

E. SARTORIUS.
BALANCE.

APPLICATION FILED OCT. 11, 1912.

1,065,844.

Patented June 24, 1913.

3 SHEETS—SHEET 1.

Fig.1.

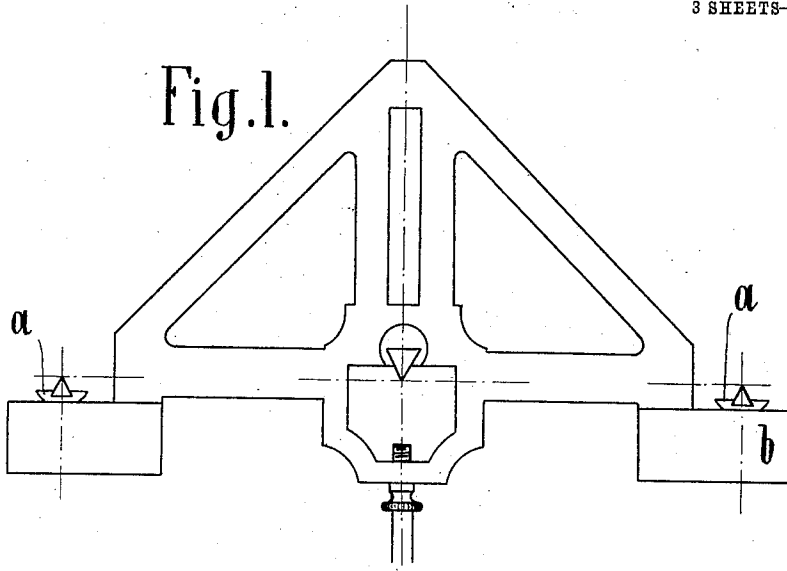


Fig.2.

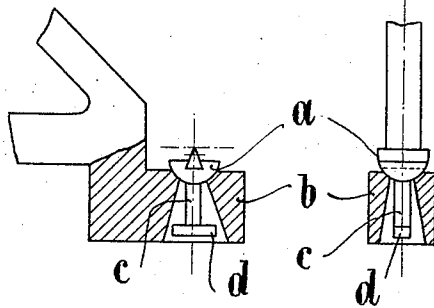
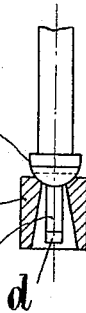


Fig.3.



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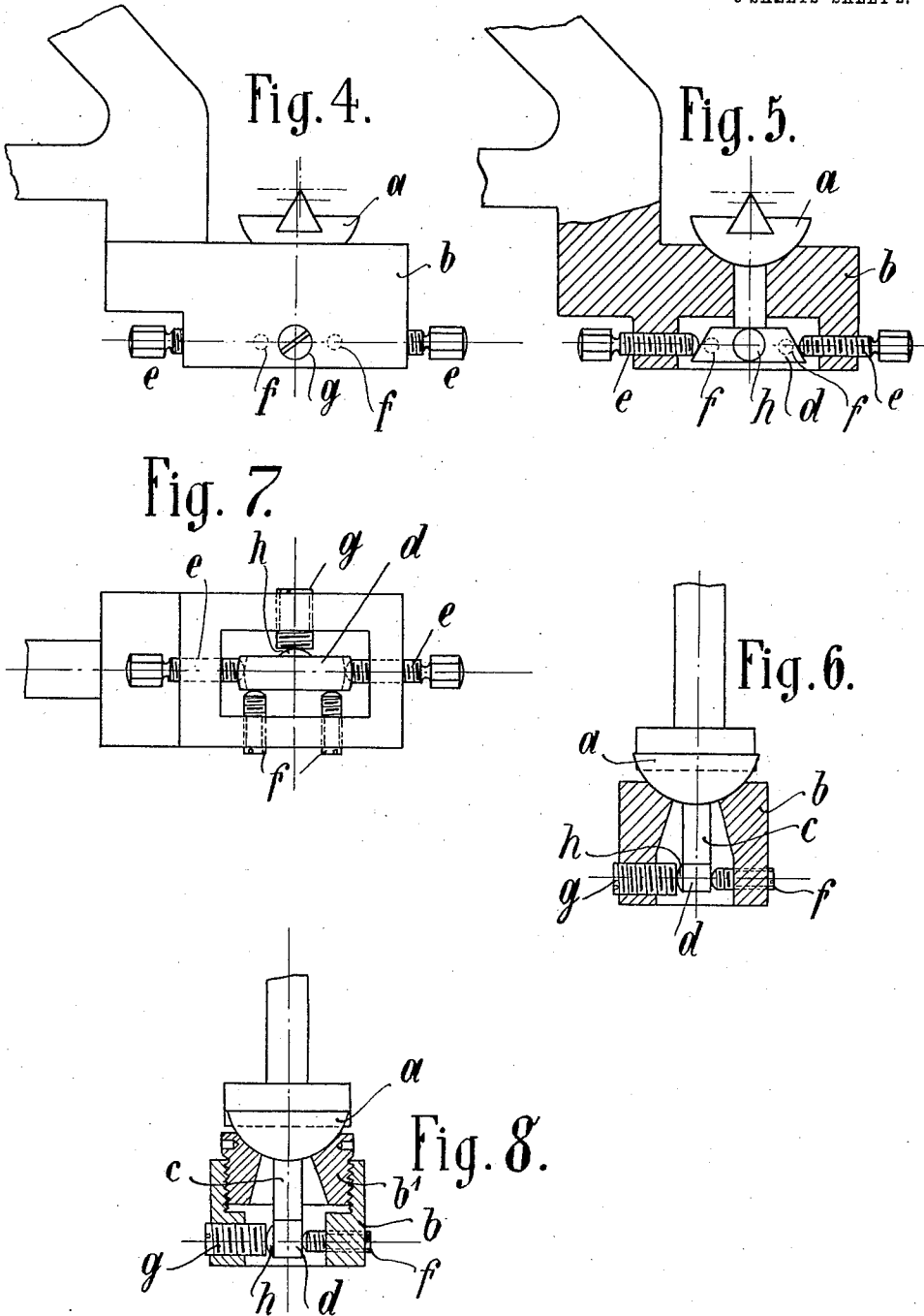
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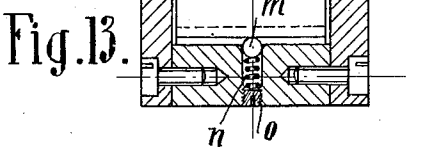
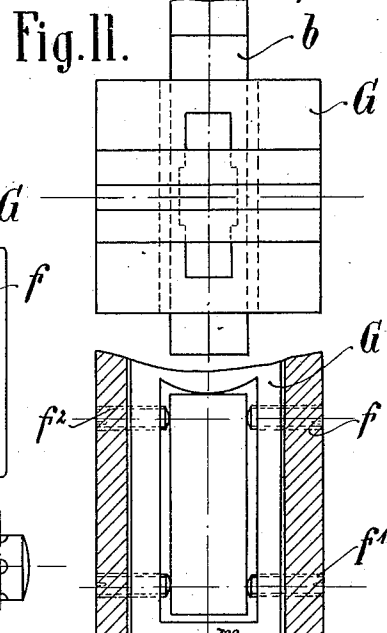
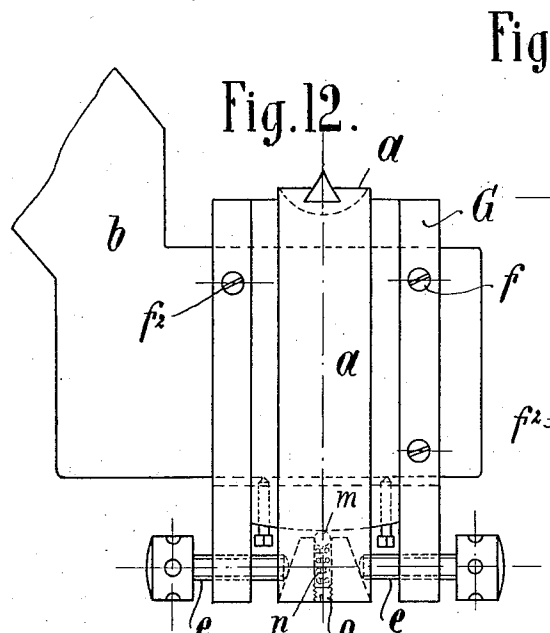
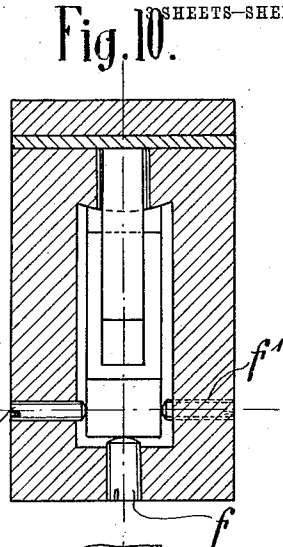
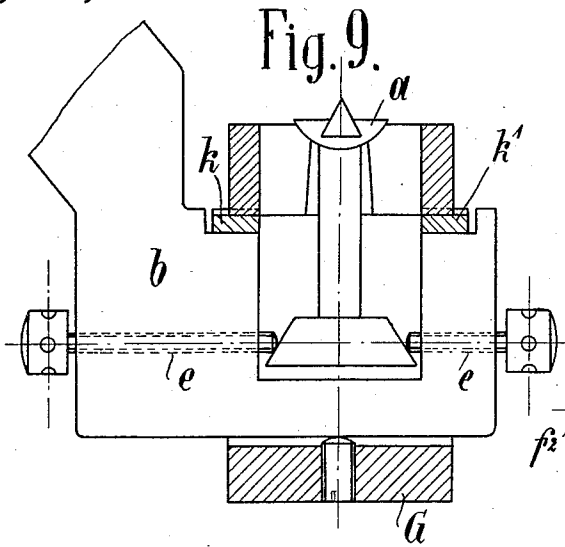
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3 SHEETS—SHEET 3.



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BALANCE.

1,065,844.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, ERICH SARTORIUS, a subject of the Emperor of Germany, residing at Göttingen, Germany, have invented certain new and useful Improvements in Balances, of which the following is a specification.

The invention relates to precision balances and has for its object to provide improved means for adjusting the terminal knife edges relatively to the main knife edge of the balance beam so that the former may be accurately positioned and maintained in position during operation with their axes parallel to the axis of the main knife edge and in one and the same horizontal plane.

Considerable difficulty has hitherto arisen in accurately adjusting the relative positions of the knife edges or supporting pivots due to a great extent to the expansion or contraction or the alteration in position due to one cause or another of the wedges, screws, or other adjusting means hitherto employed, after the adjustment has been effected with the result that a correct positioning of the parts is but temporary and accurate results are only obtained for a very brief interval of time.

In devising the present invention special attention has been paid to the importance of providing an adequate bearing surface for the supporting structure for the knife edges or supporting pivots and with this end in view the bearing surfaces are in a preferred construction of spherical or cylindrical form, the knife edge being so arranged with reference to the spherical supporting member that it lies within the circumference of such member. By this means a very slight alteration in the position of the knife edge, accomplished by suitably rotating the spherical or cylindrical supporting member is sufficient to obtain a comparatively large compensation, a movement of $\frac{1}{16}$ of a millimeter being found in practice to be sufficient for a balance beam of average length under ordinary circumstances.

Certain constructional forms of the invention will now be described with reference to the accompanying drawings which illustrate what are at present considered the best embodiments of the invention.

In the drawings Figure 1 is a view in front elevation of a balance beam embodying the invention. Figs. 2 and 3 are views

in longitudinal section and transverse section respectively of a portion of the device illustrated in Fig. 1, showing the construction of the supporting structure for the terminal knife edges. Fig. 4 is a view in front elevation, Fig. 5 a longitudinal sectional view, Fig. 6 a transverse sectional view and Fig. 7 a plan view of the adjusting devices on an enlarged scale. Fig. 8 is a view similar to Fig. 6 illustrating a modification in the form of the adjusting device. Figs. 9 to 11 are views in vertical section, transverse section and plan respectively illustrating the modification in which the supporting structures for the knife edges are of semi-cylindrical form, and Figs. 12 and 13 are views in longitudinal and transverse section respectively illustrating a modification in the form of the arrangement illustrated in Figs. 9 to 11.

Referring now to Figs. 1 to 8 the knife edge or supporting pivot is shown mounted in a supporting member *a*, in the form of a segment of a sphere, for the reception of which corresponding bearing surfaces are provided in the end of the balance beam *b*. Rigidly attached to the underside of the supporting member *a* directly opposite to the knife edge is a downwardly depending arm or lever *c* to the lower end of the latter of which a cross-piece *d* is provided. Sufficient clearance is allowed between the lever *c*, the cross-piece *d* and the wall of the opening in the end *b* of the balance beam in which they are located to allow of a certain free movement as will be hereinafter explained.

Owing to the peculiar shape of the supporting member *a* the knife edge can readily be brought to the desired correct position by means of the lever *c* and can be secured in this position by filling the opening in the underside of the end of the balance beam in which the arm *c* is located with a suitable material which will harden and remain in position for an indefinite time. The formation of the opening and the construction of the adjusting arm *c*, *d* illustrated in Figs. 2 and 3 is suitable for this purpose.

After one of the terminal knife edges has been secured in this or in any other suitable manner, the position of the second knife edge can be adjusted by means of the devices illustrated in Figs. 4 to 8. For instance the position of the cross-piece *d* can readily be determined by the adjusting

screws *e e* Figs. 4 to 6 and by the adjusting screws *f f* arranged at right angles thereto, the operation of which will be readily understood from an inspection of these figures.

5 It should be noted, however, that the cross-piece *d* in these figures is beveled (Fig. 5), so that when the adjusting screws *e e* are tightened the supporting member *a* carrying the knife edge is held firmly on its seat in the end of the beam.

10 The adjusting screws *f* as shown in Fig. 7, engage with the opposite ends of the cross-piece *d* while the adjusting screw *g* on the opposite side of the cross-piece engages with the cross-piece *d* at a point intermediate the two adjusting screws *f, f*, a circular projection *h* being provided at this point in order to allow of a ready displacement of the cross-piece and consequent adjustment. By means of this adjusting device it is possible to move the knife edge around any desired axis.

A special adjusting device is shown in Fig. 8 by means of which the supporting member *a* and consequently the knife edge can be raised or lowered as desired. As will be seen from this figure, a screw threaded annular member *b*¹ is provided for supporting the member *a*. In this construction the beveled edges of the cross-piece *d* tend in conjunction with the adjusting screws *e e* to hold the member *a* firmly on its seat after adjustment and also to prevent the annular member *b*¹ from rotating.

35 Referring now to Figs. 9 to 13 in which the supporting member is constituted by a semi-cylindrical member instead of by a member in the form of a segment of a sphere the arrangement illustrated in Figs. 9 to 11 will first be described. As will be seen from an inspection of these figures the balance beam *b* at the point at which the supporting structure for the knife edge is to be attached, is cut away to accommodate a casing or stirrup *G* the position of which can be varied with respect to its distance from the central pivot, and is adjustable around a vertical axis by means of the screws *f*¹ *f*². A locking screw *f* is provided for retaining the device in position after adjustment. The casing *G* is so formed and supported that it can be readily rotated when the locking screw *f* has been loosened, the seating surface on the end of the balance beam being either in the beam itself or as shown in the drawing, two special bearing members *h*, *h*¹ of hard or hardened material may be provided, which is essential under certain circumstances where the bearings are subject to high pressure as when heavy weights are being dealt with. The upper portion of the casing *G* is provided with a semi-circular recess in which the supporting member *a* for the knife edge is located. The supporting member *a* as in the case in which a

sphere segment is utilized is provided with a downwardly depending rod or lever having at its lower extremity a cross-piece provided with a beveled surface engaging with the adjusting screws *e* as before described with reference to Fig. 5. By adjusting these screws the supporting member *a* for the knife edge is rotated in its bearings and since as before mentioned the actual knife edge, that is to say the point of support for the scale pan or its equivalent lies within the circumference of the circular or cylindrical body *a* a ready adjustment of the terminal knife edge with respect to the main supporting pivot or knife edge may be obtained.

It will be seen that the supporting member carrying the cross-piece can be placed in position by inserting the cross-piece through the opening at the top of the casing after loosening the adjusting screws *e e* which pass through suitable holes in the end of the balance beam.

In the construction illustrated in Figs. 12 and 13 the casing *G* is seated on the upper surface of the balance beam without a portion of the balance beam being cut away as described with reference to Figs. 9 to 11. The exact formation of the curved portion of the casing *G* which engages with the upper surface of the balance beam which constitutes an arc of a circle described about a center coincident with the longitudinal edge of the supporting pivot is not essential. The balance beam is not in this construction specially formed to accommodate the supporting member for the knife edge and its adjusting attachment, the supporting structure in this instance being arranged to be placed over the casing *G*, the casing *G* being provided with a special bearing surface corresponding to the bearing surface on the supporting member for this purpose. The two legs or downwardly extending portions of the supporting member *a* are connected together on the underside of the edge *G* in any suitable manner, as for instance by means dependent upon the construction and formation of the cage employed. The adjustment of the supporting member *a* is preferably effected by means of screws operating in conjunction with beveled surfaces formed on the underside of the supporting member as previously described, the beveled surfaces being in this instance formed by cutting away a portion of the supporting member *a* as shown in Fig. 12, the adjusting screw *e* passing through holes formed in extensions projecting on either side of the supporting member *a*, instead of as in the arrangement illustrated in Figs. 9 to 11 passing through the end of the balance beam itself.

In order to maintain the supporting member *a* in its correct position when adjusting the distance between the supporting pivots,

and in order to exercise a continuously uniform pressure on the bearings, a spring-pressed ball *m* is provided operated by a spring *n* and a pressure adjusting screw *o*.

5 By this means the friction in the bearing or seating parts is always maintained uniform and while an adjustment is effected by means of the screws *e* the necessity for undue tightening of these screws is avoided with a
10 consequent reduction in the degree of expansion or distortion of the parts resulting from such adjustment. The casing *G* is adjusted by means of the screws *f*, *f*¹, *f*², and may be firmly secured to the end of the
15 balance beam by means of screws located on the underside of the casing as described with reference to Figs. 9 to 11.

An important feature of the invention for effecting the adjustment of the balance is that the correction or adjustment of the knife
20 edges in order to correctly position them in the same plane and parallel to each other may be effected quite independently of the adjustment in respect of the distance between the main and terminal knife edges,
25 the two former adjustments being in no way affected by the latter. Moreover, the supporting member for the knife edge is not maintained on its seat by friction on parallel surfaces and centrally moved when an
30 adjustment in respect of the distance between the supporting pivots has been effected, nor is any harmful pressure produced by any of the securing or adjusting
35 screws or devices. Variation in the distance between the supporting pivots is effected solely by the movement of the supporting member or of the knife edge which is accomplished by means of the adjusting screws
40 *e*. The parts may be permanently screwed in position by pouring a suitable substance in a molten or liquid state into the spaces between the component parts of the device
45 after an adjustment has been effected, the substance being such as to harden or solidify when cooled or left for a brief interval of time.

It will be understood that the invention is capable of being carried into operation in
50 a variety of ways and is not therefore to be regarded as limited except as is indicated in the appended claims.

I claim as my invention:—

1. The combination in a balance of a supporting member for the pivot having a portion of its surface in the form of a segment of a sphere engaging with a corresponding bearing surface carried by the balance beam and means located in the end of the balance
60 beam for oscillating said supporting member.

2. The combination in a balance of an adjustable supporting member for the pivot point or knife edge a portion of the surface
65 of which constitutes an arc of a circle and

engages with a corresponding bearing surface carried by the balance beam, means located on the beam for effecting a variation in the distance between the terminal pivot points or knife edges and the main knife
70 edge and means for oscillating said supporting member.

3. The combination in a balance of a pivot point or knife edge for each scale pan, supporting members adapted to be oscillated
75 and to which said pivot points are rigidly secured, each of said members having a portion of its surface in the form of an arc of a circle, bearing surfaces for said members carried by the balance beam and engaging
80 with the curved portions thereof, means for altering the distance between the pivot points for the scale pans and the main knife edge of the balance without removing the supporting members for the terminal pivot
85 points from their bearings and means for oscillating said supporting member.

4. The combination in a balance of a supporting member for each terminal pivot located upon the end of the balance beam
90 said supporting member having a portion of its surface in the form of an arc of a circle the completed circumference of which is outside of the knife edge of the pivot, bearing surfaces upon the balance beam to
95 accommodate the curved portion of the supporting member carrying the pivot and adjusting devices for oscillating said supporting member.

5. The combination in a balance of a supporting member for each of the terminal
100 pivots having a portion of its surface in the form of an arc of a circle engaging with corresponding bearing surfaces formed on the balance beam, the knife edge of the pivot
105 being located within the circumference of the circle formed by completing the arc of the circle constituted by the bearing surface on the supporting member, means for effecting the oscillation of the supporting member
110 within its bearings in a horizontal plane and means for effecting an adjustment in the position of the supporting member and holding the same in position.

6. The combination in a precision balance
115 of a supporting member for each terminal pivot point or knife edge comprising a member adapted to be oscillated and having a portion of its surface in the form of an arc of a circle the completed circumference of
120 which surrounds the knife edge of the pivot, a downwardly extending portion attached to said supporting member, means for effecting the oscillation of the supporting member in a plane parallel to the plane of the balance
125 beam and means for effecting an adjustment in the position of the supporting member and holding the same in position.

7. The combination in a precision balance of a supporting device for the terminal
130

5 pivots, a portion of the surface of said device constituting an arc of a circle the completed circumference of which surrounds the knife edge of the pivot and a downwardly
 10 extending member provided with a beveled surface, adjusting screws adapted to engage said beveled surface for effecting an adjustment in the position of the supporting member and holding the same in position.

15 8. The combination in a precision balance of a supporting device for each of the terminal pivots a portion of the surface which is in the form of an arc of a circle the completed circumference of which surrounds
 20 the knife edge of the pivot, adjusting screws, means secured to each of said supporting devices comprising a downwardly extending arm operating in conjunction with said adjusting screws for altering the position of
 25 the supporting member relative to the bearings in which it is mounted, means for altering the position of the pivot relatively to the balance beam in a vertical and in a horizontal plane and means for permanently
 30 securing the supporting member for the pivot in position when the necessary adjustment has been made.

9. The combination in a precision balance of a supporting member for each terminal
 35 knife edge, a portion of the surface of which constitutes an arc of a circle, the completed circumference of which surrounds the knife edge, bearing surfaces for accommodating
 40 said supporting member, means for effecting the oscillation of the supporting member about a point coincident with the center of the completed circle of which the arc described by the surface of the supporting member forms a part, said supporting members being adjustable with respect to the
 45 main knife edge and means for holding said members in their adjusted position.

10. The combination in a precision balance of a supporting member for each terminal pivot point or knife, one surface of which constitutes a bearing surface engaging with a bearing surface carried by the balance beam, means for effecting displacement

of the supporting member within its bearings, said supporting members being adjustable with respect to the main knife edge and means for holding said members in their adjusted position.

11. The combination in a precision balance of a supporting member for each terminal pivot point or knife edge comprising a body portion one surface of which is in the form of an arc of a circle and engages with a bearing surface carried by the balance beam, a downwardly extending projection attached to said body portion and provided with a beveled surface at its lower extremity, adjustable means cooperating with the beveled portion for effecting a displacement of the supporting member and means for varying the angle of inclination of the axis of the supporting member relatively to the balance beam.

12. The combination in a precision balance of a supporting member for each terminal pivot point or knife edge formed separately from the balance beam and having a portion of its surface in the form of an arc of a circle the completed circumference of which completely surrounds the knife edge, bearing surfaces to accommodate the curved portion of the supporting member, a downwardly extending arm attached to said supporting member and projecting below the level of the upper surface of the arm of the balance beam, adjusting screws located adjacent to the lower extremity of said arm and cooperating therewith to effect a displacement in the position of the supporting member and means for simultaneously adjusting and holding the supporting member in position when the adjustment has been effected.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

ERICH SARTORIUS.

Witnesses:

T. HENDY REED,
 S. FRIBURG.