

## Packing the steps with solid pentominoes

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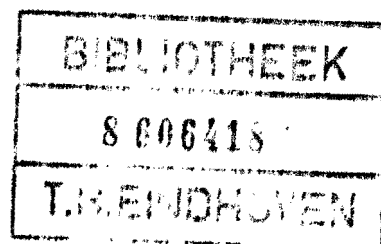
NEDERLAND

ONDERAFDELING DER WISKUNDE

TECHNOLOGICAL UNIVERSITY EINDHOVEN

THE NETHERLANDS

DEPARTMENT OF MATHEMATICS



PACKING THE STEPS WITH  
SOLID PENTOMINOES

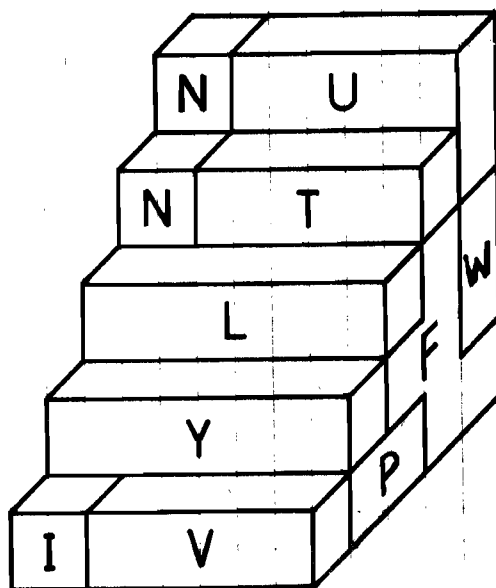
by

C.J. Bouwkamp

T.H.-Report 79-WSK-01

February 1979

I take the twelve pentominoes in their solid form so that they consist of unit cubes rather than squares. Problem 44 on page 158 of reference [1] is that of "The Steps", to be packed with the solid pentominoes. Various solutions are known. As an example, four solutions can be derived from



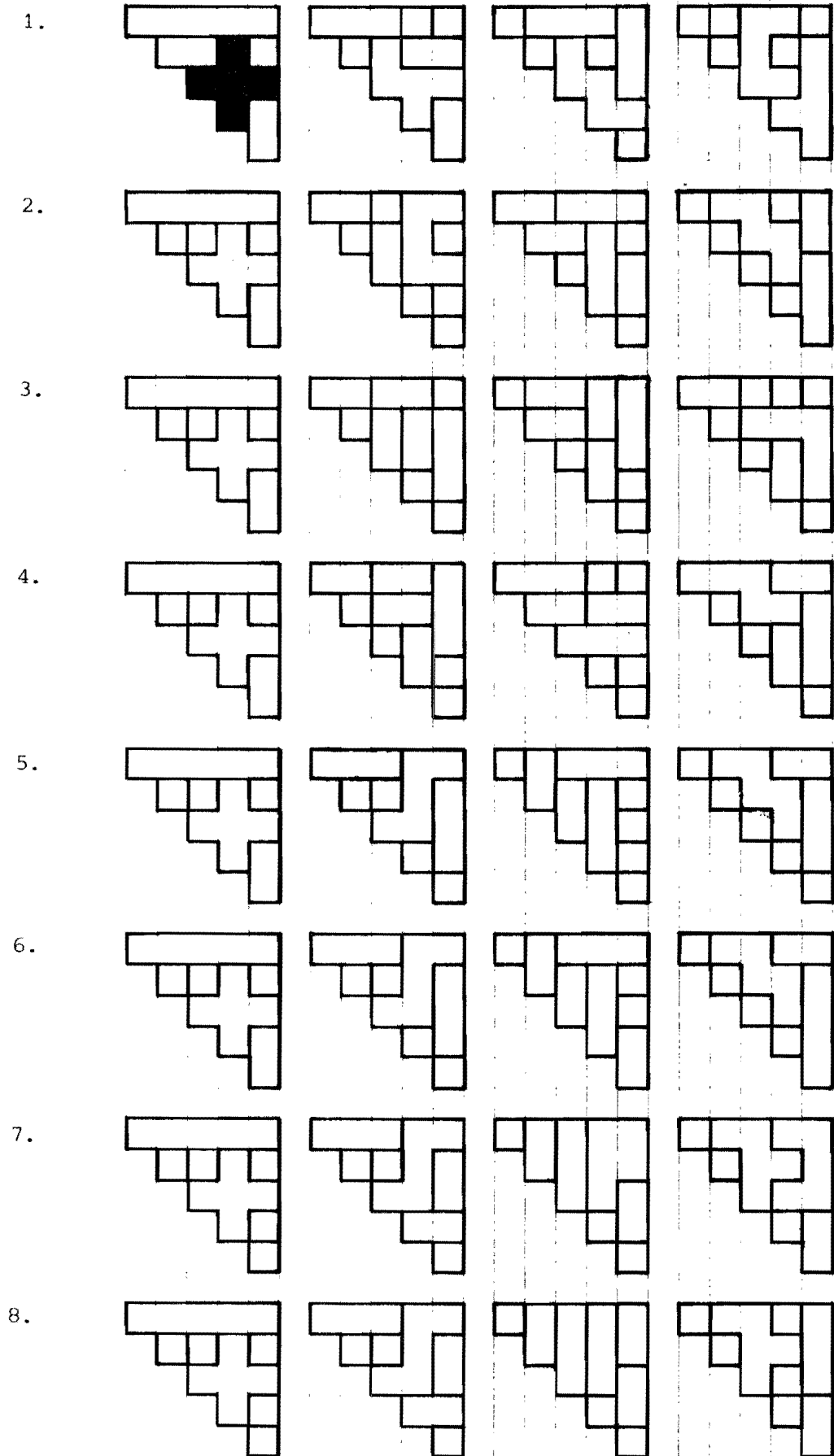
in which both blocks (L,Y) and (P,V) can be packed in two ways. These solutions come from David A. Klarner who once made the suggestion that I program the problem for the computer. At the time about a dozen solutions were known. After a few years of hesitation I finally invoked that instrument and was left with 137 different solutions modulo reflexion and rotation. (This number of solutions has nothing to do with the fine-structure constant of physics, or has it?)

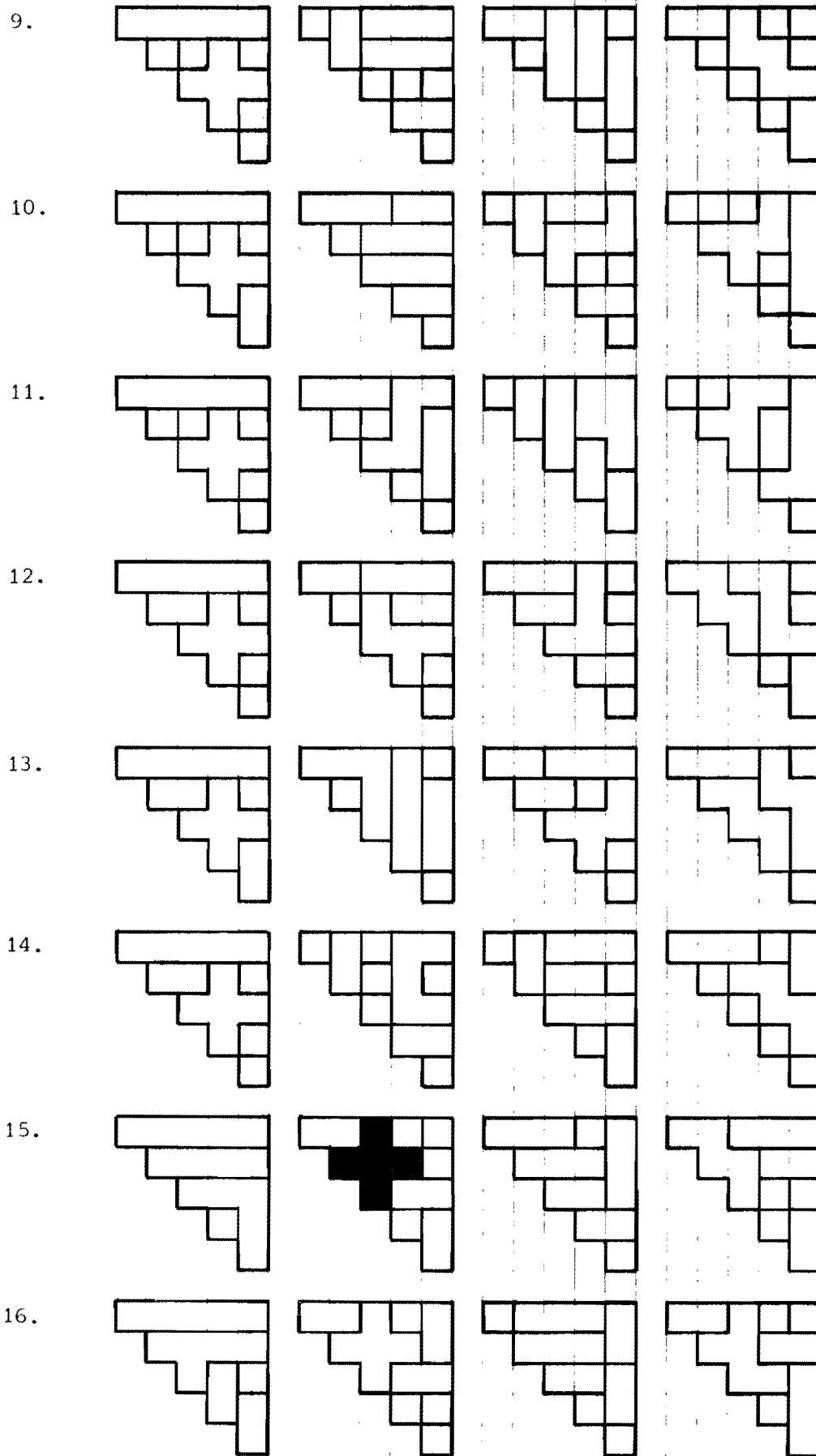
In the catalogue to follow, a solution is represented by the four cross-sections of the four layers of the steps when tilted over (reading from left to right, bottom to top layers). I eliminate symmetries by fixing pentomino I in either of two positions. Whenever pentomino X gets a new position it is marked in black. In the last two solutions pentomino I is not along an outer edge. One of them (nr. 136) was found by hand by Stan Ackermans [2] of this Department. In the few cases where the four cross-sections do not define the packing uniquely, the appropriate name of the pentomino involved is indicated. Solutions 8, 20/23, 49, 98, 113, 117 and 119 are originally due to Klarner. Solutions 11 and 106 were obtained earlier by Lushbough and Langworthy, respectively, while nr. 81 was known to Verbakel.

References:

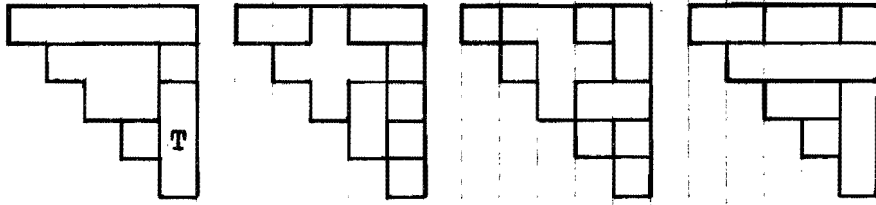
- [1] Golomb, Salomon W., Polyominoes, Charles Scribner's Sons, New York, 1965.
- [2] Meeus, J. - P.J. Torbijn, Polycubes, Les Distracts 4, CEDIC, Paris, 1977.

The reference to Stan Ackermans on page 126 with respect to fig. 15-4 is erroneous. This figure shows numbers 51 and 53 of my catalogue, but the two possibilities for block (U,P) leading to solutions 50 and 52 are not mentioned.

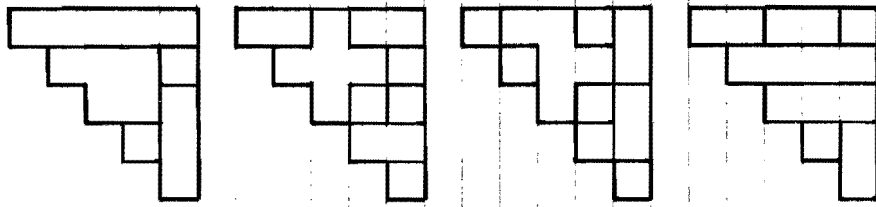




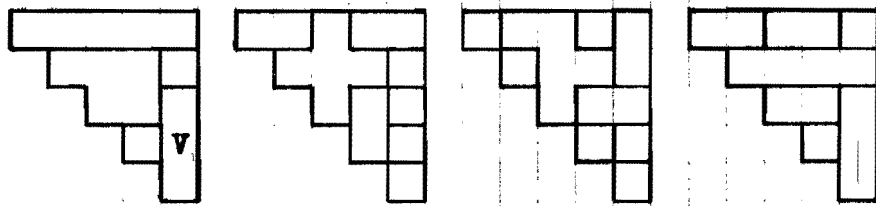
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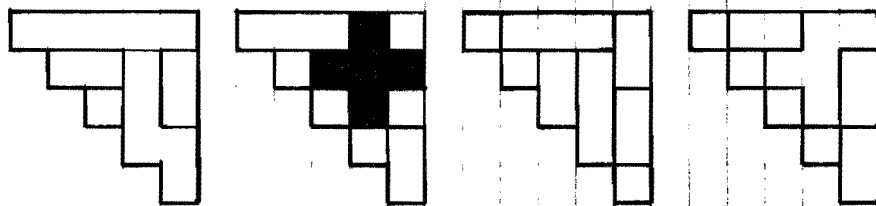
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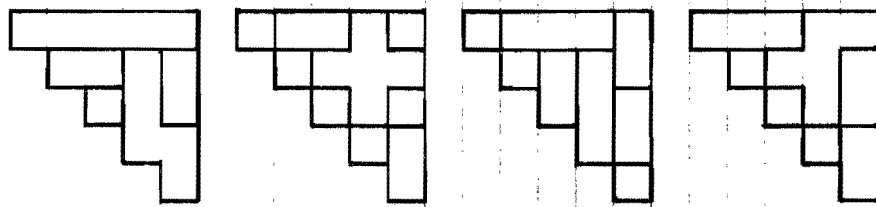
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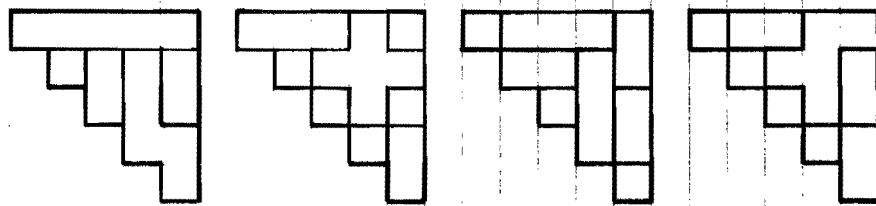
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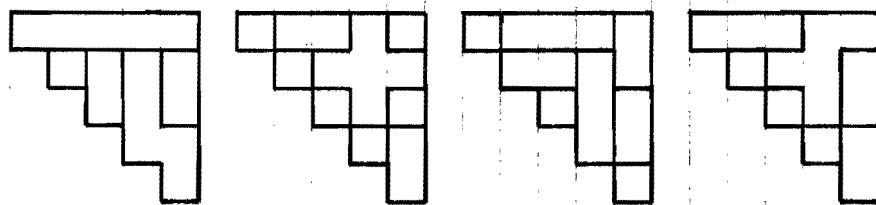
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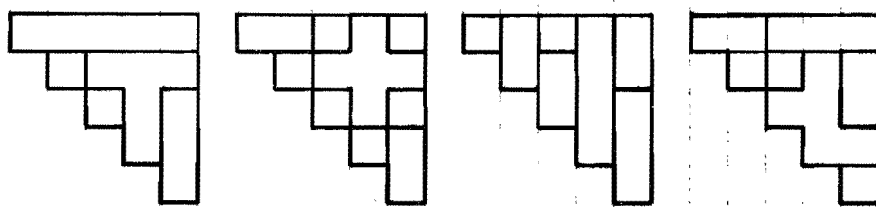
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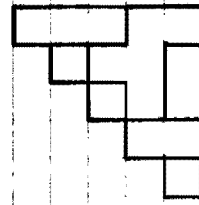
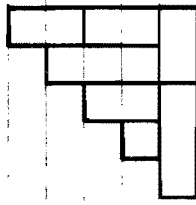
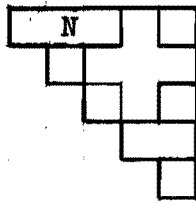
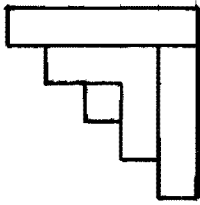
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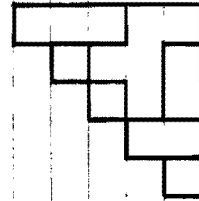
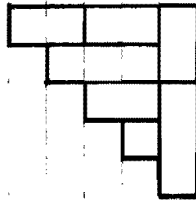
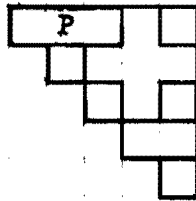
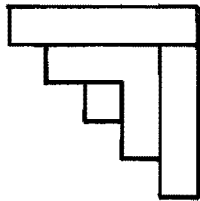
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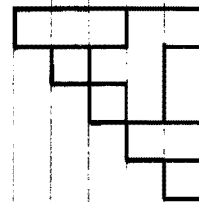
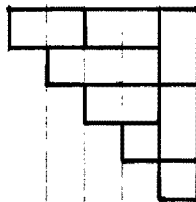
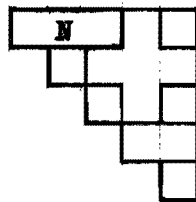
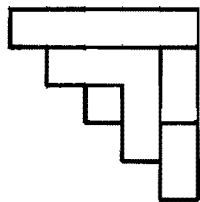
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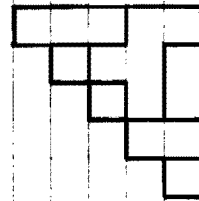
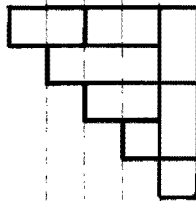
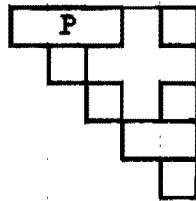
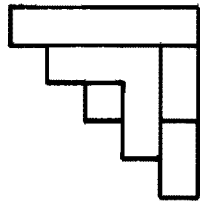
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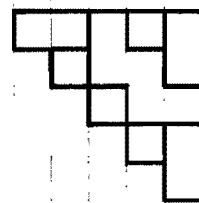
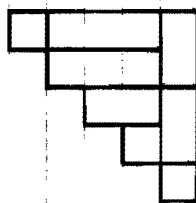
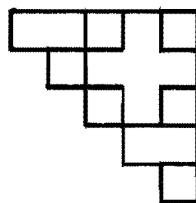
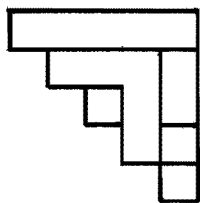
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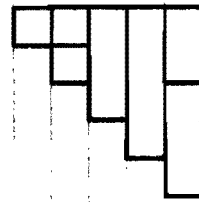
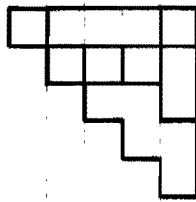
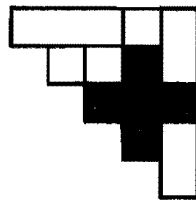
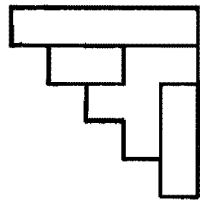
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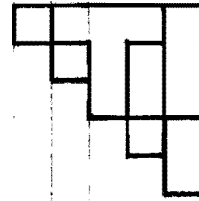
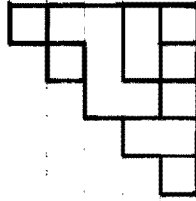
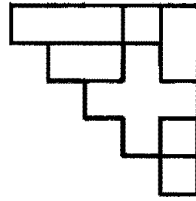
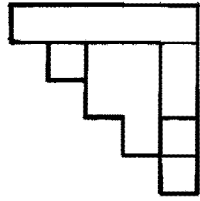
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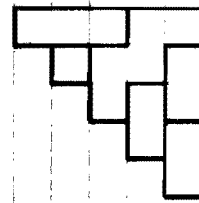
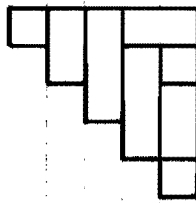
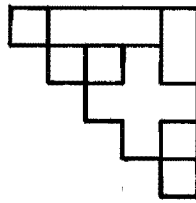
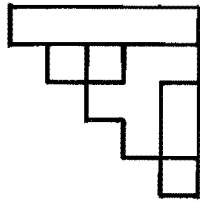
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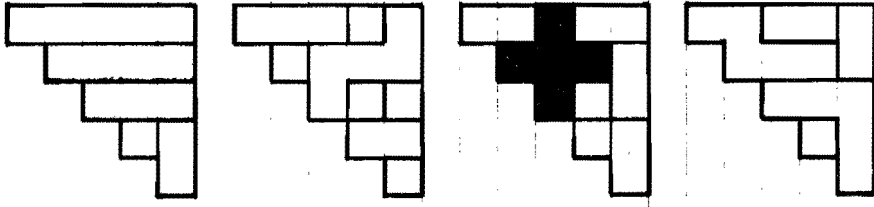


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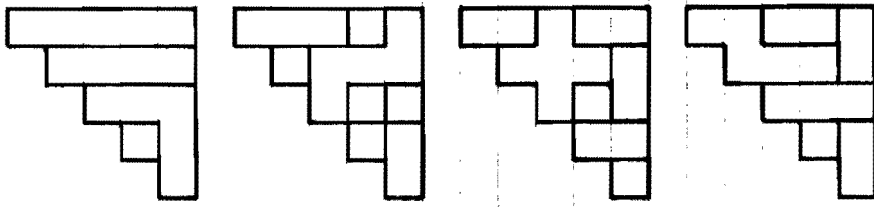




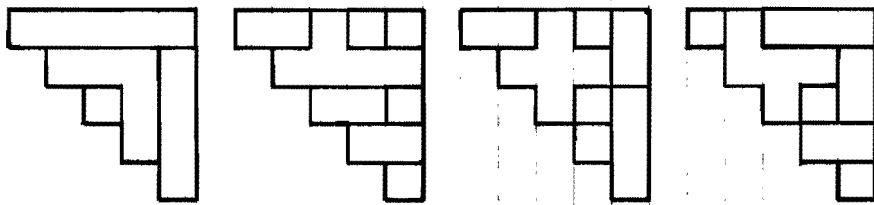
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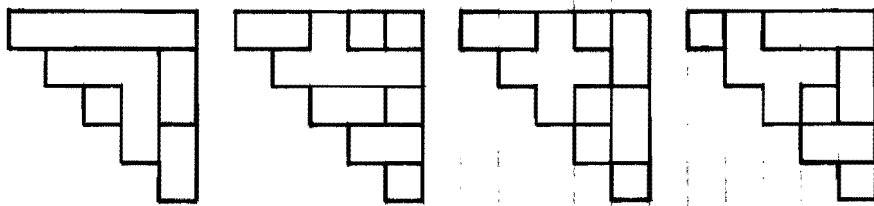
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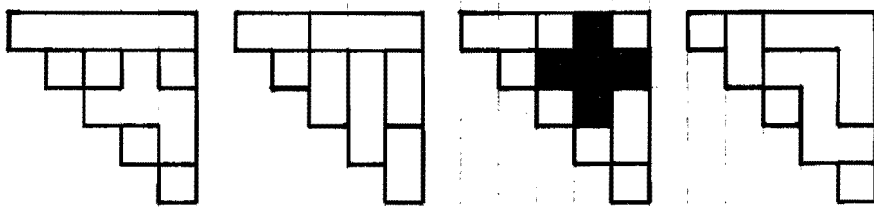
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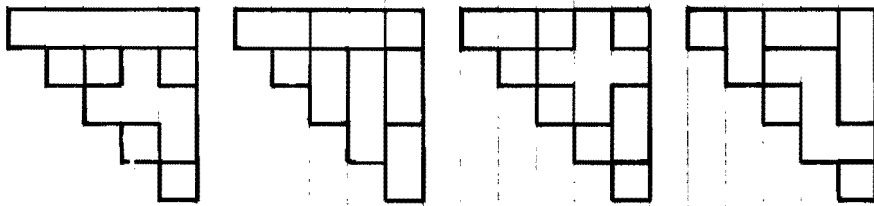
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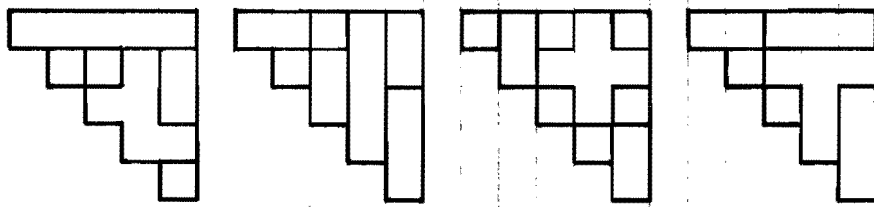
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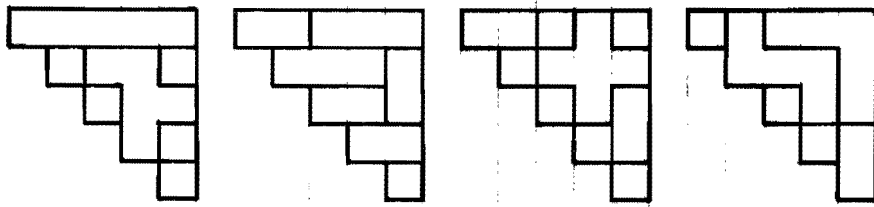
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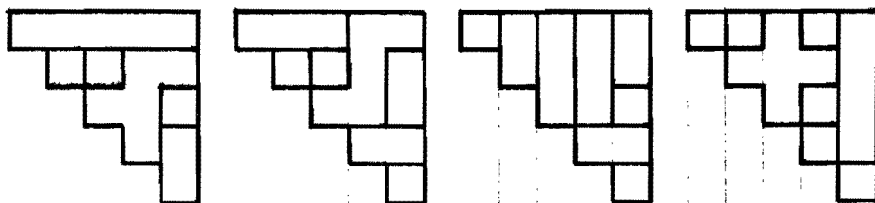


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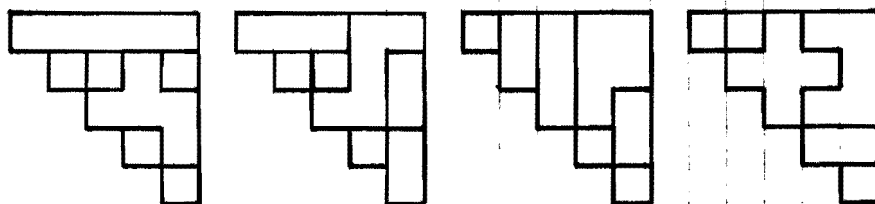




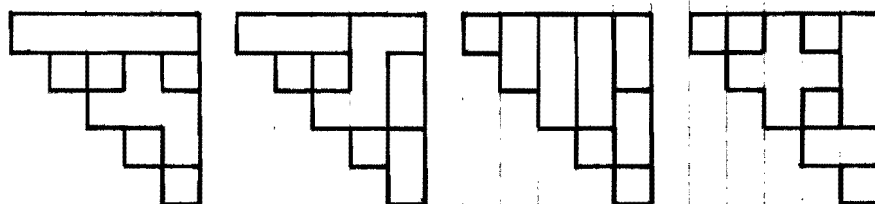
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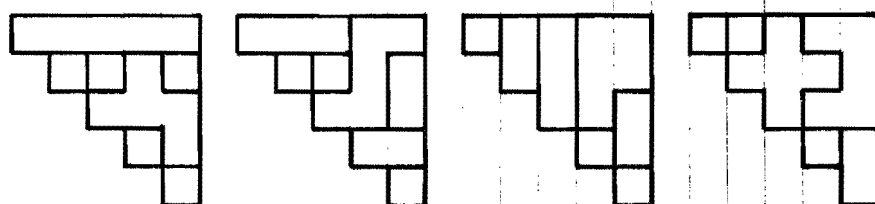
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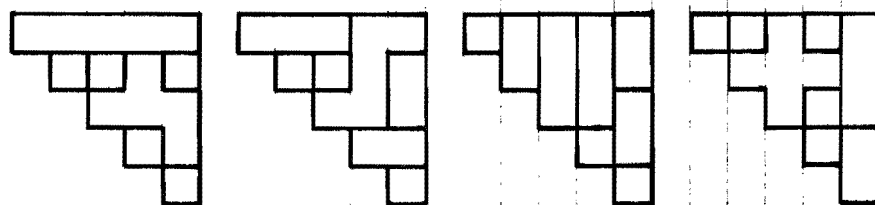
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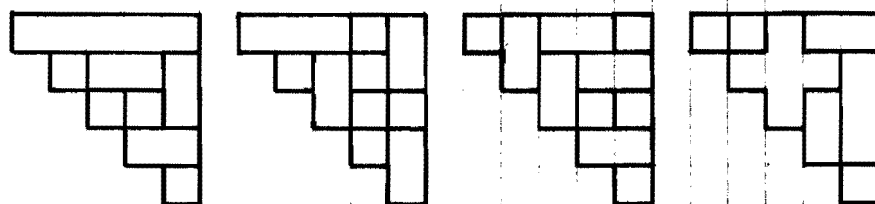
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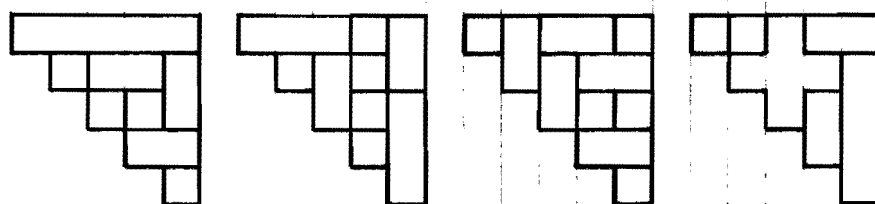
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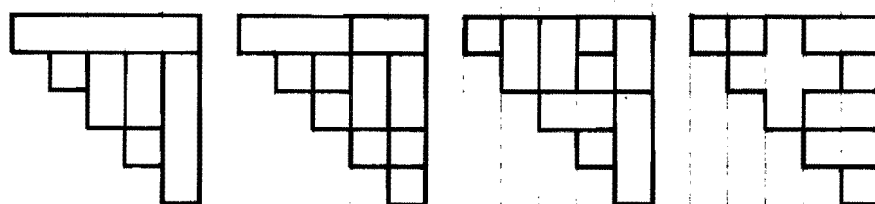
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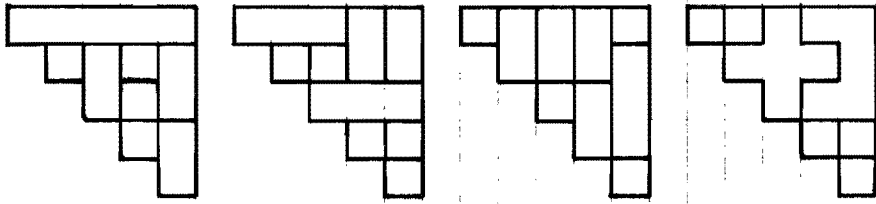
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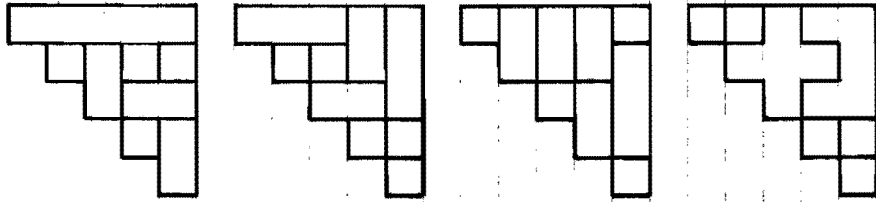
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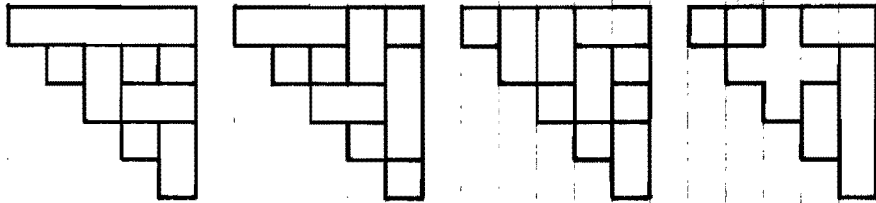
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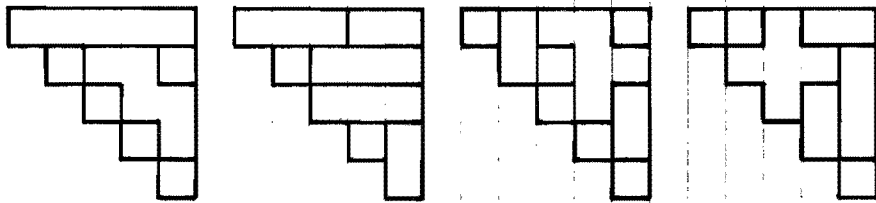
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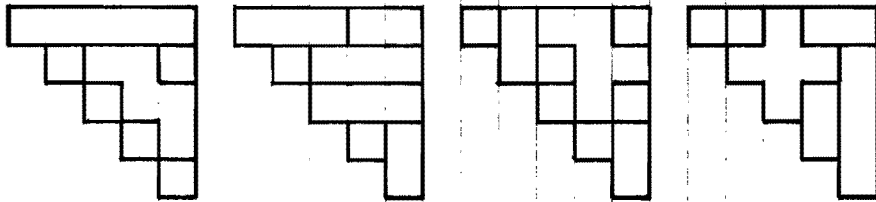
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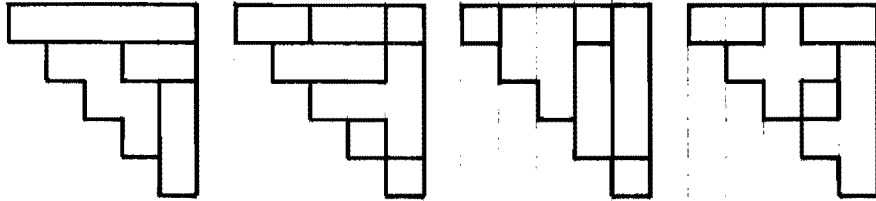
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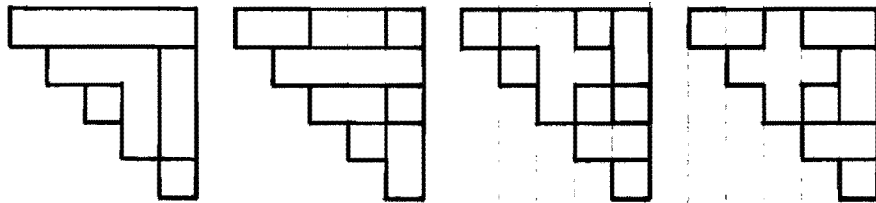
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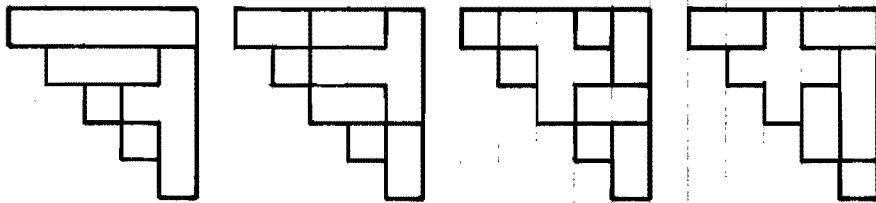
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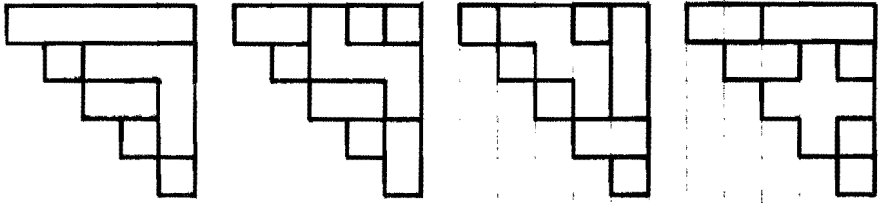


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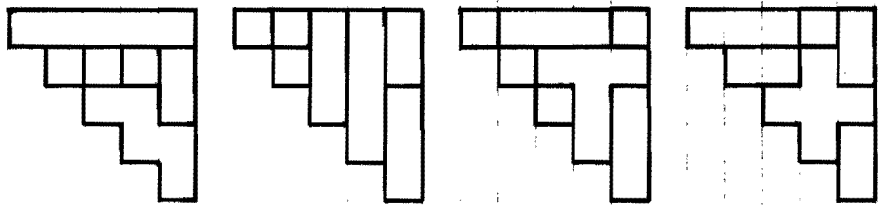




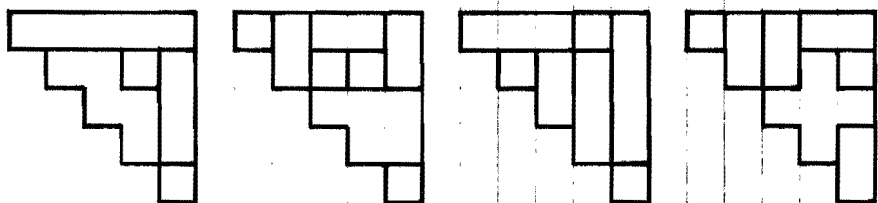
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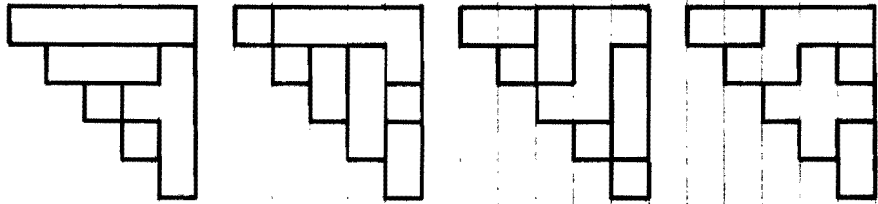
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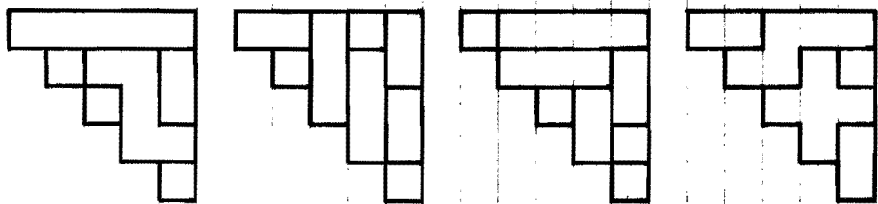
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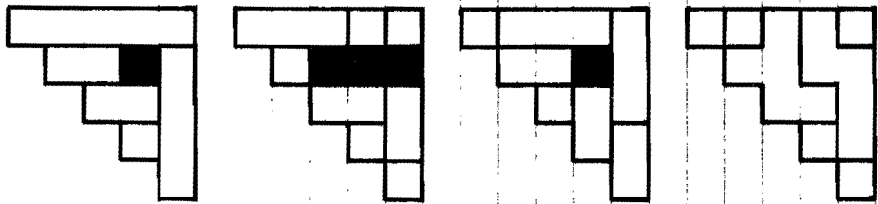
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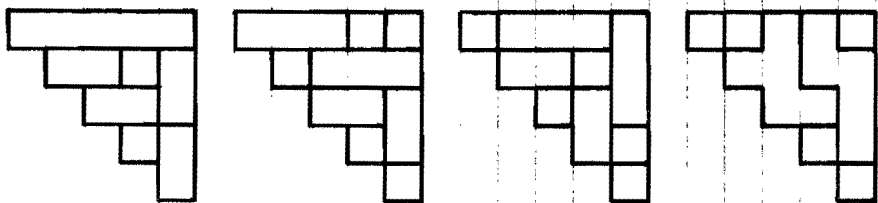
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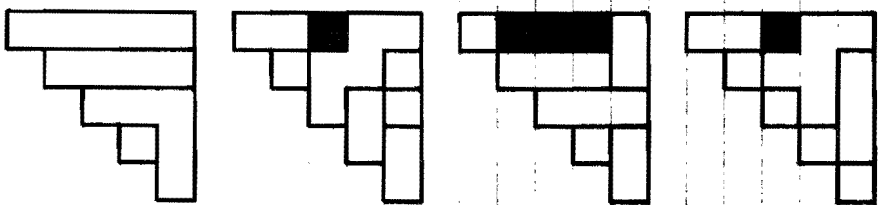
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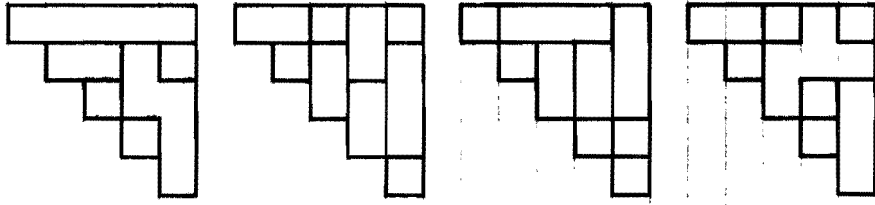
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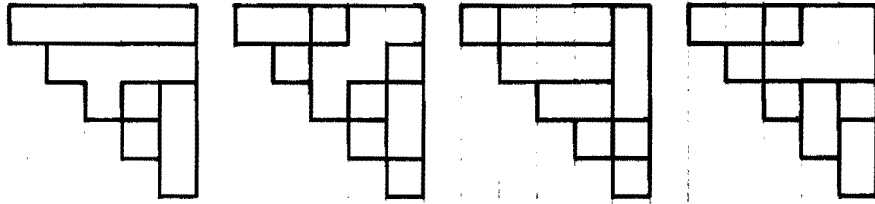
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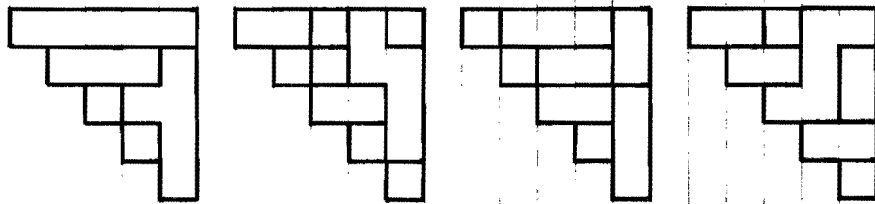
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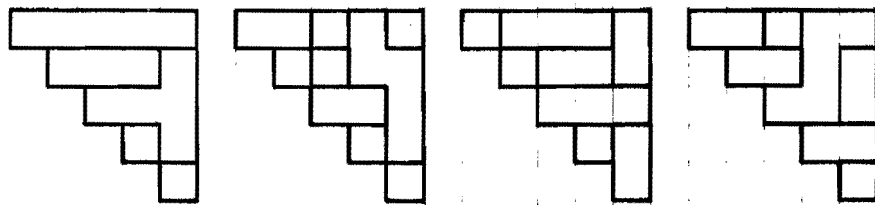
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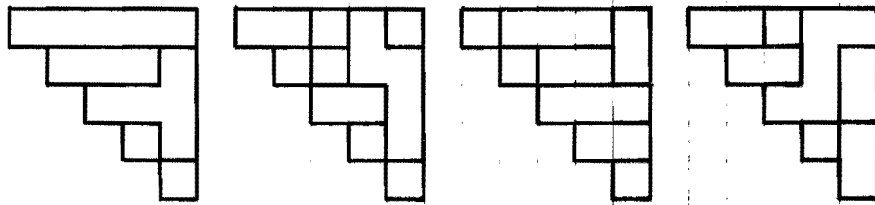
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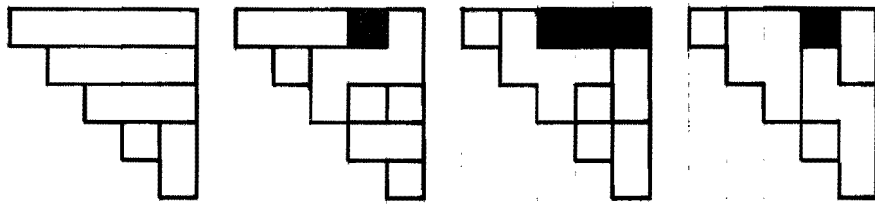
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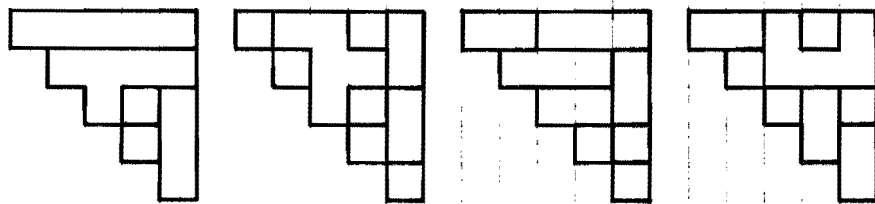
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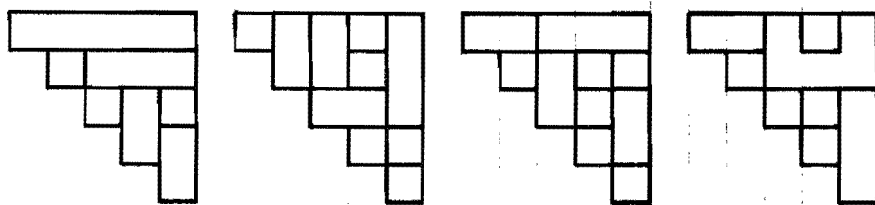
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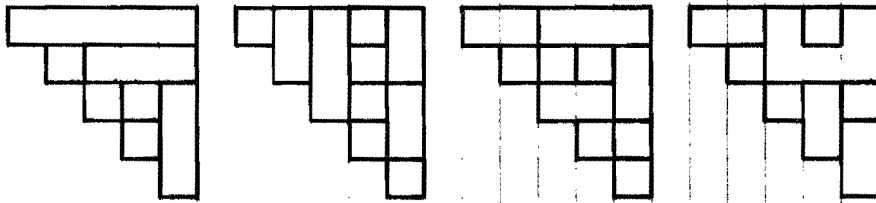
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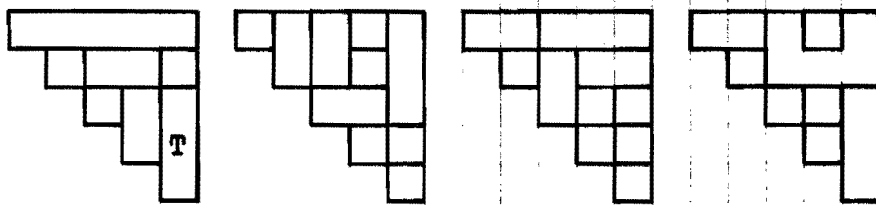
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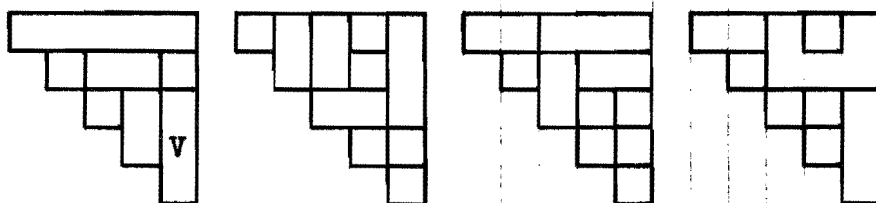
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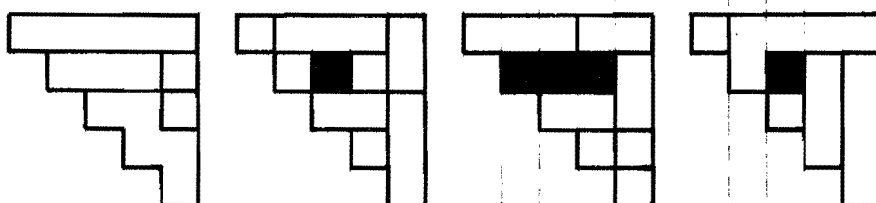
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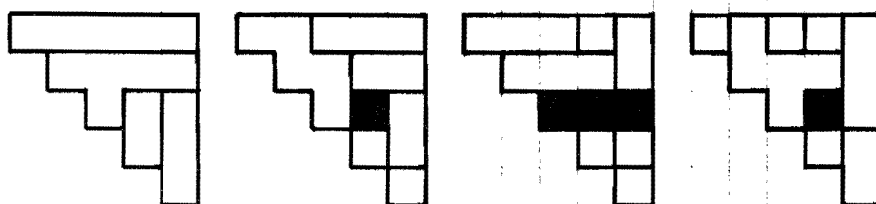
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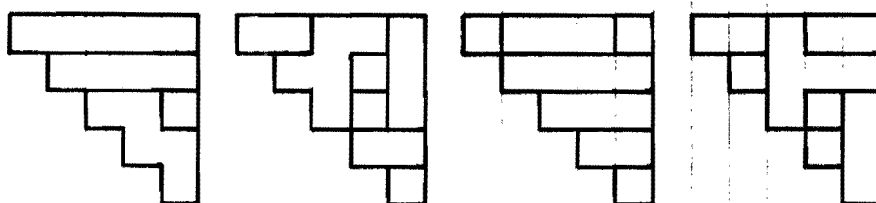
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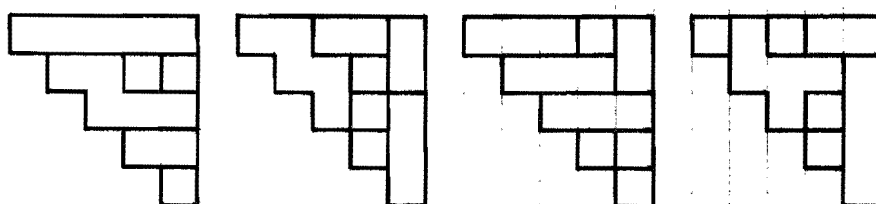
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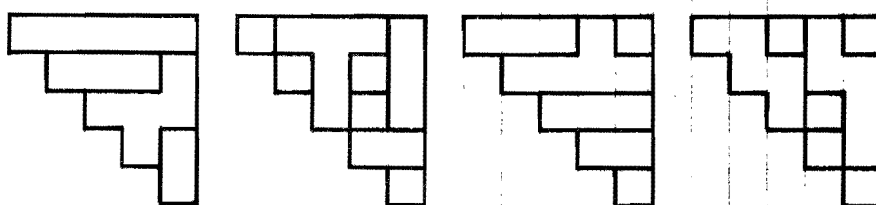
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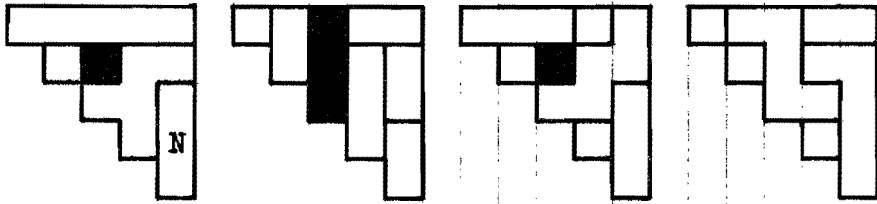


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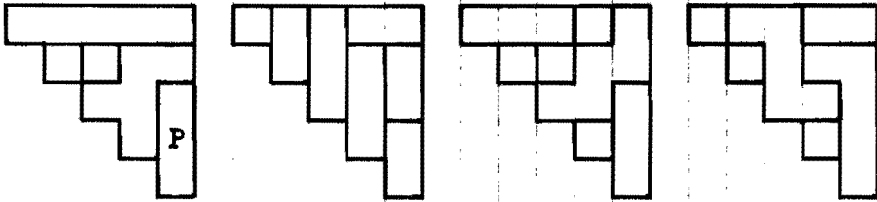




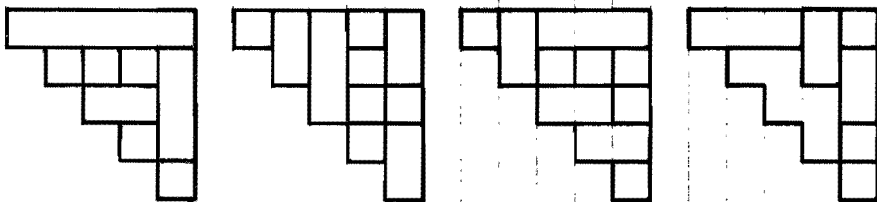
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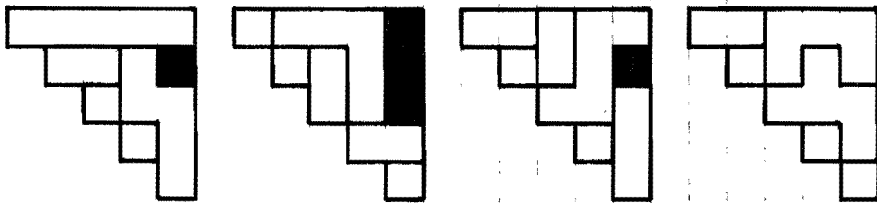
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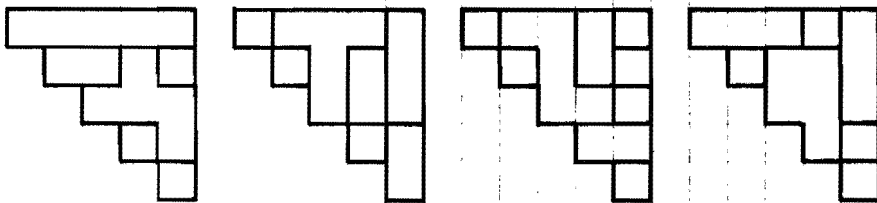
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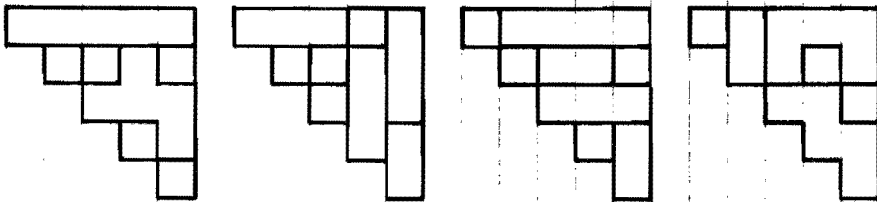
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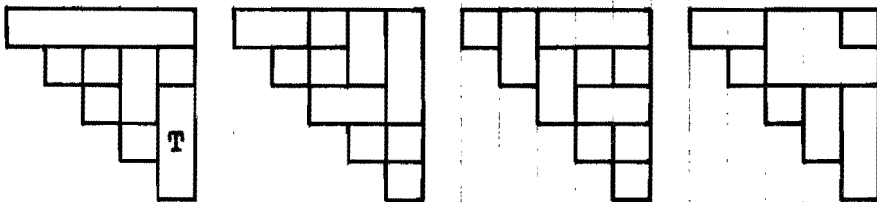
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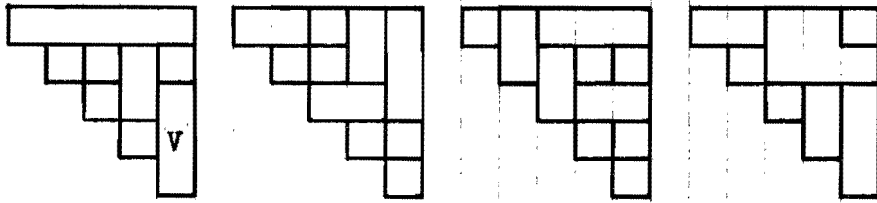
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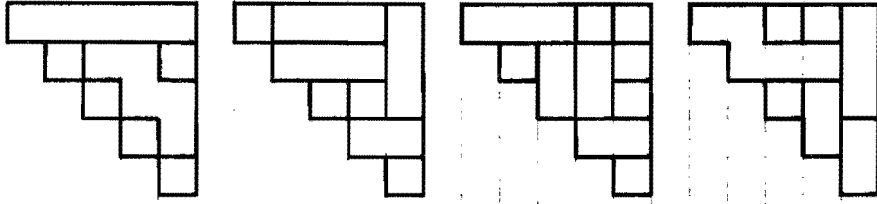


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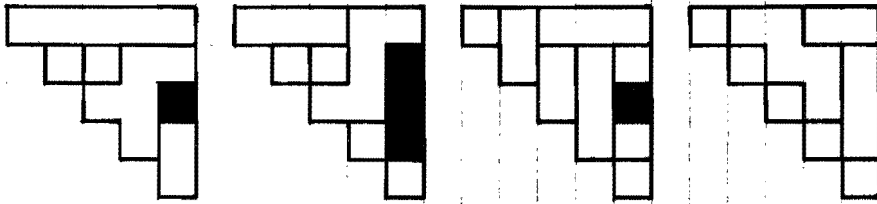




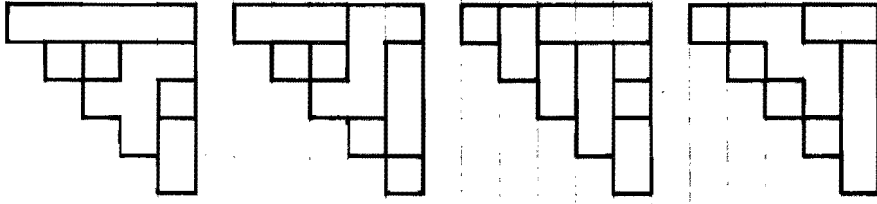
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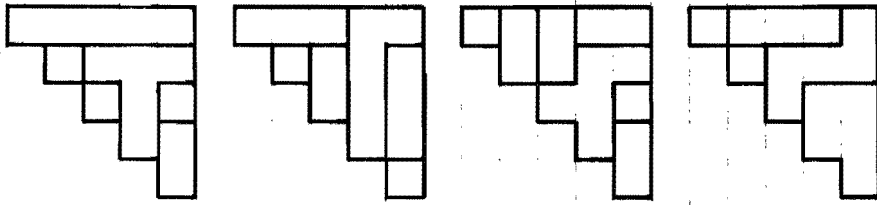
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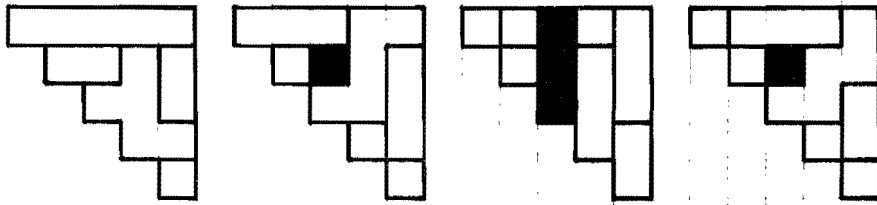
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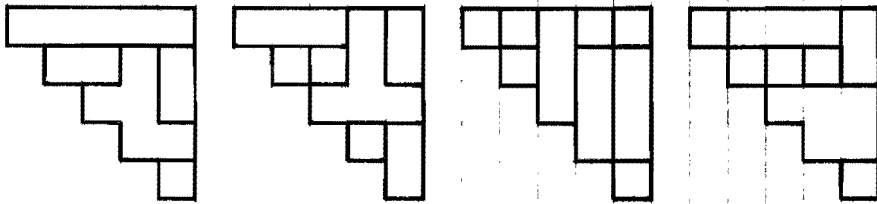
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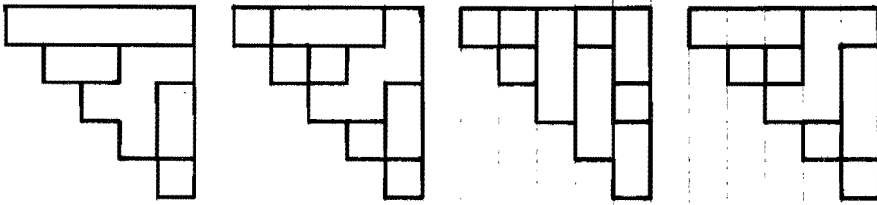
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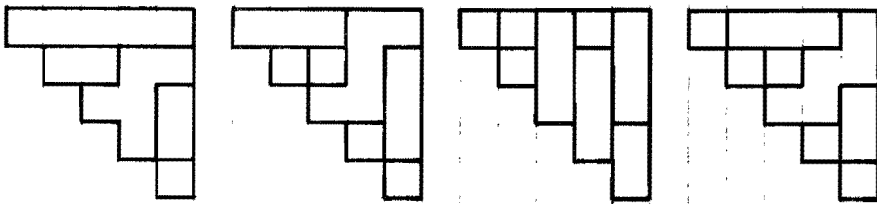
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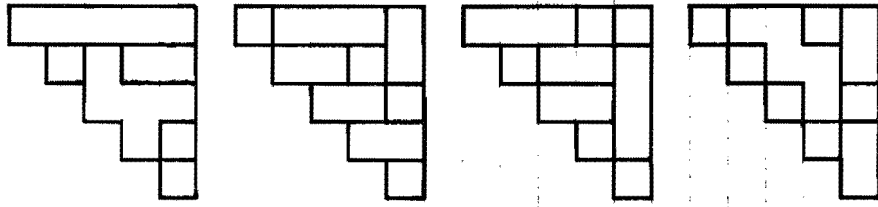


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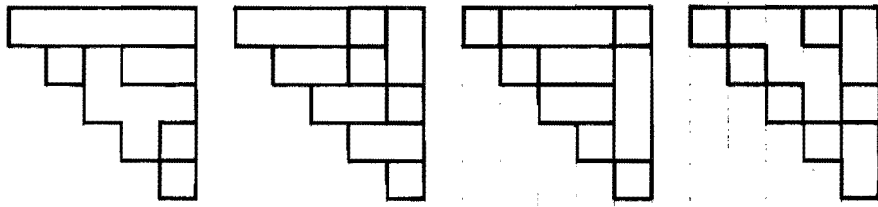




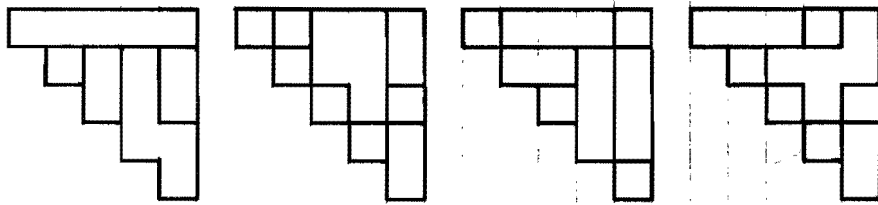
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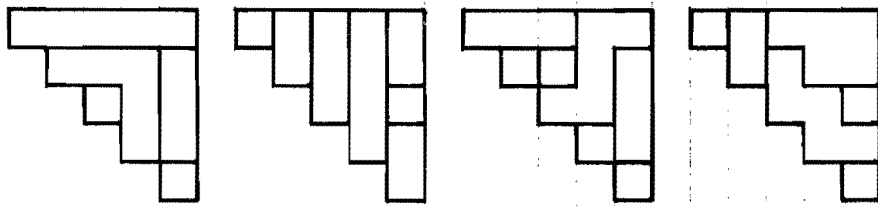
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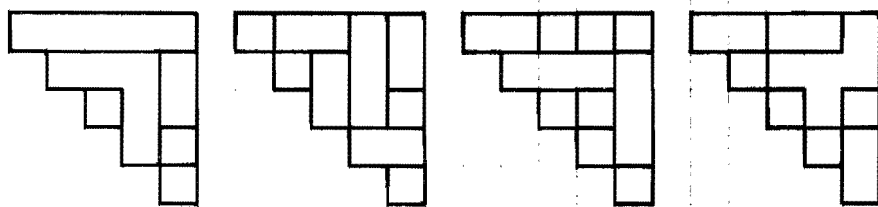
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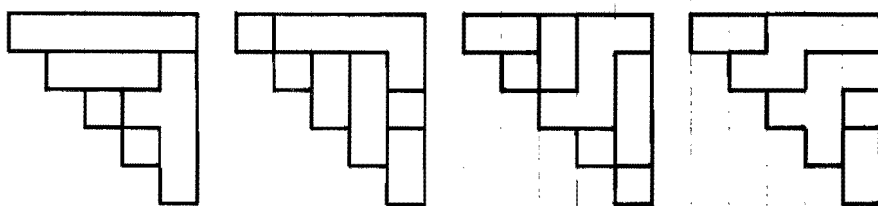
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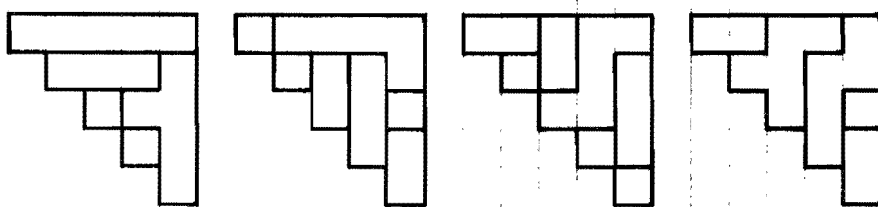
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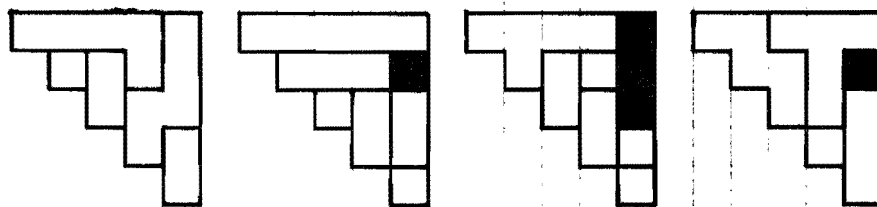
134.



135.



136.



137.

