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- (72) **Inventor; and**
- (71) **Applicant :** NAGY, Zsuzsanna [HU/HU]; Tihamér u. 22/e., H-1141 Budapest (HU).
- (74) **Agent:** ANDRAS ANTALFFY-ZSIROS, DR.; Danubia Patent & Trademark Attorneys, Bajcsy-Zsilinszky út 16., H-1051 Budapest (HU).
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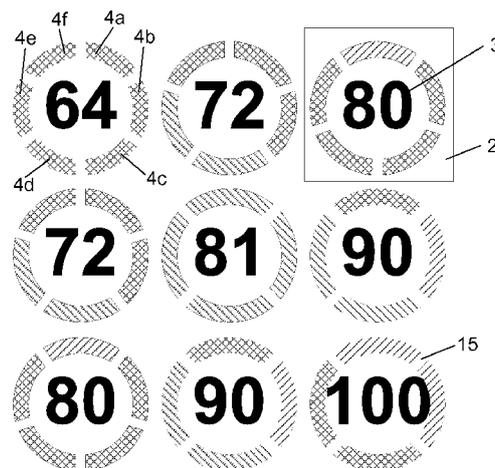
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(54) **Title:** TEACHING AID FOR INTRODUCING AND PRACTISING MATHEMATICAL OPERATIONS



**Fig. 2**

(57) **Abstract:** Teaching aid for demonstrating and practising mathematical operations, comprising a supporting board made as a rigid body of permanent shape and number fields containing at least one digit according to a pre-defined mathematical correlation and formed or arranged on the supporting board in rows and columns. The number fields (2) on said supporting board are arranged in the first, uppermost row in a manner bearing the digits (3) indicating numbers from 1 to 10 in increasing order from left to right; in the second and further rows below the uppermost row, number fields (2) are arranged on said supporting board in a manner that each number field (2) bearing digits (3) indicating numbers multiplied by a multiplication factor incremented by 1 compared to the multiplication factor used in a number field (2) arranged in the same column of a previous row just above the respective number field (2); wherein on the number fields (2) containing prime numbers indicators (4) of identical distinctive features but of a spatial design that makes them distinguishable from one another are formed; and on the number fields (2) containing numbers other than prime numbers, indicator parts (4a-4f) with distinctive features identical with the distinctive features of the unique indicators (4) associated with the prime number factors forming those numbers as their product are formed.



## **TEACHING AID FOR INTRODUCING AND PRACTISING MATHEMATICAL OPERATIONS**

The invention relates to a teaching aid for introducing and practising mathematical operations, comprising a supporting board and number fields formed or arranged on the supporting board in rows and columns, comprising at least one digit per number display field corresponding to a pre-defined mathematical correlation.

Many teaching aids have been developed the world over for teaching basic mathematical skills. These promote the acquisition of secure basic mathematical skills, from getting to know the specific numbers, through practising addition and subtraction to learning and practising the operations of multiplication and factorisation, primarily for children, pupils. US 4,372,742 discloses a mathematical teaching aid comprising rectangular display fields arranged in rows and columns on a display board. Adjacent display fields in a row comprise and display a basic number and its successive powers; the number in the respective rows are arranged so that the successive powers of a given basic number are arranged one after the other from left to right diagonally also. It is a typical feature of this solution that, for the sake of the easier recognition of the power series, optical indicators, decisively colours, are assigned to the respective display fields according to this document. Although the solution according to the document is suitable for displaying and demonstrating the powers of a chosen number, it does not in itself promote the understanding of other characteristics of numbers.

US 6,089,871 discloses a similar mathematical teaching aid, comprising 10-10 display fields arranged in rows and in columns, respectively, formed or mounted on a display board, wherein one- and two-digit numbers from 1 to 99 are indicated in the display fields from left to right and bottom-up. The respective fields comprise also the factors of the number indicated in the given field, so that the sizes of the number shown in the display field and of the multiplication factors of which the number is the product are substantially different, and hence the content of the given display field must be scrutinised with enhanced attention for someone to understand the potential factors belonging to a given number.

US 20080090212 A1 discloses a teaching aid demonstrating numbers and mathematical operations, comprising also ten times ten display fields arranged in rows and in columns, wherein the numbers shown in the respective display fields are all marked as two-digit numbers, and represent the numbers from 00 to 99 proceeding from the

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bottom left corner upwards and from left to right. In the respective display fields, albeit not in all of them, various symbols are applied to mark the factors which may be used to produce the number written in the field by multiplication. It follows from the nature of the numbers that the markings being applied are so diverse that one can establish with difficulty or not at all by looking at them what factors may be involved, and so the design significantly decelerates logical understanding.

US 20100203485 A1 discloses a teaching method for teaching multiplication and raising to powers, illustrated with display fields comprising numbers arranged in rows and columns in a 10x10 form on a display board. The display fields comprise one hundred numbers, from 1 to 100, starting from the upper left corner, horizontally from left to right and from top to bottom, and there are coloured indicators at the specific numbers to mark their respective factors, with special indicators for the numbers obtained by raising to powers. This solution, too, has the drawback that the indicators associated with the numbers imprinted in the specific display fields are not easy to identify at a glance, and the use of the aid is not attractive enough, especially not for young people.

It is a common deficiency of the prior art solutions listed above by way of example that they can only provide information optically, so they cannot be used nor made useful as a teaching aid for persons with sight impairment, for the colour-blind and the blind.

The goal of the teaching aid that is the object of the invention is to eliminate the above-listed deficiencies and drawbacks of the known teaching aids, and to create a teaching aid that would allow to understand and recognise the mathematical operations quickly, at a glance or by touch, for both people with and without sight impairment, and one that can be manufactured easily and at low cost.

It has been found that the main deficiency of the known teaching aids is that their use is rendered excessively sophisticated by the need to identify through an essentially separate process the numbers and, as the case may be, any information, indicators written in the number fields so, preferably, one should use appropriate indicators providing prompt and unambiguous information to both the unblind and the blind on the nature of the number assigned to them.

Said objective has been solved by a teaching aid according to claim 1 for demonstrating and practising mathematical operations, comprising a supporting board made as a rigid body of permanent shape and number fields containing at least one digit according to a pre-defined mathematical correlation and formed or arranged on the supporting board in rows and columns. The number fields are arranged on said supporting board in the first or uppermost row in a manner bearing digits indicating numbers from 1 to 10 in increasing order from left to right; in the second and further rows below the uppermost row, number fields are arranged on said supporting board in a manner that each number field bearing digits indicating numbers being multiplied by a multiplication factor incremented by 1 compared to the multiplication factor used in a number field arranged in the same column of a previous row just above the respective number field. On the number fields containing prime numbers indicators of identical distinctive features, but of a spatial design that makes them distinguishable from one another are formed; and on the number fields containing numbers other than prime numbers, indicator parts with distinctive features identical with the distinctive features of the unique indicators associated with the prime number factors forming those numbers as their product are formed.

Preferred embodiments of the teaching aid are described in the dependent claims.

In a preferred embodiment of the invention the supporting board is made of plastic.

In a further preferred embodiment of the invention a grid constituted of ribs protruding from the plane of the supporting board is formed on the supporting board, the areas on the supporting board delimited by the ribs are identical sized as the size of a number field, and the respective number fields are designed as depressions of the supporting board.

In a further preferred embodiment of the invention a grid constituted of ribs protruding from the plane of the supporting board is formed on the supporting board, the areas on the supporting board delimited by the ribs are identical sized as the size of a number field, and the respective number fields are designed as separate rigid tiles which during operation of the teaching aid are removably inserted in nests formed by the ribs of the supporting board.

In a further preferred embodiment of the invention the teaching aid comprising number field sets, wherein one number field set comprises as many number fields as can be placed on one supporting board at one time.

In a further preferred embodiment of the invention the indicators applied in the number fields are profiled markings.

In a further preferred embodiment of the invention the indicators applied in number fields are provided also with colour coding.

In a further preferred embodiment of the invention the indicators associated with the respective prime numbers are circular rings of different colours, and the indicators associated with other than prime numbers are composed of indicator parts realised by ring segments of said circular rings, the lengths of which segments is chosen so as to make up in combination a circular ring for the given encircled number.

In a further preferred embodiment of the invention the respective indicator parts are separated from each other by gaps detectable by physical sense.

In a further preferred embodiment of the invention the number fields are formed as number fields representing the respective numbers inside of the circular ring shaped indicators or indicator parts making up the ring.

In a further preferred embodiment of the invention the numbers indicated in the respective number fields are designed in Braille writing, and indicators associated with both prime numbers and numbers other than prime numbers are 3D profiled markings protruding from the plane of the respective number fields, and distinguishable by touch by the finger.

In a further preferred embodiment of the invention an energy source, a controllable audio-frequency generator connected with the energy source and a piezoelectric sound-generating component connected to the outlet of the audio-frequency generator are arranged in the inside of the supporting board, and a frequency-setting controlling inlet of the audio-frequency generator is connected to an outlet of a switching matrix, whereas the respective switches of the switching matrix are mounted below the respective number fields.

In a further preferred embodiment of the invention the number fields are constituted by press-sensitive foil switches of a switching matrix themselves.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic theoretical drawing of a possible embodiment of the proposed teaching aid,

Figure 2 shows a magnified view of part II of Figure 1,

Figure 3 shows the schematic plan view of a possible embodiment of the proposed teaching aid,

Figure 4 shows the main components of the teaching aid according to Figure 3 in exploded partial view,

Figure 5 shows the plan view of a further implementation of the proposed teaching aid, and

Figure 6 represents a theoretical block diagram of the circuit arrangement which may be built or integrated into the supporting board of the proposed teaching aid.

The examples to be presented in the following description are preferred embodiments of the teaching aid only and the proposed aid is not restricted to the embodiments shown here. A person skilled in the art may realise several variants based on the embodiments shown here, which all will fall within the scope of protection of the proposed teaching aid.

In the embodiment shown in Figure 1, which may be considered the simplest one, the aid comprising a supporting board 1 on which number fields 2 are formed. Although number fields 2 in the figure are rectangular, it is easy to understand that the rectangular shape is not exclusive, and the lines shown in the Figure are also drawn only to make the shape and arrangement of the respective number fields 2 unambiguous. In the embodiment shown here, a total of one hundred number fields 2 are formed on the supporting board 1 and arranged matrix-like, in ten rows and ten columns. One or several digit(s) 3 are shown in each number field 2, and indicators 4 are assigned to these digits. In the embodiment presented here, indicators 4 are substantially circular

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ring-shaped. In the example described here, digits 3 represent numbers in the range of 1 to 100, with the numbers from 1 to 10 indicated in the number fields of the uppermost row 5 of the aid, in growing order. In the first column 6 on the extreme left side, from top to bottom, the same numbers from 1 to 10 are shown in increasing order in the respective number fields 2. The numbers in number fields 2 below each other are characterised by being chosen according to a mathematical correlation whereby – except for the numbers in the uppermost row 5 – each number is multiplied by a multiplication factor that is higher by 1 than the one used for the multiplication in the number field 2 above it, that is, if the number in the first number field 2 of the first row 5 is 1, then the number indicated in number field 2 below it is 2; the one in number field 2 below that is 3; the one in number field 2 below that is 4, and so on. This rule is true of every column 6, so in the sixth column 6, the number indicated in number field 2 in the uppermost row 5 is 6; the one in the number field 2 below it is 12; and the one in the number field 2 below that is 18, and so on. One may thus observe from top to bottom in the respective columns 6 the product of the numbers written in the uppermost row 5.

In the embodiment shown here the number shown in the uppermost number field 2 on the left-hand side is 1, and it is enclosed by a closed circular ring as indicator 4. In this exemplary embodiment, the closed ring means that the number in it is a prime number. Accordingly, the number indicated in the second number field 2 from the left in the uppermost row 5 is 2, also enclosed by a closed circular ring as indicator 4, and the numbers 3, 5, 7, respectively, in the uppermost row 5 are also enclosed by a closed ring each. To make the respective digits 3 or rather the numbers they represent distinguishable from each other at first sight, in the present embodiment indicators 4 have radically different properties, e.g. colour; in this example, "1" is associated with a black indicator 4, "2" with a brown one, "3" with green one, "5" with a blue one and "7" by a purple one. Of course, the same rule applies also to the numbers written in the leftmost column 6.

The above rule cannot be applied to any of other numbers represented in number fields 2, which are not prime numbers. However, therefore, indicators 4 showing the prime factors by which the given number can be obtained as a product are assigned to the respective numbers. Accordingly, the number in the fourth number field 2 from the left

in the uppermost row 5 is 4, which can be obtained on the basis of the mathematical correlation of  $4=2 \times 2$ , so the indicator 4 written around the number is composed of two half indicator parts 4a, 4b which clearly represent the indicator 4 assigned to prime number "2". Based on the above and with the help of Figure 2, it is easy to understand that, for any number field 2 where indicator 4 comprises indicator parts 4a-4f of the same type and properties as indicator 4 assigned to prime number "2", that means that the prime number "2" must also be used to get the given number as product. This is clearly observable e.g. in Figure 1, in number field 2 at the crossing of the eighth row 5 and the eighth column 6, where the number 64 is displayed, and which is encircled, as can be seen in more detail in Figure 2, by six indicator parts 4a-4f, each of them having the same property, e.g. the same colour, as the indicator 4 assigned to prime number "2", that is,  $64=2 \times 2 \times 2 \times 2 \times 2 \times 2$ , i.e.  $2^6$ .

It is also observable in Figure 2 that the indicator parts 4a-4f having different distinctive features or properties are designed not continuously, but separated from each other by a gap 15, which is clearly visible, and the role of which is to let the user of the teaching aid obtain a picture of the nature of the factors making up the respective products at a glance, at once.

As can be observed in Figure 2, the numbers indicated in number field 2 are not prime numbers, but they can be obtained as the product of prime numbers, as is indicated in a much simpler way than in the known solutions, in a way identifiable at a glance, with the help of indicator 4 or indicator parts 4a-4f: the number at the crossing of the seventh column 6 and the tenth row 5 is 70, that is, in default case  $70=7 \times 10$  or  $10 \times 7$ . This number, however, can also be written as  $7 \times 5 \times 2$  and, therefore, the indicator 4 is constituted by three indicators parts 4a, 4b, 4c, notably by applying colour-coding – indicator part 4a of magenta colour assigned to 7 as a prime number; indicator part 4b which is blue and assigned to 5 as prime number, and indicator part 4c, in brown, assigned to 2 as prime number. It will be understood that one can interpret by a mere glance at the teaching aid in what way the prime numbers can produce the number written in number field 2.

Figure 3 shows the embodiment realised according to the theoretical schema described with the help of Figures 1 and 2, in plan view, wherein the supporting board 1 is made

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of plastic as a rigid body of permanent form and size, upon which ribs 7 forming a mesh are formed, which protrude slightly but definitely from the plane of supporting board 1 or, in another possible embodiment, ribs 7 do not protrude from the plane of supporting board 1, but there is a depression between them in supporting board 1. In this embodiment, one hundred distinct number fields 2 belong to supporting board 1 created this way, which contain in the manner described above digits 3 and indicators 4, and their size is chosen so that they should fit exactly in one of the nests 8 formed on the supporting board 1 by the ribs 7. It is an advantage of this embodiment that, on the one hand, one may use also other number fields 2 than those showing numbers in the range of 1 to 100, i.e. one may choose the numbers indicated in number fields 2 according to the mathematical correlation applied ever; furthermore, it is also possible to use and position the appropriate number fields 2 in a puzzle-like way, which may imply further tasks to be solved in a playful way.

Figure 4 depicts a detail of the embodiment according to Figure 3 in perspective view, notably supporting board 1 provided with ribs 7 defining nests 8, and a number field 2 which can be fitted into it, of a rectangular shape in this example, but for experts and those skilled in the art, it will be obvious that it may be of any other suitable form matching the shape of nest 8, hence a right-angled parallelepiped, a circle, a triangle, a hexagon etc.

Figure 5 represents a detail of a further preferred embodiment of the proposed teaching aid, wherein the respective number fields 2 on the traditionally designed supporting board 1 do not contain numerical digits 3, but there are six or twelve points/point slots in each number field 2 which correspond to the points of a Braille character. That is, instead of legible visual signs, this embodiment contains touch signs, and it is suitable to make persons with sight impairment or the blind understand clearly the values of the numbers indicated in the respective number fields 2. Obviously, in this case the size of the teaching aid must be chosen so as to make the digits 3, i.e. the numbers written with Braille characters in the respective number fields 2 identifiable by touching them by finger.

Neither are the indicators 4 associated with the digits 3 written in Braille characters markings formed, e.g. imprinted, in the plane of supporting board 1, but – similarly to

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the solutions shown under the previous embodiments – they are 3D indicators 4 slightly protruding from the plane of supporting board 1, for which it can be established beyond any doubt by touch whether the number concerned is a prime number, and indicators 4 associated with the respective prime numbers are of different touch by indicator part, to let the person using the teaching aid identify merely by touch what indicator 4 associated with a given prime number the touched indicator part belongs to.

Figure 6 represents the theoretical block diagram of a circuit arrangement which, according to a further preferred embodiment of the invention, can be built into supporting board 1 or integrated under the number fields 2 of supporting board 1. Preferably, a replaceable energy source 9, e.g. a button cell, is connected to the power supply inlet of a known programmable integrated audio frequency generator; the outlet of the audio frequency generator 10 is connected directly to the inlet of a piezoelectric sound generator device 11. The outlet of a switching matrix 13 is connected to frequency setting control inlet 12 of an audio-frequency generator 10. Switching matrix 13 is constituted of switches 14 connected into a matrix code in the known way, and arranged as foil switches under each one of number fields 2 of supporting board 1 of the teaching aid.

If the user uses the teaching aid by pressing number field 2 chosen by him, due to the flexible material of number field 2, that activates switch 14 arranged under number field 2, which results in transferring the appropriate code corresponding to the switch of switching matrix 13 to control inlet 12. With appropriate advance programming of audio-frequency generator 10, sounds of a unique frequency, distinguishable from one another by hearing, are assigned to the respective prime numbers, hence by pressing switch 14, the series of sounds emitted by sound generating device 11 also provides information on the prime numbers from which the number in the given number field 2 can be obtained as their product. The concrete construction of the teaching aid will not cause any concern to a person skilled in the art, based on the state-of-art tools and knowledge.

As can also be seen from the description of some preferred embodiments, the proposed teaching aid is capable, in a way that is different from the known solutions and in an unexpected way, of being used fully by persons with or without sense deficiency by

providing unambiguous information at a single glance or by touch or hearing of the factors of the respective product numbers, and insofar as the respective columns are concerned, it promotes also, as multiplication table, the understanding and processing of the operation of multiplication and its results.

**Claims**

1. Teaching aid for demonstrating and practising mathematical operations, comprising a supporting board and number fields containing at least one digit according to a pre-defined mathematical correlation and formed or arranged on the supporting board in rows and columns, *characterised in that*

- the supporting board (1) is made as a rigid body of permanent shape,
- the number fields (2) are arranged on said supporting board (1) in the first, uppermost row (5) in a manner bearing the digits (3) indicating numbers from 1 to 10 in increasing order from left to right;
- in the second and further rows (5) below the uppermost row (5), number fields (2) are arranged on said supporting board (1) in a manner that each number field (2) bearing digits (3) indicating numbers being multiplied by a multiplication factor incremented by 1 compared to the multiplication factor used in a number field (2) arranged in the same column (6) of a previous row (5) just above the respective number field (2);
- on the number fields (2) containing prime numbers indicators (4) of identical distinctive features, but of a spatial design that makes them distinguishable from one another are formed; and
- on the number fields (2) containing numbers other than prime numbers, indicator parts (4a-4f) with distinctive features identical with the distinctive features of the unique indicators (4) associated with the prime number factors forming those numbers as their product are formed.

2. A teaching aid according to claim 1, *characterised in that* the supporting board (1) is made of plastic.

3. A teaching aid according to claim 1 or 2, *characterised in that* a grid constituted of ribs (7) protruding from the plane of the supporting board (1) is formed on the supporting board (1), the areas on the supporting board (1) delimited by the ribs (7) are identical sized as the size of a number field (2), and the respective number fields (2) are designed as depressions of the supporting board (1).

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4. A teaching aid according to claim 1 or 2, *characterised in that* a grid constituted of ribs (7) protruding from the plane of the supporting board (1) is formed on the supporting board (1), the areas on the supporting board (1) delimited by the ribs (7) are identical sized as the size of a number field (2), and the respective number fields (2) are designed as separate rigid tiles which during operation of the teaching aid are removably inserted in nests (8) formed by the ribs (7) of the supporting board (1).
5. A teaching aid according to any of claims 1 to 4, *characterised by* comprising number field (2) sets, wherein one number field (2) set comprises as many number fields (2) as can be placed on one supporting board (1) at one time.
6. A teaching aid according to any of claims 1 to 5, *characterised in that* the indicators (4) applied in the number fields (2) are profiled markings.
7. A teaching aid according to any of claims 1 to 5, *characterised in that* the indicators (4) applied in number fields (2) are provided also with colour coding.
8. A teaching aid according to any of claims 1 to 7, *characterised in that* the indicators (4) associated with the respective prime numbers are circular rings of different colours, and the indicators (4) associated with other than prime numbers are composed of indicator parts (4a-4f) realised by ring segments of said circular rings, the lengths of which segments is chosen so as to make up in combination a circular ring for the given encircled number.
9. A teaching aid according to any of claims 1 to 8, *characterised in that* the respective indicator parts (4a-4f) are separated from each other by gaps (15) detectable by physical sense.
10. A teaching aid according to any of claims 1 to 9, *characterised in that* the number fields (2) are formed as number fields (2) representing the respective numbers inside of the circular ring shaped indicators (4) or indicator parts (4a-4f) making up the ring.
11. A teaching aid according to any of claims 1 to 9, *characterised in that* the numbers indicated in the respective number fields (2) are designed in Braille writing, and (4) indicators associated with both prime numbers and numbers other than prime numbers are 3D profiled markings protruding from the plane of the respective number fields (2), and distinguishable by touch by the finger.

12. A teaching aid according to any of claims 1 to 11, *characterised in that* an energy source (9), a controllable audio-frequency generator (10) connected with the energy source (9) and a piezoelectric sound-generating component (11) connected to the outlet of the audio-frequency generator (10) are arranged in the inside of the supporting board (1), and a frequency-setting controlling inlet (12) of the audio-frequency generator (10) is connected to an outlet of a switching matrix (13), whereas the respective switches (14) of the switching matrix (13) are mounted below the respective number fields (2).

13. A teaching aid according to claim 12, *characterised in that* the number fields (2) are constituted by press-sensitive foil switches of a switching matrix (13) themselves.

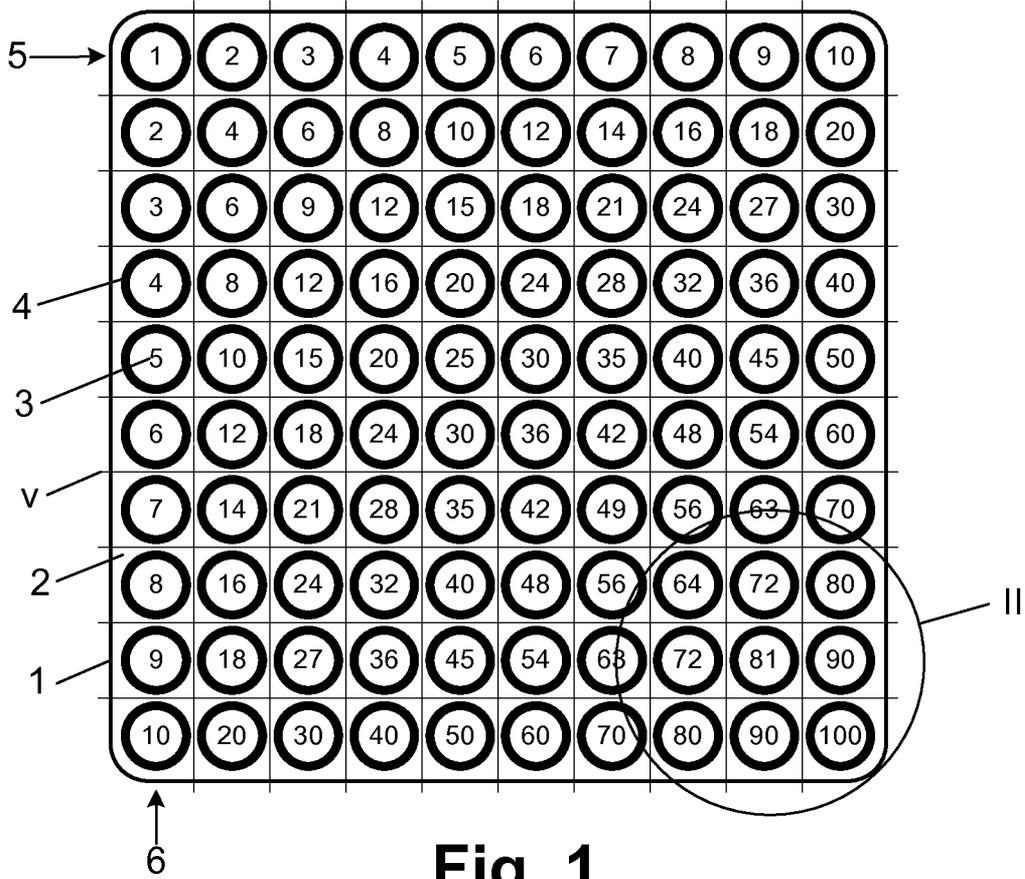


Fig. 1

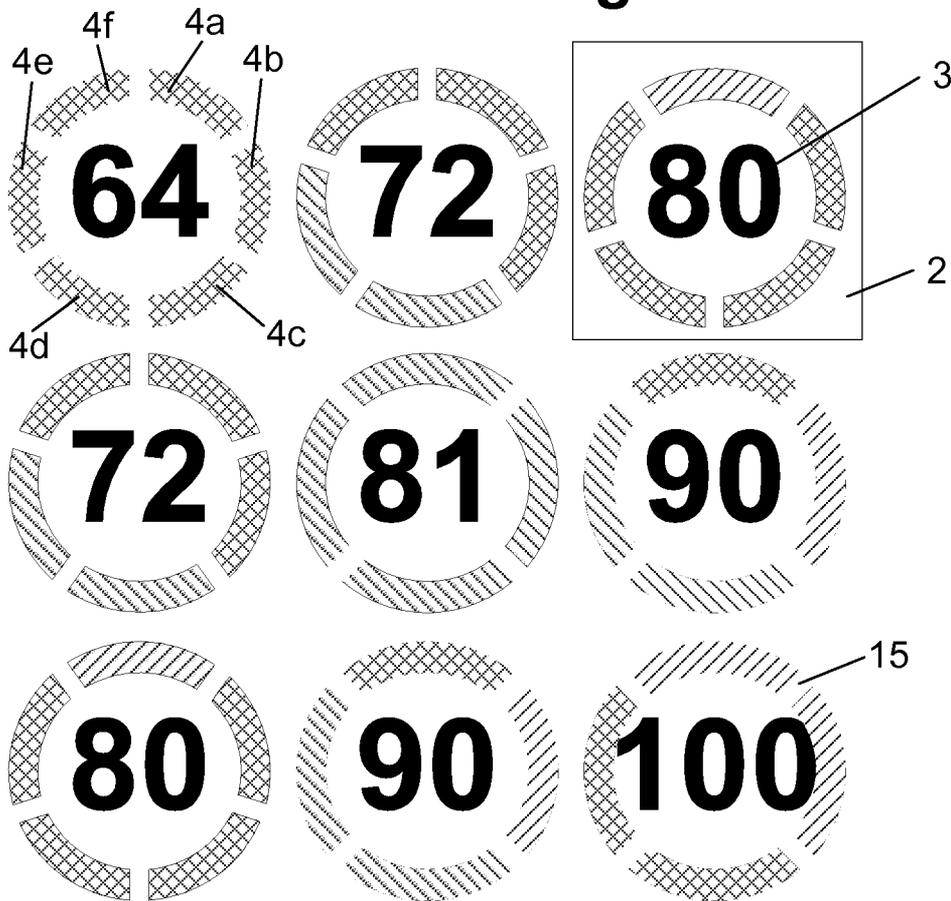
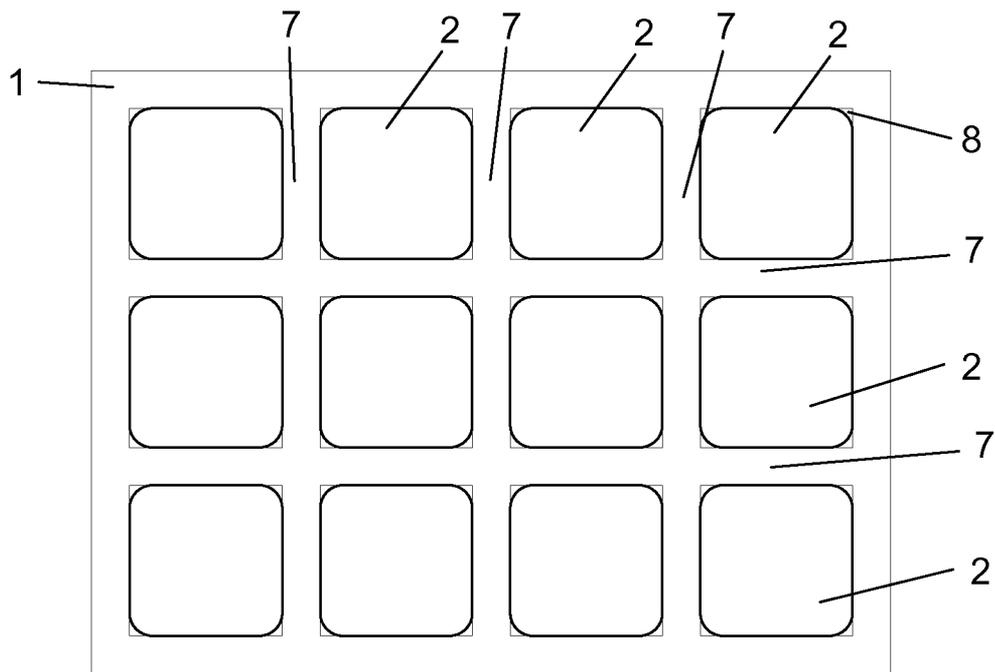
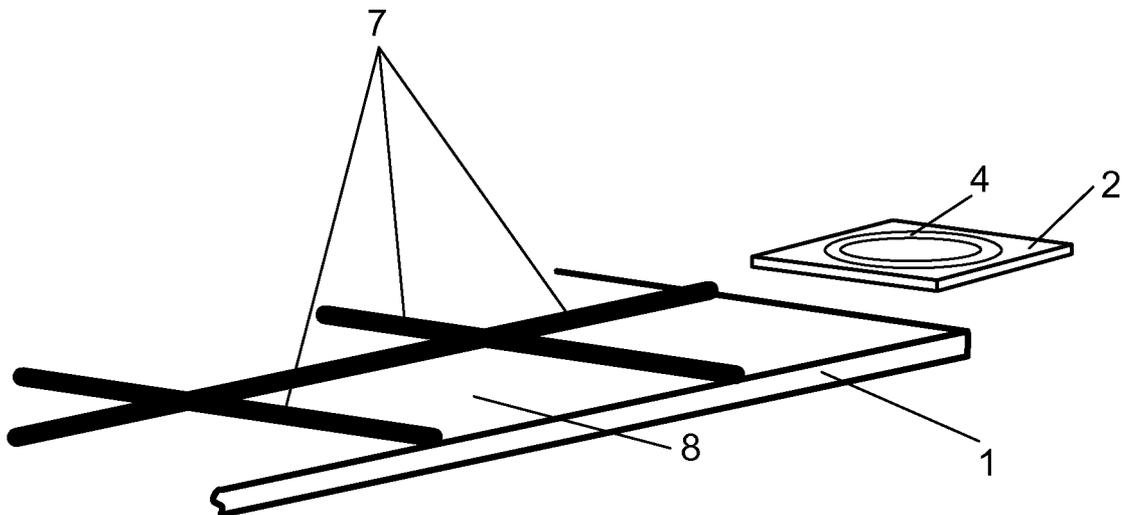


Fig. 2



**Fig. 3**



**Fig. 4**

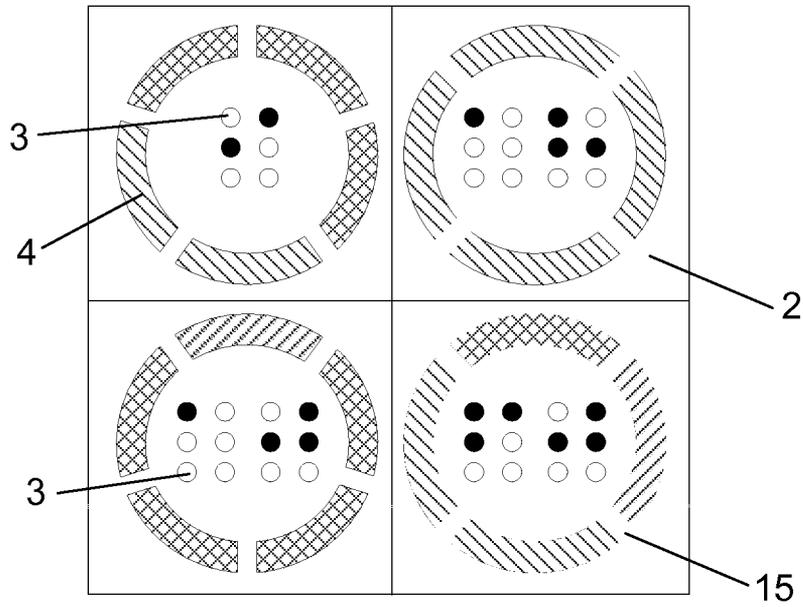


Fig. 5

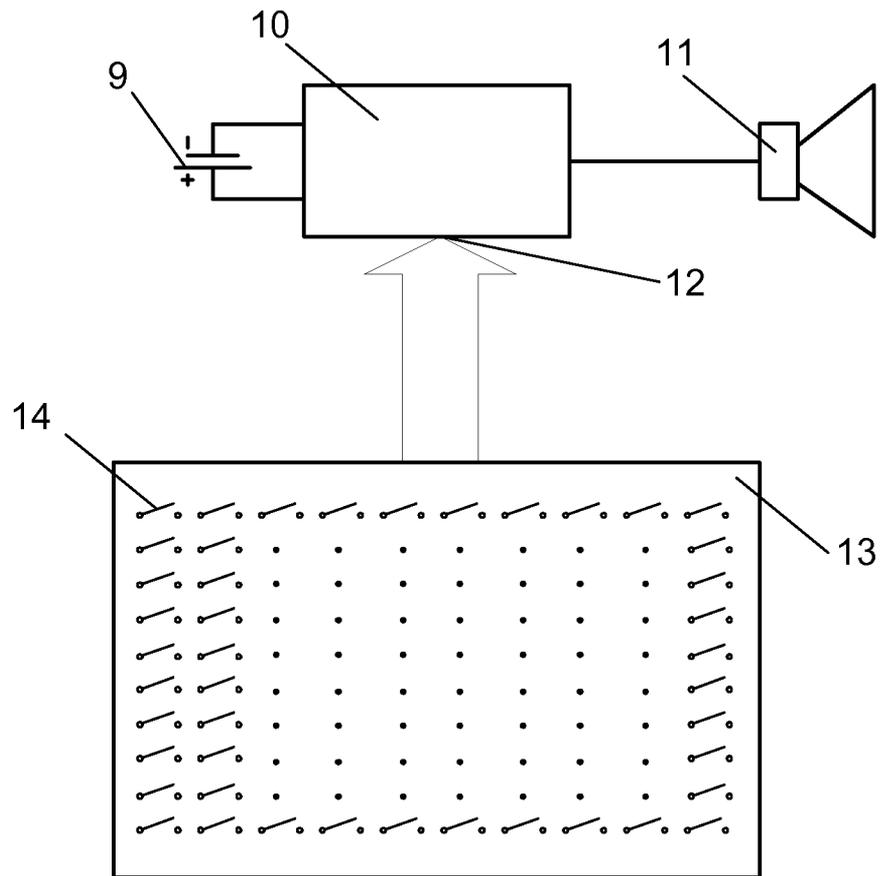


Fig. 6

# INTERNATIONAL SEARCH REPORT

International application No PCT/IB2013/050833
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<b>A. CLASSIFICATION OF SUBJECT MATTER</b> INV. G09B19/02      G09B21/00 ADD.				
According to International Patent Classification (IPC) or to both national classification and IPC				
<b>B. FIELDS SEARCHED</b>				
Minimum documentation searched (classification system followed by classification symbols) G09B				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched				
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
X	US 2010/203485 A1 (HANSEN CHRISTOPHER [US]) 12 August 2010 (2010-08-12)	1,2,5-7, 12,13		
Y	paragraphs [0007], [0021]; figure 5 -----	3,4,11		
Y	GB 2 323 698 A (MANGLES LINDA [GB]) 30 September 1998 (1998-09-30) page 5, lines 20-25; figures 1,2 -----	3,4,11		
A	US 4 445 865 A (SELLON JEFFREY [US]) 1 May 1984 (1984-05-01) claim 1; figure 1 -----	1		
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <span style="margin-left: 100px;"><input checked="" type="checkbox"/> See patent family annex.</span>				
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10 July 2013	18/07/2013			
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2013/050833

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