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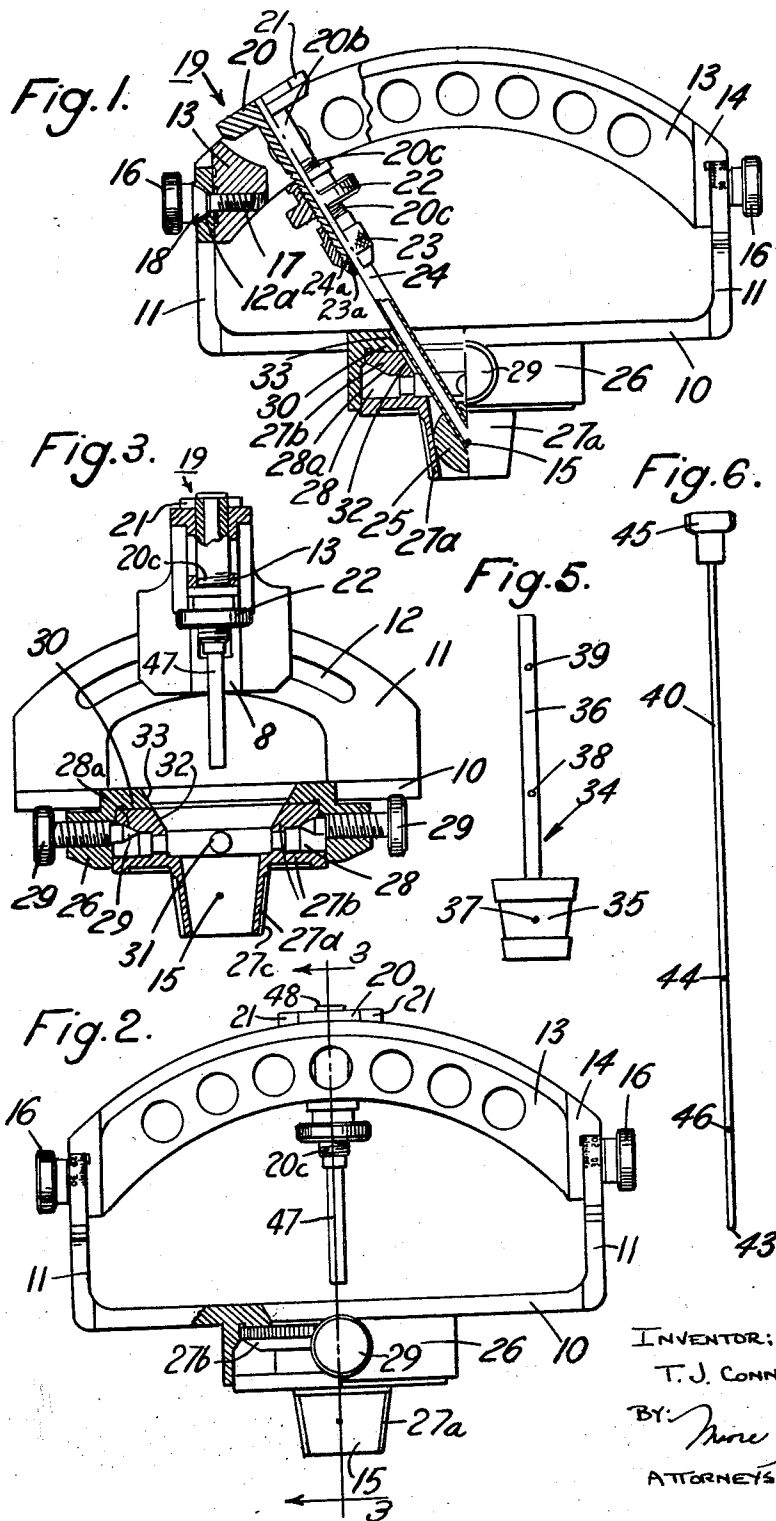
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3,135,263

SURGICAL INSTRUMENT POSITIONING DEVICE

Filed Oct. 5, 1960

3 Sheets-Sheet 1



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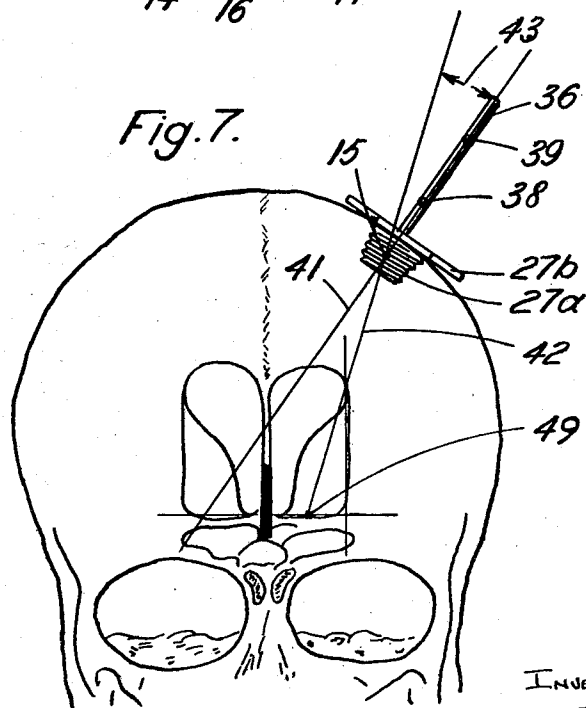
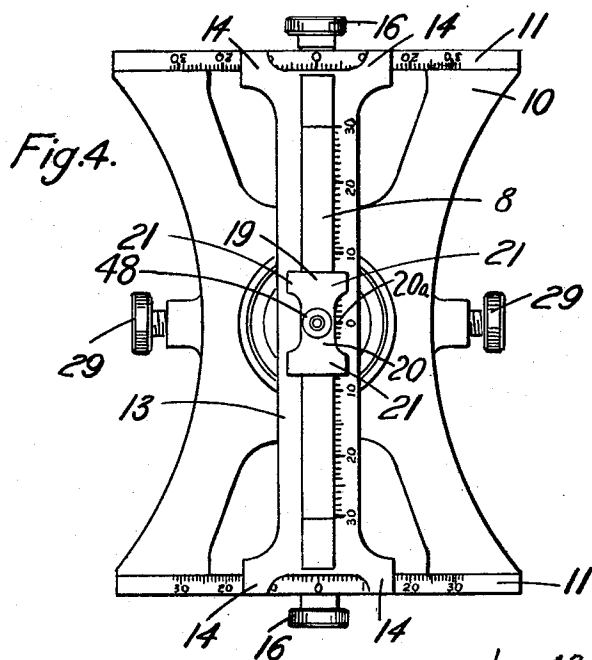
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SURGICAL INSTRUMENT POSITIONING DEVICE

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3 Sheets-Sheet 2



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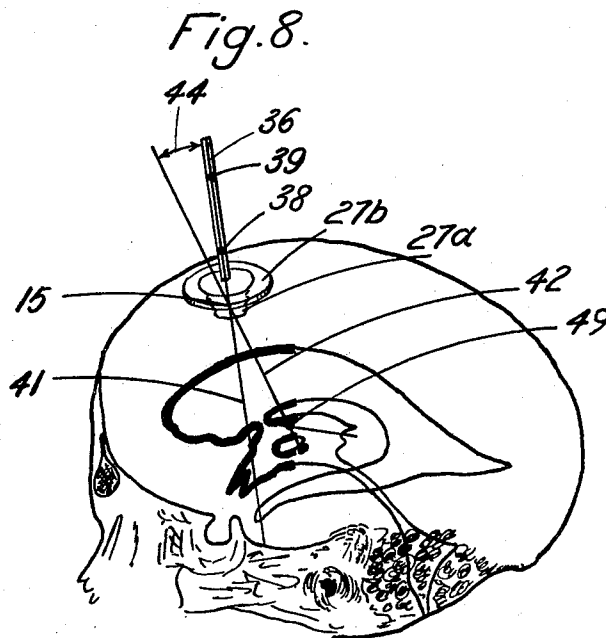
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SURGICAL INSTRUMENT POSITIONING DEVICE

Filed Oct. 5, 1960

3 Sheets-Sheet 3



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SURGICAL INSTRUMENT POSITIONING DEVICE
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3 Claims. (Cl. 128—303)

This invention relates to surgical instruments and has an important application in brain surgery, facilitating the positioning of an operating or other instrument at a precise location in the brain of the patient.

According to this invention there is provided a surgical instrument comprising a frame, a carrier or guide for an operating or other implement so mounted on the frame as to have components of arcuate movement about two axes which intersect one another at right angles and the longitudinal axis of which implement carrier or guide passes through the point of intersection of said axes.

In one construction said frame affords a first arcuate guideway which constitutes a part of said frame, a first guided member in said guideway and constituting a second arcuate guideway, a second guided member in the latter guideway and which second guided member constitutes a third guideway for an operating or other implement and which arcuate guideways are struck respectively about two axes which intersect one another at right angles and the longitudinal axis of the third guideway intersects the point of intersection of the first said two axes.

Preferably graduated scales are provided along the length of the first and second said guideways and the guided members are provided with marks respectively cooperating with the scales. Preferably means is also provided for clamping the guided members in desired positions along their scales.

In one arrangement, the frame is provided with means for universally mounting the guideway for the operating or other instrument pivotally about the point of intersections of the aforesaid axes.

In one preferred arrangement the first guideway is duplicated so as to provide similar and parallel arcuate guideways and the first guided member bridges the gap between these guideways parallel and has parts slidably engaging therein.

The frame may comprise a plate member having a pair of upstanding flanges in which said parallel guideways are respectively formed and having secured thereto detachable means for engagement with a member for locating the instrument as a whole relative to the part of the body to be operated on. The member for locating the instrument may comprise an annular threaded hollow tapered plug through which the said operating or other instrument can extend, and the plug may have one or more pairs of holes for insertion of a removable rod which slides through aligned pairs of holes to provide a positioning lever for rotating the plug and is known as a tommy-bar.

There may be associated with said radially extending third guideway a reference gauge formed with two marks spaced apart a predetermined distance along the axis of the guideway and of such a character as to show in an X-ray photograph when the instrument is on the head of the patient.

One embodiment of the invention will now be described by way of example as applied in a surgical instrument for use in operations on the brain, and the description makes reference to the accompanying drawings in which:

FIGURE 1 is a part-sectional front element of the instrument;

FIGURE 2 is a similar view to FIGURE 1 but show-

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ing a different type of guide tube and omitting the universally mounted focalising unit;

FIGURE 3 is a section on the line 3—3 of FIGURE 2;

FIGURE 4 is a plan view of the instrument shown in FIGURE 3;

FIGURE 5 shows a reference gauge for use in the instrument;

FIGURE 6 shows a depth gauge for use in the instrument; and

FIGURES 7 and 8 are diagrammatic representations of X-ray photographs taken of the reference gauge in position in the skull.

Referring to the drawings the instrument comprises a super-structure made up of a plate 10 provided with upstanding end flanges 11 in which are cut parallel arcuate slots affording guideways 12. An arcuate guided member in the form of a part circular bridge 13 spans the gap between the flanges 11 and has parts mounted in the guideways 12 and affords along its length a second arcuate guideway 8 in which slides a carrier or guide 19 for an operating or other instrument, the arrangement being such that the arcuate slots 12 and the arcuate guideway 8 are struck respectively about two axes which intersect one another at right angles at a focal point 15 which is located within a plug 27a on which the plate 10 is supported.

The part circular bridge 13 is provided with lugs 14 at its extremities which lugs overlie the flanges 11. Between the lugs 14 at each end of the bridge, a bight is cut away as shown in FIGURE 4 so that a scale marked in degrees on the part circular upper surface of the flanges 11 can be seen, and a mark to co-operate with the scale is provided in the bight at each end of the bridge and on the lengthwise line of symmetry of the bridge piece.

The part circular bridge 13 is substantially of T-section bent in an arc of a circle which is centred at the focal point 15. The part circular bridge can be clamped in any desired position relative to the guideways 12 by knurled wheels 16 which are engaged on studs 17 screwed into the ends of the part circular bridge piece 13. The wheels 16 are provided with frusto-conical end portions 18 which engage in correspondingly chamfered outer edge portions 12a of the slots 12.

The part circular bridge 13 is formed with a central slot along its length extending through the leg of the T section which slot forms the second guideway 8 and mounted in the slot is a guided member constituting a carrier 19 for the operating or other instrument. The carrier comprises a T-shaped saddle piece 20 as viewed in side elevation, the cross piece of the T extending lengthwise of the guideway 8 and being provided with lugs 21 which contact the top surface of the bridge piece, and a zero mark 20a (FIGURE 4) is provided on one side face of the saddle piece to co-operate with a scale marked in degrees on the top surface of the bridge piece. Part 20b of the leg of the T-piece 20 lies in the guideway 8 and is provided with flats on its sides preventing rotation of the T-piece in the guideway, and the lower end 20c of the T-piece extends below the lower edge of the guideway, is of reduced diameter and is screw threaded to receive a clamping nut 22 provided with a knurled head which nut engages the end of the leg of the T-section part bridge 13. The saddle piece 20 is provided with a central drilling along its length and in the arrangement shown in FIGURE 1 a continuation of the drilling is provided by a tubular locating element 24 which is held in abutment with the end 20c by a collar 23 threaded on the lower end 20c and having an internal shoulder 3a engaging a peripheral flange 25a on the upper end of the tube 24 and pressing it against the end of the part 20c. The lower end of the locating element 24 is held in a uni-

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versally pivoted mounting 25 which permits universal pivoting of the tube 24 about the point 15. The point 15 lies on the point of intersection of the axes about which the arcuate slots 12 and guideway 8 are struck.

In the arrangement shown in FIGURES 2 to 4 a guide tube 47 replaces the tube 24 and is inserted through the saddle piece 20 and the extension 20c of the saddle piece 20. Guide tube 47 is provided with a flange 48 at its upper end which abuts against the saddle piece. A number of such guide tubes 24 or 47 may be provided having appropriate internal diameters for implements to be passed through them such as the depth gauge and cannula hereinafter referred to.

The scales marked on the flanges 11 and on the bridge piece 13 enable the angular position of an instrument carried by the guide tube 24 or 47 to be defined in two planes at right angles to one another and the position of the tip of the instrument to be defined uniquely by the readings of the two scales.

The frame 10 affords in the base portion between the two flanges 11 a central boss 26 in which is detachably secured means for locating the instrument as a whole relative to the skull of the patient. The locating means comprises an annular member 27 comprising a tapered plug portion 27a the outer surface of which has cut into it a screw thread 27c which is interrupted by grooves 27d extending at right angles to the thread in the manner of a screw cutting tap. The threaded plug is integral with a flange portion 27b which is of greater diameter than the plug and which is secured to the boss 26 as set out below. The flange is provided with a peripheral slot 28 the upper surface 28a of which is chamfered and is engaged by the conical ends of a pair of set screws 29 engaged in threaded holes in the boss 26, so that by screwing the set screws inwards the flange 27b is urged firmly into engagement with a shoulder 30 formed in the boss 26. Set screws 29 provide an adjustment through 360° between boss 26 and annular member 27 together with the sub-assemblies mounted thereon. The shoulder 30 and flange 27b present a relatively large area of contact and provide a firm, smoothly adjustable mounting with great stability and accuracy for positioning the cannula 44. Annular chamfered surface 28a and set screws 29 allow a nice angular adjustment by providing the desired amount of friction between shoulder 30 and flange 27b during the final stages of angular adjustment before the flange 27b is seated firmly against shoulder 30 by further tightening of set screws 29 against chamfered annular surface 28a on flange 27b. Four radial holes 31 are drilled in the bottom of the groove 28 to provide two alternative positions for a tommy-bar. The internal surface of the threaded plug 27a is conical, and the internal surfaces of the flange 27b and the boss 26 are chamfered at 32 and 33 so as to provide a clearance for the guide tube 47 when the member 19 and the bridge piece 13 are at their respective limits of travel.

FIGURE 5 shows a neutral reference gauge 34 comprising a frusto-conical portion 35 and a reference rod portion 36. The portion 35 is provided with an identical taper to that of the internal surface of the plug 27 and the point 37 on the gauge 34 is at the same level as the focal point 15 when the gauge is positioned in the threaded plug 27a. The rod portion of the gauge 34 is provided with two reference holes 38, 39 which are disposed at a distance apart equal to the distance of the hole 38 from the point 37 which is located at the focal point 15.

FIGURE 5 shows a depth gauge comprising a cannula 44 of which is insertable through the carrier 19 and guide tube 24 or 47 and is of known length according to the position of the target so that it can not quite reach the target and has a head 45 which is arrested by the saddle piece 20 of the carrier. A small hole 46 is drilled through the cannula at 2 cms. from its tip 43.

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The operation of the invention is as follows:

In use a burr hole of suitable size (16-18 mm. burr) is made at an appropriate site in the skull (say on the coronal suture 5 cms. from the midline). Ventricular detail is visualised by lumbar encephalography or by direct tap of the frontal horn through the burr hole. When sufficient detail has been obtained the threaded plug 27a is inserted into the burr hole and the tommy-bar is inserted into two of the aligned holes 31 in the flange 27b and the plug is rotated by means of the tommy-bar until the thread is securely anchored in the skull, if necessary with the assistance of the aforesaid tommy-bar which is introduced into one of the holes 31. This however, is seldom necessary. While the threaded plug 27a is being screwed into position it is advisable to keep the flange portion 27b tangential to the curvature of the head. The reference gauge (FIGURE 4) is then inserted into the threaded plug, the mating of the coned surfaces making this joint stable while the patient is positioned for X-rays. Stability, accuracy and ease of nice adjustment by small increments form important advantages of the invention. Shoulder 30 is fitted over annular member 27 with its tapered plug portion 27a now firmly positioned on the patient's skull where it is threaded in place. Set screws 29 are advanced until they bear against annular chamfered surface 28a and cause flange 27b to engage shoulder 30 with enough friction that although they may be moved relatively with ease, they tend to maintain a given relative position pending final fine adjustment. When the exact relative angular position of shoulder 30 plus the guideway superstructure carried thereby is achieved, set screws 29 are tightened and clamp shoulder 30 and flange 27b firmly together. This clamping action is achieved without any angular displacement. It will be appreciated that in operations requiring the delicacy of brain surgery, smooth operation of the structure is vital to achieving the required accuracy of positioning the cannula 44. Once positioned, stability becomes a prime requisite to the maintenance of the necessary accuracy. This above adjustment may be repeated and rechecked many times to achieve the desired results.

The patient is placed supine, with the sagittal plane of the head as close to the vertical as can be achieved by the eye. Lateral and antero-posterior films (X-ray) are taken, using the longest tube-film distance that can be obtained conveniently. These films are developed and dried. Diagrammatic reproduction of such films are shown in FIGURES 7 and 8. Taking each X-ray film individually the target point 49 is plotted from the usual landmarks. The reference rod 36 shows on the films and its direction is continued down as a fine pencil or scratch line 41 into the skull space. The two holes 39 and 38, drilled into the rod are visible on the films, and the distance between these is measured with calipers. An equal distance from the lower hole 38, downwards along the line of the reference rod will determine the aforesaid focal point 15. If a short tube-film distance has been used a correction will have to be made for magnification error. By drawing a line 42 from the target point 49 to the point 15 an angle of correction 43 can be measured between this line and the line of the reference rod 36. A similar angular measurement 44 is made from the X-ray film in the other plane.

When the angles have been determined the reference gauge 34 is removed from the member 27 and the superstructure is set up on an adjacent table. By moving the carrier 19 to an appropriate position one of the angles e.g. the angle 43 is set on the bridge piece 13 taking care that the angle is made in the correct direction, i.e. either towards or away from the midline of the head. The bridge piece 13 itself is then moved along the guideways 12 to a setting corresponding to the angle of correction 44 obtained from the other X-ray film, with the same precautions as to direction. The super-structure is now ready, and is placed in contact with the threaded plug

27a rotating on the flange portion 27b until each angle is in what is judged to be the correct plane appropriate to the directions from which the X-ray photographs were taken. The thumb screws 16 are then tightened. Thus one of the arcs, say the bridging arc, should be set parallel to the sagittal plane of the head, the other being parallel to the coronal plane.

In order to check the correctness of the setting and to determine the length of the cannula to be used in the operation the depth gauge 44 (FIGURE 6) with its guide tube 24 or 47 is fitted into the carrier 19 and passed on into the brain; it will be in the direction of the target point 49 but will fall somewhat short of that point, usually by 2-3 cms. Further X-ray photographs in the two planes are required at this stage, both as a check on the direction and to show the position of the hole 46 which is drilled 2 cms. from the end of the gauge. Good quality X-rays are necessary and it is advisable to rotate the depth gauge before each film is exposed, until the hole 46 is so aligned that it will most clearly show. When these films are developed the accuracy of the siting of the carrier can be checked. If no further corrections are necessary the distance from the end of the depth gauge to the target point is measured from the films. The reduction factor, to discount magnification error is obtained by measuring from the films the distance between the hole 46 and the end of the gauge, a distance which is known in fact to be exactly 2 cms. By this means there can be calculated how much longer than the depth gauge a cannula would have to be to just reach the target point.

The depth gauge and its guide tube 47 is removed from the carrier and a cannula, or electrode with its guide tube are inserted so that the former may be passed the required distance into the brain. Then the lesion is made by whatever method is favoured.

While there have been described above what are presently believed to be the preferred forms of the invention, variations thereof will be obvious to those skilled in the art and all such changes and variations which fall within the spirit of the invention are intended to be covered by the generic terms in the appended claims, which are variably worded to that end.

I claim:

1. An instrument for use in brain surgery comprising a threaded hollow plug having a flange portion for assemblage in a hole formed in the skull of a patient, said threaded plug being the sole support for the instrument holder on the patient's head and serving to establish a first axis passing through the center of said hollow plug longitudinally thereof, first and second guideways extending at a selected angle with respect to each other in accordance with a selected set of coordinates, means for detachably securing said first guideway on said flange portion so that said first guideway is rotatably adjustable with respect to said hollow plug about said first axis, said first guideway establishing a second axis and constructed to constrain said second guideway to swing about said second axis, said second guideway establishing a third axis, an instrument holder movably mounted on said second guideway, said second guideway being constructed to constrain said instrument holder for movement about said third axis, said second and said third axes intersecting each other and said first axis, said in-

strument holder being constructed to direct an instrument through said hollow plug along a line passing through the skull of a patient and the direction of which in space relative to said axes can be definitely determined and maintained with precision, said means for detachably securing said guideways on said flange portion for rotatable adjustment through substantially 360 degrees, comprising surface means having a large area contact with said flange portion and means varying the frictional engagement between said surface means and said flange portion and for clamping said surface means and said flange portion together without relative angular displacement thereof to provide smooth, accurate, incremental, highly stable adjustment of said instrument holder in space relative to said selected set of coordinates.

2. A surgical instrument according to claim 1 wherein the first guideway fixed to said hollow plug is arcuate and said second guideway comprises a part which engages and slides around the first arcuate guideway and is itself formed with a second arcuate portion and wherein the implement holder is provided with a part which engages and slides around the second arcuate guideway and is also formed with a rectilinear guide for said instrument.

3. A surgical instrument according to claim 1 wherein the first guideway fixed to said hollow plug is arcuate and said second guideway comprises a part which engages and slides around the first arcuate guideway and is itself formed with a second arcuate portion and wherein the implement-holder is provided with a part which engages and slides around the second arcuate guideway and is also formed with a rectilinear guide for said instrument and wherein graduated scales are provided along the length of the first and second said arcuate guideways and the guided parts are provided with marks respectively cooperating with the scales, said surface means comprising a boss having shoulder means recessed for receiving said flange portion and bearing there against, said means for varying the frictional engagement and clamping comprising an annular chamfered surface on the under side of said flange portion and a plurality of set screws mounted in the periphery of said boss for forcing said flange portion against said shoulder means whereby the frictional engagement therebetween is nicely controlled and said boss and said flange portion can be clamped together in a precise positioned relation.

References Cited in the file of this patent

UNITED STATES PATENTS

1,093,112	Clarke	Apr. 14, 1914
2,697,433	Zehnder	Dec. 21, 1954
3,016,899	Stenvall	Jan. 16, 1962
3,017,887	Heyer	Jan. 23, 1962
3,053,256	Cooper et al.	Sept. 11, 1962
3,055,370	McKinney et al.	Sept. 25, 1962
3,061,936	De Dobbeleer	Nov. 6, 1962

FOREIGN PATENTS

240,542	Switzerland	Apr. 16, 1946
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OTHER REFERENCES

Text, "Neurological Alleviation of Parkinsonism," by Irving S. Cooper, 1956, pages 70, 71 and 72 relied upon. The Lancet, August 23, 1958, page 401 required.