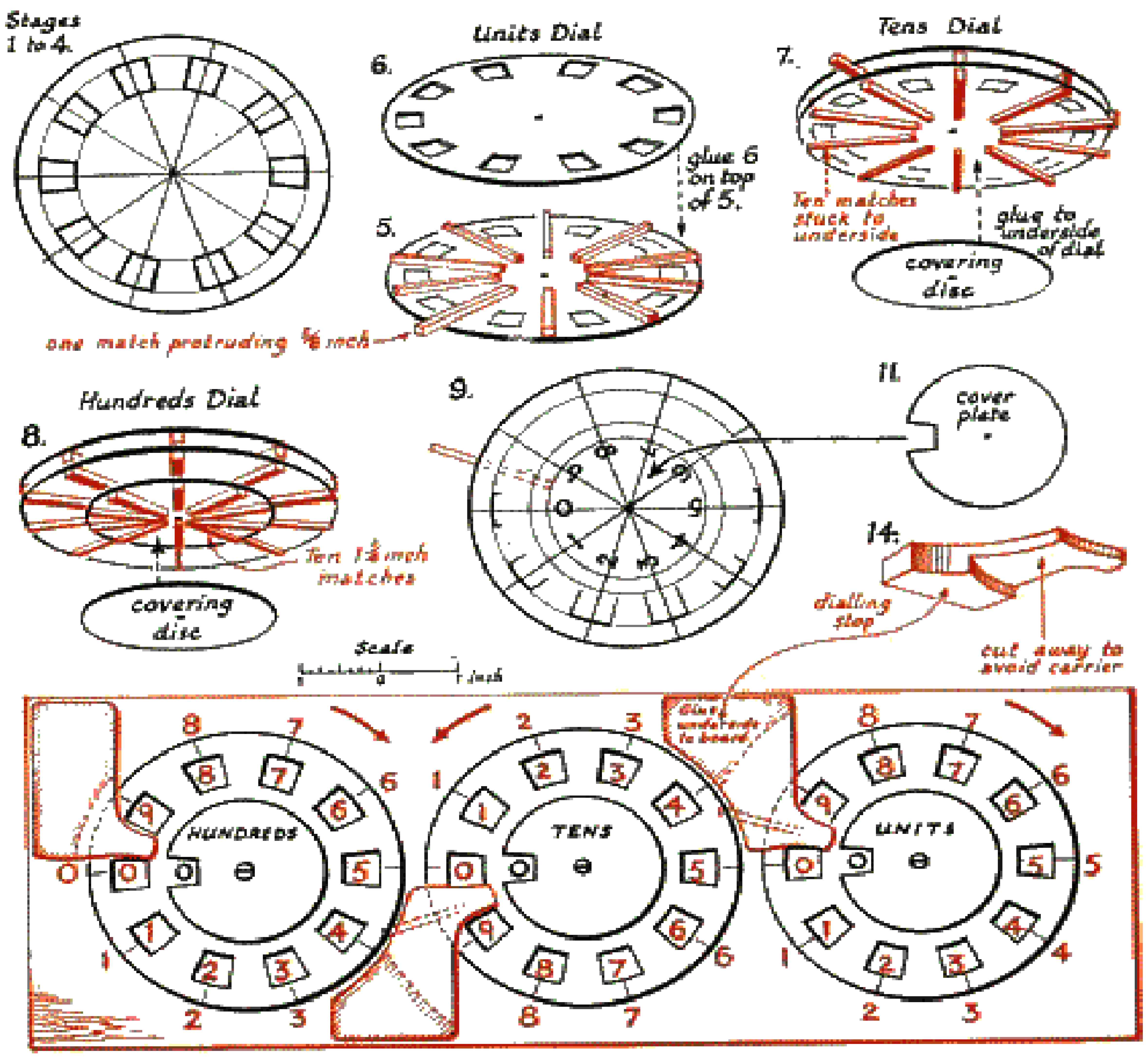

A DIAL-ADDER

Material : Fairly stiff card, 50 used matches, three ¾ inch screws, wooden backing-board about 14 inches by 5 inches, balsa wood, glue.

Construction :

1. Cut five 4 inch diameter discs from the card.
2. Use a protractor to divide each disc into ten equal sectors.
3. Draw two circles of radius 1¾ and 1¼ inches radii on each disc, concentric with the disc.
4. With the radii of the sectors as guides, cut equally spaced dialling slots between the two circles.
5. With matches stuck radially between the slots, stick together two discs. Position one of the matches to protrude ⅜ inch beyond the edge of the disc to act as a carrier. This is the units dial.
6. Cut three discs of diameter 2½ inches.
7. Repeat instruction 5. On the underside of the double disc, stick ten matches radially, all just reaching the circumference. Partly cover these by gluing on a 2½ inch disc. This is the tens dial.

Continued on page 378

63288 22505 45255 64056 44824 65151 87547 11962

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mathematical pie

No. 48 *Editorial Address :* **100, Burman Rd., Shirley, Solihull, Warwicks, England** **MAY, 1966**

GEORGE BOOLE, 1815—1864

Nowadays students' grants ensure that no bright boy or girl is denied a university education. A hundred and fifty years ago, John Boole, a Lincoln cobbler, could provide no more than a primary education for his son, but the end of school did not mean the end of learning for George Boole. Mr. Brooke, a bookseller, taught him Latin and from borrowed books he taught himself Greek, French and German. At 16 he was able to obtain a post as an assistant in a small private school at Doncaster. At 20 he established his own school in his native Lincoln.

He became interested in Mathematics and, without help, he worked through all the books he could obtain. When he was 24 his first paper was published in the Cambridge Mathematical Journal. Before his death at the age of 49, he had published over 50 important papers and several books. He developed original ideas in the treatment of differential equations and finite differences, but his greatest contribution was his work on formal logic.

As lawyers know to their cost, it is difficult to make complex statements in words which can be understood, and understood in one way only. Boole conceived the idea of expressing arguments in an algebra which uses letters to stand for statements and symbols to stand for words such as "and," "or," "not." His work attracted such attention that this man whose schooling had finished at 12 was made, at 33, the first Professor of Mathematics of the new University of Cork.

24901 14195 21238 28153 09114 07907 38602 52522

The rules of Boole's algebra of logic differ from the rules of ordinary algebra. If a, b, and c stand for numbers, "$+$" means "plus" and "$\times$" means "multiplied by," we know that

$a \times (b + c) = (a \times b) + (a + c)$ is true and

$a + (b \times c) = (a + b) \times (a + c)$ is false,

but if a, b, and c represent statements, "$+$" means "or" and "$\times$" means "and," both statements are true.

In 1938, C. E. Shannon, a student of M.I.T. saw that Boolean Algebra could be applied to problems in electrical circuits. The Bell Telephone Company developed the algebra as a means of analysing faults in telephone circuits. Now, Boolean algebra is in everyday use in the design of automatic control systems and of computers. Other algebras derived from it have led to important discoveries in nuclear physics. C.V.G.

The Mathematical Pie pamphlet 0 and 1 by T. J. Fletcher includes a section on the application of Boolean Algebra to electrical circuits.—Ed.

(*The drawing of G. Boole is reproduced by courtesy of the Rev. R. H. P. Boole, one of his descendants.*)

8	÷		+		=9
+		×		+	
	−		+		=6
÷		−		÷	
	+		÷		=3
=2		=2		=4	

WITHOUT A WORD

Each empty square requires one figure so that the working from top to bottom and from left to right is correct. Ignore the rules that you have been given in ordinary working, BODMAS. Can you find values that obey BODMAS? B.A.

DARK GLASS

You have some pieces of dark glass. Each piece reduces the light passing through it by one half. By how much is transmitted light *reduced* after passing through (*a*) 2 pieces, (*b*) 5 pieces, and (*c*) 10 pieces? J.F.H.

CUTIE

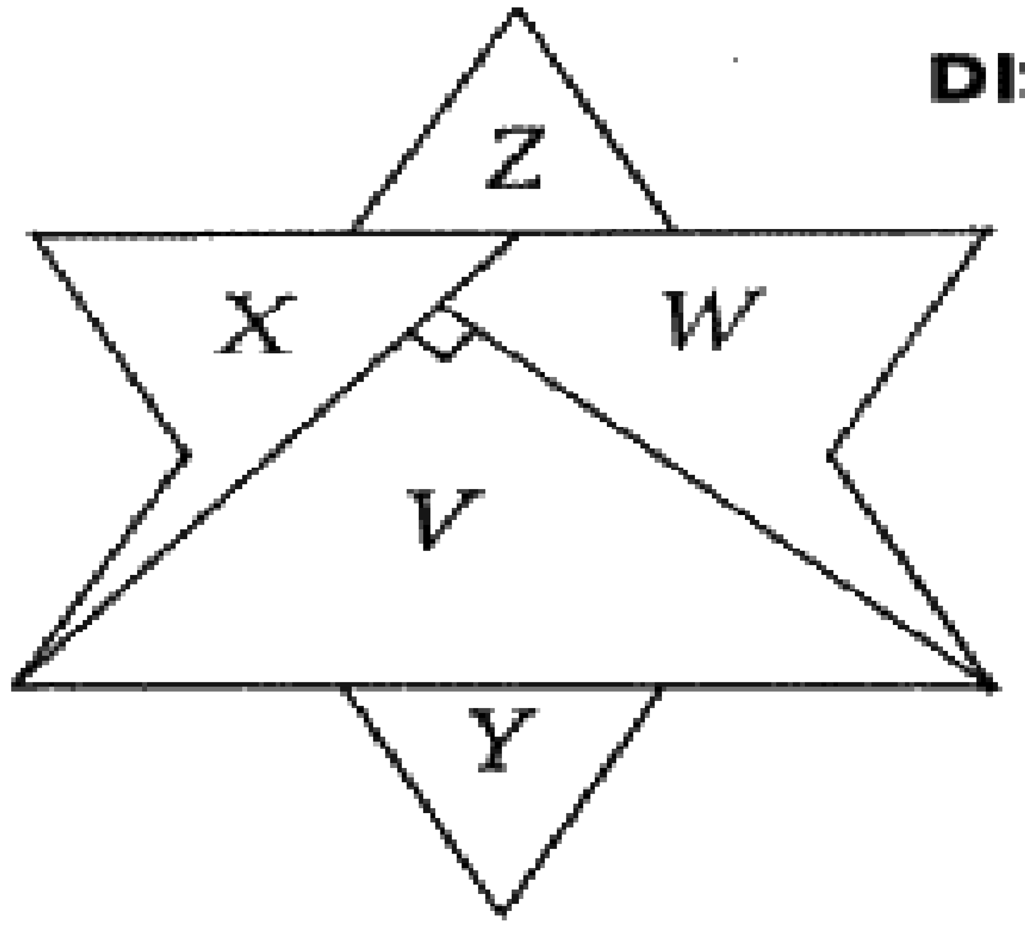
Cutie decides to start saving for her Summer holiday by putting something into her piggy bank every day. On the first day she put in a penny but she realised that a penny a day would not amount to much so the next day she put in tuppence and on the next day she put in fourpence. If she kept this up, doubling the amount every day, for a month, how much would she save? C.V.G.

FOR EXPERIENCED MATHEMATICIANS

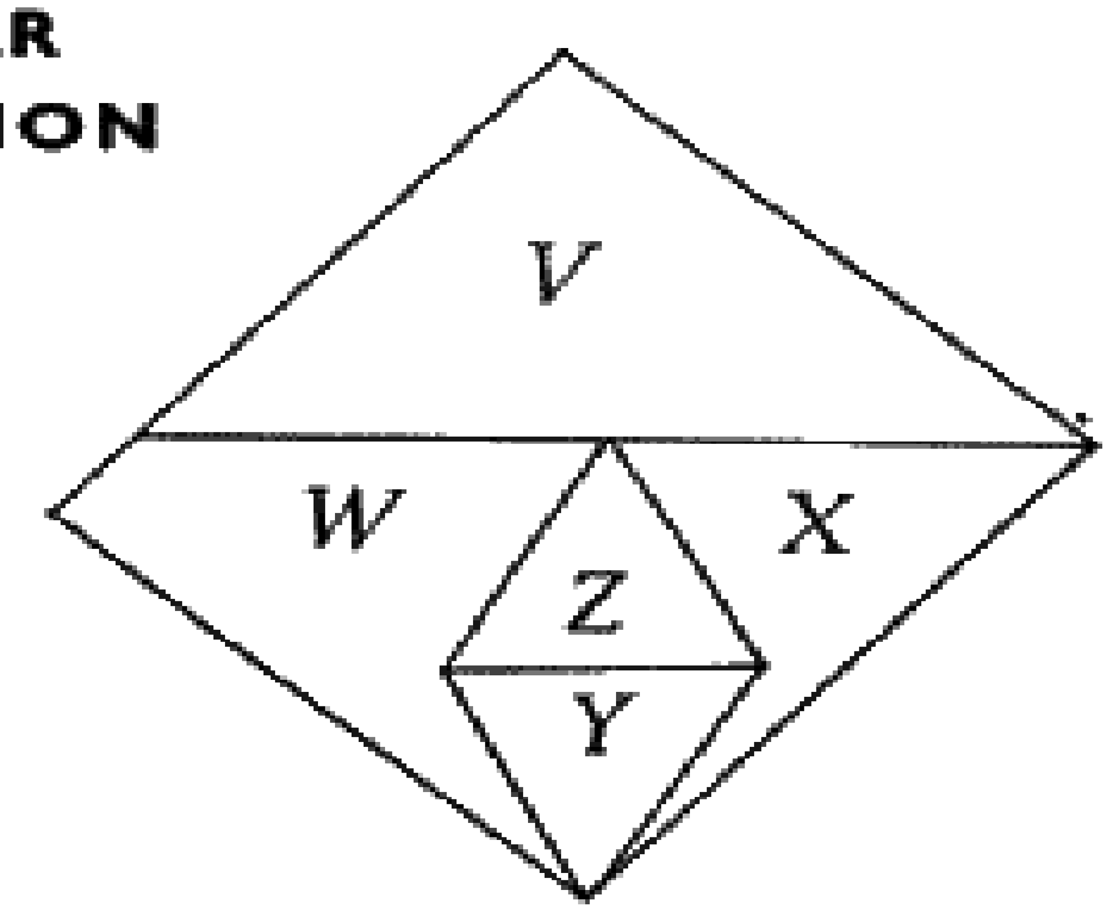
Great interest was shown in the problem of finding the lengths of the sides of the triangle circumscribing three circles, which was given in Issue No. 46. It appears that our "experienced mathematicians" have an age range of eleven to over seventy. The standard of the entries was very high, giving both calculated and drawn solutions. Excellent opportunities existed for slips in the calculation and a number of the attempts took advantage of them. The lengths of the three sides were 17.05, 31.02, and 36.95 inches correct to two places of decimals.

Book tokens have been sent to :—

C. M. Booth, Pinner; Doreen Broadberry, Shirley; Mrs. V. W. Carter, Bury St. Edmunds; Alison Cook, Weston-super-Mare; A. Cree, New Ollerton; James T. Donan, Youghal; G. F. Green, Lancing; Alan Hills, Faversham; Vanessa Hamilton, East Kilbride; Mr. N. S. Jones, Walsall; Gavin Kelley and William Taylor, Billericay; Miss R. Olsberg, Sunderland; Donald M. Salisbury, Baldock; Mr. C. Sanders, Guildford; A. Sims, Newport, Mon.



A STAR DISSECTION



SOLUTIONS TO PROBLEMS IN ISSUE No. 47

PAIRS PROBLEM The first part is satisfied by 7, 5; 4, 9; 3, 13.
Let the numbers be x and y, then $xy - (x+y) = 215$.

$$i.e., x = \frac{215+y}{y-1} = 1+\frac{216}{y-1}.$$ The factors of 216 are $2^3.3^3$.

Hence the possible pairs are 109,3; 73,4; 55,5; 37,7; 28,9; 25,10; 19,13.

WITHOUT A WORD
Three sets of solutions are possible.

3 − 1 × 4 = 8	3 − 1 × 4 = 8	3 − 2 × 4 = 4
5 + 4 ÷ 3 = 3	7 + 2 ÷ 3 = 3	7 + 2 ÷ 3 = 3
2 − 5 + 6 = 3	2 − 3 + 6 = 5	2 − 4 + 6 = 4

WEIGHT OF RAIN falling on one acre is 101¼ tons.

THE SNAIL would reach the top in 9⅜ days.

THE EQUALLY DISPERSED onions would total 37.

A CUTTING PROBLEM with the cube would leave a volume of $384\sqrt{6}$ cubic inches.

The number of prefects at the ODD'S ON Valentine Dance was 33; 18 girls and 15 boys.

Drawing FOUR balls from the bag would ensure that two were the same colour. NINE balls are required to ensure at least one of each colour. ELEVEN balls would have to be removed from the bag to be certain that three were red.

SENIOR CROSS FIGURE No. 45 5 across and 3 down are not unique.
Clues Across: 1. 136; 3. 28; 5. 4994; 6. 420; 8. 375; 10. 1024; 11. 66; 12. 162.
Clues Down: 1. 104; 2. 640; 3. 2977; 4. 84; 7. 2106; 8. 341; 9. 512; 10. 16.

$1*2*3* \ldots\ldots *n = 1$ and $\frac{1}{2}*\frac{1}{4}*\frac{1}{6}* \ldots\ldots *\frac{1}{2n} = \frac{n}{n+1}.$

JUNIOR CROSS FIGURE No. 40

Clues Across: 1. 374; 5, 3843; 6. 150; 7. 28; 8. 35; 9. 1273.
Clues Down: 2. 73582; 3, 480; 4. 13; 6. 121; 8. 33.

74299 58180 72471 62591 66854 51333 12394 80494 95889 70695 36534 94060 34021 66544 37558 90045

Continued from page 380

8. Omit instruction 5 but repeat instruction 7 on the remaining 4 inch disc. On the under side of the 2½ inch covering disc glue ten equally spaced matches radially, backing these with the remaining 2½ inch disc. This is the hundreds dial.
9. On each dial mark the digits 0 to 9 about 1 inch from the centre on the radii through the dialling slots as follows :

UNITS DIAL Enter O immediately anticlockwise of the carrier, then continue with the remaining digits in an anticlockwise direction.

TENS DIAL Enter O immediately clockwise of the carrier, then continue with the digits 1 to 9 in a clockwise direction.

HUNDREDS DIAL As for the units dial.

10. Draw a central line along the length of the backing-board. On this line mark the centres for the discs 4½ inches apart.
11. Cut three 2 inches diameter discs as cover plates for the faces of the dials. In each cut out a one-tenth sector so that one digit only can be seen at once.
12. Screw each disc assembly to the backing-board and arrange the cover plates so that the digits are viewed to the left. Glued to the screw head, the cover plates should be immovable.
13. On the board, mark the digits adjacent to the dialling slots as shown.
14. Construct dialling stops from balsa wood and fit them so that they do not obstruct the carriers.
15. Mark in arrows to indicate the direction of dialling.

The discs are designed so that the tens carrier does not operate the units dial.

Having completed this model, try making one for another number system or for pounds, shillings and pence. How could the machine be used for subtraction?

D.I.B.

A LADDER

A ladder stands against a vertical wall, and the foot slides away along the ground (which is horizontal), what is the locus of the mid-point? S.T.P.

Under the integers 1, 2, 3, 4, 5, 6, 7 write another arrangement of the same integers. Find the difference between the two numbers in each column. Prove that these absolute differences cannot be all different.

A book token will be awarded to the best solutions.—ED. R.H.C.

Write down the next term in the sequence 1, 3, 6, 12, 24, 30, 120, 240.

R.H.C.

SOLUTIONS TO PROBLEMS IN ISSUE No. 48

It has been decided that the solutions of the problems shall be given in the current issue except for competitions and Cross figures.

WITHOUT A WORD: $8 \div 2 + 5 = 9$, $2 - 3 + 7 = 6$, $5 + 4 \div 3 = 3$.

TWO DARK GLASSES reduces the light to one half squared, or one quarter ; five pieces to one thirty-second, and ten to $(\frac{1}{2})^{10}$ of the intensity.

CUTIE had saved $2^{30} - 1$ pence or over four million pounds in a thirty day month.

THE 5 TERM SERIES which adds up to 153 is $1! + 2! + 3! + 4! + 5!$

A PENNY FOR YOUR THOUGHTS shows the values in pence of the currency of the country so the next term will be 1,200

DISC JOCKEY RIDES AGAIN. The needle travels about 1¾ inches along an arc of a circle.

A LADDER falls and the path of the mid-point of the ladder is a quadrant of a circle.

THERE'S NO CATCH. The boy scored 2 runs.

B.A.

60357 99646 92565 04936 81836 09003 23809 29345

PRESIDENTIAL PROBLEM

LYNDON
B
JOHNSON

Each letter represents a different digit. Can you identify this multiplication problem? R.M.S.

THE 5 TERM SERIES

The 5 term series $1^2+2^2+3^2+4^2+5^2$ involves the first 5 natural numbers in order and adds up to 55. Can you devise another series of 5 terms involving the first 5 natural numbers, one per term, which add up to 153? R.M.S.

DISC JOCKEY RIDES AGAIN

The diameter of the latest top 20 record is 7 inches. The outer ½ inch is blank and the unused centre has a diameter of 3½ inches. If there are 91 grooves to the inch of radius, how far does the needle move during the actual playing of the record? R.M.S.

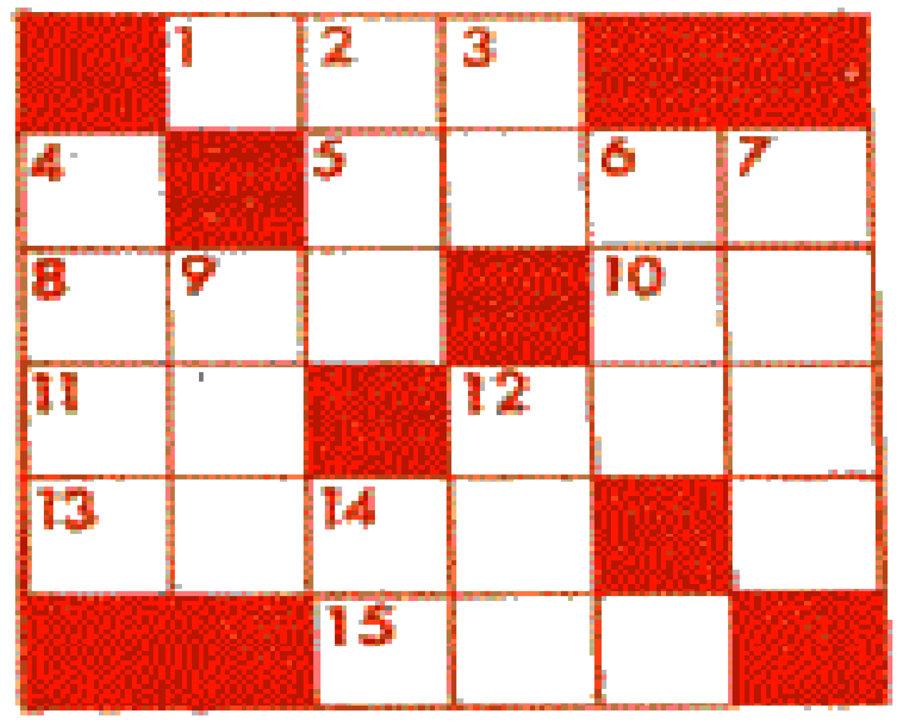
One track of Tom Lehrer's latest L.P. record is called New Math. We invite you to listen to the recording and write, in about 250 words, a similar monologue on some aspect of the new mathematics. A book token will be awarded to the writer of the best attempts which will be printed in a future issue.—ED.

THERE'S NO CATCH

There was a boy who played cricket,
But he always used to snick it.
The square of his score,
Plus nine times it — not more,
Equalled the length of the wicket.

How many runs did he make?

MODERN CROSS FIGURE



CLUES DOWN:

2. 124 + 33 in base five.
3. Both solutions of $x^2 - 11x + 30 = 0$, smaller first.
4. The next two terms in the series 1, 1, 2, 3, 5, 8, –, –.
6. Ten times the *size* of 1 across.
7. 67.61 francs in lire to 3 sig. fig. when £1 = 13.68 f ; and £1 = 1740 lire.
9. Twice the second prime after 131.
12. $\pi\int_0^3 (x^2 + 4)\,dx$ to 3 sig. fig. Take $\pi = 3.14$.
13. Number of combinations of 11 things taken from 13.

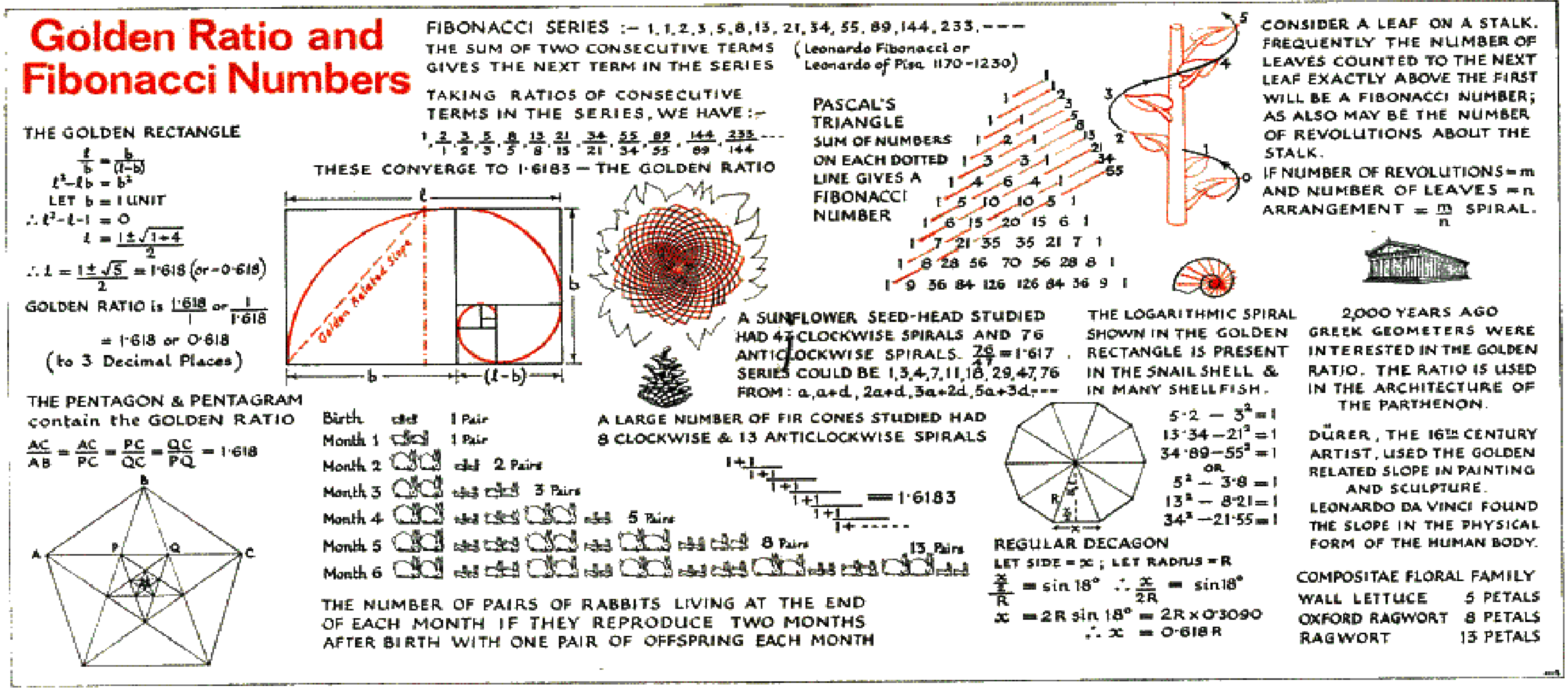
CLUES ACROSS:

1. Vectors, $(8, -2) + (4, 7)$.
5. The reciprocal of 0.618.
8. The binary number 101000010 in denary.
10. The number of possibilities with 2 dice.
11. {All perfect cubes} ∩ {Multiples of 3 below 100.}
12. The product of the number of edges and the number of faces of an icosahedron.
13. Tan θ when $\sin\theta = \frac{15}{17}$, as a decimal
15. The speed, in ft. per sec., of a body after 28 seconds falling from rest when $g = 32$ ft. per sec. per sec.

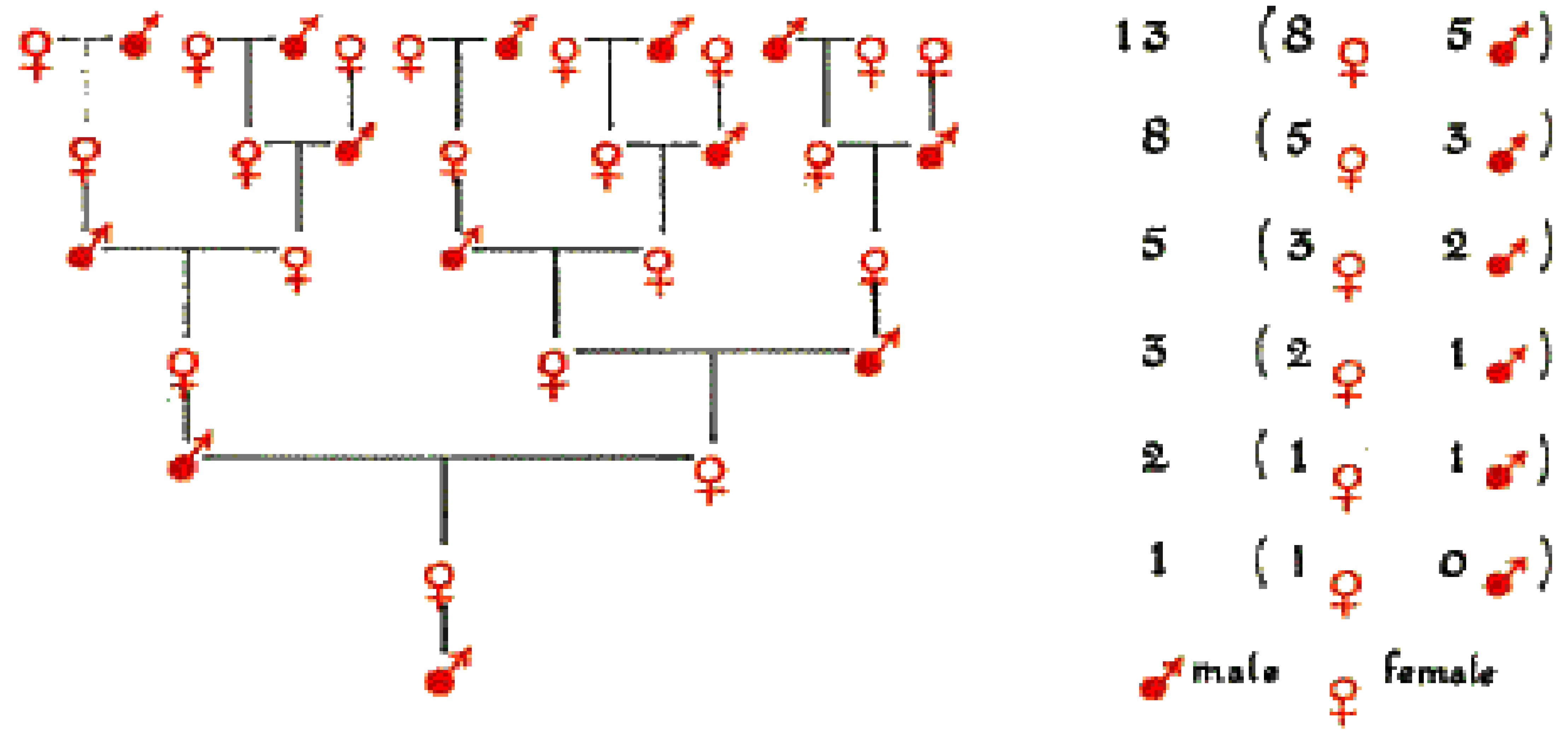
Omit commas and decimal points and work to the appropriate number of figures.

D.I.B.

70791 19153 26734 30282 44186 04142 63639 54800



The Fibonacci sequence of numbers owes its name to the Italian mathematician, Leonardo of Pisa (often abbreviated to Fibonacci). Born in Pisa between 1170 and 1175, he was educated at Bugia and travelled about the Mediterranean, collecting information about mathematics. In 1202 he returned to Pisa and published ' Liber Abaci,' a book which established the introduction of the Arabic notation in Europe and provided a foundation for future developments in algebra and arithmetic. In 1220 he published a book on geometry entitled, ' Practica Geometria.'



A drone bee (male) has a mother but no father, as the queen's unfertilised eggs hatch into drones. The queen's fertilised eggs produce either worker bees or queens. The diagram shows why the number of ancestors of a drone must in any generation be a Fibonacci number.

The sequence is also found in floral families when the number of petals is considered. This has relevance in evolution.

Ranunculaceae family : Buttercup, Larkspurs, Columbines, some Delphiniums, all have 5 petals. Lesser Celandines and other Delphiniums have 8 petals. Globe flower *some Double* Delphiniums 13 petals.

Compositae family :

Wall lettuce (rare)	5 petals	*Ragwort* (fairly common)	13 petals
Oxford ragwort	8 petals	*Asters* (fairly common)	21 petals
		Field daisies (most common)	34 petals
		Michaelmas daisies	55 petals or 89 petals

Of course, one cannot expect to find these exact numbers on every example, due to various mutations which might occur, but in general a mean score would definitely tend towards these figures.

References : Fibonacci Numbers by N. N. Vorob'ev, published by Pergammon Press ; On Growth and Form by D'Arcy W. Thompson ; Recurrence Relations by T. J. Fletcher, *Mathematical Pie* ; The Golden Section or Golden Cut by Manning Robertson (Journal of the Royal Institute of British Architects, Vol. 55, No. 1, 1948) ; The Language of Mathematics by Frank Land.

Some indication of the uses of the Golden Section in sculpture, painting, architecture and furniture is given in the book, ' Practical Applications of Dynamic Symmetry ' by Jay Hambridge, published by Yale Press, 1932. D.I.B.