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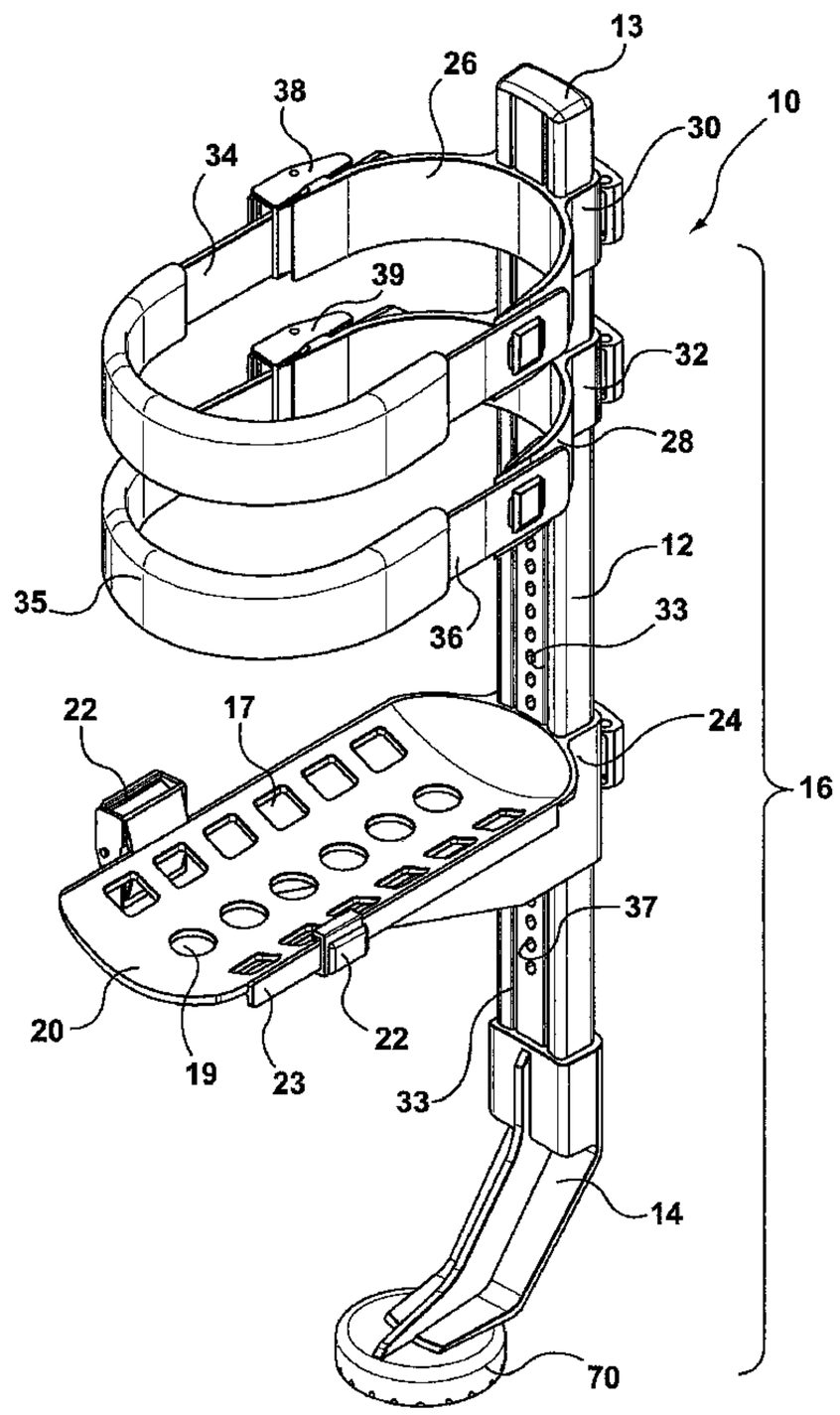
(54) Title: CRUTCH DEVICE



(57) Abrégé/Abstract:
The present invention is directed to a light weight prosthetic device made from synthetic materials for use with lower limb injuries. The device has a lower limb supporting platform and at least one stabilizing member adjustably mounted on an upright leg member. The vertical positioning of the stabilizing member(s) and the support platform can be adjusted and locked in place in the absence of any tools.

ABSTRACT

The present invention is directed to a light weight prosthetic device made from synthetic materials for use with lower limb injuries. The device has a lower limb supporting platform and at least one stabilizing member adjustably mounted on an upright leg member. The vertical positioning of the stabilizing member(s) and the support platform can be adjusted and locked in place in the absence of any tools.

CRUTCH DEVICE

FIELD OF THE INVENTION

The present invention is concerned with a crutch-like device designed to facilitate the ambulation of persons having non-weight-bearing lower leg injuries.

BACKGROUND OF THE INVENTION

Crutches have long been used as devices to assist those suffering from an injury to the lower extremities to walk. Traditional crutches extend from the shoulder/underarm to the ground to bear the weight of the injured person. Such crutches are usually fabricated from wood or light weight metal and comprise two upright shafts culminating at one end in a foot and being attached at the other end to a crossbar which is accommodated under the arm. A second crossbar at approximately the mid-point acts as a handle. There are several problems associated with these types of crutches including shoulder fatigue and the fact that it is necessary to use the muscles of the upper leg and lower back to support the lower leg in a slightly rearwardly upward manner to maintain sufficient clearance from the walking surface. This physical stature can result in painful muscle induced scoliosis. In addition, the hand or hands supporting the crutch(es) are not available for other activities. The center of gravity is also raised, thereby affecting balance.

The prior art has attempted to address the problems associated with crutches. U.S. Patent No. 5,575,299, for example, discloses a walking device having a body member which can be attached to the lower leg. However, this device does not provide means for secure attachment to the upper limb and there may therefore be some rotation about the knee which gives a user a feeling of instability. U.S. Patent No.5,300,016 discloses a foldable prosthetic device which includes a shelf for supporting the lower leg. This device is complex to manufacture and has a plurality of components transferring weight along parallel axes. Both U.S. Patent No. 5,575,299 and 5,300,016 result in

strain being applied to an already injured limb and neither provide the degree of stability required for a user to comfortably maintain their balance.

Applicant's co-pending application PCT/CA99/00279 discloses a hands-free crutch having a support platform for the injured lower extremity affixed to an upright support leg such that the weight of the person is transferred through the hip, upper leg and knee rather than the shoulder as is the case with traditional crutches and this therefore affords a more natural distribution as the center of gravity is lowered. The device can be attached to the upper leg and thigh to allow for single hand or hands free operation. The present invention is an improvement on the basic concept of the device of co-pending PCT/CA99/00279 in terms of durability, adjustability and comfort. The present invention has surprising advantages over the prior art which are made possible by virtue of the synthetic materials used in its construction and the type of adjusting mechanisms used.

SUMMARY OF THE INVENTION

A crutch, for non-weight-bearing lower leg and foot injuries or for amputees, adapted for hands-free operation is provided. The upper leg or portion thereof is supported on a platform. The forces applied to the platform are transmitted downwardly along a ground engaging upright leg support. The device is attached to the upper and lower leg by way of a series of straps.

In accordance with one aspect of the invention, there is provided a light-weight adjustable prosthetic device of synthetic material comprising:

i) an elongate, essentially vertical leg member comprising a shaft and a foot member, said leg member having a webbed core;

ii) an essentially horizontal support platform mounted on the leg member for supporting a user's weight normally supported by an uninjured leg

iii) stabilizing means mounted on the leg member to hold a user's upper leg in position;

iv) attachment means associated with the stabilizing means and the support platform to secure the device to a user's leg,

v) clamping means to maintain said stabilizing means and said support platform in a vertical position;

vi) locking means associated with said support platform to lock said support platform in position;

wherein the vertical position of each of the support platform and the stabilizing means is adjustable without the need for any tools.

BRIEF DESCRIPTION OF THE DRAWINGS

Several aspects of the invention are illustrated in the accompanying drawings, in which like numerals denote like parts throughout the several views, and in which:

Figure 1 is a perspective view of a preferred embodiment;

Figure 2 is a cross-sectional view of the leg member of Figure 1;

Figure 3 illustrates a preferred embodiment of a latch;

Figure 4 illustrates a clamping mechanism;

Figure 5 illustrates a preferred embodiment of the locking means associated with the support platform;

Figures 6 A, B, and C illustrate various aspects of a support platform;

Figures 7A-D are, respectively, bottom, side, cross-sectional and schematic representations of a preferred foot pad

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Crutches have traditionally been used to help those suffering from lower leg injuries to get around. However, crutches limit the use of the hands for other activities and are generally described as clumsy, tiring and uncomfortable.

The present invention is particularly applicable to otherwise healthy individuals who suffer a lower limb injury. The device is ideally suited to the recovery of injured workers, outdoor enthusiasts and athletes but is also applicable to patients with diabetes and other afflictions which affect circulation in the leg as well as for post-operative patients. The device also has special application for war victims such as land-mine survivors.

Unlike an artificial limb or custom-made prosthetic device, the present invention is a hands-free crutch or walking aid which can be easily adjusted, without tools for immediate use. The device supports the knee and upper leg using a universal and simple fastening system designed to be user friendly. It provides for virtually unlimited height and limb size adjustments and represents a significant improvement in comfort. The device can be adapted for use by patients of all sizes including children.

Thus, the present invention provides a prosthetic device, or walking aid, for those suffering from various types of lower leg, ankle and foot injuries such as, for example, any surgical procedures below the knee including achilles tendon, open reduction, internal fixation of the ankle, post surgical procedures to the foot such as bunion surgery and of course, fractures. The device affords a platform on which, preferably, the lower part of the leg below the knee is supported and an upright vertical support. The device takes advantage of the natural pivoting action provided in the hip and provides walking assistance by essentially rigidly extending the upper leg to a walking surface. The individual's weight is transmitted downwardly through the upper leg to the knee and along the device to the ground.

This device provides an attractive, more versatile alternative to traditional crutches. Because the device is manufactured from synthetic materials, it is light and comfortable and can be mass produced at reasonable costs. The device may replace the crutches currently provided by hospitals to patients and thus should be able to withstand extended use by several different users. It should also be easily adjustable for users of varying heights and proportions. The device must also be sturdy enough to support people of varying weights yet maintain a degree of flex along the leg member. It is by virtue of using a synthetic material that the desired properties can be achieved. Materials which have inherent characteristics of strength and flexibility are chosen so as to simulate as much as possible the normal bouncing steps associated with a natural walking action. With regard to these characteristics, synthetic materials have several advantages over wood or metal. For example,

when using a synthetic material, additives such as polymeric or organic fibres can be added to affect factors such as strength and flexibility. The amount of potential rotation about a vertical axis can also be controlled. Preferably, the device of the present invention does not conduct electricity and it has a compact design and low unit cost. The short learning curve associated with the device and its ease of use to promote the resumption of a normal lifestyle in a very short time. A preferred embodiment is illustrated in Figure 1. The device 10 comprises a shaft 12 and foot member 14 which together form a functionally unitary leg member 16. Thermoplastic polymer resins are used in the manufacture of the shaft 12 and foot member 14 as well as the various other components of the device 10. Although the foot member 14 and the shaft 12 are extruded or injection molded as separate components they are then bonded to each other to function as a unitary leg member 16. The shaft may be hinged to fold as long as in the use position the leg member functions in the same manner as if it were a unitary continuous leg. They may be thermally bonded or bonded with a high strength adhesive. The shape and positioning of the foot member14 is designed to allow, as closely as possible, the sensation of normal walking. The degree by which the ground engaging surface of the foot member is offset relative to the principal vertical axis of the leg member is selected to align the hip, the upper leg and the foot member to facilitate a more natural rolling gait. A skid resistant foot pad 70 is provided on the foot member 14.

A horizontal support platform 20 is vertically adjustably affixed to the leg member 16. The user's body weight is transferred from the upper limb to this platform 20 which may also function to cradle and support an injured lower limb. It should be understood that the device 10 may also be used where there has been an amputation and in this case, the stump of the remaining limb is supported on the platform 20. In a preferred embodiment the support platform 20 is equipped with attachment means 21 such as a strap (not shown in Figure

1, see Figure 5), to hold the lower limb in place and provide additional stability. The length of the strap is adjustable and is held in place by a latch members 22. The position of the attachment means can be adjusted along the length of the support platform to accommodate lower limbs of varying lengths and shapes as well as a long or short amputation comfortably. In a preferred embodiment, the latch members 22 slide along a ridge 23 on each side of the platform 20. Alternatively, there can be strap mount(s) at fixed locations along the length of the support platform. The support platform 20 is slidably attached to the leg member 16 and held in vertical position by way of a toolless clamping member 24. The platform may have perforations 17 to enhance the light weight characteristic of the device and to provide ventilation to prevent moisture buildup. Apertures 19 may also be provided to receive and locate nubs on a cushion member. The perforations and apertures may take on various shapes and sizes.

The present device also comprises at least one stabilizing member to align the leg within the device and to prevent side to side movement of the leg. In a preferred embodiment, upper 26 and lower 28 stabilizing devices are adjustably affixed to the shaft 12. The upper 26 and lower 28 stabilizing devices are each slidably attached to the shaft 12 and held in vertical position by clamping members 30 and 32, respectively which wrap around the shaft and, when in a closed position, grip the shaft and prevent the stabilizing devices from sliding along the shaft. A similar sliding clamp mechanism 24 is associated with the support platform 20. This type of clamping member has the advantage that by virtue of clamping about the shaft it resists the torque associated with downward pressure on the stabilizing devices and support platform. Also, the shape of the clamp prevents it from rotating around the shaft. In addition, because the clamping member is a sliding grip clamp the degree of adjustment is virtually infinite. Each of the stabilizing means 26, 28 is provided with attachment means 34, 36, respectively to secure the device to the leg. In a preferred embodiment a strap is used as the attachment means 34 and 36. The length of the strap is adjusted by sliding the strap through a latch 38,

39, respectively. The strap may be provided with padding 35 for additional comfort.

In a preferred embodiment, the shaft comprises a webbed core as shown in Figure 2 in which indexing holes 37 are incrementally spaced along a section of the shaft. These holes can be used in conjunction with a support platform locking mechanism which is described further with respect to Figure 5 to lock the support platform in position. Parallel channels 33 are integrally formed along the length of the shaft. These channels help to align and hold the clamping member in place when it is being slid up or down the shaft as discussed further with respect to Figure 4.

The resins used in the manufacture of the device are selected to be resistant to ultraviolet radiation and to assure a long life under the expected wide range of environments where the device may be used. The resins are also selected and structurally analyzed to have desired properties in terms of flexibility, strength, longevity, temperature tolerance and performance characteristics. Some exemplary types of resins that can be used are polycarbonate ABS, nylons and engineered resins.

In a preferred embodiment, the shaft 12 comprises an extruded webbed core 40 as illustrated in Figure 2. The web is relied on to provide a controlled degree of flex along its length and at the same time provide structural support for the indexing holes 37 which occur along a section of the shaft. These holes may be machine tooled into the shaft. The channels 33 which interact with the clamping members 24, 30 and 32 are integrally formed in the web. This core provides additional strength while maintaining the light weight of the device and is made possible by virtue of the synthetic material used.

In a preferred embodiment as illustrated in Figure 3, the latch 38 comprises a rocker clip which has precise tooth indexing 42. This allows for very precise adjustment of the strap customized to the user. The strap is preferably a plastic strap which is stronger and lasts longer than a fabric strap, although any kind of attachment means could be used. The strap may be provided with pads for additional comfort as illustrated in Figure 1. In a

preferred embodiment, the latch 38 is easy to use and is all plastic so that there are no metal pins or springs. This embodiment is particularly useful in situations such as around land mines where it is undesirable to have metal components which can detonate mines. Of course, it is clearly apparent that, in other situations, metal springs and pins or other latching means may be used.

As stated above, the horizontal support platform 20 and the upper 26 and lower 28 stabilizing devices can be individually vertically adjusted. This is achieved by loosening the clamping member 24, 30, or 32, respectively and sliding the support platform 20 or stabilizing devices 26, 28 vertically. Once they have been adjusted to the desired position, they are again locked in place. In a preferred embodiment the clamping member 24, 30 or 32 comprises a sliding clamp.

An exemplary clamping mechanism 30 for the adjustment of the upper stabilizing device 26 is illustrated in Figures 4A and 4B and can also be seen at 30 in Figure 1. Similar clamping mechanisms are associated with the lower stabilizing device and the support platform. The clamping member has a right rib 46 and a left rib 48 which are resiliently biased apart and define a channel 47 adapted to receive the shaft. This channel can therefore slide along the shaft. The ends of the two ribs 46, 48 terminate to form a slit 49 between them. In the open position shown in Figure 4A, the frictional grip onto the shaft is released and the stabilizing means can slide up and down the shaft. The width of the slit is selected to allow enough space for the ribs to come together enough to firmly grip the shaft. However, the slit is preferably not so wide as to allow the clamping members to so freely slide along the shaft that they fall to the bottom when the clamp is in the open position. Preferably the vertical position of the clamping member can be adjusted and then the clamp is closed to securely hold the position. A lever type member 50 is pivotally associated with one end 52 of a link arm 54 and the other end 56 is attached to a pivot axis 58. In the open position, shown in dotted lines on Figure 4B, the lever 50 is lifted thereby causing the slit 49 to enlarge sufficiently so that the clamp member is no longer tightly wrapped around the shaft and the clamp member (with its associated

stabilizing means or support platform) can be slid up or down the shaft. The clamping member may also comprise protrusions 59 which are adapted to fit within and slide along the parallel channels 33 in the shaft. To close the clamp, the lever is pushed in and this provokes the ends 52, 56 of the clamp to move towards each other thereby causing the clamp to grip the shaft in a tight frictional hold which maintains the stabilizing means and/or support platform in a fixed position. By using a locking mechanism which depends upon frictional contact with the shaft member, the degree of adjustability is virtually limitless in that the sliding clamp can be positioned anywhere along the shaft, not just at specific increments. The ability to adjust the stabilizing in this manner allows for easy and rapid customization of the device for individuals of varying height and proportions. A second incremental locking system is associated with support platform as discussed below with regard to Figure 5. Because of the inherent properties of the synthetic material used, a further degree of customization can be easily achieved by removing the cap 13 (shown in Figure 1), cutting the length of the shaft and replacing the cap.

Because of the weight and associated vertical pressure being applied to the horizontal support platform 20, a locking system 50 is provided in addition to the clamping member to ensure that the platform 20 does not creep along the shaft 12. As illustrated in Figure 5, in a preferred embodiment, the additional locking system 80 comprises at least one spring loaded pin 82 associated with the base 84 of the support platform 20. As discussed above, the shaft 12 is provided with a webbed core 40 in which there are holes 37. These holes are adapted to receive the prongs 86 of the pin 82 . The pin is provided with a springs 83 which urge the prongs 86 into a forward position and hold them in place in the holes 37. Thus, this locking system 80 which comprises at least one spring loaded pin 82 and slots 37 for receiving the prongs 86 of the pin 52 in the shaft 12, holds the support platform 20 firmly in position. When it is desirable to adjust the position of the support platform, the user simply pulls on the U portion of the pin. The springs 83 are compressed and the prongs 86 are pulled out of the holes 37. The support platform is then moved to a new

position and the spring is released to allow the prongs to advance into a different set of holes. For additional security, the base 84 of the support platform 20 comprises a downwardly projecting face 85 which is provided with alignment holes 68 which can be aligned with the holes 37 in the shaft and through which the prongs of the pin project and enhance the stability of the locking mechanism (see also Figure 6C). The downwardly projecting face 85 adds even further stability in that it resists the torsional movement of the support platform relative to the shaft generated by the downward pressure which is applied as a result of the platform supporting a user's weight.

The sliding clamp mechanism 24 and the locking mechanism 50 function in concert to provide a very secure means of holding the support platform in position. Both the sliding clamp and the locking mechanism which is associated with the base of the platform are designed to resist the torsional pressure applied to the support platform when it is supporting a user's weight. In addition, by using two different locking mechanisms in conjunction with each other the security of the support platform positioning is greatly enhanced.

It is clearly apparent to one skilled in the art that other types of locking mechanisms such as an indexed tooth system or various other systems could also be employed in this invention to lock the support platform in position.

An advantage of the present invention is that the various components can be adjusted without using any specialized tools or any tools at all. Thus, there are no tools to lose and the device can be adjusted by anyone to provide maximum efficiency of use and comfort. As opposed to custom prosthetic devices or even crutches which have to be available in a multitude of sizes, the present device is virtually universal and can be used

Referring to Figures 6A-C, in a preferred embodiment the support platform 20 may be curved to cradle the limb. As well as enhancing stability, this design provides added comfort. A cushion member 60, such as a multi-density foam pad, is fitted into the platform 20 for additional comfort. In a preferred embodiment, the cushion member is a foam pad comprising high density 64 and low density 66 foam. The cushion member may also optionally

comprise nubs 67 adapted to fit into the apertures 19 on the support platform. This arrangement holds the cushion member in place and prevents movement on the support platform when the device is in use. The cushion may be removable from the support platform for cleaning, sterilization or replacement. Alternatively, the cushion member may be adhered to the support member with an adhesive.

Figures 7A-D illustrate a preferred embodiment of the skid resistant foot pad 70. The foot pad 70 incorporates a number of indentations 72 which enhance the skid resistant properties of the rubberlike material 74. In a preferred embodiment, the foot member has a self cleaning tread and has a tapered design. As shown in Figure 7C, the footpad may also include one or more molded teeth 76 which are adapted to fit into recesses 78 in the bottom of the foot member to prevent rotation.

Although preferred embodiments of the invention have been described herein in detail, it will be understood by those skilled in the art that variations may be made thereto without departing from the spirit of the invention or the scope of the claims.

CLAIMS

What is claimed is:

1. A prosthetic device comprising:

(a) an elongate leg member comprising a shaft and a foot member fixed to the shaft;

(b) a support platform mountable on the shaft for supporting a user's weight;

(c) stabilizing means mountable on the shaft for holding a user's upper leg;

(d) adjustable attachment means associated with the stabilizing means for securing the device to a user's leg;

(e) slidable clamping means for maintaining the stabilizing means and the support platform at fixed positions along the shaft and for allowing longitudinal positional adjustment of the stabilizing means and the support platform along the shaft; and

(f) locking means associated with the support platform to lock the support platform in a longitudinal position along the shaft.

2. The device of claim 1 wherein the locking means comprises a spring loaded pin having elongate prongs for engagement with incremental holes located along the shaft, the holes being adapted to receive the prongs.

3. The device of claim 2 wherein the support platform includes a downwardly projecting face having alignment holes aligned with the holes in the shaft, and wherein the prongs project through the alignment holes.

4. The device of claim 1 wherein the shaft is an extrusion product with an internal strengthening web.

5. The device of claim 1 wherein the shaft includes at least one elongate channel disposed along the shaft.

6. The device of claim 5 wherein the clamping means includes at least one protrusion, the at least one protrusion for engaging the at least one elongate channel.

7. The device of claim 6 wherein there are two protrusions and two elongate channels, and the two elongate channels are parallel and disposed along an inside face of the shaft.

8. The device of claim 1 wherein the foot member comprises a skid resistant foot pad.

9. The device of claim 8 wherein the foot pad comprises integral molded teeth adapted to locate within recesses in the foot member thereby fixing the foot pad in a location on the foot member.

10. The device of claim 1 wherein the shaft is made from a thermoplastic polymer resin.

11. The device of claim 1 wherein the shaft is made from nylon.

12. The device of claim 1 wherein the support platform and the stabilizing means are made from a thermoplastic polymer resin.

13. The device of claim 1 wherein the clamping means includes ribs defining a channel to fittingly receive the shaft.

14. The device of claim 13 wherein the clamping means includes a lever mechanism.

15. The device of claim 14 wherein the ribs firmly grip the shaft when the lever mechanism is in a closed position.

16. The device of claim 1 wherein the shaft and the clamping means are shaped to prevent the clamping means from rotating about the shaft.

17. The device of claim 1 wherein the attachment means includes straps.

18. The device of claim 17 wherein the straps are adjustable in relation to latch members on the stabilizing means.

19. The device of claim 1 further comprising an additional attachment means for securing the device to the user's leg, wherein the additional attachment means is associated with the support platform.

20. The device of claim 19 wherein the additional attachment means includes a strap.

21. The device of claim 20 wherein the strap is connected to the support platform by latch members and is adjustable in relation to the support platform.

22. The device of claim 21 wherein the support platform includes side ridges and the latch members are slidable along the ridges.

23. The device of claim 1 wherein the shaft and the support platform are fabricated of lightweight materials.

24. The device of claim 1 wherein the materials are synthetic.

25. The device of claim 1 wherein the support platform and the stabilizing means are vertically adjustable in the absence of any separate tools thereby enabling the device to be readily customized to individuals of varying heights and proportions.

26. The device of claim 1 wherein the foot member is offset from the shaft, such that the foot member corresponds to an axis of the user's upper leg.

27. A prosthetic device comprising:

(a) an elongate leg member comprising a shaft and a foot member fixed to the shaft, the shaft including an elongate channel disposed along its length;

(b) a support platform mountable on the shaft for supporting a user's weight;

(c) stabilizing members mountable on the shaft for holding a user's upper leg;

(d) adjustable attachment straps connected with the stabilizing members for securing the device to a user's leg;

(e) slidable clamps for maintaining the stabilizing members and the support platform at fixed longitudinal positions along the shaft and allowing longitudinal positional adjustment of the stabilizing members and the support platform along the shaft, the clamps including a protrusion engageable with the elongate channel; and

(f) a locking mechanism associated with the support platform to lock the support platform in a longitudinal position along the shaft.

28. The device of claim 27 wherein the shaft and the clamps are shaped to prevent the clamps from rotating about the shaft.

29. The device of claim 27 further comprising an additional attachment strap for securing the device to a user's leg, wherein the additional attachment strap is associated with the support platform.

30. The device of claim 29 wherein the additional attachment strap is adjustable and held in place by latch members.

31. The device of claim 30 wherein the latch members are located on side ridges on the support platform and the latch members are slidable along the ridges.

32. The device of claim 27 wherein the locking mechanism comprises a spring loaded pin having elongate prongs for engagement with incremental holes located along the shaft, the holes being adapted to receive the prongs.

33. The device of claim 32 wherein the support platform includes a downwardly projecting face having alignment holes aligned with the holes in the shaft, and wherein the prongs project through the alignment holes.

34. The device of claim 27 wherein the foot member is offset from the shaft, such that the foot member corresponds to an axis of the user's upper leg.

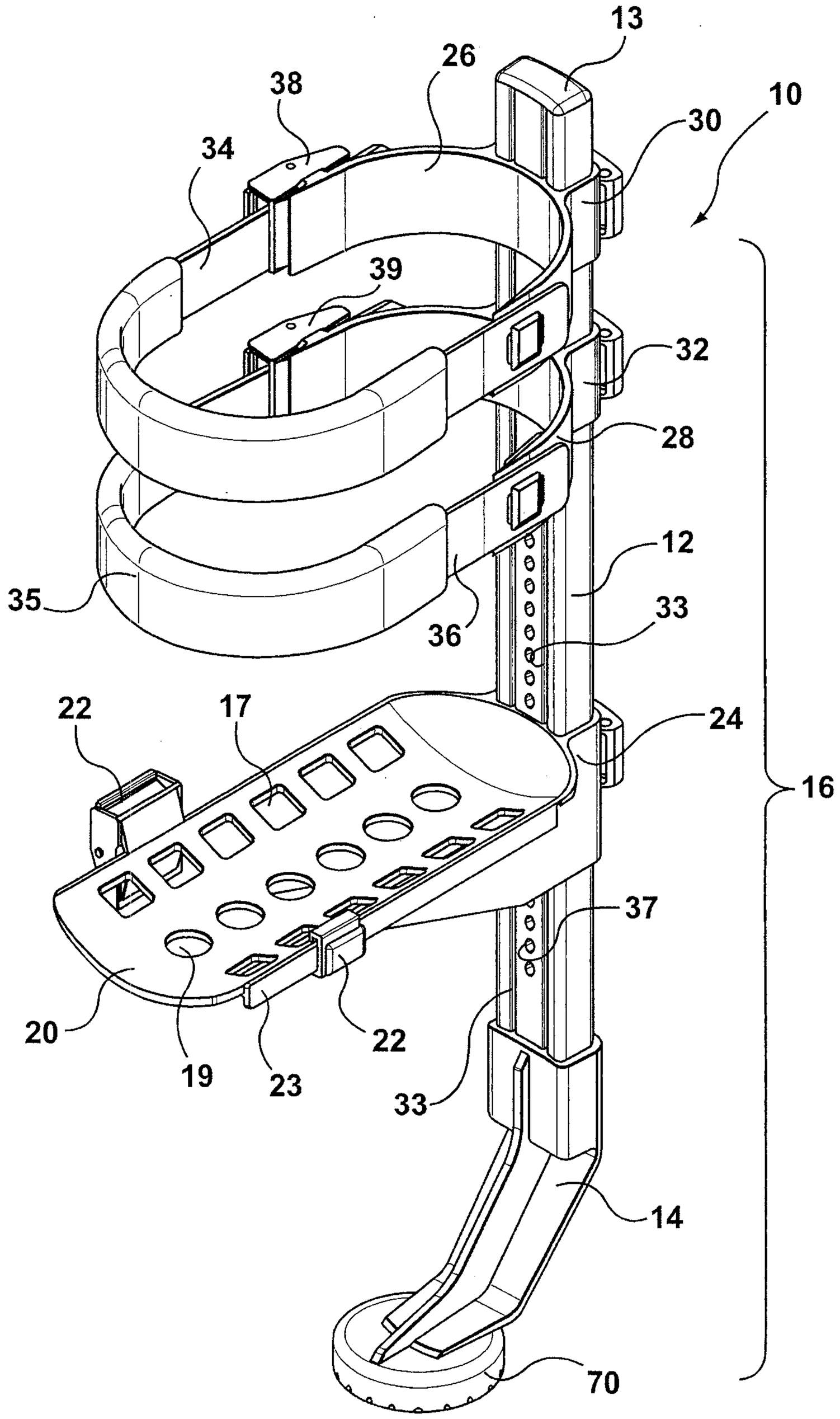

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FIG. 1

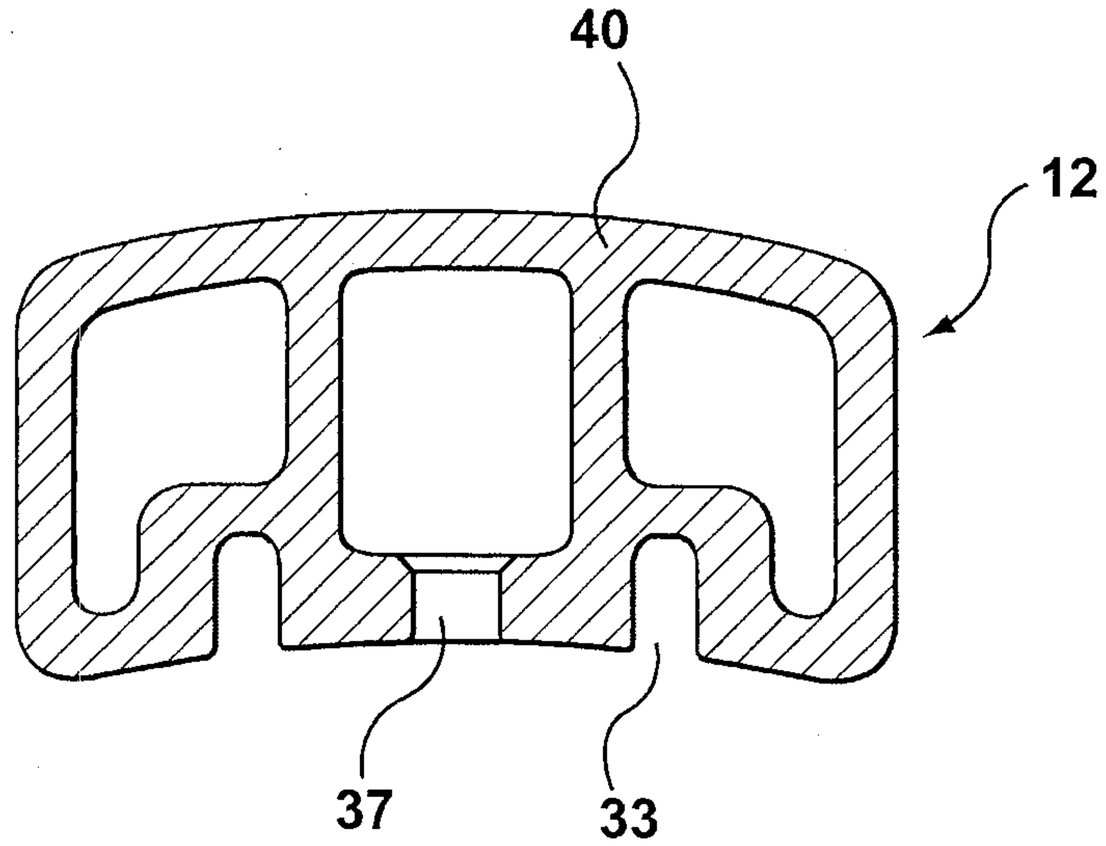


FIG. 2

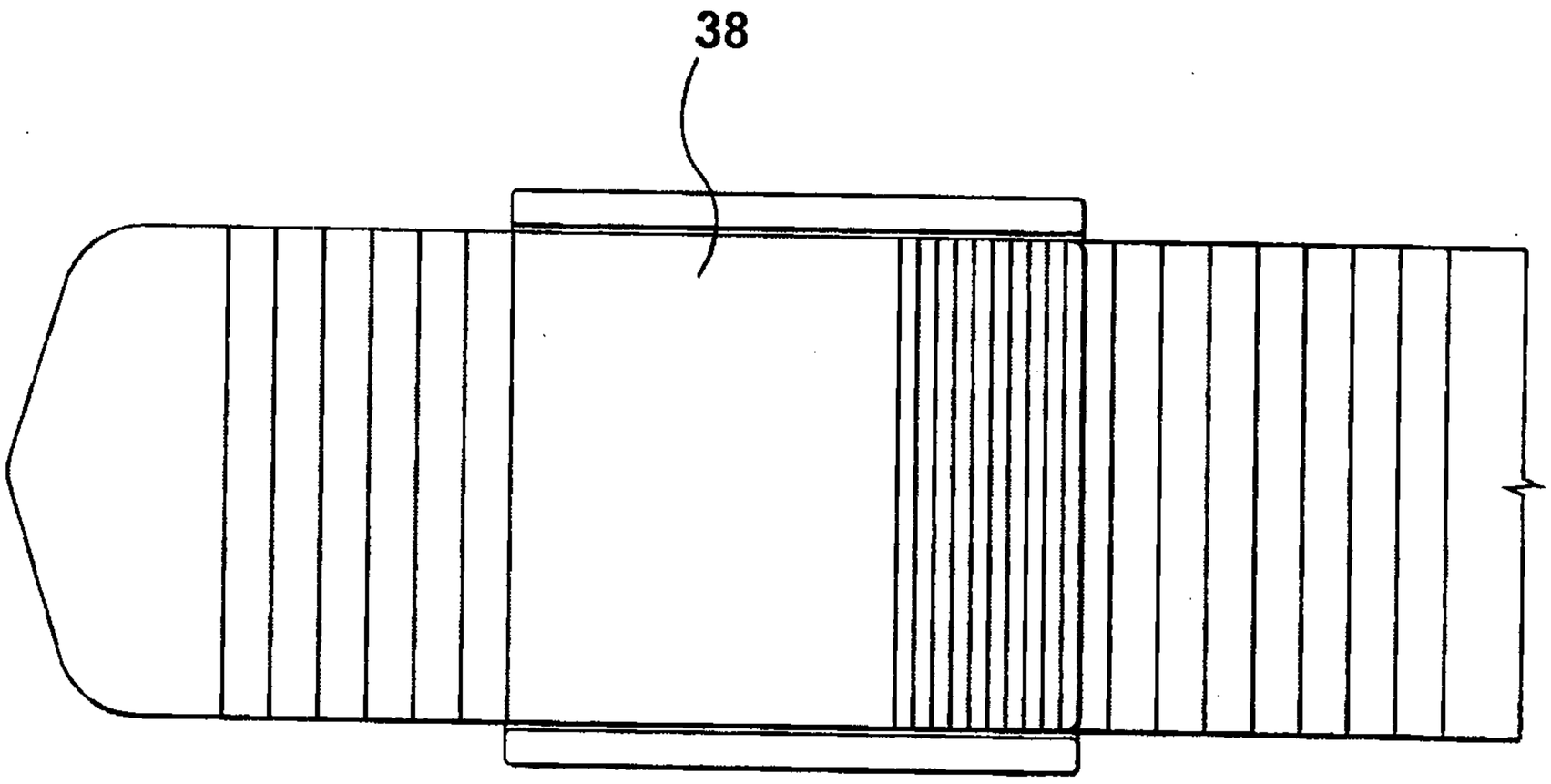


FIG. 3A

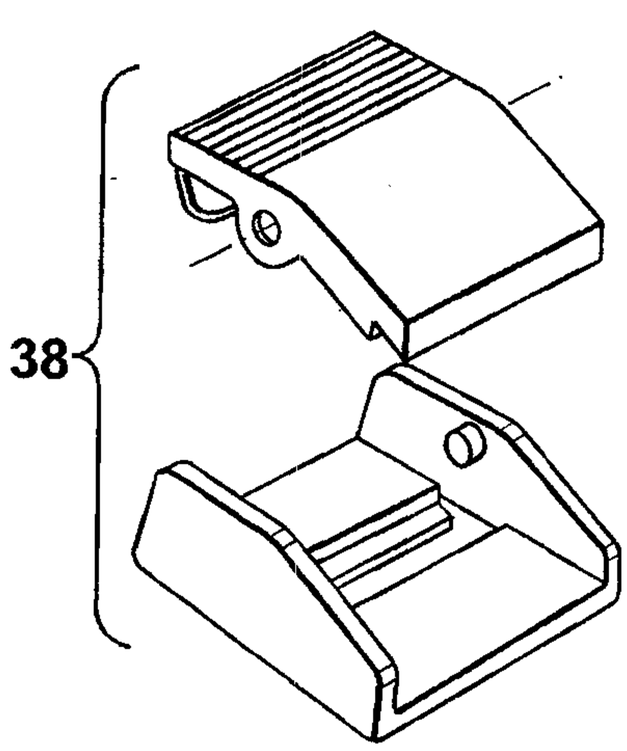


FIG. 3B

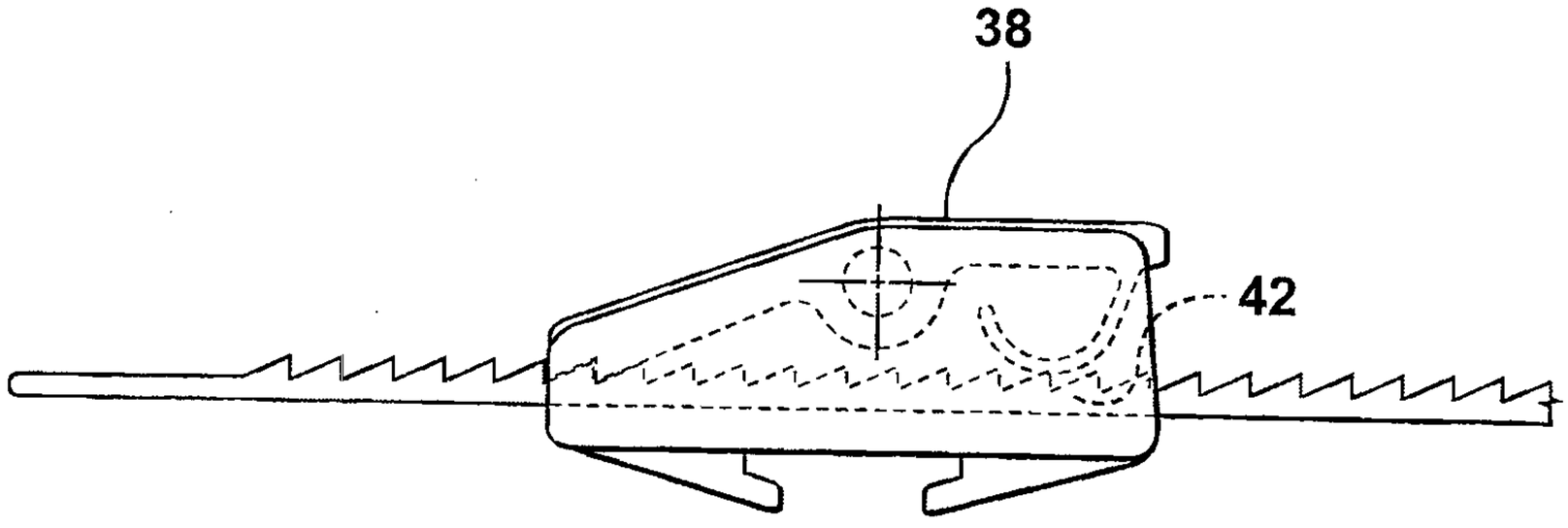


FIG. 3C

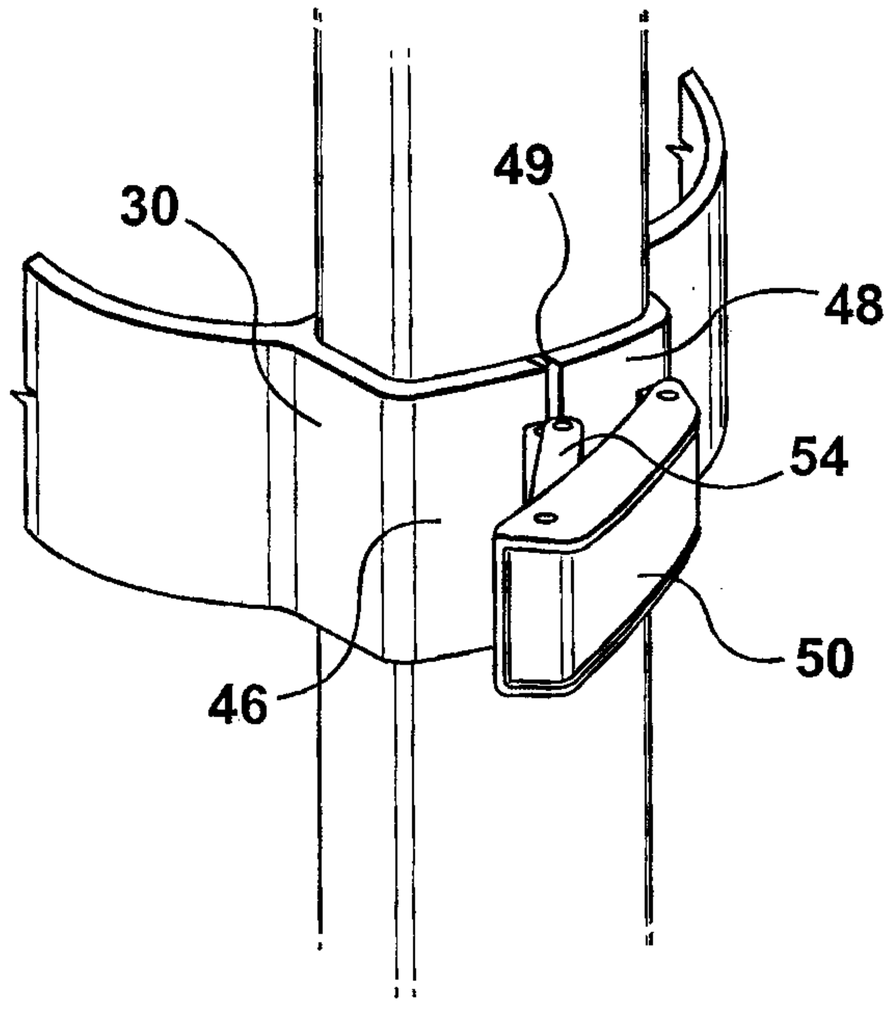


FIG. 4A

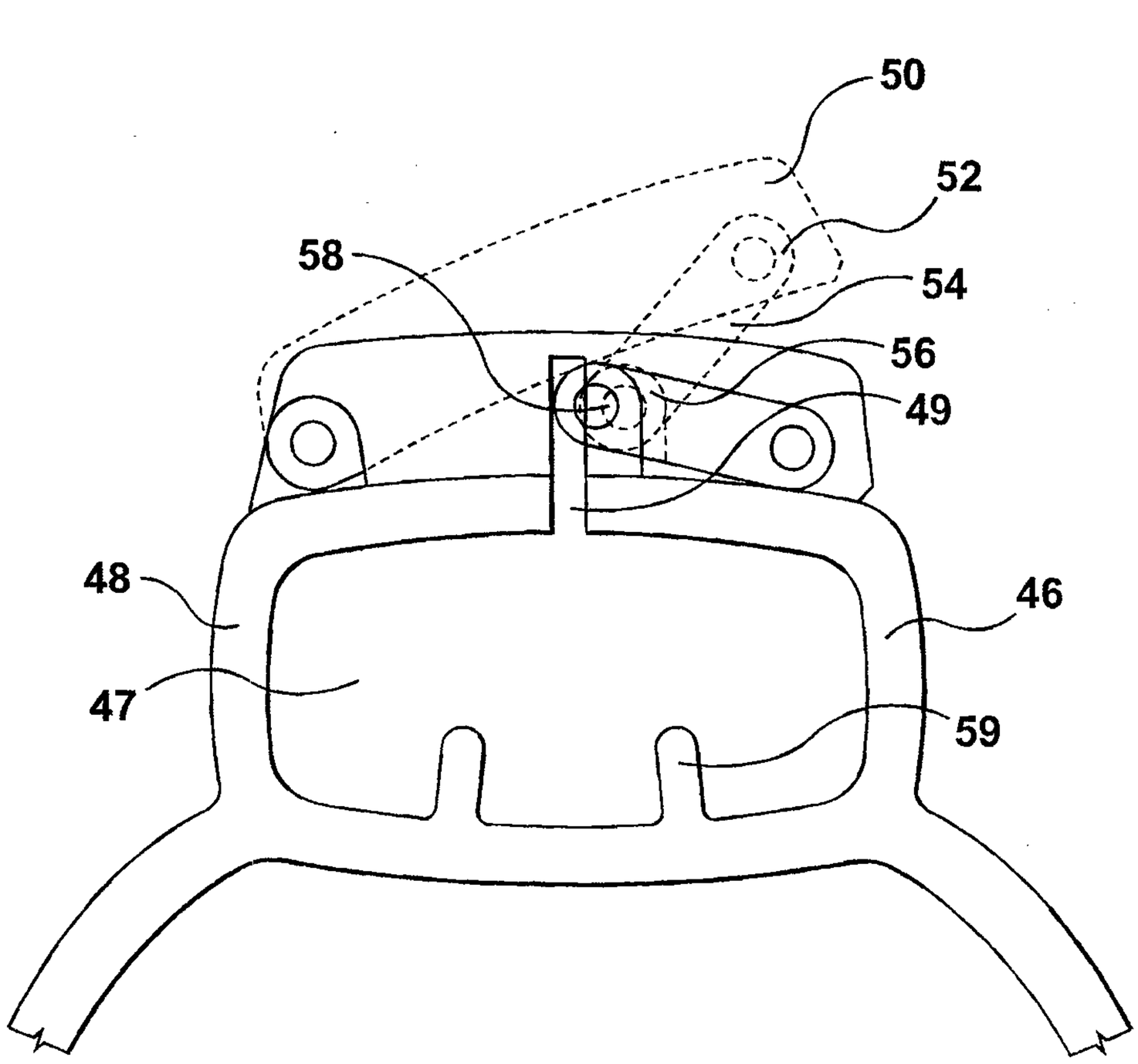


FIG. 4B

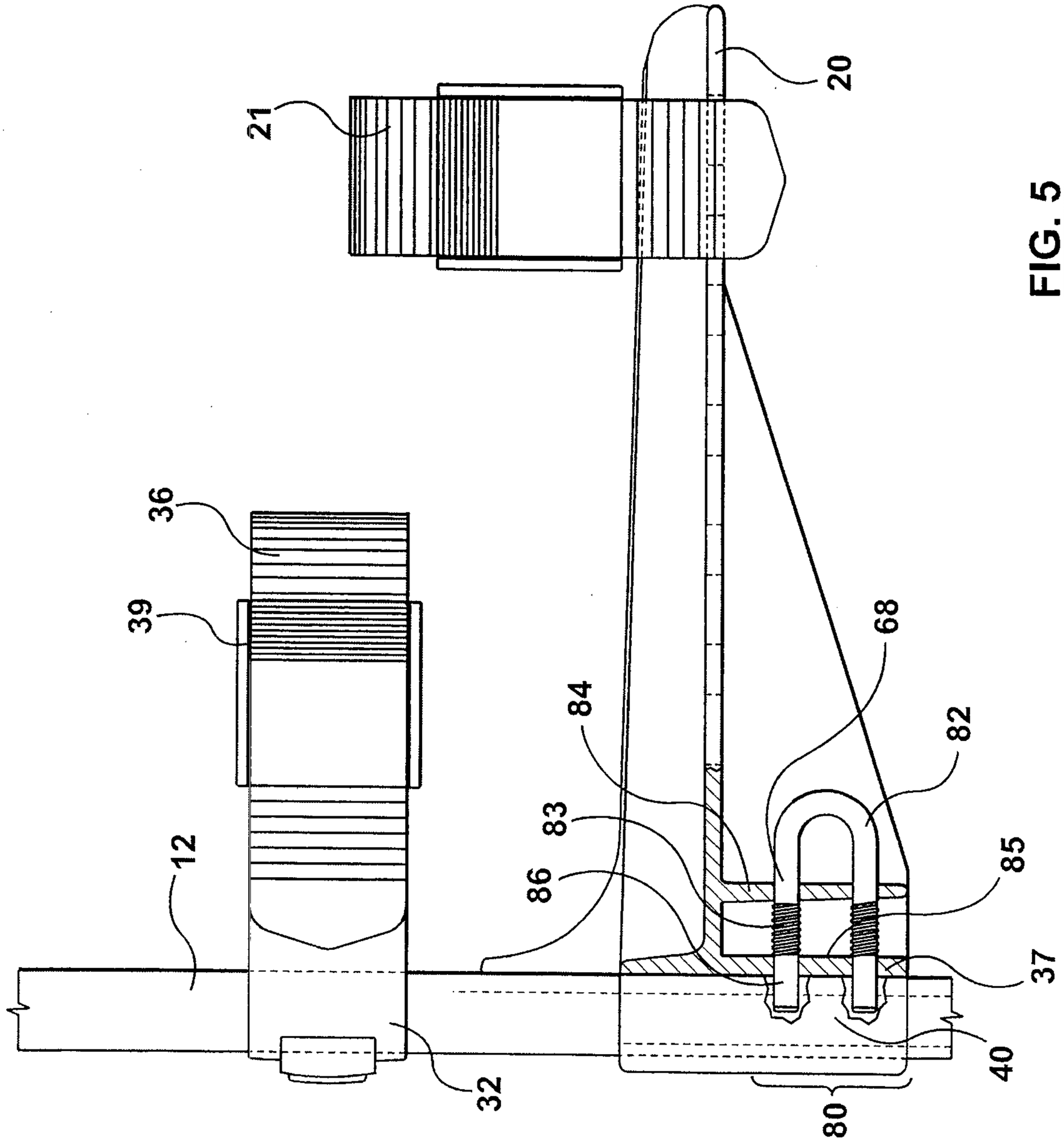


FIG. 5

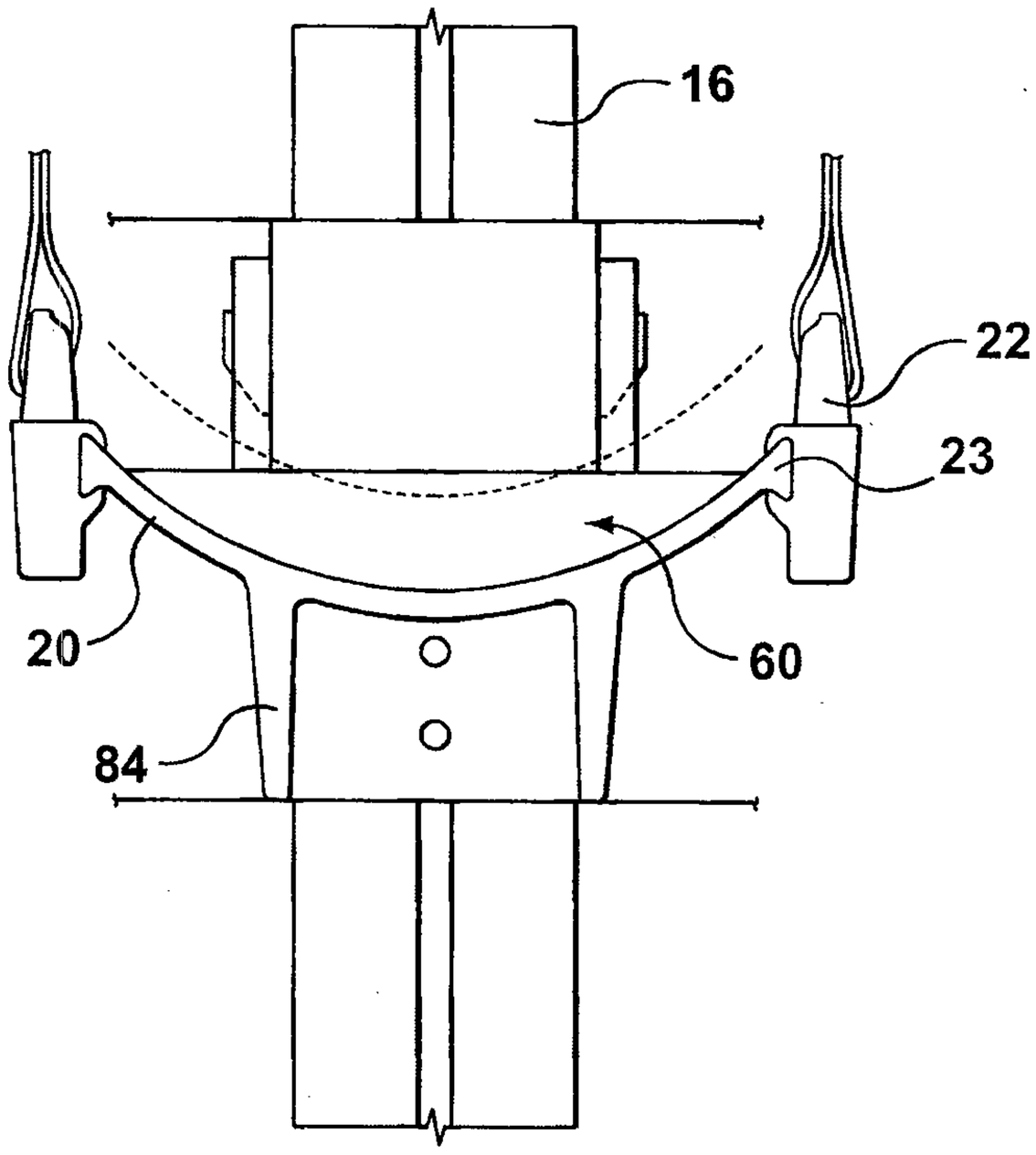


FIG. 6A

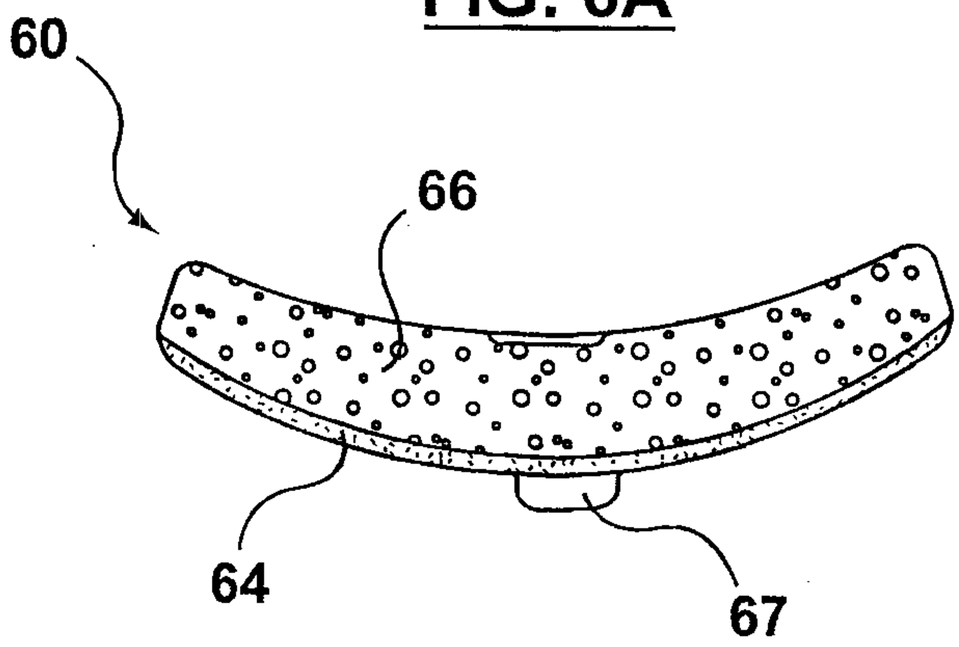


FIG. 6B

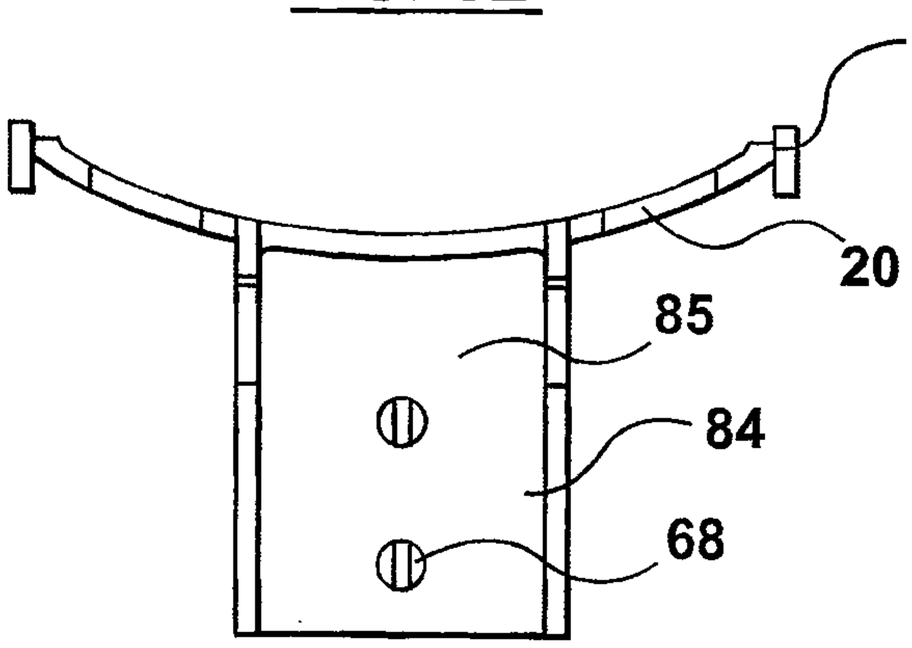


FIG. 6C

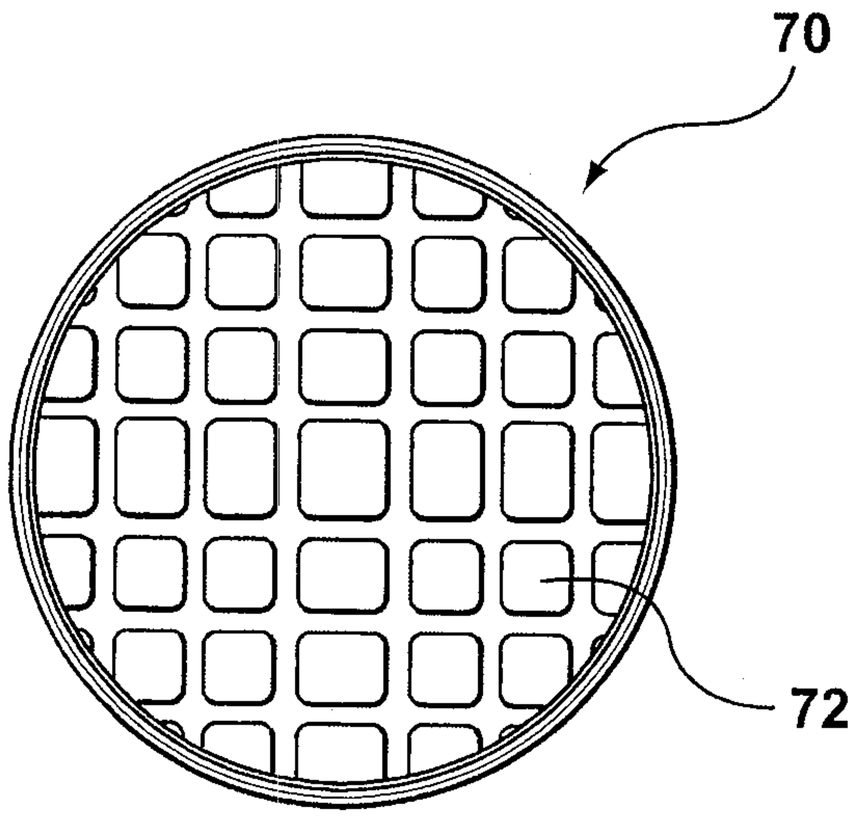


FIG. 7A

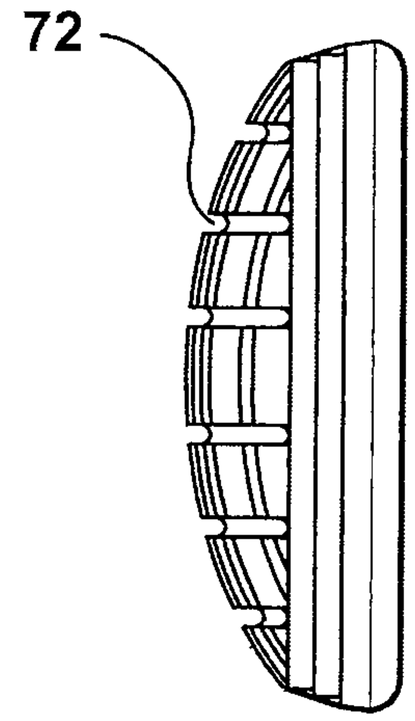


FIG. 7B

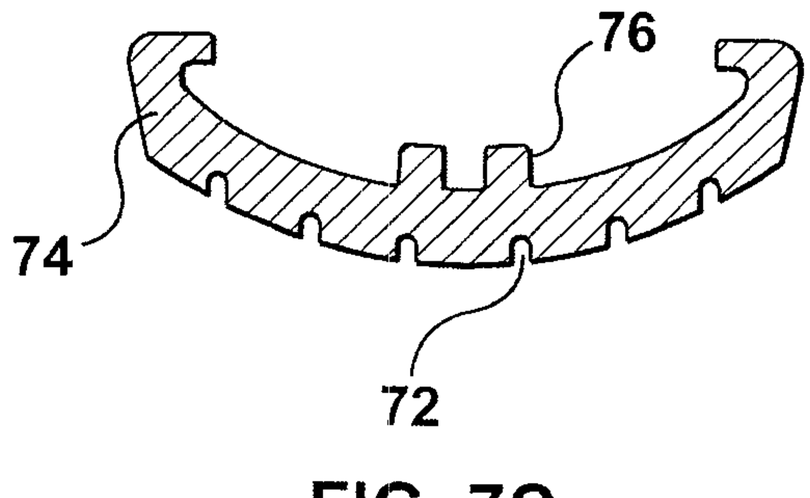


FIG. 7C

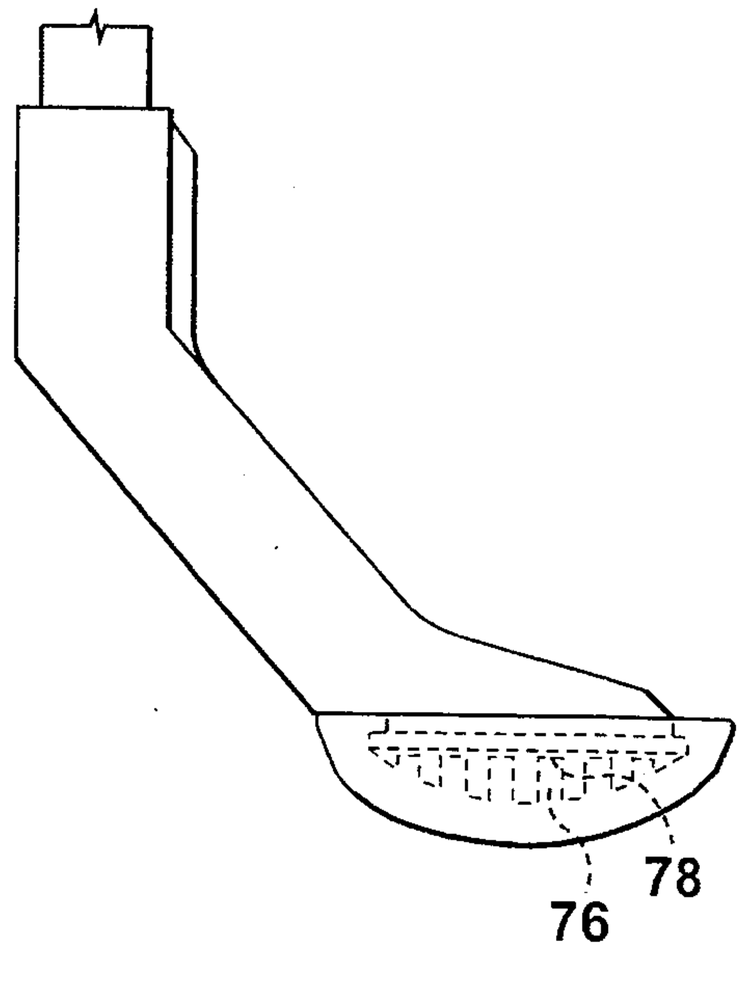
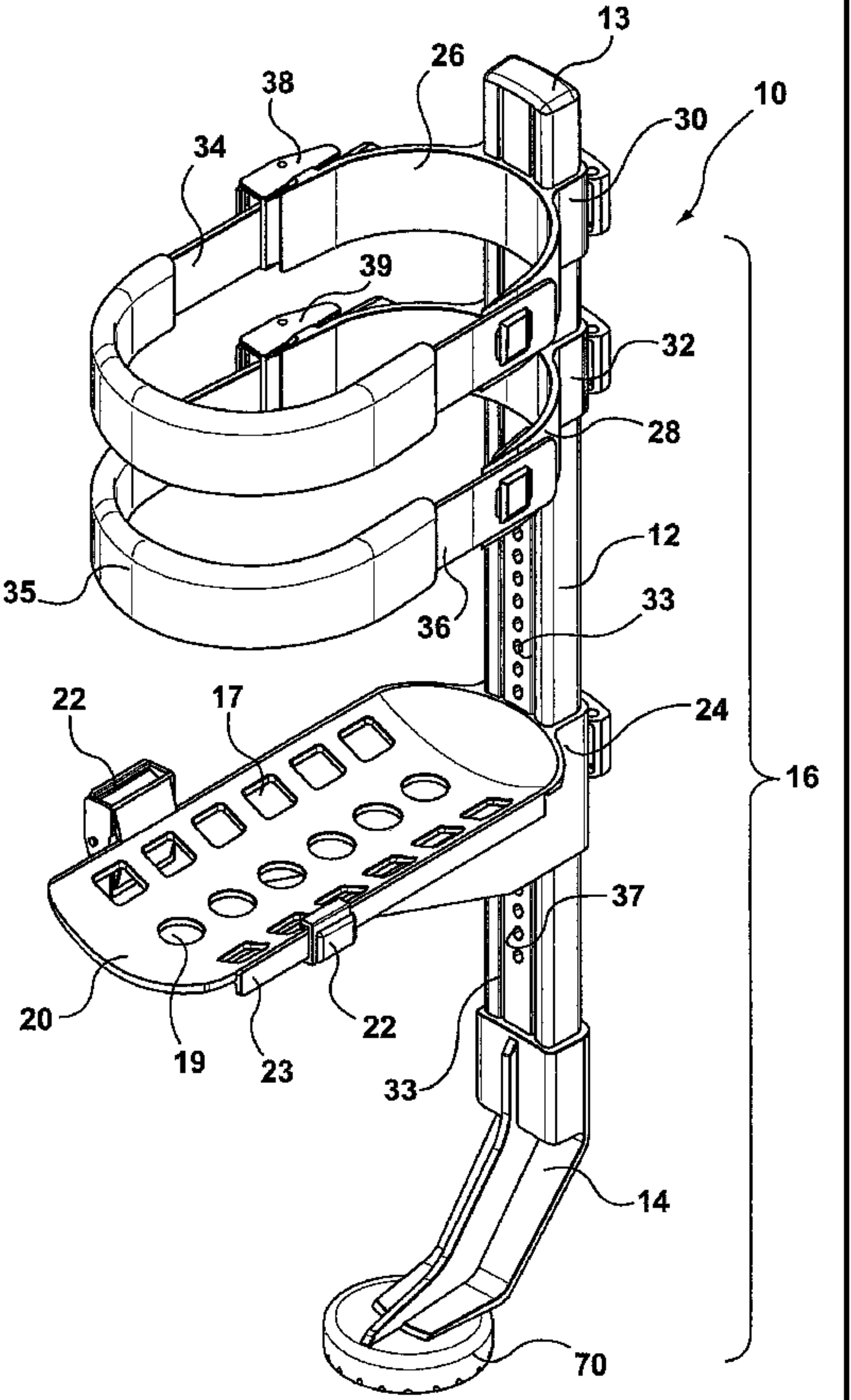


FIG. 7D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