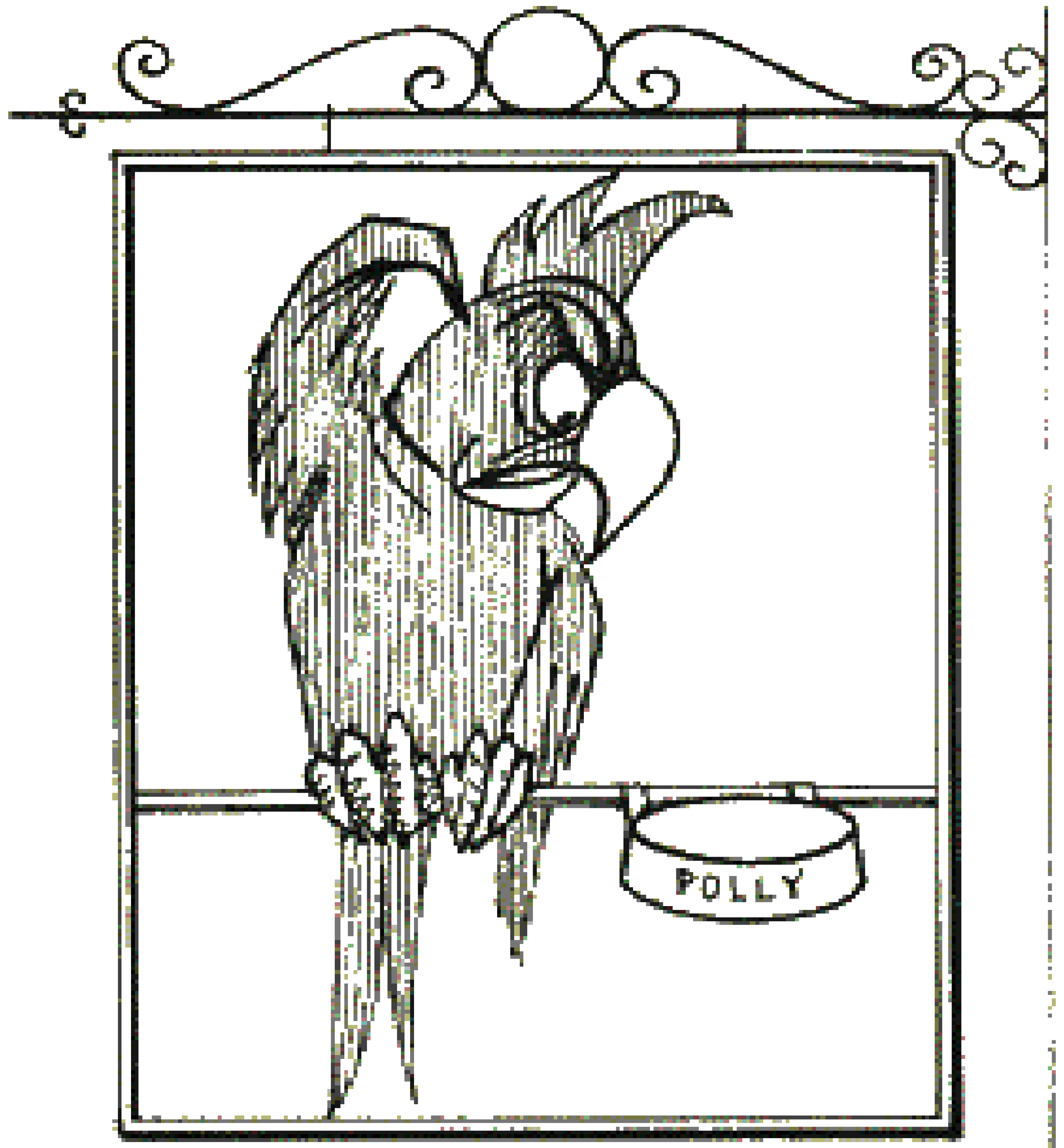
MATHEMATICAL INN SIGNS



POLLY NO MEAL

COAL IN EAR

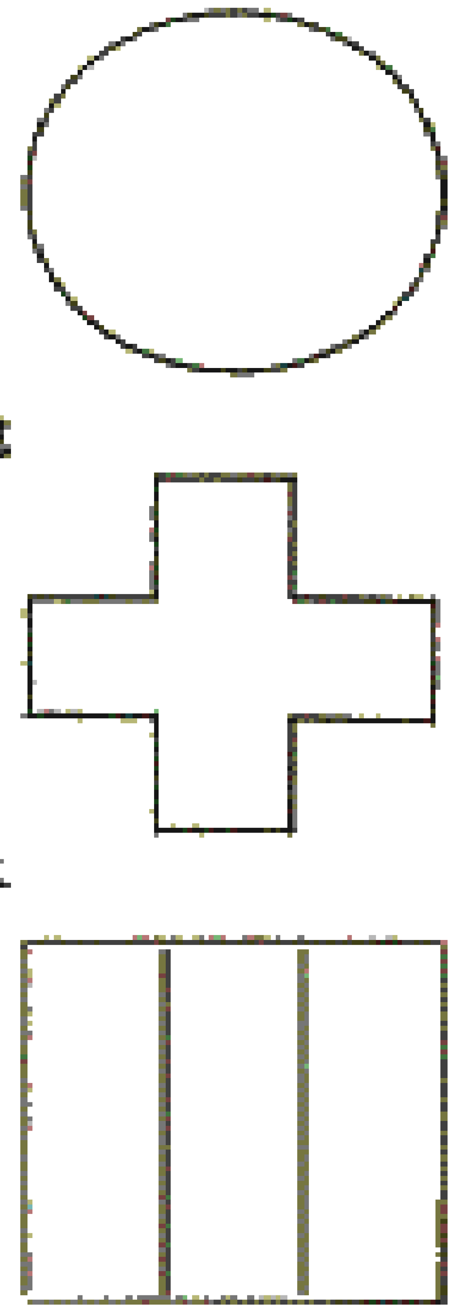
FOR TECHNICAL DRAWERS

WHAT IS IT ?

Plan Elevation

No dotted lines are omitted

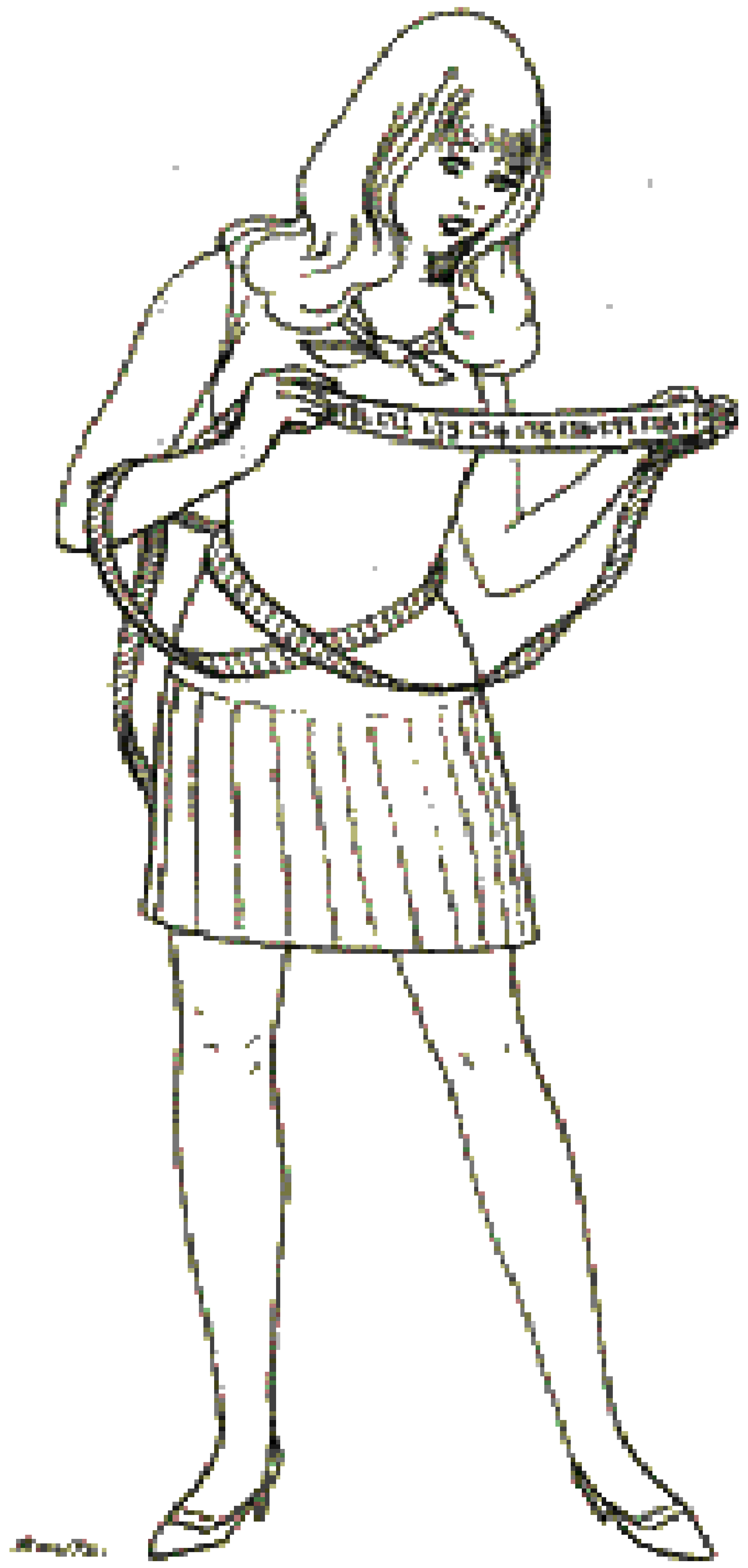
WHAT SHAPE HAS THESE THREE SECTIONS AT RIGHT ANGLES TO EACH OTHER



mathematical pie

No. 57 *Editorial Address :* **100, Burman Road, Shirley, Solihull, Warwickshire, England** **SUMMER 1969**

LOOK BEHIND THE MIRROR No. 1



In the normal course of events, when we write 367, we mean this to be interpreted as $3(100)+6(10)+7$ or $3(10)^2+6(10)+7(10)^0$ as usually the number system in use is based on powers of ten.

One day, when Alice was wondering in Numberland, she chanced to go through the Looking Glass, but when she had gone two feet she realised that she was really at -2 and in consequence of this the whole new world worked in negative number bases. Hence her understanding of 367 had then been changed to $3(-10)^2+6(-10)+7(10)^0$ which in front of the Looking Glass comes out as $3(100)+(-60)+7=247$ (base 10). Similarly in the Looking Glass 4657 comes out in the Real World as $4(-1000)+6(100)+5(10)+7(10)^0=-4{,}000+500-50+7$

$$=-3{,}443$$

Perhaps you would now like to try and find the equivalents of 1, 2, 3, etc., in the world of the Looking Glass. Enter your answers in the table and keep the sheet for our next issue.

Base 10 Numerals	Base – 10 Numerals	Base 10 Numerals	Base – 10 Numerals	Base 10 Numerals	Base – 10 Numerals	Base 10 Numerals	Base – 10 Numerals
0	0	−1	19	+10	190	−11	
+1	1	−2	18	+11		−12	
+2	2	−3	17	+12		−13	
+3	3	−4	16	+13		−14	
+4	4	−5	15	+14		−15	
+5	5	−6		:		:	
+6	6	−7		:		:	
+7	7	−8		+20		−20	
+8	8	−9		:		−21	
+9	9	−10		+30		:	
				:		−30	
				+1000		:	
						−1000	

Certainly Looking Glass mathematicians are indeed handicapped by their numeral notation. For example, in our notation it is very easy to write down the ADDITIVE INVERSE of a number. (By this we mean what number should be added to another to make zero, e.g., $12+(-12)=0$ i.e., -12 is the additive inverse of 12). What indeed is the additive inverse of 12 in the Looking Glass mathematics? Things look even worse if you seek to write down the vital statistics of our Cutie π (38, 20, 36). Poor Cutie π promptly fainted when we told her the facts of Looking Glass Life.

Can you recognise odd and even numbers in the Looking Glass mathematics; does the test for divisibility by 3 work behind the Looking Glass?

R.H.C.

PI

Many inquiries have been received about the decimal equivalent of π. The first 40 decimal places are given below, the sequence was continued in the issues 18 to 51, the figures from page 320 should be disregarded and the sequence continued from issue No. 44. This gives the decimal equivalent of π to 10,021 decimal places.

π=3.14159 26535 89793 23846 26433 83279 50288 41971

A number of mnemonics have been found from time to time to give the value to varying degrees of accuracy, e.g.:—

How I like a cuddle 3 1 4 1 6

Book tokens will be awarded to the senders of NEW mnemonics for π or any other number if it is published.

B.A.

NAPIER'S BONES

Many of you will have seen, or made, sets of Napier's Bones (See issue No. 30), which can be used as aids to multiplication. These sets that you have met will have been constructed in base ten; what about making Napier's Bones for other bases. The Bones shown are based on the scale of eight.

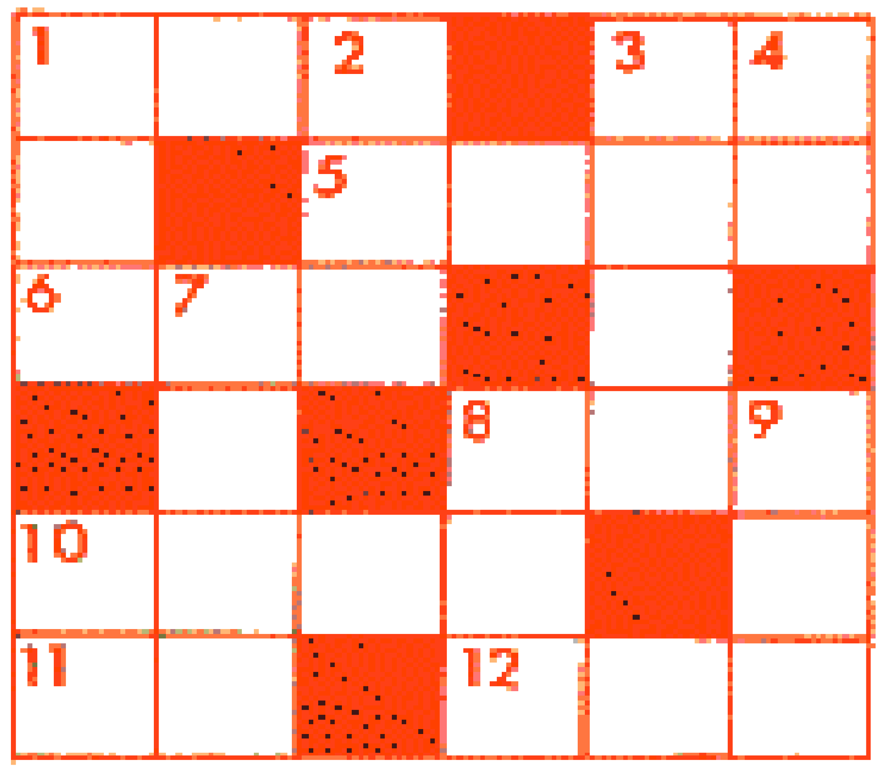
You will quickly see how these columns of numbers have been written down in scale eight and should be able to construct the corresponding cards for 1, 3, 4, 6, and 7. From the two cards shown, you can read off the multiples of 25 in scale eight.

	2	5	
1x	2	5	
2x	4	1 2	
3x	6	1 7	
4x	1 0	2 4	
5x	1 2	3 1	
6x	1 4	3 6	→ 25×6 (scale eight) = 176 (scale eight)
7x	1 6	4 3	→ 25×7 (scale eight) = 223 (scale eight)

Can you now construct the cards which you need for the scales of nine, seven, six, five, four, three, and two. You will find a problem arising from the diagonal addition, particularly with the smaller number bases.

R.H.C.

JUNIOR CROSS FIGURE No. 50



Ignore decimal points and signs in solutions.

Clues Across

1. 100 metres in yards to the nearest yard. (1m.=39.37 in.).
3. $\overrightarrow{AB}$ if $\overrightarrow{AC}=(7,1)$ and $\overrightarrow{CB}=(-2,5)$.
5. $\overrightarrow{XY}$, as an ordered pair in 3-Across, if X is the point (3.5,0.5), Y is a point on BC and XY is parallel to AB.
6. 796 (base-ten) expressed in base-twelve.
8. Area of the square on the diagonal of a rectangle 10 units by 12 units.
10. Principal (in £) which will give £20.82 simple interest at a rate of 8% in 3 years.
11. Smaller angle between the hands of a clock at 1.16.
12. (1.5, 8) rotated 180° about (4,5).

Clues Down

1. Area, in sq. units, of triangle ABC in 3 Across.
2. Volume, in cu. metres, of a cylindrical tank of diameter 7 metres and height 2.4 metres. ($\pi=3\frac{1}{7}$).
3. Sum (in £) which becomes £59.67 after an increase of $12\frac{1}{2}$%.
4. Solve: $\frac{x}{3}-12=8$.
7. Cost (in £) of filling tank in 2 Down with fuel at 7p per litre.
8. $(22)^4$.
9. Reflection of (0,6.5) in the line $y=x+2$.
10. $1\frac{1}{4}-\frac{3}{8}$ as a decimal fraction.

D.I.B.

SOLUTIONS TO PROBLEMS IN ISSUE No. 56

SENIOR CROSS FIGURE No. 52

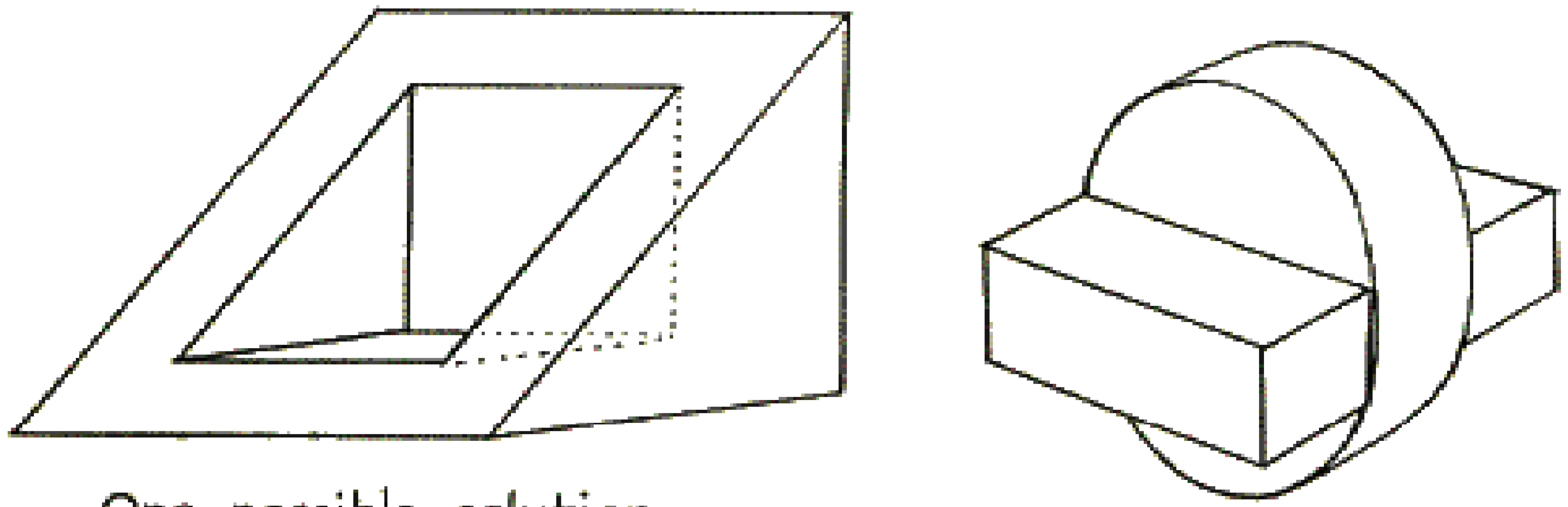
Clues Across: 1. 3467; 3. 16; 5. 65; 6. 120; 7. 6990; 11. 528; 12. 8502; 14. 780; 16. 56; 18. 23; 29. 2565.
Clues Down: 1. 36; 2. 456; 3. 12; 4. 6020; 8. 9580; 9. 925; 10. 2472; 13. 256; 15. 83; 17. 65.

JUNIOR CROSS FIGURE No. 49

Clues Across: 1. 52; 3. 136; 6. 441; 8. 42; 9. 243; 11. 100; 13. 34; 14. 456; 16. 435; 17. 35.
Clues Down: 1. 540; 2. 24; 4. 343; 5. 62; 7. 120; 10. 404; 11. 143; 12. 165; 13. 34; 15. 53.

CUTIE'S DAYDREAM—The Series is a DIVERGENT SERIES but it diverges very slowly and so it would take a long time to accumulate the necessary funds to buy the car.

WHAT IS IT?—



One possible solution

CODE OR CYPHER—There was a mistake in the article. The message should have read "SEND ILYA."

SCOTTISH EXPRESS—4472 is the number of the Flying Scotsman engine. One train travels twice as fast at the other.

TEDIOUS—A bracket was omitted $[3(2t30+e)]^2=492604$ e must be 4 and t must be equal to 8.

A NEW LOOK AT AN OLD PROBLEM

$(5,6) + (1,2) = (8,6) = (4,3)$
$(5,6) - (1,2) = (2,6) = (1,3)$
$(5,6) \times (1,2) = \quad ?$
$(5,6) \div (1,2) = \quad ?$

The above operations can be written in a more familiar way. What is a more usual way of writing (5,6)?

A less common example of operational manipulation is shown below :—

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix} \circ \begin{pmatrix} p & q \\ r & s \end{pmatrix} = \begin{pmatrix} a+p & b+q \\ c+r & d+s \end{pmatrix}$$

and $$\begin{pmatrix} a & b \\ c & d \end{pmatrix} * \begin{pmatrix} p & q \\ r & s \end{pmatrix} = \begin{pmatrix} ap+br & aq+bs \\ cp+dr & cq+ds \end{pmatrix}$$

Are these two operations commutative? that is, can the expressions in the two brackets on the left of the equals sign be interchanged without changing the value of the expression on the right of the equals sign?

Under what conditions will the expression on the right of the equals sign remain unchanged by interchanging the expressions on the left of the equals sign? Check your answer by substituting numbers in the expressions.

B.A.

STAMP COLLECTORS' CORNER No. 24

DEMOCRITUS (c.460-370 B.C.), head of the school at ABDERA in THRACE, elaborated and systemised the theory which had been first put forward by LEUCIPPUS of MILETES, that all matter consisted of small indivisible particles which he called ATOMA. Democritus supposed that in a solid the particles were fastened together by some kind of bond, but that in a fluid or in air they were in continual movement with very high speeds. He gave an explanation of air pressure which is very similar to the one now accepted. In the centuries that followed many arguments were put forward for and against the hypothesis but it was impossible to disprove or to justify until John Dalton found in 1802 that an atomic theory helped to explain chemical reactions. More recently, research has shown that the particles that Dalton identified as atoms are not indivisible. Greece issued a set of stamps with a portrait of Democritus to celebrate the opening of her first atomic power station which depends for its energy on splitting atoms.

C.V.G.

SUBSTITUTION

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WHEAT+
 FIELD
FARMER
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The addition problem on the left is correct. Each letter represents a different figure, but the same letter repeated represents the same figure each time. What is the smallest base that can be used?

Solve the problem.

THE ABSOLUTE LIMIT?

The fraction $\frac{x^2+x-2}{x^2+2x-3}$ can be evaluated for values of x by substituting the particular value of x in the fraction. x=10, the fraction $=\frac{108}{117}=0.923$, x=9, the fraction $=\frac{88}{96}=0.917$, complete the operation for values of x down to x=2.

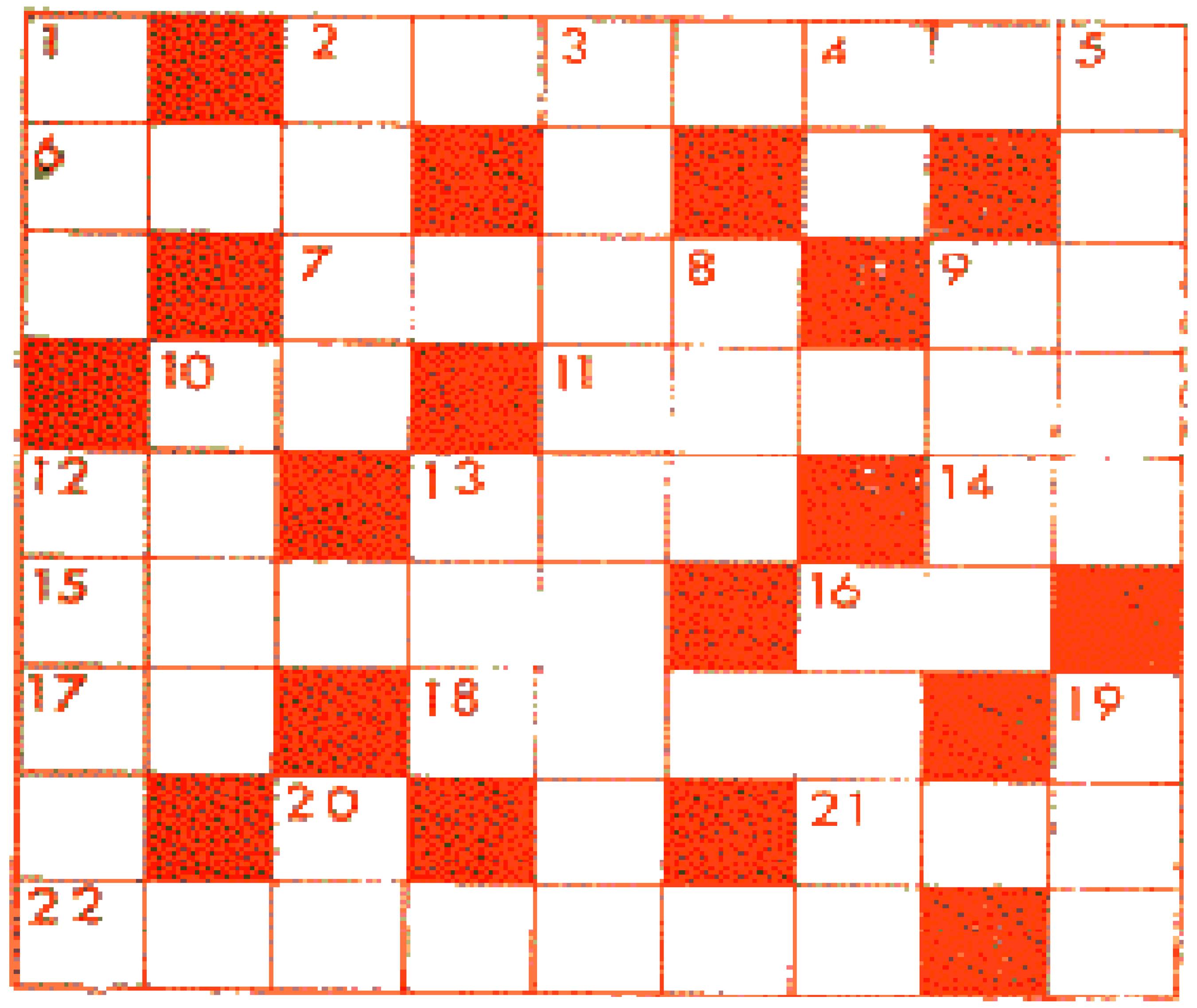
When x=1, the fraction $=\frac{0}{0}$ which cannot be evaluated. By taking fractional values of x between 2 and 1, find a reasonable value for the original fraction when x=1. Draw the graph of the function.

Can you find a simple way of overcoming the dilemma?

B.A.

SENIOR CROSS FIGURE No. 53

Submitted by Mr. G. L. Culverwell, of Bexley.



Clues Across

2. The easily remembered palindromic square of 2 Down.
6. The square of 10 Across, or the reverse of the square of the reverse of 10 Across.
7. The square of 4 Down, or the reverse 6 Across and then repeat the last digit.
9. An unfortunate number whose square is the reverse of the square of its reverse.
10. The square root of 6 Across.
11. Ten thousand more than the cube of twenty less than 4 Down.
12. The radix of our counting system.
13. Seven scores plus 16 Across.
14. Reverse of 9 Across.
15. Square of the number formed by the first three digits of 2 Across.
16. The extremely simple palindromic number, which, divided into 2 Across, produces another palindromic number consisting of itself on either side of its double.
17. Familiar with James Bond.
18. The year in which the Pope excommunicated King John of England.
21. The palindromic square root of 5 Down.
22. The cube of 3 times 4 Down, or of 9½ times the reverse of 10 Across.

Clues Down

1. The cube of a sacred number. (The digits add up to 12 Across).
2. The (monotonously?) palindromic $\sqrt{2}$ Across.
3. The ratio of the circumference to the diameter of a circle.
4. $\sqrt{7}$ Across, (the digits add up to 16 Across.
5. The easily remembered palindromic square of 21 Across.
8. The square root of two hundred and three thousand four hundred and one.
9. A palindromic number of which the square of the first two digits is the reverse of the square of the last two digits.
10. The square of 45 plus $45 \times 0\dot{5}$.
12. Five squared in Computer language.
13. The palindromic square of 16 Across.
16. The year of the union of The Allies.
19. A palindromic number whose digits add up to the sum of its first and last two digits.
20. Twenty-one times four over three.

moire patterns

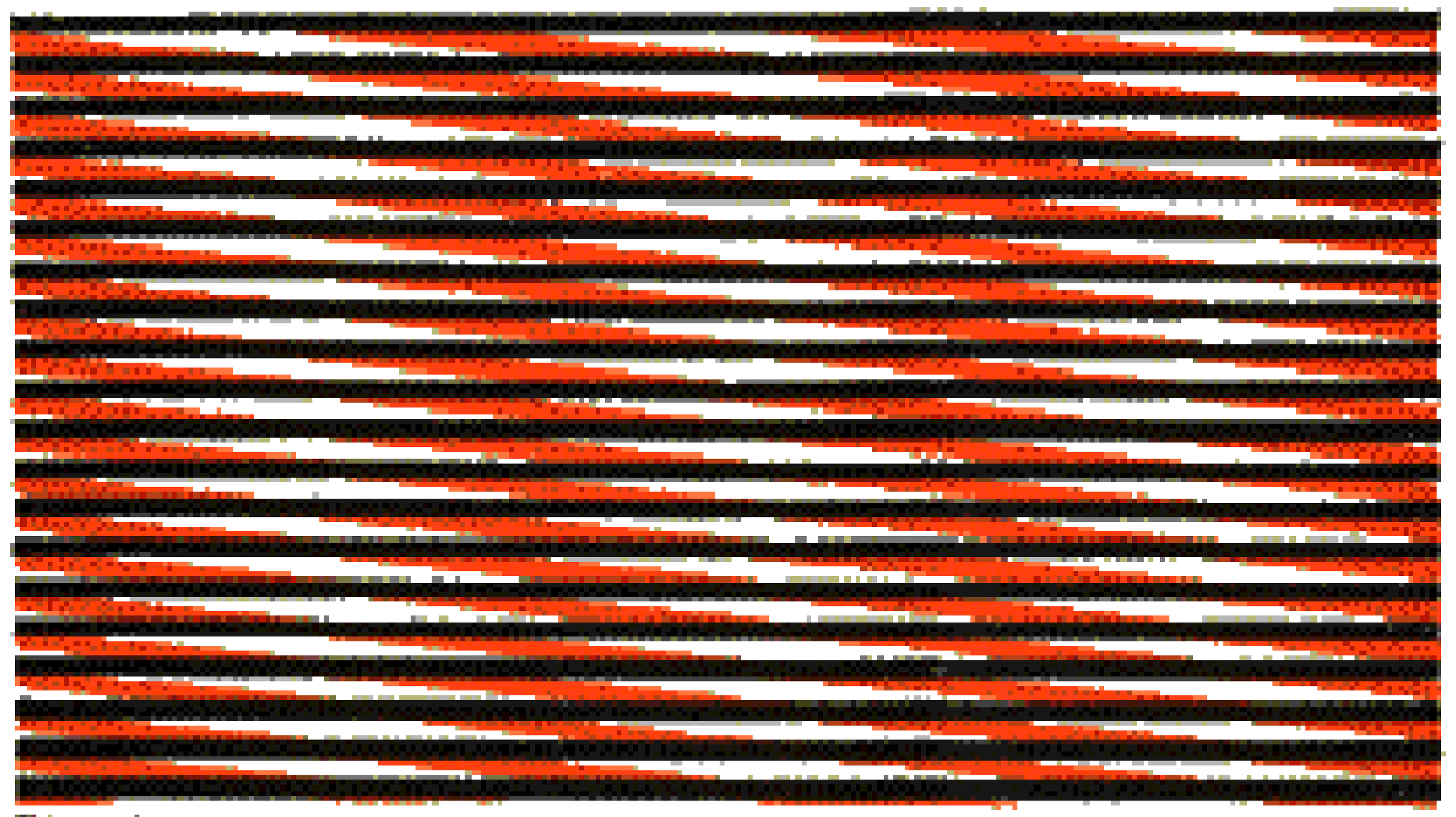


Fig 1

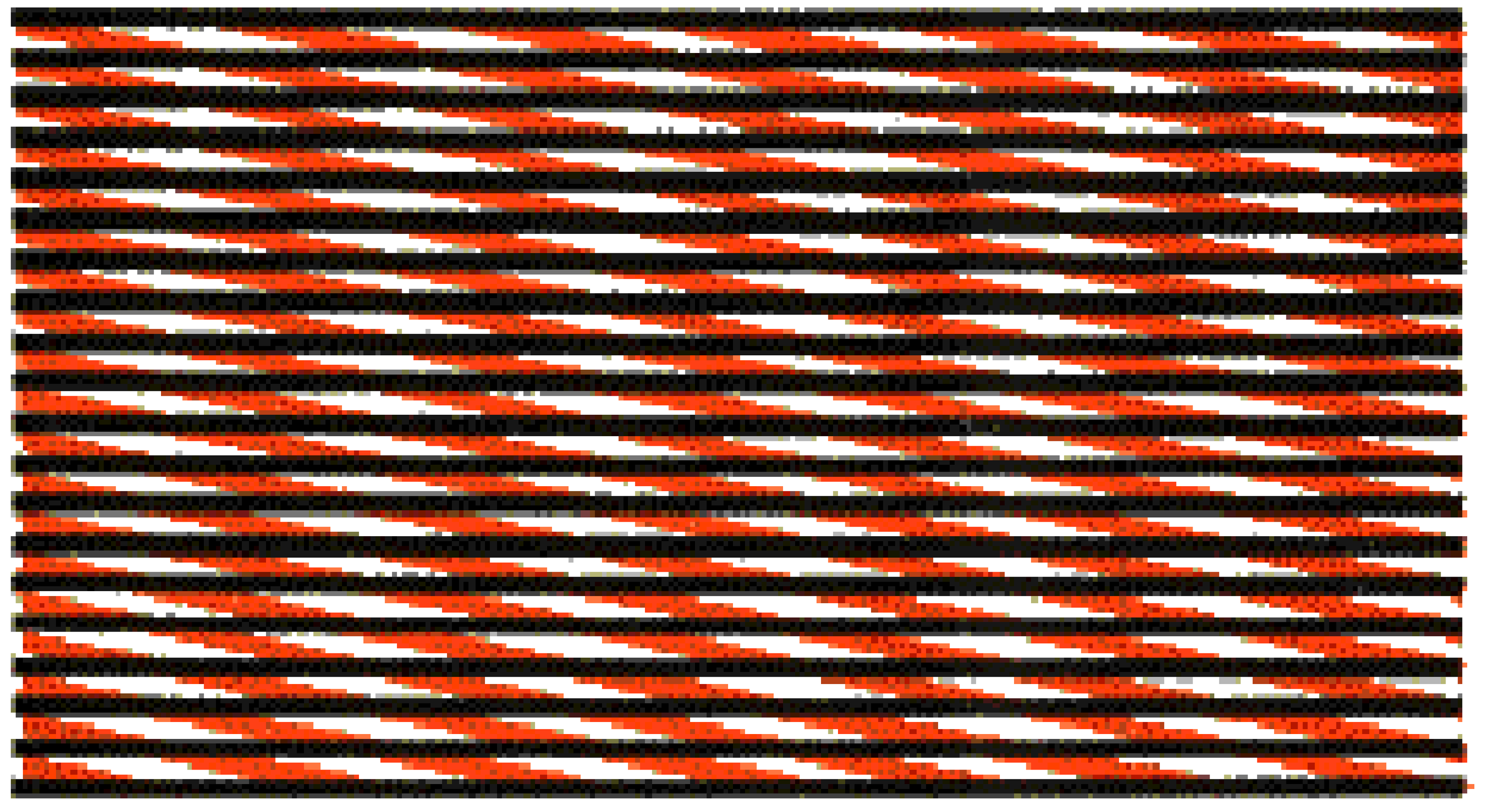


Fig 2

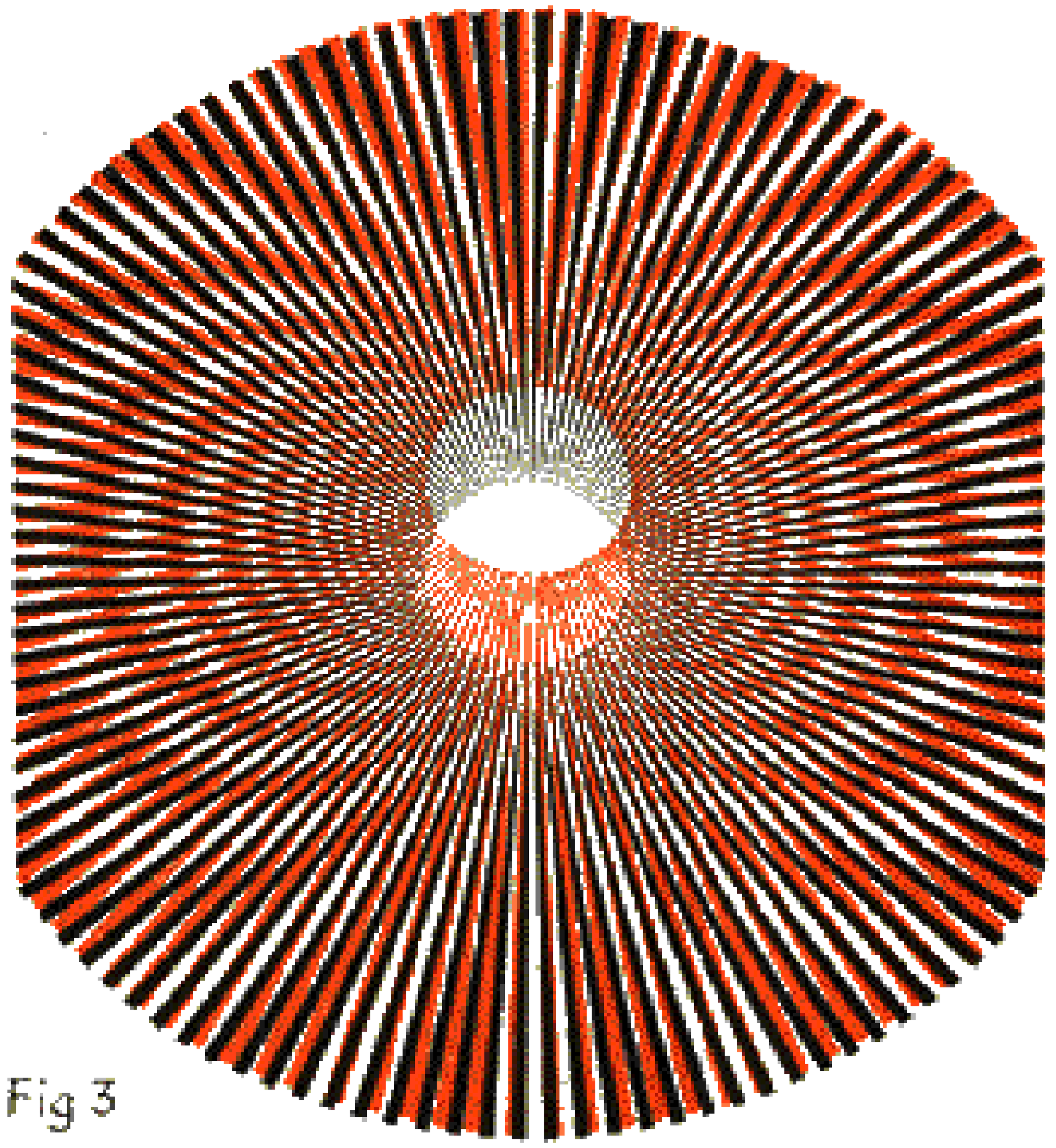


Fig 3

The material known as Moiré, or shot silk, appears to be covered with bands of colour which flow over the surface as it is moved. A similar effect can be obtained by using two transparent pieces of celluloid printed with identical patterns of lines or circles. These patterns are often called *graticules* because they look like small gratings. If two graticules are placed together and held up to the light, they produce patterns rather like those illustrated in MORE PATCHWORK PATTERNS in issue No. 33. The patterns change as one graticule is moved over the other. The illustrations at the side of the pages represent pairs of graticules. A pattern in orange is printed over an identical pattern in black. Unfortunately, we cannot reproduce the effect of the changing patterns produced by two transparent graticules. (These can be obtained commercially from PROOPS BROTHERS LTD.).

These patterns have serious applications whenever one part has to be placed accurately on another.

If two sets of equally spaced parallel lines are used, they look like one set if they are accurately aligned but if one is rotated slightly they produce cross bands, Fig. 1. As the angle between the two sets is increased more

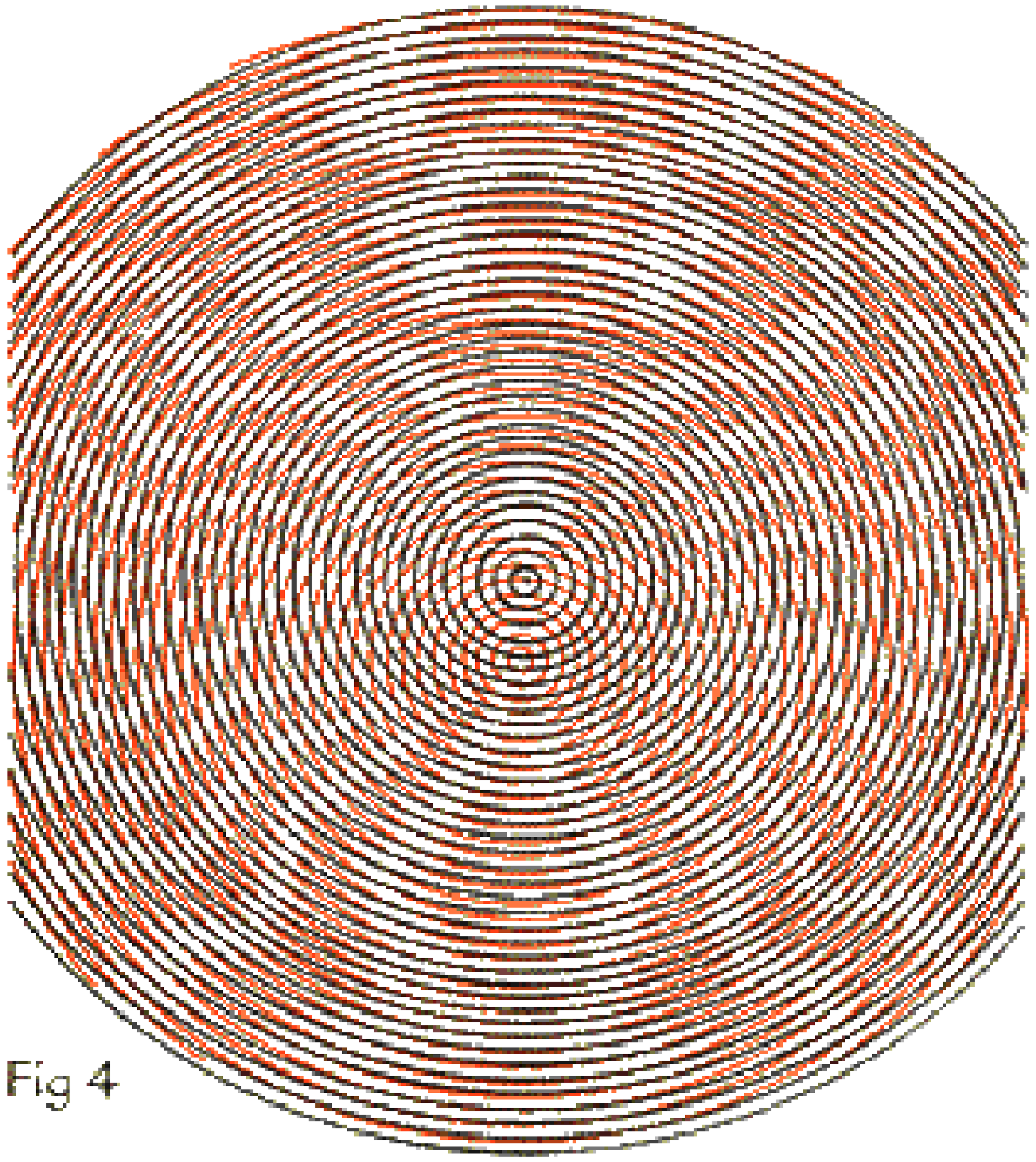


Fig 4

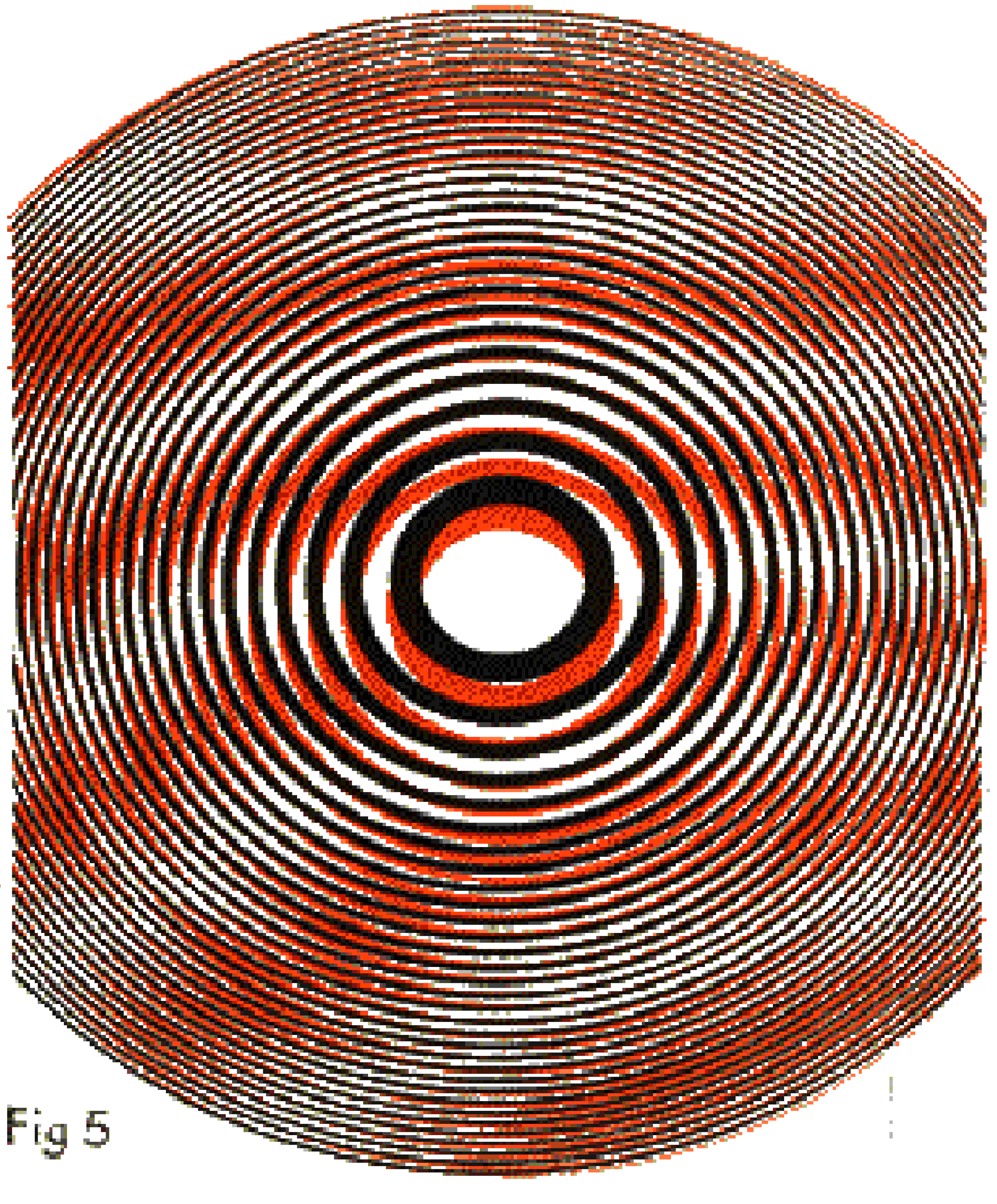


Fig 5

bands appear, Fig. 2. If two sets of radiating lines are used, they produce a pattern of circles if one is displaced slightly, Fig. 3. As the displacement increases so the number of circles increases.

In making colour reproductions of paintings a number of printings in different colours have to be placed accurately on the paper. To ensure correct alignment, the first printing may have a row of graticules in the margin. Each of the subsequent printings places another graticule on top of one of these. If a printing is out of true, a Moiré pattern is produced. By measuring the pattern, the adjustment can be calculated.

In precision engineering applications, very fine graticules are used which have to be examined under a microscope.

Readers in Sixth Forms should be able to produce a formula for finding the error in angle from the number of patterns to the inch for the parallel line graticules. Calculating displacement from the Moiré patterns produced by radiating lines or concentric circles, Fig. 4 & 5, is more difficult but not impossible for anyone who hopes to pass A level Mathematics. Concentric circles need not be equally spaced. Can you find a formula for the radii of the circles which would make a displacement produce a Moiré pattern of parallel lines?

C.V.G.