 10} \times \frac{100}{100 \times 100}, \text{ we obtain } \frac{2{\cdot}6}{1000} = 0{\cdot}0026.$$

The answer will, therefore, be 0·00245.

It occasionally happens that the slide projects too far from the end of the rule body to allow a required value to be used on scale B. When this is so the slide must be re-set by putting the cursor over one of the indices ⟨P or Q⟩ and bringing the corresponding one at the other end of the slide to the cursor line. The cursor is then moved over the required number and the calculation carried on as before. After re-setting, the readings will be in the reverse order; what was on adjacent scales will now be on opposite ones and vice versa.

EXERCISES.

$5{\cdot}608 \div 0{\cdot}7345 = 7{\cdot}635.$	$645 \div 0{\cdot}478 = 1350.$
$8{\cdot}972 \div 18{\cdot}26 = 0{\cdot}4914.$	$0{\cdot}198 \div 0{\cdot}256 = 0{\cdot}774.$
$372{\cdot}5 \div 22{\cdot}68 = 16{\cdot}42.$	$1871 \div 235 = 7{\cdot}96.$
$19{\cdot}84 \div 55{\cdot}55 = 0{\cdot}3572.$	$2{\cdot}847 \div 60{\cdot}75 = 0{\cdot}04686.$
$\frac{17}{33} = 0{\cdot}5152.$	$\frac{11}{75} = 0{\cdot}1467.$
$\frac{11}{16} = 0{\cdot}6875.$	$\frac{19}{80} = 0{\cdot}2375.$

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Combined Multiplication and Division.

Since division on the A and B scales consists of subtracting a length proportional to the logarithm of the divisor from another length proportional to the logarithm of the dividend, the process may be reversed and the two lengths added, in which case the product of the two numbers would be obtained. As the gauge point 1 Q or 10 Q is the point from which the length on the slide is measured, the product must be read at the other end, that is, against the number that is taken on the B scale. The total length, and hence the product, will be found on the A scale.

Remembering that the product is now read against a factor, we may use the rule already given for the position of the answer.

Rule. If we set on adjacent scales we read on adjacent scales; if we set on opposite scales we read on opposite scales.

If we set 1 Q to a factor on the upper A scale, we read the product on the upper or lower A scale, depending on whether the second factor is on the upper or lower B scale; the setting of 10 Q to a factor on the lower A scale means that the product will be read above the second factor if it is on the upper B scale, or below it if it is on the lower B scale. Again, if 1 Q is set to a factor on the lower A scale, the product will be on A over or under the second factor, depending on whether it is on the lower or upper B scale; and by setting 10 Q to a factor on the upper A scale, we find the answer above or below the second factor, depending on whether it is on the lower or upper B scale.

This question of selecting the answers on the A scale has been explained at considerable length because it is of the utmost importance to understand which reading is to be taken. Uncertainty on this point will make it impossible for anyone to use this slide rule efficiently.

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EXAMPLE. Multiply 125 by 56.

Bringing 1 Q to 125 on A and moving the cursor over 56 on B we read the product, 7000, on the lower A scale under the cursor line. In setting 1 Q to the upper A scale, we were using adjacent scales and so must read on the scale adjacent to the second factor.

EXAMPLE. $235 \times 781 \times 798 = 146{,}500{,}000$.

Set the cursor over 235 on the upper A scale, bring 10 Q to it, move the cursor over 781 on B, the product of these factors will be on the upper A scale, bring 10 Q under the cursor again, put the cursor over 798 on B, and read the figures 1465 on A. A rough calculation will show that the answer will be 146,500,000.

Combined multiplication and division problems are very simply worked if a multiplication follows a division and if only the scales A and B are used. In these calculations the slide is moved for division and the cursor for multiplication. When the slide is in position to indicate a quotient opposite one of the indices it is also in position for the next multiplication, which may be carried out by moving the cursor over the required factor on B. No results need be read until the final answer is reached.

EXAMPLE. $\dfrac{24{\cdot}5 \times 678 \times 45{\cdot}2}{345 \times 57{\cdot}1 \times 1{\cdot}08} = 35{\cdot}29.$

Bring 345 on the upper B scale to 24·5 on A, move the cursor over 678 on B, bring 57·1 under the cursor, move the latter over 45·2, bring 1·08 under the cursor, move the cursor over 10 Q, and read 35·29 on the lower A scale.

In the last example, we see from the above rule that all these quotients and products would be on the lower scale, since adjacent scales were used with the factors on the lower B scale in each case.

By shifting the decimal points in the numerator and denominator terms an approximate answer may be obtained without difficulty. For instance, the above example could be changed without altering its value to —

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$$\frac{2{\cdot}45\times4{\cdot}52\times6{\cdot}78}{3{\cdot}45\times5{\cdot}71\times1{\cdot}08}\times 10.$$ and approximately to —

$$\frac{2\times5\times7}{3\times6\times1}\times 10 = 40$$ almost.

Alternatively, having set the problem out so that we have only units to the left of the decimal points, the size of the result at each stage of the calculation will be obvious. Working the above example again, we set 3·45 on B to 2·45 on A — the quotient, which is about 0·71, is under 10 Q; move the cursor line over 4·52 on B — the product on the lower A scale is about 3·2; bring 5·71 on B under the cursor line — this quotient is under 10 Q and is about 0·56; move the cursor over 6·78 on B — the product under the cursor line on the lower A scale is about 3·8; set 1·08 on B under the cursor line and read 3·529 on A under 1 Q. As shown in the example, this must be multiplied by 10, and the answer is, therefore, 35·29.

EXAMPLE. $$\frac{842\times1760\times382.5}{7361\times2383\times546}=0{\cdot}05918.$$

By shifting the decimal points, we change this to —

$$\frac{8{\cdot}42\times1{\cdot}76\times3{\cdot}825}{7.361\times2{\cdot}383\times5{\cdot}46}\times\frac{1}{10}.$$

Set 7·361 on B to 8·42 on A, move the cursor over 1·76 on B, bring 2·383 under the cursor, move the cursor over 3·825 on B, put 5·46 under the cursor, and read 0·5918 on A under 10 Q. Divide this by 10, which makes the answer 0·05918.

MULTIPLICATION OF THREE NUMBERS.

The following, while hardly having a general application, is a method which, in certain calculations, may be used to give very quick results; it could be used to advantage in estimating materials, prices, etc., when such calculations have to be done

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frequently. To use it occasionally on different kinds of problems would probably lead to confusion.

The index 10 P is displaced to the right of 1 Q a distance equal to the space between the two red cursor lines, and by using these two lines we can connect the B and C scales. In this way the three scales may be utilised for one setting, such as for finding the product of three factors with one movement of the slide.

EXAMPLE. $28 \times 96 \times 124 = 333{,}300$.

Set 96 on C to 28 on A, move the left hand cursor line over 124 on B, and read 3333, the significant figures in the product, on A under the right hand cursor line.

EXAMPLE. For the purpose of calcutating freight charges find the cubical contents of the following packing cases, their overall dimensions being:

1. length	8 ft.,	height 4 ft. 6 in.,	width 5 ft. 9 in.
2. "	6 ft. 6 in.,	" 2 ft. 8 in.,	" 6 ft. 4 in.
3. "	7 ft. 9 in.,	" 4 ft. 3 in.,	" 3 ft. 3 in.
4. "	9 ft. 8 in.,	" 5 ft. 9 in.,	" 6 ft. 4 in.
5. "	2 ft. 6 in.,	" 3 ft. 7 in.,	" 4 ft. 11 in.

1. Set 8 on C to 4·5 on A, move the left hand cursor line over 5·75 on B, and, under the right hand cursor line, read 207 cubic feet on A.

2. Set 6·5 on C to 2·667 on A, move the left hand cursor line to 6·333 on B, and read 109·7 cubic feet on A under the right hand cursor line.

3. Set 4·25 on C to 7·75 on A, move the left hand cursor line over 3·25 on B, and, under the right hand cursor line, read 107 cubic feet.

4. Set 9·67 on C to 5·75 on A, put the left hand cursor line over 6·333, and read 352 cubic feet on A under the right hand cursor line.

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5. To find 7 in. and 11 in. in decimals of a foot, set 1 Q to 12 on A and, above 7 and 11 respectively on A, read 0·583 and 0·917 on B. Set 2·5 on C to 3·583 on A, put the cursor over 4·917 on B, and read 44·05 cubic feet on A.

DIVISION WITH TWO DIVISORS.

To divide a number by two divisors with one setting, put one divisor on B to the number on A, bring the right hand cursor line over the second divisor on C, and read the quotient on A under the left hand cursor line.

EXAMPLE. $\frac{3560}{746 \times 86} = 0{\cdot}0555.$

Set 746 on the B scale to 356 on the upper A scale, put the right hand cursor line over 86 on C, and, under the left hand cursor line, read the quotient, 0·0555, on A.

RECIPROCALS AND SQUARE ROOTS.

It has already been explained how multiplication and division are carried out on the A and B scales by adding and subtracting lengths respectively. These processes are reversed on the A and C scales since the values on C are reciprocals. For instance, on the A and C scales 8×4 is really worked as $8 \div {}^1/_4$ and $8 \div 4$ as $8 \times {}^1/_4$.

When the slide is completely in the rule body so that the long line at the left hand end is continuous across the rule body and slide, each value on A will be in line with its reciprocal on C. For this purpose the scales are taken in opposite pairs — one top and one bottom. For example, under 2 on A read 0·5 on the lower C scale; over 2·5 read 0·4; under 3 read 0·3333; over 5 on the lower A scale read 0·2 on the upper C scale; over 8 read 0·125.

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With the slide entirely in the rule body, each pair of values in line on opposite A and C scales gives a constant product of 1 when multiplied together. The product, of course, may be any number having 1 as its significant figure.

This is so since the indices 1 P and 10 P are against 1 and 10 respectively on the A scale. And when 1 P or 10 P is set to any number on A, we find in line on A and C, all factors of that number; this property of these scales has many applications and may be utilised for the extraction of square roots. The square root af a number is found by setting P to the number on A and finding the two equal factors. These will be in line on A and C, and are the square roots. As the approximate size of the roots will be known, no difficulty will be found in selecting the correct one from the two answers given to each setting. For instance, with 1 P set to 2·75 on the upper A scale, we read 1·658 on the upper A and C scales, while at the same places on the lower scales we read 5·241. The former is the square root of 2·75 obviously, and the latter of 27·5. Two other coinciding values will be found on the opposite A and C scales at 2·95 and 9·328. These relate to the graduations indicated by 1 P on the lower A scale, and are respectively $\sqrt{8{\cdot}7}$ and $\sqrt{87}$. We cannot be in doubt as to which numbers these roots apply, as the rule given for multiplication shows that with factors on adjacent scales we read on adjacent scales, in this case we should read above 1 P; therefore with the number above 1 P the roots will be on adjacent scales; with the number below 1 P the roots must be on opposite scales. This applies in the reverse order to 10 P. By moving the decimal points in the four roots given above, we could find the square root of any number having the significant figures 275 or 87. If the number is pointed off in periods of two figures as in arithmetic, the number of figures in the root will be at once apparent as well as the first figure.

EXAMPLE. $\sqrt{36840} = 192.$

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Pointing this off from the decimal point, we obtain 3,68,40. Three figures will, therefore, be required, and the first figure will be 1. Set 10 P to 3684 on A, move the cursor over the rule face until it is over the same value on adjacent A and C scales ⟨adjacent scales are required because the number is below 10 P⟩, the root is seen to be 192 on the upper scales. The other coinciding point cannot be considered since the roots are on opposite scales. They relate to the number above 10 P.

EXAMPLE. $\sqrt{0{\cdot}0146} = 0{\cdot}1208$.

Pointing off, we get 0·01,46, and setting 1 P to 146 on A, we find, on adjacent scales, the root 0·1208.

FOREIGN EXCHANGE CALCULATIONS.

At the left hand end of the A and C scales the letters «Exch» will be noticed. These letters are marked in black and red on the different scales to call attention to the fact that those parts of the A and C scales must be used together which have the letters of the same colour: the upper A and lower C scales, and upper C with lower A. In this order the A and C scales are used for finding the equivalent value of currency in different countries. By setting the slide completely in the rule body, the dark line at the left hand end of the rule is continuous across the rule body and slide in this position, and moving the cursor over the rate of exchange on A, we read the value of the unit of the currency of one country in terms of money of another country on C. For instance, with 4·85 dollars to the pound, the dollar is equal to £ 0·2062 or 4s. $1^1/_2$ d. To carry out this conversion, set the slide right in the rule body, move the cursor over 4·85 on A, and read £ 0·2062, the price of $ 1, under the cursor line on the upper C scale. This may be changed to shillings and pence by means of the scale on the upper edge of the rule body. We find that £ 0·2 = 4s., leaving £ 0·0062 to be taken on the pence scale, where it is seen to be $1^1/_2$ d.

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EXAMPLES.

When £ 1 = 33·90 pesetas, 1 peseta = £ 0·0295 = 7·1 d.
When £ 1 = 11·60 florins, 1 florin = £ 0·0862 = 1 s. $8^{3}/_{4}$ d.
When £ 1 = 4·29 dollars, 1 dollar = £ 0.2331 = 4 s. 7·9 d.
When £ 1 = 24·60 francs, 1 franc = £ 0·04065 = $9^{3}/_{4}$ d.

In the first example, the rate of exchange, 33·9, will be found at the right hand end of the upper A scale or to the left of the lower A scale, the latter must be used as the C scale is not far enough to the right for the other point. The decimal, 0·1, in the answer is obtained by estimating the distance 0·0295 is beyond 7 d. on the scale at the upper edge of the rule body, this length is about one tenth of the space between 7 d. and 8 d.

The following are taken from a New York Exchange quotation:

100 f. ⟨Paris⟩ = $ 3·92; at the same rate $ 100 = 2551 f. This is read on the upper C scale above 3·92 on A.

100 fl. ⟨Amsterdam⟩ = $ 40·04; above 40·04 on A read $ 100 = 249·75 fl. on C.

100 mk. ⟨Berlin⟩ = $ 23·69; under 23·69 on A read $ 100 = 422·1 mk.

A sum of money is to be transferred from Berlin to Amsterdam. In Berlin the exchange is quoted 100 fl. 168·80 mk. In Amsterdam the quotation is 100 mk. = 59.35 fl. By reading on C over 59·35 on A we find the price of 100 florins at the rate in Amsterdam. This is seen to be 168·5 marks. It is, therefore, advantageous to remit marks.

Copenhagen is quoted in Zurich at 111, this will be seen from the slide rule to be equivalent to 90·09 in Copenhagen. Zurich, on the same date, is quoted 90·35 in Copenhagen, which is seen to 110·70 in Zurich.

The slide rule will be found of assistance in obtaining solutions by means of the Chain Rule. In this case, the methods of combined multiplication and division may be used.

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EXAMPLE. Find the number of florins in a pound, when 1 pound equals 20·42 marks, 100 marks equals 23·69 dollars, 40·04 dollars equals 100 florins.

$$\begin{aligned} x \text{ fl.} &= £\ 1 \\ £\ 1 &= 20{\cdot}42 \text{ mk.} \\ 100 \text{ mk.} &= \$\ 23{\cdot}69 \\ \$\ 40{\cdot}04 &= 100 \text{ fl.} \end{aligned}$$

$$x = \frac{1 \times 20{\cdot}42 \times 23{\cdot}69 \times 100}{1 \times 100 \times 40{\cdot}04}$$

$$\text{or } x = \frac{20{\cdot}42 \times 23{\cdot}69}{40{\cdot}04}$$

Set 40·04 on B to 20·42 on A, and since the next factor is too much to the right, put the cursor over 1 Q and push the slide through until 10 Q comes under the cursor line, now move the cursor over 23·69 on B and read 12·08 florins, the required answer, on A.

EXAMPLE. The pound is quoted at 20·41 in Berlin and at 25·25 in Zurich. Swiss francs are 80·07 in Berlin. Which is the better way of remitting pounds to Berlin: 1. direct from London, or 2. through Zurich?

Multiplying $\frac{25{\cdot}25 \times 81{\cdot}07}{100}$, we find that 20·47 marks are obtained through Zurich; this is, therefore, the better way.

It will be understood, of course, that the hundred in the above denominator does not influence the slide rule calculation in any way, nor can it be set on the rule; it simply means that the decimal point in the result must be moved two places to the left.

EXAMPLE. Convert 5263 dollars to pounds at an exchange of 4.855.

Set 4855 on B to 5263 on A, move the cursor over 1 Q, and read £ 1084 on the upper A scale.

EXAMPLE. Convert 1342 dollars to marks at an exchange of 4·51.

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Set 1 Q to 1342 on A, move the cursor over 4·51 on B, and read 6052 marks on the lower A scale.

EXAMPLE. How many marks can be obtained for £ 16. 17s. 4d. at an exchange of 20·34?

£ 16. 17s. 4d. = £ 16·867. Set 1 Q to 16·867 on A, move the cursor over 20·34 on B, and read 343·1 marks on the upper A scale.

Further foreign exchange calculations will be found in the chapter on proportion.

RATIO AND PROPORTION.

If 1 Q is set to 2 on the A scale a ratio of 2 to 1 will be set up between the two scales, and by setting 1 Q to any point x on A, we obtain a ratio of x to 1 between all coinciding points on the A and B scales. This makes the slide rule particularly convenient for the solution of problems in proportion and comparisons between different systems of units.

EXAMPLE. Two men, who earn respectively £ 245 and £ 135, were given an increase, after which the first received £ 285. What would the second one get if their salaries were increased in the same ratio?

Set 245 on B to 285 on A, and against 135 on B, read the answer, £ 157, on A.

EXAMPLE. The cost of production of a certain article is decreased in ratio 10:9. The selling price, which is 5s. 6d., is to be decreased in the same ratio to the nearest penny. What is the new price?

If 10 ⟨10 Q⟩ on B is set to 9 on A, the latter will be the reduced prices and the former will give the original prices. With the slide thus set, put the cursor over 66d. on B and read 59·4d. on A. This is, to the nearest penny, 4s. 11d. This example could also be worked in shillings; the required price, 4·95s. will be found on A under 5·5 on B. To reduce 0·95s. to pence, set 12 on B to 1 on A, and read 11·4d. on the upper B scale under 0·95 on A

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EXAMPLE. A retailer reduces the profit on certain articles in the ratio 8:7 and finds that his sales increase in the ratio 3:4. In what ratio does his profit increase or decrease?

Four articles are now sold in place of three, so set 4 on B to 3 on A, and move the cursor over 8 on B. B will now be sales after the reduction and A will be sales before it. The profit on B per article, at present 8, must become 7, and this is accomplished by bringing 7 on B under the cursor. The scales are now set to the required ratio which may be read off anywhere. It is seen that 7 on B coincides with 6 an A. The ratio is, therefore 6:7, and since the point on B is greater than the one on A, there will be an increase in profit.

EXAMPLE. Find the cost of 350 kg., 560 kg., 140 kg., and 325 kg. if 1000 kg. cost $ 1785. Also find the weights obtainable for $ 1500. $ 850, $ 650, and $ 950.

The known weight on one scale must be set to its price on another scale. Therefore, set $ 1785 on the upper B scale to 1000 kg. ⟨1⟩ on the upper A scale. With this setting the B scale will be dollars, and the A scale will be kilogrammes. Bring the cursor line over 350 kg. on A and read the corresponding price, $ 625, on B under it; against 560 kg. on A read $ 1000 on B; against 140 kg. on A read $ 250 on B; and against 325 kg. on A read $ 580. With the same setting, read the weights, 840 kg., 476 kg., 364 kg., and 532 kg. on A against $ 1500, $ 850, $ 650, and $ 950 respectively on B.

The rule given for multiplication and division applies equally in these examples. Where the parity is set on adjacent scales, the answer will be read on the scale adjacent to the required value. In the last example, 1000 kg. and its price were set on adjacent scales, and each weight and its price were found on adjacent scales. If, however, the weight to be bought for $ 120 is required, it will be seen that, as now set, the slide projects too far to the left, and to obtain this reading it must be re-set. This is done

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by moving the cursor over 10 Q and bringing 1 Q under it, the required weight will be found on A in line with 120 kg. on B, but as re-setting amounts to reversing the order of the scales, the answer will be read on an opposite scale — the lower A scale — and will be 67·2 kg. That this is equivalent to setting on opposite scales may be seen by moving the cursor over 1000 ⟨10⟩ on the lower A scale, when the upper B scale will show 1785 under the cursor line.

EXAMPLE. A New York quotation for electrolytic copper is $ 265 per short ton. Find the prices of 320 lb., 968 lb., 550 lb., and 1420 lb.

The values which must coincide on the two scales, in this case, are 2000 lb. and the cost $ 265. Set $ 265 on B to 2000 lb. on A, and against each of the above weights on A, read the corresponding cost on B. The prices are: $ 42·40 for 320 lb., $ 72·90 for 550 lb., $ 128·30 for 968 lb., and $ 188·20 for 1420 lb.

It will be understood that the same setting gives prices for more than 2000 lb. as well as for the smaller quantities, but had the weights been in tons at the above price the setting would have been 265 on B to 1 on A — either upper or lower scale.

EXAMPLE. If an English ton of copper costs £ 59, find the cost of 380 lb., 560 lb., 912 lb., and 1760 lb.

The coinciding points on the scales will be 2240 lb. and the cost, £ 59. Set £ 59 on B to 2240 lb. on A, and against each weight on A, read the price on B. Above 380 lb. on A read £ 10 ⟨1 Q⟩; above 560 lb. read £ 14·75 ⟨£ 14. 15s. 0d.⟩ on B; above 912 lb. on A read £ 24 on B; below 1760 lb. read £ 46·36 ⟨£ 46. 7s. $2\frac{1}{2}$ d⟩

The slide rule is extremely useful for finding the equivalent values in different systems of units. For this purpose it is not necessary to know the value of the unit of one system in terms of that of the other, any point of equality will be sufficient. It is usual to take these points where they will be easiest to set on

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the scales and so that they will, if possible, be whole numbers. For instance, in converting from centimetres to inches, we set 13 inches to 33 centimetres. This point of equality gives an accurate and easy setting. Many of these convertion numbers will be found on the back of the slide rule in the first two tables to the left.

EXAMPLE. How many U. S. gallons are contained in 1210 Imp. gallons?

In the second table, we find that 6 U. S. gallons equal 5 Imp. gallons. We, therefore, set 6 on B to 5 on A, and putting the cursor over 1210 on A, read 1452 U. S. gallons on the upper B scale.

These values on A and B are interchangeable in these problems. In the last example, we could have set imperial gallons on B to U. S. gallons on A. It occasionally happens that, when the setting is made, the required value on one scale is not against the other scale. This may be remedied by putting the cursor over one of the indices, P or Q, and pushing the slide through until the corresponding index at the other end comes under the cursor line. The reading may then be taken in the usual way.

EXAMPLE. Convert 112·5 Imp. gallons to litres.

It will be seen from the back of the rule that 46 Imp. gallons = 209 litres. Set 46 on B to 209 on A, and read, under 112·5 on B, the answer, 511 litres, on the lower A scale.

EXAMPLE. Convert 32 inches to centimetres and 124 centimetres to inches.

Set 13 on B to 33 on A, move the cursor over 32 in. on B, and read 81·3 cm. on A. With the same setting, read the second answer, 48·8 in., on B under 124 on A.

EXAMPLE. Certain merchandise is sold at £ 2. 10 s. 0 d. per English cwt. What is the price in dollars per American cwt., if $ 4·86 = £ 1?

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As 100 English cwt. = 112 American cwt., 100 and 112 must be brought together on the A and B scales, but as this is not simple proportion, care must be taken to ensure that the first reading will be found on the A scale, so that the slide may be moved without upsetting the first position. Set 112 on B to 100 on A, both upper scales being used, move the cursor over 2·5 on B to get the price of one U. S. cwt. in pounds sterling, leave the cursor in this position, and move the slide to the right until 4·86 on B is against 1 on the lower A scale. The rule is now set for converting pounds sterling on A into dollars on B, and since the price of one U. S. cwt. is under the cursor line on A, the answer, $ 10·85, will coincide with it on B.

EXAMPLE. If coal costs £ 1. 16 s. 0 d. per ton, find the price in francs per 1000 kilogrammes, when £ 1 = 25·30 francs.

One ton equals 1016 kilogrammes. Set 1016 kg. on B to £ 1·8 on A. The price of 1000 kg. in pounds sterling is on A above 1000 ⟨1 Q⟩, but since this is required in francs, it is read on A below 25·3 on B and is 44·80 francs.

In the above example, 1 Q, being against the price in pounds of 1000 kg. on A, is in position for multiplication, and this price will be found multiplied by 25·3 when read on A under 25·3 on B.

In computing volumes of materials, such as timber, stone, etc., we frequently have constant sectional area but variable length; such calculations are very easily carried out on this slide rule.

EXAMPLE. Find the contents in 3×14 planks which are 14, 16, 18, 20, 22, and 24 feet long.

Set 1 Q to 3 on A, move the cursor over 14 on B, bring 12 on B to the cursor line. The setting is now complete, and under any length on B, find the contents on A. Under the above lengths on B read 49, 56, 63, 70, 77, and 84 feet super on A.

EXAMPLE. Freight to a certain destination is charged at 2 s. 9 d. for 27 cubic feet. Find the cost of forwarding the five cases considered on page 25. The volumes already calculated are: ⟨1⟩ 207 cu. ft., ⟨2⟩ 109·7 cu. ft., ⟨3⟩ 107 cu. ft., ⟨4⟩ 352 cu. ft., ⟨5⟩ 44·05 cu. ft.,

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Set 2·75 s. on B to 27 cu. ft. on A, and in line with each of the above volumes on A, read the corresponding price on B in shillings. The readings are as follows:

1.	21·08 s.	= £ 1.	1 s. 1 d.
2.	11·17 s.	=	11 s. 2 d.
3.	10·9 s.	=	10 s. 11 d.
4.	35·85 s.	= £ 1.	15 s. 10 d.
5.	4·485 s.	=	4 s. 6 d.

Having written these prices as in the first column, we may convert the decimals of a shilling to pence by setting 12 on B to 1 on A and reading against the above parts of a shilling on A, the equivalent in pence on B. These readings are 0·96 d., 2·04 d., 10·8 d., 10·2 d., 5·82 d. and to the nearest penny are as set down above.

When many foreign exchange convertions are required at the same rate, it is more convenient to work these by means of proportion on the slide rule than by the method already explained.

EXAMPLE. At an exchange of 4·85, find the equivalent in pounds sterling of $ 1924, $ 1565, $ 985, $ 645, and $ 587.

Set 4·85 on B to 1 on A. The graduations on B now represent dollars, and on A pounds. Put the cursor over 1924 on B and read £ 396·7 on A; under 1565 read £ 322·7; over 986 on the lower B scale read £ 203·3 on A; over 645 read £ 133; and over 587 read £ 121 on A. The answers then are £ 396. 14 s. 0 d., £ 322. 14 s. 0 d., £ 203. 6 s. 0 d., £ 133, and £ 121.

Comparison between two foreign currencies when their rates of exchange on a third country are known, is simply made by setting the two rates together on A and B and reading at any of the required coinciding points. For instance, 650 Norwegian kroner at 31·68 kr. to the pound sterling may be converted into pesetas at 34·02 pes. to the pound by setting 31·68 on B to 34·02 on A. B is now kroner and A is pesetas. Against 650 kr. on B read 698 pes. on A. Once the setting has been made any

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value may be read; against 700 kr. read 752 pes.; against 17 kr. read 18·26 pes; against 1515 pes. read 1410 kr.; against 55 pes. read 51·20 kr.

The following is an example of the use of this slide rule in calculating foreign exchange commissions.

Zurich must not sell to Berlin under 123·20 and, therefore, Amsterdam must not buy over 207·2. The exchanges are 123·31 and 207·37. Subtracting the former from the latter we get 0·11 or 0·0893 %. We find this value by placing 11 on scale B to 123·2 on scale A and reading the rate per cent., 0·0893, on B over 100 on A. Subtracting 207·2 from 207·37 we get 0·17. If we put the cursor over 207·2 on A and try to bring 17 on D to it we notice that we must push the slide to the right. This indicates a decrease in the rate. Further calculation is not necessary, but should we carry out the calculation we would obtain 0·0821 %.

EXAMPLE. A business owned by three partners, whose shares are £ 1300, £ 1700, and £ 2150, makes a profit of £ 760. 18 s. 0 d. This is to be divided between the three partners in proportion to their investments. What does each receive?

Set the capital, £ 5150, on B to £ 760·9 on A and, against each share on B, read the corresponding profit on A; over 1300 read £ 192; over 1700 read £ 251·1; over 2150 read £ 317·6. With the same setting the rate per cent., 14·77, will be found over 1 Q on the upper A scale.

Problems in inverse proportion are conveniently solved on the A and C scales. They may, of course, be worked on the A and B scales, but then require an extra movement of the slide.

EXAMPLE. An upholsterer needs 120 yards of cloth 27 inches wide; being unable to obtain this, he has the choice of 33 in., 36 in., and 54 in. materials. What length would be wanted in each case to cover the same surface?

Set 27 on C to 120 on A and, above 33, 36, and 54 inches on A, read 98·2, 90, and 60 yards respectively on C.

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PERCENTAGES.

The slide rule methods of calculating percentages are simple and easily remembered, and they have the advantage that once the rule is set, a number of values can be read off without moving the slide. These calculations are worked in the same way as proportion on the A and B scales, the index 1 Q or 10 Q being taken as 100%.

To find any percentage of a given number, set 10 Q or 1 Q to the number on scale A and, against any rate per cent. on scale B, read the answer on A.

When 10 Q is set to $ 920 on A, in line with each rate per cent. on B will be found the corresponding percentage on A. Under 95% on B read $ 874 on A; under 85% read $ 782; under 75% read $ 690; under 55% read $ 506; under 35% read $ 322; over 25·1% on the upper B scale read $ 231 on A; over 16·3% read $ 150; under 9% on the lower B scale read $ 82·80 on A; under 6% read $ 55·20; and under 4½% read $ 41·40. It will, of course, be understood that 9% and 90% are read at the same place on the scales.

The position of the answer is found by the rule given on page 13 and further explained on page 22. In finding the above percentages of $ 920, we set 10 Q and 920 on adjacent scales, and, therefore, each answer was found on the scale adjacent to its rate per cent.

When a number of percentages are to be calculated, it usually saves time to set that index which leaves the greater portion of the slide within the rule body, and thus gives the wider scale range. When the required value on B is beyond the A scale, the slide must be re-set by putting the cursor line over whichever index can be found against the A scale and pushing the slide through until the corresponding index at the other end of the slide comes under the cursor line. After re-setting the answers will be on opposite scales if the original setting was on adjacent scales, and vice versa.

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EXAMPLE. Find 90% and 14% of 550.

Set 10 Q over 550 on A, move the cursor over 90% on the lower B scale, and read 495 on the adjacent A scale. If the cursor is now moved over 14 on B it will be found impossible to read against it on the A scale, and 1 Q must be brought to the position occupied by 10 Q, that is to 550 on the A scale, when the answer, 77, will be read on the lower A scale under 14 on the upper B scale.

It will be understood that the first setting in the above example should not have been used, since the second one gives both answers.

If 100 on B ⟨1 Q⟩ it set to £ 3250 on the lower A scale, any percentage of this amount may be read on A in line with the required rate per cent. on B, opposite scales being used. It is seen that 91% is £ 2958, 79% is £ 2568, 68% is £ 2210, 58% is £ 1885, 36·5% is £ 1186 — all read on the upper A scale; 24·5% is £ 796, 20·3% is £ 660, 14·3% is £ 465, 11·2% is £ 364 — read on the lower A scale.

EXAMPLE. Find the market price of the following securities:

1. $ 7,200 stock quoted at 96·46.
2. $ 8,100 „ „ „ 91·09.
3. $ 21,500 „ „ „ 88·37.

1. Set 100 on B (10 Q⟩ to 72 on the lower A scale, move the cursor over 96·46 on B and, since adjacent scales were used in setting, read the market price, $ 6944, on the lower A scale.

2. Set 10 Q to 81 on the lower A scale, move the cursor over 91·09 on B, and read $ 7378 on the lower A scale.

3. Set 10 Q to 215 on the upper A scale, move the cursor over 88·37 on the lower B scale and, since opposite scales were used in setting, read the market price, $ 19,000, on the upper A scale.

To deduct a fixed percentage from a series of numbers, set 100 minus the rate per cent. on B to 100 on A and, in line with each of the numbers on B, read the answer on A.

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EXAMPLE. Reduce $ 9100, $ 50,000, $ 156, £ 227, and £ 1490 by 7%.

Set 93 ⟨100—7⟩ on B to 100 on A, using adjacent scales. All the values on B are 7% less than the coinciding ones on A, and so against each of the above amounts on A, read the reduced amount on B; above 9100 on A read $ 8460 on B; above 50,000 read $ 46,500; under 156 read $ 145·10; under 227 read £ 211; under 1490 read £ 1386.

EXAMPLE. Deduct 31·4% from £ 700, £ 450, £ 250, £ 115, and £ 362.

Set 100—31·4 ⟨68·6⟩ on the lower B scale to 100 on the lower A scale, and in line with the first three amounts on A, read £ 480, £ 308·8 ⟨£ 308. 16s. 0d.⟩, £ 171·5 ⟨£ 171. 10s. 0d.⟩ on B, and after changing indices to bring the other amounts against the B scale, read, on opposite scales now, £ 78·9 ⟨£ 78. 18s. 0d.⟩ under 115, and £ 248·3 ⟨£ 248. 6s. 0d.⟩ over 362.

It will have been noticed in the last example that, when 100 minus the rate per cent. on B is set to the adjacent A scale, the answer will be on the scale adjacent to the amount to be reduced. For instance, in deducting 5% we set 95 on the lower B scale to 100 on the lower A scale, and read on the lower B scale when the amounts to be reduced are on the lower A scale, and when these amounts are on the upper A scale we read on the upper B scale. When the percentage to be deducted is large, such as 80%, it will be convenient to set this ⟨20 in deducting 80%⟩ on the upper B scale to 100 on the upper A scale. The readings will again be on adjacent scales, but when the slide has to be re-set to enable certain readings to be taken they will be on opposite scales. An answer read on the wrong scale will contain such a large error that it will be at once apparent.

A number may be increased by any desired percentage by setting 100 on B to 100 plus the rate per cent. on A and reading the answer on A against the number on B.

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EXAMPLE. A price list is to be increased by 14%; the items are £ 1360, £ 1250, £ 930, £ 800 and £ 700. What are the new prices?

Set 100 ⟨1 Q⟩ on B to 114 on A, and against each of the items on B, read the increased amount on A; over 1360 on the upper B scale read £ 1550 on the upper A scale; over 1250 read £ 1425; under 930 on the lower B scale read £ 1060 on the lower A scale; under 800 read £ 912; and under 700 read £ 798.

When many percentages are to be added to, or subtracted from, the same number, the answers may be read off with one setting if 100 on B is set to the number on A; the answers are then found on A against 100 plus the rate per cent. on B for addition, and against 100 minus the rate per cent. on B for subtraction.

EXAMPLE. Increase $ 4600 by $3\frac{1}{2}\%$, $6\frac{1}{2}\%$, and $8\frac{1}{2}\%$; also reduce it by 7%, 11%, and 14%.

Set 100 on B ⟨1 Q⟩ to 4600 on the lower A scale. This setting is on opposite scales, so the answer must be found on opposite scales. Under 103·5 on the upper B scale read $ 4761 on the lower A scale; under 106·5 read $ 4900; under 108·5 read $ 4991; under 93 on the upper B scale read $ 4278 on the lower A scale; under 89 read $ 4094; and under 86 read $ 3956.

We could have set 100 on the lower B scale to 4600 on the lower A scale and read the answers on A below 100 plus or minus the rates per cent on the lower B scale, but this cannot be done when the percentage to be added exceeds 10%, nor will the first setting be suitable for deducting more than 20%. When more than 20% has to be subtracted, since we cannot read less than 80 on the upper scale, the lower B scale must be used.

The rate per cent. may be found by setting 100 on B to the total quantity on A and reading, against any percentage on A, the rate per cent. on B. For instance, set 100 on B ⟨10 Q is the

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most convenient in this case) to 500 on A, and, against any percentage on A, find its rate per cent. of 500 on B; under 100 on A read 20% on B; under 105 read 21%; under 120 read 24%; under 150 read 30%; over 264 read 52·8%; over 44·15 read 8·83%, and so on. A small part of the scale cannot be read with this setting, and the slide must be re-set to obtain these readings.

EXAMPLE. The four partners in a business invest the following amounts; £ 7460, £ 8570, £ 4850, £ 5660; what per cent. of the total capital is held by each partner.

The capital is £ 26,540. Set 100 on B (1 Q) to 26,540 on the lower A scale and, over 7460 on A, read 28·11% on the upper B scale; over 8570 read 32·29%; over 4850 read 18·27%; and over 5660 read 21·33%.

When a price is to be increased by a number of percentages in such a way that the first addition is a percentage added to the original price, the second is a percentage of the increased price added to it, and so on, this slide rule will be found of great assistance, and, having arranged the correct setting, we may read off at once a whole series of prices increased by the required percentages. Should it be required to increase a price by 10%, then increase this new price by 12%, increase this again by 5%, add 3% to the price obtained after the 5% addition, and increase this last price by 2%, we may do this by setting 100 on B to 110 (100+10%) on A for the first addition, moving the cursor over 112 (100+12%) for the second addition, bringing 100 on B under the cursor line and moving the cursor over 105 (100+5%) on B for the third addition, putting 100 on B under the cursor line and moving the cursor over 103 (100+3%) on B, bringing 100 on B under the cursor line again and moving the cursor over 102 (100+2%) on B. Under the cursor line on A we now find 135·9, this shows that the required price will be obtained by increasing the original price by 35·9%. If 100 on B is now brought against 135·9 on A, each number on A

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will be 35·9% greater than the coinciding number on B. If the prices to be increased were £ 131, £ 150, £ 50, and £ 70, the new prices would be found on A in line with 131, 150, 50, and 70 on B, and they would be £ 178, £ 203·9 ⟨£ 203. 18 s. 0 d.⟩, £ 67·95 ⟨£ 67. 19 s. 0 d.⟩, and £ 95·1 ⟨£ 95. 2 s. 0 d.⟩ respectively. Had the prices to be increased by the above percentages been 12 s. 6 d., 8 s. 5 d., 6 s. 3 d., 4 s. 2 d., 1 s. 8 d., and $10^1/_2$ d., the above setting would be used, and the new prices would be on A in line with each of the original prices on B, which may be taken as shillings and decimals or as pence. Taking them in pence, the new prices are seen to be 204 d. ⟨17 s.⟩, 137·25 d. ⟨11 s. $5^1/_4$ d.⟩, 101·75 d. ⟨8 s. $5^3/_4$ d.⟩, 68 d. ⟨5 s. 8 d.⟩, 27·2 d. ⟨2 s. $3^1/_4$ d.⟩, 14·26 d. ⟨1 s. $2^1/_4$ d.⟩.

EXAMPLE. The prices, $ 150, $ 175, $ 350, and $ 560, are each to be increased by $3^1/_2$%, the resulting amounts are to be increased by 7%, these are to be increased by 21%, and finally 4% is to be deducted from the sums obtained after adding the 21%. What are the new prices?

Set 100 on B to 103·5 ⟨$100+3^1/_2$⟩ on A, bring the cursor over 107 ⟨100+7⟩ on B, bring 100 on B under the cursor, move the cursor over 121 ⟨100+21⟩ on B, bring 100 on B under the cursor, move the cursor over 96 ⟨100−4⟩ on B, and push the slide to the left until 100 on B is again under the cursor line. The setting is now complete, and against each of the given prices on B, find the new price on A. These are $ 193, $ 225, $ 450, and $ 720. It will be seen, from the position occupied by 1 Q, that the addition and subtraction of the above percentages is equivalent to one addition of $28^1/_2$%.

That the $28^1/_2$%, in the last example, is being added is apparent from the fact that 1 Q lies to the right of 100 on A; had it been to the left, a percentage would have been deducted from the original prices. This setting shows that what was priced at $ 100 originally, costs $ 128·50 at the new rate. It will also be seen

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that the upper A and B scales must be used for this setting throughout, and so the old and new prices will be on adjacent scales.

EXAMPLE. It is necessary to deduct 20% from a certain number, from the remainder to deduct 7%, to decrease this by 10%, and then by 4%. What per cent. of the original number must be deducted to give the same answer?

Set 100 ⟨10 Q⟩ on B to 80 ⟨100—20⟩ on A, move the cursor over 93 ⟨100—7⟩ on B, bring 10 Q under the cursor line, put the cursor over 90 ⟨100—10⟩ on B, bring 10 Q under the cursor line again, move the cursor over 96 ⟨100—4⟩ on B, and read 64·3 on A under the cursor line. This is the amount that would remain after deducting the above percentages from 100, and so the answer is 100—64·3 = 35·7%. By setting 100 on B ⟨10 Q or 1 Q⟩ to 64·3 as indicated by the cursor, we may read the value of any number less 35·7%; against £ 85 on B read £ 54·6 on A; against £ 190 read £ 122; and against £ 45 read £ 28·9.

EXAMPLE. An article was sold at a price which leaves a profit of 10% on the purchase price, and a rebate of 7% was obtained on the purchase; what was the profit per cent.?

Set the true purchase price ⟨100%⟩ on the lower B scale to 93 ⟨100—7⟩ on A, and under the selling price, 110, on the upper A scale read 118·4 on B. The profit is, therefore, 18·4% on the purchase price or, using the scale on the upper edge of the rule body, 15·5% on the sale price.

EXAMPLE. If goods are bought at $ 31·80, $ 36·40, and $ 40·30, and are to be sold so as to make a profit of 35% on the selling price in each case, at what price must they be sold?

The scale on the upper edge of the rule body shows that 35% on the selling price is 54% on the buying price. Set 100 ⟨1 Q⟩ on B to 154 on A, and read under each buying price on B, the required selling price on A. The prices are $ 49, $ 56, and $ 62.

EXAMPLE. An article was bought for £ 39. 12 s. 0 d. and sold for £ 53; what was the profit per cent. on this transaction?

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The purchase price is £ 39·6. Set the selling price, £ 53, on B over £ 39·6 on A. Then all the selling prices on B and all the purchase prices on A are in the same ratio, and the profit per cent. will be the same for all coinciding values on the two scales. We may, therefore, call the purchase price 100, and find the corresponding selling price on B under 100 on the upper A scale, this reading is 134, thus showing that the profit is 34% on the purchase price. If the profit on the selling price is required, the selling price on B must be taken as 100, and the purchase price, read underneath, is seen to be 75. The profit is, therefore, 25% on the selling price. The last answer could have been obtained from the scale on the upper edge of the rule body.

EXAMPLE. Goods, which were bought for $ 49, are to be sold to gain a profit of 18% on the selling price; what is the selling price?

On the upper edge of rule body we see that 18% on the selling price equals 22% on the purchase price. Set 100 on B ⟨1 Q⟩ to 122 on A, and read, under 49 on B, the required selling price, $ 59·80, on A.

EXAMPLE. Goods are sold at a profit of 50% on the selling price, but if, in a particular case, a discount of 30%, then another of 10%, and finally 2% are allowed, what profit will be left on the selling price?

The scale on the upper edge of the rule body shows that 50% on the selling price is 100% on the purchase price. If the purchase price is taken at 100 then the selling price will be 200. To carry out the first deduction of 30%, set 100 on the lower B scale to 200 on the upper A scale, and move the cursor over 70 on B. Bring 10 Q ⟨100⟩ under the cursor line, and move the latter over 90 on B for the second deduction. Bring 10 Q ⟨100⟩ under the cursor line, and move the cursor over 98, this does the deduction by 2%. Bring 10 Q under the cursor line again; the reading on the upper A scale shows that the selling price is reduced by these deductions from 200 to 123·5. The purchase

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price, taken as 100, is 81% of this new selling price as indicated by the reading on the lower B scale under 100 on A. This shows that the profit has been reduced to 19% of the purchase price. What cost $ 75 must be sold for $ 92·60, read on the upper A scale over 75 on the lower B scale; what cost $ 55 must be sold for $ 68. For this last reading 10 Q has to be replaced by 1 Q, and the answer is read on A under 55 on B.

EXAMPLE. Determine the true rate of interest on 4% stock bought at 87·5.

Set 4 on B to 87·5 on A, since £ 87·5 earns £ 4, and over 100 on A read the true rate 4·57%.

EXAMPLE. Determine the true rate of interest on 3½% stock bought when at a premium of 11·35%.

Set 3·5 on B to 111·35 on A, since $ 111·35 earns $ 3½, and read about 3,14% on B over 100 on A.

SIMPLE INTEREST.

The calculation of simple interest for any number of days is easily carried out on this slide rule, either when the rate per cent. is based on a year of 360 days or on one of 365 days. The short cursor line to the left of the centre one is used in the latter case.

When the rate per cent. is given for a year of 365 days, the centre cursor line is put over the principal on A, the slide is moved until the rate per cent. on C comes under the short cursor line, the centre cursor line is now moved over the number of days on B, and the answer is read, under the cursor line, on A.

The answer is found on the A scale in accordance with the rule already given; when the rate per cent. is on the C scale adjacent to the principal on the A scale, the interest will be on that portion of the A scale which is adjacent to the B scale on which the days are. When the rate per cent. and the principal are on opposite scales, the days and the interest will also be on opposite scales.

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EXAMPLE. Determine the interest on $ 385 for 215 days at 8% per annum.

Set the centre cursor line over $ 385 on A, bring 8% on C to the short cursor line, move the centre cursor line over 215 days on B, and read the answer, $ 18·14, under the cursor line on A.

In the above example, the lower C scale was set to the lower A scale and, since these are adjacent scales, the answer must be read on that A scale which is adjacent to the days on B.

The approximate size of the answer, when it is not clear from practical experience, will be apparent from the interest formula $i = \frac{P}{100} \times r \times \frac{d}{365}$, the above example is $\frac{385}{100} \times 8 \times \frac{215}{365} = 4 \times 8 \times \frac{2}{3}$ roughly, and the answer is about 21.

EXAMPLE. Find the interest on £ 1860 for 84 days at $7\frac{1}{2}\%$ per annum.

Set the centre cursor line over £ 1860 on A, bring 7·5% on C under the short cursor line, move the cursor over 84 days on B and read £ 32·1 on A under the cursor line.

Estimating the size of the last answer, we get $\frac{1860}{100} \times 7{\cdot}5 \times \frac{84}{365}$, which is approximately $19 \times 7 \times \frac{1}{4} =$ £ 33 nearly.

EXAMPLE. Find the interest on £ 4645 for 207 days at $5\frac{1}{2}\%$ per annum.

Set the centre cursor line over £ 4645 on the lower A scale, bring 5·5% on C under the short cursor line, put the centre cursor line over 207 days on B and read £ 144·8 on A under it.

The lower A and C scales were used in setting the principal and rate, and, therefore, since the days are on the upper B scale, the required interest will be on the upper A scale. An approximate answer may be found as follows:

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$i = \frac{4645}{100} \times 5{\cdot}5 \times \frac{207}{365} = 46 \times 6 \times \frac{2}{3}$ approximately, and the answer may be taken as about £ 180.

EXAMPLE. Determine the interest on $ 466·70 for 84 days at $2^1/_4\%$ per annum.

Set the centre cursor line over $ 466·70 on A, bring $2{\cdot}25\%$ under the short cursor line, move the centre cursor line over 84 days on B and, since opposite A and C scales were used, read the answer, $ 2.42, on the upper A scale.

After the slide is set with the rate per cent. under the short cursor line, it occasionally happens that the point on the B scale showing the days is beyond the end of the A scale. When this is so, the cursor line is put over one of the indices and the corresponding one at the other end of the slide is brought to it. The interest will now be on the A scale in line with the days on B, but after thus changing indices, the scales will be in the reverse order; what was set on adjacent scales will be read now on opposite scales and vice versa.

EXAMPLE. What will be the interest on £ 375 for 113 days at $4^1/_2\%$ per annum?

Set the centre cursor line over £ 375 on A and bring $4{\cdot}5\%$ on C to the short cursor line. Since 113 on B is beyond the A scale, put the cursor line over 1 P and bring 10 P to it, set the centre cursor line over 113 days on B and read £ 5·227 under it on A.

In the last example, the original setting was between adjacent scales, and so, after re-setting, the days and the required answer were on opposite scales. In estimating the size of the answer, we may take $\frac{375}{100}$ as 4, $4^1/_2\%$ as 4%, and $\frac{113}{365}$ as $\frac{1}{3}$; the interest then is $4 \times 4 \times \frac{1}{3} =$ £ 5 nearly.

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EXAMPLE. Find the interest on £ 35. 17 s. 6 d. for 127 days at 4% per annum.

The principal is £ 35·879. Set the centre cursor line over £ 35·879 on A, move the slide until 4% on the upper C scale comes under the short cursor line, bring the centre cursor line over 127 days on B and read the interest, £ 0·499, under the cursor line on A. This is 10 s. almost.

The setting was between opposite scales, so the interest must be read on the lower A scale since the days were on the upper B scale. The answer is approximately $0{\cdot}36 \times 4 \times \frac{1}{3} = £\ 0{\cdot}48$.

EXAMPLE. Calculate the interest on £ 3078 for 24 days at $2\frac{1}{2}\%$ per annum.

Set the centre cursor line over £ 3078 on A, bring 2·5% on C under the small cursor line, move the centre cursor line over 24 days on B and read £ 5·06 on the lower A scale, since opposite scales were used.

An approximate answer would be $30 \times 2\frac{1}{2} \times \frac{1}{15} = £\ 5$.

It will be understood from the foregoing that the rate per cent, principal, or number of days may be found by changing the order of the settings.

EXAMPLE. The interest on £ 3078 for 24 days amounts to £ 5·06. Find the rate per cent per annum.

Set the centre cursor line over £ 5·06 on A, bring 24 days on B to it, move the cursor line over £ 3078 on A and, since the days and interest were on opposite scales, read the rate per cent., 2·5, on the upper C scale under the short cursor line.

EXAMPLE. If the interest on £ 4645 for 207 days is £ 144·8, determine the rate per cent. per annum.

Set 207 days on B to £ 144·8 on A, put the centre cursor line over £ 4645 on A and, since adjacent scales were used for the interest and days, read the rate, 5·5%, on the C scale nearest to the principal — the lower C scale — under the short cursor line.

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EXAMPLE. In how many days will the interest on $ 8765 amount to $ 539·75 at $8^{3}/_{4}\%$ per annum?

Set the centre cursor line over $ 8765 on A, bring $8{\cdot}75\%$ on C under the short cursor line, move the centre cursor line $ 539·75 on A and read 257 days on the lower B scale since adjacent scales are used for the principal and rate.

When the rate per cent. is based on a year of 360 days the interest is calculated as above explained, but the centre cursor line is used throughout.

EXAMPLE. Find the interest on $ 1860 for 84 days at $7^{1}/_{2}\%$ per annum ⟨360 days⟩.

Set the centre cursor line over $ 1860 on A, bring $7{\cdot}5\%$ on C under it, move the centre cursor line over 84 days on B and read $ 32·55 on the A scale under the cursor line.

The rate per cent. in the following examples is given for a year of 365 days.

EXERCISES.

Principal		Rate	Days	Interest	
£ 15. 6 s. 4 d.	⟨£ 15·317⟩	$3^{1}/_{2}\%$	72	£ 0·106	⟨2 s. 1 d.⟩.
£ 54. 6 s. 4 d.	⟨£ 54·317⟩	6%	23	£ 0·2055	⟨4 s. 1 d.⟩.
£ 46. 1 s. 6 d.	⟨£ 46·075⟩	2%	149	£ 0·376	⟨7 s. 6 d.⟩.
£ 12. 19 s. 8 d.	⟨£ 12·983⟩	$6^{3}/_{4}\%$	97	£ 0·233	⟨4 s. 8 d.⟩.
£ 23. 10 s. 4 d.	⟨£ 23·517⟩	$5^{1}/_{2}\%$	37	£ 0·131	⟨2 s. 7 d.⟩.
£ 75. 15 s. 1 d.	⟨£ 75·754⟩	5%	305	£ 3·165	⟨£ 3. 3 s. 4 d.⟩.
£ 234. 13 s. 0 d.	⟨£ 234·65⟩	$6^{1}/_{2}\%$	317	£ 13·24	⟨£ 13. 4 s. 10 d.⟩.
£ 648. 3 s. 0 d.	⟨£ 648·15⟩	$4^{1}/_{2}\%$	223	£ 17·82	⟨£ 17. 16 s. 5 d.⟩.
£ 798. 5 s. 0 d.	⟨£ 798·25⟩	$7^{1}/_{4}\%$	46	£ 7·294	⟨£ 7. 5 s. 11 d.⟩.
	$ 21·65	$6^{1}/_{2}\%$	52	$ 0·20.	
	$ 2018	$3^{1}/_{2}\%$	19	$ 3·68.	
	$ 4019	$2^{1}/_{2}\%$	179	$ 49·23.	
	$ 4657	7%	74	$ 66·08.	
	$ 8079	$7^{1}/_{2}\%$	113	$ 187·60.	
	$ 6735	8%	289	$ 426·50.	

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