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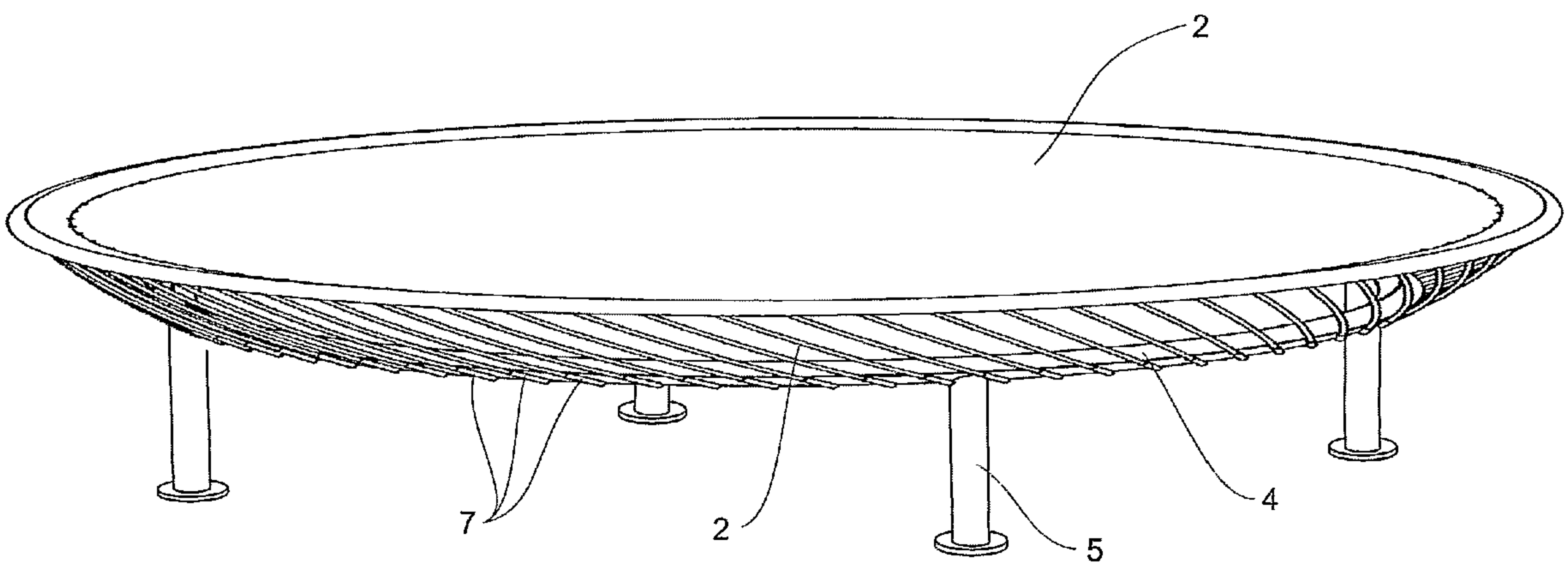
(54) **Titre :** TRAMPOLINE
(54) **Title:** A TRAMPOLINE



(57) **Abrégé/Abstract:**
A trampoline comprising a flexible mat (1), a plurality of resiliently flexible rods (2) retained in a frame (3) and coupled to the mat (1) about a periphery of the mat (1), whereby the rods (2) are less than about 0.45 metres in length.

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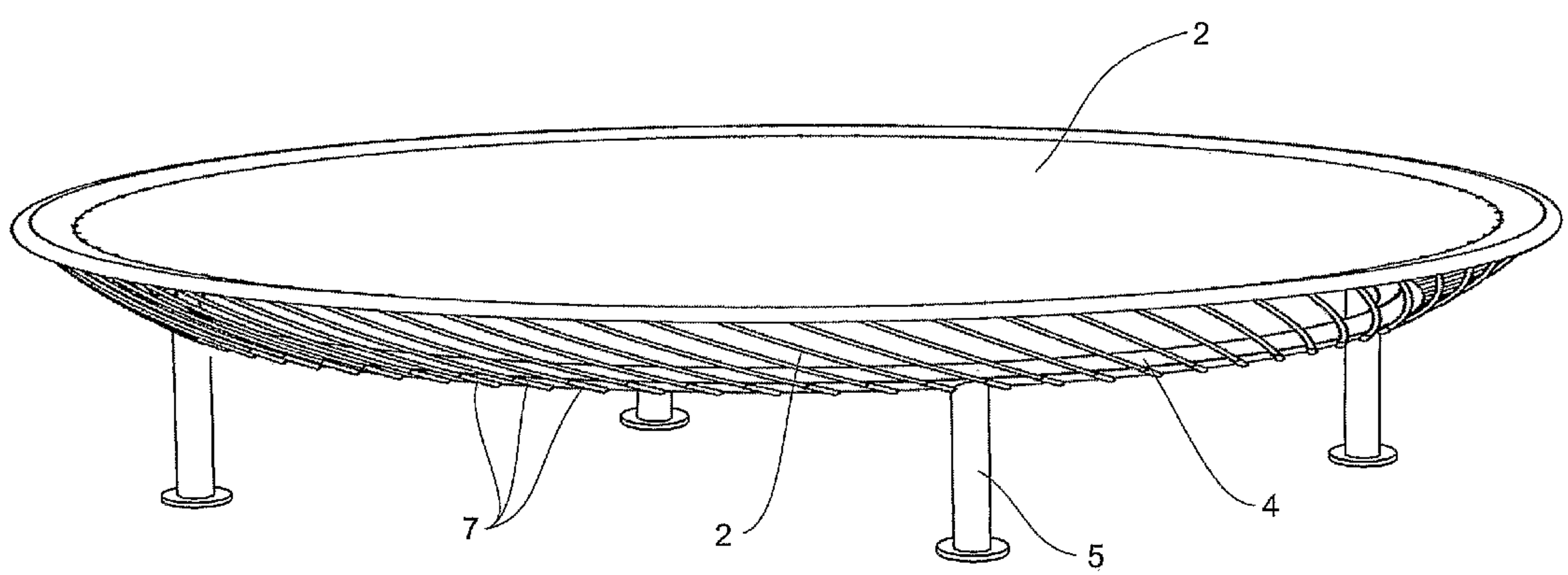
(54) **Title:** A TRAMPOLINE



(57) **Abstract:** A trampoline comprising a flexible mat (1), a plurality of resiliently flexible rods (2) retained in a frame (3) and coupled to the mat (1) about a periphery of the mat (1), whereby the rods (2) are less than about 0.45 metres in length.

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"A TRAMPOLINE"

FIELD OF INVENTION

The invention relates to improvements to a trampoline for sporting and/or recreational use which is soft-edged relative to conventional trampolines which support the mat of the trampoline via a solid peripheral frame and exposed springs between the frame and the mat.

BACKGROUND

US patent 6,319,174 discloses a form of soft-edged trampoline in which the mat of the trampoline is supported by a plurality of resiliently flexible rods received in a frame of the trampoline at the lower ends of the rods and coupled to the periphery of the bouncing mat of the trampoline at their upper ends, and which avoids the need for a solid frame about the exterior of the bouncing mat and exposed springs between the frame and periphery of the mat.

SUMMARY OF THE INVENTION

The invention provides an improved or at least alternative form of such a soft-edged trampoline.

In broad terms in one aspect the invention comprises a trampoline including a flexible mat, a plurality of resiliently flexible rods the lower ends of which are retained in a frame of the trampoline and the upper ends of which are coupled to the mat about a periphery of the mat to support the mat, in which the rods are less than about 0.45 metres in length

Preferably the rods are between about 0.1 and 0.45 metres in length. The rods may be between about 0.1 and 0.3 metres in length.

Preferably the rods have a stiffness against bending within the range of about 25 to about 3000 N/m.

Preferably the rod stiffness against bending is in the range 500 to 1500 N/m, more preferably about 600 to about 900 N/m and most preferably about 700 N/m.

Preferably the rods are deflected at their upper ends, from a natural state of rest when the rods are in position in the frame at their lower ends but before connection with the mat edge at their upper ends, to connection with the mat, up to about 450 mm.

Preferably the rod deflection is in the range 50 to 200 mm.

In accordance with the invention the rods which support the mat are shorter than previously contemplated but surprisingly still enable construction of a trampoline which functions well. That is, the rods may still apply load radially or laterally outwards to tension the mat appropriately for normal functioning of the trampoline, and give the mat edge a vertical stiffness that is sufficiently resilient, impact-absorbing and safe for a jumper who might land on the edge out of control.

In this specification (including claims) the term "trampoline" is intended to extend to smaller trampolines commonly referred to as rebounders also, as well as larger trampolines of all sizes. Trampolines of the invention may be circular, square, rectangular, or of other shapes such as octagonally shaped in plan view for example.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described with reference to the accompanying drawings by way of example and without intending to be limiting, wherein:

Figure 1 is a perspective view of a preferred form trampoline,

Figure 2 is a side view of the trampoline of Figure 1,

Figure 3 is similar to Figure 1 but of one side of the trampoline only and showing a portion of the edge of the mat of the trampoline cut away, and

Figure 3a is an enlarged view of the cut away edge portion of the trampoline,

Figure 4 shows the rod deflection measurement at the trampoline edge,

Figure 5 shows the range of rod stiffnesses and rod deflections that achieve the edge and mat properties required in accordance with the invention,

Figure 6 illustrates the cantilever rod notation for the equations given subsequently, and

Figure 7 shows rod length vs diameter for GRP rods to achieve the shown stiffnesses.

DETAILED DESCRIPTION OF PREFERRED FORMS

Referring to Figures 1 to 3, a preferred form trampoline comprises a flexible mat 1 on which users may bounce, a plurality of resiliently flexible rods 2, and a base frame 3. The preferred form trampoline shown is circular in shape but the trampoline could be of any other desired shape such as oval, square, rectangular or similar.

The base frame of the preferred form trampoline comprises a circular beam 4 typically formed of steel or aluminium for example, which may be supported from the ground by legs 5.

The rods 2 are typically fibreglass rods and may be pultruded glass reinforced plastic rods, but may alternatively be formed of spring steel for example. The lower ends of the rods are retained by the base frame 3 and the upper ends of the rods connect to fittings 6 as will be further described, which are coupled to the mat 1 about the periphery of the mat. In the preferred form the lower ends of the rods 2 enter into tubular holders 7 fixed to the circular beam as shown, but the lower ends of the rods may be coupled to the circular beam, or a base frame of the trampoline of any other form, in any suitable way.

In the preferred form the mat, which is typically heavy canvas or a woven synthetic material, is doubled back upon itself and fixed by stitching for example about the periphery of the mat to form a continuous pocket 8 extending about the periphery of the mat. A number of the fittings 6 are positioned within this pocket in the peripheral edge of the mat as shown in Figures 3 and 3a in particular. The fittings may be loosely captured within the pocket or alternatively may be stitched to the mat within the edge pocket, or mechanically fastened to the mat via rivets for example.

The rods in the preferred form each have a ball-shaped upper end 12 which connects to a socket cavity in the underside of one of the fittings 6. Typically the fittings 6 will be formed from a plastics material, by injection moulding for example. The fittings may optionally include a slight dome on the body of the fitting over the socket cavity, on the underside of the fitting. Also in the preferred form the fittings have an outer edge which in use is closest to the outer peripheral edge of the mat, which edge is wider in the planar than in the inner edge of fittings, so that the fittings have an approximate truncated triangular shape and plan view, with concave sides, but this is non-limiting and in other forms the fitting could be alternatively shaped.

The rods are less than about 0.45 metres in length. Typically the rods are between about 0.1 and 0.30-0.45 metres in length, and are pultruded glass reinforced plastic rods.

We have surprisingly found that a trampoline with rods which are shorter than previously contemplated still provide a trampoline having a good balance of properties of, first, sufficient vertical stiffness at the mat edge so that that the edge will not "collapse" when a jumper lands on the edge, and second tension of the mat laterally to provide good jumping performance when a jumper is jumping centrally on the mat. Unexpectedly we have found that such shorter rods can still be deflected sufficiently so as to apply load radially outwards to tension the mat for good jumping performance of the trampoline, while at the same time giving the mat edge a vertical stiffness that is sufficiently resilient, impact-absorbing and safe for a jumper who might land on the edge out of control. Figure 5 plots these two measures.

In set up of the trampoline from its component parts, after assembly of the base frame 3 as required, the lower ends of the rods 2 are inserted into the holders 7. At this point the upper ends of the rods are free so that each rod will be in an undeflected position, as indicated at 2a in Figure 4. The mat 1 is then draped over the frame and rods and the upper ends of each of the rods are coupled to the fittings 6 one by one, about the periphery of the trampoline. After some initial rods have been connected, then subsequently as the upper end of each rod is coupled to the trampoline mat, the rods will be deflected inwardly towards the centre of the trampoline, to the deflected position indicated at 2b in Figure 4. When the upper ends of all of the rods have been connected to the matter about the periphery of the mat, all of the rods will be in this deflected position 2b. The distance between the upper end of any rod in its deflected position as at 2b, and its undeflected position when not coupled to the mat (with the mat held by the other rods) as indicated at 2a is the rod deflection x indicated as in Figure 4. This deflection may be up to about 450 mm, and will typically be between about 50 to 200 mm. At the same time the rods preferably have a stiffness against cantilever bending in the range about 25 to about 3000 N/m, and typically 500 to 1500 N/m.

The following further analysis makes use of the rod stiffness given above:

First the simple cantilever deflection formula is used. The notation is shown in Figure 6 and is defined below. The deflection x is given by:

$$x = \frac{SL^3}{3EI} \qquad \text{(equation 1)}$$

where the second moment of area I is given as:

$$I = \frac{\pi d^4}{64}.C_I \qquad \text{(equation 2)}$$

The stiffness k can be derived from equation 1 as:

$$k = \frac{S}{x} = \frac{3EI}{L^3} \qquad \text{(equation 3)}$$

and this can be expanded with equation 2 to give:

$$k = \frac{3E\pi d^4}{64L^3}.C_I \qquad \text{(equation 4)}$$

Rearranging, the rod length can be found as:

$$L = \sqrt[3]{\frac{3E\pi d^4}{64k}.C_I} \qquad \text{(equation 5)}$$

This final equation 5 allows calculation of the rod length L for any given rod diameter d and Young's Modulus E, assuming the stiffness, k, is known, which has been defined above as nominally 700N/m; and a value for C_I, which is given below

Where:

I	=	Actual measured 2nd moment of area (corrected for GRP if appropriate) (m^4)
S	=	Rod tip load (N)
L	=	Rod free length from socket exit to ball center (m)
d	=	Rod diameter (m)
C_I	=	Coefficient correcting to actual measured I value (C_I= 0.83 for pultruded GRP of glass fraction 70%+; but 1 for homogeneous materials such as steel)
x	=	Rod tip deflection, perpendicular to undeflected centreline (m)
E	=	Young's Modulous (for GRP rods=41 Gpa)
k	=	"Spring stiffness" for cantilever typically 700N/m

As an example equation 5 is plotted in Figure 7 for the range of rod stiffnesses expected, being 500 N/m to 1500 N/m, but nominally 700N/m. This is for glass reinforced pultruded rods. Other materials need another plot to define the length to diameter. Figure 7 shows the combinations of rod length and rod diameter that will give performance for a trampoline edge in accordance with the invention. With the specified initial deflection x these combinations will at the same time also give optimum performance to the trampoline mat as well.

Thus the figure shows the rod combinations required to achieve the two key functions of mat tension and edge stiffness. These two functions can be achieved with different materials in the same way as shown in the example, but using the appropriate Young's Modulous, E, and coefficient, C_1.

The foregoing describes the invention including preferred forms thereof. Alterations and modifications as will be obvious to those skilled in the art are intended to be incorporated within the scope hereof as defined in the accompanying claims.

CLAIMS:

1. A trampoline including a flexible mat, a plurality of resiliently flexible rods the lower ends of which are retained in a frame of the trampoline and the upper ends of which are coupled to the mat about a periphery of the mat to support the mat, in which the rods are less than about 0.45 metres in length.

2. A trampoline according to claim 1 wherein the rods are between about 0.1 and 0.45 metres in length.

3. A trampoline according to claim 1 wherein the rods are less than about 0.3 metres in length.

4. A trampoline according to anyone of claims 1 to 3 wherein the rods have a stiffness against bending within the range of about 25 to about 3000 N/m.

5. A trampoline according to anyone of claims 1 to 3 wherein rods have a stiffness against bending in the range 500 to 1500 N/m.

6. A trampoline according to anyone of claims 1 to 3 wherein the rod stiffness against bending is in the range of about 600 to about 900 N/m.

7. A trampoline according to anyone of claims 1 to 3 wherein the rod stiffness against bending is about 700 N/m.

8. A trampoline according to any one of claims 1 to 7 wherein the rods are deflected at their upper ends, from a natural state of rest when the rods are in position in the frame at their lower ends but before connection with the mat edge at their upper ends, to connection with the mat, up to about 450 mm.

9. A trampoline according to any one of claims 1 to 7 wherein the rods are deflected at their upper ends, from a natural state of rest when the rods are in position in the frame at their lower ends but before connection with the mat edge at their upper ends, to connection with the mat, in the range 50 to 200 mm.

10. A trampoline according to any one of claims 1 to 9 wherein the rods are pultruded fibreglass rods.

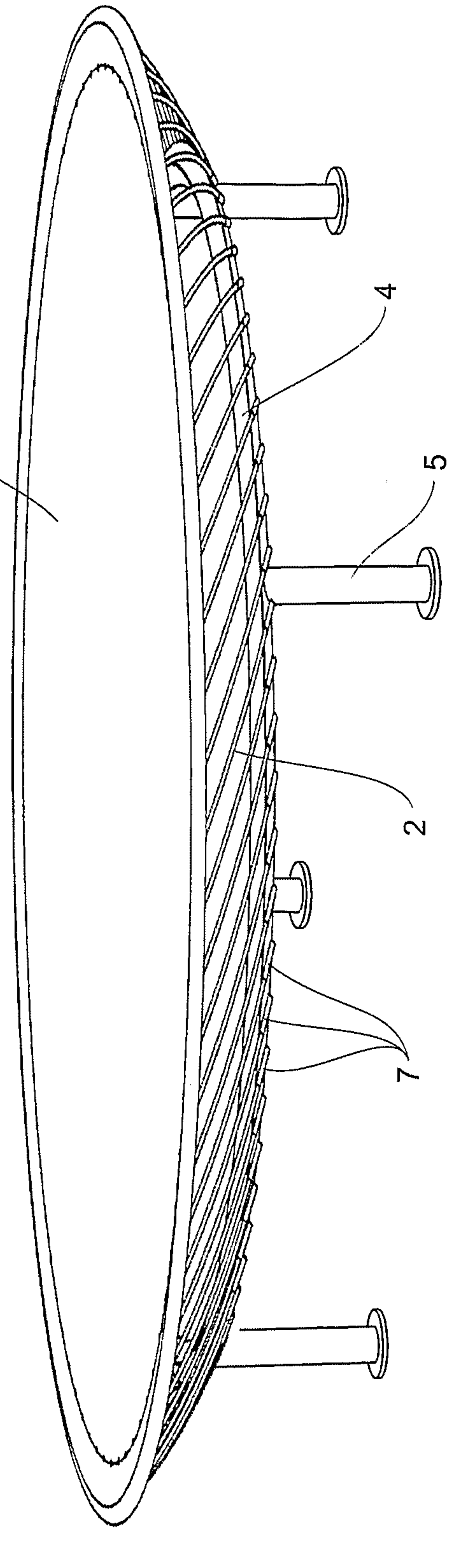


FIGURE 1

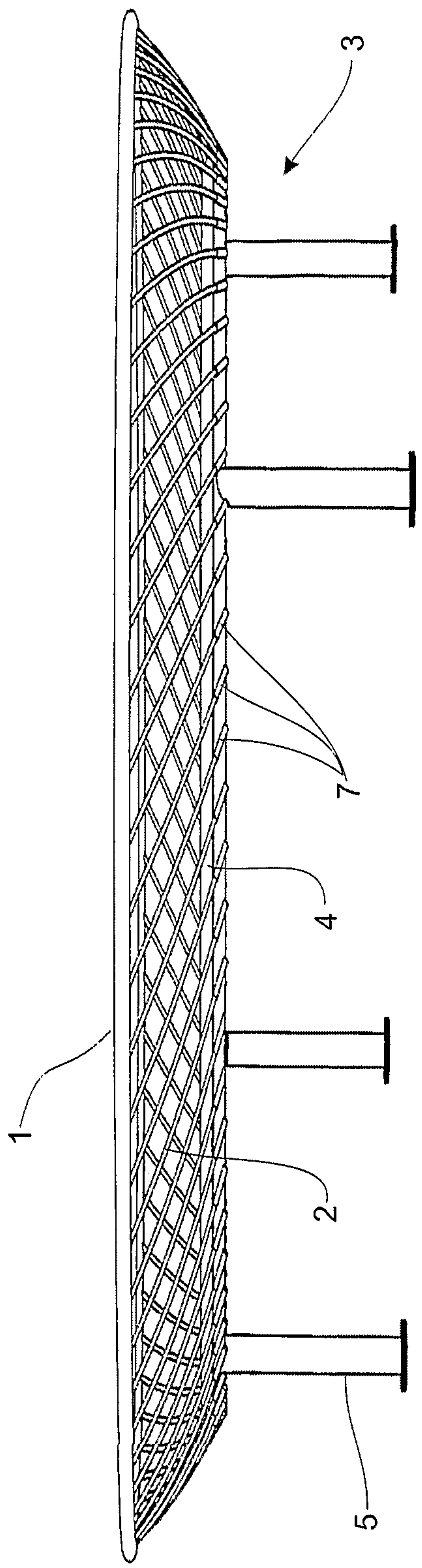


FIGURE 2

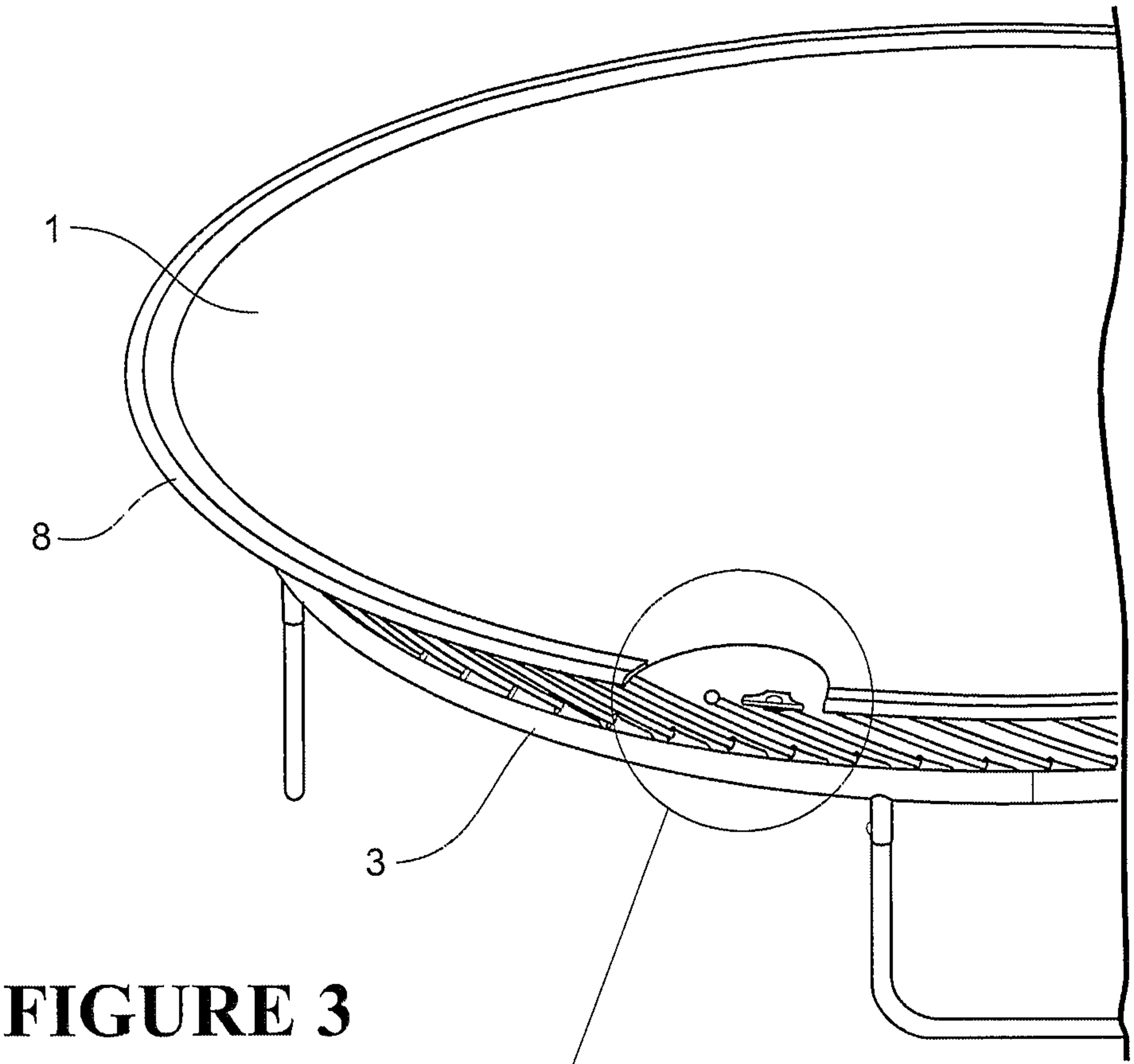


FIGURE 3

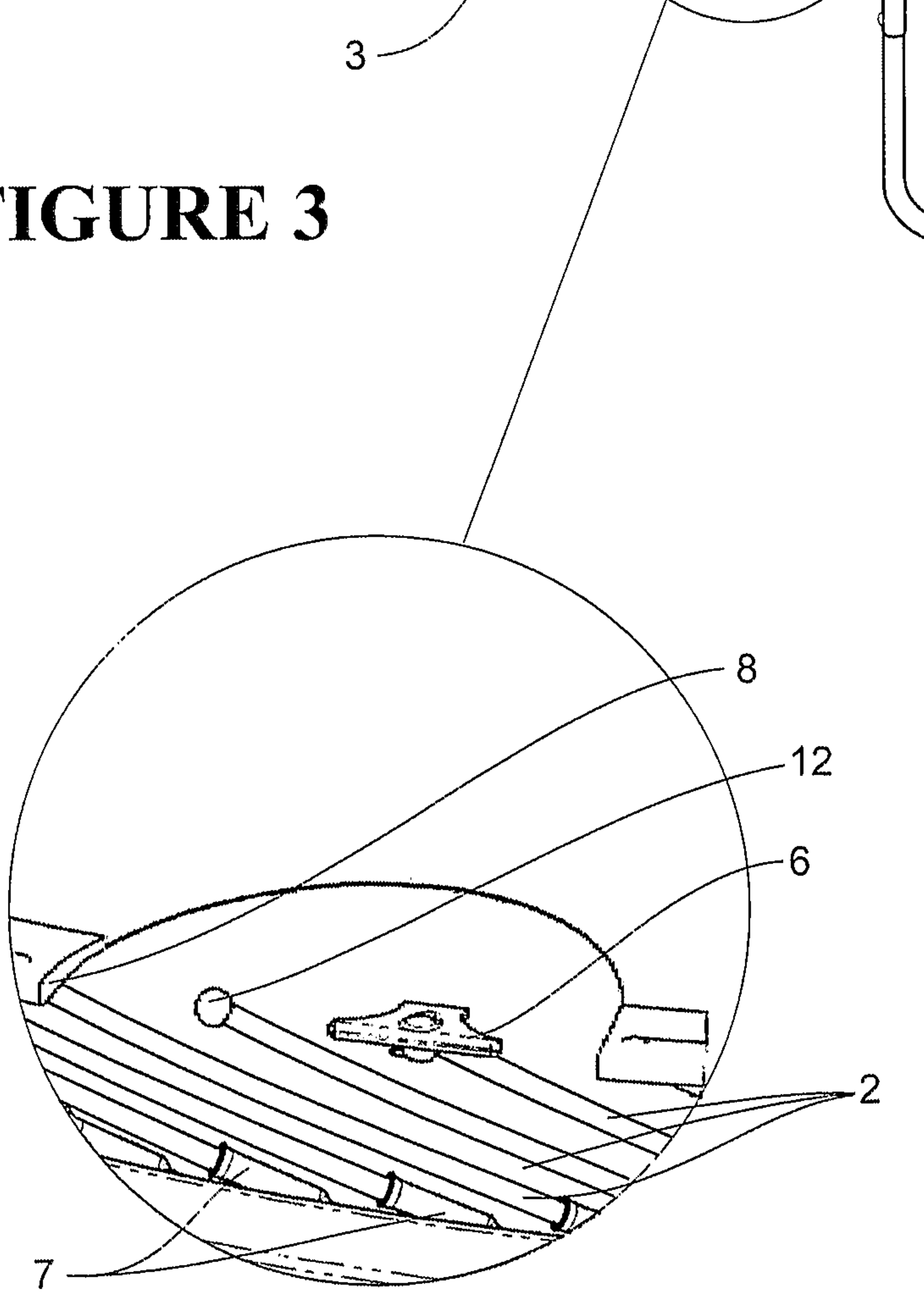


FIGURE 3a

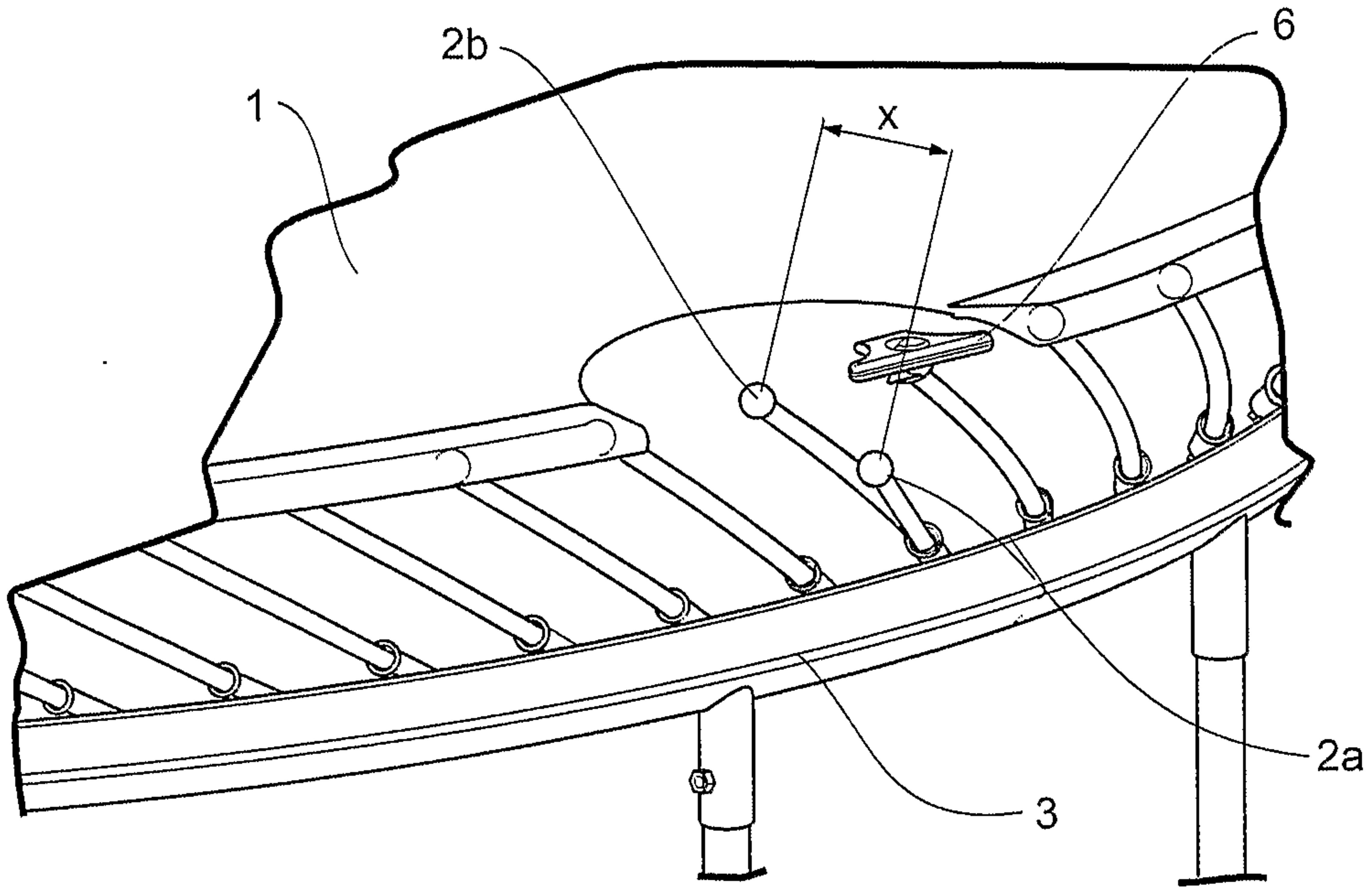


FIGURE 4

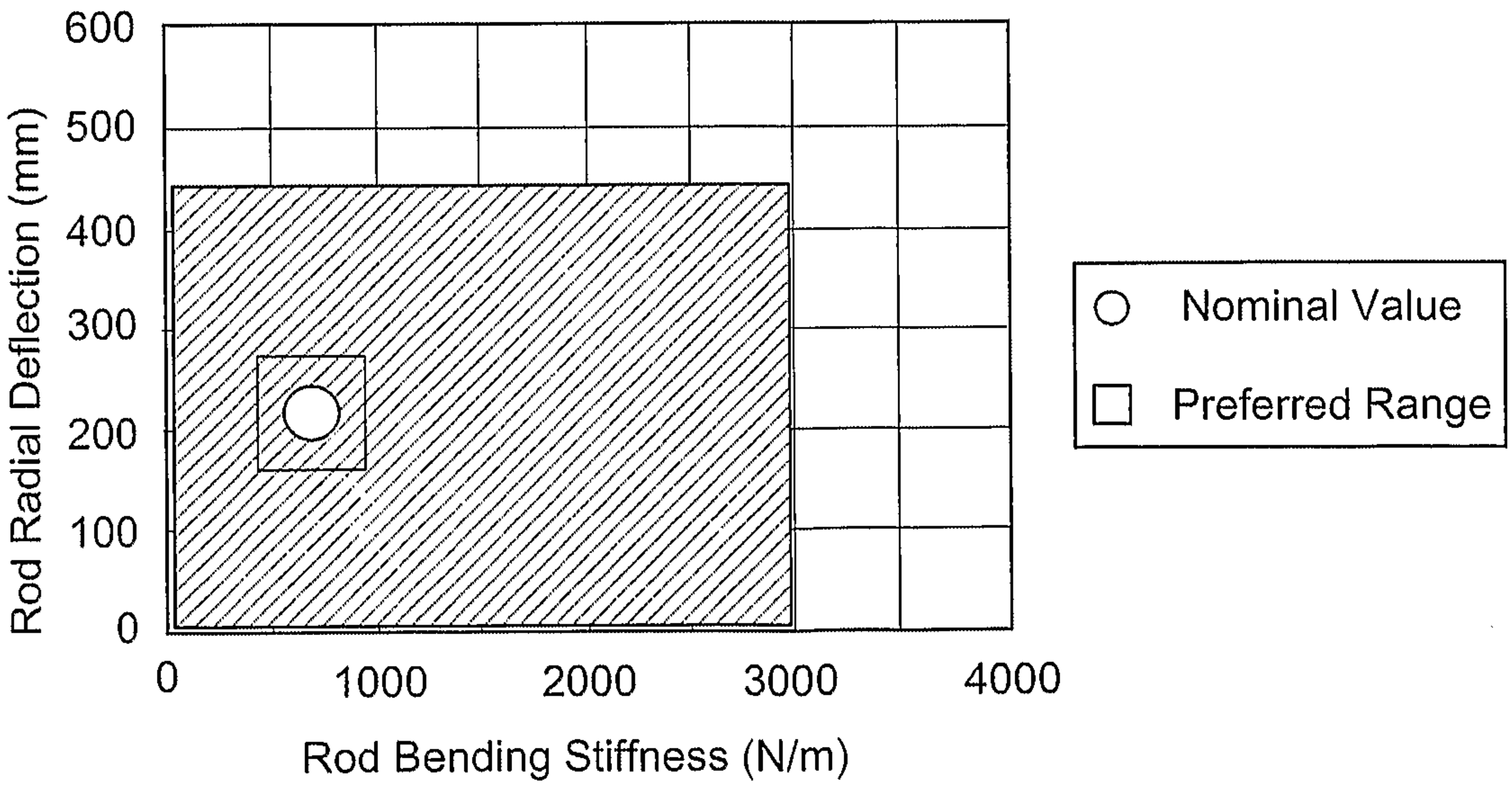


FIGURE 5

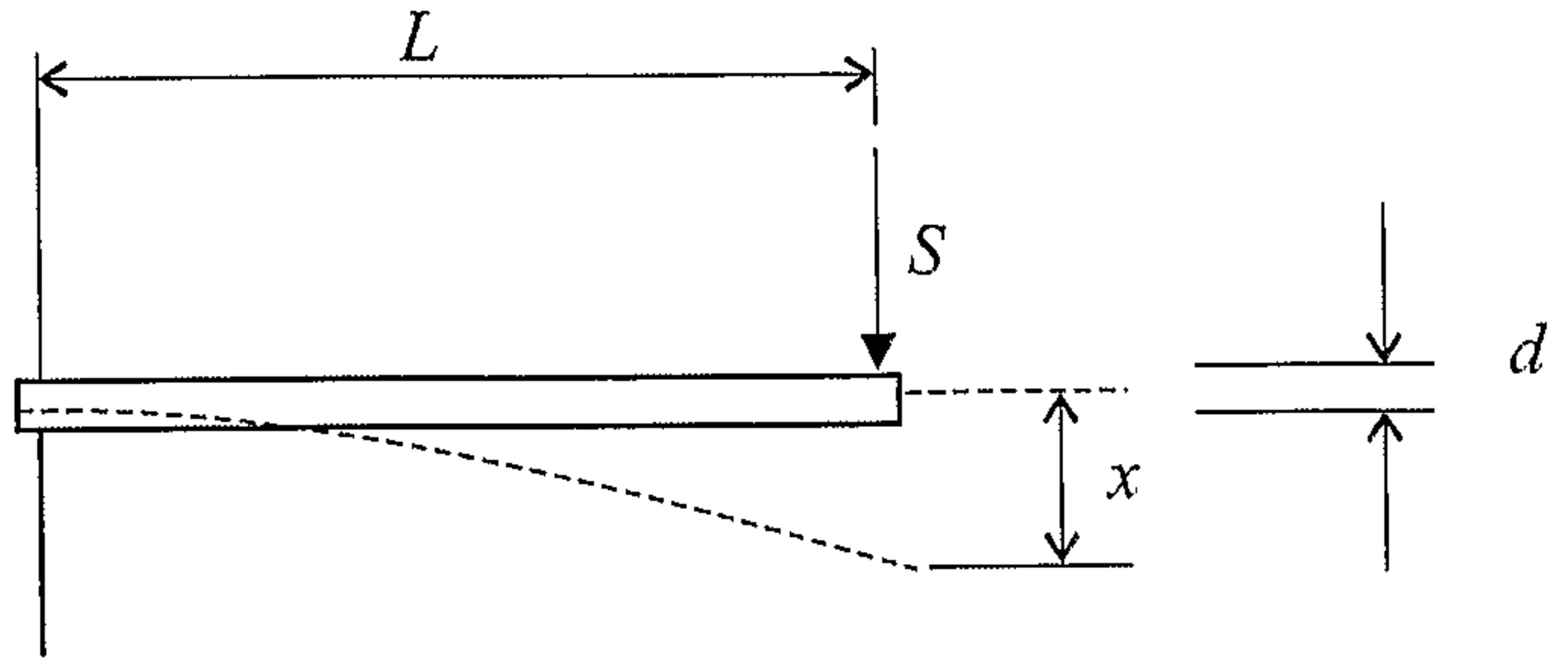


FIGURE 6

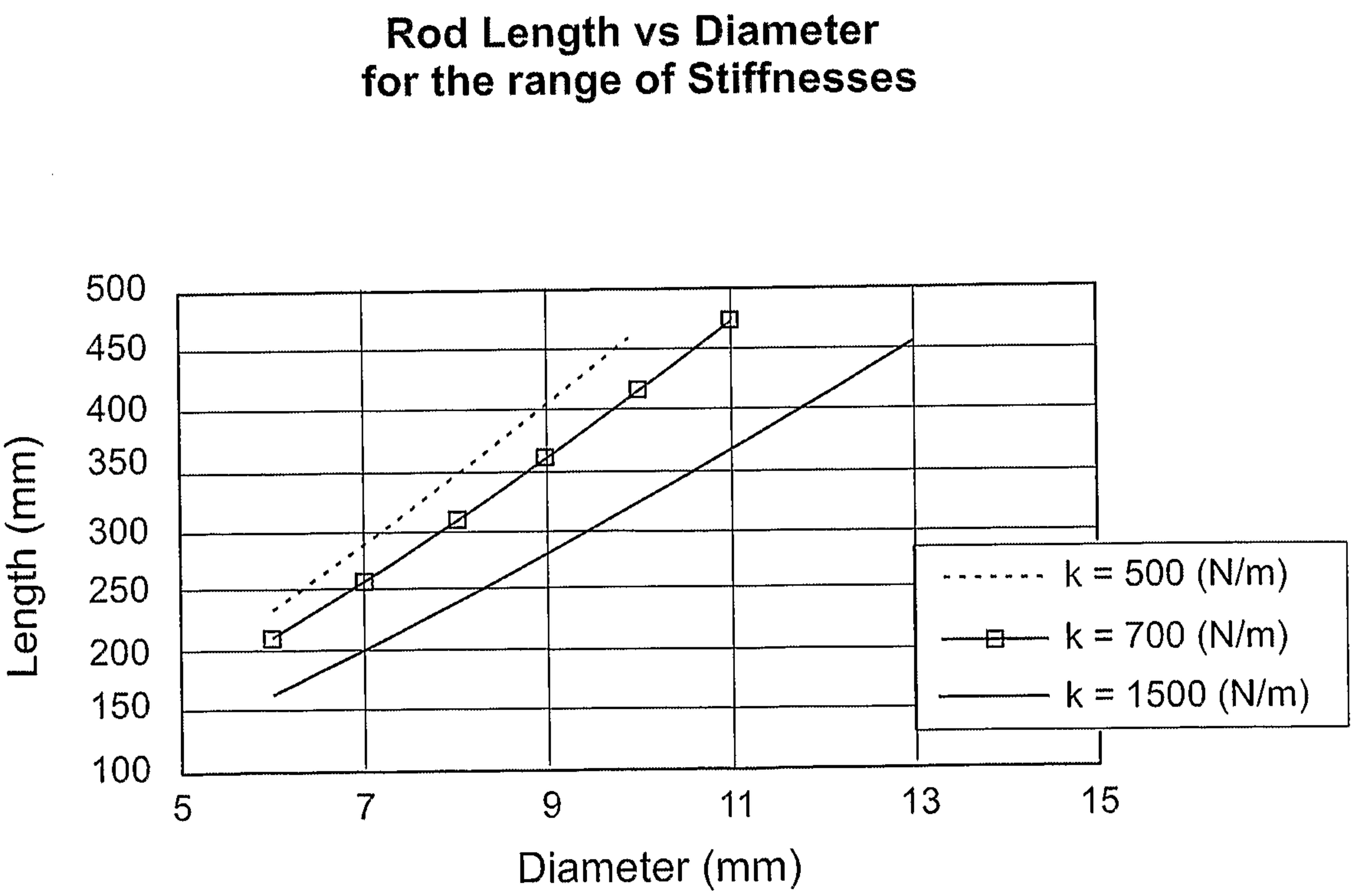
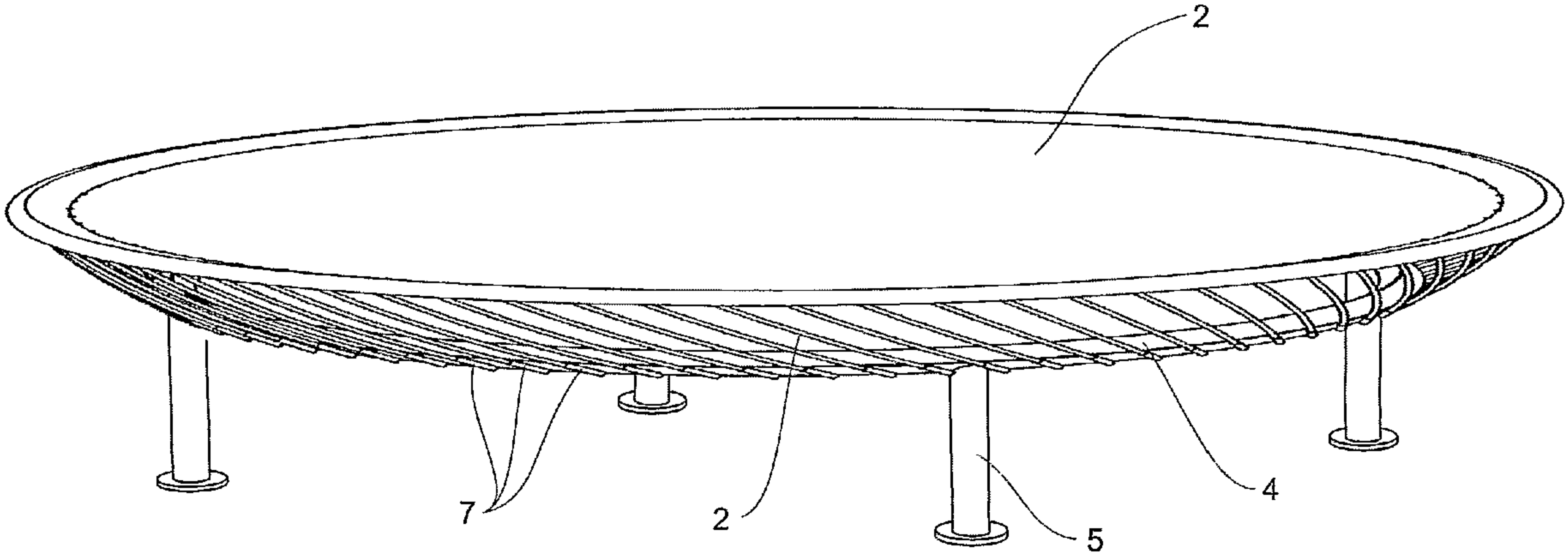


FIGURE 7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