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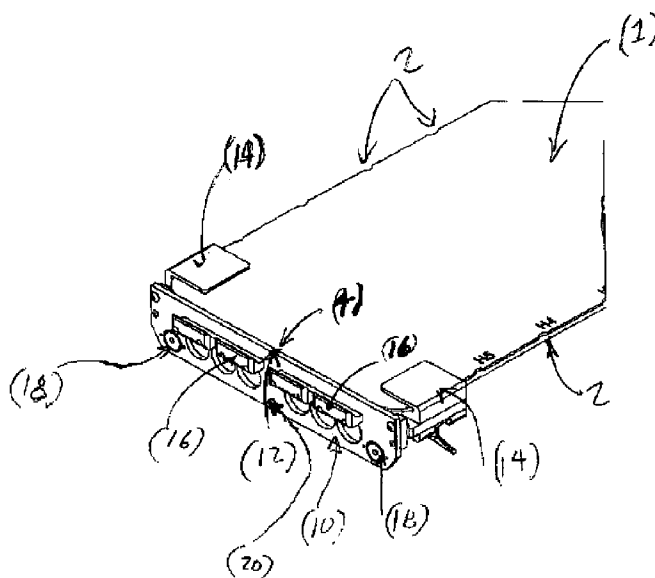
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(54) Title: RADIOLUCENT PATIENT TREATMENT TABLE WITH REMOVABLE TIP EXTENSION BASE AND ACCESSORIES



(57) Abstract: The present invention provides a radiolucent patient treatment table top with a removable tip extension base that can be accurately and repeatably mounted at the end of a table top that is completely metal free in the area of interest for imaging and treatment. The table top is composed primarily of polymer composites reinforced with carbon fibers or other non-metallic fibers such as Kevlar?. The table top allows for accurately and repeatably mounting removable tip extension members, radiographic phantoms, immobilization devices, brachytherapy steppers, and other devices to the end and sides of the patient table top. The present invention further provides a method of adding a variety of useful accessories without introducing any permanent metal components in the imaging/treatment area of the table top.

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**RADIOLUCENT PATENT TREATMENT TABLE WITH REMOVABLE TIP
EXTENSION BASE AND ACCESSORIES**

[0001] This application claims the benefit of U.S. Provisional Application 60/782,033 filed 14 March 2006, entitled “Radiolucent Patent Treatment Table with Removable Tip Extension Base and Accessories.”

BACKGROUND OF THE INVENTION

[0002] In modern medical procedures that require both imaging and treatment by x-rays, it is desirable to have a patient table top (also referred to as a couch top) that is transparent to x-radiation. The advent of Cone Beam CT has made it increasingly important that performance of the table top during x-ray imaging be properly taken in to account. Any metal in the CT slice can cause artifacting which reduces image quality and can interfere with calculations that are used to determine the optimum patient radiation dosage. Examples of equipment capable of X-ray and Cone Beam CT application on radiation therapy equipment include Varian Medical System’s On Board Imager (OBI) and Elekta’s XVI system.

[0003] Traditionally, radiation therapy table tops have been made from metal. Up until now, incorporating metal was necessary in order to carry the weight of the patient. Newer radiation therapy treatment table tops generally have metal free imaging and treatment sections, but contain an integral metal tip extension base for attaching extensions and accessories. This “universal tip” is used for certain procedures, but is not required for others. Since it is a permanent part of the table top, it interferes with imaging and treatment at the tip of the table top. It would thus be preferable for this tip to be removable so that it is only attached to the table top when needed. One manufacturer includes a removable tip extension, however, the attachment method of this tip extension (the Medical Intelligence I-beam™ table top) base requires that metal be permanently built in to the tip of the table top. This embedded metal interferes with both imaging and treatment radiation.

[0004] Brachytherapy and urological procedures often require attaching accessories to the tip of the patient table top. These include items such a stirrups to hold the patients legs and the stepper devices that are used to aim and insert the catheters through which the radioactive seeds are delivered. Traditionally, only static x-rays were taken during these procedures. However,

once again, the advent of modern 3D imaging techniques such as Cone Beam CT has made it possible to acquire a three dimensional understanding of the position of the organ of interest and the device or devices that are being used to treat the patient. Through DICOM, the data from these images can be input into treatment planning software so that improved treatment delivery can be achieved. All of this makes it desirable to be able to take metal free images through the entire table top.

SUMMARY OF THE INVENTION

[0005] The present invention addresses the above limitations in the prior art and provides a removable tip extension base that can be accurately and repeatably mounted at the end of a table top that is completely metal free in the area of interest for imaging and treatment. The table top is composed primarily of polymer composites reinforced with carbon fibers or other non-metallic fibers such as Kevlar®. The table top allows for accurately and repeatably mounting of removable tip extension members, radiographic phantoms, immobilization devices, brachytherapy steppers, and other devices to the end and sides of the patient table top. However, when the accessories are removed, the result is a completely metal free table top. This improves imaging performance and in particular it improves performance with the new Cone Beam CT technologies that are becoming more prevalent on c-arms and high-energy radiation treatment (Radiation Therapy) machines. In addition, tip extensions of specific function can also be produced this way.

[0006] Specifically, the present invention provides a radiolucent patient table top system comprising a patient table with a front, an underside, at least one side and a mounting support structure and further comprising;

- a. a section which is completely metal free beyond the mounting support structure;
- b. the section capable of receiving removable accessories; and
- c. a removable tip extension base wherein the tip extension base provides a universal attachment mechanism which allows one or more accessories to be attached to the table.

[0007] The present invention further provides a radiolucent patient table with at least one support beam and comprising a removable tip extension base that has a back face and is attached to the patient table and wherein the tip extension base provides a universal attachment mechanism for attaching one or more accessories to the table.

[0008] The present invention also provides a removable modular clamp comprising an upper body, a lower body and a modular center section.

[0009] In another embodiment, the present invention provides a method of performing brachytherapy treatment procedures using a table top of the present invention comprising;

- a. placing legs of a patient in radiolucent stirrups;
- b. planning imaging and treatment;
- c. placing a brachytherapy aiming stepper device at the end of the table top;
- d. inserting a cannula(i) into the patient;
- e. removing the brachytherapy stepper device ; and
- f. imaging and treating the patient with radiation.

[00010] In yet another embodiment, the present invention provides a method of treating a patient's head, neck or abdomen with external beam radiation therapy using a table top of the present invention comprising;

- a. attaching a tip extension base to a tip of the table top;
- b. attaching an extension to the tip extension base to increase the length of the table top;
- c. placing a patient on the table top and locating the patient's abdomen over the radiolucent table top; and
- d. treating the patient.

BRIEF DESCRIPTION OF THE DRAWINGS

- [00011] FIG. 1 illustrates a patient table top of the present invention.
- [00012] FIG. 2 is an underside view of a table top of the present invention.
- [00013] FIG. 3 illustrates a removable tip extension base of the present invention.
- [00014] FIG. 4 illustrates a tip extension base of the present invention attached to a table top.
- [00015] FIG. 5 illustrates a QA phantom accessory attached to a tip extension base that is attached to a table top.
- [00016] FIG. 6 illustrates a table extension accessory attached to a tip extension base that is attached to a table top.
- [00017] FIG. 7 illustrates a drop leaf extension accessory attached to a table top.
- [00018] FIG. 8 illustrates a brachytherapy stepper assembly accessory attached to a table top.
- [00019] FIG. 9 illustrates a removable modular clamp of the present invention.
- [00020] FIG. 10 illustrates a removable modular clamp of the present invention.
- [00021] FIGS. 11A and 11B illustrate a removable modular clamp of the present invention in a locked and unlocked position indexed to a table top.
- [00022] FIGS. 12A-12D illustrate removable modular clamps of the present invention.
- [00023] FIG. 13 illustrates a table top of the present invention with recessed edges.
- [00024] FIG. 14A illustrates a table top with support beams
- [00025] FIG. 14B illustrates a sliding beam clamp attached to a tip extension base.
- [00026] FIG. 14C illustrates a cross-section of a beam and removable clamp.

DETAILED DESCRIPTION OF THE INVENTION

[00027] The present invention is based on clamping the tip extension to the sides of the table top. This clamping method is unique because it allows extremely high tip loads to be absorbed by the table top. Since the clamps attach to a section of the side of the table top, a large moment load can be reacted. In order to accurately and repeatably mount to the table top, the present invention provides a male and female mating feature along the front edge of the table top. This locates the Tip Extension Base from side to side and can also be used to locate the Tip Extension Base front to back and up and down (X, Y and Z coordinates). Alternatively, the surfaces (top, bottom, front and sides) of the table top can be used to locate the Tip Extension Base.

[00028] In a preferred embodiment, a groove or bump runs down the length of either side of the table top to allow the clamps a feature to lock on to, making it harder to dislodge that clamp once it is tightened. By placing indexing features down the length of either side of the couch top, the clamps can be located at a specific longitudinal coordinate. Clamps can be designed so that they can be placed at these discreet locations, located continuously along the length. In order to locate the clamp at the indexing features, the clamp can contain the mating feature, spring loaded pins or other methods of ensuring that the clamp is accurately located. In addition, clamps can be designed so that one clamp can be used in either manner. By producing a modular clamp, a variety of additional accessories can be developed, in addition to the available specific devices and the tip extension base. This clamp is produced in sections so that common parts become the building blocks for other accessories.

[00029] It is desirable that table tops designed for medical applications to be free of features on their top surface that could collect fluids. In a preferred embodiment, a clamp groove is placed longitudinally down either side of the bottom of the table top. This provides a feature that can be grabbed by a clamp but does not present a fluid gathering site.

[00030] Although we have shown a flat upper surface in most of the accompanying figures, this means that the top of the clamp rises above the top plane of the table top. This can become an obstruction in cases where additional devices may need to be placed on the top surface of the table top. In a preferred embodiment, the edges of the table top can be recessed either locally or

completely along each edge so that the top of the clamp is flush or slightly below the top surface of the table top.

[00031] A table top of the instant invention provides a particularly good platform for modern brachytherapy that is coupled with C-arm or Cone Beam CT technology. A new methodology for imaging and treating the patient in which minimal movement of the patient is required is possible with the present invention. This is particularly important in brachytherapy because imaging of the patient commonly occurs after the delivery needles have been inserted into sensitive areas such as the perineum. Moving the patient at this time can be quite risky. An example of the methodology applied to gynecological or prostrate procedures that can now be followed is to:

[00032] 1) Attach a drop leaf tip extension (leg support board) to the tip of the table top which allows the patient's legs to be rotated to horizontal. The leaf is initially placed in the down or vertical position so that the patient can easily sit at the tip of the table top.

[00033] 2) The patient then lies back on the table top and the drop leaf extension is rotated to horizontal. Thereby, placing the patient in the horizontal position.

[00034] 3) Stirrups may then be attached and the patient's legs are then placed up in the stirrups. The drop leaf tip extension can now be removed, leaving the lower abdomen area free for imaging studies. By using radiolucent composite stirrups we are able to image through them, including when using Cone Beam CT. Imaging may take place at this time.

[00035] 4) The brachytherapy stepper (aiming device) can be attached in place of the drop leaf tip extension. At this point, insertion of cannula(i) or catheter can take place. By removing the stepper, one can now take images and Cone Beam CT studies without moving the patient longitudinally down the table top because there is not metal or other artifacting features present at the tip of the table top.

[00036] 5) Once the medical staff are confident of the treatment plan and positioning of the cannula(i) or catheter, treatment can commence.

[00037] The present invention provides a method of adding a variety of useful accessories without introducing any permanent metal components in the imaging/treatment area of the table top. The accessories can include at least one selected from the group consisting of tip extension, a head support board, a head and neck immobilization board, an x-ray phantom, a leg support board, a brachytherapy stepper assembly and a tip extension base stirrup, brachytherapy stepper device, clamps, modular clamps, tip extension base, and drop leaf tip extension. In addition, the design of the present table top system allows a table to be constructed that is uniform in carbon fiber skin thickness so that image artifacting is minimized. In addition, the uniform construction also allows for minimum electron generation when used in high energy radiation therapy.

[00038] Furthermore, the present invention provides a method of attaching accessories that is also compatible with adding accessories to the tip of a sliding beam couch top that does not have a permanent connection across the front of the two beams.

[00039] The table top and accessories of this invention are designed so that the best possible imaging and treatment configurations are possible. With all accessories removed, the table top is completely metal free in the area of interest.

[00040] Figure 1 shows a table top of the current invention (1). Indexing features (2) are present down either side of the table top. The indexing features are commonly used in radiation therapy to locate patient positioning devices. In this invention, they additionally provide discreet locations at which clamps may be located. A notch (4) is present on the front edge of the table top to accept a matting feature present for accurate alignment purposes on the tip accessories. It does not matter whether a male feature or female feature is used on the table top as long as the corresponding feature is placed on the accessory. The table top is mounted to a base (6) which may be of a static or motion type. In this configuration, the portion of the table top that extends beyond the base (6) is completely metal free.

[00041] Figure 2 shows the tip of the table top from the underside (3). Optional grooves (8) are placed longitudinally down either side of the bottom surface to help with alignment of the accessory clamps.

[00042] Figure 3 demonstrates the free standing Tip Extension Base (10). A protrusion (12) is present which mates with the corresponding feature (4) of the table top (shown in FIG. 1). A pair of clamps (14) are integrated into the Tip Extension Base so that it may be secured on either edge of the table top. Hanging hooks (16), an alignment pin (20), and a pair of magnets (18) are used to attach extension devices to the Tip Extension Base.

[00043] Figure 4 shows the Tip Extension Base securely attached to the front of the table top. Figure 5 shows a quality assurance (QA) phantom (22) attached to the Tip Extension Base (10) which is itself attached to the table top (1).

[00044] Figure 6 shows a table top (1) with an extension (24). Figure 7 shows a table top (1) which has a drop leaf extension (28) attached to its tip. This extension can be moved from vertical (26) to horizontal (28) and can be used to help patients get on the table for brachytherapy procedures. Two additional clamps (30) are shown on the table. The clamps contain a section of universal rail (32) which provides an industry standard method for attaching a variety of accessories, including stirrups.

[00045] Figure 8 shows a table top (1) with a brachytherapy stepper (34) attached to the tip and two radiolucent stirrups (38) attached to either side of the table top. By removing the brachytherapy stepper (34), clear access is gained to the perineum for imaging, including Cone Beam CT.

[00046] Figure 9 shows a modular clamp with upper (40), middle (42) and lower (44) sections. By changing the middle section (42) a variety of accessories can be created efficiently. The center section can be at least one selected from the group consisting of a universal rail, an arm board mating component, a tip extension base member, a tip extension member, and a stirrup. The clamp of figure 9 contains a middle section (42) which mounts the universal rail (32). The lower section (44) contains an optional raised bump (45) which mates with the clamp groove (8) and aids in securely fastening the clamp to the table top. Figure 10 demonstrates a method of creating additional devices by changing the middle section (46) to a new component.

[00047] Figures 11A and 11B and 12 demonstrate a method which can be used to design a clamp that can be located at the discrete points of the table indexing features (2). A circular

knob (48) is provided that is machined in such a way that a locating feature (50) and (52) is present to engage the table feature (2). When turned 90 degrees, the feature no longer engages the table notch (2) and the clamp is free to be positioned continuously down the edge of the table. Figure (12) shows addition cut away views of the clamp so that we can see the knob.

[00048] In a preferred embodiment, it is preferable that the accessory clamps remain flush or below the top surface of the table top. This embodiment is illustrated in Figure 13. The edges are recessed (54) so that the upper section (40) of the clamp remains flush with the top surface (56) of the table top. This allows other devices to be placed on top of the table top without interference from the clamp. The same geometrical treatment may also be applied to the front edge (58).

[00049] In figure 14A it is demonstrated that the same approach of using a removable Tip Extension Base and clamps can be applied to a table top that has support beams (60) with modular insert surfaces (62). Beam clamps can be fixed to the back of the tip extension base or slide on a linear bearing way. The support beam cross section (68) is shown in Figure 14(C) with one possible clamp configuration (66) in which a knob (70) is used to tighten the clamp to the support beam. Figure 14C illustrates a sliding beam clamp (63) attached to the tip extension base (64).

WE CLAIM:

1. A radiolucent patient table top system comprising a patient table with a front, an underside, at least one side and a mounting support structure and further comprising;
 - a. a section which is completely metal free beyond the mounting support structure;
 - b. the section capable of receiving removable accessories; and
 - c. a removable tip extension base wherein the tip extension base provides a universal attachment mechanism which allows one or more accessories to be attached to the table.
2. The patient table top system of claim 1 wherein the tip extension base can be accurately and repeatably aligned with the patient table.
3. The patient table top system of claim 2 which can be aligned by means of at least one male and at least one female feature, one of which is placed on the front of the table and the other on the tip extension base.
4. The patient table top system of claim 1 wherein the tip extension base is attached to the table by means of at least one integrated clamp which attaches to at least one side of the table and the front of the table.
5. The patient table top system of claim 1 wherein the one or more accessories is at least one selected from the group consisting of a length extension, a head support board, a head and neck immobilization board, an x-ray phantom, a leg support board, a brachytherapy stepper assembly and a tip extension base.
6. The patient table top system of claim 1 further comprising a clamp groove which runs along the under side of at least one side of the table and the front of the table wherein the clamp groove is capable of accepting a mating geometry located on a clamp.
7. The patient table top system of claim 1 further comprising discreet indexing features so that the one or more accessories can be accurately and repeatably located.

8. A removable modular clamp comprising an upper body, a lower body and a modular center section.
9. The removable modular clamp of claim 8 wherein the center section is at least one selected from the group consisting of a universal rail, an arm board mating component, a tip extension base member, a tip extension member, and a stirrup.
10. A removable clamp comprising a feature that allows it to be accurately and repeatably located to at least one discreet table indexing feature.
11. A removable clamp comprising an upper body, a lower body and a modular center section and further comprising a raised bump on the lower body so that the clamp can be more firmly affixed to a table top of claim 6.
12. A radiolucent patient table with at least one support beam and comprising a removable tip extension base that has a back face and is attached to the patient table and wherein the tip extension base provides a universal attachment mechanism for attaching one or more accessories to the table.
13. The patient table of claim 12 wherein the tip extension base is attached to the table by at least one integrated clamp that attaches to the at least one beam.
14. The patient table of claim 13 wherein the at least one clamp can slide laterally on a back face of the tip extension base to accommodate the lateral motion of the support beams.
15. The patient table of claim 12 wherein the accessories is at least one selected from the group consisting of tip extension, a head support board, a head and neck immobilization board, an x-ray phantom, a leg support board, a brachytherapy stepper assembly and a tip extension base stirrup, brachytherapy stepper device, clamps, modular clamps, tip extension base, and drop leaf tip extension.
16. A patient table top system of claim 1 wherein at least on of the side and front edges are recessed, allowing clamps and accessories to remain flush or below the top surface.
17. A table top of claim 1 further comprising at least one radiolucent stirrup attached thereto.

18. A method of performing brachytherapy treatment procedures using a table top of claim 1 comprising;
 - a. placing legs of a patient in radiolucent stirrups;
 - b. planning imaging and treatment;
 - c. placing a brachytherapy aiming stepper device at the end of the table top;
 - d. inserting a cannula(i) into the patient;
 - e. removing the brachytherapy stepper device ; and
 - f. imaging and treating the patient with radiation.

19. A method of treating a patient with external beam radiation therapy using a table top of claim 1 comprising;
 - a. attaching a tip extension base to a tip of the table top;
 - b. attaching an extension to the tip extension base to increase the length of the table top;
 - c. placing a patient on the table top and locating the patient's abdomen over the radiolucent table top; and
 - d. treating the patient.

20. A method of treating a patient with external beam radiation therapy using a table top of claim 1 comprising;
 - a. attaching a tip extension base to a tip of the table top;
 - b. attaching a head and neck treatment device extension to the tip extension base;
 - c. placing a patient on the table top and locating the patient's head on the head and neck treatment device; and
 - d. treating the patient.

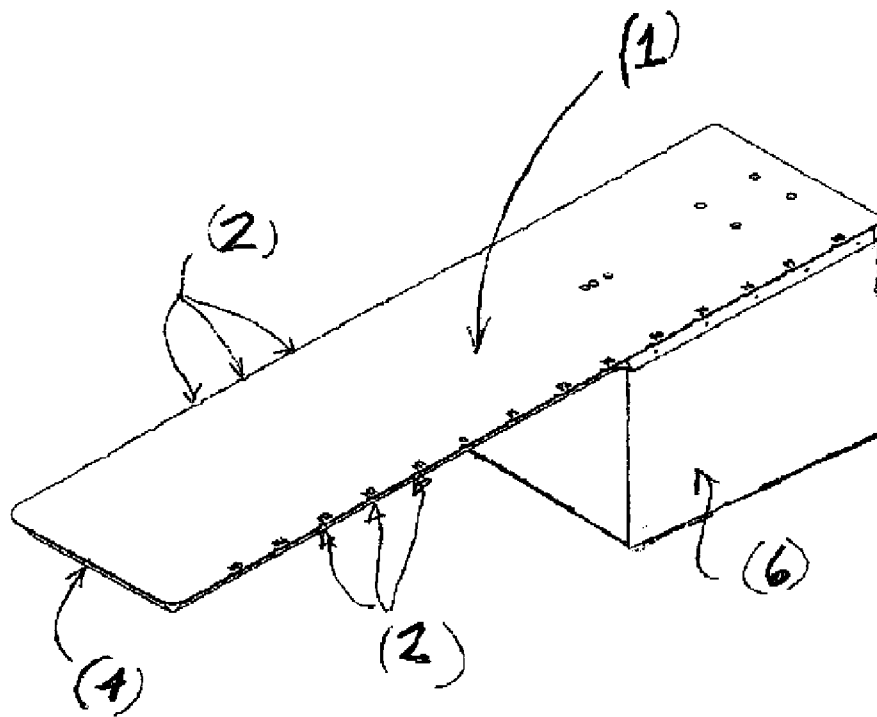


FIG 1

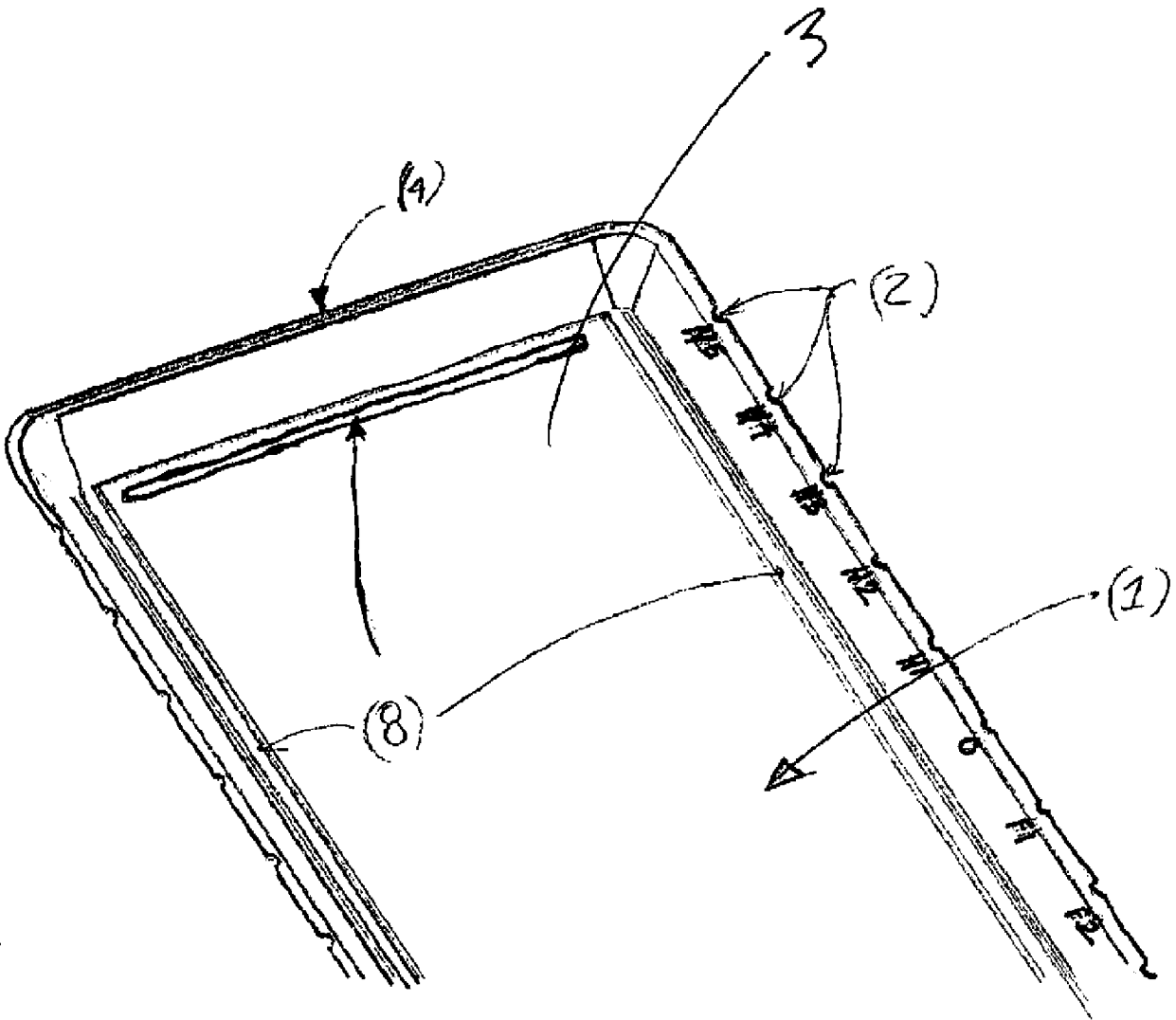


FIG 2

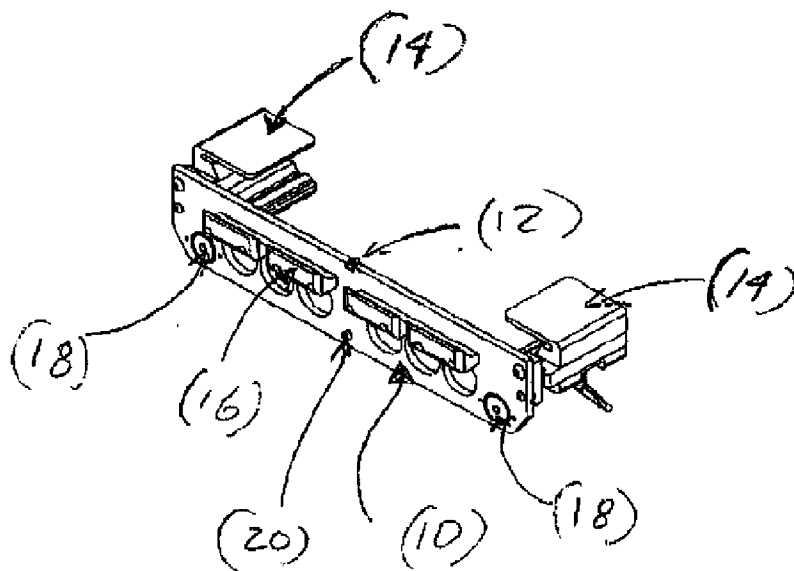


FIG 3

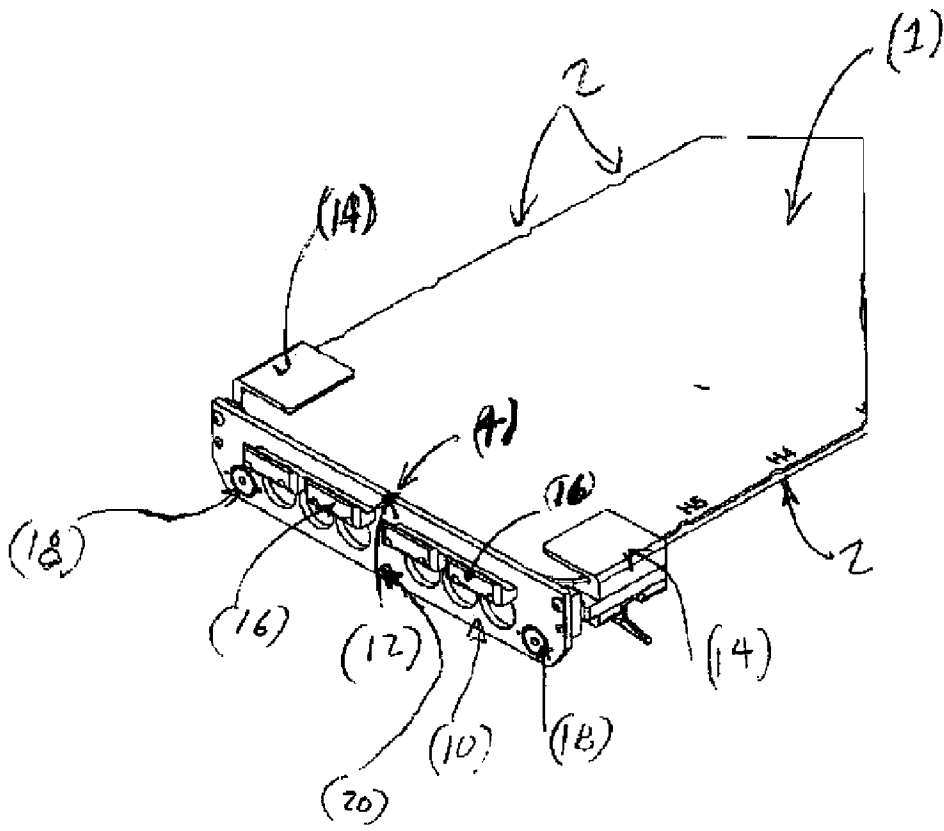


FIG 4

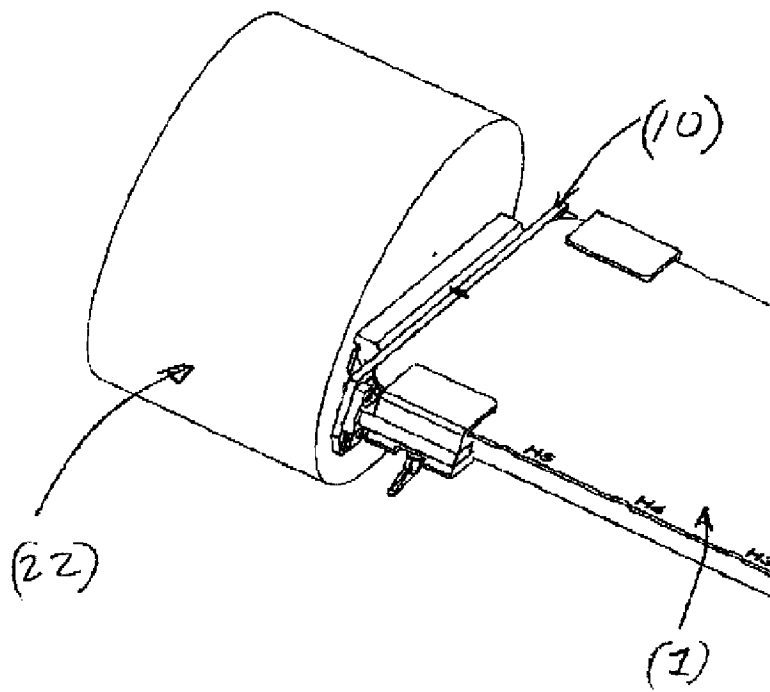


FIG 5

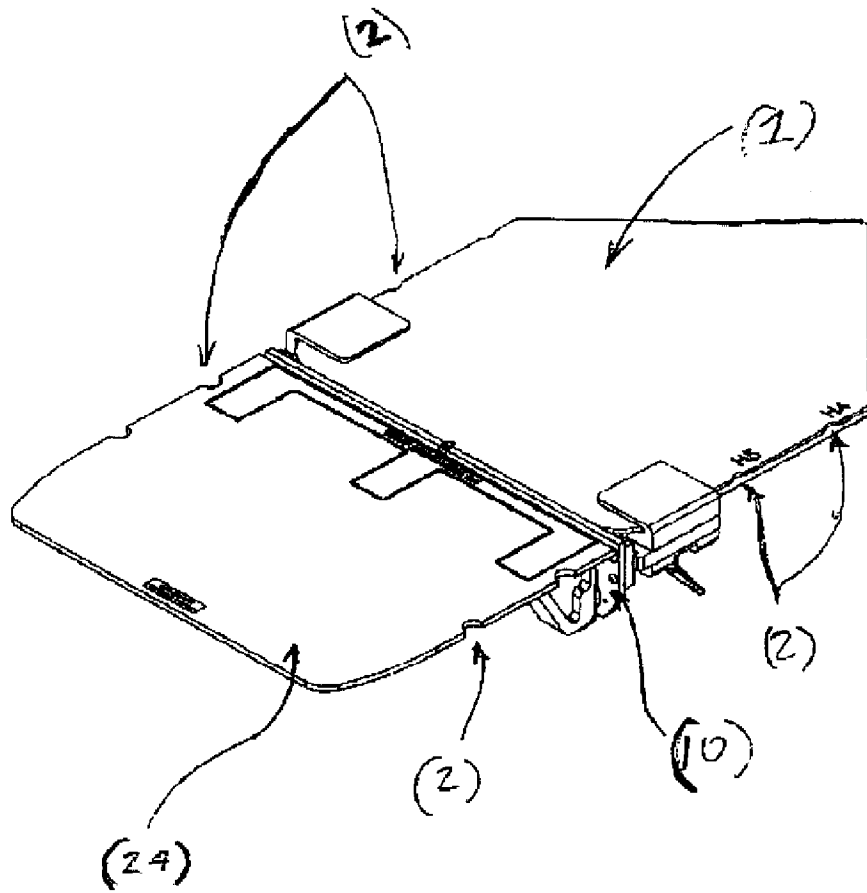


FIG 6

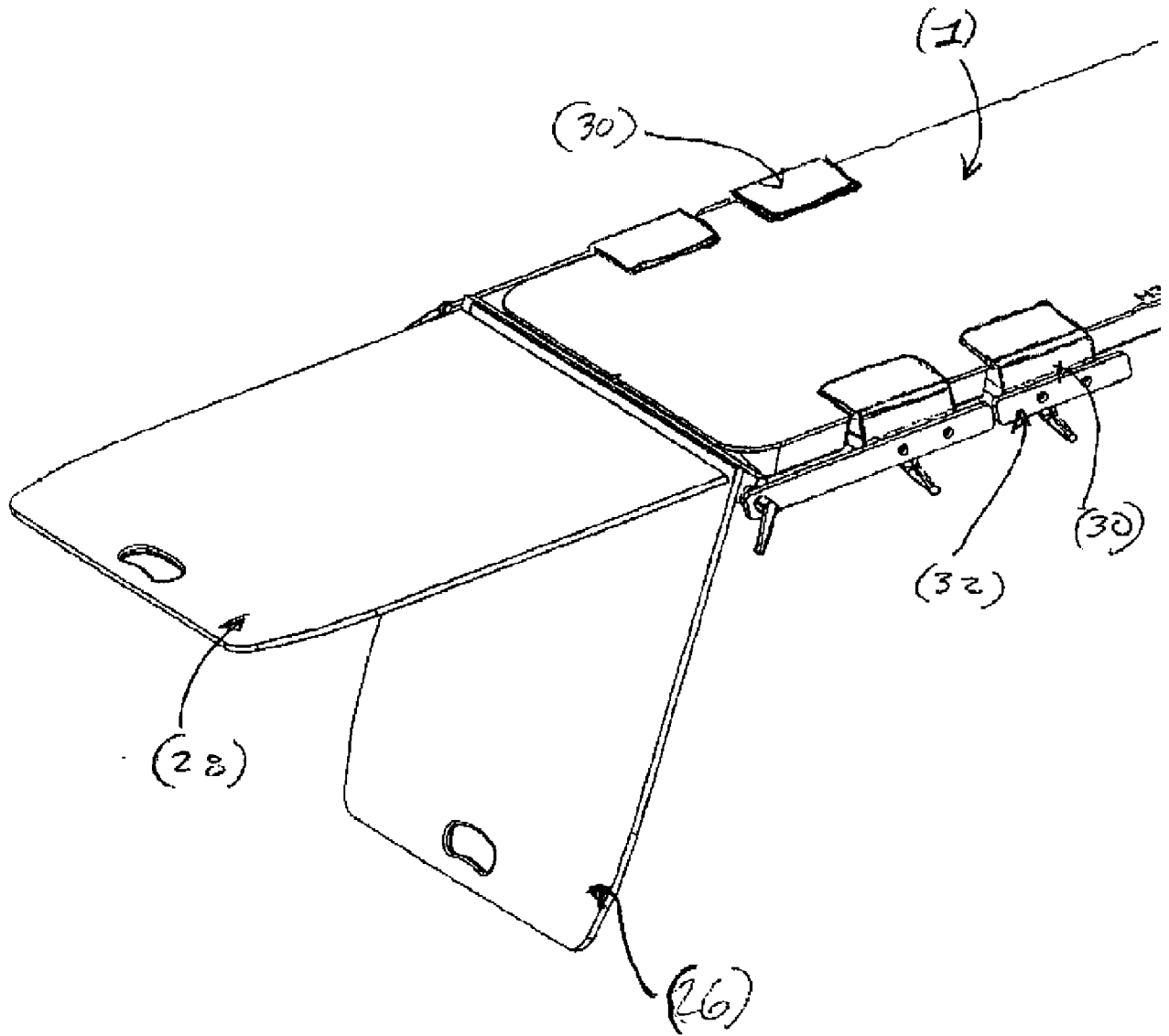


FIG 7

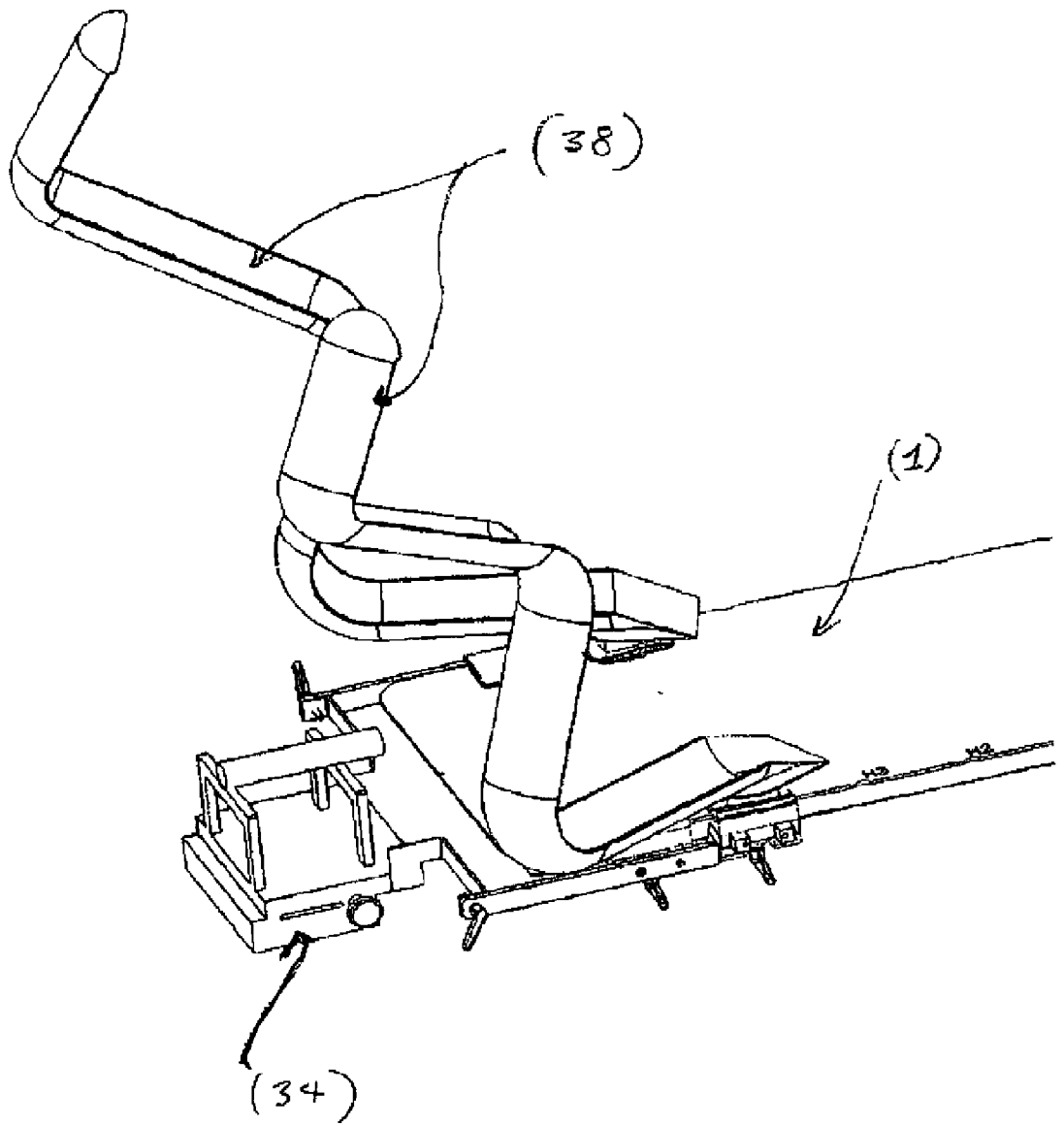


FIG 8

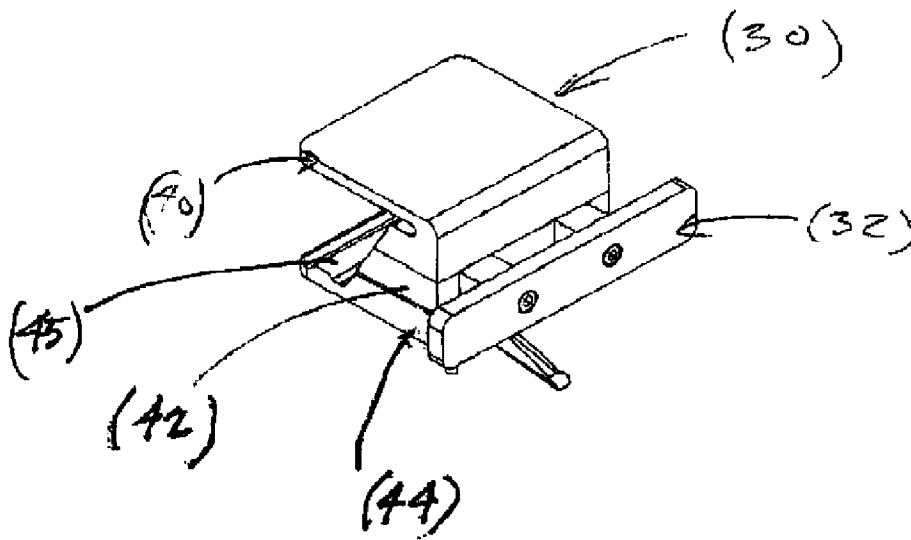


FIG 9

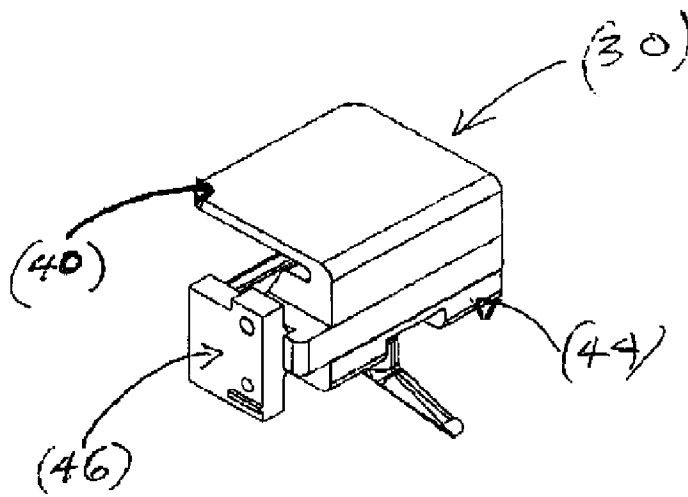


FIG 10

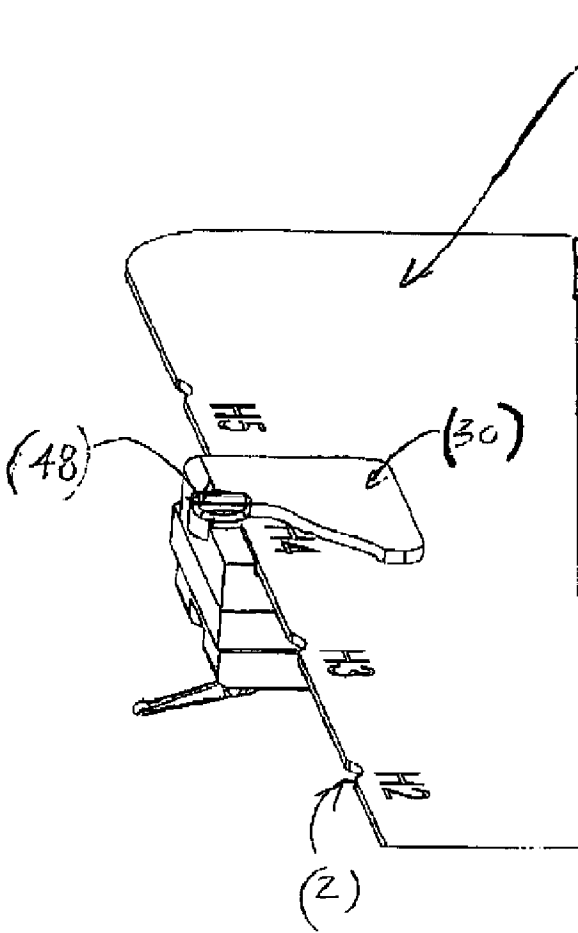


FIG 11A

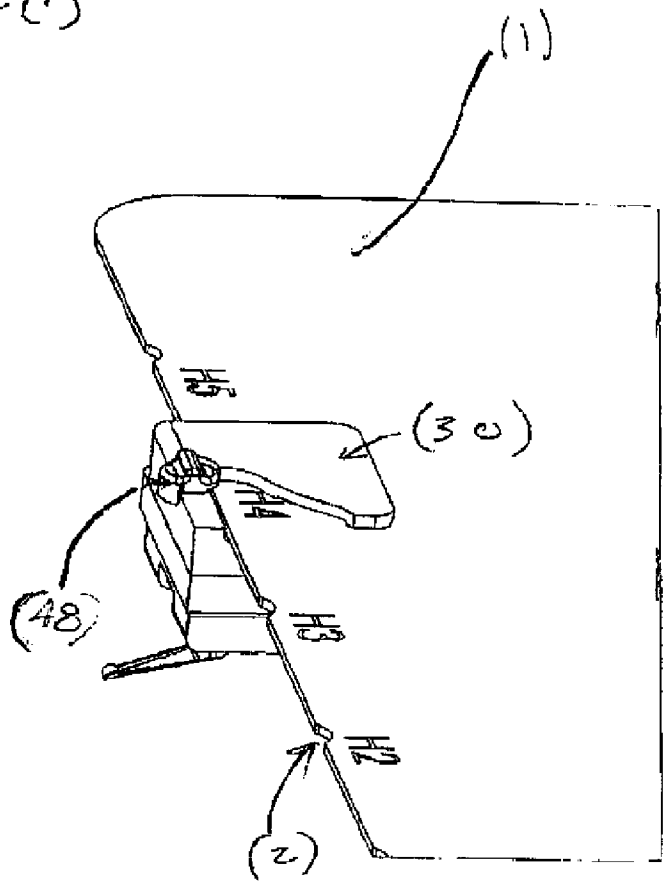


FIG 11B

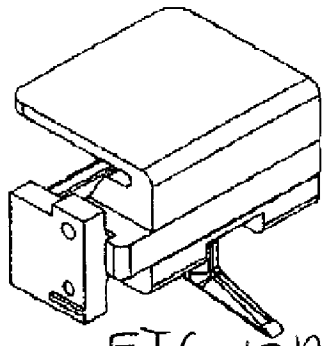


FIG. 12A

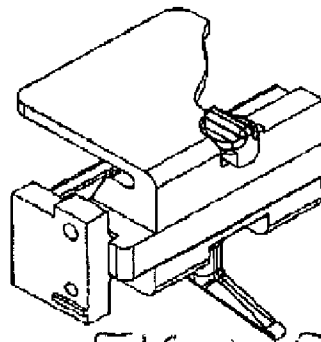
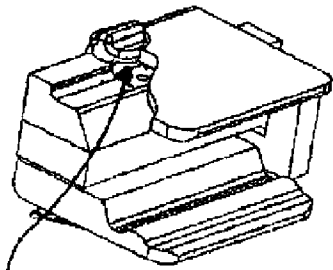
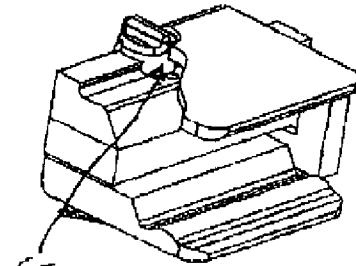


FIG 12B



(52) FIG 12C



(50) FIG 12D

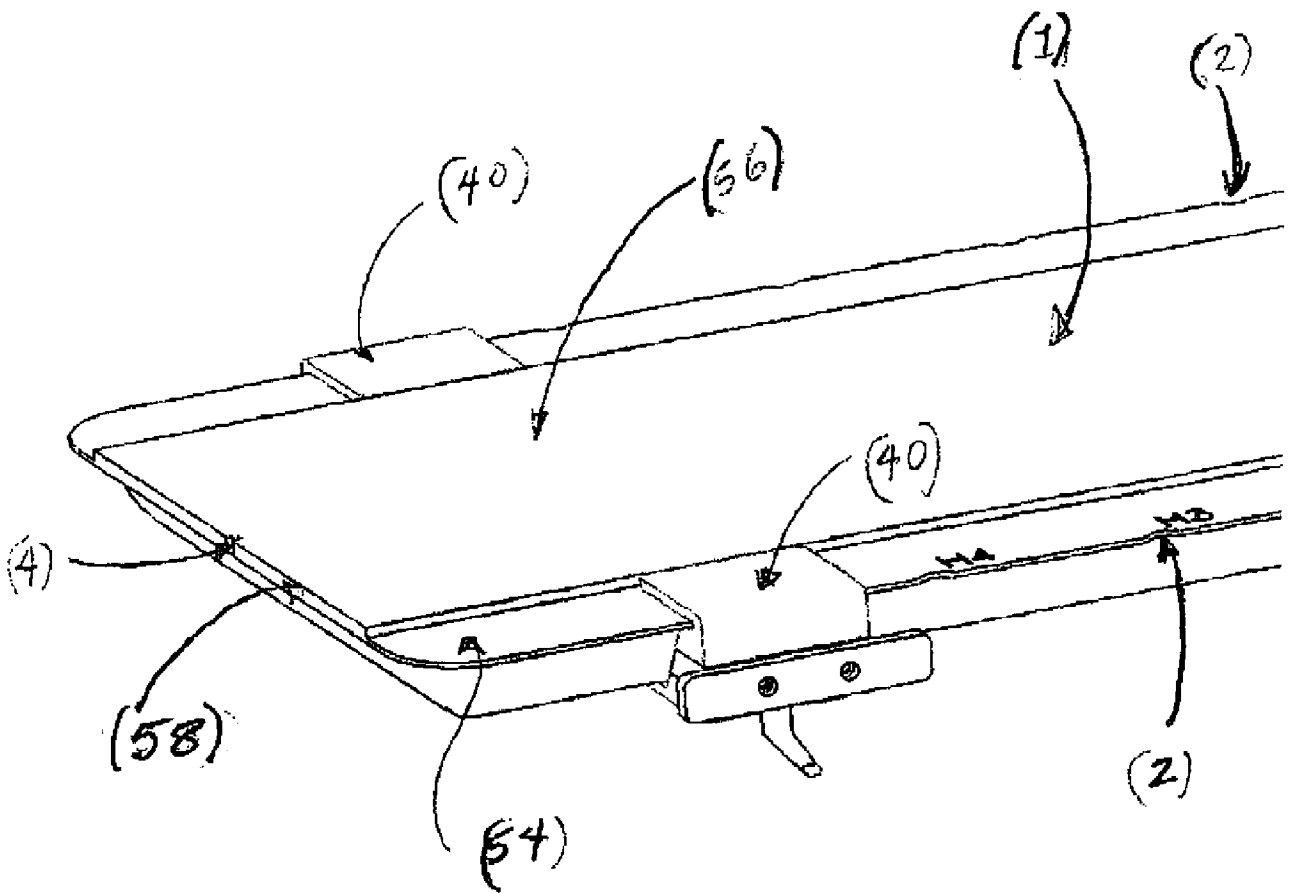


FIG 13

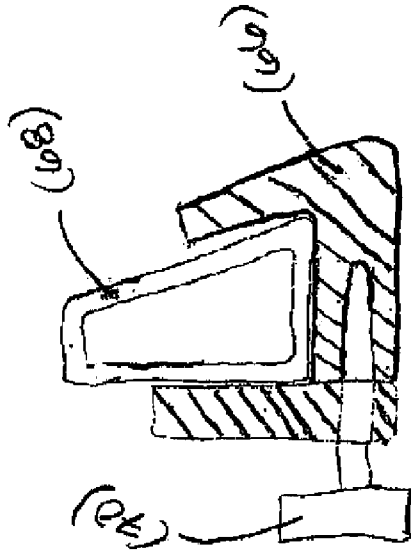


FIG 14C

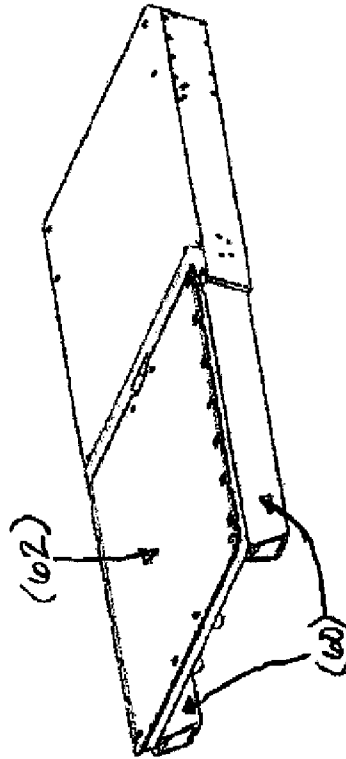


FIG 14A

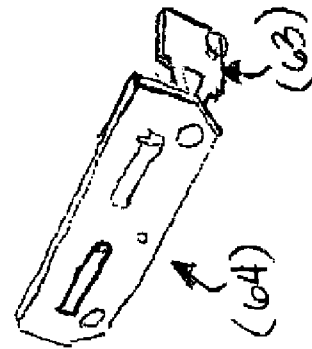


FIG 14B

Beam clamps can be fixed to the back of the tip extension base or slide on a linear bearing way