May 9, 1967 V. GUREWICH 3,318,304

MECHANICAL DEVICE FOR REDUCING BLOOD CLOTTING IN LEGS

Filed Sept. 18, 1963 2 Sheets-Sheet 1

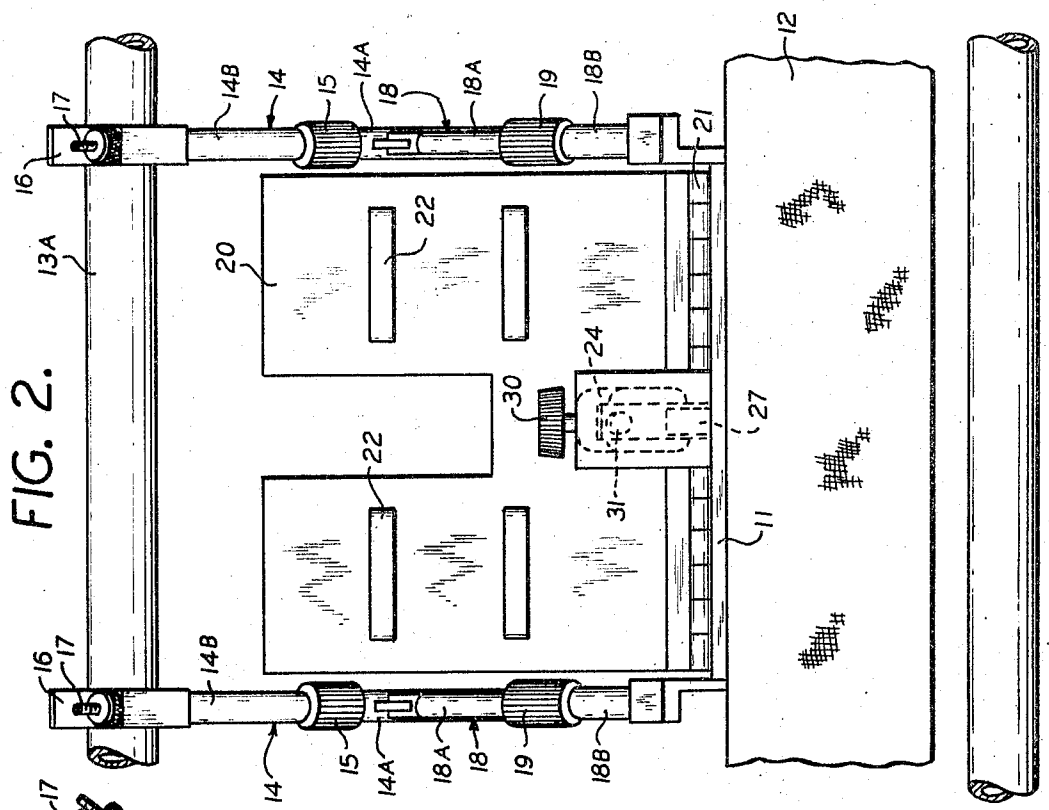


FIG. 2.

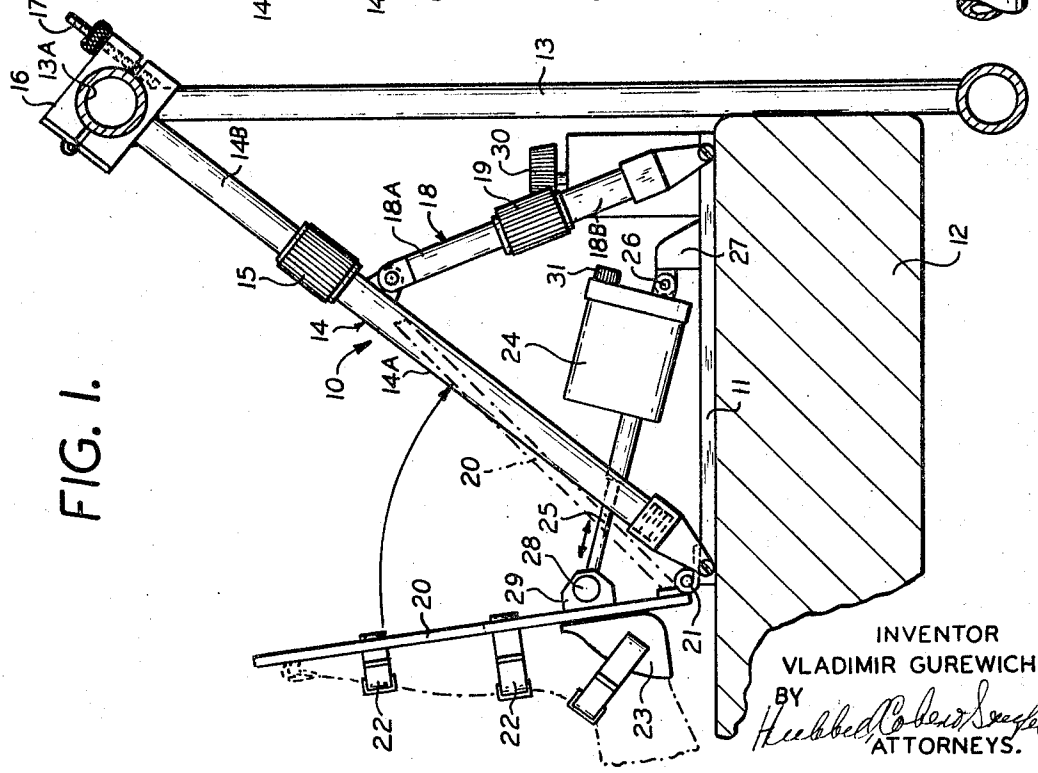


FIG. 1.

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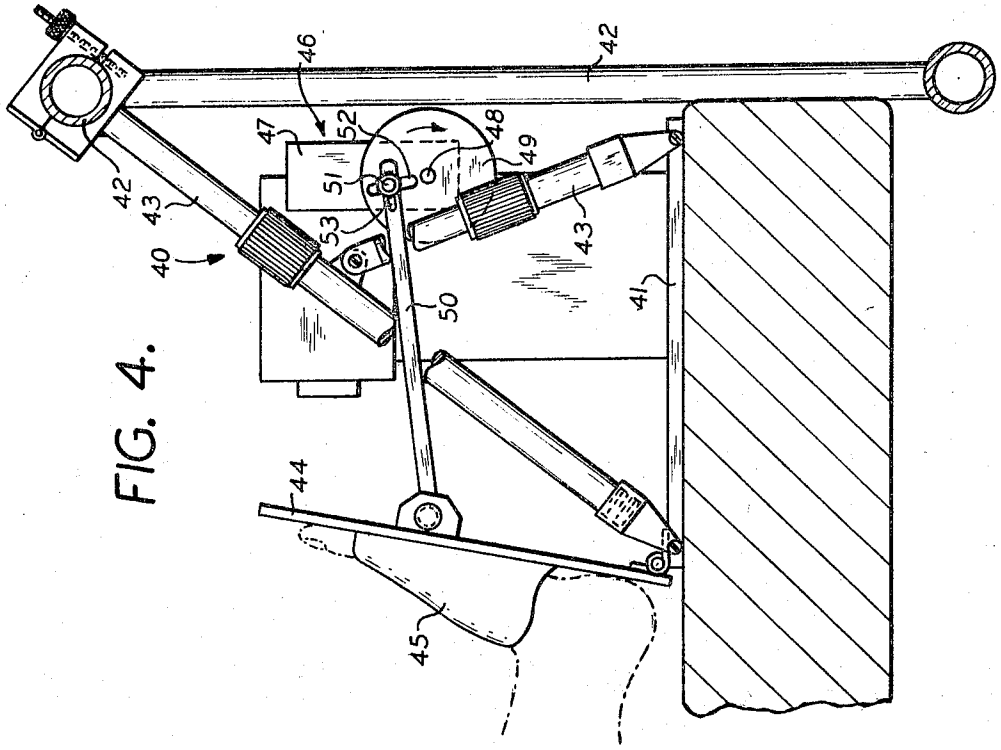


FIG. 4.

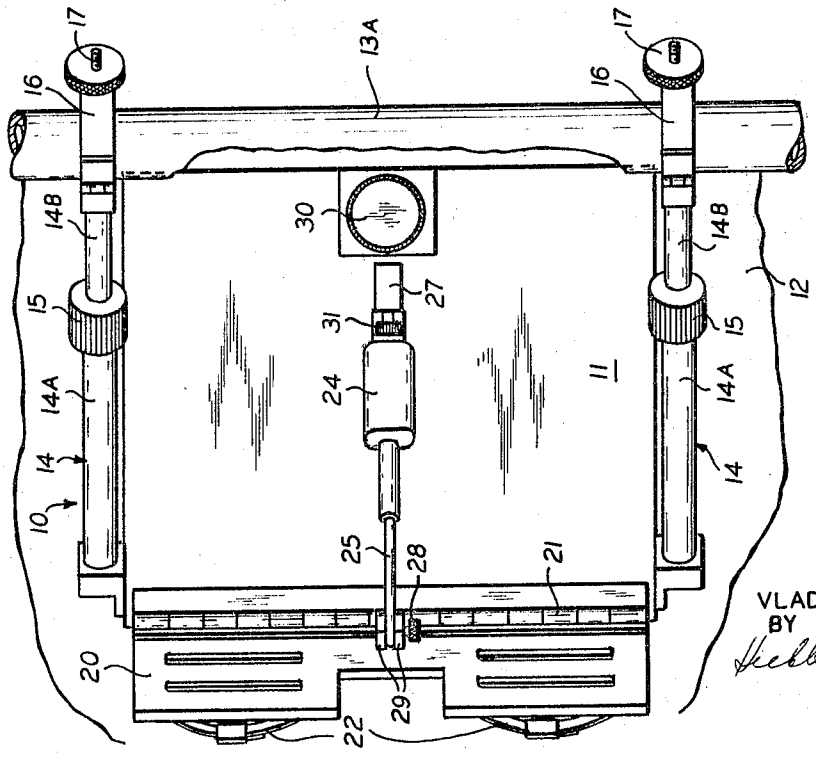


FIG. 3.

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MECHANICAL DEVICE FOR REDUCING BLOOD CLOTTING IN LEGS

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13 Claims. (Cl. 128—25)

This invention relates to a mechanical device for reducing blood clotting in legs and more particularly to a foot and leg exerciser for reducing blood clotting in legs. Most particularly the present invention relates to a power operated foot and leg exerciser which is adapted to oscillate the feet of a bedridden patient in order to operate the "calf pumps" and thereby reduce blood clotting in the patient's legs.

It has been recognized since the 1940's that post-operative and other bedridden patients show a marked tendency to form blood clots in the lower legs due to the stagnation of leg blood flow. Such clotting carries the danger of fatal pulmonary embolism and of chronic pulmonary hypertension. In post-operative patients, it has been believed up until recently that walking reduces this danger. However, recent studies tend to discount the prophylactic value of early ambulism as far as prevention of thrombosis is concerned. An example of such studies is that of N. L. Browse, British Medical Journal, 1962, 32, 1721.

It is also well recognized that the alternate flexing and relaxing of the calf muscles serves as a pump for the venous blood flow in the leg. As good blood flow is the antithesis of blood stagnation, operation of the "calf pump" shows a strong tendency to combat clotting.

It is therefore one object of the present invention to provide an apparatus attachable to a hospital bed, which apparatus will cause the flexing and relaxing of the calf muscles to thus operate the "calf pump" and reduce blood stagnation.

Another object of the present invention is to provide an apparatus for oscillating the feet of a patient to cause the flexing and relaxing of the calf muscles to thus operate the "calf pump" and reduce blood stagnation.

Still a further object of this invention is to provide an apparatus which is readily attachable to a bed and which is detachably connected to the feet of a bedridden patient for oscillating the feet whereby to flex and relax the calf muscles to operate the "calf pumps" and thus reduce blood stagnation in the legs.

The foregoing object and other features and advantages of this invention are attained by a foot exerciser comprising essentially a base for supporting the same on the mattress of a bed. Means in the form of adjustable positioning bars are provided to effect adjustment of the exerciser to a given patient or bed. A foot pedal, including means for securing one's foot thereto is pivotally connected to the base. A power operated means carried on the base is operatively connected to the foot pedal so as to forceably induce the leg and foot of a patient secured thereto to be exercised in a manner to enhance circulation of the blood through the leg. Means are also provided to effect independent adjustment of both the stroke and speed of the foot pedal.

A feature of this invention resides in the provision that the body exerciser is relatively simple in construction, can be readily fabricated, and is positive in operation.

Another feature of this invention resides in the provision that both the stroke and speed of the exerciser can be controlled by a single adjustment.

Still another feature of this invention resides in the provision that the exerciser can be readily adjusted to the size of the patient or to the bed.

Other features and advantages will become more readily apparent when considered in view of the drawings and the specification in which:

FIGURE 1 is a side elevation view of the body exerciser of this invention shown in an operative position adjacent the foot end of a bed;

FIGURE 2 is a rear elevation view of the exerciser of FIG. 1;

FIG. 3 is a plan view of the exerciser of FIG. 1; and

FIGURE 4 is a side elevation view of a modified form of the invention.

Referring to the drawings, there is shown the foot and leg exerciser **10** of this invention. The exerciser **10** comprises essentially a base member or plate **11** which forms the support for the exerciser **10** on the mattress **12** of a bed. Accordingly the exerciser **10** is located adjacent the foot end **13** of the bed. Pivotally connected to each side of the base plate **11** and adjacent to the front end thereof is a positioning bar **14** by which the base of exerciser is secured to the foot rail **13A** of a bed. In the illustrated embodiment, each of the positioning bars **14** comprises a pair of nested, telescoping members **14A**, **14B** which are suitably extended and retracted to adjust the position of the exerciser **10** with respect to the foot of the bed or patient, as the case may be.

Means in the form of sleeve or coupler **15** is utilized to fixedly secure the nested sections **14A**, **14B** of the positioning bars **14** in their adjusted position.

As shown, one end of each positioning bar **14** is pivotally connected to the side edge of the base plate **11**. The other end of the positioning bar **14** has connected thereto a split clamp **16** by which it is secured to the upper rail **13A** of the foot end of the bed. A suitable screw means **17** is provided for securing the split clamp **16** to the frame of the bed.

An adjustable strut **18** is interconnected between each of the positioning bars **14** intermediate the ends thereof and the base plate **11**. As shown, the respective struts **18**, like the positioning bars, are formed of nested telescoping tubular members **18A**, **18B** which can be fixedly adjusted with respect to one another by means of a friction clamp or sleeve **19**. Each strut **18** is pivoted at one end to an intermediate portion of its corresponding positioning bar and is pivoted at its other end to the side of the base plate **11** adjacent the rear end thereof.

A foot pedal **20** is hingedly connected to the front end of the base plate by a suitable hinge construction **21**. The arrangement of the foot pedal **20** is such that it can pivot about its hinge with a to and fro movement. As best seen in FIG. 2, the foot pedal **20** comprises a single plate to which both feet of a patient are secured. Means in the form of straps **22** are provided for securing each foot of the patient to the foot pedal **20**. If desired, a floating heel support **23** may be provided to position the person's foot with reference thereto.

The means for power operating the foot pedal, as disclosed in the embodiment shown in FIGS. 1 to 3 comprises an electro-mechanical linear actuator or solenoid **24** which has a reciprocating plunger **25**. As shown one end of the solenoid or actuator is pivotally mounted about a pivot **26** on a fixed bracket **27**. The free end of the plunger is pivotally connected to the foot pedal by means of a pin **28** inserted through aligned apertures in the end of the plunger **25** and a bifurcated lug **29** secured to the foot pedal **20**. Suitable control means **30** are connected in circuit with the electro-magnetic linear actuator or solenoid to control the speed of the plunger and foot pedal connected thereto. Also, means **31** are provided for adjusting the stroke of the plunger.

With the exerciser described, a patient recovering from a surgical operation can be exercised without requiring the patient to leave his bed. This is attained by positioning the patient on his bed so that his feet can be readily secured to the foot pedal **20** in a manner so that in the non-operative position of the device, the patient's knees are slightly flexed. Therefore, upon energizing the electro-mechanical linear actuator **24**, the pedal **20** connected to the plunger thereof is forcibly oscillated in a continuous and uniform back and forth movement. Such movement will cause the patient's legs to be exercised in a manner which will enhance circulation of the blood through the legs of the patient. By properly controlling both the speed and stroke of the plunger **25** of the actuator **24**, the movement of the foot pedal **20** can be regulated accordingly so as to attain maximum benefit with minimum uncomfort. Once the exerciser has been adjusted to a given patient and the actuator energized, the presence of an attendant is no longer necessary.

If desired, a suitable means for timing the duration of the actuator **24** may be incorporated in the circuit controlling the same.

While the embodiment of the invention disclosed in FIGS. 1 to 3 discloses a foot pedal **20** in which the patient's two feet are secured to a single pedal so as to require that both feet be moved in unison, it will be apparent that if desired, the foot pedal may be made in two parts, each actuated by its own actuating means so as to alternately oscillate the same so that one leg extends as the other leg of the patient is being flexed.

FIGURE 4 illustrates a modified embodiment of the invention. In this form of the invention, the exerciser **40** comprises a base plate **41** which is adjusted to the bed **42** or the patient by means of the positioning bars **43** and supporting studs **43** similar to the corresponding construction described with reference to FIGS. 1 to 3. Pivotally connected to the front end of the base plate **41** is a foot pedal **44** to which the patient's foot is secured. In this form of the invention, a broad foot strap **45** is provided for securing each foot of the patient to the foot pedal.

The actuating means **46** in this form of the invention comprises an electric motor **47** which is energized by any suitable electrical power source. Connected to the armature or spindle **48** of the motor **47** is a drive means in the form of a wheel **49** fixed to rotate with the motor spindle **48**. An actuating arm **50** or link is interconnected between the drive wheel **49** and the pedal **44**. The link **50** has one end pivotally connected to the foot pedal and has its other end connected eccentrically to the wheel **49**. It will therefore be noted that upon energizing of the motor **47**, the rotation of the wheel **49** connected to the motor spindle **48** will impart an oscillatory motion to the actuating arm **50** which translates the rotary motion of the drive wheel **49** into an oscillation motion to rock the foot pedal to and fro.

Means in the form of a co-operating slot and pin connection may be provided between the drive wheel **49** and the link **50** so as to adjustably control the stroke and/or speed of the foot pedal. By radially adjusting the connecting pin **51** of the link **50** in the radial slot **52** of the wheel **49**, the speed of the foot pedal **44** can be controlled accordingly.

A longitudinally extending slot **53** in the end of the actuating arm **50** is utilized for adjusting the stroke of the foot pedal. This is readily attained by positioning the pin **51** along the link slot **53**. Thus in operation energization of the motor will cause the rotary motion of the drive wheel to be translated through the connecting link **50** to an oscillating movement of the foot pedal **44** so that the legs and feet of the patient connected thereto will be forcibly exercised to stimulate the circulation or pumping of the blood through the legs of the patient. From the foregoing, the body exercisers **10**, **40** constructed in accordance with this invention are relatively

simple in construction, positive in operation and relatively inexpensive to manufacture. The exercisers can be readily adjusted to suit the needs of the patient without requiring the patient to be removed from his bed. Further, the utilization of the exercisers of this invention will greatly increase the efficiency with which experienced hospital personnel can be utilized.

While the instant invention has been described in detail with reference to several embodiments thereof, it will be understood that variations and modifications thereof may be practiced without departing from the spirit or scope of the invention.

What is claimed is:

1. In combination with a bed, a power operated foot exerciser for inducing blood flow in the leg of a patient confined to the bed comprising,
- (a) a base plate,
- (b) means for connecting said base plate adjacent the foot of the bed,
- (c) an upwardly extending foot pedal,
- (d) means for securing a foot of the patient to said foot pedal,
- (e) horizontal pivot means extending perpendicular to the longitudinal axis of the bed for connecting said foot pedal to said base plate to impart oscillatory movement to said foot without imparting substantial oscillatory movement to the leg of the patient,
- (f) actuating means for pivoting said foot pedal about said pivot means, and
- (g) power means for driving said actuating means.

2. The combination of claim **1**, further comprising means for securing the other foot of said patient to said foot pedal.

3. The combination of claim **1**, further comprising means for adjustably positioing said base plate along said longitudinal axis of said bed.

4. The invention as defined in claim **1** wherein said power means includes:
- (a) an electro-mechanical linear actuator having a reciprocating plunger, and
- (b) said plunger having its free end connected to said foot pedal whereupon actuation of said plunger effects to and fro movement of said foot pedal about its pivot.

5. The invention as definedin claim **4** and including,
- (a) means for controlling the speed of said acuator.

6. The invention as defined in claim **4** and including,
- (a) means to control the stroke of said plunger.

7. The invention as defined in claim **4** wherein said power means includes:
- (a) means to control the speed of said plunger, and
- (b) means for adjusting the stroke of said plunger.

8. The invention as defined in claim **1** wherein said power means includes:
- (a) an electric motor having a spindle,
- (b) a driving means connected to the spindle of said motor to rotate therewith,
- (c) a link interconnecting said driving means to said foot pedal,
- (d) said link having one end pivotally connected to said foot pedal and having its other end eccentrically pivoted to said driving means whereby rotation of said drive means is translated into an oscillating movement of said foot pedal through said link.

9. A power operated exerciser for use in bed comprising,
- (a) a base plate adapted to rest on a mattress of a bed adjacent the foot end thereof,
- (b) a pair of positioning bars,
- (c) means pivotally connecting one end of said positioning bars to said base plate,
- (d) means connecting the other end of said positioning bars to the foot board of a bed,
- (e) a strut interconnected between each of said positioning bars and said base plate, said strut being

pivotally connected at one end to an intermediate portion of said positioning bar and pivotally connected at its other end to said base plate,

(f) a food pedal hingedly connected to the forward edge of said base plate,

(g) strap means for securing a foot of a person lying in bed to said pedal,

(h) actuating means for oscillating said pedal with one's foot secured thereto about its hinged connection,

(i) said actuating means including a motor with rotating spindle,

(j) a driving wheel connected to the spindle of said motor to rotate therewith, and

(k) a link interconnecting said foot pedal and said driving wheel, one end of said link being pivotally connected to said foot pedal and the other end of said link being eccentrically connected to said wheel whereby the rotary motion of said wheel is translated into an oscillating motion of said foot pedal to forcibly effect the exercising of the person having his foot secured to said pedal.

10. The invention as defined in claim **9** including:

(a) means to adjust both the speed and the stroke of said foot pedal.

11. A power operated foot and leg exerciser particularly useful in bed by post-operative patients comprising,

(a) a base plate adapted to rest on a mattress of a bed adjacent the foot end thereof,

(b) a pair of extensible positioning bars,

(c) means pivotally connecting one end of said extensible positioning bars to said base plate,

(d) means pivotally connecting the other end of said extensible positioning bars to the foot board of a bed,

(e) means for effecting adjustment of the length of said extensible positioning bars,

(f) means for positively securing said extensible bars in the adjusted position thereof,

(g) an extensible strut interconnecting each of said positioning bars to said base plate, said extensible strut being pivotally connected at one end thereof to an intermediate portion of said extensible positioning bar, and pivotally connected at its other end to said base plate,

(h) means for securing the length of the struts in their respective extended positions,

(i) a foot pedal hingedly connected to the leading edge of said base plate,

(j) strap means for securing a foot of a person lying in bed to said pedal,

(k) actuating means for reciprocating said pedal with one's foot secured thereto about its hinged connection,

(l) said actuating means including a motor,

(m) a driving wheel connected to said motor, said wheel having a radial slot formed therein,

(n) a link interconnecting said foot pedal and said driving wheel, one end of said link being pivotally connected to said foot pedal,

(o) a pin adjustably positioned in said slot for connecting the other end of said link eccentrically on said wheel whereby the rotary motion of said wheel is translated into a reciprocating motion of said foot pedal to forcibly effect the exercising of the person having his foot secured to said pedal, and the adjustment of said pin connection in said slot varies the speed of said foot pedal accordingly.

12. The invention as defined in claim **11** wherein,

(a) said link is provided with an elongated slot for receiving said pin so that by adjusting said pin along said slot, the stroke of the foot pedal is rendered adjustable accordingly.

13. A power operated foot and leg exerciser for use in bed by post-operative patients comprising,

(a) a base plate adapted to rest on a mattress of a bed adjacent the foot end thereof,

(b) a pair of extensible positioning bars, each of said bars being formed of nested telescoping members,

(c) means pivotally connecting one end of each of said extensible positioning bars to the side edge of said base plate,

(d) split clamp means connected to the other end of said positioning bars for connecting the same to the foot frame of a bed,

(e) means for securing the adjusted length of said extensible positioning bars, said latter means including an adjustment sleeve,

(f) an extensible strut of nested members interconnecting each of said positioning bars to said base plate, said strut being pivotally connected at one end to an intermediate portion of said positioning bar and pivotally connected at its other end to said base plate,

(g) means for fixing the adjusted length of the respective struts,

(h) a foot pedal hingedly connected to the forward edge of said base plate,

(i) strap means for securing a foot of a person lying in bed to said pedal,

(j) actuating means for reciprocating said pedal about its hinged connection with one's foot secured thereto,

(k) said actuating means including an electro-mechanical linear actuator having a reciprocating plunger,

(l) said plunger having its free end connected to said foot pedal,

(m) means for controlling the speed of said actuator,

(n) and means for adjusting the stroke of said plunger.

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