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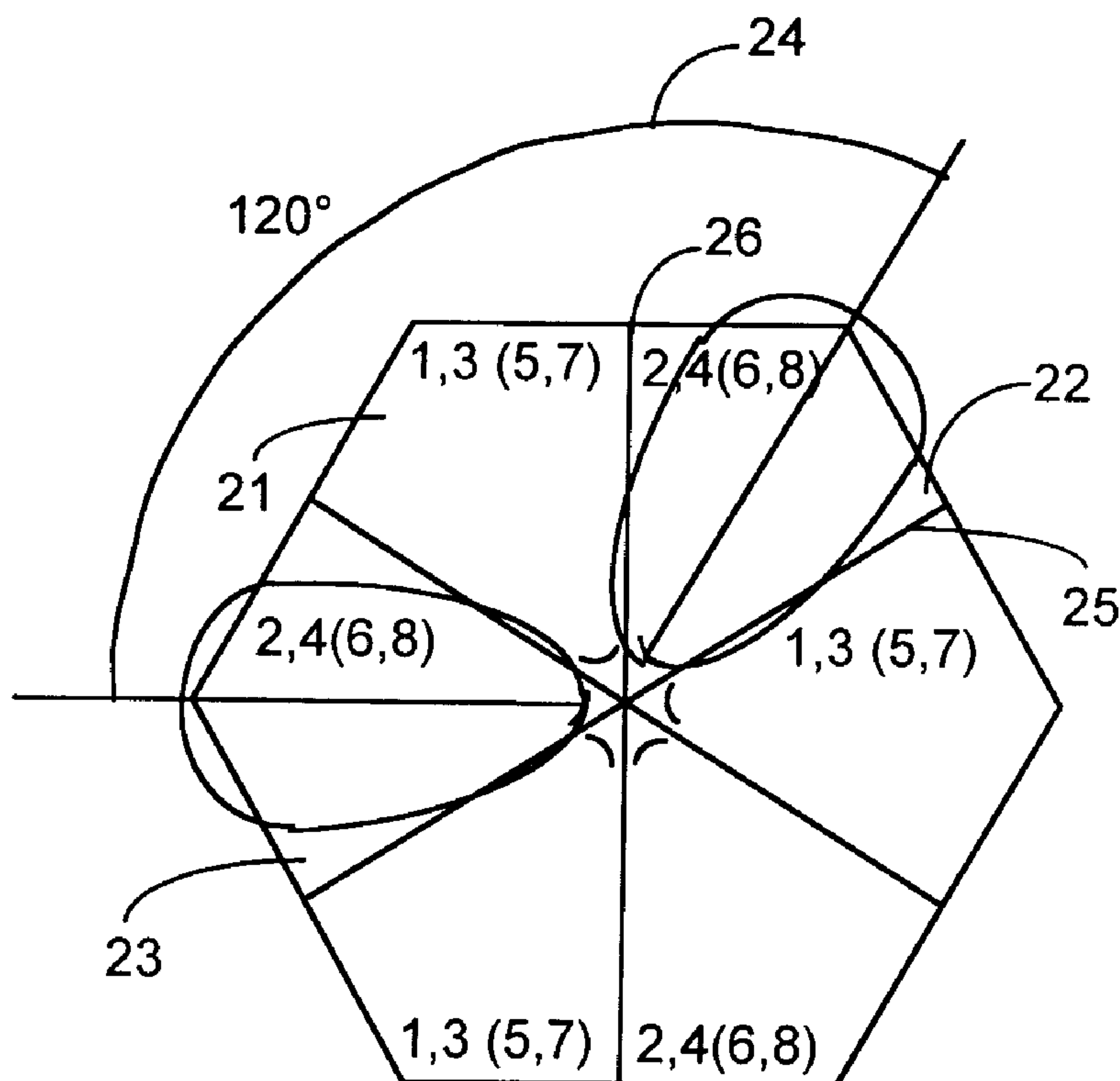
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(54) **FREQUENCE RE-UTILISER DANS UN SYSTEME RADIO  
D'ONDES POINT A POINT MILLIMETRIQUE**

(54) **FREQUENCY REUSE IN MILLIMETRIC WAVE POINT-TO-  
POINT RADIO SYSTEM**



## **FREQUENCY REUSE IN MILLIMETRIC WAVE POINT-TO-MULTI-POINT RADIO SYSTEM**

### FIELD OF THE INVENTION

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This invention relates to a frequency plan for point-to-multi-point radio systems and is particularly concerned with frequency reuse.

### BACKGROUND OF THE INVENTION

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Frequency planning is a method of optimizing spectrum usage, enhancing channel capacity and reducing interference. Frequency planning involves channel numbering, channel grouping into subsets, cell planning and channel assignment. A principle aim of frequency planning is ensuring adequate channel isolation to avoid energy spillover between channels so that the adjacent channel interference is reduced to a minimum. In the wireless mobile environment, frequency planning is required to provide adequate repeat distance in order to ensure co-channel interference is acceptable while maintaining a high channel capacity. On the other hand, in a multi-point radio system, fixed remote stations make use of highly directional antennas pointing at a cell site. A multi-point radio system basically consists of cell sites and remote stations for one way or two-way communications. The horizontal area to be covered is divided into one or more cells wherein each cell is divided into equal sectors. Each cell site makes use of sector beams to provide radio coverage in each sector.

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In order to increase capacity, same frequency carrier is reused in more than one sector. However, the problem associated with using the same frequency carrier in more than one sector of a cell is that if the same frequency carrier is reused in adjacent sectors, a remote station located near a sector boundary, i.e. between a first and second sector of a cell, will see nearly equal strength of the two signals on the same carrier frequency thereby providing an unacceptable signal to noise ratio.

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Frequency reuse in point-to-multi-point radio systems have in the past mainly dealt with the reuse of frequencies across different cell sites. Unfortunately, the problem associated with this approach is that at VHF and microwave frequencies, scattering is too high to permit the reuse in the same cell.

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### SUMMARY OF THE INVENTION

An object of the present invention is to provide an improved frequency plan for a point-to-multi-point radio system.

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A further object of the present invention is to provide a method of reusing frequencies across sectors in the same cell site efficiently.

In accordance with the present invention there is provided a method of  
15 assigning frequencies in a cell site in a point-to-multi-point radio system comprising assigning a first set of frequencies from a plurality of frequencies available at said cell to a first sector of said cell, assigning a second set of frequencies from said plurality of frequencies to sectors adjacent to said first sector, the frequencies in said second set being different than the frequencies in said first set, and reusing said first set of  
20 frequencies in non-adjacent sector to alternate from one sector to the next between said first and second set of frequencies, wherein said first and second set of frequencies comprise  $n$  frequencies wherein  $n = z / 2$ , and  $z =$  number of frequencies available at that cell.

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### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be further understood from the following description with reference to the drawings in which:

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FIG. 1 illustrates a known cell site configuration with six sectors;

FIG. 2a illustrates a frequency plan in accordance with one embodiment of the present invention; and

5 FIG. 2b illustrates a further frequency plan in accordance with a further embodiment of the present invention.

### DETAILED DESCRIPTION

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Referring now to FIG. 1, we have shown a typical cell site configuration for use in a point-to-multi-point radio system. The cell site 10 can be divided up into a number of sectors 11. The cell site may have a radius of several kilometers to provide point-to-multi-point communication between a site transceiver centrally located thereof 12 and remote stations 13 and 14. Remote stations 13 and 14 make use of highly directional antennas 15 and 16, respectively, pointing at the cell site antenna 17 albeit within the confines of the sector 18.

Generally, the horizontal area to be covered is divided into one or more cells wherein each cell is divided into equal sectors. In FIG. 1, the cell shown is divided into six sectors. The cell site makes use of a sector beam 19 to illuminate the sector and in particular provide coverage where remote stations 13 and 14 are located. In order to prevent adjacent channel interference, different carrier frequencies are used in each of the sectors as indicated earlier, however, this results in the decrease in a capacity of the system.

With the frequency reuse plan of the present invention, the capacity of a cell site is increased by reusing the same carrier frequency in alternate sectors as shown in FIG. 2a. That is, adjacent sectors make use of different carrier frequencies, thereby enabling the increase in capacity of the cell site.

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As illustrated in FIG. 2b, a system wherein four channels per cell sites are assigned, each sector is allocated two channels. For example, sector 21 in a four channel system would be allocated channels 1 and 3 and sector 22 would be allocated channels 2 and 4. Channels 1 and 3 would not be allocated again unless separated by a sector making use of a different set of carrier frequencies or channels. This way, sectors making use of the same channels or carrier frequency such as sector 22 and 23 are provided with 120 degrees of angular isolation 24 between the reuse of the same frequency. If the cell site is allocated eight channels or carrier frequencies, each sector can make use of four channels in a frequency plan as illustrated in FIG. 2b. Therefore, each sector is allocated a set of frequencies comprised of  $n$  channels wherein  $n = z/2$  and  $z =$  number of frequencies in channels available at that cell. Frequencies that are reused in alternate sectors are provided with an angular isolation of  $\emptyset = 2 \times 360^\circ/x$   $x \geq 4$  wherein  $x$  is an even number of sectors in the cell.

If additional cell sites are required, sector frequencies are located to prevent a sector of a first cell site from using the same channel or carrier frequency as a sector of an adjacent cell site.

Links between cell sites or inter-cell point-to-point links is achieved by providing an inter-cell beam aligned with edges of sector beams illustrated by lines 25 and 26 of FIG. 2b where sector antenna gain is lowest and thereby reduces interference. This method provides three times the system capacity compared to the prior art wherein all the frequencies are used once in the whole cell.

WHAT IS CLAIMED IS

1. A method of assigning frequencies to a cell site in a point-to-multi-point radio system, comprising:

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a) assigning a first set of frequencies from a plurality of frequencies available at said cell to a first sector of said cell;

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b) assigning a second set of frequencies from said plurality of frequencies to sectors adjacent to said first sector, the frequencies in said second set being different than the frequencies in said first set; and

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c) reusing said first set of frequencies in a non-adjacent sector to alternate from one sector to the next between said first and second set of frequencies wherein said first and second set of frequencies comprises  $n$  frequencies wherein  $n = z/2$  and  $z =$  the number of frequencies available at that cell.

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2. A method as defined in Claim 1, wherein frequencies that are reused in alternate sectors are provided with an angular isolation of  $\emptyset = 2 \times 360^\circ/x$   $x \geq 4$  wherein  $x$  is an even number of sectors in the cell.

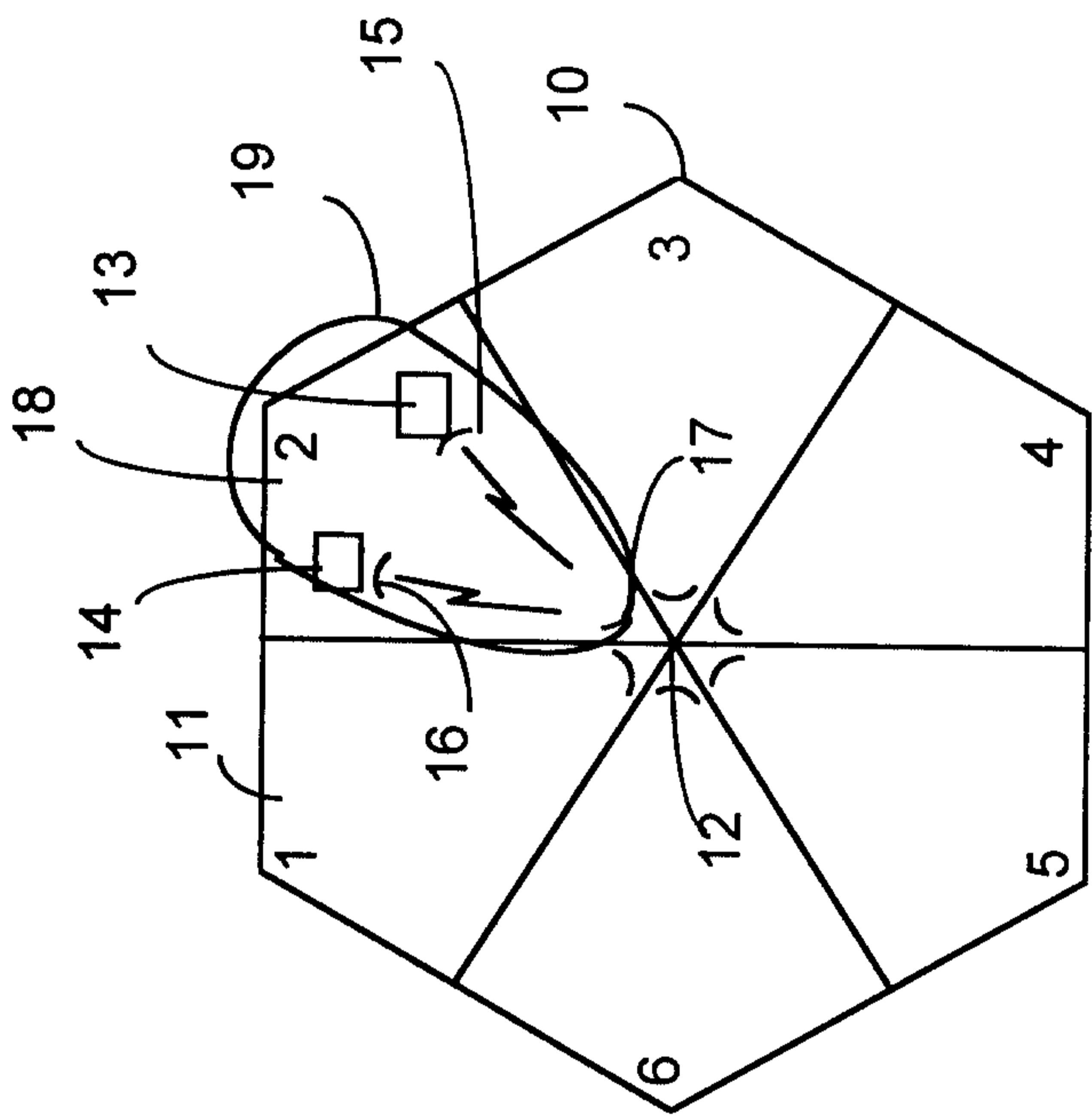


Fig. 1  
Prior Art

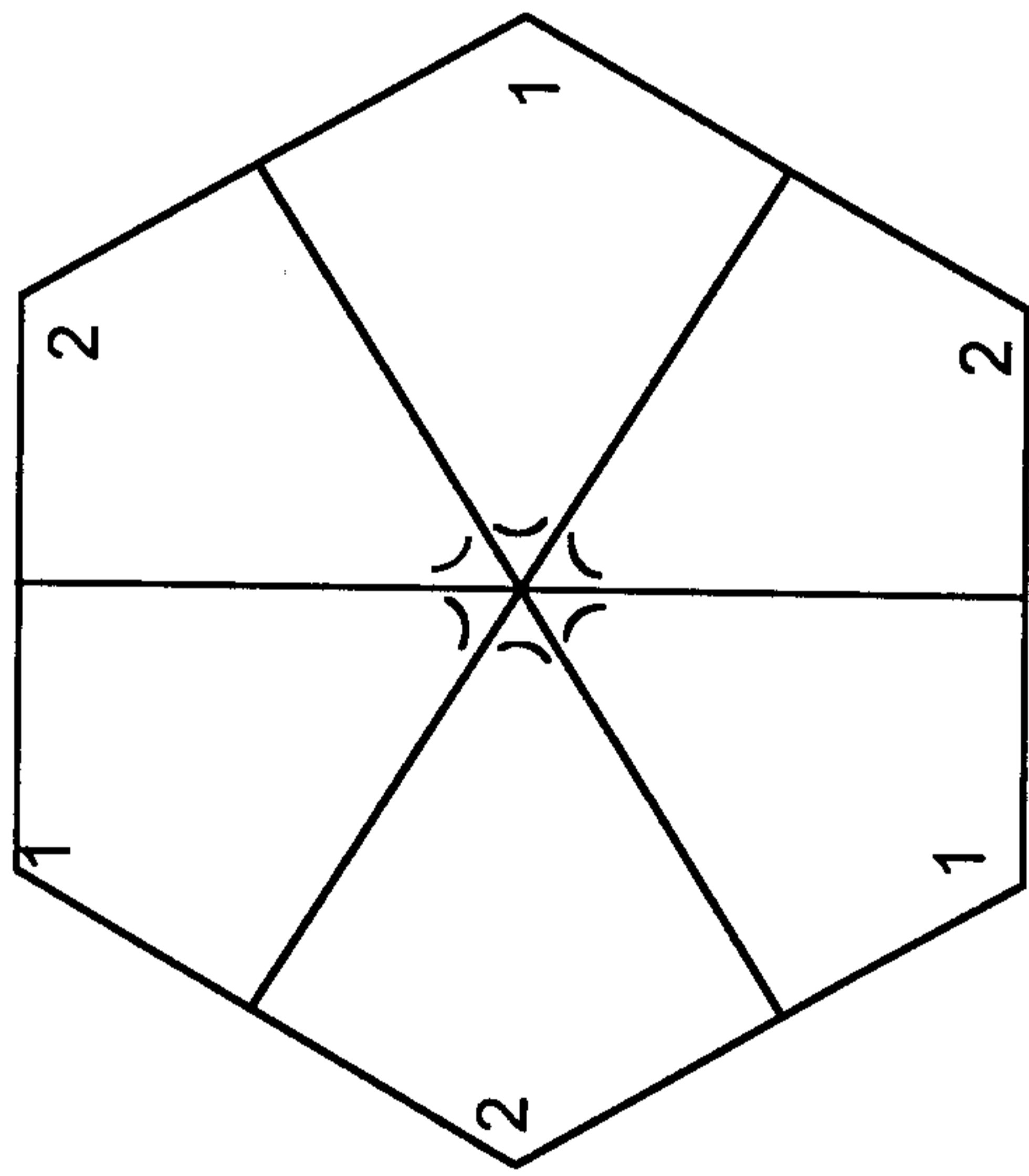


Fig. 2a

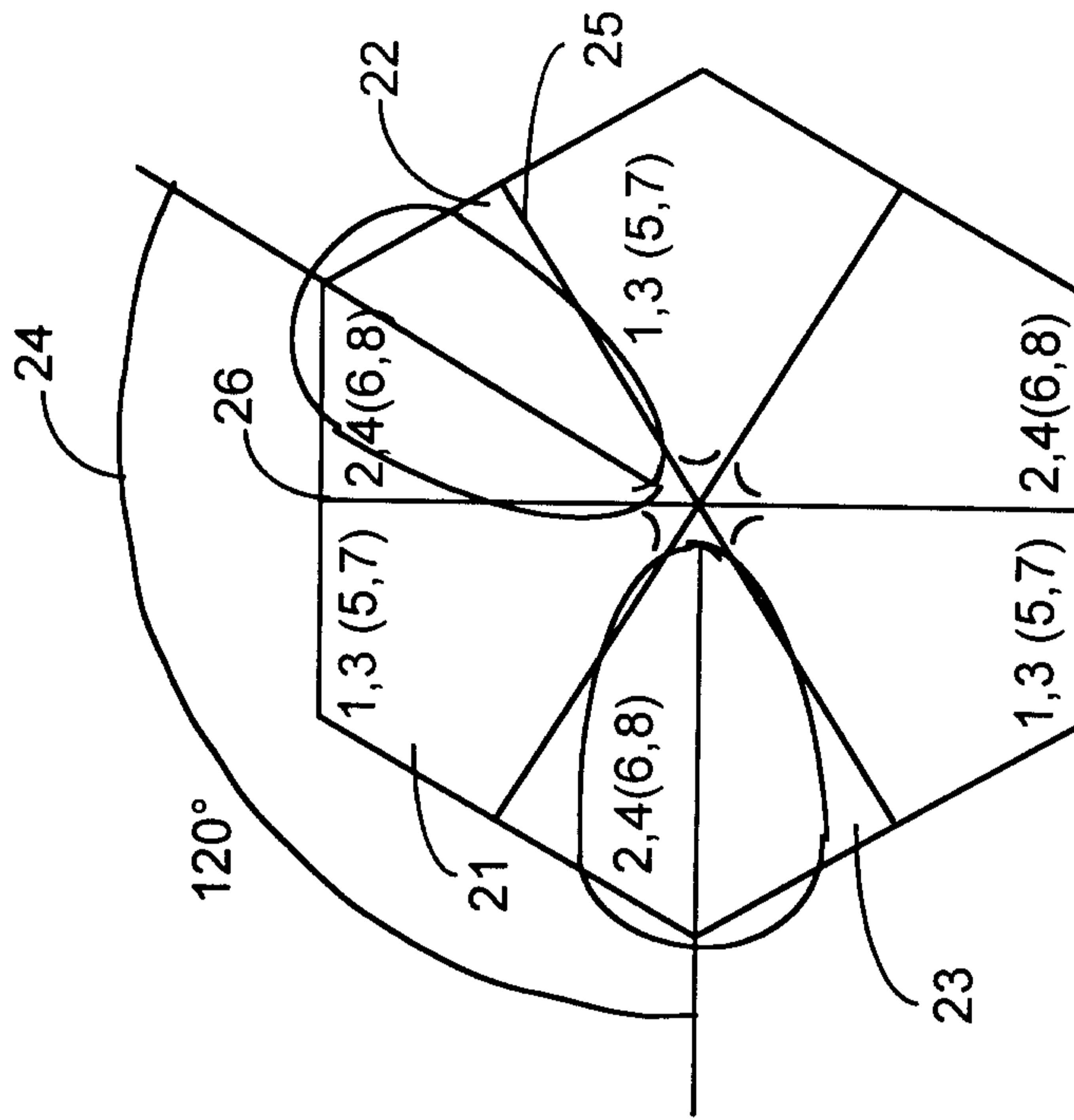


Fig. 2b