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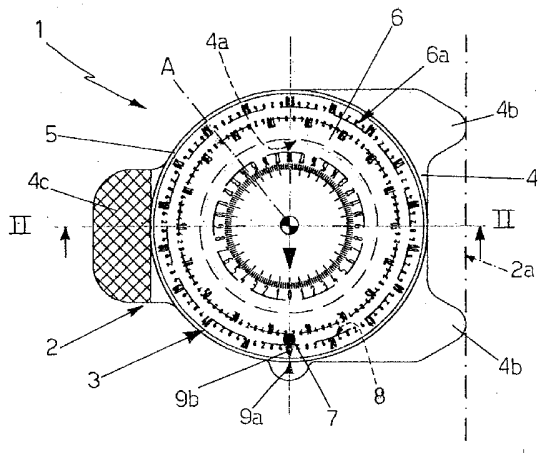
(54) **Title:** MEASURING DEVICE FOR THE INCLINATION OF THE BACKBONE



(57) **Abstract:** A measuring device (1) for measuring the inclination of the vertebral column, comprising a supporting element (2, 4) provided with a lateral reference edge (2a) designed to be set so that it bears upon the portion of the vertebral column that is to be measured, and at least one inclinometer (3) fixed on the supporting element (2) in such a way as to be able to detect and indicate the inclination of the lateral reference edge (2a) with respect to the vertical; the inclinometer (3) comprising a bushing (5) fixed on the supporting element (2) in such a way that it can turn, an indicating ball (7) set so that it is free to move inside an annular groove (8) made on the surface of the top end (5a) of the aforesaid bushing (5), and a goniometer (6) with circular scale fixed on the surface of the end (5a) of the bushing (5) in such a way that its circular graduated scale (6a) is set above and in a position corresponding to the annular groove (8); the aforesaid annular groove (8) being moreover sealed and filled with a viscous fluid that is able to brake the free movement of the indicating ball (7).

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MEASURING DEVICE FOR THE INCLINATION OF THE BACKBONE

TECHNICAL FIELD

The present invention relates to a device for measuring the inclination of the vertebral column.

In particular, the present invention relates to a measuring device capable of measuring some parameters of the curve that the vertebral column forms on the sagittal plane in such a way as to enable a quantitative evaluation of thoracic kyphosis, lumbar lordosis, and their variation in the passage of the patient from the upright position to the sitting position, which is a use to which the ensuing treatment will make explicit reference, without this implying, however, any loss in generality.

BACKGROUND ART

As is known, in the last few years, there have been developed radiographic diagnostic methods and surface methods of diagnosis capable of providing a quantitative evaluation of some alterations in the vertebral column, such as thoracic hyperkyphosis and lumbar hyperlordosis. In order to furnish reliable results, the surface diagnostic methods referred to above entail an accurate measurement of the inclination with respect to the vertical of particular portions of the vertebral column.

So far, the devices that have been used for making these measurements have been made up of a plane supporting plate, designed to be set with one pre-set lateral reference edge which bears upon the portion of the vertebral column that is to be measured, and of an inclinometer fixed to the plane supporting plate in such a way as to be able to detect and indicate the inclination with respect to the vertical of the lateral reference edge of the plane supporting plate.

As regards the inclinometer fixed to the plane supporting plate, currently it is made up of a goniometer with circular scale positioned at the centre of the plane reference plate and of a ballasted indicating needle, which is mounted so that it is free to turn at the centre of the aforesaid circular-scale goniometer. The ballasted indicating needle is obviously made in such a way that distribution of the weights with respect to the axis of rotation of the indicating needle will be such as to maintain the needle itself always in a perfectly vertical position independently of the orientation assumed by the plane reference plate and by the circular-scale goniometer that is fixed to it.

In the above type of measuring devices, the inclination of the portion of the vertebral column is indicated by the tip of the indicating needle directly on the circular scale of the goniometer.

Unfortunately, devices for measuring the inclination of the vertebral column that are currently known are intrinsically far from precise and have to be reset very often during use, this involving a relatively complicated operation, which considerably lengthens the times required for carrying out completely all the measurements envisaged for each individual patient.

A second major drawback of currently known measuring devices is that they must be set with the plane supporting plate in a perfectly vertical position in order to be able to furnish reliable measurements.

Furthermore, frequently the measuring devices described above are also provided with a magnetized needle, which is sensitive to the earth's magnetic field, like the needle of a compass, which is mounted so that it is free to turn at the centre of the circular-scale goniometer in such a way as to be able to

indicate, on the circular scale of the aforesaid goniometer, the angle of drift to which the patient is subject while he attempts to walk upright.

Unfortunately, the simultaneous presence within the inclinometer of both the magnetized needle and the ballasted indicating needle is a cause of additional reading problems: frequently, in fact, the magnetized needle hinders both the reading of the position of the indicating needle on the circular scale of the goniometer and the free rotation of the indicating needle of the inclinometer, thus falsifying the measurements.

DISCLOSURE OF THE INVENTION

The purpose of the present invention is to provide a device for measuring the inclination of the vertebral column which will be free from the drawbacks described above.

According to the present invention, a device for measuring the inclination of the vertebral column is provided, which comprises a supporting element provided with a lateral reference edge designed to be set so that it bears upon the portion of the vertebral column that is to be measured, and at least one inclinometer fixed on the supporting element in such a way as to be able to detect and indicate the inclination of said lateral reference edge with respect to the vertical; the measuring device being characterized in that said inclinometer comprises a main body fixed to said supporting element, an indicating ball set so that it is free to move inside an annular groove made on the main body of said inclinometer, and a goniometer with circular scale fixed on said main body in such a way that its circular graduated scale is set above and in a position corresponding to the annular groove.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described with reference to the annexed drawings, which illustrate a non-limiting example of embodiment thereof, in which:

- Figure 1 is a plan view of a device for measuring the inclination of the vertebral column built according to the teachings of the present invention;
- Figure 2 is a side view of the measuring device illustrated in Figure 1, sectioned according to the line of cross section II-II; whilst
- Figure 3 is a schematic illustration of the measuring device that forms the subject of the present invention; and
- Figure 4 is a plan view of a variant of the measuring device illustrated in Figures 1 and 2.

BEST MODE FOR CARRYING OUT THE INVENTION

With reference to Figures 1 and 2, the reference number 1 designates, as a whole, a measuring device that is particularly suitable for measuring the inclination of any portion whatsoever of the vertebral column with respect to the vertical.

The measuring device 1 is made up of a supporting element 2 provided with a lateral reference edge 2a designed to be set so that it bears upon the portion of the vertebral column that is to be measured, and at least of an inclinometer 3 fixed on the supporting element 2 in such a way as to be able to detect and indicate the inclination with respect to the vertical of the lateral reference edge 2a of the supporting element 2.

In greater detail, once again with reference to Figures 1 and 2, the supporting element 2 is made up of a plane plate 4 having a substantially rectangular shape and being provided, at the centre, with a through hole 4a having a circular section, within which the inclinometer 3 is designed to be housed. The plane plate 4 is preferably, but not necessarily, made of transparent plastic material and is provided with two

projecting appendages 4b, which extend in cantilever fashion from the main body at the two edges of one and the same external side edge.

The two projecting appendages 4b are designed to be set so that they bear upon the two vertebrae that delimit the portion of the vertebral column that is to be measured, and hence the straight line that passes through the ends of the two projecting appendages 4b defines the lateral reference edge 2a of the supporting element 2.

In the example illustrated, the plane plate 4 is further provided with a third projecting appendage 4c, which extends in cantilever fashion from a central portion of the external side edge opposite to the one provided with the two projecting appendages 4b and functions as gripping point for gripping the measuring device 1.

With reference to Figures 1 and 2, the inclinometer 3 comprises, instead, the following; a cylindrical tubular bushing 5, mounted so that it can turn inside the through hole 4a; a circular-scale goniometer 6, which is rigidly fixed on the surface of the top axial end 5a of the bushing 5; and an indicating ball 7, which is set so that it can move freely inside an annular groove 8 made on the surface of the top axial end 5a of the bushing 5.

The annular groove 8 of the bushing 5 lies on a plane parallel to the plane plate 4 and is preferably, but not necessarily, filled with a given amount of transparent viscous liquid, which is able to brake the free movement of the indicating ball 7 inside the annular groove 8 itself. In the case in point, the viscous liquid is designed to brake the pendular movement of the indicating ball 7 inside the annular groove 8 when the supporting element 2 is set in a vertical position.

In greater detail, the bushing 5 is inserted in the plane plate 4 in such a way as to be able to be manually rotated about the axis A of the through hole 4a, whilst the annular groove 8 is made on the surface of the top axial end 5a of the bushing 5 in such a way as to be coaxial with the axis A.

As regards, instead, the circular-scale goniometer 6, it is made up of a circular disk 6 of transparent material, which has, in the vicinity of its outer perimetral rim a circular graduated scale 6a, by means of which it is possible to determine, in a known way, the amplitude of any plane angle that has its vertex at the centre of the circular graduated scale 6a. The circular disk 6 is attached on the surface of the top axial end 5a of the bushing 5 so as to be coaxial with the axis A and is sized in such a way as to close the annular groove 8 in a fluid-tight way in order to prevent the indicating ball 7 and the viscous liquid contained in the annular groove 8 from coming out.

In addition to what has been described above, it should be pointed out that the circular disk 6 must moreover be sized in such a way that the circular graduated scale 6a will extend exactly above and in a position corresponding to the annular groove 8.

Finally, two notches or reference marks 9a and 9b are made on the plane plate 4 and on the body of the inclinometer 3 for enabling fast positioning of the measuring device 1 in the reset position.

In the case in point, when the two notches 9a and 9b are facing one another, the inclinometer 3 is oriented on the supporting element 2, or on the plane plate 4, in such a way that the zero present on the circular graduated scale 6a of the goniometer 6 sets itself exactly in the position in which the indicating ball 7 would position itself in the case where

the lateral reference edge 2a of the supporting element 2 were perfectly vertical.

In the example illustrated, the reference notch 9a is made on the upper face of the plane plate 4, in a position corresponding to the outer perimetral rim of the bushing 5, whilst the second reference notch 9b is made in the vicinity of the outer perimetral rim of the goniometer 6.

Of course, the notches 9a and 9b are etched or printed on the plane plate 4 and on the body of the inclinometer 3 in ideal conditions at the end of assembly of the measuring device 1.

Finally, as regards the indicating ball 7, this must be made using a material having a specific weight greater than that of the viscous liquid, and its external surface must be coloured in such a way as to be clearly distinguishable from the viscous liquid and from the body of the bushing 5.

With reference to Figure 2, the inclinometer 1 is preferably, but not necessarily, also provided with a magnetic compass 10, which is inserted in the central through hole present on the bushing 5 in such a way as to be fixed to the body of the bushing 5 itself. The magnetic compass 10 will not be described any further herein since it is of a known type.

Operation of the measuring device 1 will now be described, assuming that the operation of resetting, which consists in turning the inclinometer 3 until the notches 9a and 9b are set aligned one in front of the other, has already been carried out.

With reference to Figure 3, in use the measuring device 1 is rested with the two projecting appendages 4b in succession on three pre-set points of the vertebral column in order to

determine the local value of the inclination of the vertebral column with respect to the vertical.

In greater detail, the measuring device 1 is first rested with the two projecting appendages 4b bearing upon the point P_1 of the vertebral column situated immediately below the spinous process of the prominent vertebra so as to determine the angle of inclination α, and then bearing upon a point P_2 of the vertebral column situated at the point of inflection between the thoracic kyphosis and the lumbar lordosis so as to determine the angle of inclination β, and, finally, bearing upon the point P_3 of the vertebral column situated on the line that joins the posterior superior iliac spines of the vertebral column so as to determine the angle of inclination γ.

The sum of the angles detected in the points P_1 and P_2, i.e., the sum of the angles α and β yields what is called the "surface angle of thoracic kyphosis", whilst the sum of the angles detected in the points P_2 and P_3, i.e., the sum of the angles β and γ yields what is called the "surface angle of lumbar lordosis".

To determine the variation in the quantities referred to above in passing from the upright position to the sitting position, it is obviously necessary to take the measurements on the three points P_1, P_2 and P_3 of the vertebral column both with the patient in the upright position and with the patient in the sitting position.

The advantages of the measuring device described above are evident and multiple. In the first place, reading of the measurement is more immediate than in currently known devices because the value of inclination of the portion of the vertebral column is indicated directly on the circular graduated scale 6a of the goniometer 6 by the position of the

indicating ball 7. In the second place, the particular structure of the inclinometer 3 enables use of a much more precise scale than the ones currently used, and in which the tenths of degree are clearly identifiable.

A further advantage of the measuring device 1 is that the reading error due to the position of the observer with respect to the instrument is altogether eliminated.

In addition to what has been said above, the measuring device 1 has, finally, the further advantage of being able to be equipped with a magnetic compass, without this jeopardizing the reliability of the measurements performed. The particular structure of the measuring device 1 rules out, in fact, any interference between the inclinometer 3 and the magnetic compass 10, it being merely sufficient to use an indicating ball 7 made of non-magnetic material.

Finally, it is clear that modifications and variations may be made to the measuring device described and illustrated herein, without thereby departing from the scope of the present invention.

In particular, with reference to the variant illustrated in Figure 4, the measuring device 1 may be equipped with two inclinometers 3. In this case, the plane plate 4 is provided with two through holes 4a, each of which is occupied by a respective inclinometer 3.

According to a further variant (not illustrated), the inclinometer 3 may be made of a single piece with the supporting element 2, making the annular groove 8 directly in the plane plate 4.

C L A I M S

1. A measuring device (1) for measuring the inclination of the vertebral column, comprising a supporting element (2), provided with a lateral reference edge (2a) designed to be set so that it bears upon the portion of the vertebral column that is to be measured, and at least one inclinometer (3) fixed on the supporting element (2) in such a way as to be able to detect and indicate the inclination of said lateral reference edge (2a) with respect to the vertical; the measuring device (1) being characterized in that said inclinometer (3) comprises a main body (5) fixed to said supporting element (2), an indicating ball (7) set so that it is free to move inside an annular groove (8) made on the main body (5) of said inclinometer (3), and a goniometer (6) with circular scale fixed on said main body (5) in such a way that its circular graduated scale (6a) is set above and in a position corresponding to the annular groove (8).

2. The measuring device according to Claim 1, characterized in that said annular groove (8) is filled with a given amount of viscous liquid, which is able to brake the free movement of the indicating ball (7) inside the annular groove (8).

3. The measuring device according to Claim 1 or Claim 2, characterized in that said supporting element (2) comprises a plane plate (4) having a substantially rectangular shape and being provided, at the centre, with a through hole (4a), within which said inclinometer (3) is designed to be housed.

4. The measuring device according to Claim 3, characterized in that the main body (5) of said inclinometer (3) is constituted by a bushing (5) inserted inside the through hole (4a), in such a way as to be able to be rotated manually about the axis (A) of the through hole (4a).

5.- The measuring device according Claim 4, characterized in that said annular groove (8) is made on the surface of the top axial end (5a) of said bushing (5) in such a way as to be coaxial with the axis (A) of the through hole (4a).

6.- The measuring device according to Claim 5, characterized in that said circular-scale goniometer (6) comprises a circular disk (6) made of transparent material, which has, in the vicinity of its outer perimetral rim, a circular graduated scale (6a); said circular disk (6) being fixed on the surface of the top axial end (5a) of said bushing (5) in such a way that the circular graduated scale (6a) is positioned immediately above said annular groove (8).

7.- The measuring device according to any on of Claims 3 to 6, characterized in that said plane plate (4) is provided with two projecting appendages (4b), which extend in cantilever fashion from the plate itself at the two edges of one and the same external side edge and are designed to be set so that they bear upon the vertebrae that delimit the portion of the vertebral column that is to be measured; the lateral reference edge (2a) of said supporting element (2) being defined by the straight line that passes through the ends of said two projecting appendages (4b).

8.- The measuring device (1) according to any one of the preceding claims, characterized in that it comprises a magnetic compass (10) coupled to said inclinometer (3).

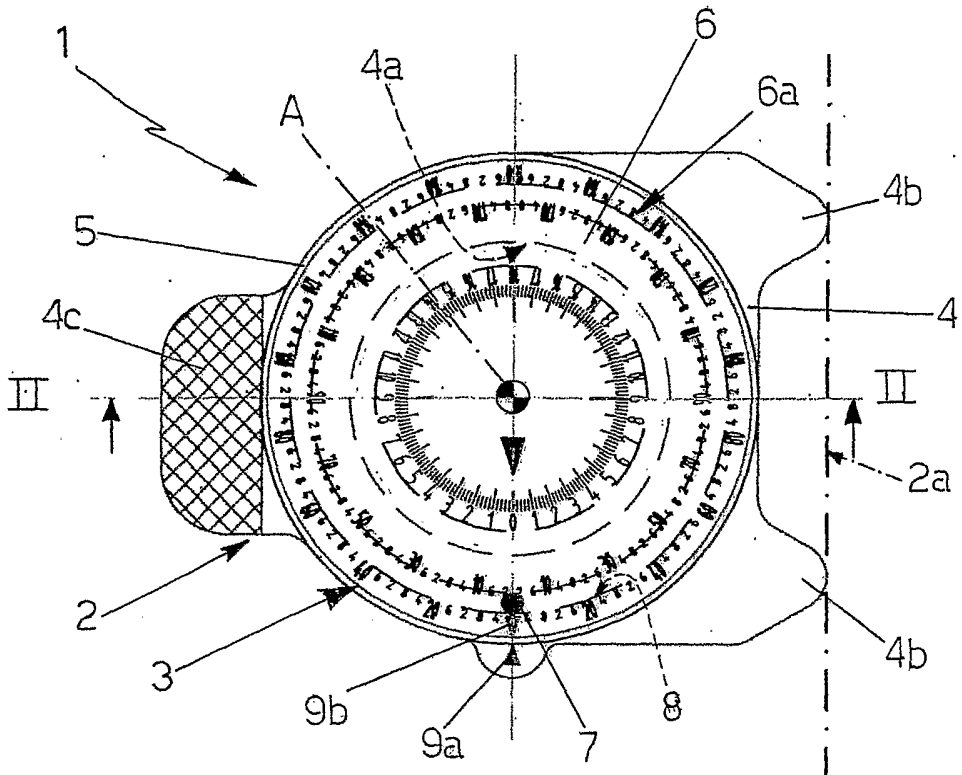

Fig.1

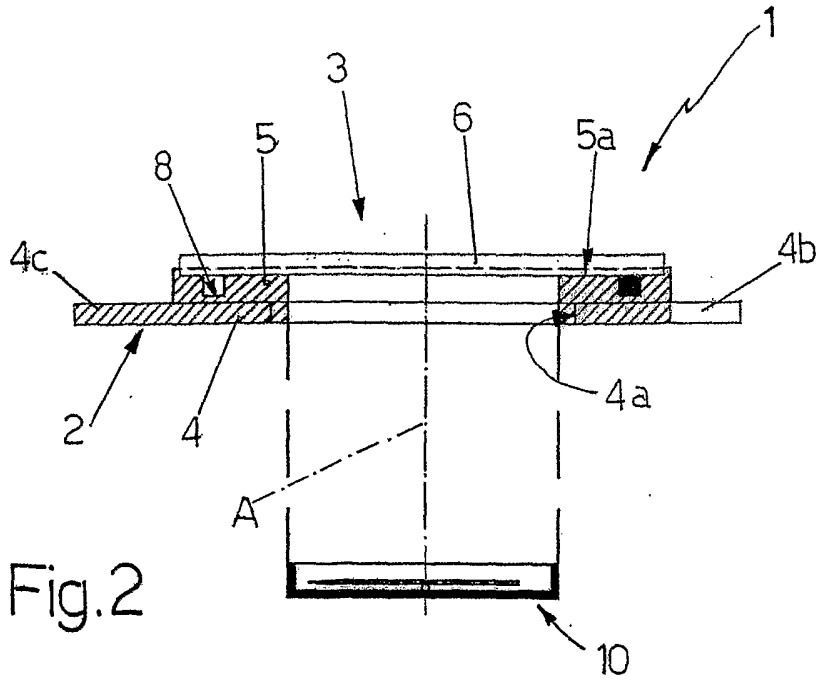

Fig.2

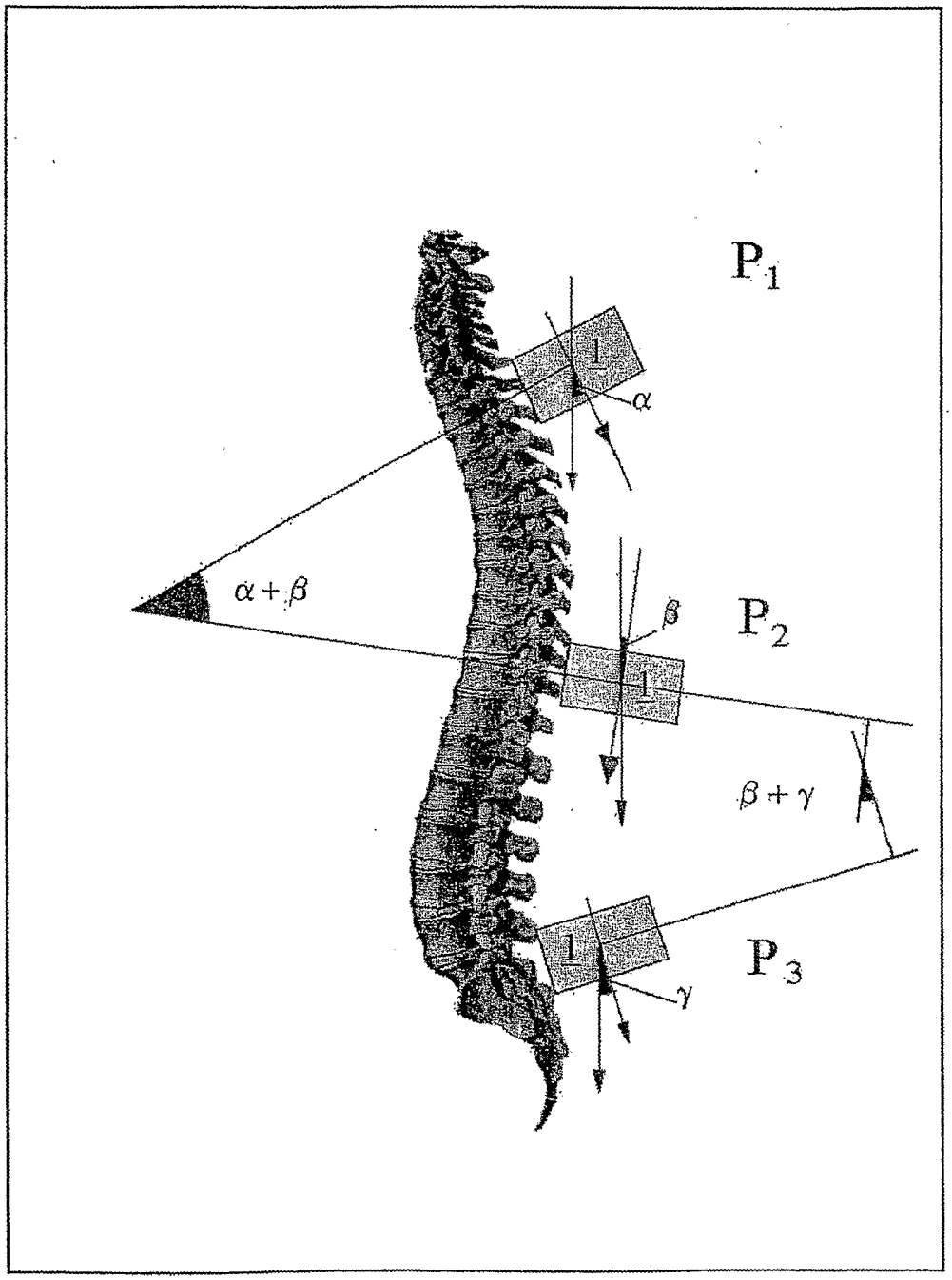

Fig. 3

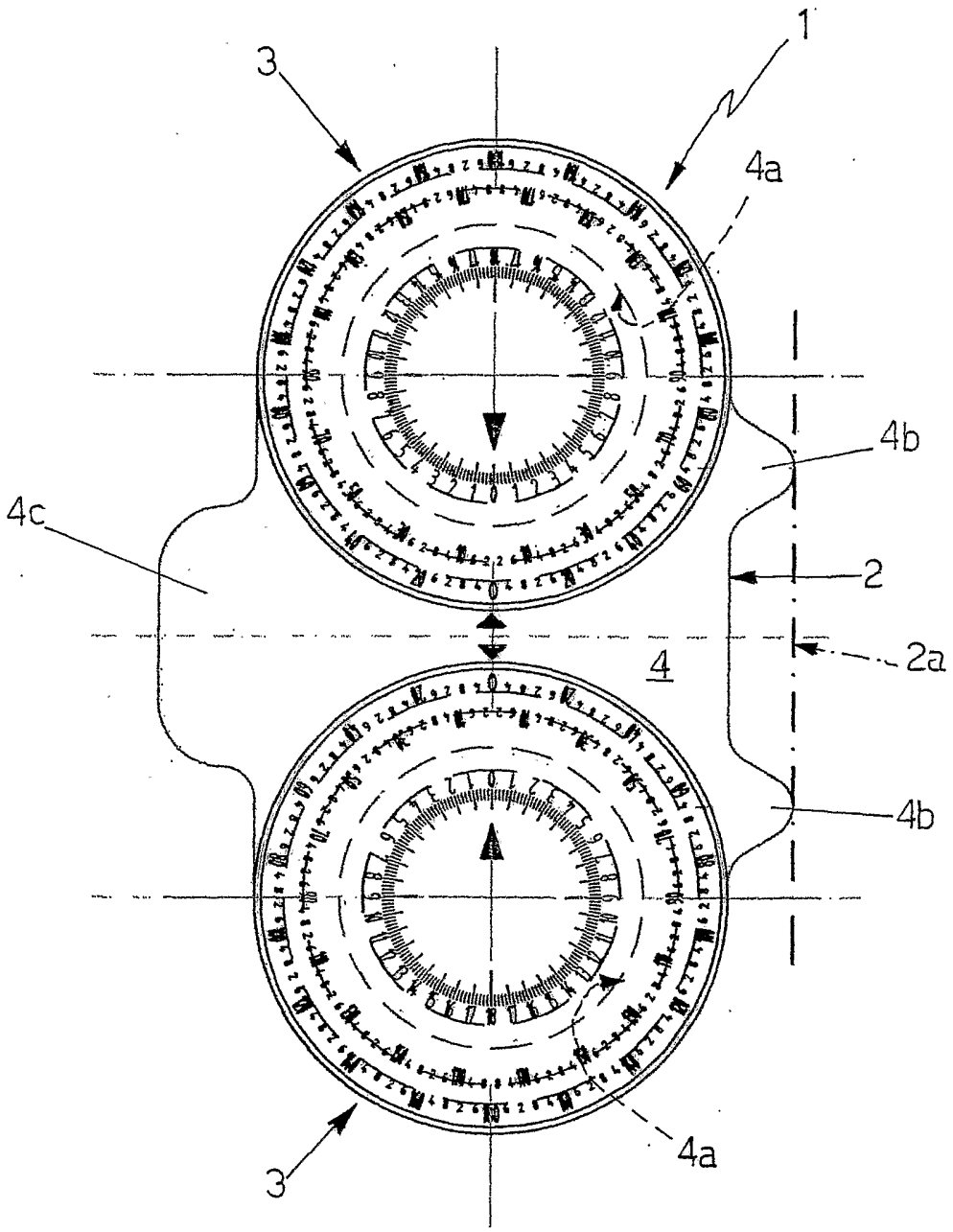

Fig.4