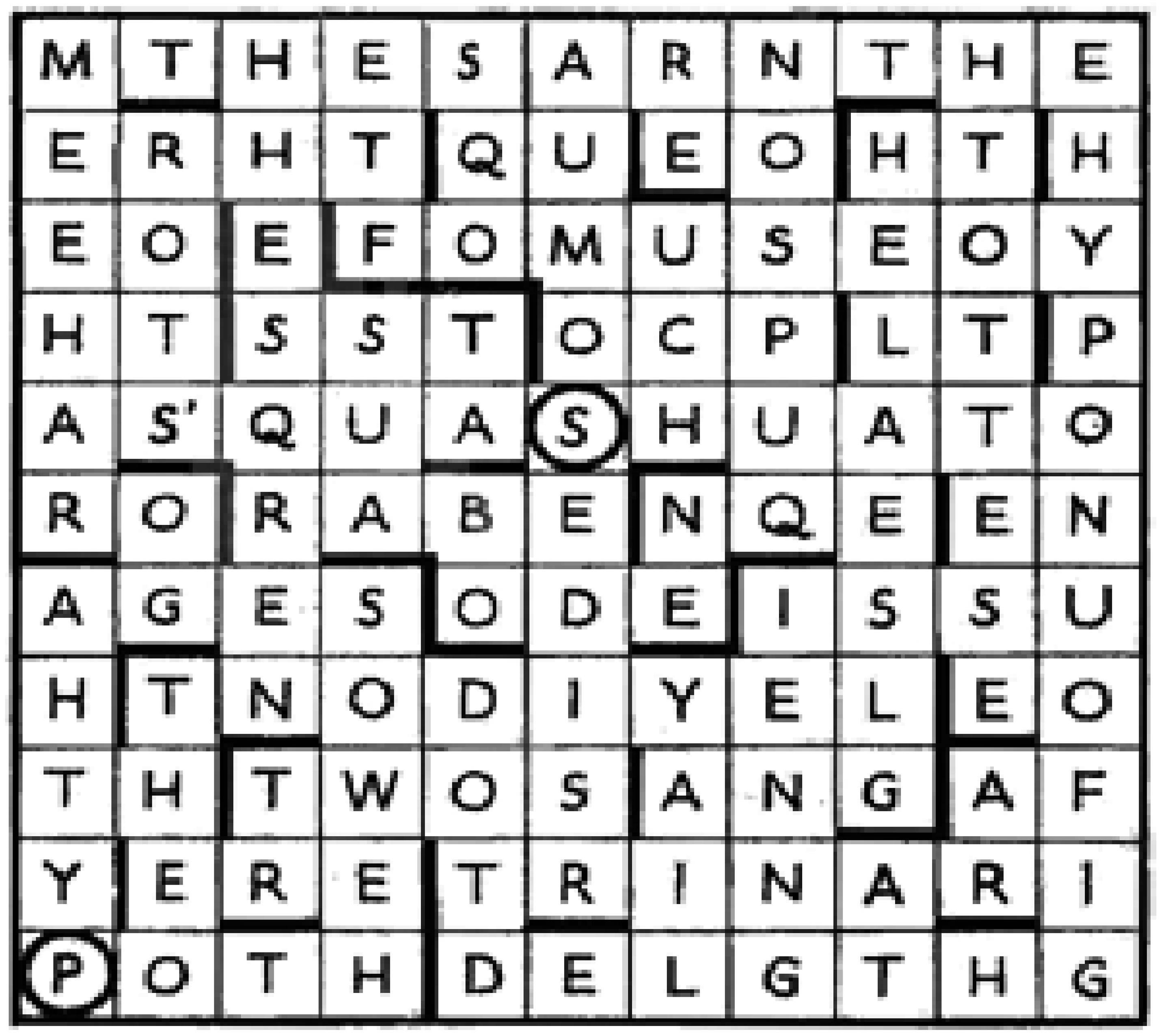
A SPELLING MAZE

Can you work through this maze from P to S? As usual, you must not cross a thick line. You may cross the thinner lines horizontally or vertically (no diagonal moves allowed), but as you thread your way through, the letters you visit should spell out a sensible "message".

When you have finished, there should be only 13 unlucky squares whose letters have not been used: shade them.



E.G.

THURBER DOG

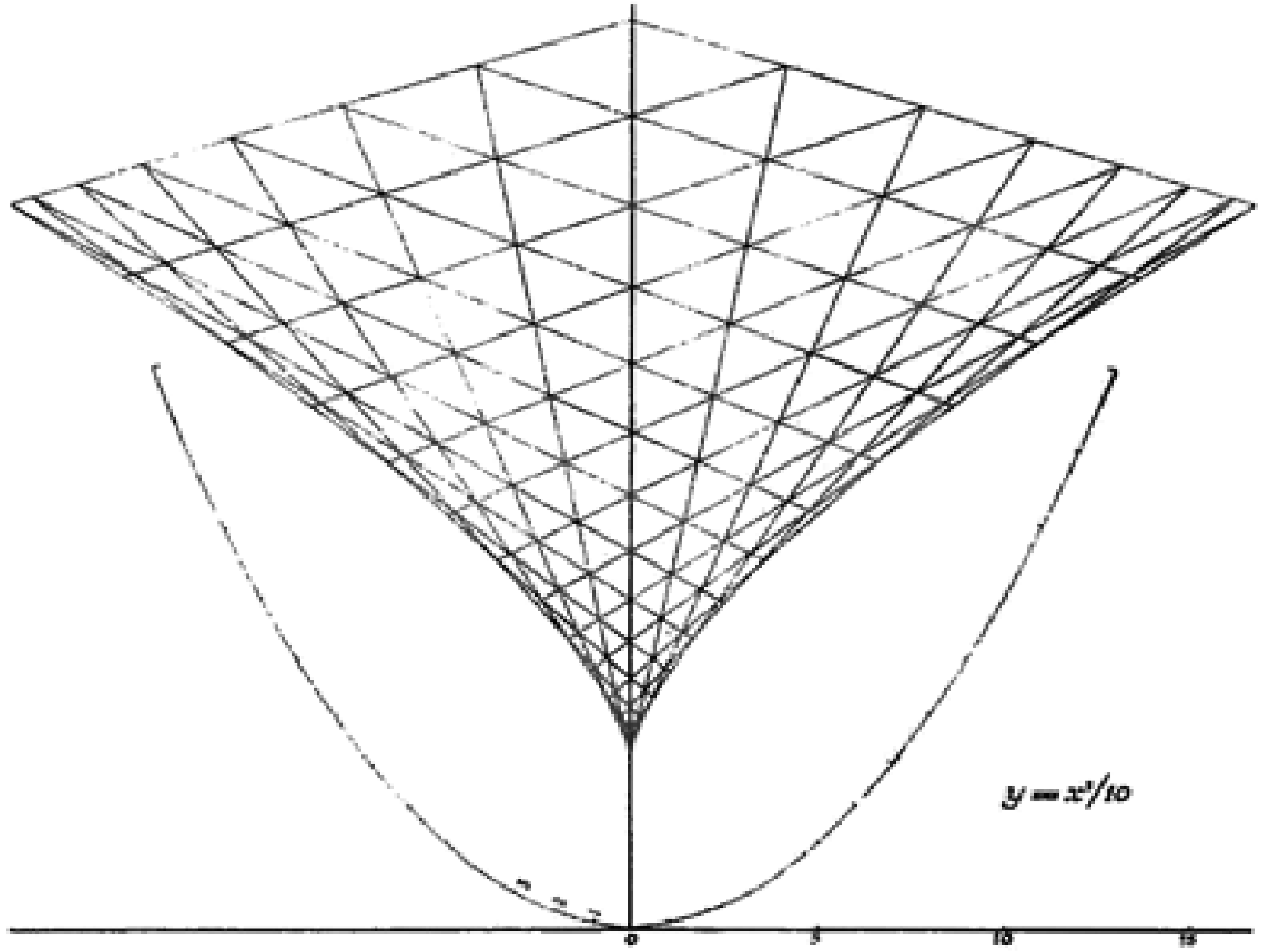
We apologise for the fact that we printed the design for the making of the "Thurber Dog" in our Issue No. 73, Autumn 1974, on page 380 without permission. Acknowledgement is now given here to the fact that this design was originally created by Robert Neale and appeared in THE BEST OF ORIGAMI by Samuel Randlett and published by Faber and Faber Ltd., London, and E. P. Dutton and Co. Inc., New York.

Ed.

join the in s mathematical pie

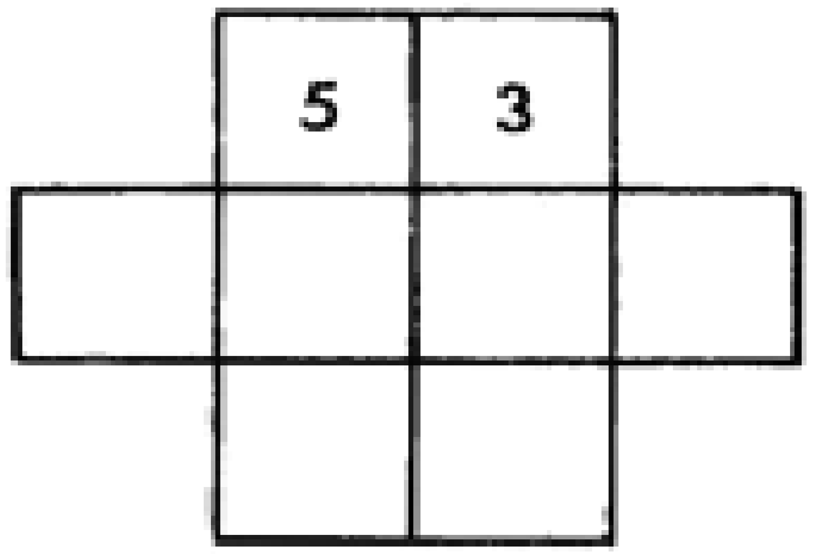
No. 78 — *Editorial Address :* West View, Fiveways, Nr. Warwick — SUMMER, 1976

THIRTY-ONE STRAIGHT LINES



NUMBER PROBLEM

suggested by R. I. Wright, The City School, Lincoln



Place the figures 1, 2, 4, 5, 7 and 8 in the remaining spaces so that no two consecutive numbers are adjacent across a side or a vertex of the spaces.

HOW TO DRAW "THIRTY-ONE STRAIGHT LINES"

Most mathematical embroidery patterns consist of a network of rectangles. In the network of triangles on the front cover, the lines are normals to a parabola.

Figure 1 shows how easy it is to construct the normals. The parabola used was $y=x^2/10$, plotted on centimetre graph paper. The normal at P passes through the point on the y-axis 5 cm above P.

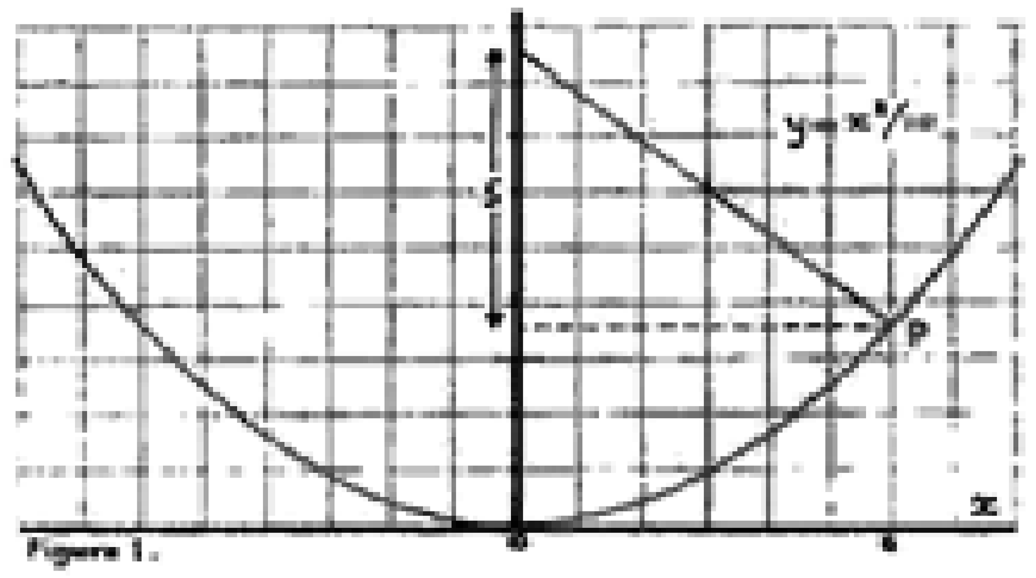


Figure 1.

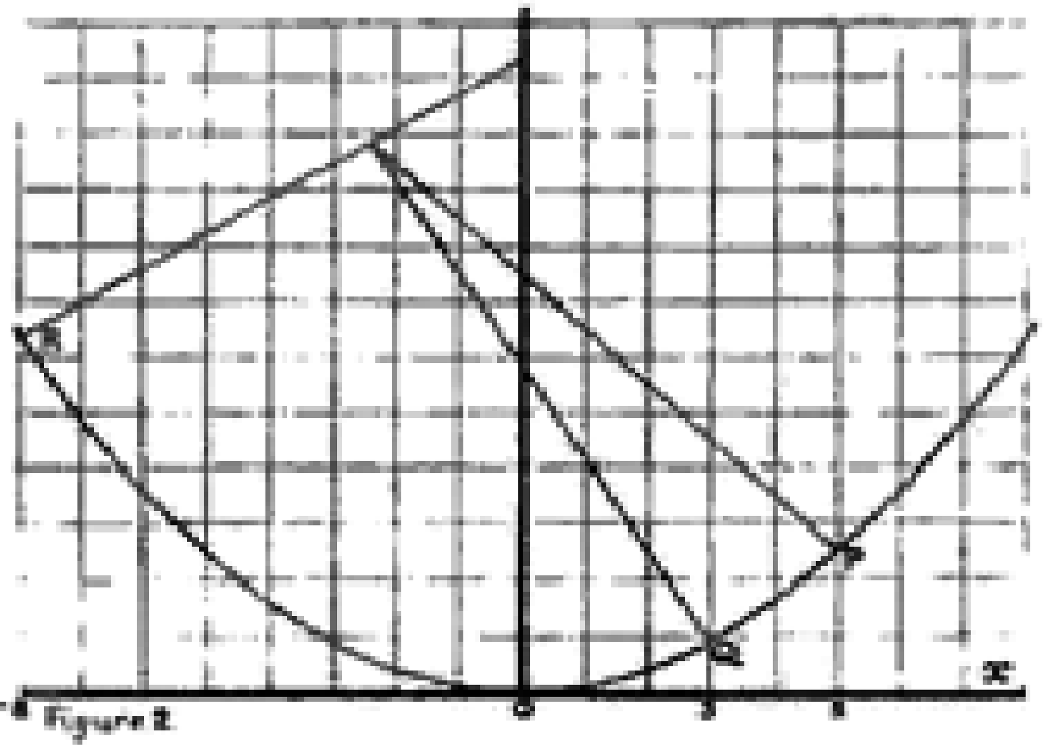


Figure 2.

In figure 2 the normals at the points where $x=3$ and $x=5$ are shown intersecting on the normal at the point $x=-8$. Generally the normals at three points intersect. The sum of the x-co-ordinates of the three points is zero. There are, however, some exceptions, for example, the normals at the points $x=4$ and $x=-8$. Normals at pairs of points like this meet on a curve called the evolute of the parabola.

To make the pattern, plot the parabola $y=x^2/10$ from $x=-15$ to $x=+15$ and construct the normals at $x=-15$, $x=-14$, . . . up to $x=+15$. Only the portions of the normals inside the evolute are used.

There is an interesting consequence of using a sequence of three different colours, say, red, yellow and blue, red, yellow and blue, . . . for the lines.

EQUALITY OF THE SEXES

If two boys and a girl can beat their father at tug-of-war, but the mother can win a similar contest against a boy and two girls. Who would win a contest between the father and a girl against the mother and a boy?

P.J.G.

HOW?

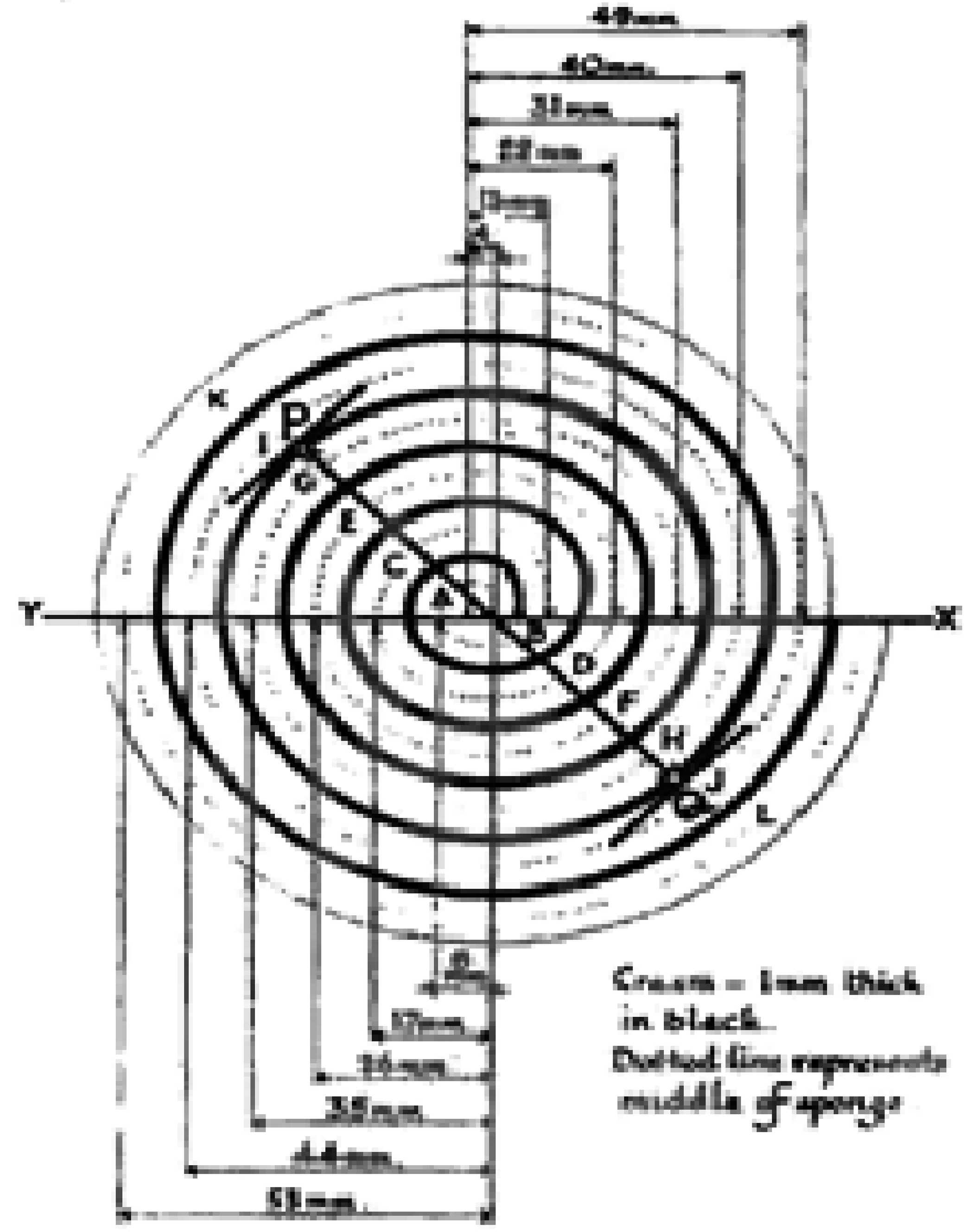
When Cutie Pie was on holiday she stayed at a hotel on the beach front. On the same beach is a pier and a lighthouse. She decides to visit both of them one day and walks as far as the pier in 5 minutes, but then takes a further 15 minutes to reach the lighthouse, although it is only twice as far from the hotel as the pier is from the hotel and she walks at the same pace. How can this be?

P.J.G.

SOLUTION TO PROBLEM IN ISSUE No. 74

FOOD FOR THOUGHT

Diameter of cake at thickest part is 71 mm (P-Q).

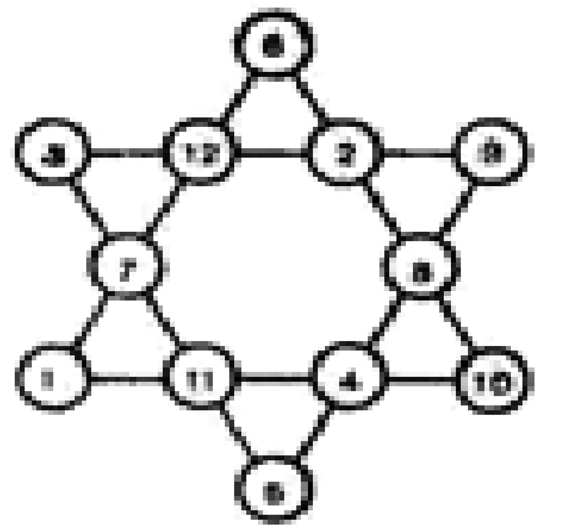


SOLUTIONS TO PROBLEMS IN ISSUE No. 77

JUNIOR CROSS FIGURE No. 68

1	6	9		2	3
8	4		7	4	7
	5	1	2		5
1		5	6	7	
1	2	0		1	5
1	3		5	4	6

DAVID'S DOZEN



SCRAMBLE

The complete diagram is a KANGEROO.

COUNTER ESPIONAGE

(a) Maintain a symmetrical pattern about the centre counter after taking the centre counter on the first move.

(b) Take any counter except the centre one; maintain a symmetrical pattern ignoring the centre counter.

SENIOR "DOUBLE CROSS" No. 2

A is 3, C is 7, E is 1, H is 4, I is 9, M is 6, P is 0, S is 8, T is 2, R is 5.
The message reads MATHS PIE EACH TERM CHEAP AT THE PRICE.
ACT, ASS, THEATRE, EAR, IT, MAR, IT, APE, CHARTER, HEM, ETE, are the solutions to the word clues across.

TOP OF THE POPS

Cutie Pie should start at C and count to the left.

BALANCING ACT

$m=\frac{w}{w-2}$

AMAZING CODES

The key to the Hampton Court maze is 67.

B.A.

LETTER TO THE EDITOR

Miss C. Barnes of Arborfield, Reading, writes:—

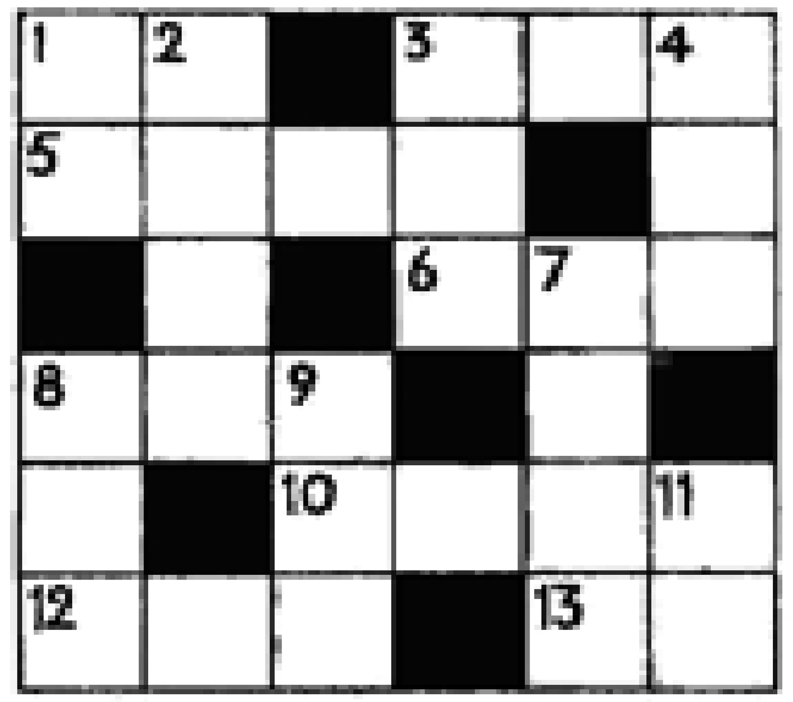
I am a bellringer and it came to my notice that the article "Plain Enough" in the Summer 1975 issue was incorrect. The method written was, in fact, original or just plain hunt. A plain course of anything but this (including Plain Bob) contains "dodges".

She then included a course of plain bob and from it can be seen that the only bell that follows the path is the treble (No. 1) and all the other bells dodge. Plain bob doubles and original are both called methods, not peals. With five bell methods, an actual peal consists of 4,800 changes. The number of changes that are possible on five bells is 5! (i.e., 120). Forty of these 120's make up a peal.

We are grateful to Miss Barnes for this clarification and have sent her a book token.

Ed.

JUNIOR CROSS FIGURE No. 69 "Firsts and Lasts"



CLUES ACROSS

1. (First odd square plus the first even square) squared.
3. First 3-digit even number divided by the last 1-digit number (ignore the decimal point).
5. The first 2-digit prime multiplied by the last 2-digit prime, with the first 3-digit prime added to the result.
6. The last 3-digit number minus the last 2-digit square.
8. The last 3-digit cube minus the last 2-digit square.
10. The first 2-digit square multiplied by the last 2-digit square.
12. (The first even cube plus the first even square), multiplied by the first 3-digit square and divided by the first even number.
13. The first 2-digit square plus the last 1-digit cube.

CLUES DOWN

1. First year of adult life?
2. The first 2-digit cube multiplied by the last 2-digit cube, trebled.
3. The last 1-digit prime multiplied by the first 2-digit cube.
4. The first 2-digit square plus the last even 3-digit cube.
7. The first 2-digit number plus the last 3-digit odd square plus the first 3-digit odd square.
8. The last 1-digit prime, cubed and then doubled.
9. The first 2-digit number multiplied by the last 2-digit square.
11. The first even number that is both a square and a cube.

E.G.

ROMAN FAR AND WIDE

Ten matches are arranged to create the following equation in Roman numerals:—

$$XI+I=X$$

This equation is, of course, not true. Make it into a correct equation without moving any of the matches in any way.

P.J.G.

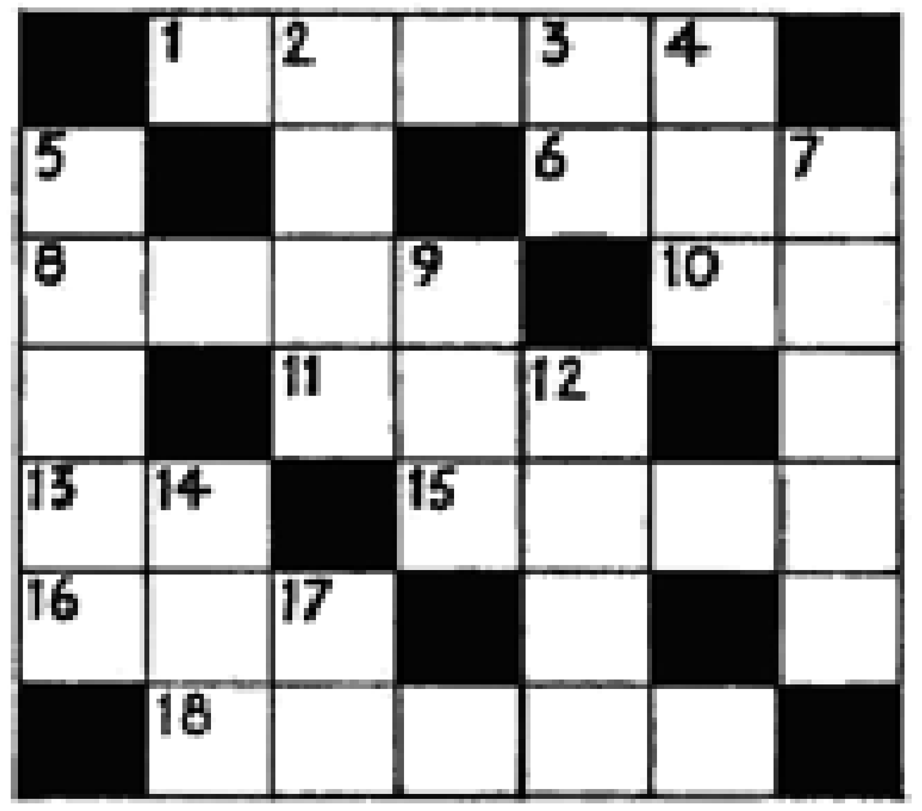
RE-ORGANISATION

1
2 3
4 5 6
7 8 9 10

Ten numbered discs are arranged as shown on the left to form a triangle facing away from you. By moving 3 discs only, it is possible to reverse the triangle so that it points towards you. Describe which three discs you would move and to where you would move them.

P.J.G.

SENIOR CROSS FIGURE No. 70



CLUES ACROSS

1. The coefficients of the terms of $(x+y)^3$, followed by their sum.
6. The sum of all the two-digit squares, with its digits reversed.
8. The product of the first and last two-digit squares.
10. A prime factor of 888.
11. 27·5 squared minus 18·5 squared is palindromic.
13. A prime number.
15. x, in degrees and minutes, if x is between 0 and 90 and $3\sin^2 x - 4\sin x + 1 = 0$.
16. The 33rd triangular number.
18. The product of the last two-digit square and the last three-digit square.

CLUES DOWN

2. Cosine 69°33′.
3. The value of y in 9 down.
4. The product of the last single digit number and the last two-digit prime.
5. The product of the first and the last three-digit cubes.
7. e.
9. (x,y) on $y=x^2-10x+35$ so that the gradient of the curve is 2.
12. Two consecutive squares.
14. (a,b,c) if $a+2b=21$, $b+2c=20$ and $c+2a=25$.
17. Sixteen across divided by 33 is appropriate.

E.G.

NEXT THURSDAY'S CHILD

Monday's Child is fair of face — *Tuesday's Child is full of grace* — *Wednesday's Child is full of woe* — *Thursday's Child has far to go*

Friday's Child is loving and giving — *Saturday's Child works hard for a living* — *The child that is born on the Sabbath Day is bonny and blythe, good and gay*

Table I: Day remainder

Su	M	Tu	W	Th	F	Sa
0	1	2	3	4	5	6

Table II: Month remainder

J	F	M	A	M	J	J	A	S	O	N	D
0	3	3	6	1	4	6	2	5	0	3	5

Table III

0	3	3
6	1	4
6	2	5
0	3	5

In the last issue we promised we'd tell you *why* the process worked for this century. Remember what we did to find on which day of the week a particular date fell. Take 20th March, 1976.

1.	Day of month	20	6 casting out the sevens
2.	Month remainder	3	3
3.	Year of the century	76	6
4.	Number of leap years so far	19	5
	TOTAL		$20 = 2\times7+6$

Hence 20th March was a Saturday.

We start with the calendar for January 1900 which was as shown on the right. If we cast out the sevens we see that the remainders are the same for all the dates in the same column. These are the day remainders of Table I. January has 3 days more than 4 exact weeks and so February starts "3 days late". These 3 days are carried on into March because February normally has 28 days. March adds another 3 days to the total to make the month remainder for April equal to 6. April adds 2 more days giving $8=1\times7+1$, so 1 is carried through into May. In this way we have the month remainders of Tables II and III.

Su	M	Tu	W	Th	F	Sa
0	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

An ordinary year of 365 days is 52 weeks *and* 1 *day* and so if there were no leap years, your birthday would occur 1 day later in the week each year. Hence item 3 in the calculation. However, every fourth year (except the century year unless it is divisible by 400) is a leap year with an extra day, 29th February, in it, and so we need to take into account the number of leap year days so far (item 4). Adding all these and casting out complete weeks of 7 days leaves a remainder of 6, which we see from Table I is a Saturday.

We can calculate that 31st December, 1999, will be a Friday and so 1st January, 2000, will be a Saturday. To take care of this we need to add a "Century remainder" of 5. But 2000 is a century leap year for it is divisible by 400, and so we have to take into account the leap year day early in 2000. For that reason it is better to use 6 as our century remainder and remember to take off one for January and February 2000. We can calculate 31st December, 2099, to be a Thursday, and so the century remainder for 2100 will be 4.

Table IV gives the century remainders for years from 1800 onwards.

Table IV
Century remainders

1800—1899	2	2300—2399	0
1900—1999	0	*2400—2499	6
*2000—2099	6	2500—2599	4
2100—2199	4	2600—2699	2
2200—2299	2	2700—2799	0 and so on

So that to calculate on which day of the week 10th July, 2545, falls—

1.	Day of month	10	3
2.	Month remainder	6	6
3.	Year of century	45	3
4.	Leap year days	11	4
5.	Century remainder	4	4
			$20=2\times7+6$

Hence the tenth of July, 2545, will be a Saturday.

*REMEMBER That in January and February of the Century Leap Years we have to use 5 and not 6. Next time we will look back into the past and calculate some historical dates.

R.M.S.

HONOURS EVEN

Arrange the Jack, Queen, King and Ace of the four suits of a pack of cards in a 4×4 array so that no two honours of the same kind nor two cards of the same suit appear in the same line or column.

P.J.G.