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A reclinable chair

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ABSTRACT

A chair having (10) includes a supporting frame (20,22) and a main support supported by the supporting frame. A seat portion (14) is supported above the supporting frame. A reclinable back portion operably connected with the main support for reclining action relative to the main support. A first recline spring (95) has an elongate spring portion having dimensions of length, width and thickness, wherein the width is greater than the thickness and further having a longitudinal axis aligned with the length of the elongate spring portion. The recline spring operably connected between the main support and the reclinable back portion (16) for resisting reclining action of the back portion through bending about an axis transverse to the longitudinal axis. The first recline spring (95) is rotatable about the longitudinal axis to adopt any one of a plurality of spring positions, at each of which the spring portion exhibits a differing spring rate in resistance to bending about the transverse axis.

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COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

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Invention Title:	A RECLINABLE CHAIR

The following statement is a full description of this invention, including the best method of performing it known to me/us

A RECLINABLE CHAIR

Field of the Invention

The present invention relates to a reclinable chair. In particular, although not exclusively, the invention relates to a synchro-tilt type chair in which the seat portion tilts rearwardly in synchronism with reclining action of the back portion. The invention is described primarily in the context of commercial office chairs. However, the invention is not limited in its application to commercial office chairs and may have application to any other type of seating such as public seating for theatres, aircraft or domestic seating.

Background to the Invention

Reclining office chairs are well known. There are certain disadvantages associated with the conventional form of reclining office chair. One of the disadvantages is that as the occupant of the chair reclines rearwardly, his head drops in height. Therefore, the eye level of the chair's occupant will not be maintained constant. This may pose a difficulty if the occupant is working at a computer terminal where it is desirable to maintain a constant eye level relative to the screen. Additionally, in meetings it is also desirable to maintain a constant eye level relative to the other attendees of the meeting. Any person who undergoes a dip in eye level may effectively drop out of the conversation.

Another difficulty with conventional reclining chairs is that relative movement between the back portion and the seat portion may lead to frictional grabbing of occupant's shirt, thereby pulling out the occupant's shirt from his trousers.

US Patent No. 5,871,258 is in respect of a reclining office chair. The seat portion of the chair has a front portion connected to a rear portion by a resilient section in order that the rear portion carries most of the occupant's weight. The seat portion is operably connected to the reclining mechanism such that as the back portion reclines, the rear portion of the seat also tilts but additionally moves in a downward and forward motion. It will be appreciated that this further only serves to exacerbate the problem of tipping eye level. In this case, not only is the occupant's head dropping on account of their reclining action but also, the rear portion of the seat supporting the occupant's weight is also moving downwardly, with the practically certain result that the eye level of the occupant will dip during reclining action.

US Patent No. 5,314,237 raises the vertical height of the seat support during recline and thereby claims to achieve consistent vertical eye level. However, the chair disclosed in this US patent suffers from another shortcoming. As the seat portion lifts, the forward edge of the seat portion will accordingly be raised and thereby act as a hard edge bearing against the back of the occupant's knees. This can lead to circulatory problems for the occupant and/or lifting of the users feet from the floor with consequent poor posture.

Flexing of seat backs in the lumbar region of the user is also a desirable feature of modern office chairs. Chair occupants come in a wide range of different sizes and weights and it is therefore necessary for chair manufacturers to produce a chair which caters for a wide range of occupant sizes and weights. A larger, weightier person will be able to flex a chair back easily. On the otherhand, a person of light build may only be able to flex the back portion with a high degree of force. Accordingly, a person of light build may not receive much satisfaction from the feature of a flexible back portion.

Another common feature of reclinable chairs is the use of recline springs to resist rearward recline. Adjustment mechanisms are often provided to adjust the spring tension of the recline springs to suit the build of the occupant of the chair. Where such adjustment mechanism operate directly against the action of the spring eg by way of a rotatable knob, generally a large number of turns of the knob are required in order to gradually stiffen the spring. Otherwise, the knob would be too stiff to turn in order to bring about the required adjustment.

It is therefore an object of at least preferred embodiments of the present invention to provide a chair which overcomes or at least addresses some of the foregoing disadvantages, or which at least provides the public with a useful choice.

Summary of the Invention

The reader is also referred to our divisional specification number 65654/01.

The term "comprising" as used in this specification and claims means "consisting at least in part of"; that is to say when interpreting statements in this specification and claims which include "comprising", the features prefaced by that term in each statement all need to be present but other features can also be present. Related terms such as "comprise" and "comprised" are to be interpreted in a similar manner.

Described herein is a chair comprising: a supporting frame; a seat portion which is foldable about a transverse fold to define a rearward portion behind the transverse fold and a forward portion, forward of the transverse fold, the seat portion being supported above the supporting frame by its rearward portion; a reclinable back portion; and a recline mechanism with which the back portion is connected for reclining action of the back portion, the recline mechanism being operably linked to the rearward portion of the seat portion such that on reclining action of the back portion, the rearward portion is moved to increase in rearward tilt angle and to obtain a net increase in height above the supporting frame, with a consequent folding of the seat portion about the transverse fold line under the weight of the occupant.

In order to achieve a foldable seat portion, the seat portion may be flexible. The seat portion may be constructed of a resiliently flexible material such as plastic. In a preferred form of the invention, the seat portion may comprise a panel which has apertures eg slots to enhance its flexibility. The slotted pattern may extend across the entirety of the panel with a specific arrangement of slots provided to increase comfort for the seat occupant. For example, the slotted panel may have the slots arranged to accommodate the ischial protuberosities of the occupant. Alternatively, the slotted pattern may simply exist in a specific zone to provide flexing about the transverse fold. The transverse fold may be shaped as a straight line, depending upon the arrangement of the slots or apertures in the seat panel or according to the manner in which the seat portion is supported. The transverse fold may alternatively take the shape of a curve lying in the plane of the seat portion.

Where the seat portion takes the form of a panel, stiffening webs may be provided which offer little resistance to flexing towards the forward edge of the seat portion and greater resistance to flexing towards the rear of the seat portion. The resistance offered may progressively increase from the front edge of the seat portion towards the rear. Accordingly, the stiffening webs may be tapered to offer the varying resistance.

In an alternative less preferred form, the seat portion may comprise the forward portion and the rearward portion being articulated.

In a preferred form, the rearward portion of the seat portion is supported, at least in part, by the recline mechanism while the forward portion is substantially unsupported. The

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depth position of the seat portion may be adjustable relative to the back portion and/or the supporting base. Accordingly, the positioning of the transverse fold may be variable as a function of the seat depth position. For example, the seat portion may be moveable forward/backward relative to guides forming part of the recline mechanism with the forward edge of the guides or a transition in curvature defining the transverse fold. The ease of folding may be dependent upon the depth position of the seat portion. As described above, this may be achieved by the seat portion having an increased resistance to folding in the directly rearwardly from the forward edge of the seat portion.

The recline mechanism preferably interconnects the seat portion, the supporting frame and the back portion. In a most preferred form, the recline mechanism is in the form of a four bar linkage. The four bar linkage may be replicated on each side of the chair. Therefore, the following description of the four elements of the four bar linkage may apply to single elements or alternatively to duplicated elements on opposite sides of the chair. The first linkage is in the form of a main support. The main support may be selectively height adjustable by the user. However, the main support is in normally fixed disposition relative to the supporting frame. In the most preferred form, the main support is supported at the top of a height adjustable gas spring extending upwardly as part of the supporting frame.

The second linkage of the four bar linkage may be the seat portion itself. Where the seat portion is depth adjustable, then the second linkage may comprise a guide for the depth adjustment.

The third linkage of the four bar linkage preferably comprises a front support linkage extending between the main support and the second linkage.

The fourth linkage is preferably in the form of a drive linkage which is pivotable about a drive axis through the main support, being connected to the second linkage and being operably linked to be driven about the drive axis by rearward recline action of the back portion.

Preferably, the back portion is also supported from the main support. The back portion is preferably attached to a back attach portion which is pivotally connected to the main support at a recline axis. The recline axis of the back portion is preferably below the seat portion. In a most preferred form, the recline axis is below the ischial protuberosities of the occupant.

Preferably, the back portion is biased against reclining action by a recline biasing device. This may be in the form of a one or more springs. In a most preferred form, the biasing force is adjustable. In a preferred embodiment there may be two back extension arms extending from the back portion. These extension arms could be an integral part of the back attach portion or alternatively could be rigidly connected thereto. With the two extension arms pivotally connecting the back portion to the main support, the one or more springs are preferably held by one or both of the back extension arms, with the spring(s) acting against the main support.
Preferably there are two springs in the form of leaf springs. Preferably, the first spring has a predetermined spring rate (or spring constant). The second spring may be clamped against the first spring with the combination having a resultant spring rate with the degree of clamping being variable to adjust the resultant spring rate. Preferably, the second spring has a high spring constant in its unclamped state in order that only a small clamping adjustment is required to bring about an appreciable change in the resultant spring rate of the combination.

One or more recline abutment surfaces may define the recline limit of the back portion. Preferably, the recline abutment surfaces are provided on one or both of the back extension arms and the main support.

Furthermore, there may be provided one or more forward abutment surfaces which define the forward position of the back portion. Preferably, the forward abutment surfaces are disposed on one or both of the back extension arms and the main support. In a most preferred form, one or both of the back extension arms include a pin which travels within a slot of the main support. The slot has a base which engages against the pin when the pin reaches a position of travel within the slots corresponding to the forward position of the back portion. Additionally, cushioning may be provided to cushion the abutment between the forward abutment surfaces. This may comprise an O-ring encircling the pin.

Desirably, a recline lock is provided, to lock the back portion against reclining action. The recline lock may be selectively lockable by the user. In a preferred form, the recline lock acts against a lock abutment surface on one or both of the back extension arms. Preferably, the recline lock is in the form of a push rod/bar which, when selectively operated by the user acts against the lock abutment surfaces of both extension arms at the same time.

Another preferred feature is that the back portion is flexible or at least flexible at a part corresponding to the lumbar region of the occupant. Preferably the flexibility ie the stiffness is adjustable. The flexibility may be adjustable selectively, although it is preferred that the adjustment takes place automatically in response to the weight imparted by the occupant on the seat portion. Preferably, the larger the weight, the greater the stiffness imparted to the back portion.

Preferably, the adjustment can be achieved through the use of a tensionable biasing device provided to act against the flexible back portion, with a varying degree of tension to impart a varying degree of stiffness to the back portion. For example, the biasing device may be in the form of a spring. Preferably, there are two flat springs lying against the back portion at a lower region thereof adjacent the connection of the back portion to the back attach portion.

Preferably, the tensioning of the biasing device is achieved by means of an interconnecting linkage which in response to the occupant's weight on the seat portion, tensions the biasing device by a corresponding amount. Preferably, the interconnecting linkage interconnects the biasing device with the drive linkage. In a most preferred form, where the biasing device is in the form of a leaf spring lying against the back portion, the leaf spring is connected to a spring carrier forming part of the interconnecting linkage, the spring carrier being pivotally mounted to the back attached portion in a manner whereby the weight of the occupant on the seat portion is transferred through to the spring carrier so as to bend the leaf spring against the back portion. As there may be two four bar linkages provided on opposite sides of the chair, there may accordingly be provided two interconnecting linkages with two spring carriers receiving two leaf springs. The back portion may include a back frame which, in its lower regions defines a rearwardly facing channel. Preferably, each leaf spring engages within the channel on a respective side of the back frame. Preferably, each interconnecting linkage also includes two push links, each interconnecting the associated spring carrier with the associated drive linkage. The back attach portion may be in the form of a housing ie the back attach housing. The spring carrier(s) and the push link(s) may be at least partly received within the back attach housing. Each leaf spring and associated spring carrier may be of integral construction.

The supporting frame may be of any type. Preferably, the supporting frame is of the conventional type with a central support and a plurality of radiating legs with castors. The

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supporting frame may incorporate a height adjustable gas spring.

A tension limit may be provided to prevent over-tensioning of the tensionable biasing device. For example, rotation of the spring carrier may be stopped against the back attach housing.

Described herein is a chair having: a supporting frame; a seat portion supported above the supporting frame; and a back portion having a flexible portion, wherein the flexibility of the flexible portion is adjustable as a function of the weight of an occupant on the seat portion.

The seat portion and the back portion could be integral or alternatively could be discrete portions of the chair. Preferably, a recline mechanism is provided which interconnects the seat portion, the back portion and the supporting base.

The flexibility of the flexible portion may be adjustable by way of a stiffness adjustment device. This may be in the form of a tensionable biasing device. The tensionable biasing device preferably acts against the flexible portion to impart stiffness thereto with the tension of the biasing device being adjustable as a function of the weight of an occupant on the seat portion. The tensionable biasing device may be interconnected by a means of an interconnection with the seat portion, the seat portion being moveable on the application of weight from an occupant whereby the weight of the occupant acts through the interconnection to adjust the biasing device as a function of the weight of the occupant. Preferably, the interconnection comprises a series of links to transfer the weight of the occupant into increased tension of the biasing device. Preferably, the biasing device is in the form of one or more springs such as leaf springs and the interconnecting linkage acts to bend the one or more springs against the flexible portion of the back, thereby increasing the stiffness of the flexible portion.

In a most preferred form, the interconnection includes a four bar synchro-tilt mechanism which tilts the seat portion synchronously with back recline. The four bar synchro-tilt mechanism may take the form of the four bar linkage described above. The drive link of the four bar linkage may be connected to a push link which is in turn connected to a spring carrier as described above.

A tension limit may be provided to prevent over-tensioning of the tensionable biasing device. This may be in the form of a physical stop which acts against the spring carrier.

Described herein is a chair having: a supporting frame; a main support supported by the supporting frame; a seat portion supported above the supporting frame; a reclinable back portion operably connected with the main support for reclining action relative to the main support; a first recline spring operably connected between the main support and the reclinable back portion for resisting reclining action of the back portion; and a second recline spring operably connected between the main support and the reclinable back portion; the second recline spring being selectively adjustable to impart a varying amount of resistance to the reclining action of the back portion.

The resistance imparted by the second spring may be adjustable between a nil amount and a predetermined amount.

The first recline spring may be in the form of a leaf spring or spring bar. The second recline spring may also be in the form of a leaf spring or spring bar. The leaf springs may be flat or bent. Preferably, the first leaf spring is substantially flat when untensioned, although desirably the first leaf spring is pretensioned into a curved configuration in order to provide an initial resistance to reclining action. A forward limit may be provided to define the forward active position of the back portion. The first recline spring and selectively the second recline springs bias the back portion into the forward active position. Additionally, a rearward recline limit may also be provided to define the rearmost position of the back portion.

In one form, the adjustment device brings about adjustment of the length of the second leaf spring. Alternatively, the adjustment device may bring about adjustment of the curvature of the second leaf spring. This may be achieved by way of a cam having a cam surface bearing against the second spring, the position of the cam being moveable to adjust the curvature of the second spring. Preferably, the cam is pivotable about a pivot axis with the cam surface including a plurality of distinct portions of progressively increasing distance from the pivot axis in either a clockwise or anticlockwise direction. The cam surface may also include a stop to limit rotation of a cam about the pivot axis.

The first and second springs may be spaced from each other and may operate independently of each other. However, in a most preferred form of the invention, the first and second springs lie against each other for at least a portion of the length of the springs.

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In this form, the cam may be incorporated into a clamp to clamp the second recline spring against the first recline spring.

The main support may be in the form of a transversely extending main transom. Furthermore, the back portion may include two spaced arms pivotally mounted to the main transom. In this form of the invention, preferably the first leaf spring extends between the two spaced arms and bears against the side of the main support to bias the back portion against reclining action. The ends of the first leaf spring may be received in aligned, facing slots in each arm. Preferably, the second spring is shorter than the first spring with one end being received in one of the slots.

In addition to the action of the first and optionally second recline springs, the back portion may be operably connected to the seat portion whereby the weight of the occupant resists reclining action of the back portion. This may be achieved by way of a four-bar linkage supporting the seat portion with the back portion being operably connected to the four-bar linkage so that reclining action of the back portion brings about a net increase in height of the seat portion.

As claimed herein, in accordance an aspect of the present invention there is provided a chair having: a supporting frame; a main support supported by the supporting frame; a seat portion supported above the supporting frame; a reclinable back portion operably connected with the main support for reclining action relative to the main support; a first recline spring comprising an elongate spring portion having dimensions of length, width and thickness wherein the width is greater than the thickness and further having a longitudinal axis aligned with the length of the elongate spring portion, the recline spring being operably connected between the main support and the reclinable back portion for resisting reclining action of the back portion through bending about an axis transverse to the longitudinal axis, wherein the first recline spring is rotatable about the longitudinal axis to adopt any one of a plurality of spring positions, at each of which the spring portion exhibits a differing spring rate in resistance to bending about the transverse axis.

The back portion may be reclinable between a forward active position and a rear most position. For this purpose, a forward limit may be provided to define the forward active position and a rearward recline limit may also define the rear most position. In recline action, the main support and the back portion move relative to each other. The first recline spring may be arranged such that as the main support and the back portion move

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relative to each other, they bear against the first recline spring, tending to flex the elongate spring portion about the transverse axis thereby biasing the back portion toward the forward active position through the inherent resistance of the spring. However, at the forward active position, the arrangement may be such that the main support and the back portion exert no pretension on the first recline spring. This enables the first recline spring to be easily rotated about the longitudinal axis.

In a preferred form of the invention, an intermediate portion of the first recline spring bears against the main support with an end portion of the first recline spring bearing against the back portion. In a more preferred form of the invention, the ends of the first recline spring bear against the back portion with a central part of the first recline spring bearing against the main support. More specifically, the main support may be in the form of a transversely extending main transom. Furthermore, the back may include two spaced arms pivotally mounted to the main transom. In this form of the invention, the first recline spring may extend alongside the main transom with the two ends journaled in each arm and with a central part of the first recline spring bearing against the main transom. However, the invention is not limited to such an arrangement. It is conceivable that in an alternative arrangement the two ends of the first recline spring could be rotatably journaled in the main support with an intermediate part bearing against the back portion.

Preferably, the elongate spring portion of the first recline spring is in the form of a flat bar which may be rotated about its longitudinal axis. It will be appreciated that the flat bar can be rotated into a number of positions. There may be three positions, the first with the width dimension of the flat bar arranged to be substantially aligned with the transverse bending axis. This exhibits an easy resistance to bending. In a second adoptable spring position, the flat bar may be arranged with its width dimension diagonally to the transverse bending axis. This exhibits a medium resistance to bending. In a third adoptable position, the width of the flat bar is arranged transverse to the bending axis. With the whole of the width resisting bending, this correlates to the hardest spring position.

The spring portion is not limited to being in the form of a flat bar and other cross-sections are possible including elliptical or oval cross-sections. There may be more than one elongate spring portion incorporated into the first recline spring.

Where the first recline spring bears against the back portion and the main support, cylindrical bosses may be incorporated into the first recline spring. For example, the ends

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of the first recline spring may be fitted with cylindrical bosses to be journaled in the arms of the back portion. Similarly, a cylindrical boss may also be provided at an intermediate portion of the first recline spring where the first recline spring bears against the main support. In this connection, the main support may also incorporate a bearer against which the cylindrical boss bears. This may be in the form of a complementary bore or recess. In particular, the main support may have a rearward extension which preferably incorporates a semi-cylindrical recess to accommodate the central cylindrical boss of the first recline spring.

The first recline spring may be integrally formed with the spring portion(s) and the cylindrical boss(es). However, most preferably the bosses slide onto the spring portion.

Furthermore, the invention may include an actuator to selectively rotate the recline spring. The actuator may be in the form of a paddle

Advantageously, locators are also provided to define each of the plurality of adoptable spring positions. The spring positions may be defined by complementary projections and detents provided in one or more of the cylindrical bosses and the corresponding bearer. For example, grooves may be provided in the central cylindrical boss with a rib provided in the bearer, the engagement between the rib and each one of the grooves defining each of the adoptable spring positions.

The invention may also provide a second recline spring. The second recline spring may be adjusted as with the first recline spring and accordingly may include all of the features described above in connection with the first recline spring. However, in a most preferred form of the invention the second recline spring is non-adjustable. Preferably, the arrangement is such that the second recline spring has a pre-load in the forward active position. The second recline spring may be already bent or flexed to achieve the pre-load. The second recline spring may extend alongside the first recline spring. The second recline spring may be journaled in a similar fashion as described above for the first recline spring. The second recline spring may be in the form of flat bar. However, in a preferred form of the invention, the second recline spring is in the form of a rod, preferably a cylindrical rod.

In addition to the action of the first and optional second recline springs, the back portion may be operably connected to the seat portion whereby the weight of the occupant assists

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in resisting reclining action of the back portion.

The invention consists in the foregoing and also envisages constructions of which the following gives examples.

Brief Description of the Figures

In order that the invention may be more fully understood, one embodiment will now be described by way of example with reference to the Figures in which:
Figure 1 is a perspective, partially exploded view of a chair in accordance with a preferred embodiment of the present invention;
Figure 2a is an exploded perspective view of a back portion of the chair shown in Figure 1;
Figure 2b is a perspective view of a back attach casting forming part of the back portion of the chair illustrated in Figure 2;
Figure 3 is an assembled view of a lower portion of the back portion of the chair illustrated in Figure 2;
Figure 4 is a perspective view of a main transom of the chair of Figure 1;
Figure 5 is a perspective view of the assembled chair from the underside of the main transom illustrated in Figure 4;
Figure 6a is a perspective view of the assembled chair looking down upon the main transom illustrated in Figure 4;
Figure 6b illustrates an adjustable clamp;
Figure 6c is a plan view of the cam for the adjustable clamp;
Figure 7 is an enlarged perspective view of a portion of the main transom illustrated in Figure 4;
Figure 8 is a perspective view of the chair of Figure 1 from the underside with the main transom removed, illustrating certain components of a recline lock;
Figure 9 is a graph illustrating the change in resistance to backward recline achievable by the adjustable clamp illustrated in Figures 6a-6c;
Figure 10 is a perspective view of a control lever for the recline lock;
Figure 10a is a perspective view of a modified form of the back extension arm;
Figure 10b1 is a perspective view of a modified form of the transom from above;
Figure 10b2 is a perspective view of a modified form of the transom from below;
Figure 10c is a perspective view illustrating the modified form of the back extension arm of Figure 10a in assembly with the modified form of the main transom of Figure 10b;

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Figure 10d is a perspective view of a modified form of a first recline spring;
Figure 10e is a perspective view illustrating the first recline spring of Figure 10d in assembly with the back extension arms and the main transom together with a second recline spring;
Figure 10f is a diagrammatic illustration of a first adoptable position of the first recline spring;
Figure 10g is a diagrammatic illustration of a second adoptable position of the first recline spring;
Figure 10h is a diagrammatic illustration of a third adoptable spring position of the first recline spring;
Figure 10i is a perspective view similar to Figure 10e with the first recline spring in the third adoptable spring position;
Figure 10j is a diagrammatic view illustrating engagement between a part of the first recline spring and a part of the main transom;
Figure 10k is a graphical illustration of the change in spring constant as the first recline spring is rotated through the three adoptable spring positions illustrated in Figures 10f-10h;
Figure 10l is a more detailed view of the assembly as in Figures 10e and 10c, with additional parts removed for clarity;
Figure 10m is a further perspective view of the modified form of the back extension arm 70' of Figure 10a, shown from another angle;
Figure 10n is a perspective view similar to Figure 10e, but showing a modified second spring;
Figure 10o is a further perspective view of a modified form of the back extension arm 70" similar to that of Figure 10a, shown from another angle;
Figure 11 is a further exploded view of parts making up the back portion;
Figure 12 is a perspective view from the rear of the assembled parts illustrated in Figure 11;
Figure 13 is a perspective view illustrating in exploded fashion, a spring carrier and a leaf spring;
Figure 14 is a perspective view of the chair from the side rear, with certain parts removed for clarity;
Figure 15a is a schematic view of the main elements of the recline mechanism of the chair;
Figure 15b is a perspective view of a seat guide, being one of the elements shown in Figure 15a;
Figure 16 is a side view of the chair illustrated in Figure 1, illustrating the arrangement of

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the main links with occupant weight applied to the seat portion;

Figure 17 is a side view as per Figure 16, except with the occupant weight removed from the seat portion.

Figure 18 is a side view of the chair of Figure 1; illustrating the recline action of the chair;

Figure 19a is a perspective view of a seat panel of the chair illustrated in Figure 1;

Figure 19b is a perspective view of the underside of the seat panel shown in Figure 19a;

Figure 19c is a plan view of the underside of the seat panel illustrated in Figure 19b;

Figure 19d is a perspective view of a detail of the underside of the seat panel illustrated in Figure 19b;

Figure 20a is a schematic longitudinal sectional view through the middle of the seat panel illustrated in Figure 19a;

Figure 20b is a schematic view of the side edge;

Figure 20c is a schematic transverse sectional view through the seat panel at approximately 150 mm forward of the rear edge;

Figure 20d is a schematic transverse sectional view at approximately 120 mm from the front edge;

Figure 20e is a schematic view of the front edge of the seat panel illustrated in Figure 19a;

Figure 21 is a perspective view of the chair with the seat panel removed to show a seat depth adjustment mechanism;

Figure 22 is a perspective view showing a detail of Figure 23;

Figure 23 is a perspective view with the seat panel removed, showing the workings of the seat depth adjustment mechanism;

Figure 24 is a side view of a portion of the chair with the seat panel in an extended position;

Figure 25 is a view of a portion of a chair illustrated in Figure 24 with the seat panel in a retracted position;

Figure 26 is an underside perspective view of the portion of the chair illustrated in Figures 24 and 25 illustrating the seat depth adjustment mechanism;

Figure 27 is a perspective view of the back portion of the chair illustrated in Figure 1 with an assembled lumbar support mechanism;

Figure 28 is a perspective view of the back portion of Figure 27, with the elements of the lumbar support mechanism illustrated in exploded configuration;

Figure 29 is a perspective view of a part of the lumbar support mechanism illustrated in Figure 28;

Figure 30 is a further view of a portion of the lumbar support mechanism illustrated in Figure 28;

Figure 31 is a plan view of a ripple strip, forming part of the lumbar support mechanism illustrated in Figure 28;

Figure 32 is a cross-sectional view of the ripple strip illustrated in Figure 31 along A-A;

Figure 34 is a cross-sectional view illustrating a modified form of the lumbar support mechanism;

Figure 35 is a perspective view of a bellows for use in the modified form of the lumbar support mechanism illustrated in Figure 34;

Figure 36 is a perspective view of a modified form of the lumbar support panel illustrated in Figure 30;

Figure 37 is a back view of the back portion of the chair illustrated in Figure 1;

Figure 38 is a cross-sectional detail through A-A of Figure 37;

Figure 39 is a perspective view of a preferred form of a wheeled base;

Figure 40 is an underside perspective view of the leg assembly forming part of the wheeled base illustrated in Figure 39;

Figure 41 is a perspective view of a castor forming part of the mobile base illustrated in Figure 39;

Figure 42 is a perspective view of an axle assembly forming part of the castor illustrated in Figure 41;

Figure 43 is a perspective view of a topper pad; and

Figure 44 is a schematic bottom view of a slightly modified form of the seat panel illustrated in Figure 19a.

Description of Preferred Embodiment

Since the Figures illustrate the chair from various different angles as convenient to explain certain parts, an arrow marked "F" has been inserted into the drawings where appropriate. Accordingly the terms forward, rearward, left side and right side should be construed accordingly.

Figure 1 illustrates an office chair 10 including a main assembly having a seat portion 14 and a back portion 16. The seat portion 14 and the back portion 16 are supported above the ground by a supporting frame including a wheeled base 18 and a central support column 20. The central support column 20 houses a pneumatic spring (not shown) for height adjustment of the seat portion 14 in conventional fashion. The pneumatic spring is connected to the main transom 22 of the chair which is illustrated in Figure 4. The main transom 22 extends transversely across the chair and is connected to the pneumatic spring

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by way of central spring connection ring 23.

Figure 1 also illustrates two detachable arm assemblies 24. The arm assemblies 24 each include an upper armrest 26 which is padded for user comfort. Each arm assembly 24 includes an upright support structure 28. The armrest 26 is mounted to the upper end of the upright support structure 28. The lower end of the upright support structure has an elongate attachment portion 30 extending inwardly therefrom at a downwardly inclined angle relative to the upright support structure 28.

The elongate attachment portion 30 is releasably engaged within one end of the main transom 22. The manner of attachment is not significant to the present invention and the reader may refer to our co-pending Australian Patent Application No. 65651/01, the details of which are incorporated herein by reference.

Back Portion

The back portion 16 is defined by a peripheral frame 34 which is approximately rectangular in shape, as shown in Figure 2. In the finished chair the peripheral frame 34 has a mesh fabric stretched over it in a manner described more fully in connection with Figures 37 and 38. Within the opening defined by the rectangular peripheral frame 34, a lumbar support mechanism 36 is provided which is described in more detail in connection with Figures 27 to 33.

Figure 2 illustrates more clearly the form of the peripheral frame 34. The peripheral frame 34 is constructed of a flexible plastics material such as injection moulded reinforced polyester. The peripheral frame 34 is of integral construction and comprises two upright members 38, a top beam 40 and a bottom beam 42. The upright members 38 are bowed with a gentle serpentine curve sweeping forwardly in the upward direction and then rearwardly beyond the lumbar region. This is a shape which is comfortable to the chair occupant. The upright members 38 include channels 44 which are open in the direction facing rearwardly as shown in Figure 12. The upright members 38 are also joined by an intermediate back beam 46. The back beam 46 supports the lumbar support mechanism 36 in a manner more fully described in connection with Figures 27 to 33.

Rigidly connected to the lower end of the peripheral frame 34 is a back attach casting 48.

The back attach casting 48 is an integrally cast component as shown in Figure 2b. The back attach casting 48 includes two pairs of sprigs 50 which engage with aligned apertures 52 provided at the bottom of the upright members 38. This enables the lower region of the peripheral frame 34 to be securely fixed to the back attach casting 48. An additional snap fitting (not shown) may be provided.

The back attach casting 48 also includes 2 pairs of opposed walls 54 on opposite sides (more clearly seen in Figure 11). Each pair of spaced walls 54 defines a forwardly extending channel 64 in which a spring carrier 60 is received. Each pair of opposed walls 54 includes aligned slots 56. The spring carrier 60 (to be described more fully in connection with Figure 11) has pins 62 on opposite sides to engage with the aligned slots 56.

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Furthermore, the back attach casting 48 includes two forwardly extending hollow projections 66. The hollow projections 66 each define a socket 68. Two back extension arms 70 are welded within respective sockets 68 of the hollow projections 66.

Referring to Figure 3 for greater clarity, each back extension arm 70 includes a forward nose portion 72 and a chin portion 74. An extension arm aperture 75 extends through the back extension arm 70 in a position rearwardly of the nose portion 72 and the chin portion 74.

Reference is now made to Figure 4 which illustrates the main transom 22 which extends transversely across the chair as already explained. The main transom 22 is supported on a pneumatic spring at central spring support ring 23. The main transom is a beam-like construction of diecast aluminium with pivot features 76 formed at opposite ends. At each end, the pivot features comprise opposed supporting webs 78. The opposed supporting web 78 have rear aligned apertures 80. In the assembled chair, the extension arm aperture 75 of one of the back extension arm is aligned with the rear aligned apertures 80 on one side of the main transom to receive a main pivot pin (not shown) therethrough. Likewise the other back extension arm 70 is pivotally attached to the main transom 22 on the other side. Each back extension arm is pivotable about the associated main pivot pin and the recline axis R of the back portion 16 is thereby defined.

Recline Limits

As mentioned above, a nose portion 72 is defined forwardly of each back extension arm 70. The nose portion 72 has two bosses 84 extending sideways from the flanks of the nose portion 72. The bosses 84 are receivable within facing slots 86 in the opposed supporting webs 78. Each of the facing slots 86 has a base formed therein. During rotation of the back extension arm 70 about pivot R, the bosses 84 move within respective ones of the facing slots 86. In the forward most position of the back portion 16 in its pivoting action about the recline axis R, the bosses 84 will bottom out at the bases of the slots 86 thereby defining forward limits. This is referred to as the "forward active position"of the back portion 16.

The chin portion 74 of each back extension arm 70 includes a first abutment surface 88 for engagement with a second abutment surface 90 provided as part of the rear wall of the main transom 22. On each side, when the first abutment surface 88 engages with the second abutment surface 90, the rearward recline limit of the back portion 16 of the chair will be thereby defined. It would not be possible for the chair portion 16 to recline back any further once the two abutment surfaces come into engagement although flexing of the peripheral frame is still possible in this position. One end of the main transom 22 illustrating the pivot features 76 in greater detail can be seen in Figure 7.

Recline Biasing Device

Referring to Figure 3 the inner flanks of the chin portions 74 of both back extension arms 70 include facing aligned slots 92, the left one of which can be seen in the Figure. A first recline spring 94 in the form of an elongate bar or leaf spring has each end received in a respective one of the facing slots 92. As shown in Figure 4, the main transom 22 has a reaction surface 98 against which the first spring 94 engages. The reaction surface 98 is centrally disposed and has a depth corresponding to the depth of the first spring 94. The reaction surface 98 forms part of an integrally formed projection extending rearwardly from the main transom 22. As the back portion 16 reclines rearwardly about the recline axis R, the first recline spring 94 engages against the reaction surface 98, thereby biasing the back portion 16 against reclining action.

A second recline spring 96 also has one end received in one of the facing slots 92. However, the second recline spring 96 is somewhat shorter than the first recline spring 94 so the second end of the second recline spring 96 is not received within the other facing slot 92 (see Figure 8). As shown, the second spring is also in the form of a elongate spring bar or leaf spring. The second spring 96 lays behind the first spring 94, against the first spring 94, for at least half the length of the first spring 94. An adjustable clamp 100 (see Figure 6b) is provided to clamp the free end of the second spring 96 against the first spring 94 and thus alter the curvature of the second spring 96 and thereby alter its spring rate. The second spring 96 is disposed such that increased clamping against the first spring will act to increase its spring rate. The net force biasing the back portion against recline will thereby be the sum of the spring force provided by the first spring 94 and the spring force provided by the second spring 96. With the second spring more tightly clamped to the first spring 94, the resultant spring rate will be higher than for a more relaxed clamping between the two springs. The first spring 94 has a factory set spring rate. The second spring 96 is selected to have a high spring rate, greater than the spring rate of the first spring 94. Thereby, a small adjustment of the clamping between the first spring 94 and the second spring 96 will bring about an appreciable change in the spring rate of the second spring 96. The clamping of the two springs may also have an affect on the spring rate of the first spring 94.

The adjustable clamp 100 is illustrated in Figure 6b. The adjustable clamp 100 includes a U-shaped bracket 101 which extends around the two recline springs 94, 96. A cam 102 is mounted on axle 103 extending between the two legs of the U-shaped bracket 101. The axle 103 is journaled for rotation about an axis 104. The cam 102 includes four cam surface portions 105a, 105b, 105c and 105d as shown in Figure 6c. The cam surface portions are substantially flat as indicated and each is spaced a different amount from the cam axis 104. The spacing decreases in the clockwise direction around the cam 102 from 105a through to 105d. The cam 102 bears against the free end of the second spring 96. The chair occupant can adjust the position of the cam to determine which of the cam surface portions 105a-105d will bear against the free end of the second spring 96. A progressively higher clamping force and hence higher resultant spring rate of the second spring can be obtained as the occupant rotates the cam 102 through to the maximum setting at 105a. At 105e, an extension to the cam 102 is provided to prevent over rotation of the cam 102. A knob 103b is provided for user adjustment of the cam 102.

The change in the net spring force over distance is illustrated graphically in Figure 9 for each of the positions of the cam 102. In position 1, the clamping is such that no force is contributed from the second spring 96. The first spring thereby offers an initial resistance of typically 10 kg. As the cam position is adjusted, the second spring contributes to the overall force so that the initial resistance to recline is increased above 10 kg, say approximately 11 kg. It will be appreciated that in changing the force offered by the second spring from 0 kg to approximately 1 kg, it is only necessary to act against a maximum of approximately 1 kg of force offered by the second spring 96. This is considerably lesser force than if the first spring 94 was adjusted to increase its initial resistance from 10 kg to 11 kg since the whole of the spring force would need to be acted against to bring about the required adjustment. In the particular embodiment described in which the first and second springs 94, 96 lay flat against each other, adjustment of the second spring 96 may bring about some change in the spring constant of the first spring. However, this is not graphically illustrated in Figure 9.

Recline Lock

Figure 5 illustrates a recline lock which may be operated selectively by the user to prevent the back portion from reclining. As can be seen in Figure 4, the main transom 22 includes four rearwardly extending projections 106. The recline lock comprises an elongate lock bar 107 which has four slots 108 arranged therein, with the lengthwise direction of the slots 108 arranged in the lengthwise direction of the bar 107. The slots 108 each receive one of the rearwardly extending projections 106 as shown in Figure 5. The elongate lock bar 107 is slidable from side to side between a recline lock position and a recline operative position. The projections 106 received in the slots 108 thereby define the limit of travel of the elongate lock bar 107. The elongate lock bar 107 is biased toward the recline operative position by spring 109.

The elongate lock bar 107 can be seen in Figure 8 in which the main transom 22 has been removed for greater clarity. The lock bar 107 has at each end a rearwardly extending lock bit 110. The lock bits 110 thereby move from side to side with the movement of the elongate lock bar 107. Each lock bit is moveable into a recline lock position whereby the lock bit 110 is engaged against a recline locking face 112 provided on the chin portion 74 of the back extension arms as shown in Figure 3. Reverting to Figure 8, the left-hand side lock bit 110 (shown on the right in the figure) moves from a recline operative position in which is it clear of the associated back extension arm 70, to a position in which it is engaged against the recline lock face 112 on the associated arm 70.

The arrangement in connection with the right hand lock bit 110 (shown in the left in the figure) is slightly different. It can be seen that the associated extension arm 70 has the recline lock face 112. Additionally, the associated arm 70 is provided with the rebate 114 adjacent to the recline lock face 112. In the recline lock position, the lock bit 110 is engaged with the recline lock face 112 whereas in the recline operative position, the left lock bit 110 is received within the rebate 114. When the lock bit is received within the rebate 114, the associated back extension arm 70 can still pivot freely about the recline axis. Figure 9 illustrates an alternative view from underneath.

Figure 10 illustrates the lock bar control lever 116 which is mounted underneath the seat portion 14 in a forward position on the left hand side. The lever 116 is connected to cable actuator 118. The cable actuator 118 is connected to a control cable 120 which operates in the conventional fashion. The control cable 120 controls the position of the elongate lock bar 107 (see Figure 5). The cable actuator 118 is rotatable by operation of the control lever 116. The cable actuator 118 has a dimple provided on the forward edge which is engageable with the two position detent 122. The dimple 121 is locatable in either of two positions, the first of which corresponds to the recline lock position of the elongate lock bar 107, and the second of which corresponds to the recline operative position of the elongate lock bar 107. The user thus selects whether the recline lock is on or off according to the position of the lock bar control lever 116.

Modified Form of Back Extension Arms, Main Transom, Recline Springs and Recline Lock

Figure 10a illustrates a modified form of the back extension arm 70'. The back extension arm 70' has a forked forward end forming a right fork 93c and a left fork 93d with an extension arm aperture 75' extending transversely through both forks. Two such back extension arms 70' are rotatably mounted about the recline axis R to the main transom 22' as shown in its modified form in Figure 10b1. From Figure 10b2, it can be seen that the main transom 22' has pivot features 76' formed at opposite ends. At each end, the pivot features include a pair of spaced supporting webs in the form of inner and outer lobes 78' through which extends aligned apertures 80'. The alignment of the apertures 80' defines the recline axis R about which the back extension arms 70' pivot. A pin inserted through each pair of apertures 80' mounts each back extension arm 70' to the main transom 22'. The inner lobe 78' is inserted between the forks 93c, 93d of the associated back extension arm 70'.

From Figure 10a, it can be seen that the rearward end of the upper abutment surface 93 has a skid 93e which engages with complementary ramp 76a on the main transom 22'. The ramp 76a is curved with a centre of curvature centred on the recline axis R. This defines a potential pinching point where the occupant of the chair might jam his fingers or shirt tails etc. Therefore outer lobe 78' extends rearwardly beyond the ramp 76a to act as a guard. Figure 10c illustrates one of the back extension arms 70' rotatably mounted to the main transom 22'.

Figure 10a illustrates an alternative form of recline lock mechanism. It can been seen that the forward end of the back extension arm 70' is provided with a substantially flat upper abutment surface 93 comprised of a forward surface portion 93a, forward of the recline axis R and a rearward surface portion 93b, rearward of the recline axis R. In assembly of the back extension arm 70' with the main transom 22', the abutment surface 93 lies underneath an upper portion of the main transom (see Figure 10c). The rearward surface portion 93b thus defines the forward recline limit which will be reached when the back extension arm 70' pivots so that the rearward surface portion 93b abuts the underside of the main transom 22'. Conversely, the rearward recline limit will be defined when arm 70' rotates such that the forward surface portion 93a abuts the underside of the main transom 22'. The engagement between the forward surface portion 93a and the underside of the main transom 22' thus defines the rearward recline limit.

A recline lock may be operated selectively by the user to prevent the back portion from reclining or to set an intermediate recline limit. As seen in Figure 10a, the forward end of the back extension arm 70' is formed with a transversely extending slide 70a in which is slidably mounted a key 107a. The slide 70a has a closed inner end 70c which has an aperture 70b. A spring (not shown) is received in the slide 70a between the key 107a and the closed end 70c to bias the key 107a outwardly away from the closed end 70c. The key 107a is slidable within the slide against the action of the spring by means of a cable connected to the inner end of the key 107a which is adjustable in the same manner described in Figure 10. The key has first and second abutment surfaces 107b and 107c. When the key 107a is in the innermost position (relative to the chair as a whole) illustrated in Figure 10a, then the first abutment surface 107b does not interfere with the reclining action of the back extension arm 70' as already described. This is referred to as the hyper-recline position, allowing recline of 15°.

As already explained, the forward end of the back extension arm 70' is forked as shown to define right and left forks 93c, 93d. As the key 107a is moved into a position whereby the first abutment surface 107b is aligned with the right fork 93c then the first abutment surface 107b will interfere with the recline action of the back extension arm because the first abutment surface 107b will hit the underside of the main transom 22' before the forward surface portion 93a normally would. This allows recline of 12°. When the key 107a is moved so that the second abutment surface 107c is aligned with the right fork 93c then the second abutment surface 107c is disposed such that any recline of the back extension arm 70' is prevented or at least largely prevented. A recline lock is thereby defined.

In Figure 10a, it can be seen that the side of the back extension arm 70' includes two cylindrical bores 92a and 92b which face like bores on the facing side of the other back extension arm (not shown). As shown in Figure 10e, first and second recline springs 95, 97 extend between the facing bores. The second recline spring 97 is in the form of an elongate rod, the ends of which are received in facing bores 92b of the two back extension arms 70'.

The main transom 22' includes a rearward extension 22a having a bearing block 98' seated in a complementary recess on the upper surface of the rearward extension 22a. The bearing block 98' defines a semi-cylindrical recess to receive a central portion of the second recline spring 97. As the back extension arms 70' recline relative to the main transom 22', the second recline spring 97 is caused to bend downwardly at its ends while the intermediate portion is held fixed by being seated in the bearing block 98' on the main transom 22'. The second recline spring 97 thus resists rearward recline and biases the back extension arms 70' toward the forward recline limit. The second recline spring 97 is pre-loaded at the forward recline limit by being slightly bent. This is achieved by having the centres of the bores 92b slightly above the centre of the spring in the recess of the bearing block 98'.

The first recline spring 95 operates on a similar principle but is somewhat more complex. The first recline spring 95 is illustrated in greater detail in Figure 10d and comprises a spring portion 95a, in the form of a flat bar. The outer ends of the first recline spring 95 are fitted with cylindrical bosses 99a to be received in the facing cylindrical bores 92a provided in the back extension arms 70'. Additionally, a central cylindrical boss 99b is fitted onto the bar 95a. The central boss 99b is slotted to allow the bar 99a to pass through. As shown in Figure 10e, the central cylindrical boss 99b is seated in a semi-cylindrical recess provided in the bearing block 98' on the main transom 22'. The bearing block 98' may be provided with upstands at its sides to locate the boss 99b relative to the bearing. The flat bar spring portion 95a provides resistance to recline through its inherent resistance to bending about a bending axis arranged transversely to the length of the spring 95. It will be appreciated that with the configuration of the ends of the first spring 95 and the central cylindrical boss 99b bearing against the main transom 22', the bending axis will be defined which extends generally transverse to the longitudinal axis of the spring 95. The arrangement is such that no pre-load is applied to flat spring portion 95a in the forward active position. The central recess in the bearing block 98' and the cylindrical bores 92a are thus aligned for this reason.

The first recline spring 95 is adjustable to change the spring rate. This is achieved by rotating the first spring 95 about the longitudinal axis of the spring through the use of paddle 99c which is fixed onto the spring bar portion 95a. It can be seen from the cross-sectional views shown in 10f-10h, the spring portion 95a has a thickness and a width dimension, the width dimension being greater than the thickness dimension. In Figure 10f, the spring 95 is oriented so that the width dimension is arranged substantially parallel to the bending axis. This represents the 'easy' spring position. In Figure 10g, the thickness dimension is arranged diagonally to the transverse bending axis. Such an arrangement will present a greater resistance to bending about the transverse axis. This accordingly represents the "medium" spring position. Furthermore, in Figure 10h, the width dimension is arranged transversely to the bending axis. Such an arrangement presents the greatest resistance to bending and is thus deemed the "hard" position for the first recline spring 95. The first recline spring 95 is thus adjustable through 90° to provide three adoptable spring positions at each of which the spring exhibits a different spring rate. This is visually depicted in Figure 10k which illustrates graphically the change in net spring force over distance as the spring is adjusted between easy (A), medium (B) and hard (C). Furthermore, Figure 10e illustrates the first spring 95 in the easy position whereas Figure 10i illustrate the first spring 95 in the hard position.

In order to locate the first recline spring 95 in the adoptable spring positions, locators are provided in the form of grooves 99d provided in the cylindrical boss 99b. A complementary rib 99e is disposed in the semi-cylindrical recess of the bearing block 98a. The rib 99e can engage with any one of the complementary grooves 99b to accordingly locate the first spring 95 in that position. It may be necessary to remove most of the loading on the first spring 95 in order to change the spring position. Accordingly, it may be necessary to bring the back portion to the forward active position to achieve this.

Figure 10e illustrates in greater detail the form of the cylindrical bosses 99a on the first spring 95. The end of each boss is cut away to define a semi-circular rebate 99d thereby defining a diametrical abutment face 99e. As can be seen in Figure 10m, the end of bore 92a is provided with a projecting quadrant 92c. With the boss 99a assembled in the bore 92a, the quadrant 92c projects into the semi-circular rebate 99d. The spring 95 is rotatable through 90° between a first rotatable limit where one face of the quadrant 92c abuts against one half of the diametrical abutment face 99e and a second rotatable limit where the other face of the quadrant 92c abuts against the other half of the diametrical abutment face 99e. The interaction between the quadrant 92c and the diametrical abutment face 99c limits the rotation of the spring 95 to 90°.

Figures 10n and 10o show a modified version of the back extension arm 70" and recline springs 95", 97". Unless described below, the features should be considered the same as for Figures 10a to 10m. The primary difference is that the second recline spring 97", is formed as an elongate bar which is rectangular in cross-section. The ends of the elongate bar 97" are received in facing bores 92b " (only one of which is shown) of the two back extension arms 70". The rectangular spring 97" is used for ease of manufacture. The cylindrical bosses 99a" of the first recline spring also have a slightly different configuration from the embodiment described above. The shapes of the diametrical

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abutment faces 99e″ on the first recline spring are also different to those shown above.

As can be seen from Figure 10o, the two bores 92a″, 92b″ are shown as being formed directly in the back extension arms 70″. It is also envisaged that a plastic insert could be fitted into the side of each arm 70″, with the bores 92a″ and 90b″ formed in the insert.

Stiffness adjustment of Peripheral Frame

Figure 11 illustrates a further exploded view of parts assembled with the peripheral frame 34. As described previously, a back attach casting 48 is fixed to the back of the peripheral frame 34. The back attach casting 48 has two upright channels 64 arranged at either end each defined by opposed walls 54. The opposed walls 54 have aligned slots 56 arranged therein for receipt of pins 62 provided on a spring carrier 60. The specific form of the spring carrier 60 is illustrated more clearly in Figure 13. The spring carrier 60 is in the form of an elongate member which is approximately square or rectangular in cross section with the pins 62 being arranged on opposite sides. One end of the member is provided with a rebate 124. The other end of the spring carrier is forked for pivotal connection with

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another linkage as will subsequently be explained. The forked end has aligned apertures 126.

The rebate 124 has spaced threaded bores 130 provided therein. A leaf spring 128 has a lower end 131 shaped to be received within the rebate 124. The lower end 131 has two spaced apertures 133 provided therein. These apertures 133 align with the threaded bores 130 provided on the spring carrier so that the leaf spring 128 may be securely fastened to the spring carrier 60. From the lower end 131 in the upwards direction, the leaf spring 128 gradually increases in width with a slight tapering in thickness, although overall the leaf spring 128 is of generally elongate configuration as shown. The leaf spring 128 is constructed from high tensile spring steel.

As can be seen in Figure 11, there are two spring carriers provided on opposite sides of the back portion, each received within a respective one of the channels 64 and mounted for pivotal movement about an axis defined through the bases of the aligned slots 56.

Figure 12 illustrates the assembled combination whereby each of the leaf springs lie against the back of the peripheral frame 34 in a respective channel 44. As already described the peripheral frame 34 has a degree of flexibility. By rotating the spring carrier about pins 62 so that the forked end 125 moves rearwardly, the leaf spring 128 will be caused to act against the lower portion of the peripheral frame thereby increasing its stiffness against rearward flexing. The two spring carriers act in unison in a manner which will be described in connection with Figures 14 to 17. The stiffness of the lower portion of the peripheral frame 34 can thereby be adjusted by adjustment of the position of the spring carrier 60. Further, the channels 64 in which each of the spring carriers 60 are received are closed rearwardly by a rear wall 135 of the back attach casting 48. The rear wall 135 defines a stop against which the forked ends 125 of the spring carriers engage, thereby defining the maximum rotation of the spring carrier 60 and thus the maximum stiffness which can be imparted by the leaf spring 128 to the peripheral frame 34.

Figure 14 illustrates the main elements of the recline mechanism. The back attach casting 48 has been removed for clarity, together with the right back extension arm 70. The left back extension arm 70 is shown in position pivotally connected to the main transom 22 about the recline axis R. The first and second recline springs 94, 96 are also illustrated. The forked end 125 of each spring carrier 60 is connected to a push link 139. Reverting to Figure 3, it can be seen that the lower portion of the peripheral frame 34 has an access opening 143 to enable the push link 139 to engage with the forked end 125 of the spring carrier 60 disposed within the assembled back attach casting 48. The forward end of the push link 139 is connected to a drive link 141 which is one element of a four bar linkage which will be understood more fully from a consideration of the schematic illustration of Figure 15. Figure 15 illustrates only one four bar linkage and it will be apparent to the reader that two such four bar linkages are provided, one on each side of the chair 10. The drive link 141 extends at an inclined upwards angle from its connection with push link 139. The drive link 141 is curved along its length with the centre of the curve being disposed rearwardly and upwardly. The drive link 141 is mainly of rectangular cross section.

The drive link 141 is pivotally connected at an intermediate location along its length to the main transom 22 for pivoting motion about the recline axis R. Specifically, the drive link 141 is pivotally connected to lie adjacent to the outer one of the opposed supporting webs 78 of the main transom 22. A common pivot pin (not shown) interconnects both of the opposed supporting webs 78, the back attach arm 70 through aperture 75, and the drive link 141.

The main transom 22 forms another element of the four bar linkage. As has already been explained, the main transom 22 is centrally mounted to the supporting frame at the top of the central support column 20 which incorporates a height adjustable pneumatic spring 145. The height adjustment 145 is selectively operable by the chair occupant. However, the main transom 22 is normally stationary relative to the supporting frame.

The seat portion 14 is slidably mounted to a seat guide 149 in a manner which will be described more fully in connection with Figures 21 to 26. The seat guide 149 thereby forms another element of the four bar linkage. The upper end of the drive link 141 is pivotally connected to the seat guide 149. Another link in the form of a front support link 151 interconnects the seat guide 149 and the main transom 22. The front support link 151 is of generally rectangular cross section and, like the drive link 141 is curved along its length with the centre of curvature disposed upwardly and rearwardly.

From Figure 14 it can be seen that both ends of the drive link 141 are forked. The lower end is forked to accommodate the lower end of the push link 139. The upper end of the drive link 141 is also forked. The seat guide also has a dependent lobe 155 as shown in Figure 15b. The forked upper ends of drive link 141 are disposed on each side of the lobe 155 and the inner fork is pivotally connected between the lobe 155 and the side wall of the seat guide 149. The outer fork is fanned in shape for aesthetic reasons and the pivotal connection does not extend therethrough. Likewise, the upper end of the front support link 141 is also forked with the inner fork being pivotally connected between a seat guide 149 and another lobe 157 (see Figure 15b), with the outer fork being of fanned shape. The lower end of the front support link 151 is pivotally connected on the outside of the outer one of the opposed supporting web 78 (see Figure 4) by means of a pin (not shown) extending through aligned forward apertures 153 on the forward end of the opposed supporting webs 78. It will be appreciated that the connection of the lower end of the drive link 141 and the front support link 151 are blind connections as shown for aesthetic reasons.

Operation of Recline Mechanism

The operation of the recline mechanism will now be explained in connection with Figure 15a. Reference is only made to the four bar linkage elements on one side of the chair. The reader will appreciate that the elements are duplicated on the other side of the chair. As already stated above, the back portion 16 is reclinable about recline axis R. First and second recline springs bias the seat portion 16 into a forward position which is determined by the engagement between the first abutment surfaces on the back extension arms 70 in engagement and the second abutment surfaces of the main transom 22. In the unoccupied state, the arrangement of the elements of the four bar linkage is determined by the spring tension of leaf spring 128. The natural resiliency of the leaf spring 128 will tend to straighten the leaf spring 128 thereby urging the spring carrier 60 in a clockwise direction about the pins 62. This determines the position of the push link in the unoccupied state of the chair. With no force exerted on the seat guide 149, the elements of the four bar linkage will be held in an unoccupied position on account of the natural resiliency of the spring 128 acting through push link 139.

When a user bears weight W against the seat portion 14, this will be taken up by the seat guide 149 whereby the drive link 141 will be driven to rotate in an anticlockwise direction around recline axis R. This will cause the push link 139 to move generally upwardly and rearwardly thereby rotating spring carrier 60 anticlockwise about pivot pins 62. The lower portion of the peripheral frame 34 is rigidly held within back attach casting 48 which is stopped in its forward active position as already explained. With anticlockwise rotation of the spring carrier 60, the leaf spring 128 will be caused to bend with the upper part pushing against the back of the peripheral frame 34. There may be a small forward movement of the peripheral frame 34. At a certain point, depending upon the flexibility of the peripheral frame 34, the peripheral frame 34 will cease moving forwardly and the occupant's weight will instead be taken up by a spring tension in leaf spring 128 as it flexes against the back of the peripheral frame 34. This has the effect of stiffening the back portion against rearward flexing. It will be appreciated that the tension imparted to leaf spring 128 will depend upon the weight of the user W applied to the seat portion 14. The greater the weight W, the greater the tension taken up by the leaf spring 128 and thus the greater the degree of stiffness imparted to the leaf spring 128 to resist rearward flexing of the peripheral frame 34. Accordingly, the stiffness of the peripheral frame 34 will be adjusted according to the weight W of the chair occupant.

If the occupant's weight W exceeds a predetermined level then the leaf spring 128 will be tensioned to a point where the forked end 125 of the spring carrier 60 engages against the rear wall 135 of the back attach casting 48. This provides a limit to the amount of tension imparted to the leaf spring 128. The limit is reached at about 80 kg. Figure 16 illustrates by way of arrows the motion of various parts of the chair 10 as the user applies weight W. The leaf spring 128 will cause an intermediate portion of the peripheral frame 34 to bend forwardly by a small amount as indicated by arrow F. When the occupant alights from the chair the motion of the spring will be as indicated by arrow S and the seat portion 14 will move upwardly as indicated by arrow U in Figure 17.

As already mentioned, the gentle serpentine shape of the peripheral frame 34 is designed to correspond with the shape of the occupant's spine for the comfort of the occupant. With the flexing action of the back portion, the ergonomics of the chair are further enhanced because this enables the occupant to exercise his spine. The general health of a person's spine is enhanced by movement. The stiffness of the back portion in rearward flexing is adjusted according to the occupant's weight. Therefore, within a certain range, the ease of rearward flexing will correlate to the weight of the occupant. Therefore, a light person will be able to obtain full benefit from the rearward flexing action by applying a light force against the peripheral frame. Also, a heavier person will encounter a greater resistance to flexing, ensuring that the peripheral frame is not to floppy for a large person. The chair is designed so that the occupant will be able to obtain deflection through flexing in the range of 80 mm to 120 mm.

Figure 18 illustrates the reclining action of the chair 10. When the user applies their weight to the seat portion 14, the seat portion will move downwardly as already described and adopt a position just above the seat guide 149 as illustrated by the solid lines. Once a user has applied their weight to the seat portion 14, the leaf spring 128 takes up a corresponding amount of spring tension whereupon the spring carrier 60 and the push link 139 will adopt a more or less fixed position relative to the back attach casting 48. Therefore, as the user leans against the back portion 16, the back attach casting 48, spring carrier 60, push link 139 act in unison driving the drive arm 141 to rotate in a clockwise direction through push link 139. The arrangement of the four bar linkage is such that the seat guide 149 will adopt a position with a net increase in height and with an increase in rearward tilt angle compared to the occupied position of the seat guide 149 before recline. In practice, there may be some slight shifting between the leaf spring 128, the spring carrier 60 and the push link 139.

Since the seat portion 14 undergoes a net increase in height with the rearward recline action, the occupant's weight W will be counteracting the recline action, together with the bias applied by the first and second recline springs 94, 96. The weight of the occupant W will therefore be a variable factor in the ease with which the back portion 16 reclines. If the adjustable second recline spring 96 is set at a constant level then a heavier person will encounter a greater resistance to reclining action than a lighter person. This establishes an automatic correlation between the weight of the person and the resistance to the reclining action. For a large proportion of people who fit within physical norms this automatic adjustment may be sufficient. However, people come in all different shapes and sizes and therefore additional adjustment is required through the use of the clamping adjustment as explained previously. For example, a very tall, light person may obtain leverage through their height which makes the back portion 16 fall back too easily against their low weight W.

The net increase in height also has the advantage of raising the occupant during recline so that the eye level of the chair occupant can be maintained even though he is undergoing a reclining action.

Once the chair is fully reclined (as determined by the first abutment surface 88 engaging against second abutment surface 90), the peripheral frame will still be able to flex under additional force applied by the chair occupant. As already mentioned, it is considered that the peripheral frame will be capable of undergoing deflection in the range of 80 mm to 120 mm. During the recline action, it is considered that the weight of the user against the back portion will bring about a deflection of up to 20 mm. Therefore, once the recline limit is reached, the occupant still has further deflection available through flexing of the peripheral frame in the range of 60 to 100 mm.

As explained subsequently in connection with Figures 21 to 26, the seat portion 14 is only supported by the seat guide 149 at a rear portion thereof with a forward portion being unsupported. As shown in Figure 15b, a transition point 161 is disposed behind the forward edge 160 of the seat guide 149. The transition point 161 marks the boundary between the planar upper surface 178 of the seat guide 149 and a forwardly inclined lead surface 285. The seat portion 149 is foldable transversely at this location. The transition point 161 hence defines the division between the rearward portion and the forward portion of the seat portion 14. Since the seat portion 14 is slidable forwardly and rearwardly for seat depth adjustment as will be explained in connection with Figures 21 to 26, the division between rearward portion and forward portion will vary as a function of seat depth.

Figure 18 illustrates the changing curvature of the back portion 16 and seat portion 14 in recline. The solid lines indicate the forward active position in the occupied configuration. The dotted lines illustrate the reclined position. As the back portion 16 reclines, the seat guide 149 attains a net increase in height and an increased rearward tilt. This effectively cups the occupant's derrière, negating any inclination to slide forwardly during the recline action. The seat portion 14 is also flexible and since the occupant's derrière is undergoing a net increase in height together with increased rearward tilt, a greater amount of weight from the occupant's legs will be brought to bear against the forward portion of the seat portion 14. Accordingly, the seat portion 14, will be allowed to fold transversely at the transition point 161 on the seat guide 149. To achieve maximum benefit from the cupping action, the occupant ought to adjust the seat depth so that with his derriere abutting the back portion, transition point 161 approximately corresponds to the gluteal fold of the occupant's derriere. Therefore, during recline, the occupant's derriere will be cupped between the rear portion of the seat portion 14 and a lower region of the back portion 16 while the forward portion of the seat drops forwardly under the weight of the occupant's legs. Locating the transverse fold at the gluteal fold of the occupant ensures that undesirable pressure will not be brought to bear against the back of the occupant's legs.

Seat Panel

Figure 19a is a perspective view of a preferred form of the seat portion 14. The seat portion 14 is in the form of a flexible plastic panel, whose flexibility is enhanced by the arrangement of slots as indicated. The plastic panel may be injection moulded plastic such as TPR.

It will be noted that while the seat panel 14 is depicted in the computer generated drawings of Figures 19 to be a flat panel, the seat panel is in fact dish shaped as can be seen from the schematic views illustrating the various cross-sections in Figures 20a to 20e. Figure 20a is a longitudinal section through the middle of the seat panel 14 illustrating the general curved configuration with a rolled over edge. The edge drops by an amount of dimension A. Figure 20b illustrates the side edge of the seat panel 14. The side edge is flatter than the middle section. Additionally, the forward edge dips down a dimension B, where B is larger than A. Figure 20c illustrates a transverse sectional view at about 150 mm from the rear of the seat whereas the view Figure 20d depicts the transverse cross sectional view 120 mm from the front edge. This is essentially a flat shape. Therefore, the rear part of the seat behind 120 mm from the front edge is essentially dished for user comfort whereas in front of this, the seat portion inclines downwardly in the forward direction. Additionally, as can be seen in Figure 20e, the front edge is also curved so as to incline downwardly toward the sides.

The illustrations in Figure 20 are merely indicative of the moulded shape of the seat panel 14. The seat panel is also flexible to accommodate the occupant and to respond to movement of the occupant. The arrangement of slots in the seat panel 14 as shown in Figure 19a is designed to enhance the flexibility of the seat panel 14. The arrangement of slots in the forward half of the panel is designed to facilitate folding along the transverse fold. In particular, it can be seen that the slots are arranged in a series of spaced sinuous lines 163 extending transversely across the seat portion 14 with the central part being shaped convex forwardly with the outer parts being shaped concave forwardly. The lines of slots 163 are discontinuous. As already explained, the seat portion 14 is dished at least in a rearward part. This dishing may be accentuated by the occupant in the seat. The series of spaced sinuous lines 163 enables the seat panel 14 to fold transversely, even though the rear part is dished. Furthermore, at the front corners, the slotted pattern 164 is such as to extend diagonally across the corners following the curvature of the transverse sinuous lines 163. In this way, if the user moves a leg to one of the forward corners then the diagonal arrangement of the slots 164 will enable the forward corner to fold under the weight of the occupant's leg.

In the rear half of the panel, the slots are arranged in a pattern to accommodate the ischial protuberosities of the occupant. In particular, the slotted pattern provides two spaced, approximately rectangular zones 162 whose locations correspond to the ischial protuberosities of the occupant (assuming the occupant is properly seated with an appropriate seat depth adjustment). The two zones 162 interrupt the transverse slot pattern. Each zone is comprised of slots arranged in a series of longitudinally extending, transversely spaced sinuous lines. The lines of slots are discontinuous. The longitudinal arrangement of slots in each zone 162 enables the remaining material between the longitudinal lines of slots to spread apart thereby creating pockets, one for each ischial protuberosity of the seat occupant.

Figure 19b illustrates longitudinal stiffening webs 165 provided on the underside of seat panel 14. There are fine stiffening webs, two disposed along the opposite side edges. A further two are disposed on each side at 60 mm from the corresponding side edge. Another is centrally disposed. The longitudinal stiffening webs are constant in height from the back edge of the seat portion until the taper start point 164 from where they progressively reduce in height until a taper finish point 166. (The central web however terminates early) The seat portion 14 accommodates a depth adjustment as will be explained in connection with Figures 21 to 26. The seat portion folds transversely about the transition point 161 on the seat guide 149.

It will be appreciated that if the seat panel 14 is located in a rearward position in order to suit a small person then the depth of the stiffening ribs in the region at the transition point 161 is shallow thereby offering little resistance to flexing. Generally, this suits a small, light weight person. However, for a larger person, the seat panel will be disposed further forwardly in relation to the seat guide 149. The depth of the stiffening ribs in the location of the transition point 161 will be deeper, thereby offering increased resistance to bending. This suits a larger, heaver person.

The start taper point 164 is at a position which corresponds to the transition point 161 when the seat is at its full forward position to suit a large person. The taper finish point 166 is at a position corresponding to the transition point on the seat guide 149 with the seat in the rear most position to suit a small person. The taper start point 164 and the taper finish point 161 define a transition zone therebetween. The transverse fold may be disposed at a range of positions within the transition zone, dependent on seat depth adjustment. The pattern of transversely extending sinuous lines of plots extends for at least the transition zone.

Figure 19b also illustrates transverse stiffening webs 168. The stiffening webs 168 follow the pattern of the transversely arranged sinuous slots 163. As already explained, the seat panel is moulded in a dished shape. However, it is desirable to limit curvature, especially about a longitudinal axis at the front part of the seat portion. Accordingly, the transverse

stiffening webs 168 help to retain the shape of the front part without inhibiting the transverse folding action under the weight of the user.
Additionally, a back web is provided along the back of the seat panel 14 on the underside as shown in Figure 19b.

Figure 19d illustrates in greater detail the arrangement of features along one side edge. Between the two longitudinal webs 165 is a series of spacer blocks 270 extending in a line between the taper start point 164 and the taper finish point 166. Between each of the spacer blocks 270 is a wedge-shaped gap 272 widening towards the top. As will be explained in connection with Figures 21 to 26, the seat panel 14 sits atop a seat carriage 167. Depending upon the position of the seat carriage 167 relative to the seat guide 149, there will normally be a forward portion of the seat guide 149 (including the lead surface 285) in front of the seat carriage 167. A rear part of the seat panel 14 is secured atop the seat carriage 167 so that forwardly of the seat carriage 167 there will be a gap between the seat guide 149 and the seat panel 14. The spacer blocks 270 occupy this gap and bear against the top of the seat guide 149. It can be seen that the spacer blocks 270 also taper off in height as shown. Furthermore, the spacer blocks 270 will define the maximum curvature of the seat panel along the transverse fold since once the side walls of the wedge- shaped gaps 272 engaged with each other, further curvature will be prevented.

Seat Depth Adjustment Mechanism

Figure 21 illustrates the main elements of the seat depth adjustment mechanism. The seat guide 149 is one of the elements of the four bar linkage discussed previously. There are two seat guides 149 disposed on opposite sides of the chair. The two seat guides 149 provide a guide for a slidable seat carriage 167. A rear part of the seat panel 14 illustrated in Figures 19 and 20 is attached to the carriage 167. The rear half only of the seat panel 14 is attached to the seat carriage 167. The seat panel 14 may be moved forwardly and rearwardly by the sliding action of the seat carriage 167 on the seat guide 149.

Rearwardly of the spacer blocks 270 on the underside of the seat panel 14 is a longitudinally extending rib 274 and then a short tab 276 spaced rearwardly of the longitudinally extending rib 274. The rib 274 engages within a channel 278 (see Figure 22) of the seat carriage 167 and the tab 276 is a snap fit connection within the recess 280 located rearwardly on the seat carriage 167. Furthermore, four spaced retention tabs 282 engage against soffit 284 of the carriage 167. The retention tabs 282 retain the seat panel 14 engaged with the seat carriage 167 while the longitudinal rib is the main load bearing part.

Figure 21 also illustrates the controls for the height adjustable pneumatic spring 145. A height adjustment control lever 169 is mounted for pivotal motion on the outside of the right hand seat guide 149. The pivotal motion of the height adjustment control lever 169 is replicated by the height adjustment control actuator 170 which is connected to one end of a control cable 172. The other end of the control cable 172 is connected to the top end of pneumatic gas spring 145. As the user lifts the height adjustment control lever 167, the control cable 172 releases the gas spring in the conventional known manner and the chair occupant adjusts the height of the seat portion 14 to suit his requirements.

Figure 22 is a further detailed view of the left side of the seat carriage 167. The seat guide 149 includes a plastic seat guide liner 176. The seat guide liner is of elongate configuration with an upper glide surface 178 and an inner glide surface 180. The inner glide surface 180 is spaced from the inner side of the metal part seat guide 149 with a peripheral wall 182 maintaining the inner glide surface 180 in spaced configuration therefrom. The seat guide liner 176 is thereby hollow behind the inner glide surface 180. The upper glide surface 178 is received within a rebate in the upper surface of the metal part of the seat guide 149 in order that the upper glide surface 178 is contiguous with the upper surface of the metal part of the seat guide 149. The seat guide liner 176 provides a bearing surface for easy sliding of the seat carriage 167. As such, the seat guide liner 176 may be comprised of nylon or acetal. The reader will appreciate that a symmetrical arrangement is provided on the right hand side of the chair.

The seat carriage 167 is of unitary cast aluminum construction and comprises two spaced slides, each of which engages with a respective seat guide 149. Each slide is of a generally L-shaped configuration having an upright glide surface 186 on an inner wall for sliding engagement with the inner glide surface 180 and a horizontal glide surface 187 for engaging with the upper glide surface 178. The carriage is of a symmetrical configuration about a central upright longitudinally extending plane of the chair. The two slides provided on the right and left are thereby of opposite configuration. The two slides are joined by transversely extending bearers 190.

The inner glide surface 180 is moulded with a series of archlets which extend from the inner glide surface 180. The archlets 184 protrude inwardly to bear against the upright glide surface 186 of the seat carriage 167. The archlets may be arranged in any pattern but preferably they are staggered along the length of the inner glide surface 180. Both of the seat guide liners 176 have inwardly extending archlets bearing against the associated upright glide surfaces of 186 of the carriage 167. The archlets 184 thereby act against the carriage to centre the carriage 167 centrally between the two seat guides 149. Furthermore, in the event that the parts are not accurately tooled, the resilient archlets 184 will take up any slack between the upright glide surface 186 and the inner glide surface 180. This assists to prevent jamming of the carriage 167 within the seat guides 149.

Figure 23 illustrates the control for seat depth adjustment. The inner wall of both slides 185 have a lower edge with a series of spaced notches 192. A seat depth adjustment bar 194 has two teeth 196, each arranged at opposite ends of the bar 194. The seat depth adjustment bar 194 is moveable between a latched position in which the teeth 196 engage in a respective one of the notches 192 and an unlatched position in which the carriage 167 is free to slide along the seat guide 149. The seat depth adjustment bar 194 is controlled by a seat depth adjustment button 200. The seat depth adjustment button 200 is moveable from the latched position against the bias of a spring (not shown) to move the seat depth adjustment bar 194 into the unlatched position whereby the teeth 196 no longer engage in the notches 192. The seat carriage 167 can then be slid to an appropriate seat depth whereupon the occupant releases the seat depth adjustment button 200 to enable the teeth 196 to engage with the closest of the notches 192.

A seat depth stop 174 (Figure 21) formed as a dependent projection from the seat carriage 167 determines the forward position of the seat carriage 167 as it engages with the adjustment bar 194 or sleeves 158 receiving the ends of the adjustment bar 194. The rear limit is defined by a pin (not shown) extending inwardly from the seat guide 149 to engage within a slot of the seat carriage 167. The slot is machined to define a stop to engage with the join in the rear most position of the seat portion.

Lumbar Support Mechanism

Figure 27 is a perspective view of the back portion 16 illustrating the main components of a lumbar support mechanism 36. The lumbar support mechanism 36 includes a lumbar support panel 207. The lumbar support panel 207 is provided with two-spaced upright tracks in the form of C-shaped channels 209. It can be seen that the lumbar support panel 207 is provided with horizontal slots extending in the horizontal direction. However, in another embodiment, (not shown) the slots may extend vertically. The lumbar support panel 207 is provided with a grab bar 211 to enable height adjustment by the chair occupant. The lumbar support panel 207 is integrally moulded of plastic material such as nylon.

As can be seen more clearly in Figure 28, mounted to the back beam 46 is a pair of hinges 214. The hinges 214 are mounted at spaced locations along the back beam 46, one to the left hand side and one to the right hand side. Figure 29 illustrates in greater detail the form of the hinges 214. The hinge 214 is a two piece component comprised of a short arm 215 to which a swivel 217 is pivotally mounted. The short arm 215 is an integrally cast metal component in the form comprising side walls 216 and an intermediate web 218. At one end of the short arm, the side walls 216 are provided with aligned apertures 220. The side walls 216 are fortified within the region of the aligned apertures 220. The apertures 220 are not circular in form but of slightly elongate configuration for effective operation of the lumbar support mechanism as will be understood.

At the other end of the short arm, the swivel 217 is pivotally mounted about pivot 221. The swivel 217 includes a plate-like member and two ball-like formations 222, protruding from the end of the short arm. The ball-like formations 222 are shaped to engage within the same channel 209 provided on the rear of the lumbar support panel 207. Each of the hinges 214 is connected to the back beam 46 by the use of a pin (not shown) extending through the aligned apertures 220 as well as two aligned apertures 224 provided on the back beam 46. The apertures 224 are circular and the pin is also of circular cross-section. This enables the hinges 214 to pivot as well as to achieve a translatory movement within a small range defined by the shape of the aligned apertures 220.

As shown in Figure 30, the two ball-like formations 222 of each hinge are received in a one of the channels 209. The lumbar support panel 207 is thereby slidable on the hinges 214. The chair occupant can adjust the position of the lumbar support panel 207 by grabbing the grab bar 211 and physically sliding the panel 207 up or down.

The panel 207 abuts against the top of the back attach casting 48 to stop it from sliding down until the balls disengage from the channel. Additionally caps (not shown) close the top of the channels 209.

Also illustrated in Figure 30 is a preferred form of a biasing device in the form of spring unit 226. Each hinge 214 has a spring unit 226 associated with it for biasing the associated hinge 214 and the lumbar support panel 207 in the forwards direction. The spring unit 226 includes two first bars 228 (only one of which is shown in Figure 30). The first bars 228 are received between the side walls 216 of the hinge 214. Two second bars

230 bear against the back beam 46. Two spring portions 232 bias the two first bars 228 away from the two second bars 230 in order to bias the lumbar support panel 207 forwardly of the chair. Each spring unit 226 is of integral construction made from spring wire.

The lumbar support panel 207 is of generally curved configuration as illustrated in Figure 28 to conform with the shape of the occupant's spine. In the completed chair, the peripheral frame 34 of the back portion has a mesh fabric stretched taut across the opening, thereby defining the forward surface of the back portion 16. The lumbar support panel 207 is suitably provided with padding (not shown) on its forward surface. The forward surface of the lumbar support panel 207 or that of the padding (where appropriate) lays behind the mesh fabric. As the user leans against the chair back, some stretching of the mesh fabric will envitably occur and the occupant's lumbar spine region will be supported by the lumbar support panel 207 against the bias of the spring units 226. This offers the chair occupant a small force exerted on the lumbar region of the spine being in the vicinity of about 5 kg. This is considered to be comfortable to the chair's occupant. The lumbar support panel 207 thereby offers a floating support to the occupant of the chair. The hinges will to an extent be able to pivot about aligned apertures 220 independently of each other, depending on which side of the back portion the occupant is leaning against. Additionally, the lumbar support panel can also pivot about a horizontal axis between the two pivots 221.

Figures 31 to 33 illustrates the form of a ripple strip which may be embedded at the base of the channels 209. The ripple strip is of unitary moulded plastics construction. The upper surface of the ripple strip is undulating with the dips in the undulations serving to locate the ball-like formations 222 of the hinges 214. The ball-like formations are held within the channels 209 by inwardly directed lips 237 at the edges of the channels 209. The ripple strip is comprised of a resilient plastics material. The rises 235 of the ripple strip must undergo deformation to enable each ball-like formation 222 to move along the channel 209 over the rise 235. The ripple strip 234 may be glued into position in the base of the channel 209. Alternatively, the profile of the ripple strip may be integrally moulded into the base of the channel 209.

Figure 34 illustrates a modified form of the lumbar adjustment mechanism 245 which, in addition to of the spring units 226, includes user adjustable bladder units 247. The spring units 226 may be substituted for lighter spring units. Alternatively, bladder units may be used in lieu of the spring units 226. The bladder units are each in the form of an inflatable bellows as illustrated in Figure 35. Each bellows 247 is disposed between the back beam and a corresponding hinge 214. The rear of the web 218 of each hinge 214 includes a circular recess (not shown) to accommodate the bellows 247. Both bellows 247 are linked to a user actuable pump (not shown) disposed on the underside of the grab bar 211b as shown in Figure 36 which shows a slightly modified form of a lumbar support panel. An appropriate pump can be obtained from Dielectrics Industries of Massachusetts. See for example US Patent No. 5,372,487 which describes an appropriate user actuable pump. The pump P is connected to both bellows 247 by means of conduits. Both of the bellows 247 are linked by a T-connection to equalise the inflation of the bellows 247.

While the pumps are not shown in Figure 36, depressible levers 249 which operate the pumps are illustrated on the underside of the grab bar 211b. The depressible levers 249 are pivotally mounted about a common pivot centrally disposed on the underside of the grab bar 211b. Each of the pumps P is positioned where indicated between an associated lever 249 and the underside of the grab bar 211b. To operate the pumps P, the occupant depresses the outer end of the either lever 249 and pumps the pumps P to inflate the bellows 247. If the amount of air in the bellows is too great causing the lumbar support panel to extend too far forwardly, the occupant of the chair can release some of the pressure by actuating a pressure release 250 associated with each lever 249. Each pressure release 250 is associated with a valve in the conduits leading to the bellows 247 to release pressure from the bellows 247.

Therefore, the occupant of the chair can adjust the forward position of the lumbar support panel 207b by adjusting the inflation of the bellows 247. Since the bellows 247 are air-filled they will possess a natural resiliency because the air can be compressed in the bellows 247 as the chair occupant pushes against the lumbar support panel 207b.

Upholstery

Figure 38 shows a cross section through A-A of Figure 37, to illustrate the manner of attaching an upholstery fabric to the peripheral frame 34 of the chair. Figure 38 specifically illustrates the cross-section of the upright members 38 of the peripheral frame 34. As has been described previously, the uprights of the peripheral frame each include a rearwardly open channel 44 in which the leaf spring 128 resides as has been explained previously. The upright member 38 also includes a second rearwardly open channel 252 of much narrower configuration than the first mentioned rearwardly open channel 44. The second rearwardly open channel 252 receives an attachment strip 254. The attachment strip 254 is of extruded resilient plastics material in the form shown. The attachment strip 254 includes a series of barbs 256 which engage with the side walls of the second rearwardly open channel 252 to assist in holding the attachment strip 254 within the channel 252. The attachment strip 254 also includes an attachment portion 258 to which the mesh fabric 260 can be sewn. Suitably, the raw edge of the mesh fabric is folded under and the mesh fabric 260 is sewn to the attachment portion 258.

Only one side of the back portion is illustrated in Figure 38 and the other side will be symmetrical through the central plane of the chair. The mesh fabric 260 is sized so that with the attachment strip 254 secured within the second rearwardly open channel 252 on both sides of the back portion 16, the mesh fabric 260 will be relatively taut across the peripheral frame. The top of the mesh fabric 260 is also held within a top rearwardly open channel 253, in the same manner. The bottom of the mesh fabric 260 is held within a bottom rearwardly open channel 255 in the same manner.

Topper Pad Assembly

Despite the fact that the seat panel 14 and the back portion 16 have been designed with a view to the occupant's comfort, a chair's appearance of comfort is also important. As the occupant approaches, a chair with soft padded upholstery will be visually more comfortable compared to a chair with a panel for a seat and taut mesh for the back portion, even if both chairs have the same comfort performance over time. Accordingly, a topper pad 330 has been developed as shown in Figure 43. The topper pad 330 wraps over the back portion 16 of the chair, covering the mesh fabric 260. The topper pad 330 may be assembled with the chair. Alternatively, the topper pad may be retrofitted to an existing chair. The topper pad 330 is in the form of an upholstered pad formed of two sheets of fabric eg leather, sewn together in a conventional manner to form a pocket open at one end. A pad such as a layer of foam is inserted in through the open end and then that end is sewn up in the conventional manner. On the rear side 332 the topper pad has first upper connection flap 334 and a second lower connection flap 336. The upper connection flap is in the form of a transverse flap substantially shorter than the transverse width of the topper pad 330. The upper flap 334 is sewn along one edge to the rear side 332 of the topper pad 330 at approximately 1/5 along the length of the topper pad 330 from the upper end 336. The upper flap incorporates a metal channel section 338 at its free end. In use, the rear side 332 of the topper pad 330 is placed against the front of the back portion 16 with the top 1/5 of the topper pad 330 overhanging the top of the back portion 16. The upper flap 334 also hangs over the top beam 40 with the channel section 338 tucking under the lower edge of the top beam 40. Accordingly, the channel section 338 is shaped to snugly engage under the lower edge of top beam 40.

The lower flap 336 is sewn across its upper edge at about approximately 1/8 from the bottom edge 340 of the topper pad 330. The lower flap 336 extends transversely across the width of the topper pad but is substantially shorter than the width of the topper pad. Both the lower flap 336 and the upper flat 334 are centrally located about the longitudinal centreline of the topper pad. At the lower edge of the lower flap 336 are a series of spaced spring clips 342 which comprise a loop of elastic material to which a metal L-section bracket is attached. The L-section bracket engages on the underside of the bottom beam 42. When the peripheral frame 34 is engaged with the back attach casting 48, the metal brackets will be held therebetween to securely fix the bottom of the topper pad 330 to the peripheral frame 34 of the chair. Additionally, the upper edge 336 of the topper pad which depends below the top beam 40 is secured in place. This may be achieved through the use of hook and loop pile fasteners (not shown).

Wheeled Base

Figure 39 illustrates a preferred form of the wheeled base 18. The wheeled base includes five radially extending legs 300. Each of the legs is supported by a respective castor 302. As more clearly illustrated in Figure 40, the five legs 300 make up an unitary cast leg assembly. Each leg is elongate and substantially plate-like in thickness, strengthened by a strengthening web 304 extending longitudinally along each leg 300. The strengthening webs 304 terminate at their inner ends at a centrally disposed annular boss 306. At their outer ends, each of the legs 300 is provided with an integrally formed dependent connector 308. Each dependent connector 308 is in the form of a socket or sleeve. As the legs are substantially plate-like in configuration, the end of each leg 300 terminates in a clip-on bumper 301 comprised of resilient plastic or rubber material.

Figure 41 illustrates the form of the castor 302. Each castor 302 comprises two spaced wheel portions 312. The wheel portions 312 are rotatably mounted on an axle 314 forming part of an axle assembly 316 illustrated in Figure 42. The axle assembly 316 is an integrally cast or machined component incorporating the axle 314, a connector pin 318 and an intermediate portion 320 extending between the axle 314 and the connector pin 318. The wheel portions 312 are received on opposite ends of the axle 314 and rotatably held there by means of a snap-fitting. In the assembled configuration illustrated in Figure 41, the connector pin 318 is disposed between the two wheel portions 312. Furthermore, there is a further gap provided between the connector pin 318 and the wheel portions 312 to receive the dependent connector 308. The connector pin 318 releasably engages with the dependent connector 308 enabling the pin to rotate within the dependent connector 308 about the longitudinal axis of the pin 318. A snap-fit connection may be provided therebetween. In assembled configuration of the leg 300 and the castor 302, only a small clearance need be provided between the underside of the leg 300 and the top of the castor 302. This provides for a compact arrangement of low height (typically less than 65mm), causing minimal disruption to the movement of the chair occupant's feet under the seat portion.

As can be seen in Figure 41, a part-cylindrical cover 320 extends between the two wheel portions 312 to partly close the gap therebetween.

Figure 44 illustrates in schematic form, the underside of the slotted seat panel 14. Mounted to the underside of the seat panel 14 is a scabbard which is curved in form. The scabbard 350 houses an instruction slide 352 which is also curved and slides in and out of the scabbard at one end. From above, the instruction slide 352 has printed indicia thereon providing user instructions to the seat occupant.

The foregoing describes only embodiment of the present invention and modifications may be made thereto without departing from the spirit of the invention.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A chair having: a supporting frame;

a main support supported by the supporting frame;

a seat portion supported above the supporting frame;

a reclinable back portion operably connected with the main support for reclining action relative to the main support;

a first recline spring comprising an elongate spring portion having dimensions of length, width and thickness wherein the width is greater than the thickness and further having a longitudinal axis aligned with the length of the elongate spring portion, the recline spring being operably connected between the main support and the reclinable back portion for resisting reclining action of the back portion through bending about an axis transverse to the longitudinal axis, wherein the first recline spring is rotatable about the longitudinal axis to adopt any one of a plurality of spring positions, at each of which the spring portion exhibits a differing spring rate in resistance to bending about the transverse axis.

2. The chair as claimed in claim 1 wherein the back portion is reclinable between a forward active position and a rear most position and a forward limit is provided to define the forward active position of the back portion and wherein the first recline spring is arranged such that as the main support and the back portion move relative to each other during recline action, each bears against the first recline spring, tending to flex the elongate spring portion about the transverse axis thereby biasing the back portion toward the forward active position through the inherent resistance of the spring.

3. The chair as claimed in claim 2 wherein, at the forward active position, no pretension is exerted on the first recline spring.

4. The chair as claimed in any one of claims 1 to 3 wherein an intermediate portion of the first recline spring bears against the main support with an end portion of the first recline spring bearing against the back portion.

5. The chair as claimed in any one of claims 1 to 3 wherein the ends of the first recline spring bear against the back portion with an intermediate part of the first recline spring bearing against the main support.

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6. The chair as claimed in claim 5 wherein the main support comprises a transversely extending main transom and the back portion includes two spaced arms pivotally mounted to the main transom with the first recline spring extending alongside the main transom with the two ends journaled in each arm and with an intermediate part of the first recline spring bearing against the main transom.

7. The chair as claimed in claim 6 wherein the main transom has a rearward extension.

8. The chair as claimed in claim 7 wherein the ends of the first recline spring are fitted with cylindrical bosses to be journaled in the arms of the back portion and the intermediate part has a cylindrical boss to bear against the main transom.

9. The chair as claimed in claim 8 wherein the main transom incorporates a bearer having a complementary bore or recess against which the cylindrical boss bears.

10. The chair as claimed in any one of claims 1 to 9 wherein locators are provided to define each of the plurality of adoptable spring positions.

11. The chair as claimed in claim 10 when dependent on claim 9 wherein the locators comprise complementary projections and detents provided in one or more of the cylindrical bosses and the corresponding bearer.

12. The chair as claimed in any one of claims 1 to 11 wherein the elongate spring portion of the first recline spring is in the form of a flat bar.

13. The chair as claimed in claim 12 wherein there are three spring positions, the first with the width dimension of the flat bar arranged substantially aligned with the transverse bending axis, a second adoptable spring position having the width dimension arranged diagonally to the transverse bending axis and a third with the width of the flat bar arranged transversely to the bending axis.

14. The chair as claimed in any one of claims 1 to 13 wherein there is more than one elongate spring portion incorporated into the first recline spring.

15. The chair as claimed in any one of claims 1 to 14 wherein the first recline spring includes an actuator for selective user rotation of the first recline spring.

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16. The chair as claimed in any one of claims 1 to 15 further including a second recline spring.

17. The chair as claimed in claim 16 wherein the second recline spring is adjustable.

18. The chair as claimed in claim 16 wherein the second recline spring is non-adjustable.

19. The chair as claimed in any one of claims 16 to 18 when dependent on claim 2 wherein the second recline spring exhibits a preload in the forward active position.

20. The chair as claimed in any one of claims 1 to 19 wherein the back portion is operably connected to the seat portion whereby the weight of the occupant assists in resisting reclining action of the back portion.

Dated this 31st day of August 2005
By their Patent Attorneys
A J PARK
On behalf of the Applicant
Per:

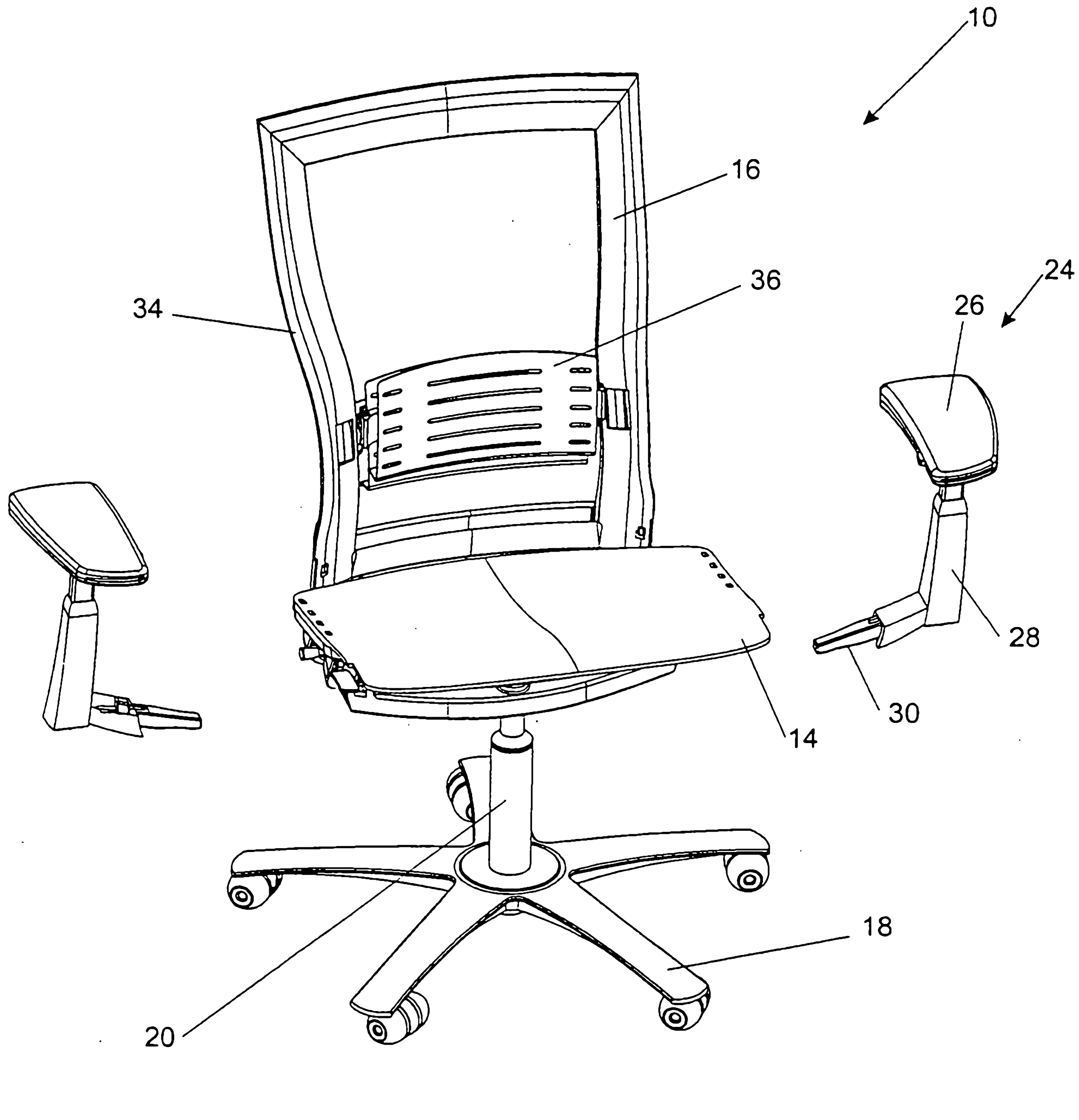


FIGURE 1

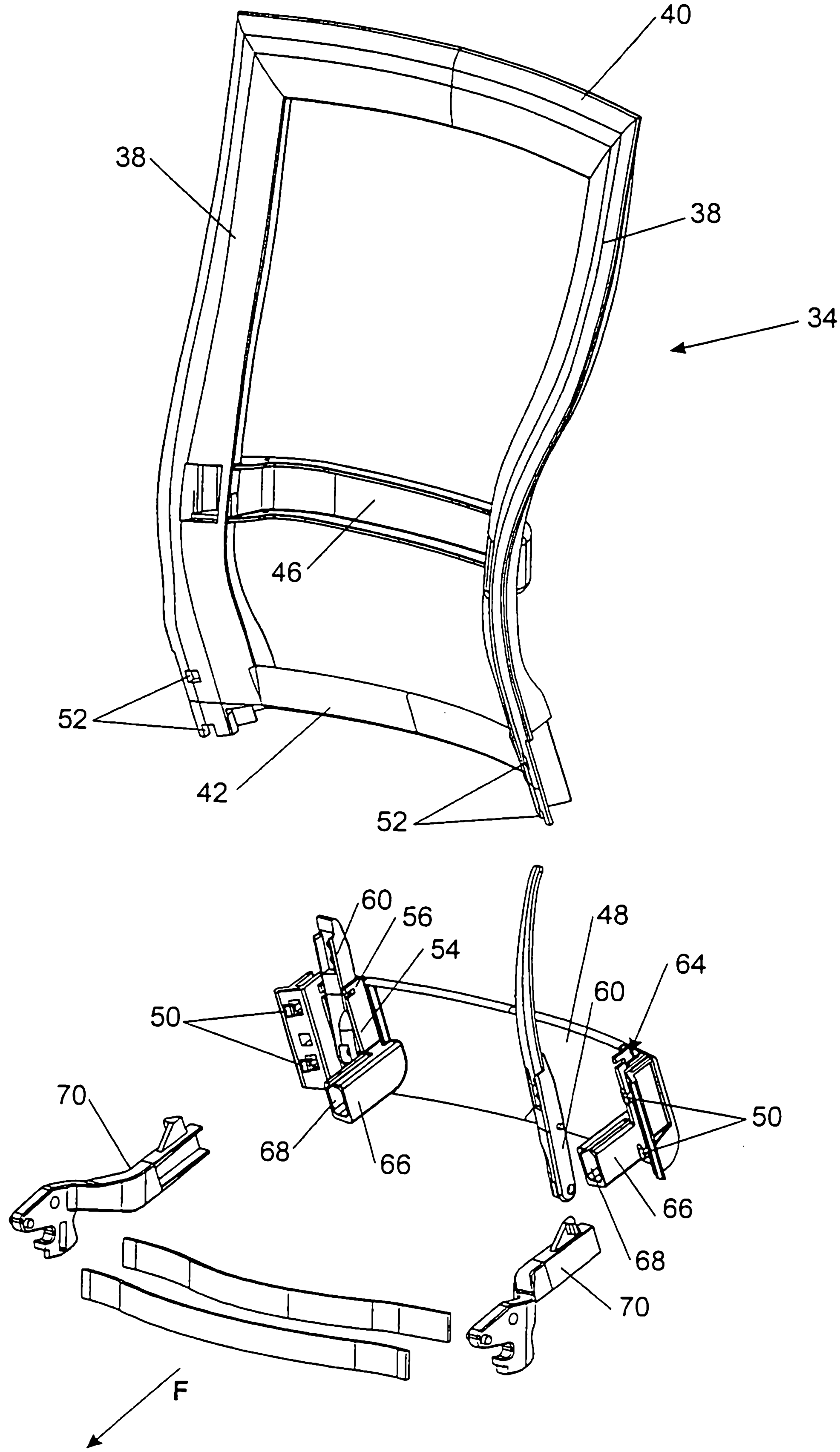


FIGURE 2a

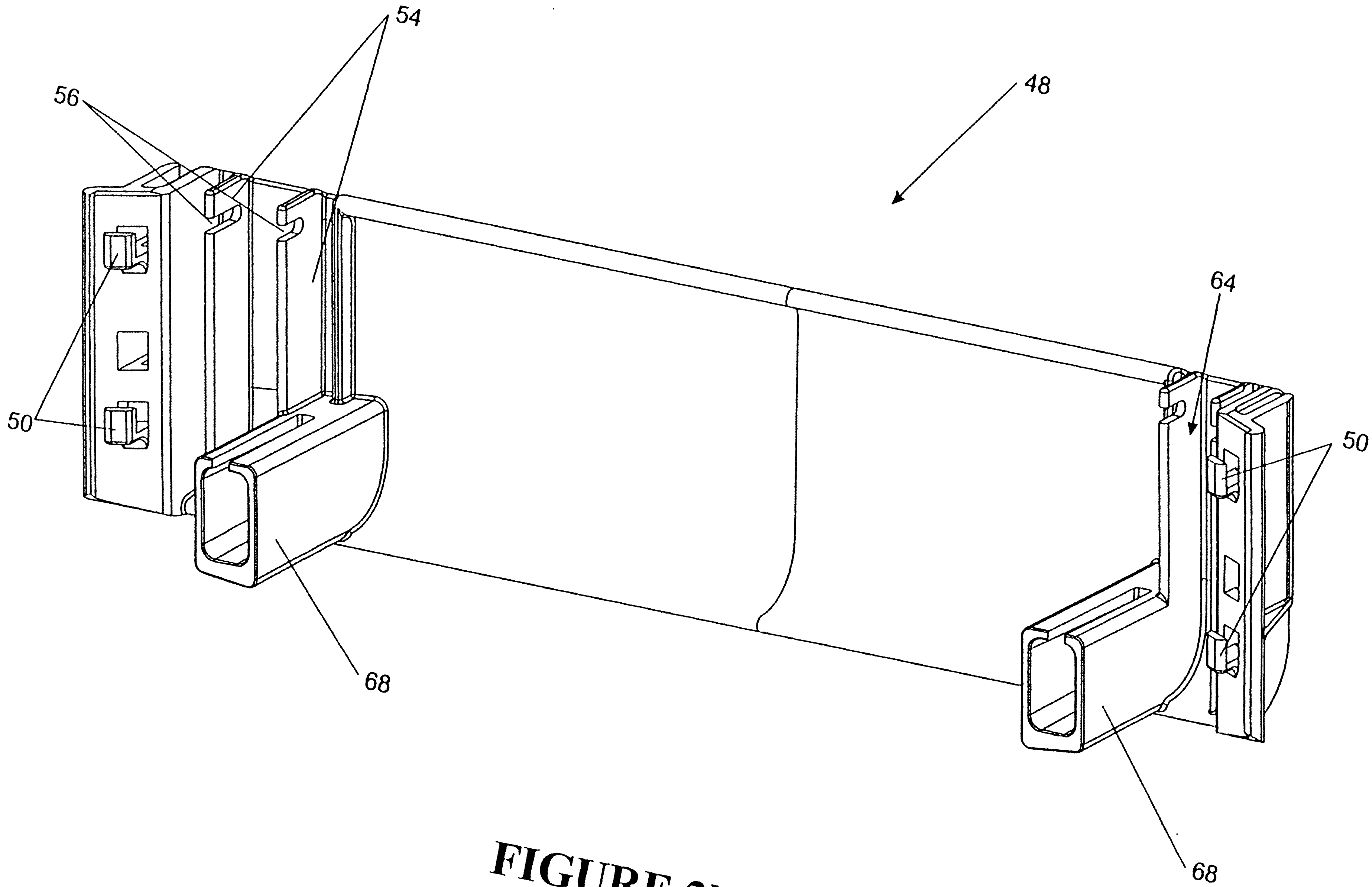


FIGURE 2b

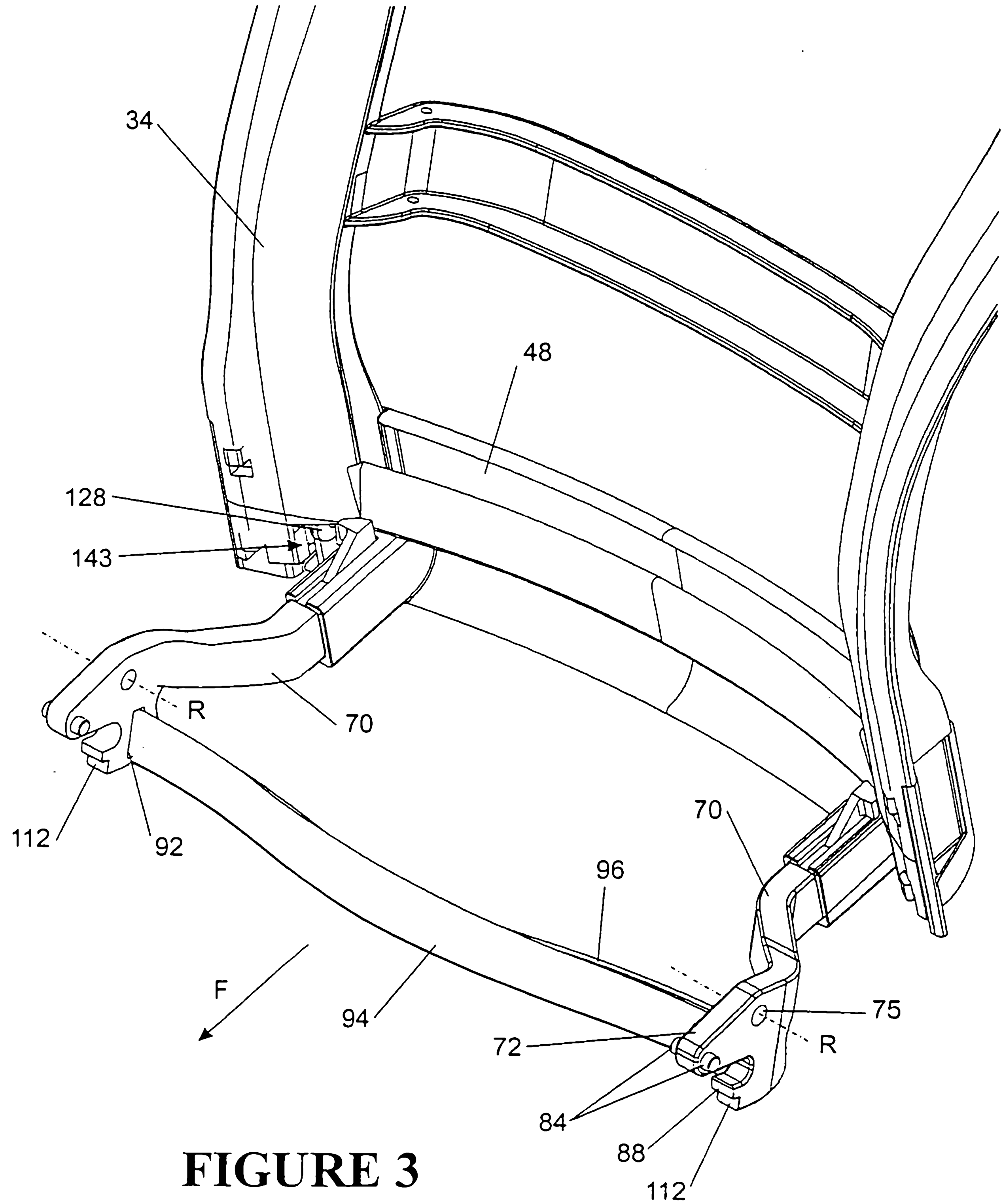


FIGURE 3

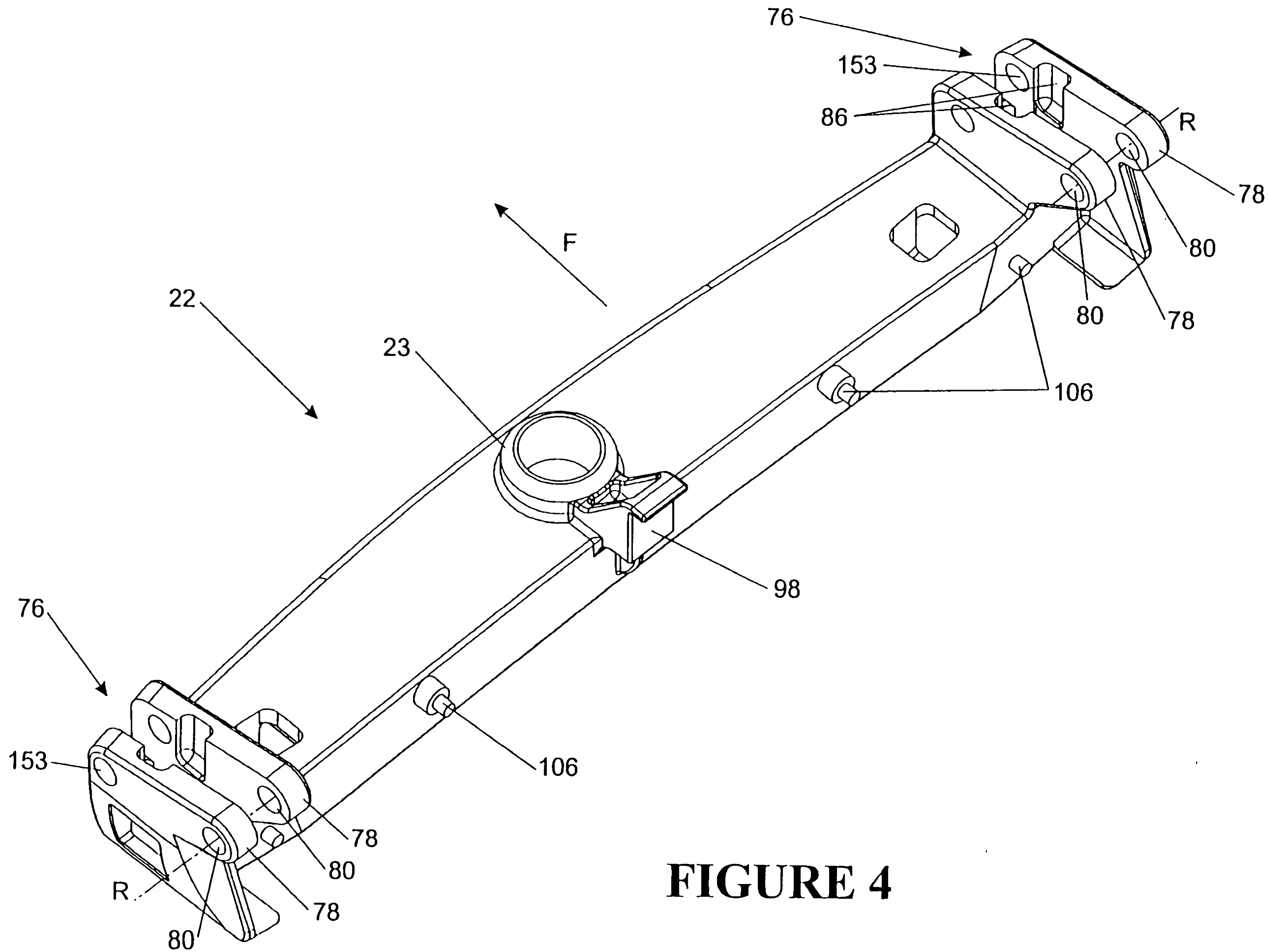


FIGURE 4

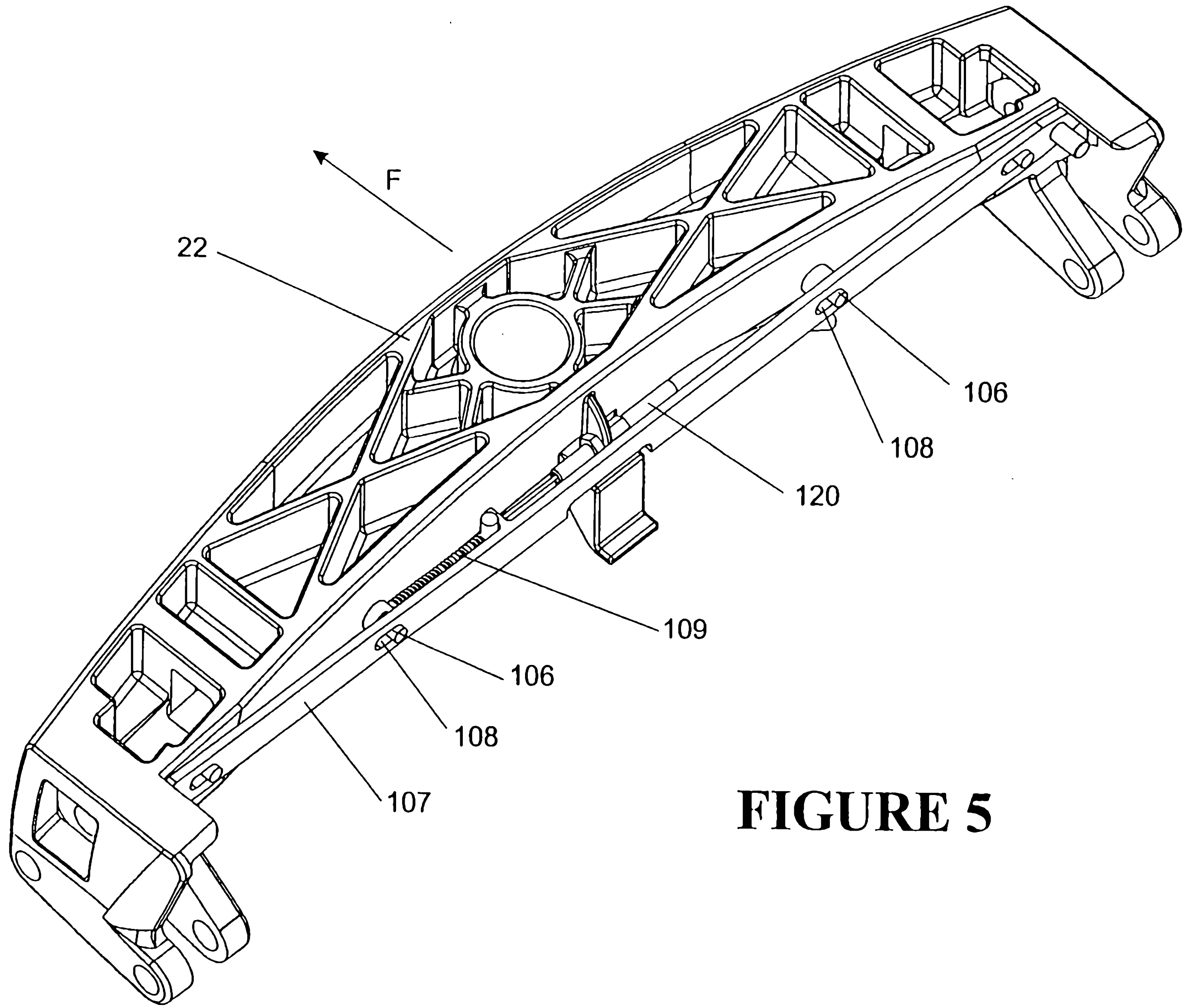


FIGURE 5

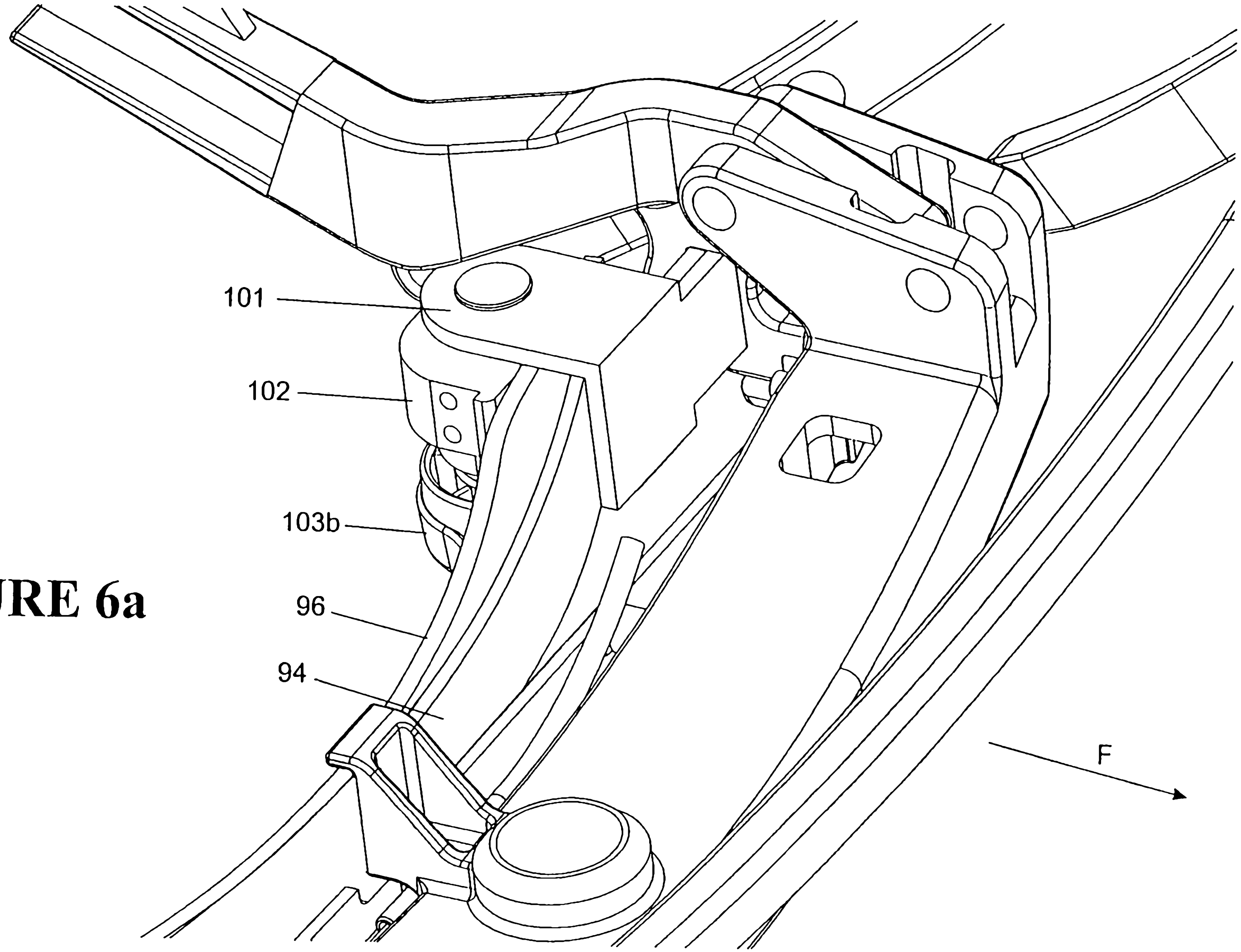


FIGURE 6a

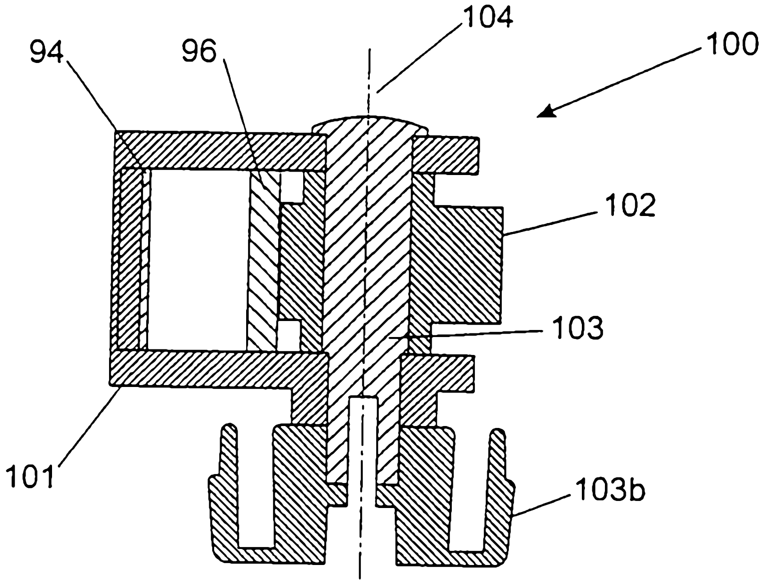


FIGURE 6b

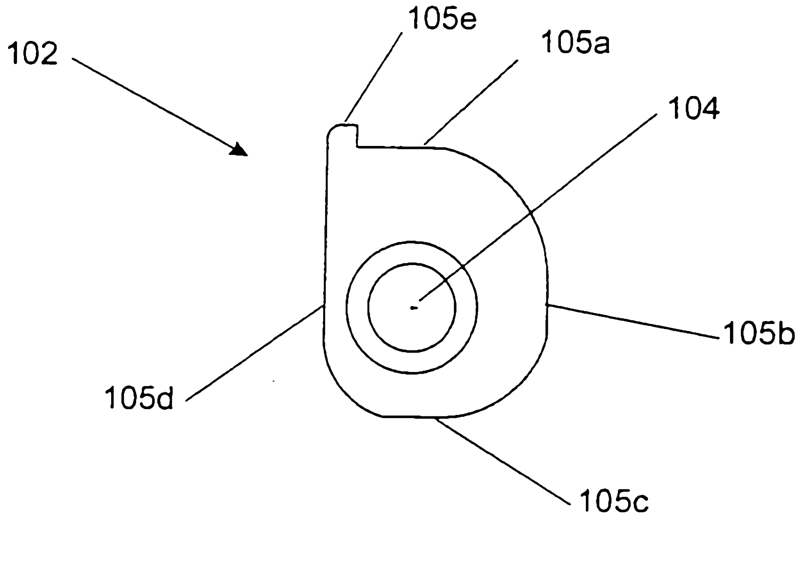


FIGURE 6c

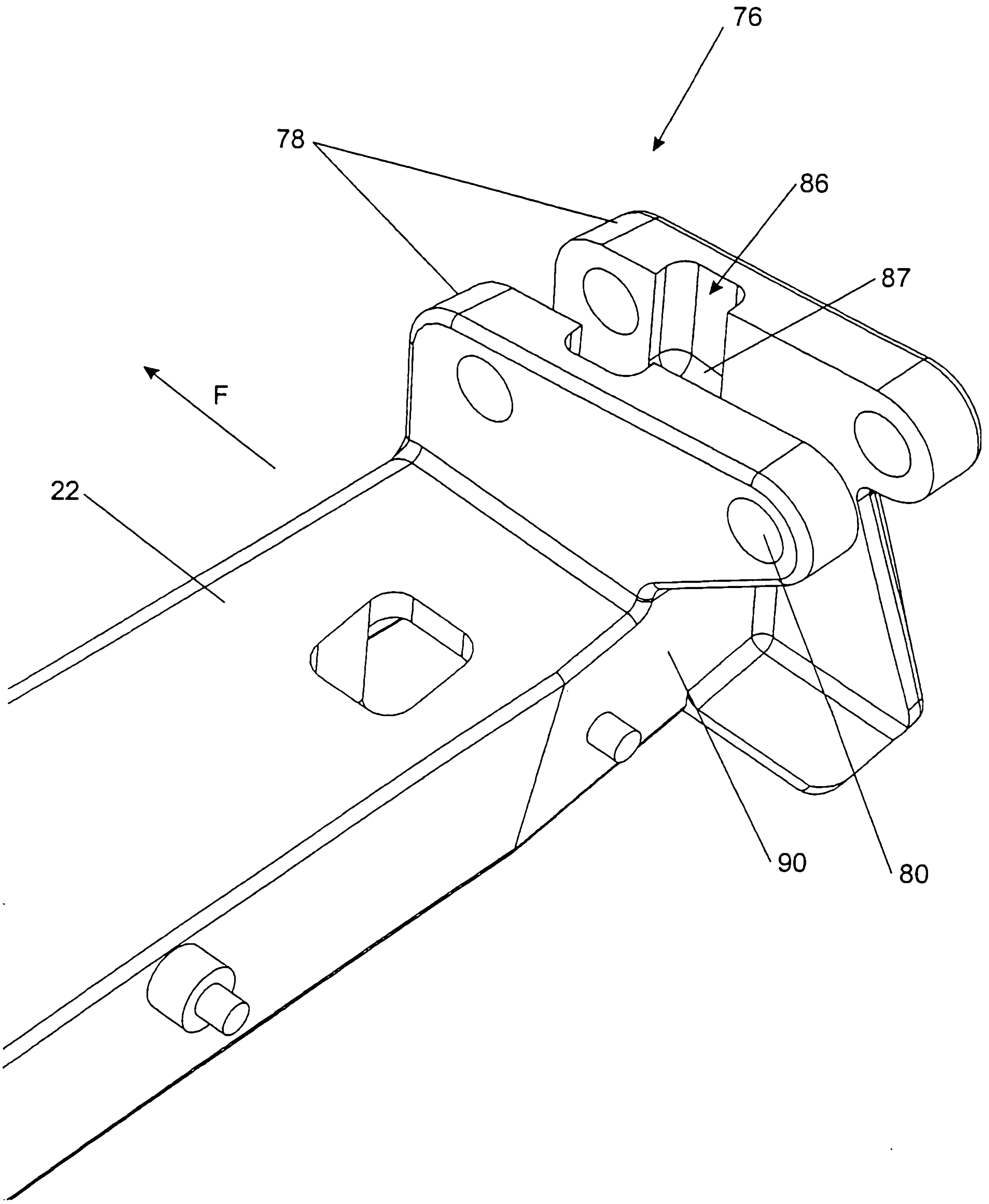
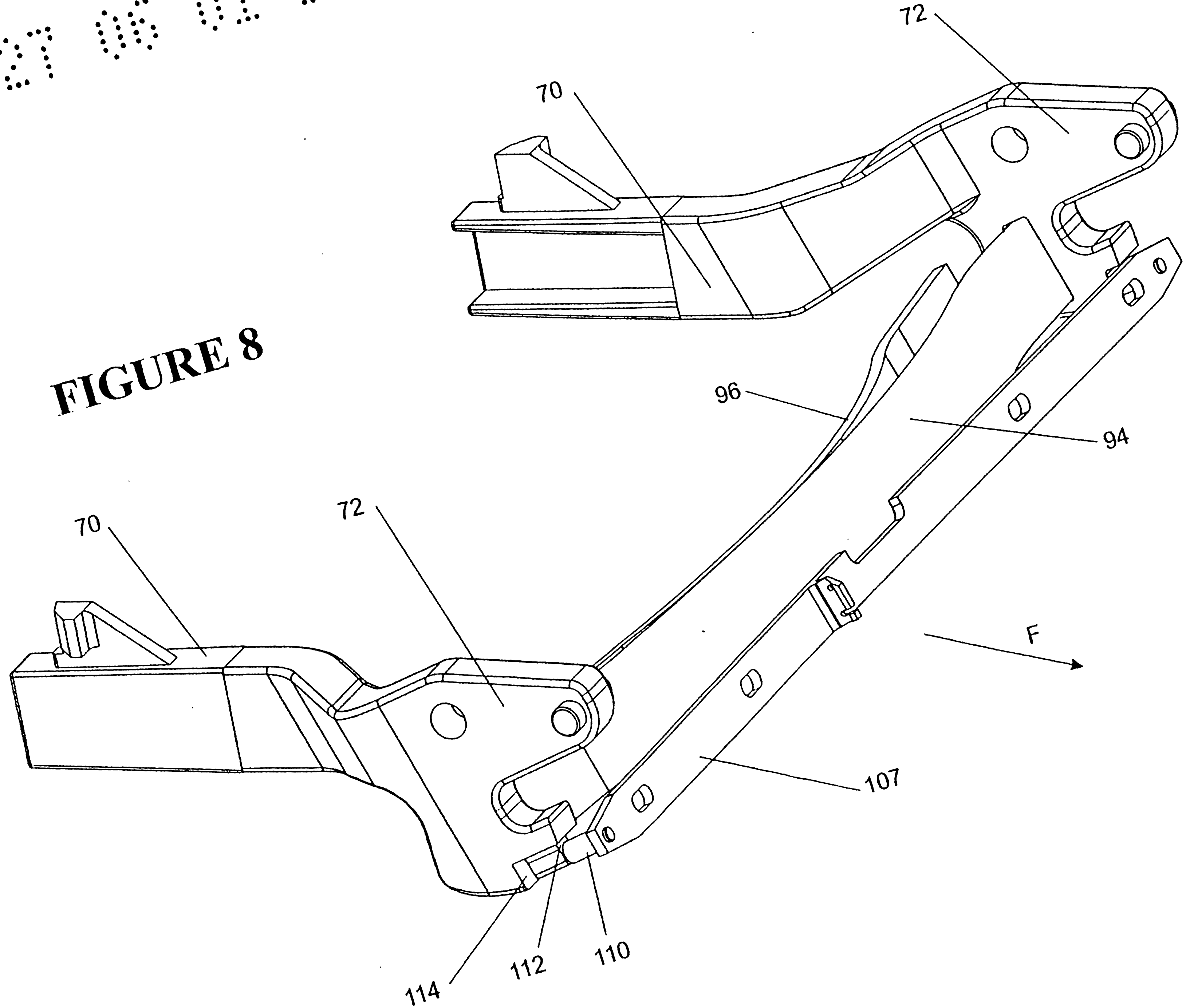


FIGURE 7

FIGURE 8



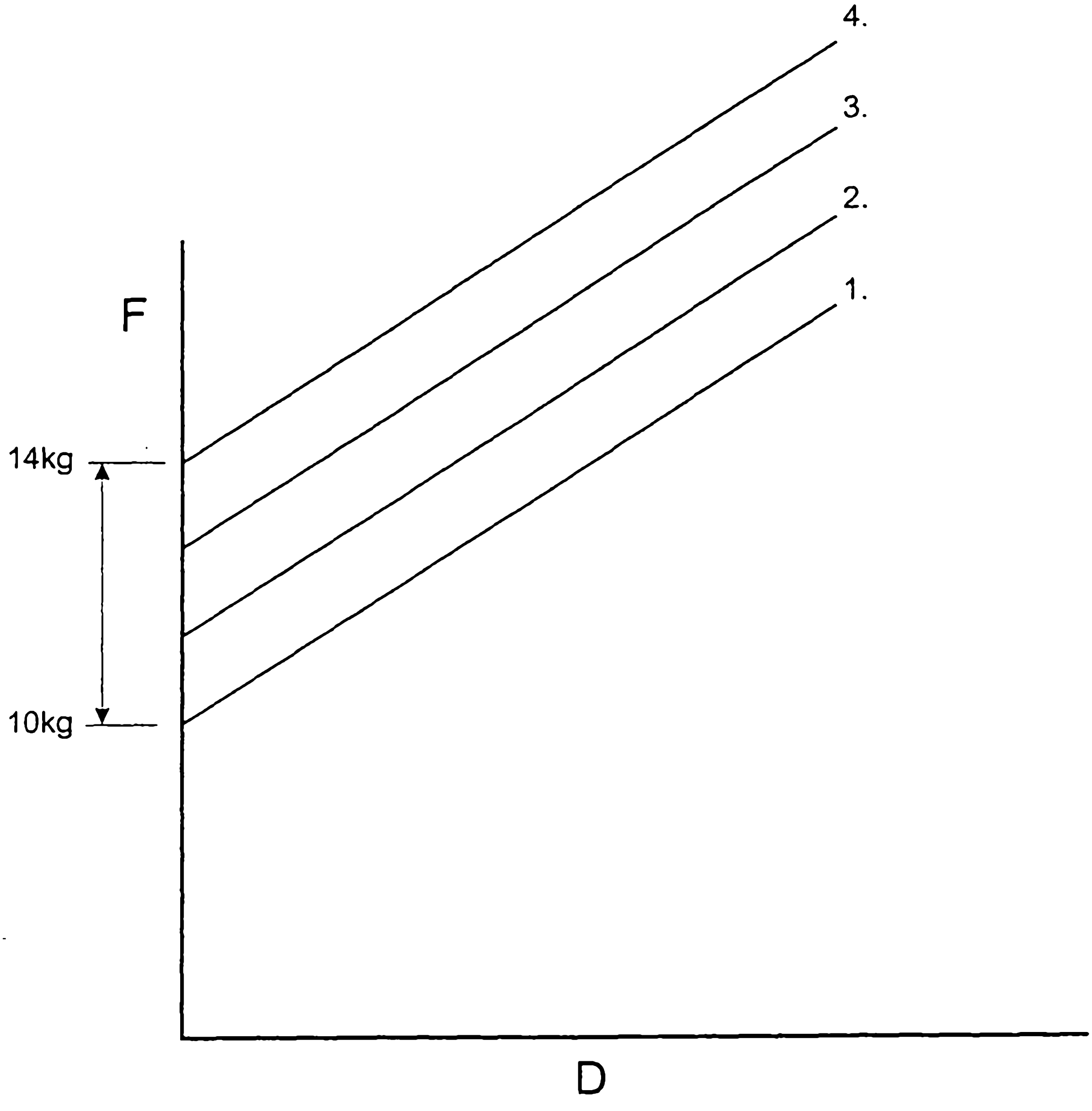


FIGURE 9

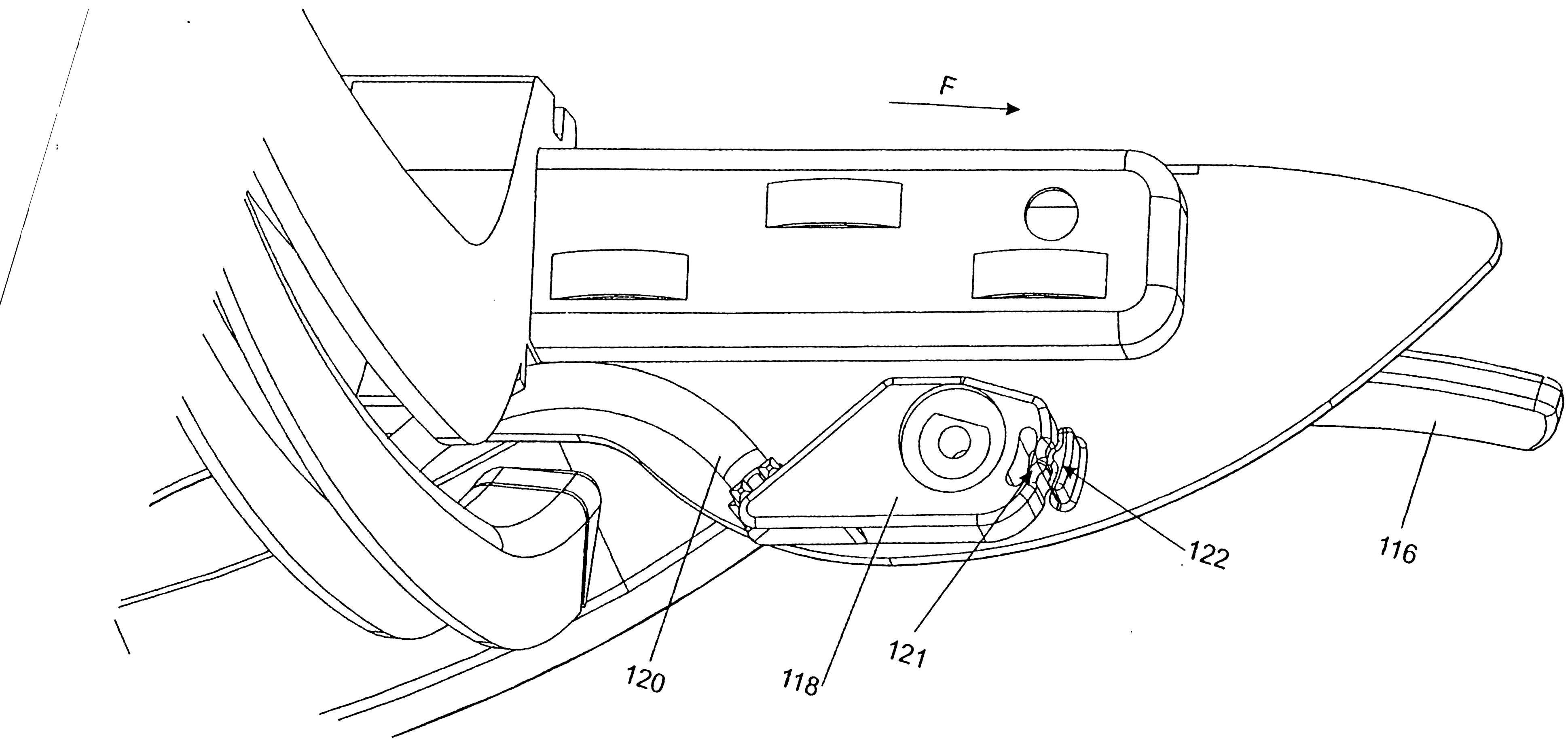
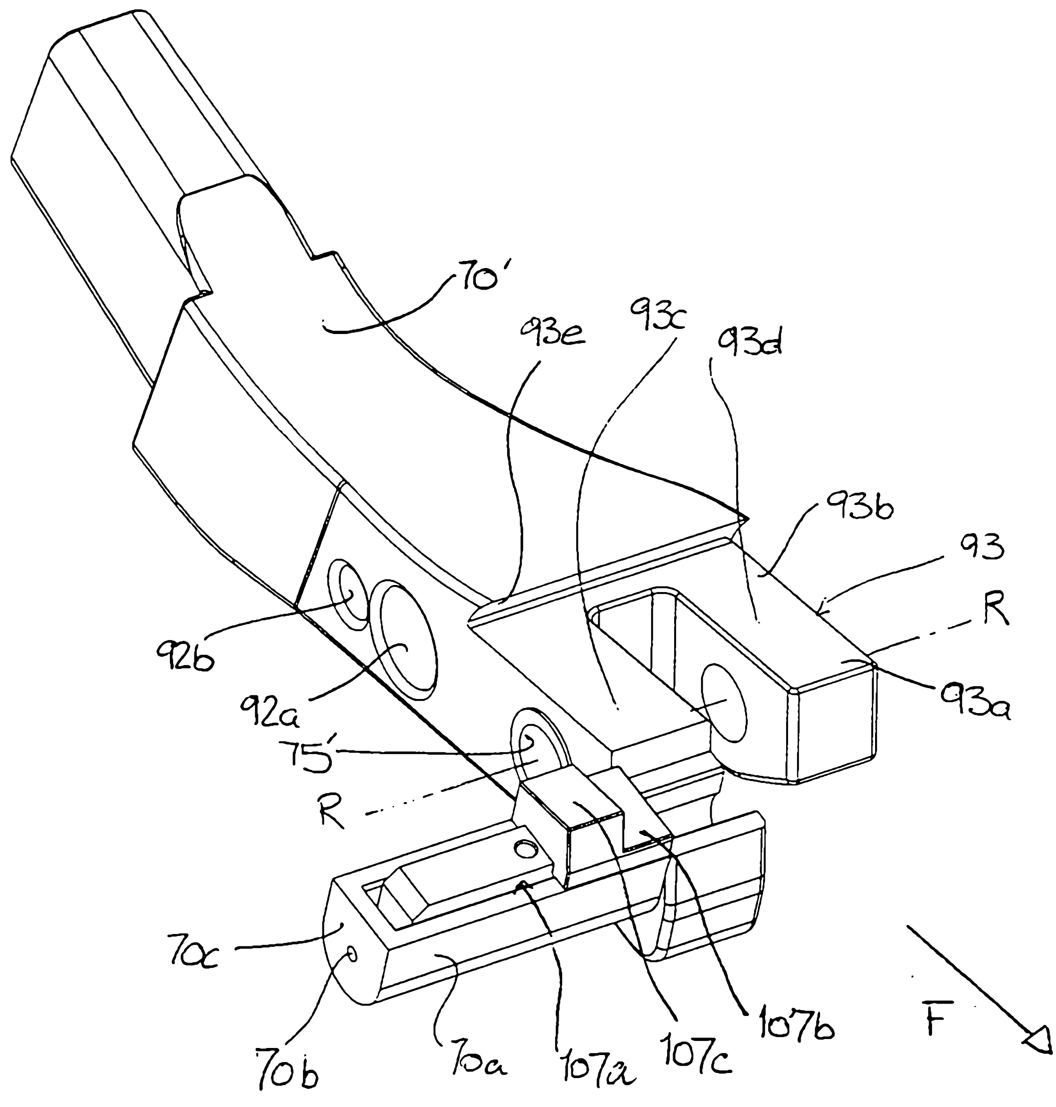


FIGURE 10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93d
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93
R
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92b
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75'
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70c
70b
70a
107a
107c
107b
F

FIG 10a

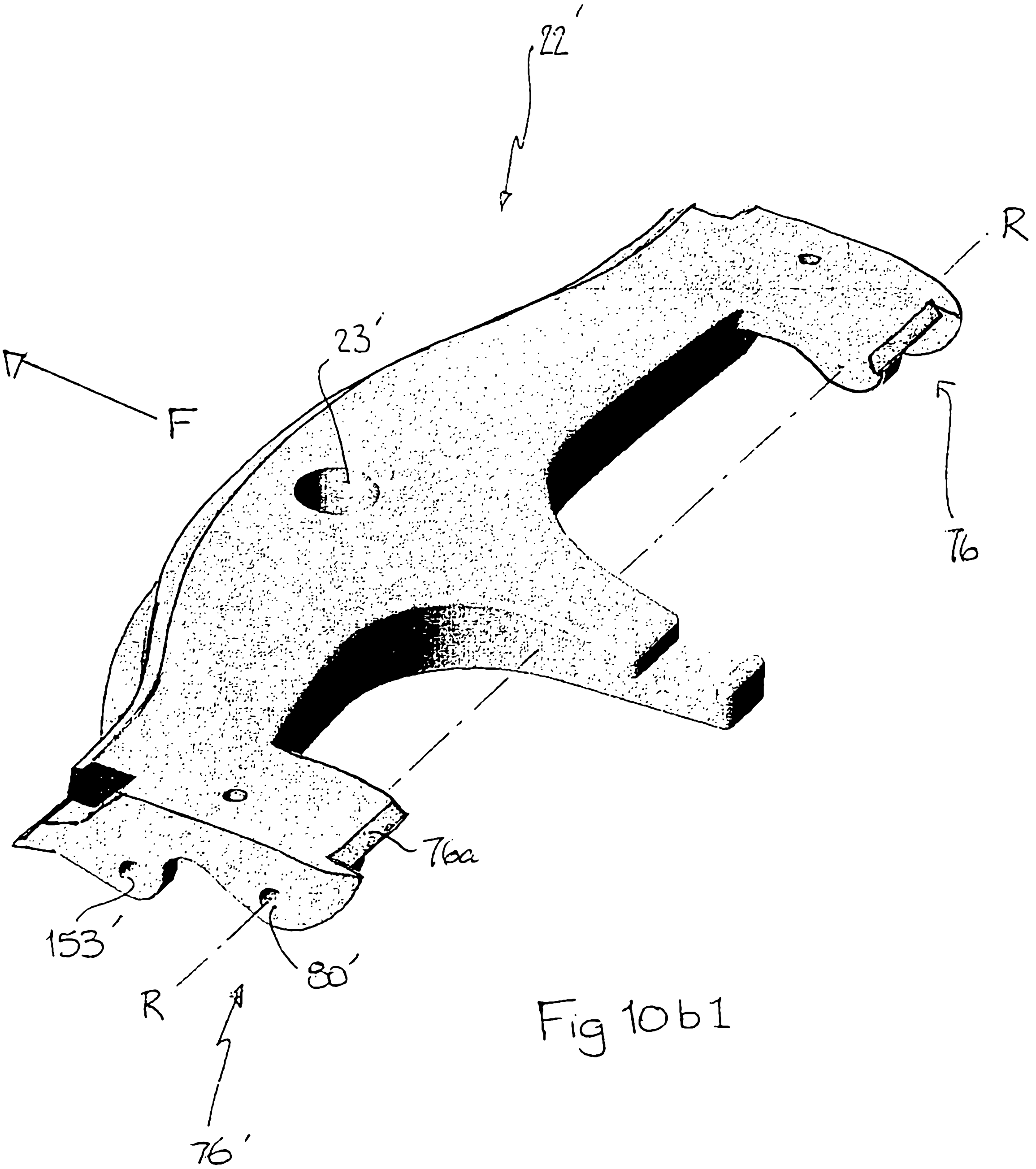

Fig 10b1

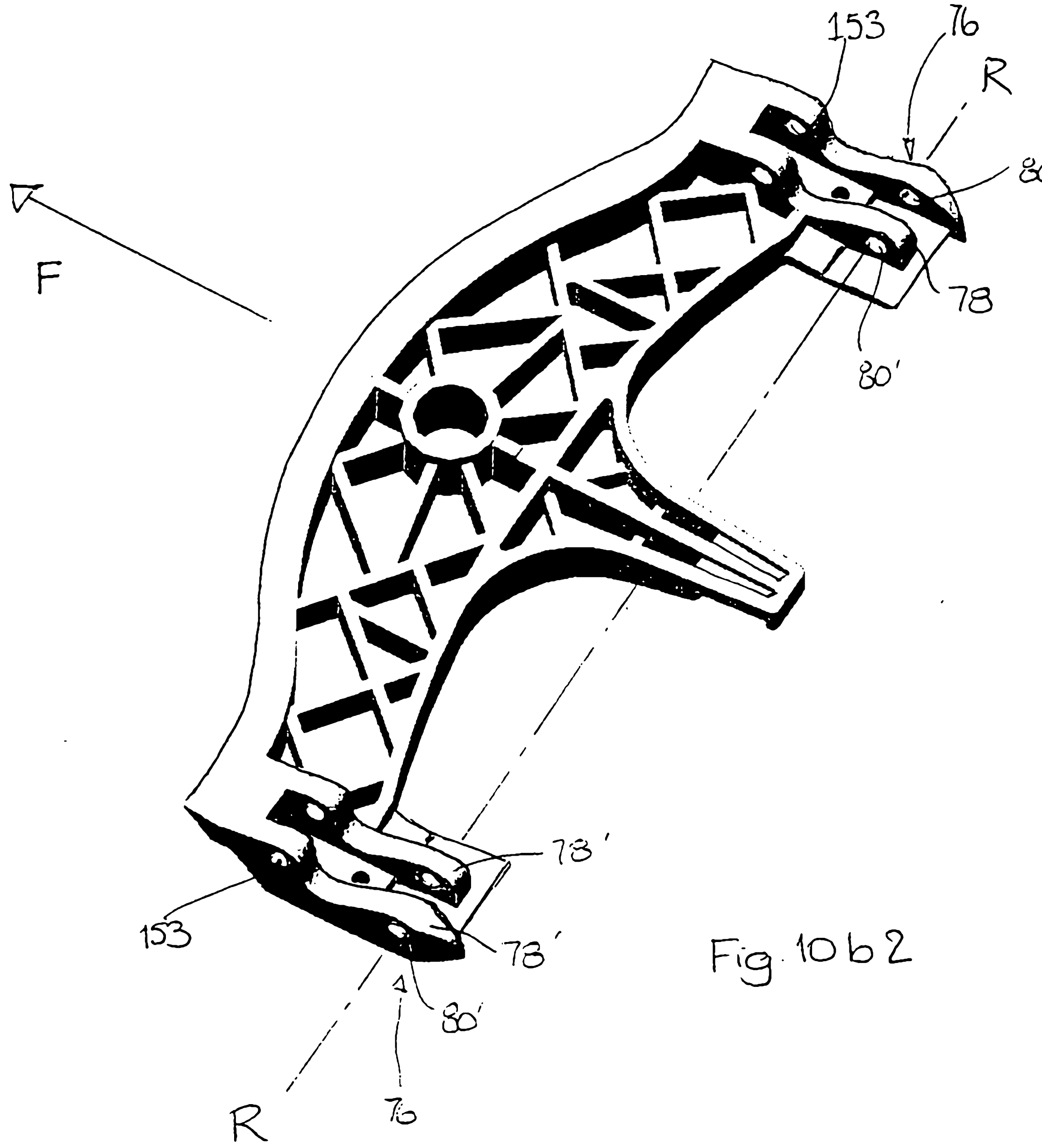

Fig. 10 b 2

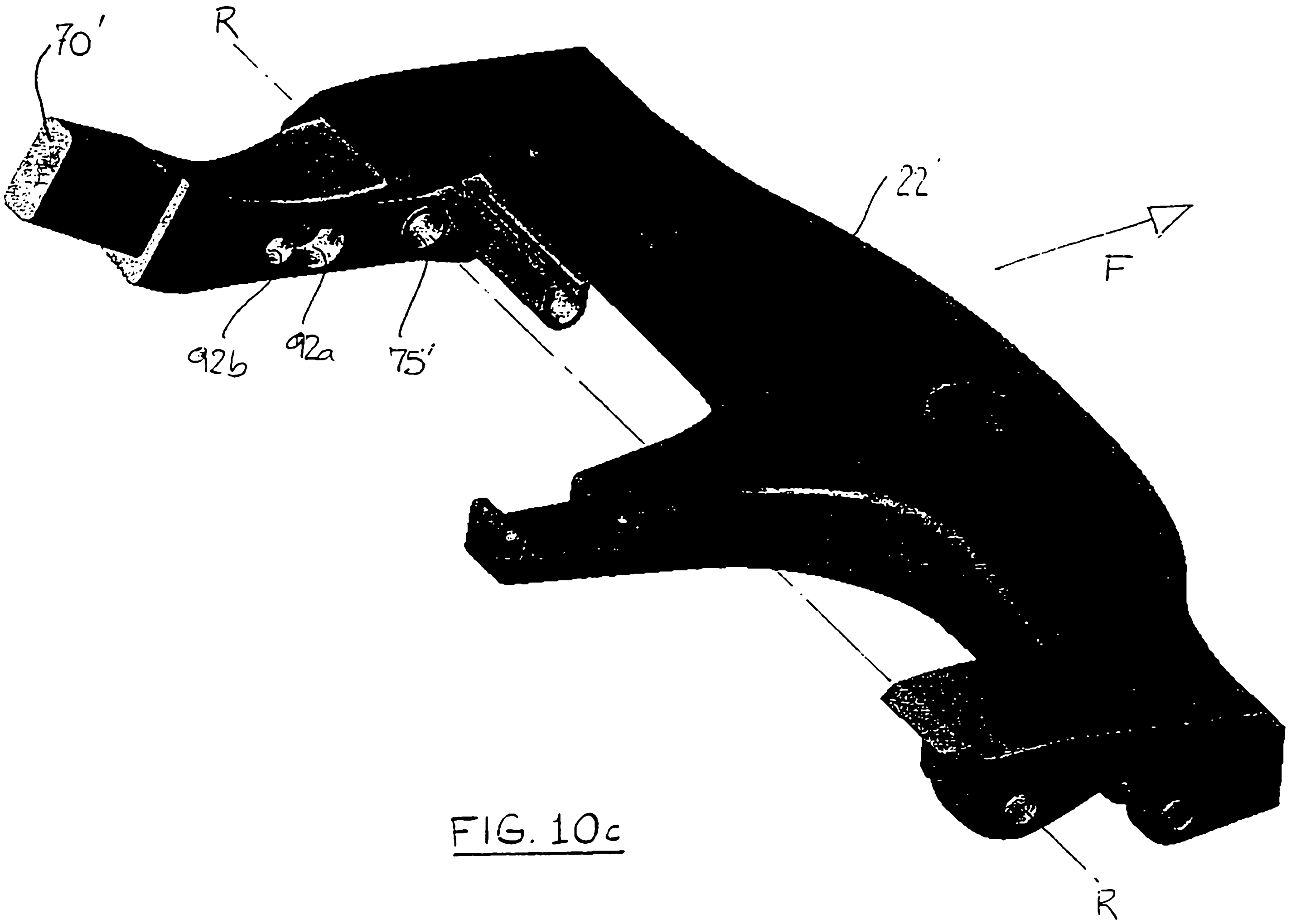

FIG. 10c

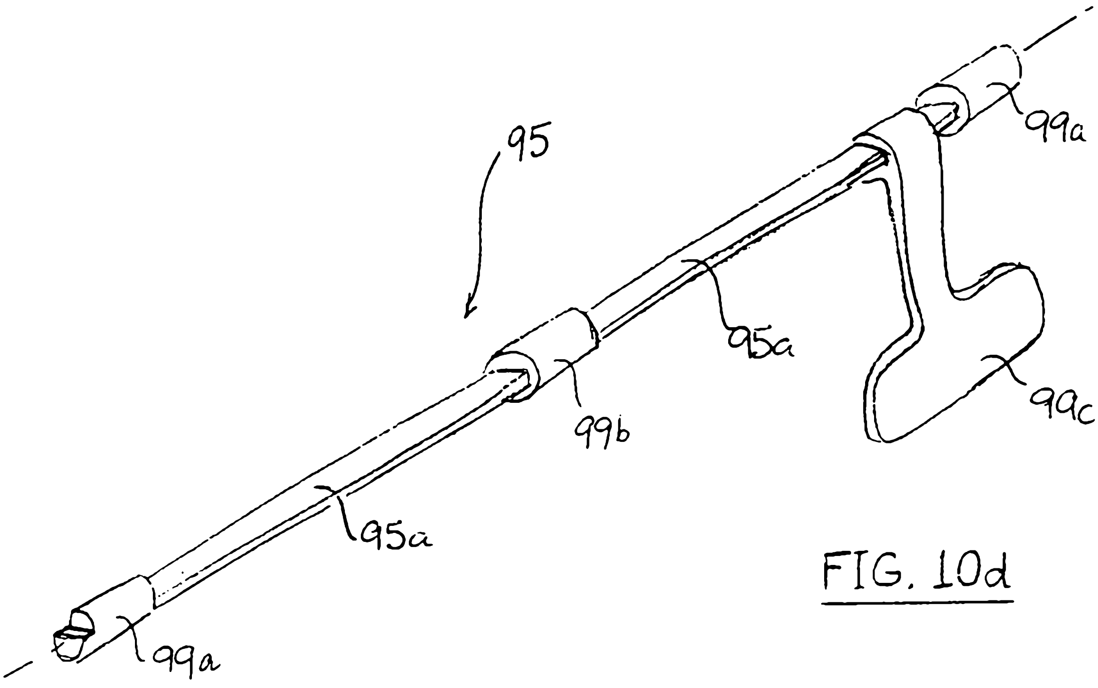

FIG. 10d

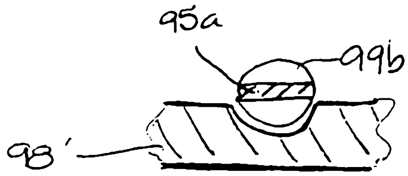

FIG. 10f

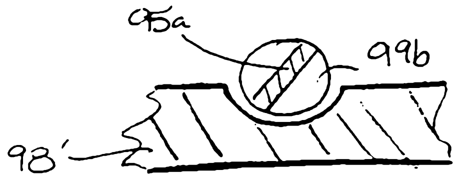

FIG. 10g

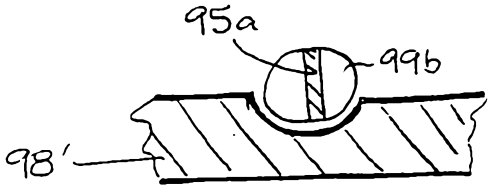

FIG. 10h

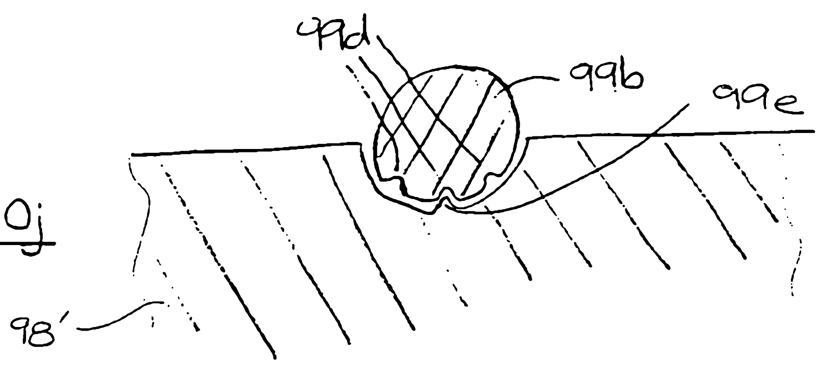

FIG. 10j

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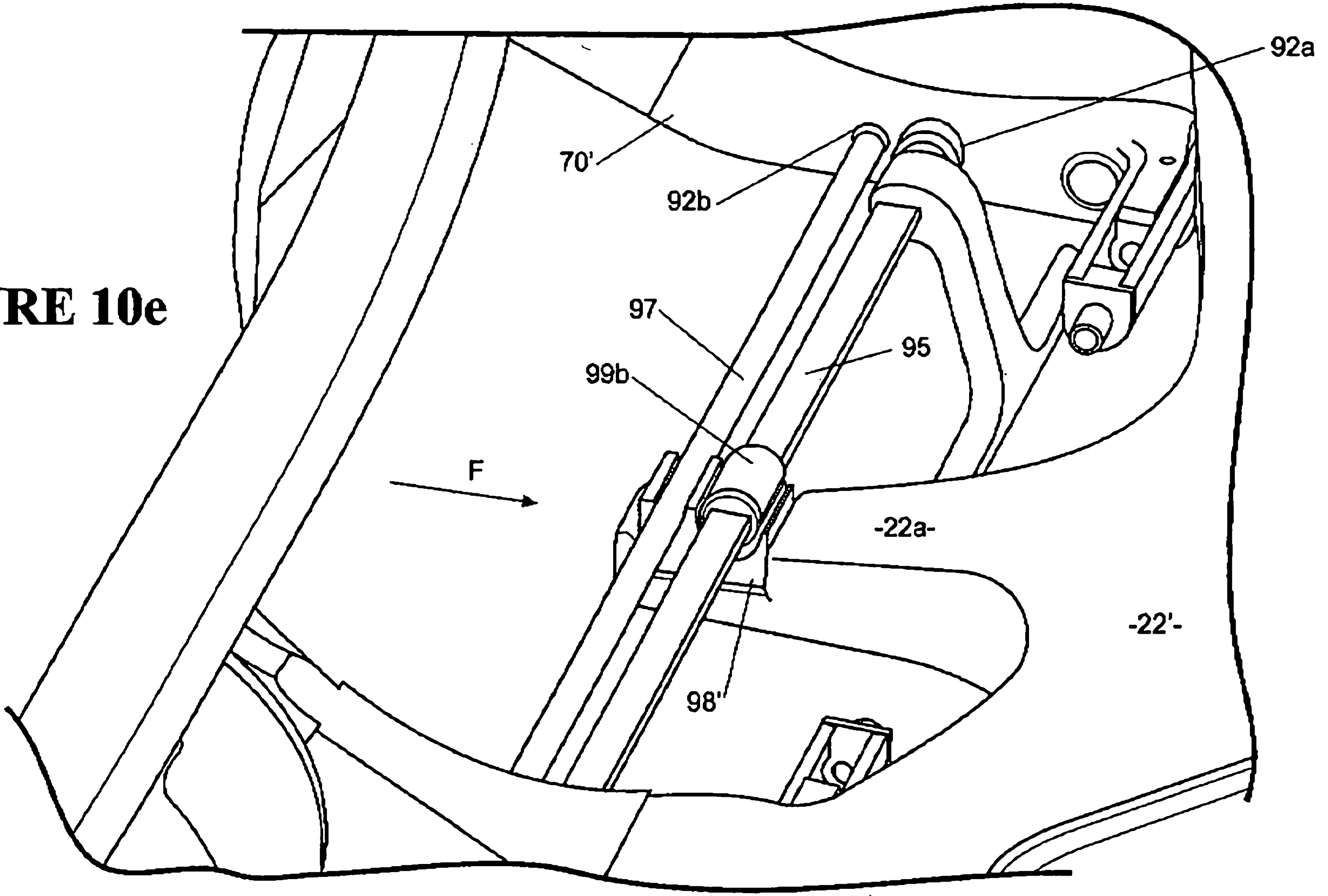
FIGURE 10e



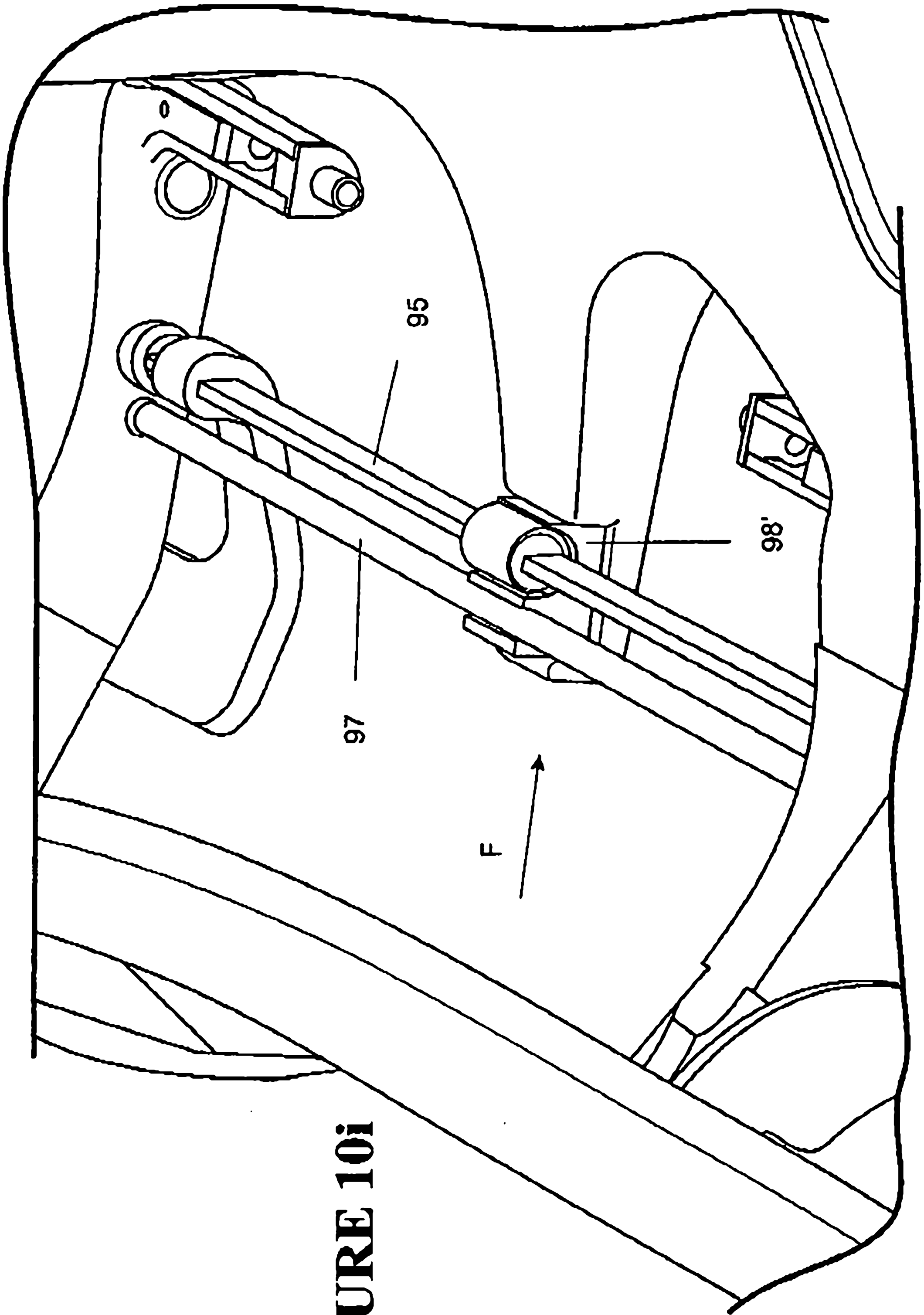


FIGURE 10i

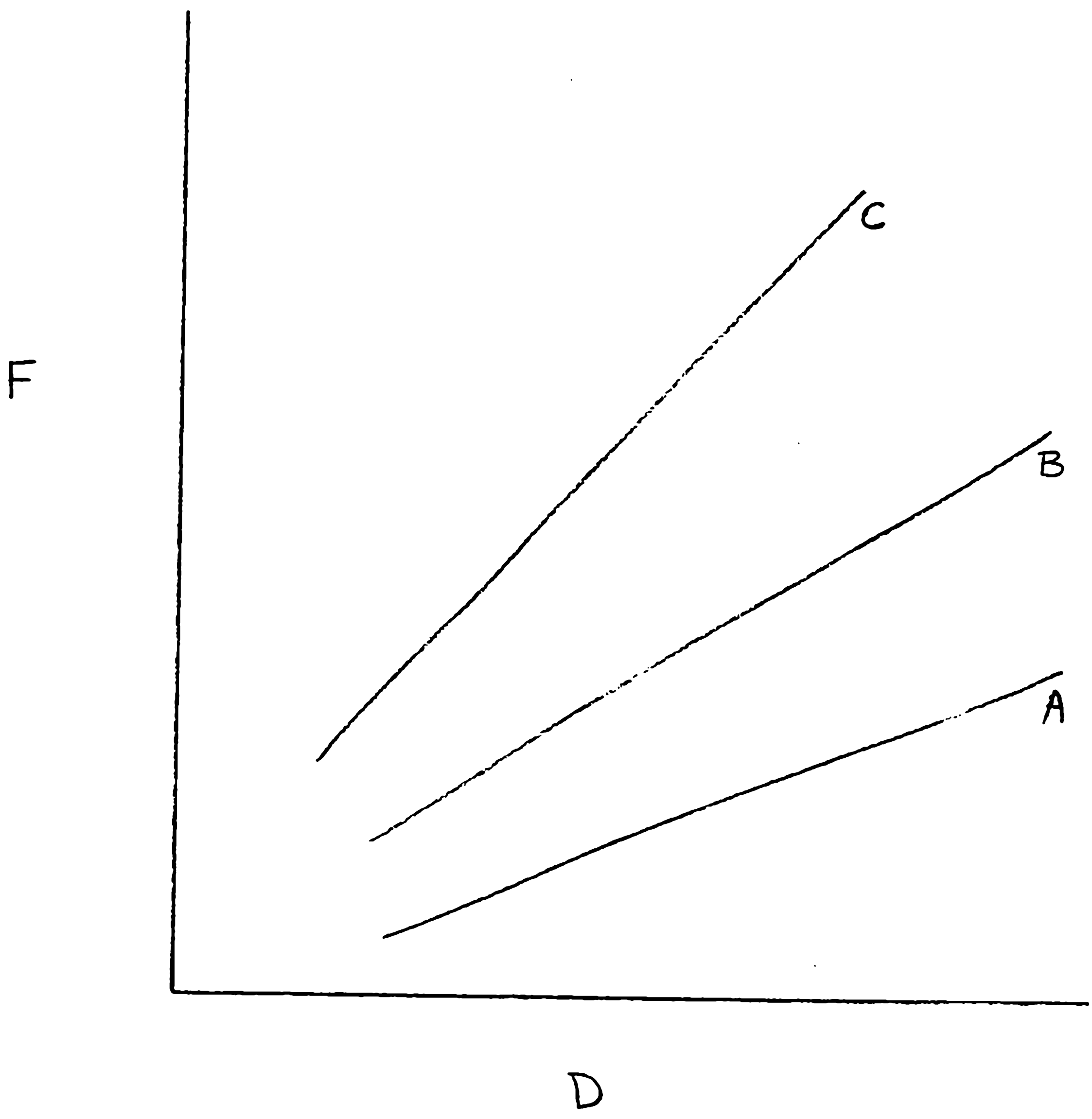


FIG. 10K

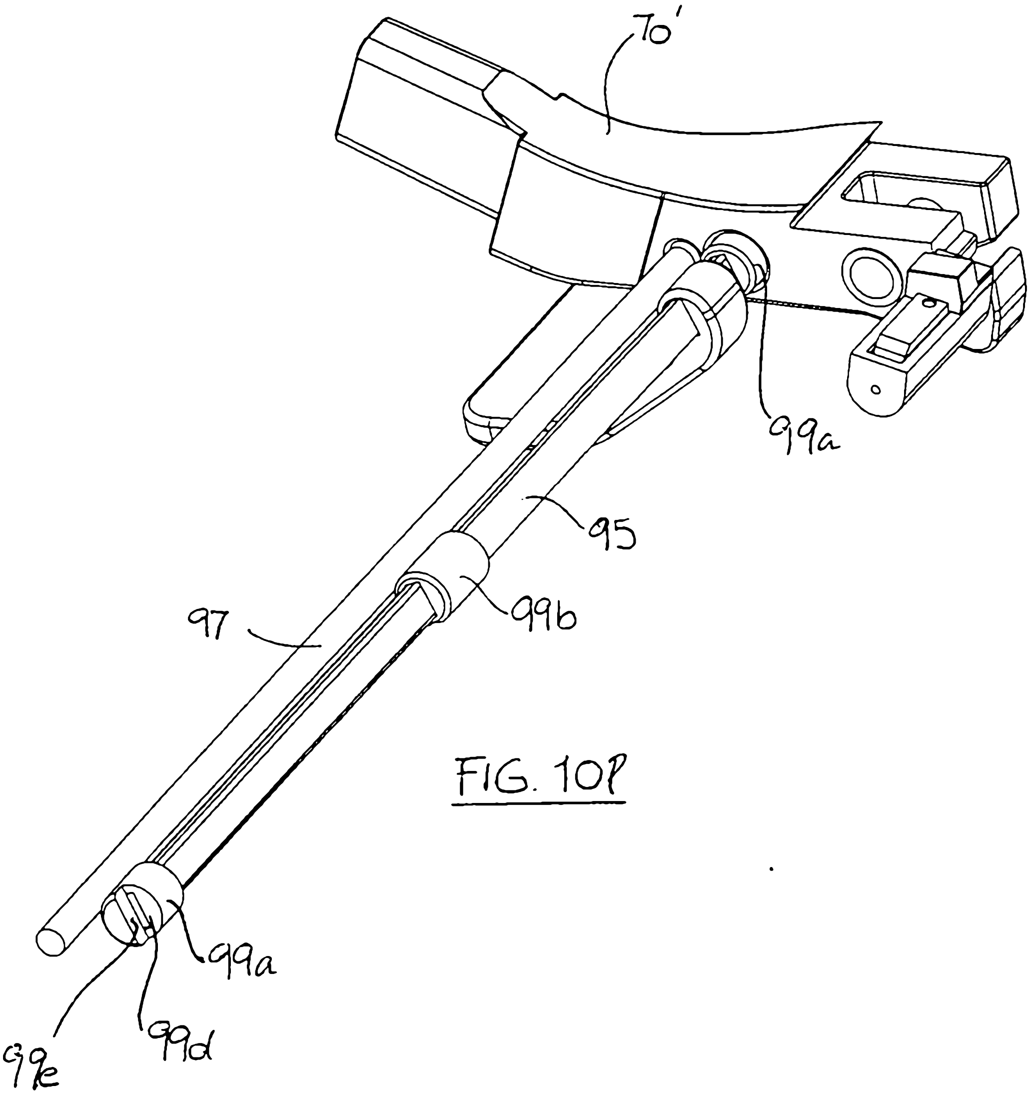


FIG. 10P

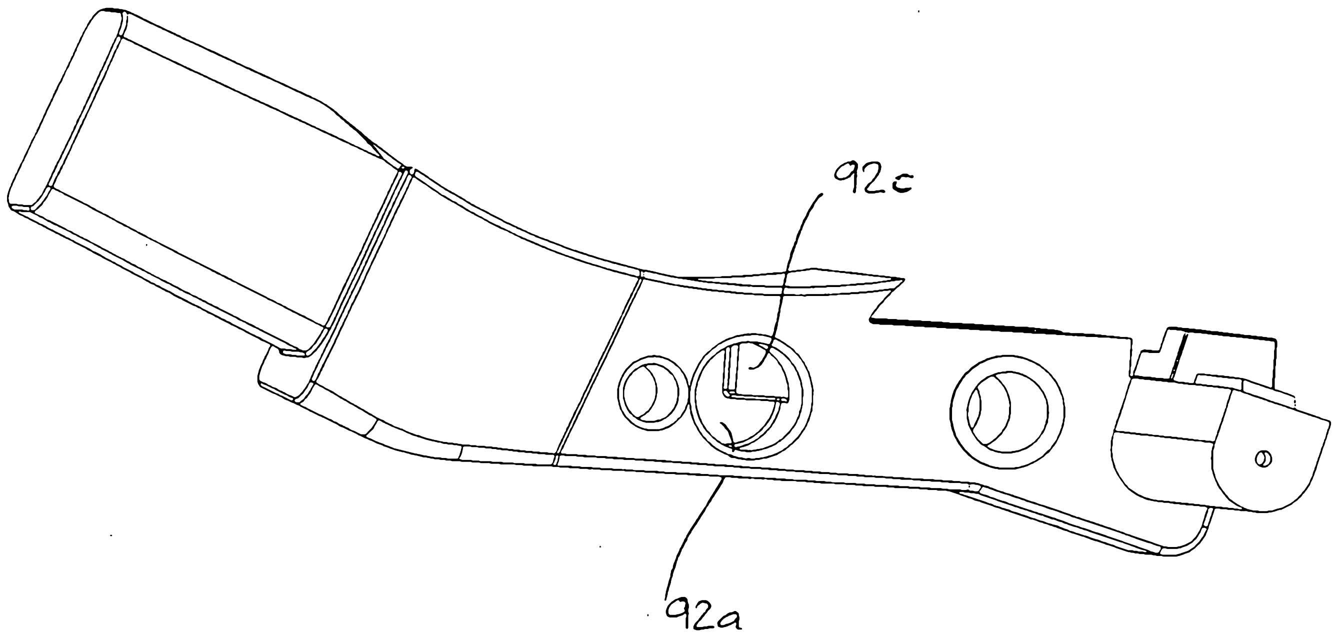


FIG. 10m

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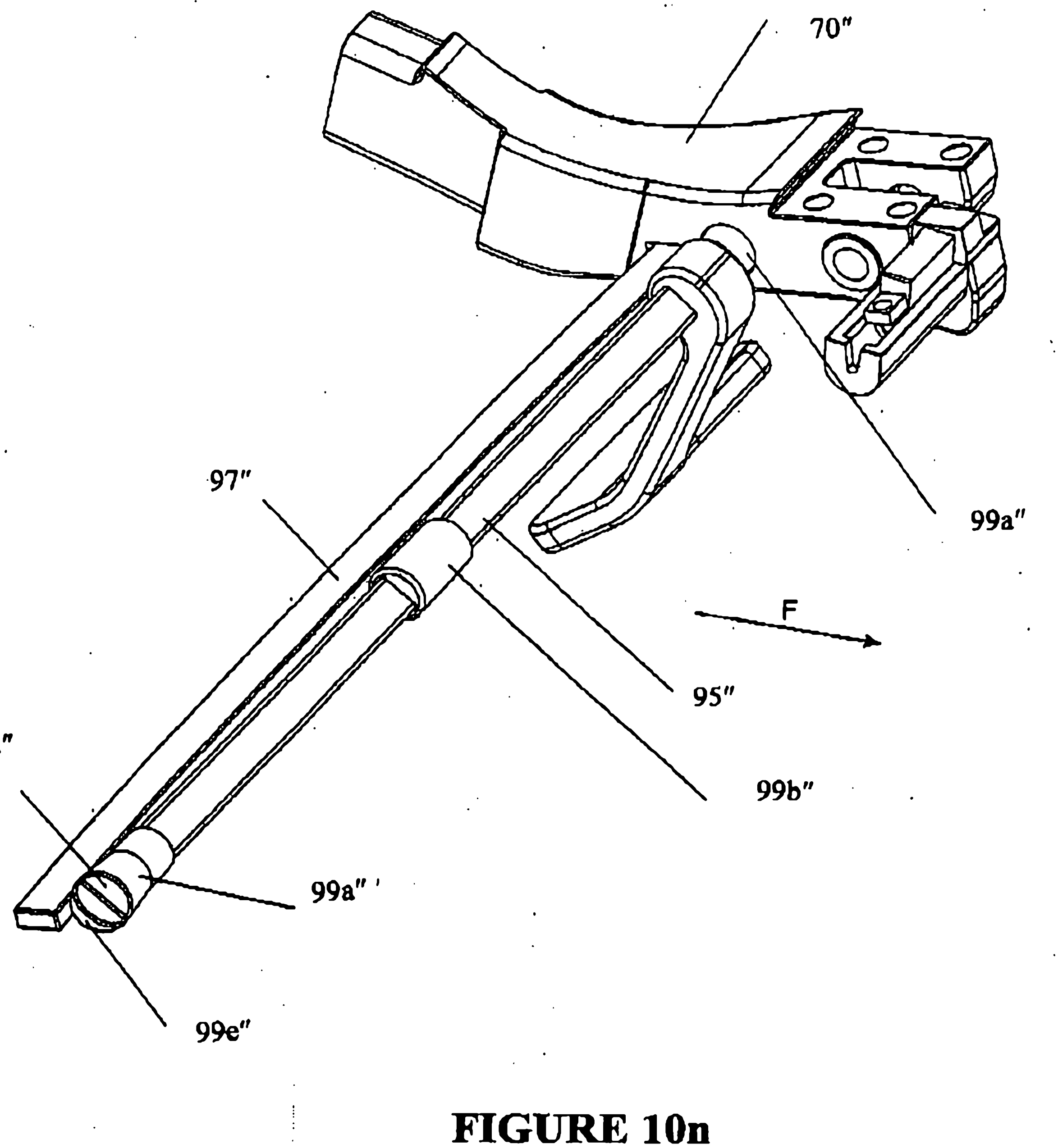

FIGURE 10n

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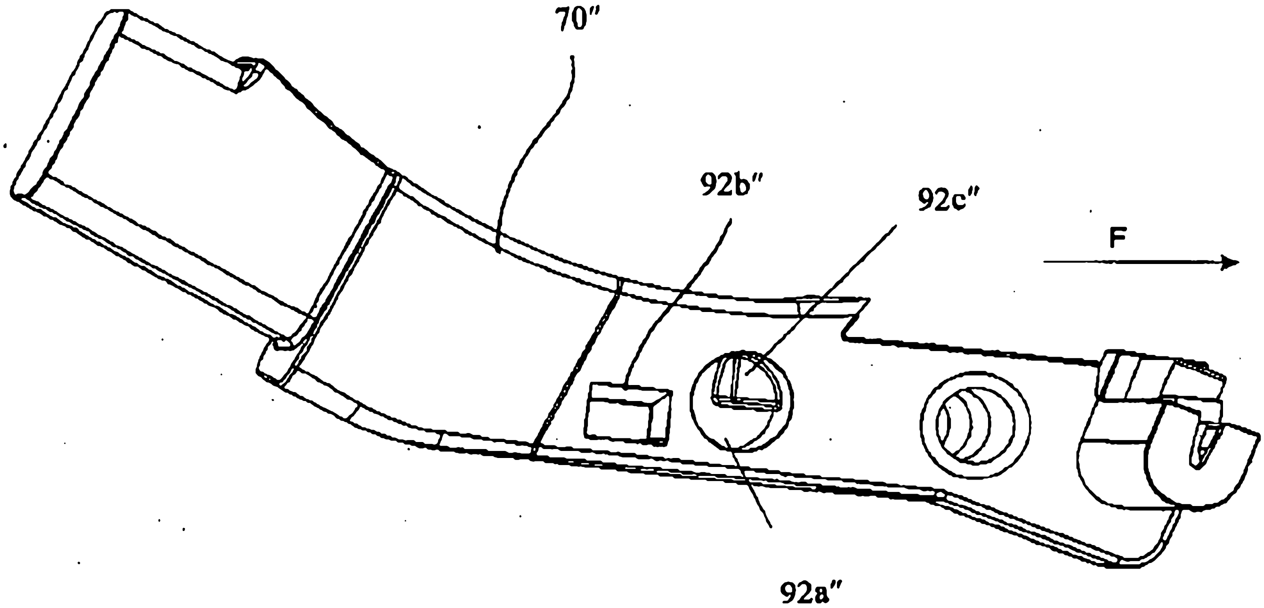


FIGURE 10o

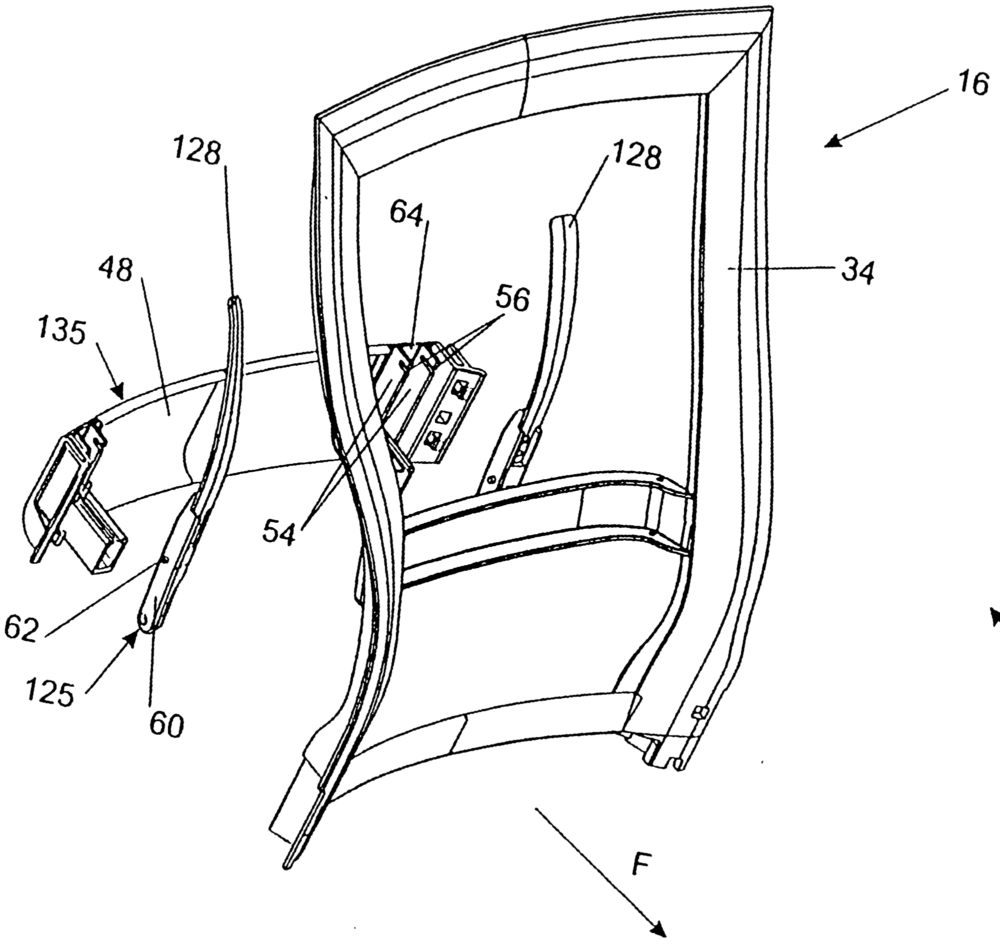


FIGURE 11

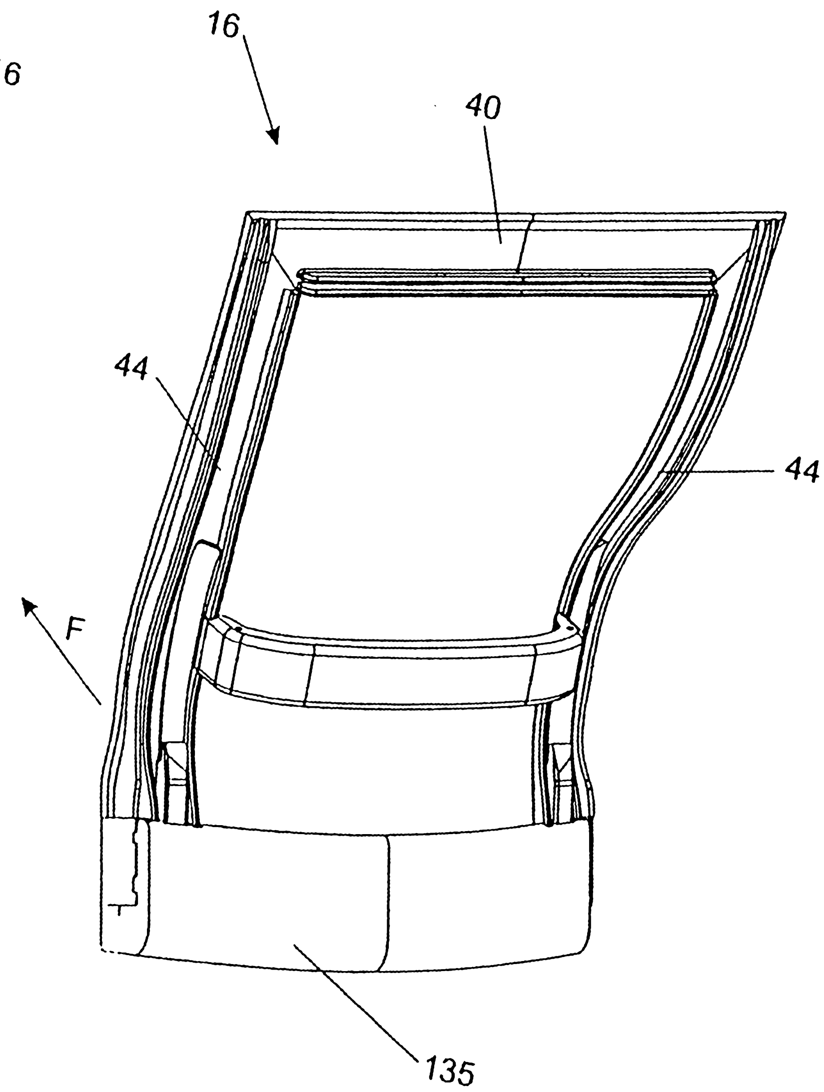
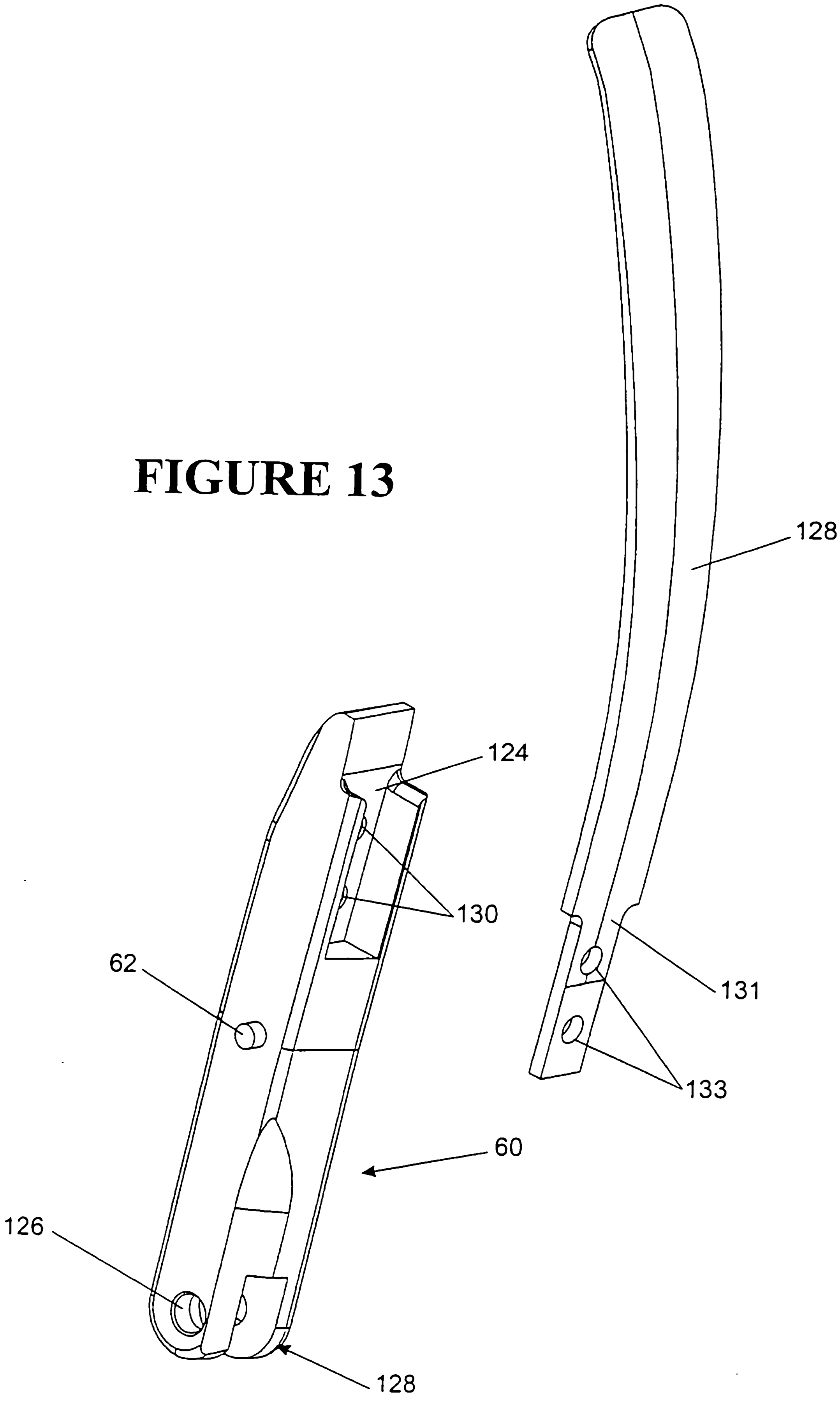


FIGURE 12

FIGURE 13



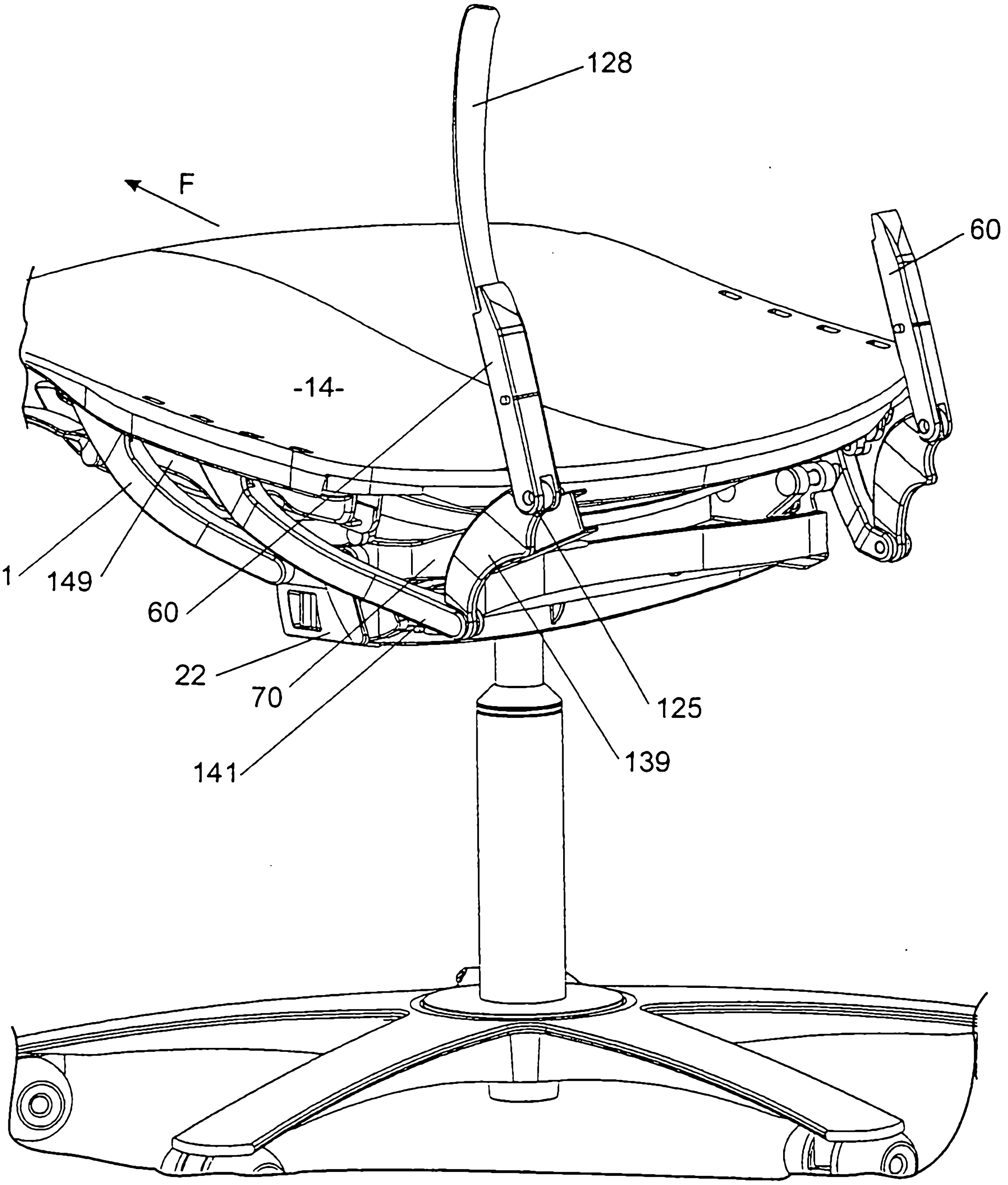


FIGURE 14

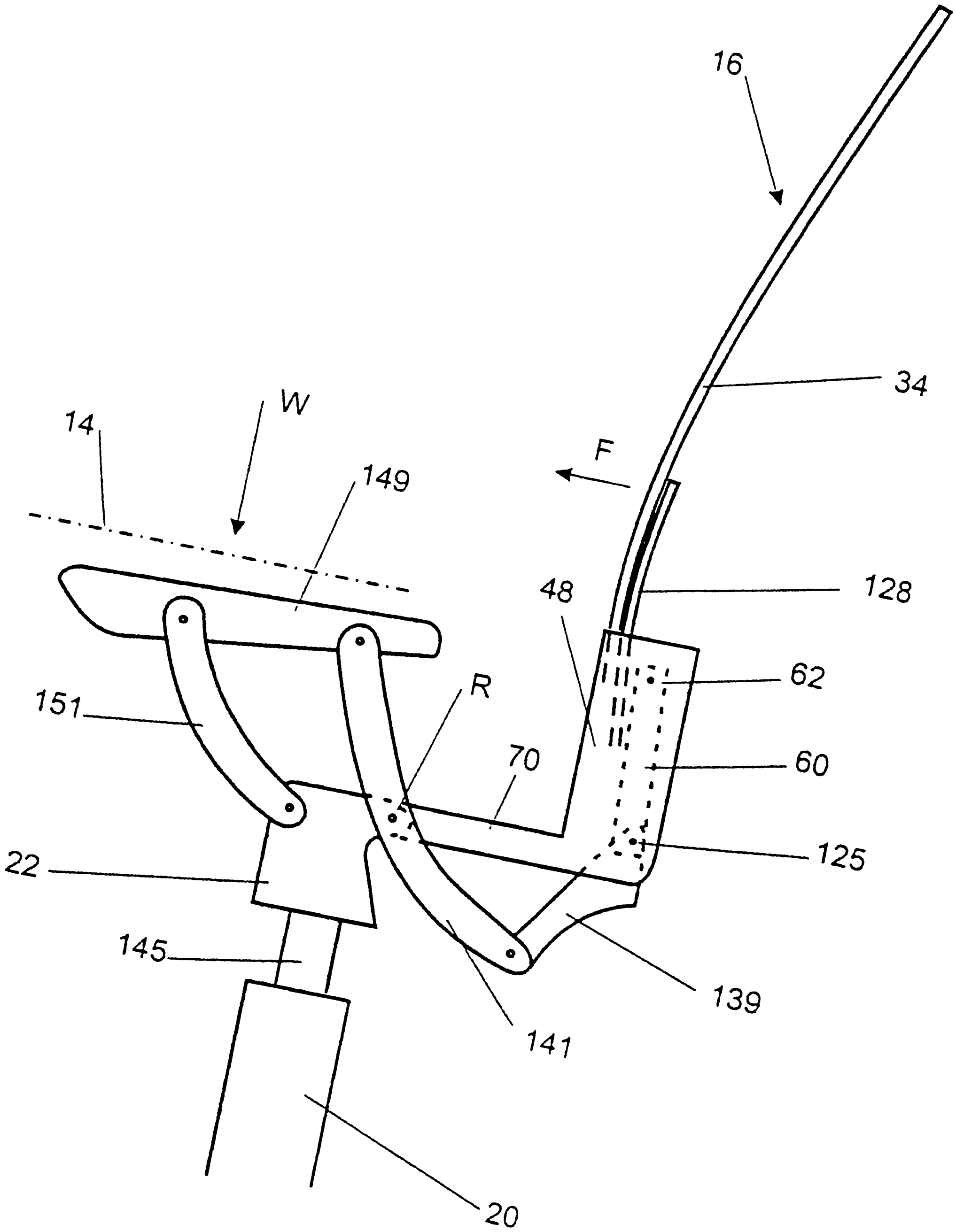


FIGURE 15a

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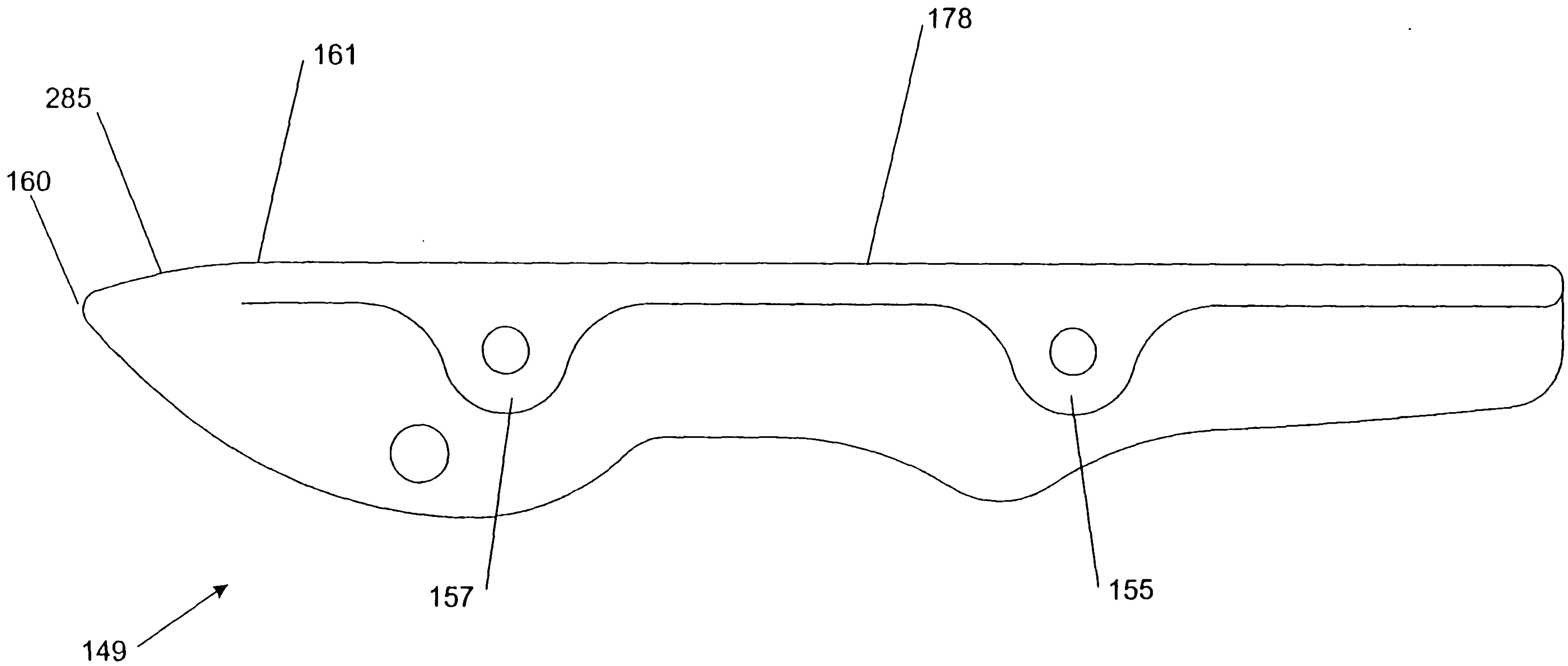


FIGURE 15b

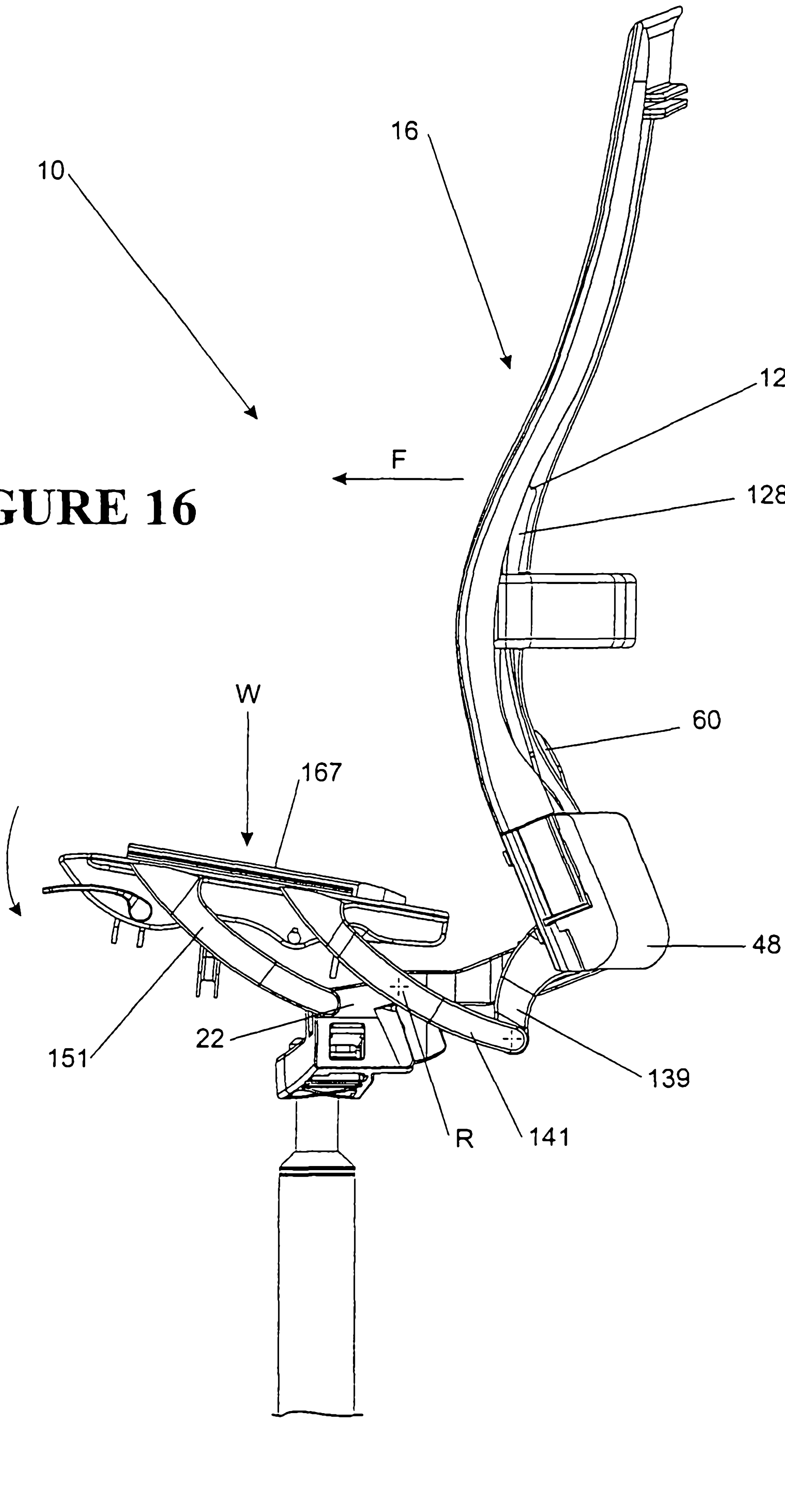
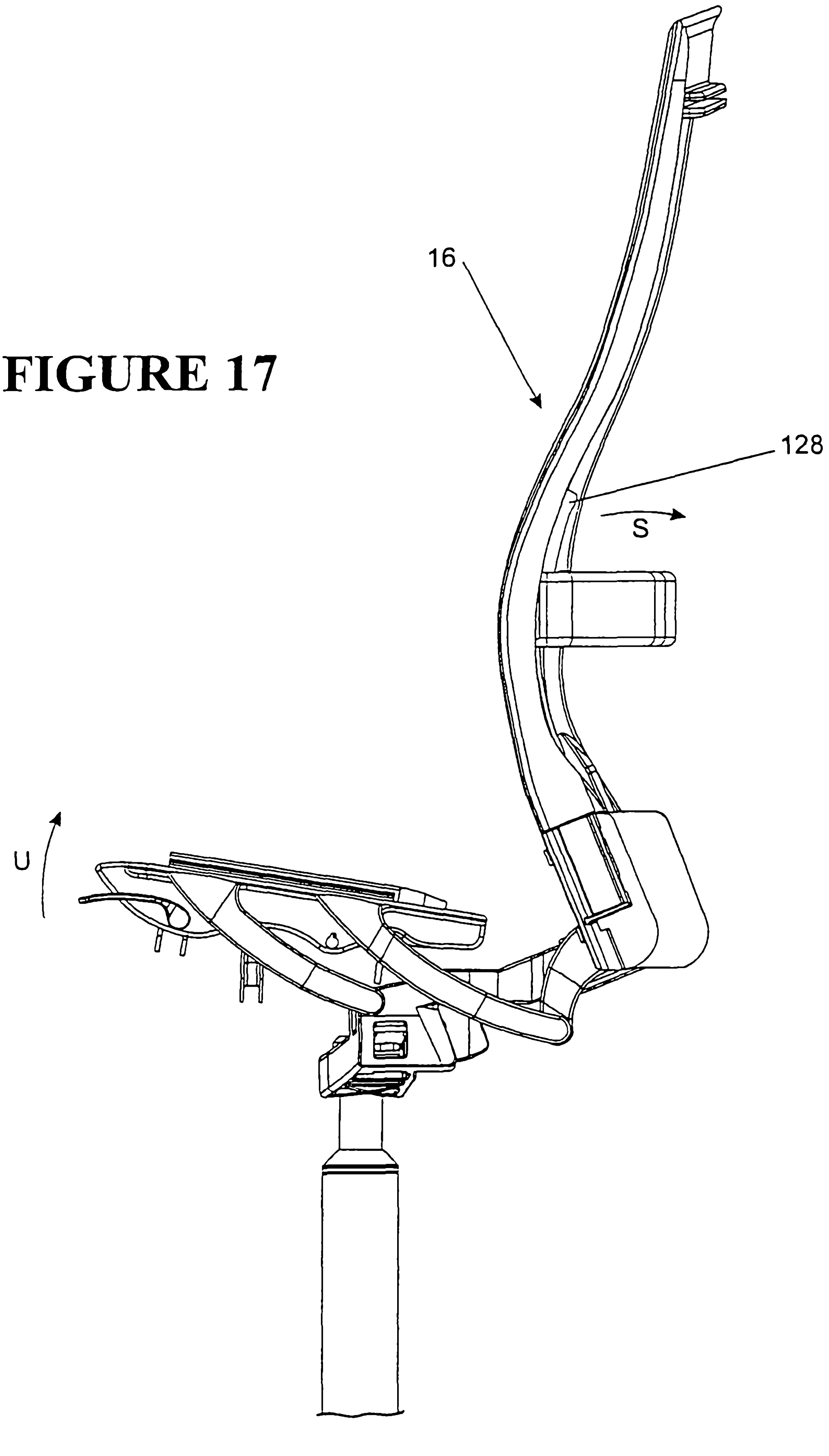


FIGURE 16

FIGURE 17



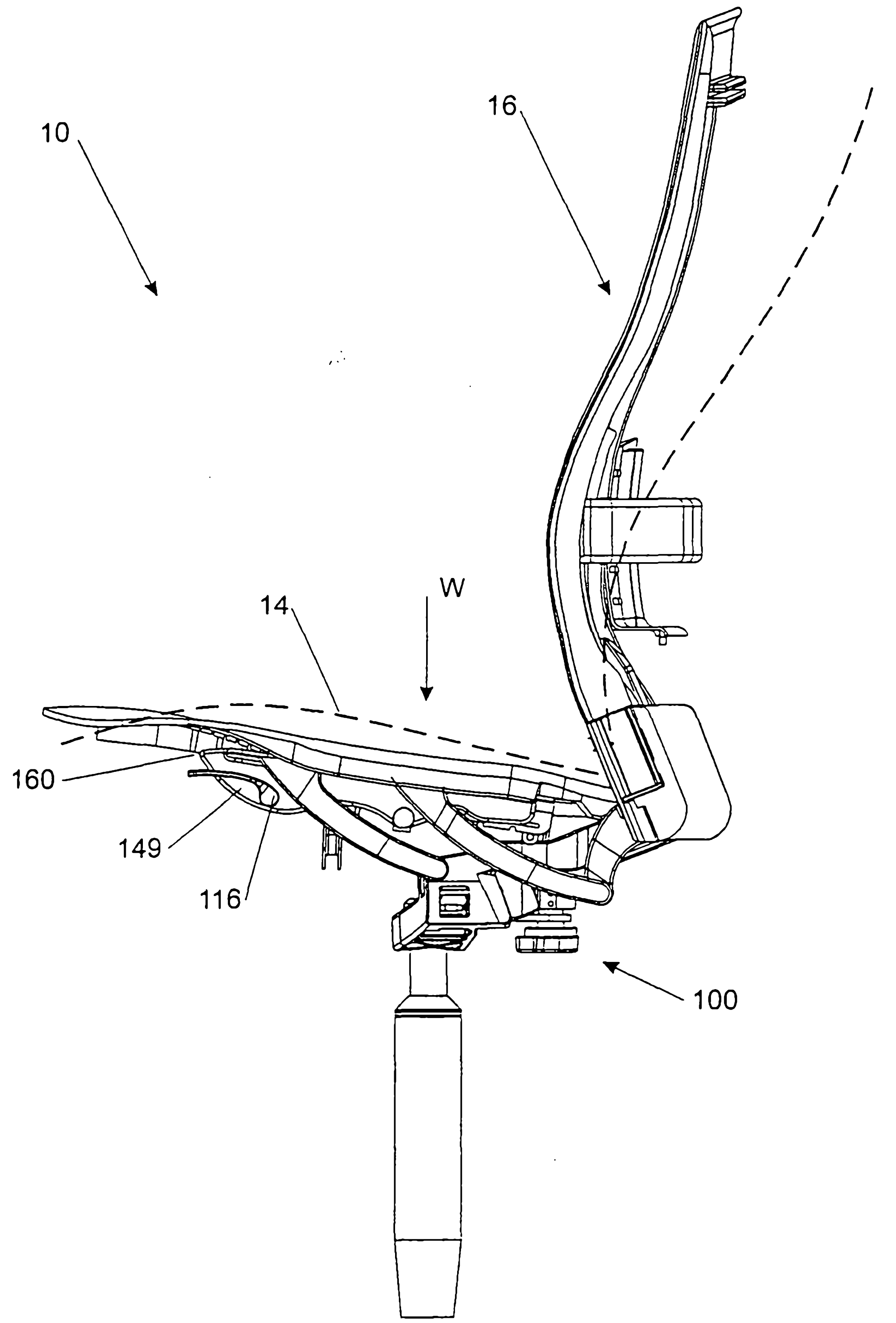


FIGURE 18

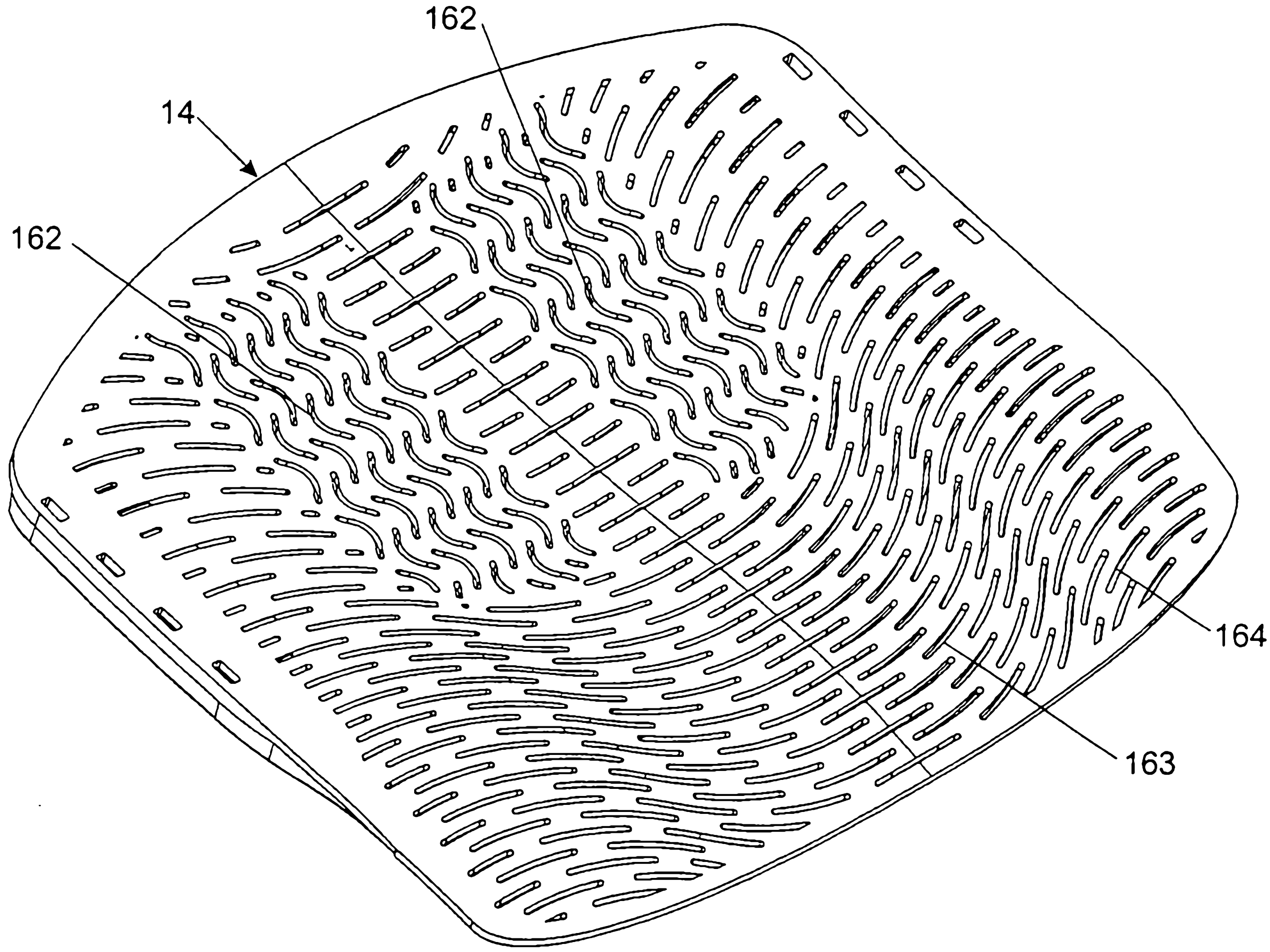


FIGURE 19a

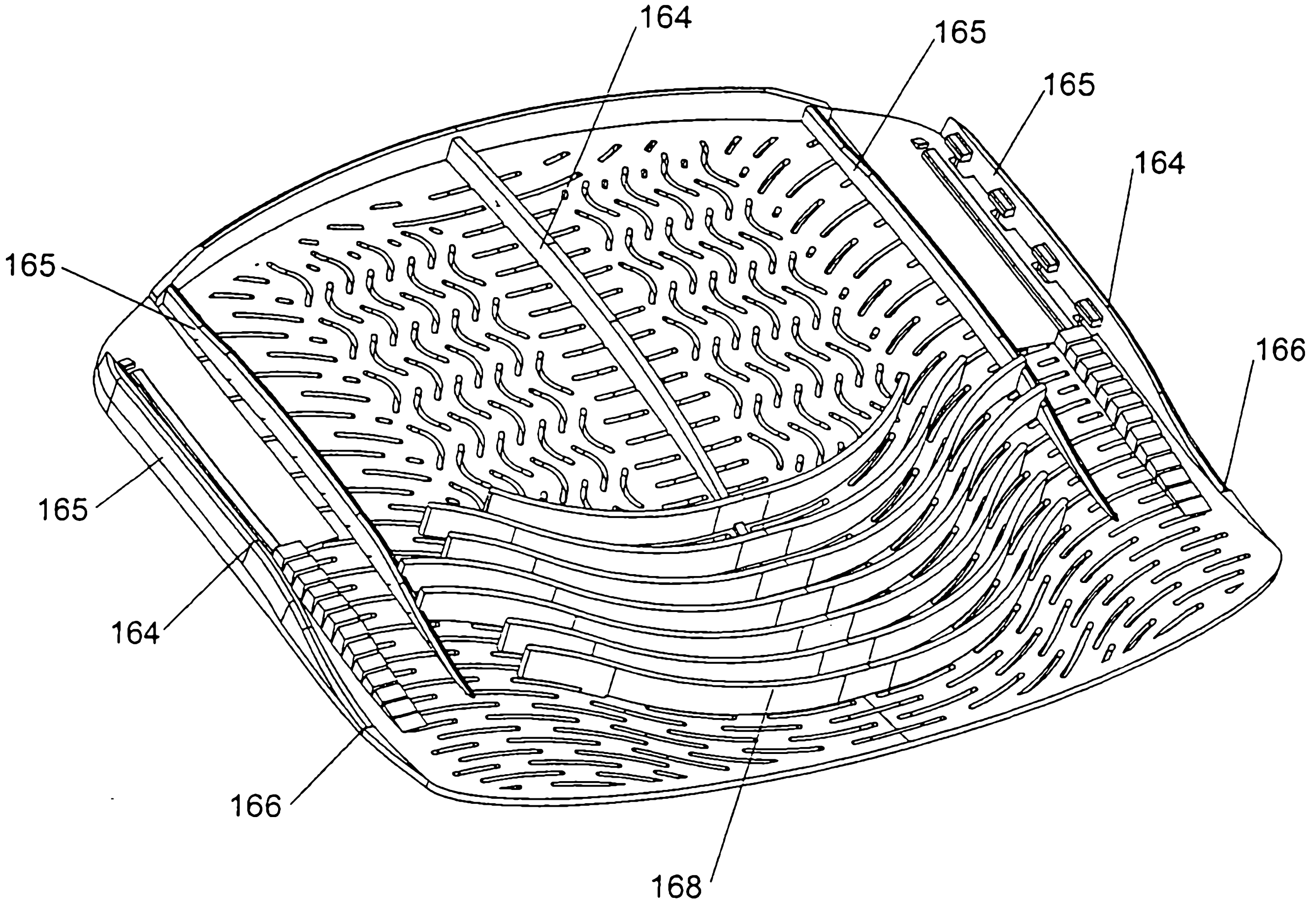


FIGURE 19b

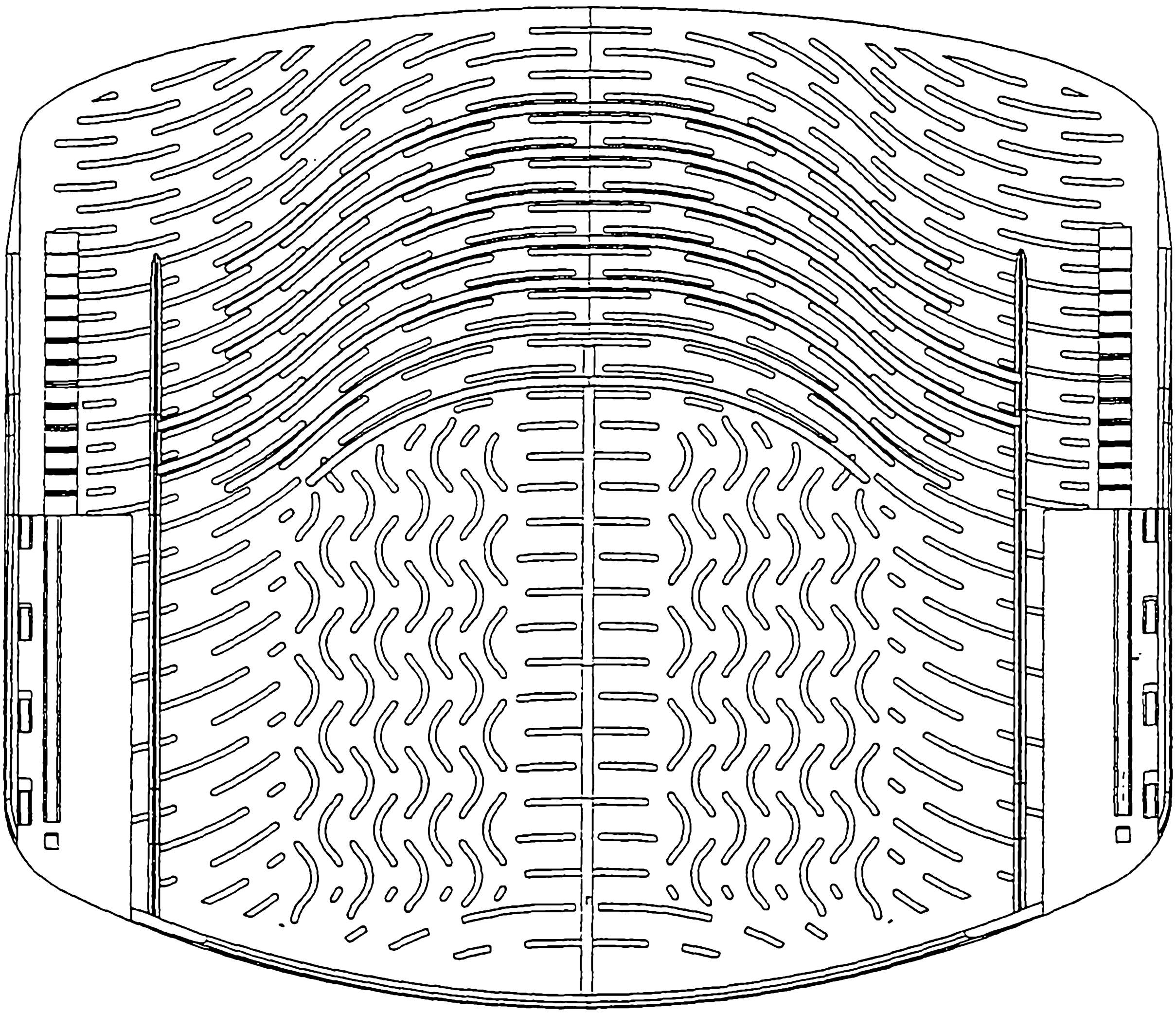


FIGURE 19c

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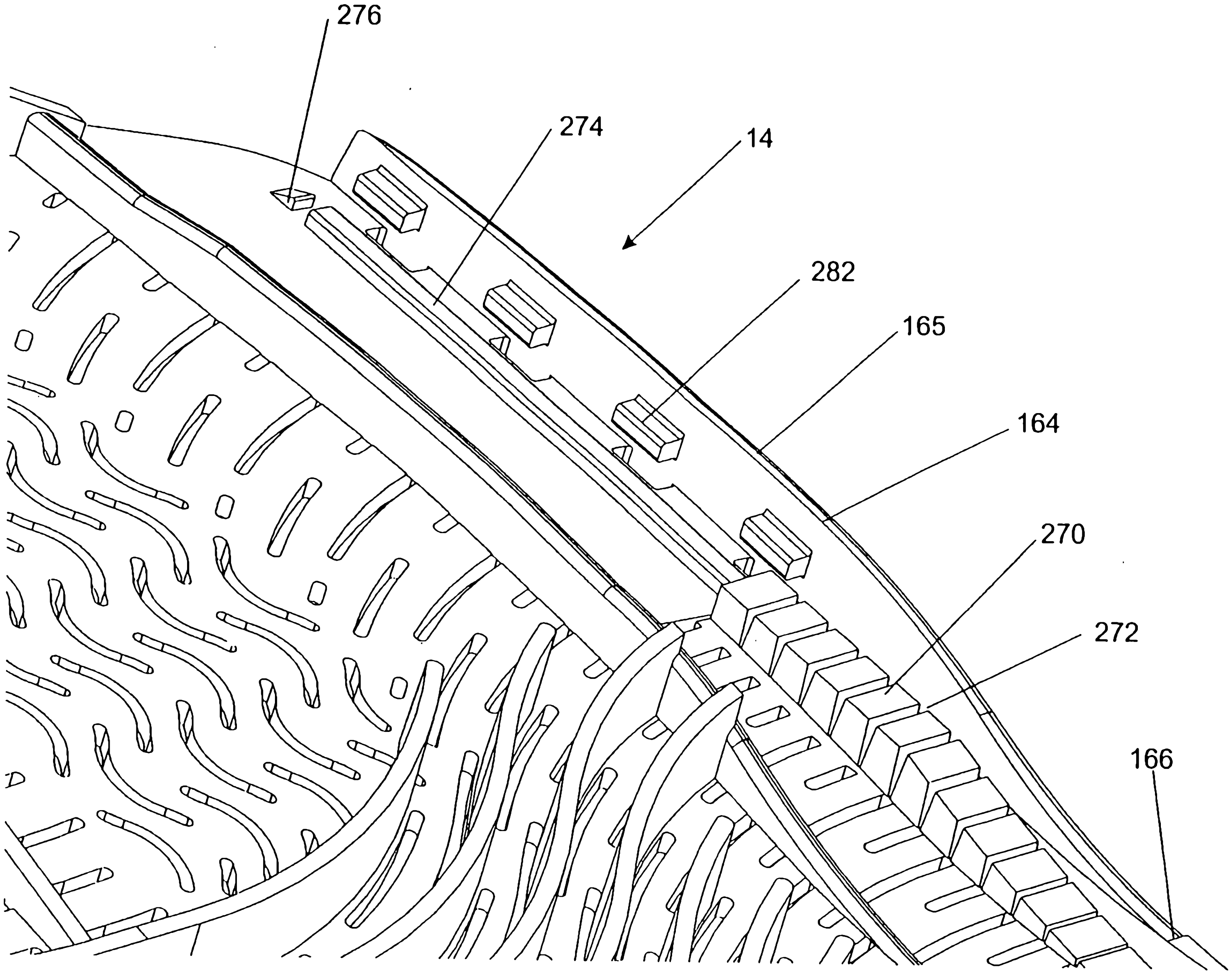

FIGURE 19d

FIGURE 20a

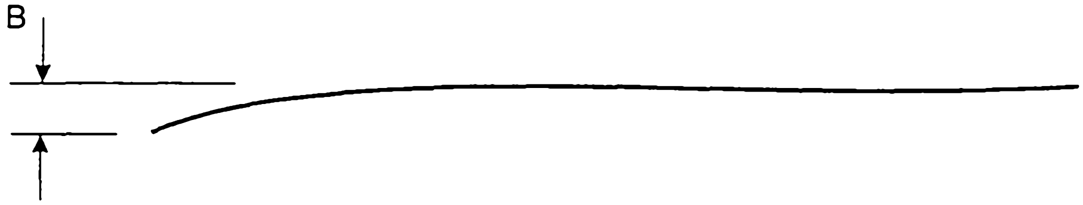

FIGURE 20b

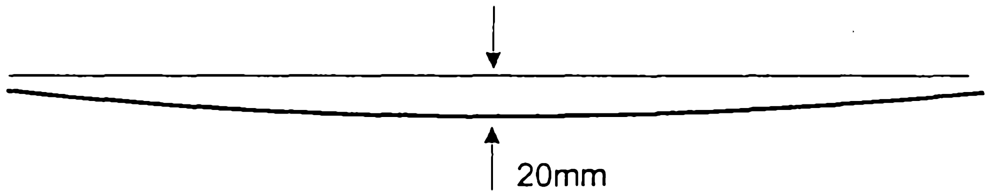

FIGURE 20c

FIGURE 20d

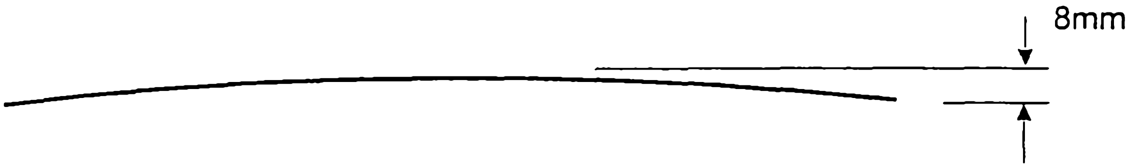

FIGURE 20e

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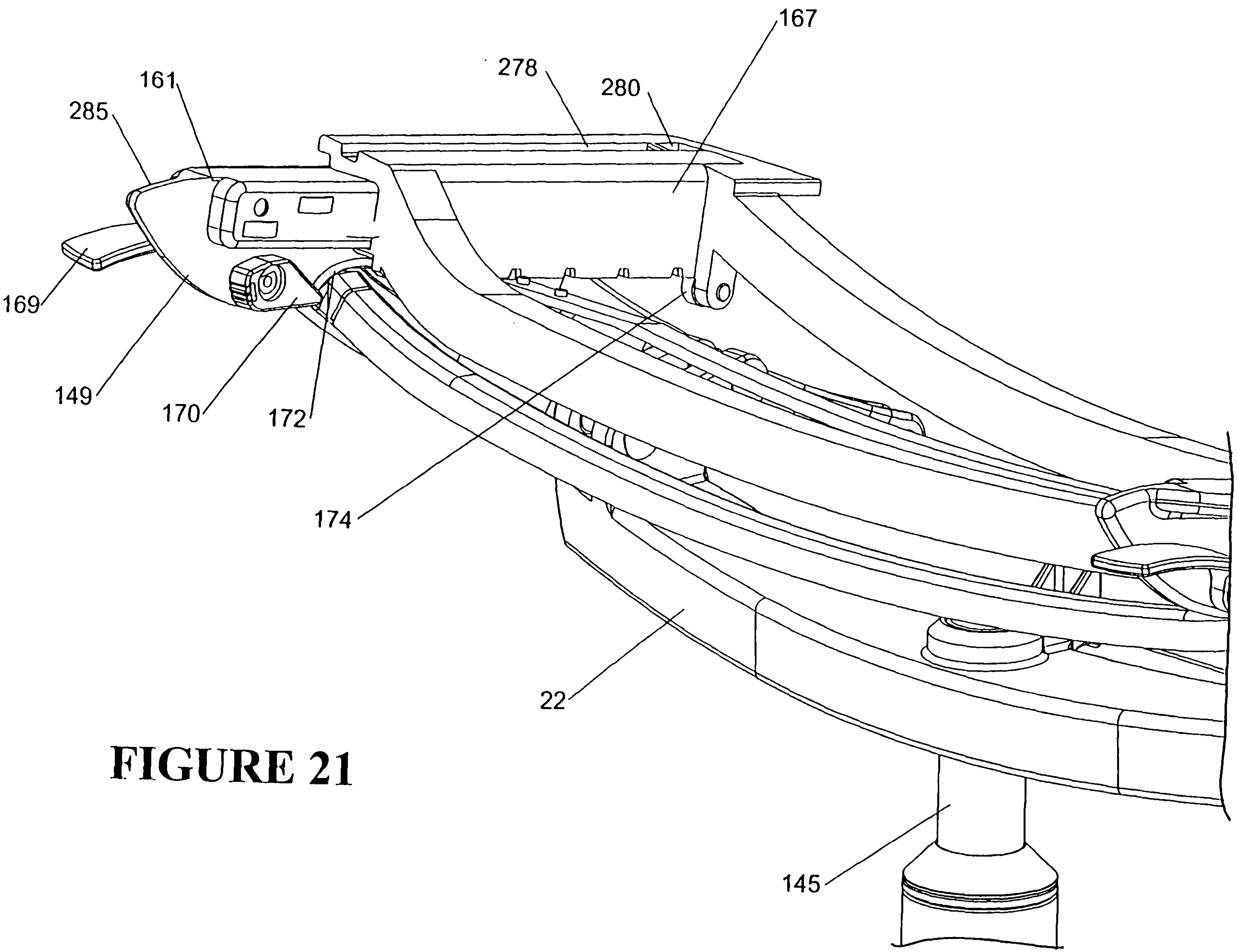

FIGURE 21

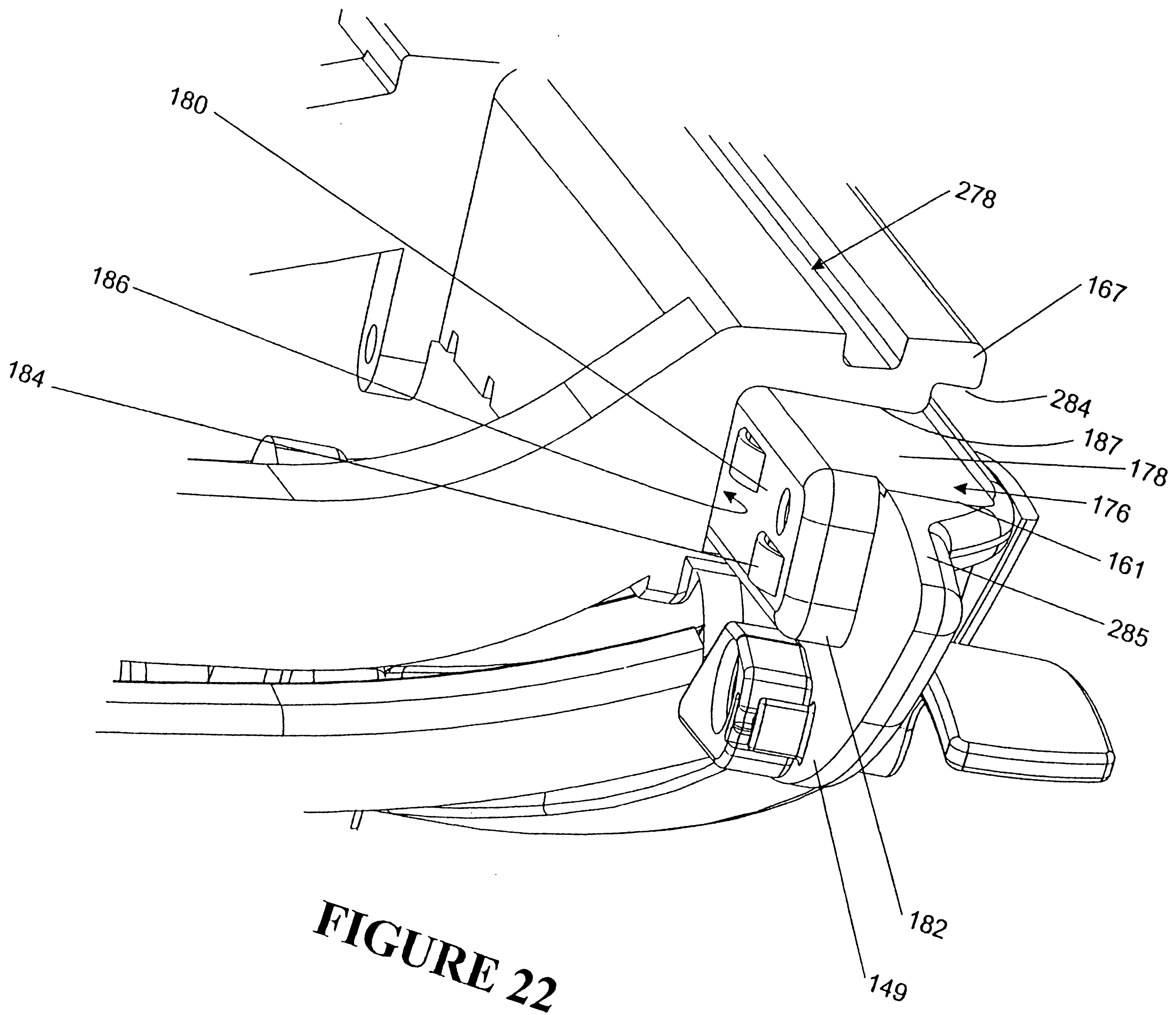

FIGURE 22

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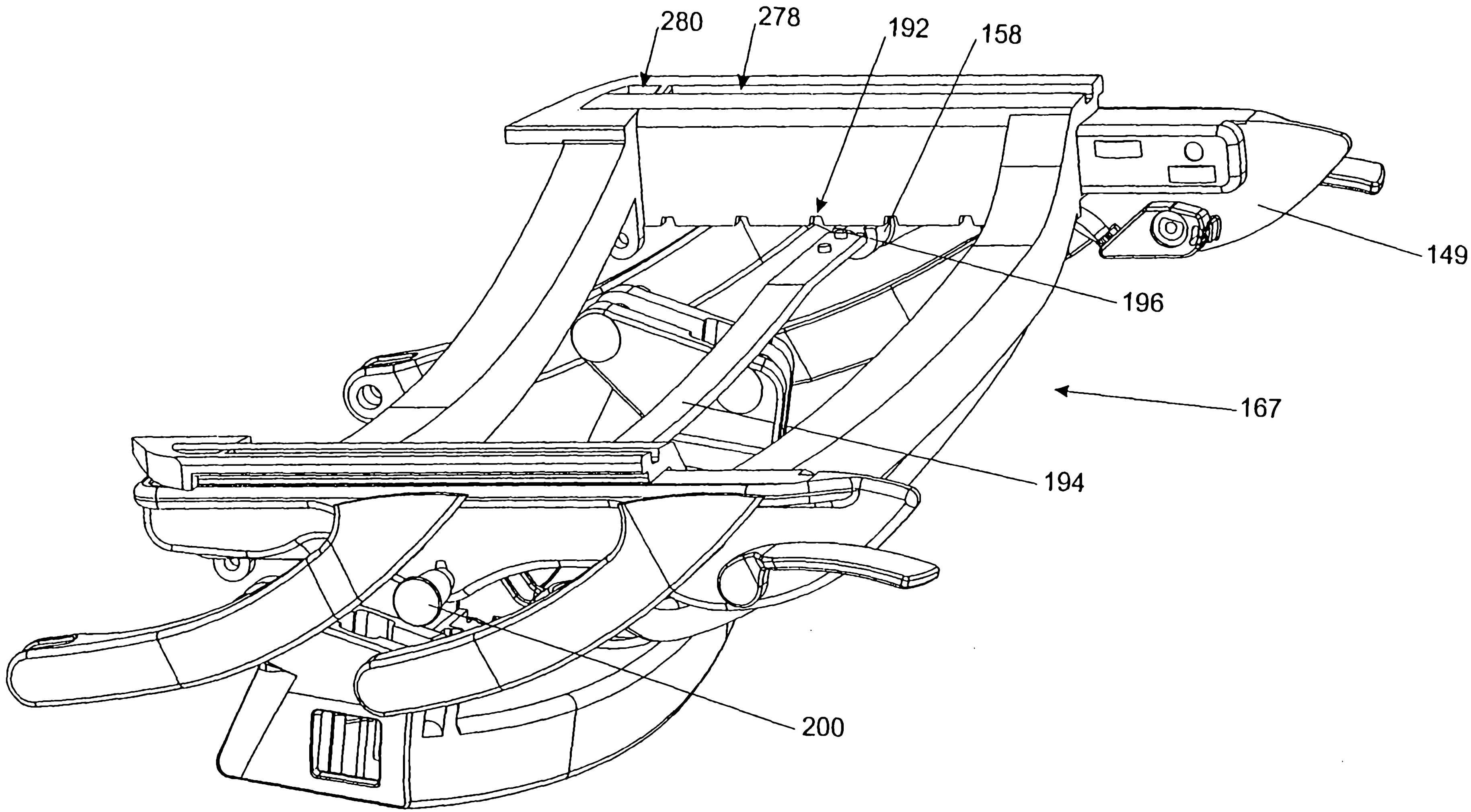

FIGURE 23

27 06 01 54083

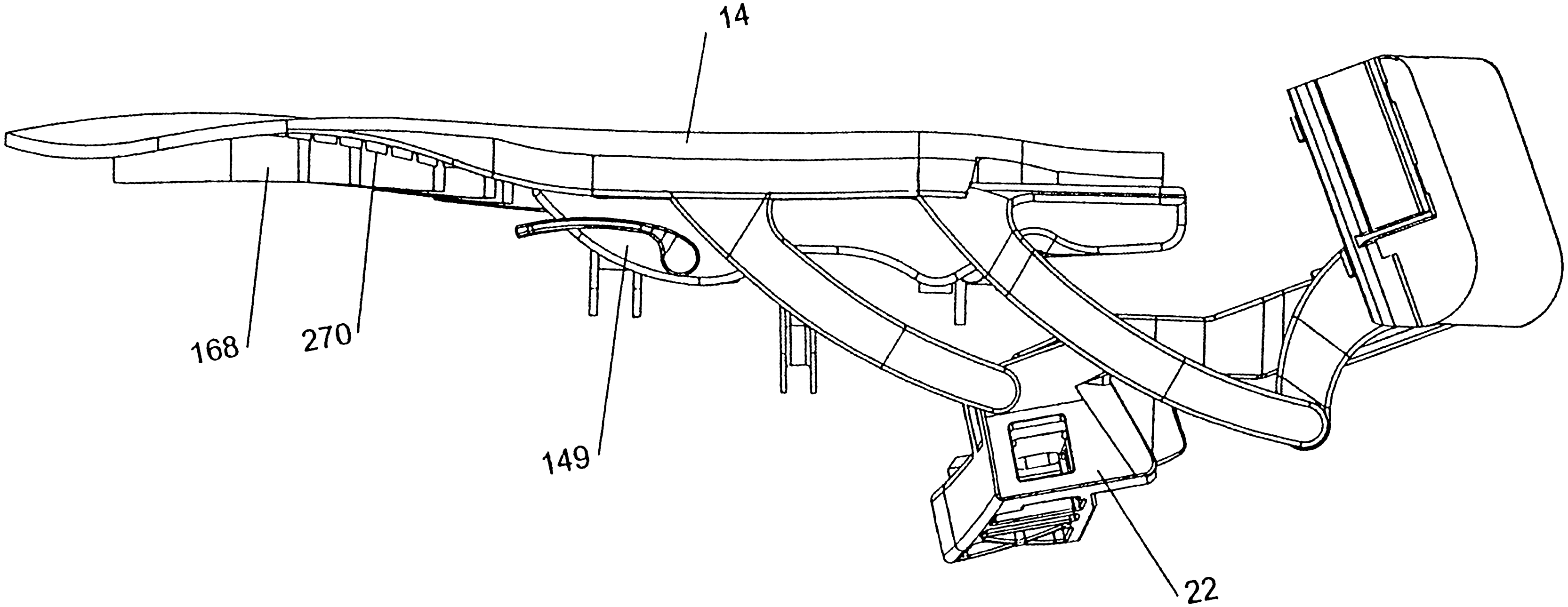

FIGURE 24

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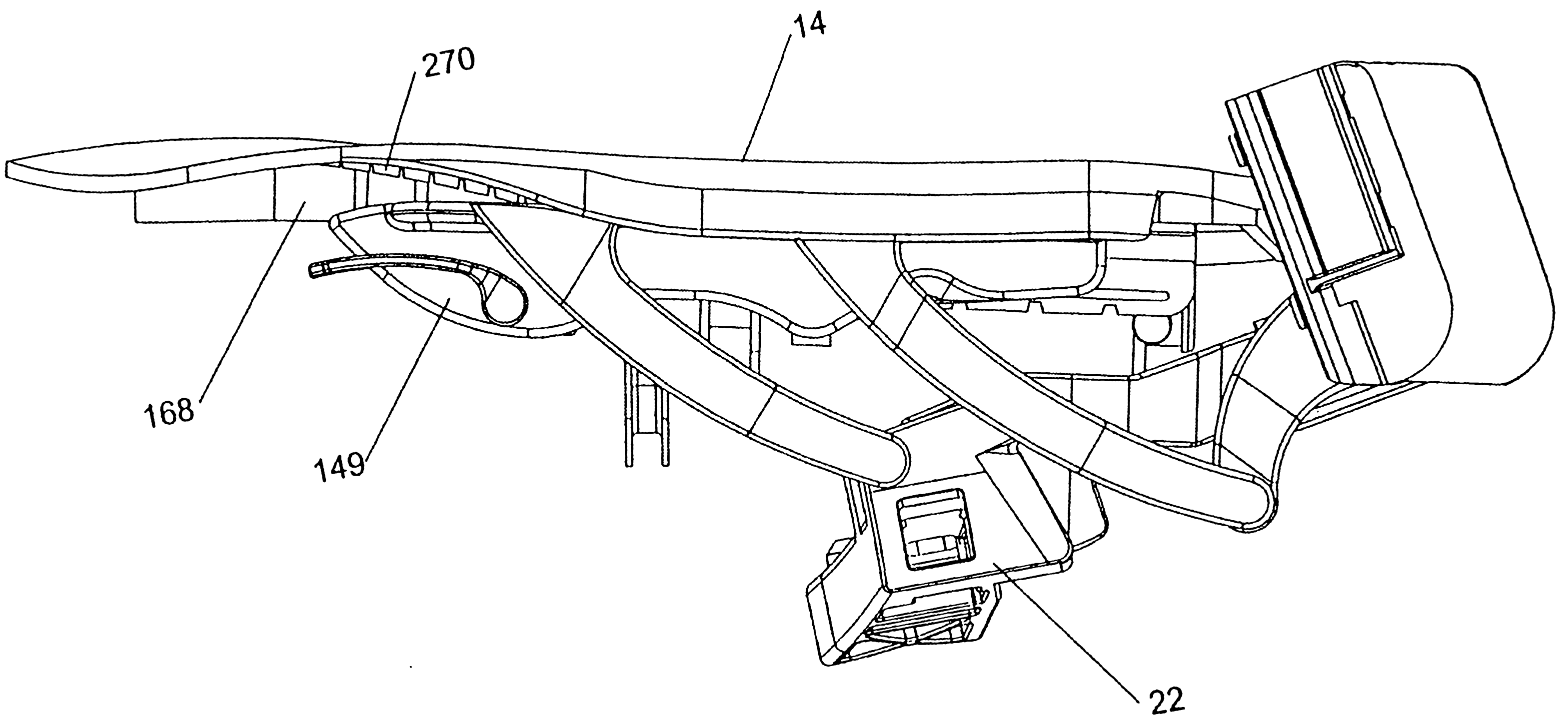

FIGURE 25

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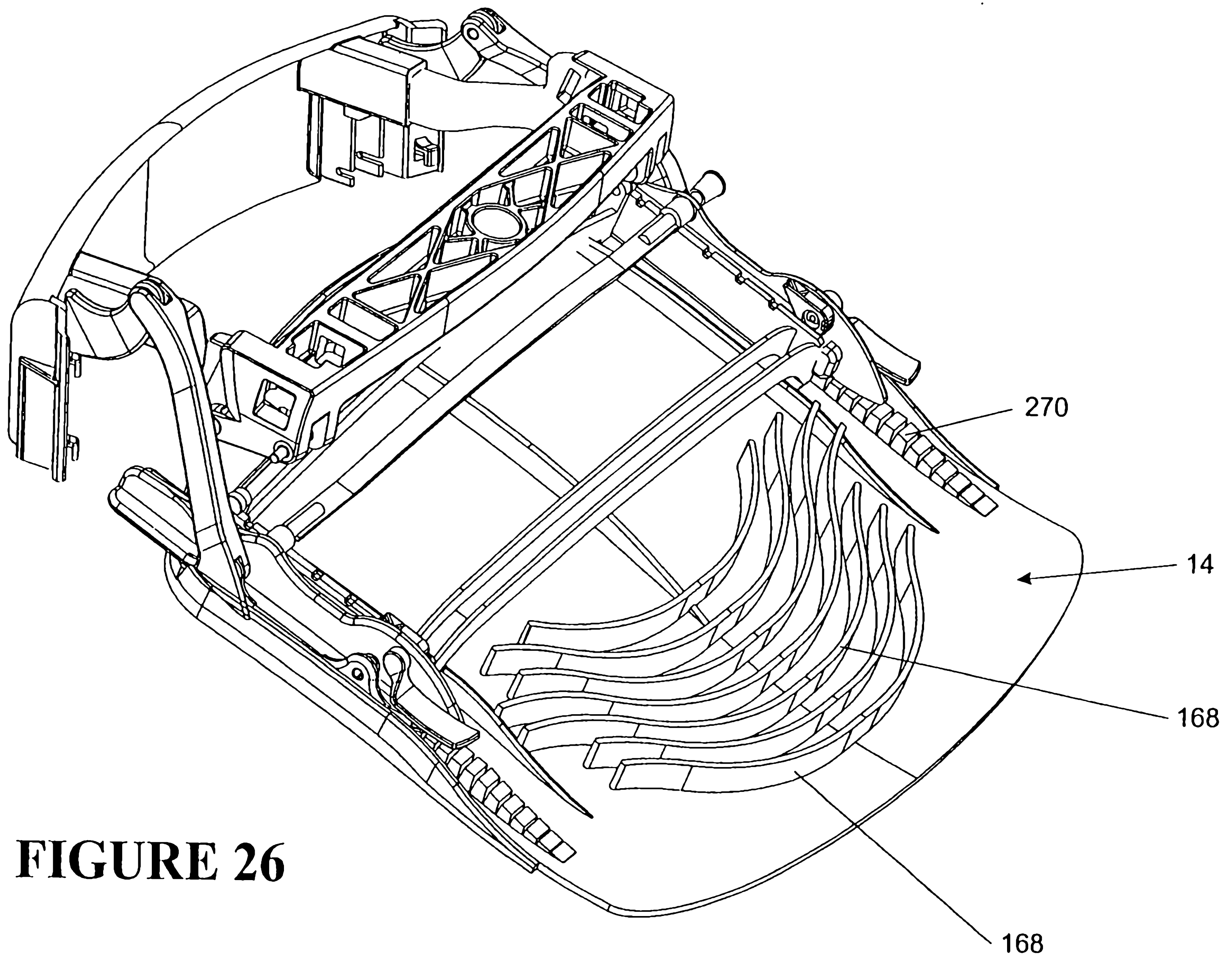

FIGURE 26

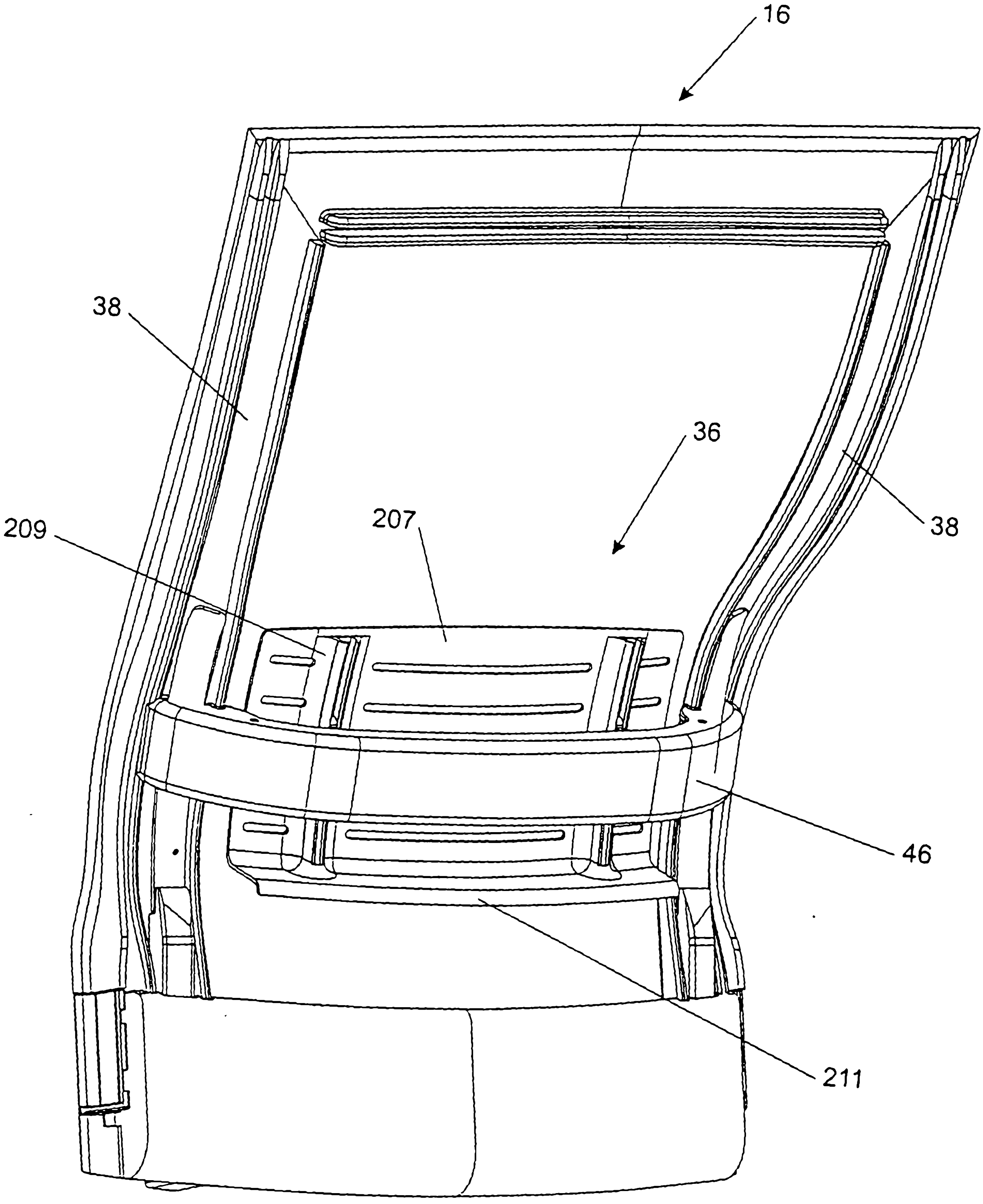

FIGURE 27

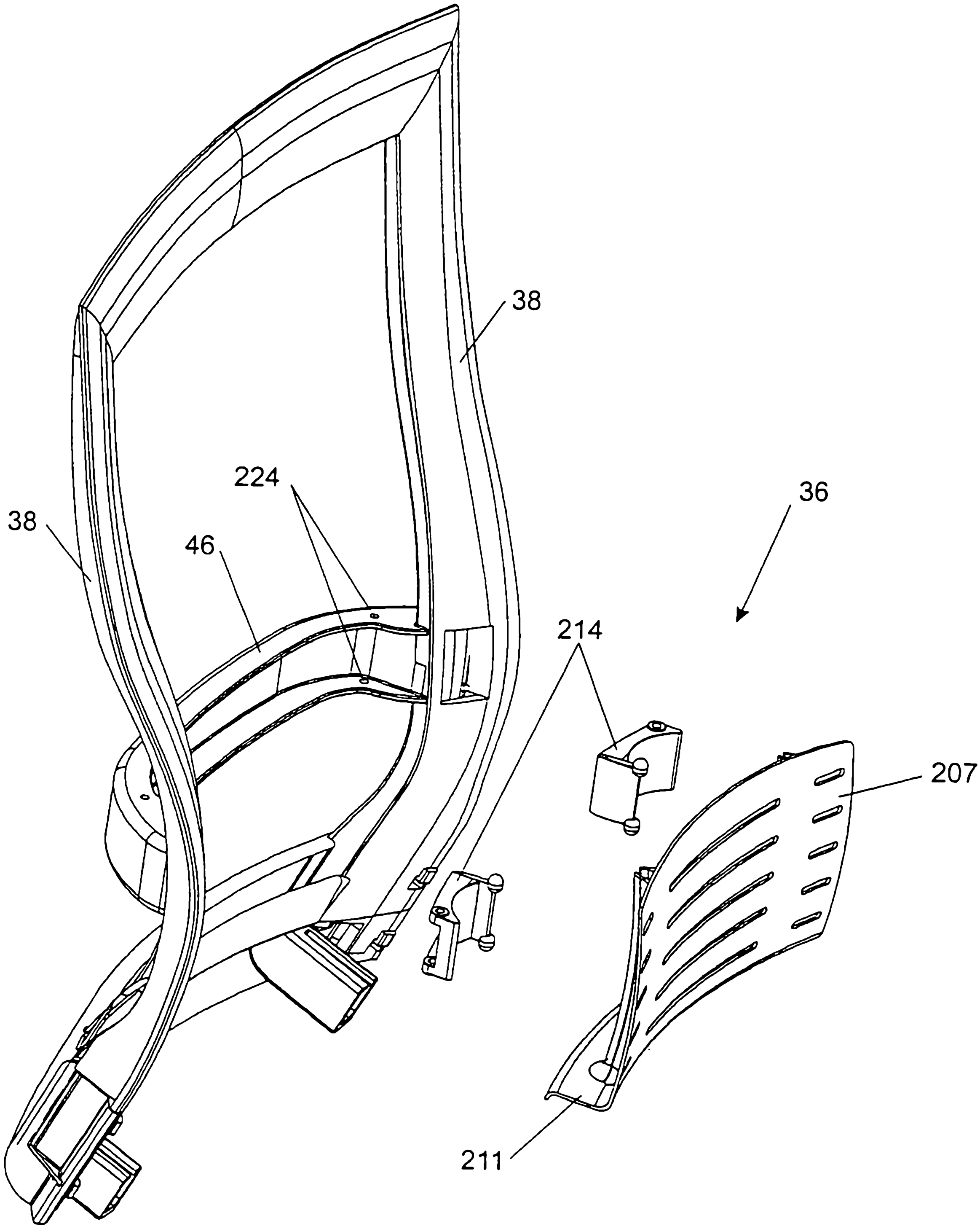

FIGURE 28

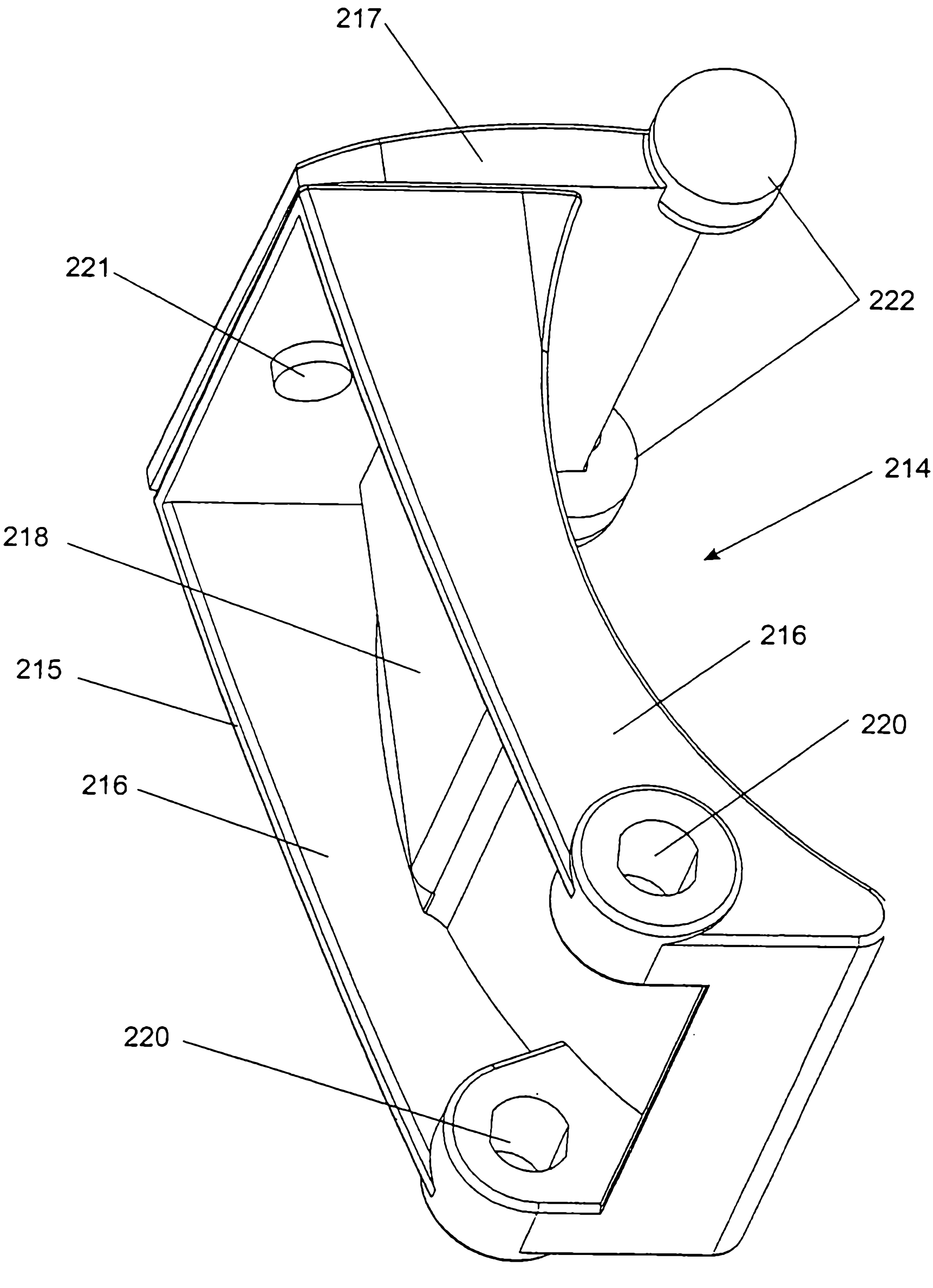

FIGURE 29

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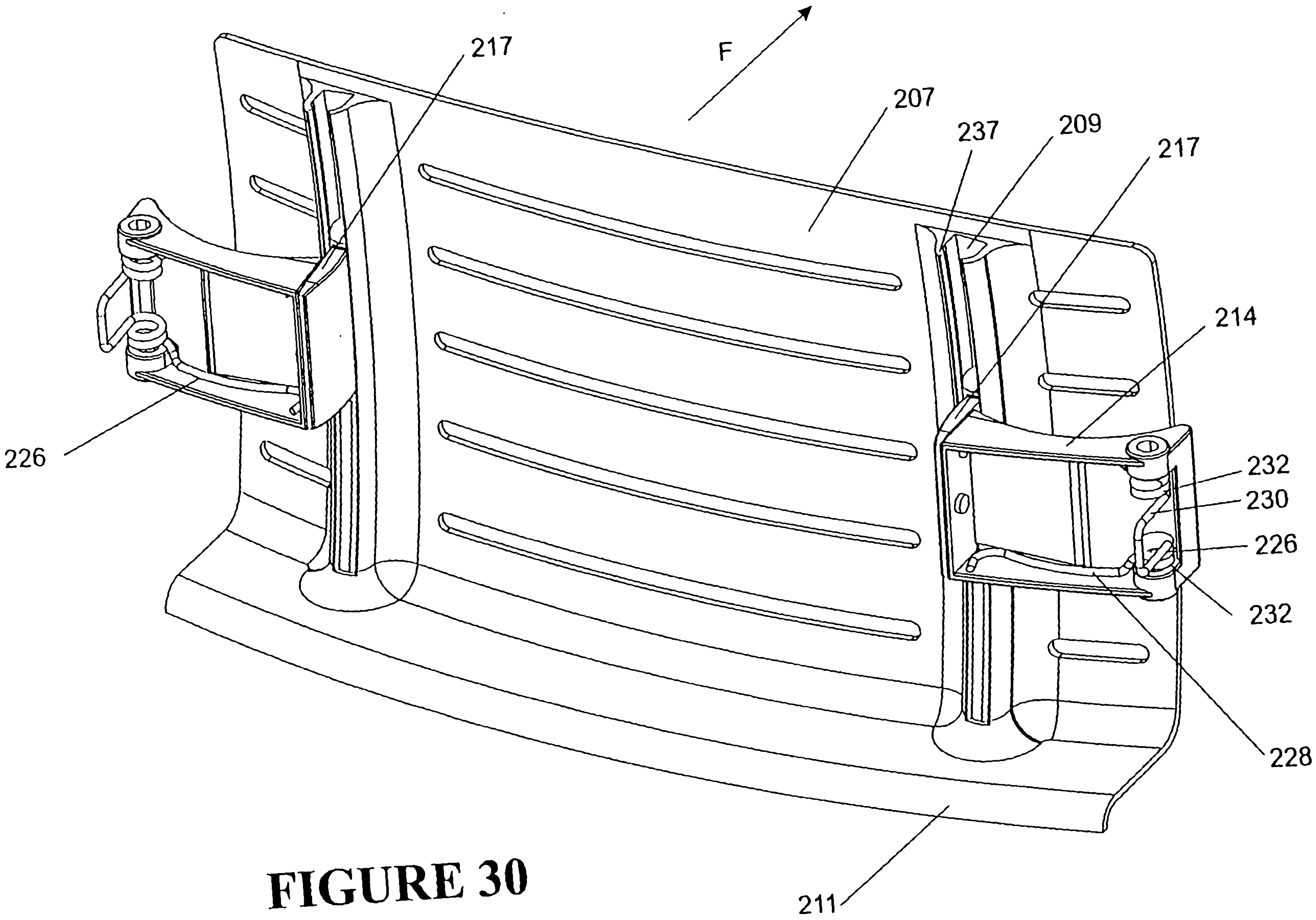

FIGURE 30

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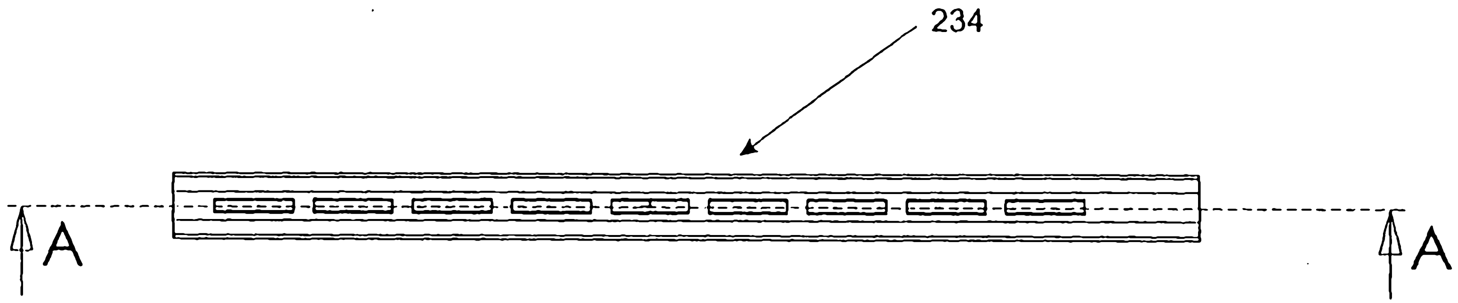

FIGURE 31

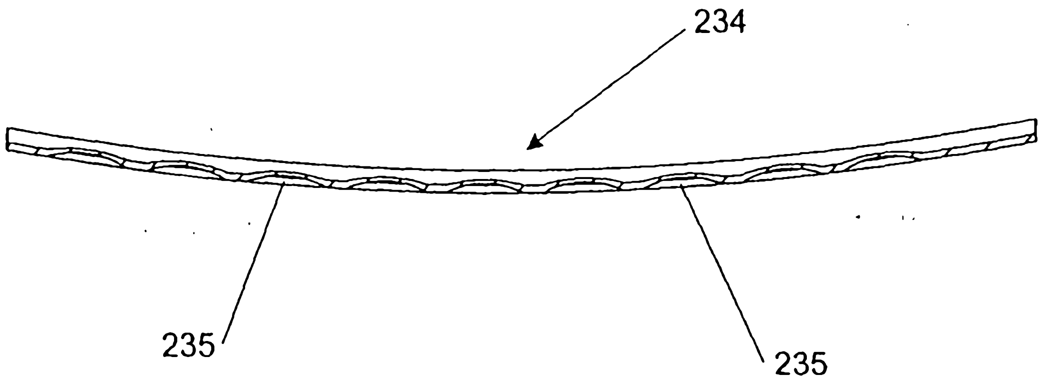

FIGURE 32

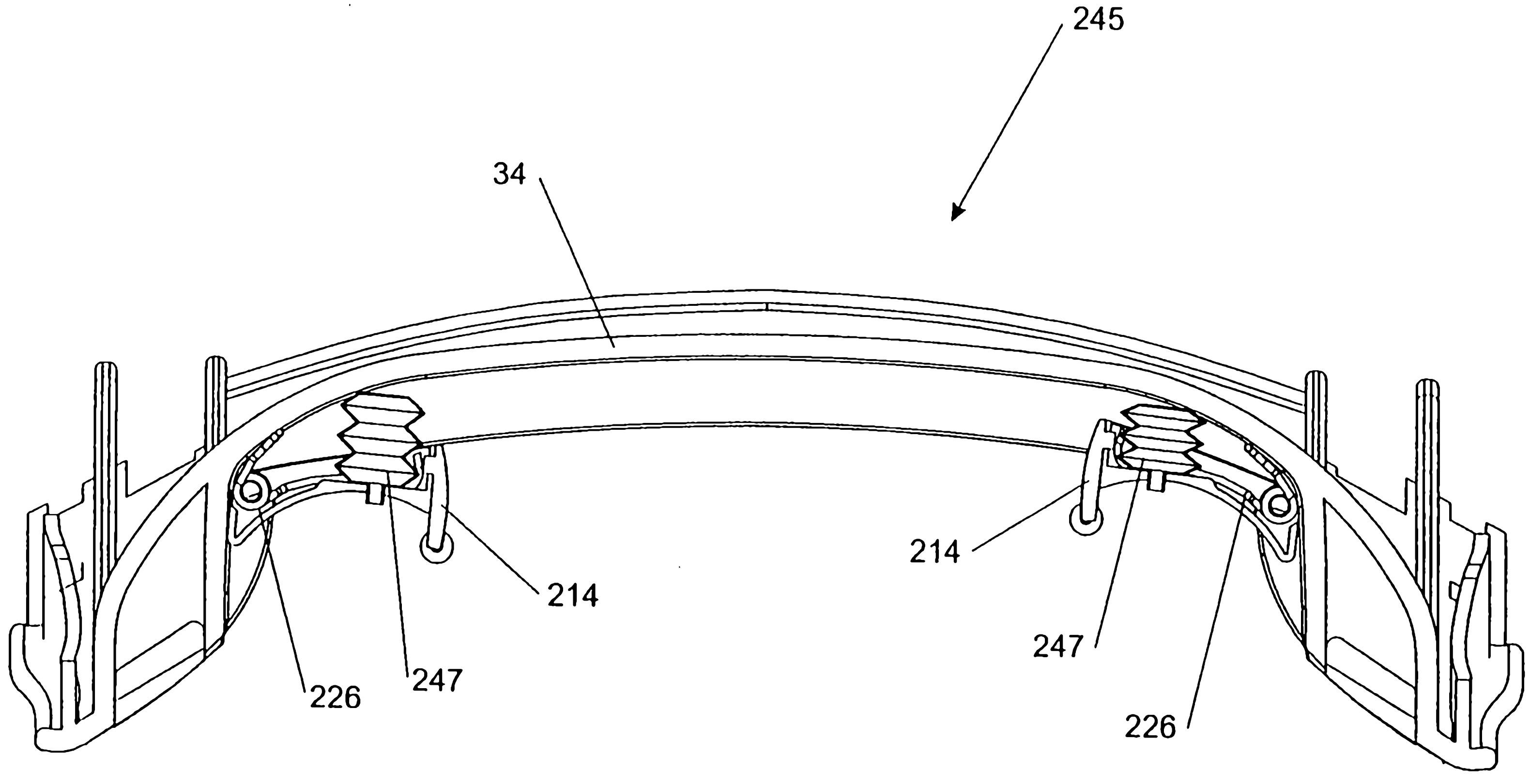

FIGURE 34

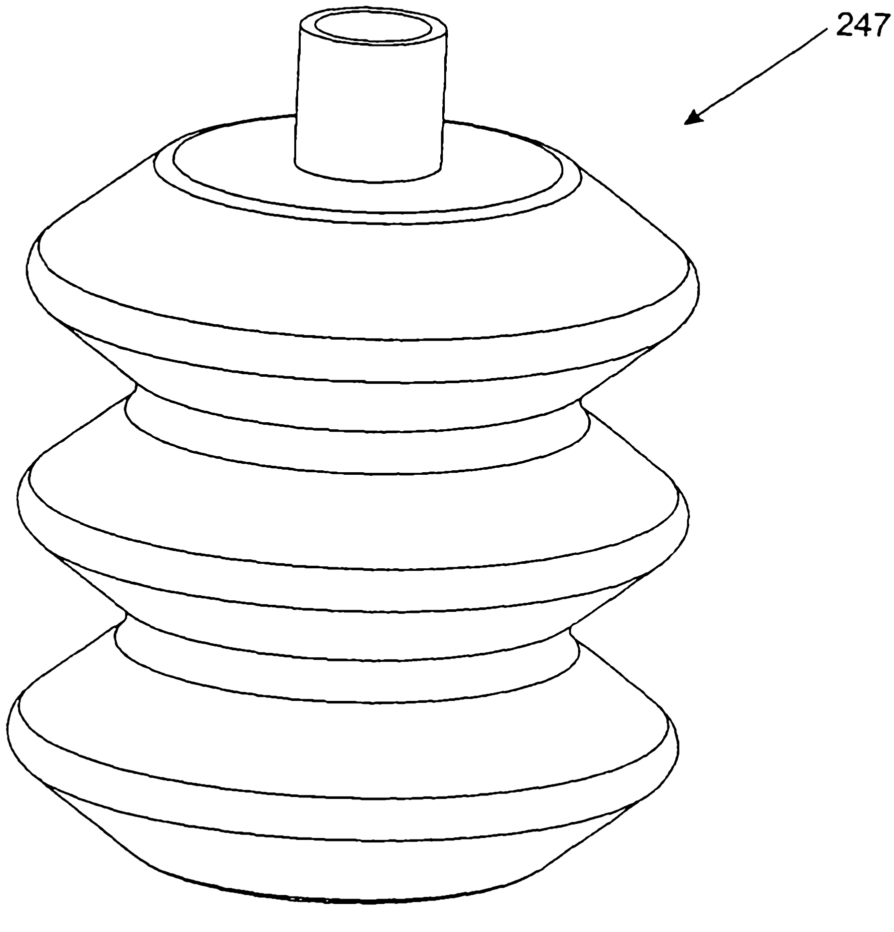

FIGURE 35

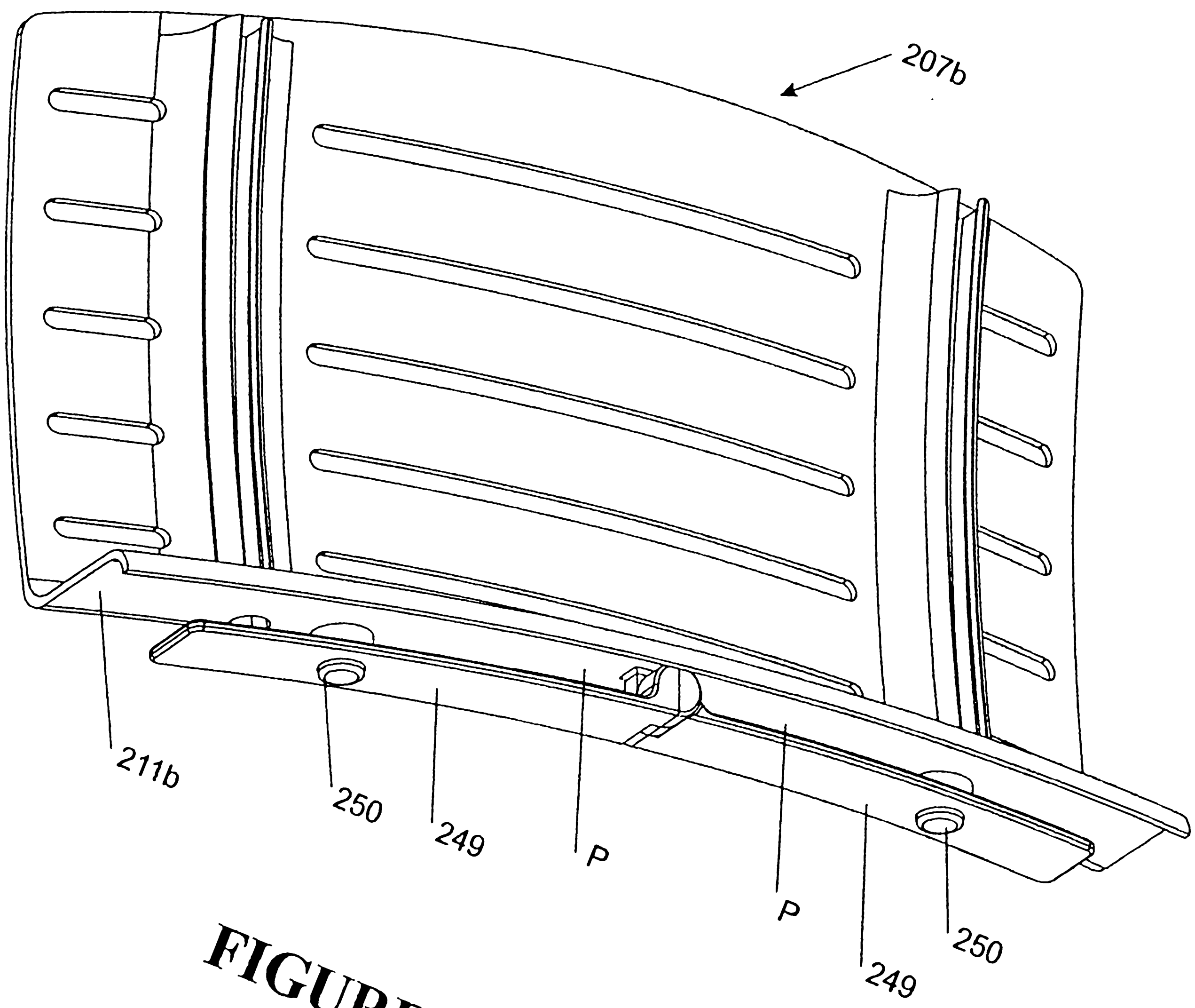

FIGURE 36

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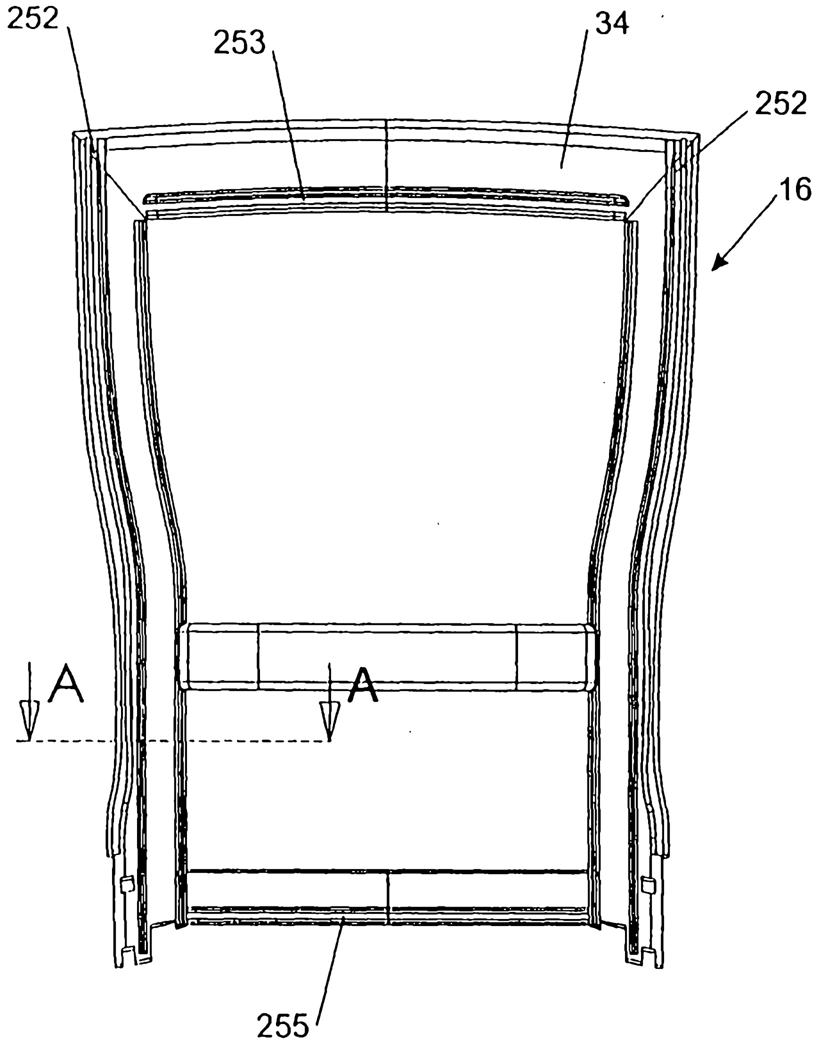

FIGURE 37

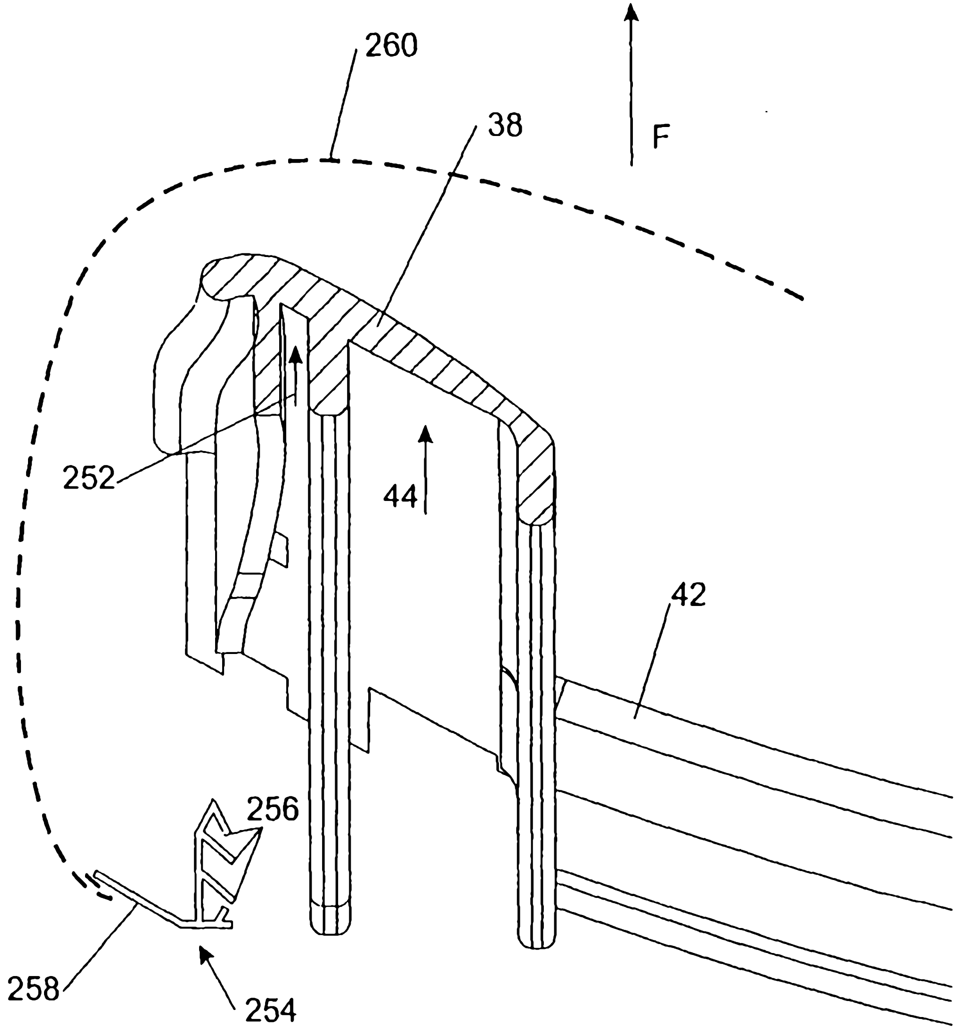

FIGURE 38

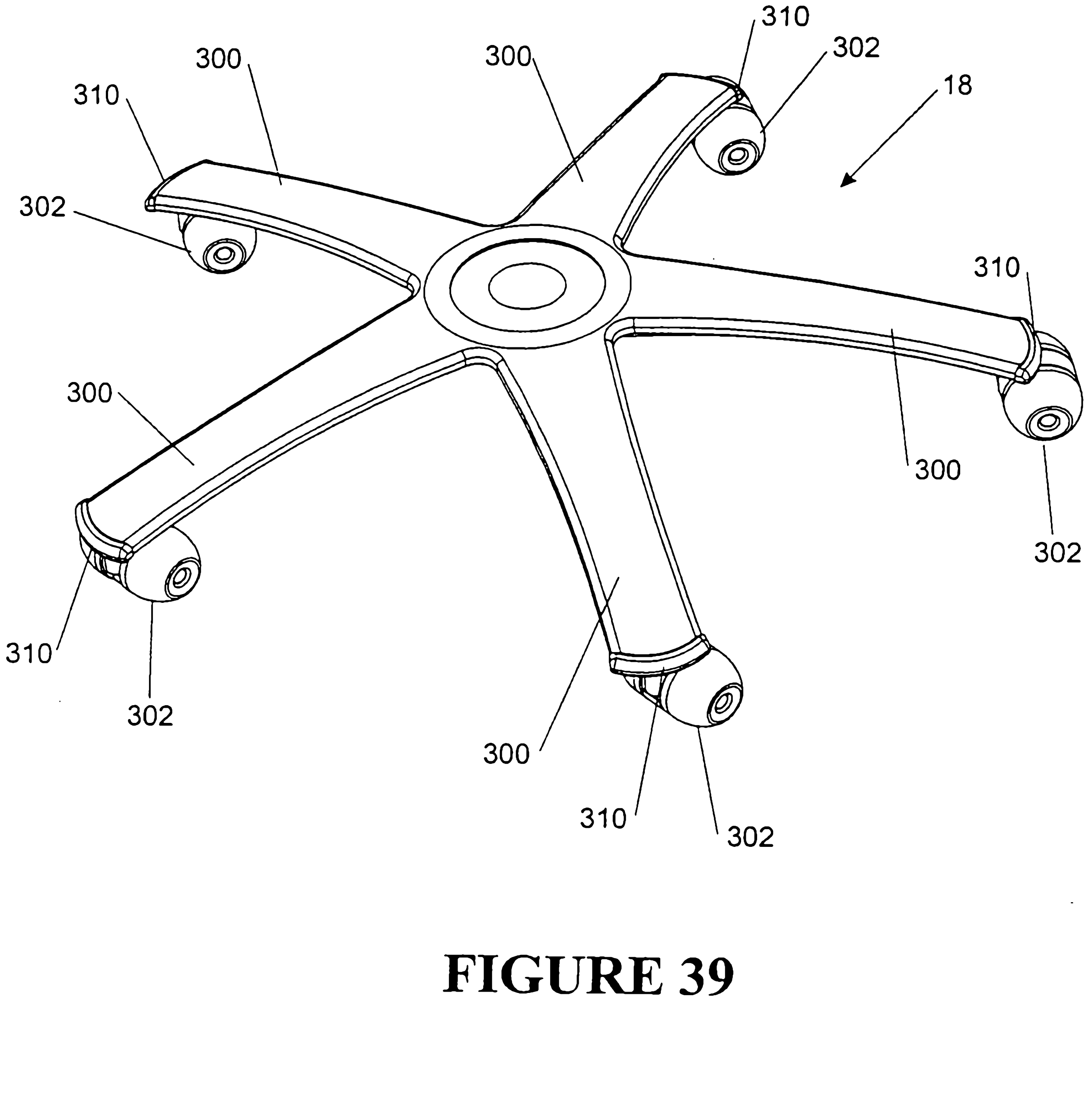

FIGURE 39

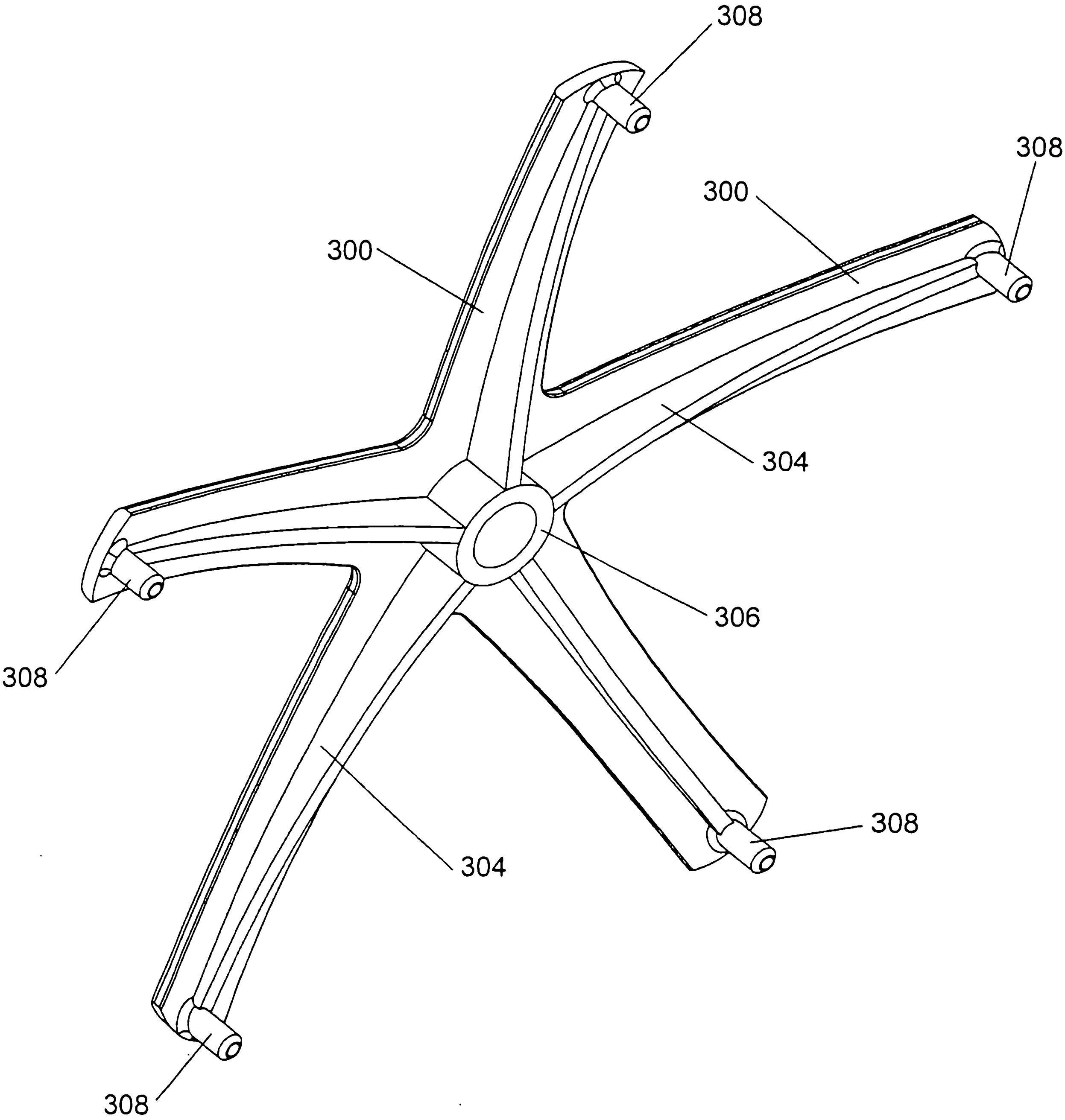

FIGURE 40

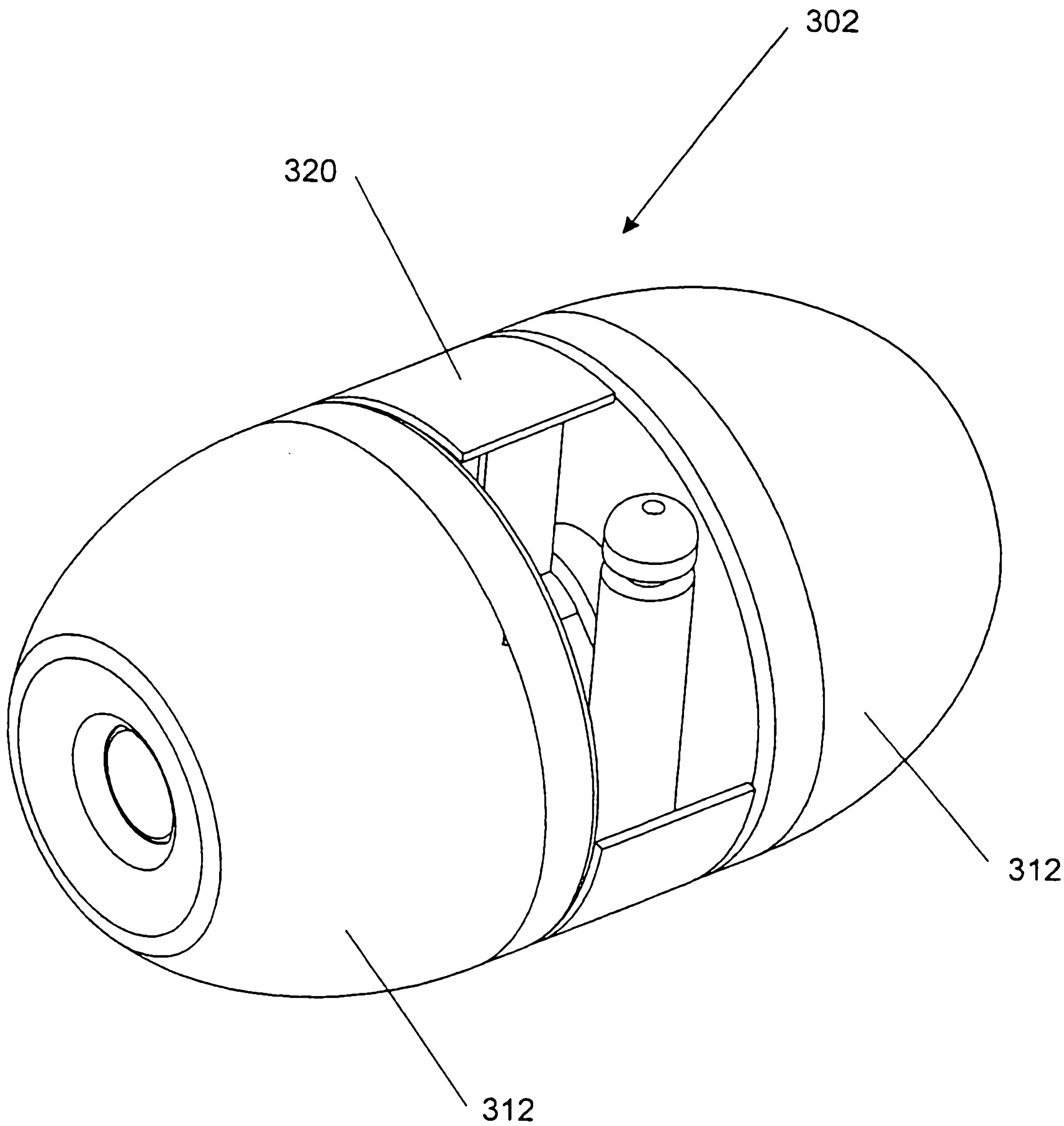

FIGURE 41

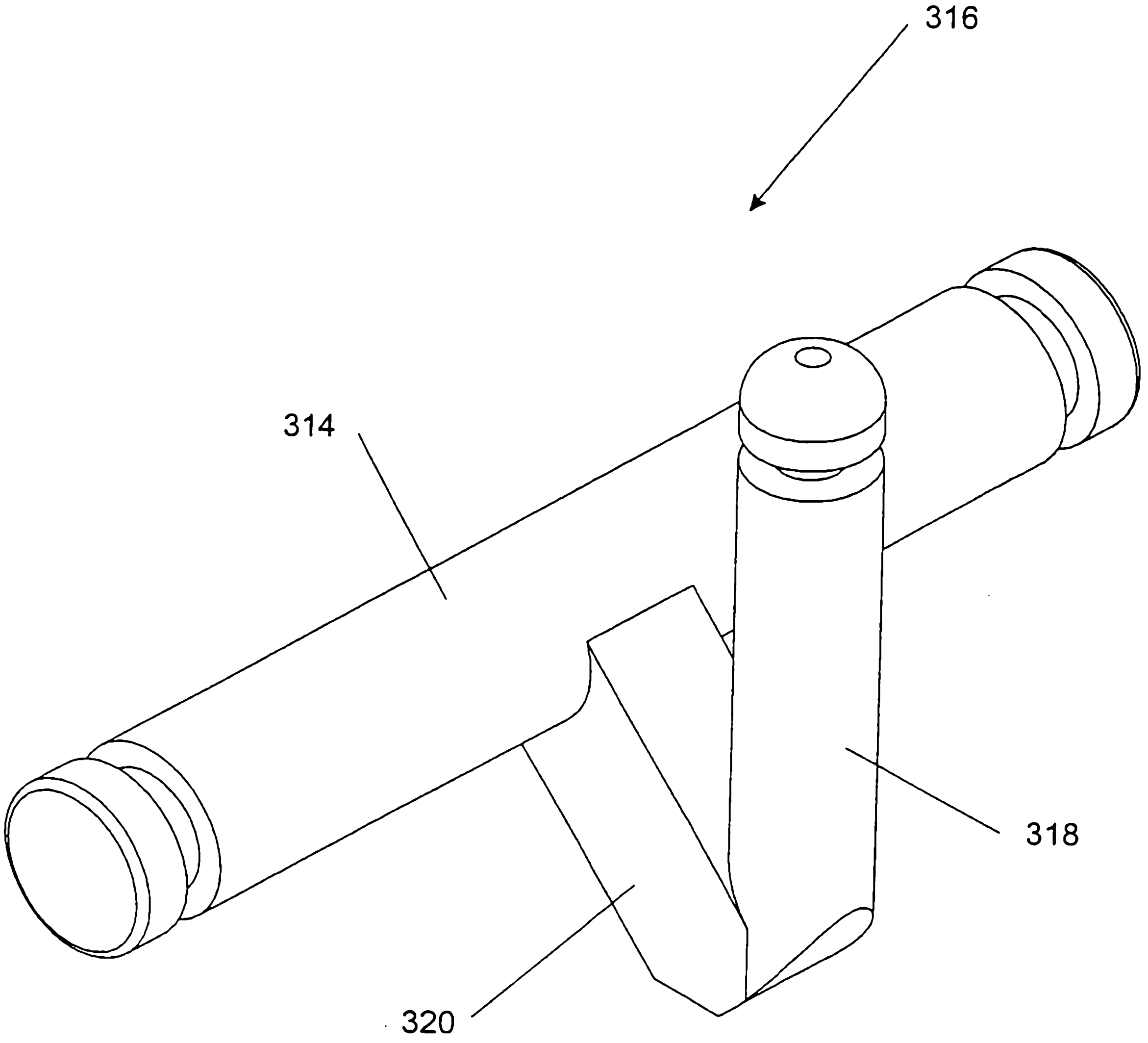

FIGURE 42

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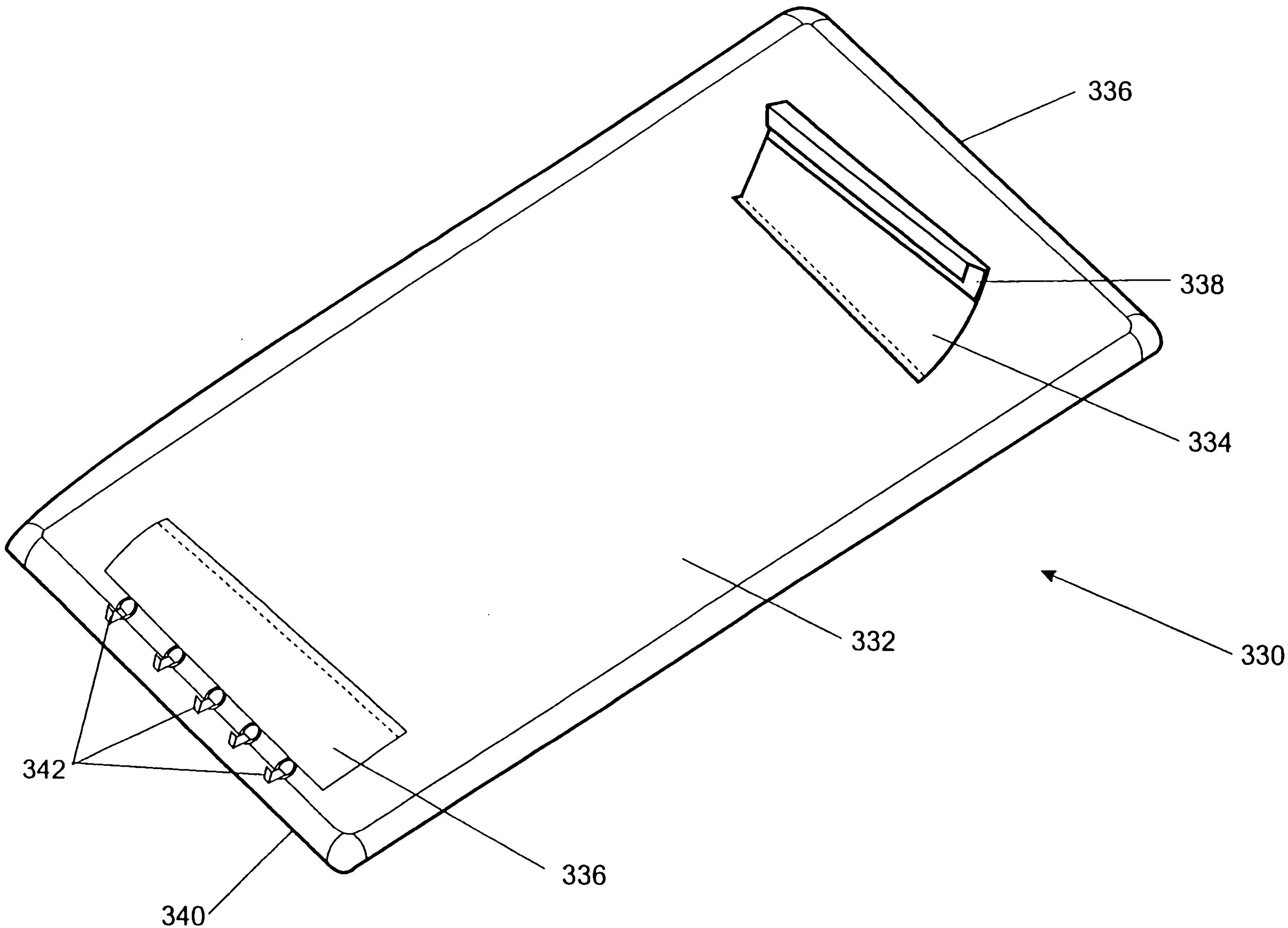

FIGURE 43

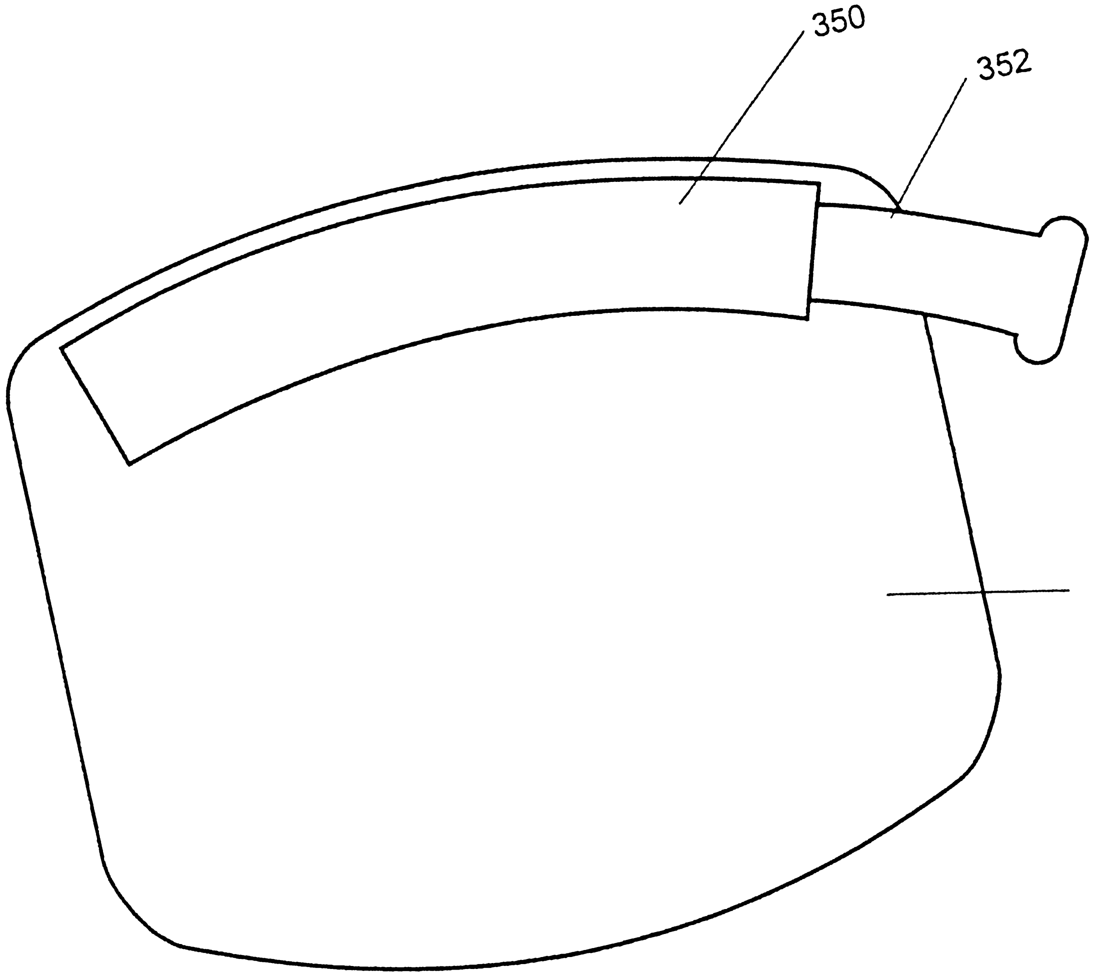

FIGURE 44