# United States Patent [19]

**Rabjohn**

[11] **3,710,787**

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## [54] INTERMITTENT TRACTION APPARATUS


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[52] **U.S. Cl.** .....**128/75,** 242/54 R

[51] **Int. Cl.** .....**A61h 1/02**

[58] **Field of Search** .....128/75, 84 R, 84 B, 84 C; 254/167-173; 242/54 R



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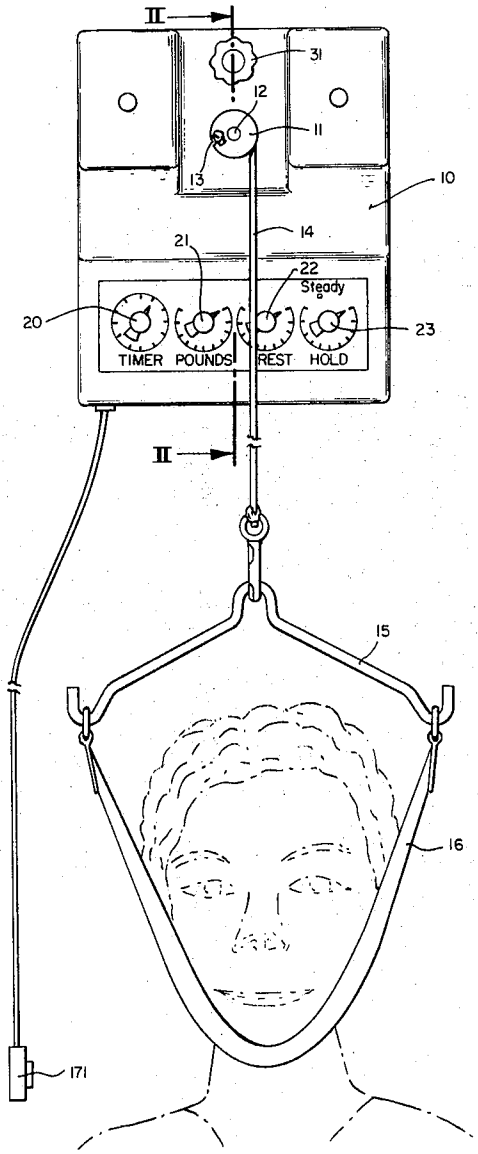
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[57] **ABSTRACT**

An intermittent traction apparatus is provided having an electric motor which pivots on its own shaft in such a manner that when the motor is running in a forward direction and traction is being applied to the patient, the motor itself pivots in order to close a normally open switch. When the motor is directed to turn in a reverse direction, the direction of its torque pivots the motor away from the switch, permitting the switch to open thus cutting off the circuit and stopping the rotation of the motor. An electric circuit is provided which includes a separate circuit for causing the motor to apply tension to the patient and another circuit releasing such tension, and a gate circuit controlled by a timer switches from the one circuit to the other in a manner to apply the traction intermittently.


**8 Claims, 4 Drawing Figures**



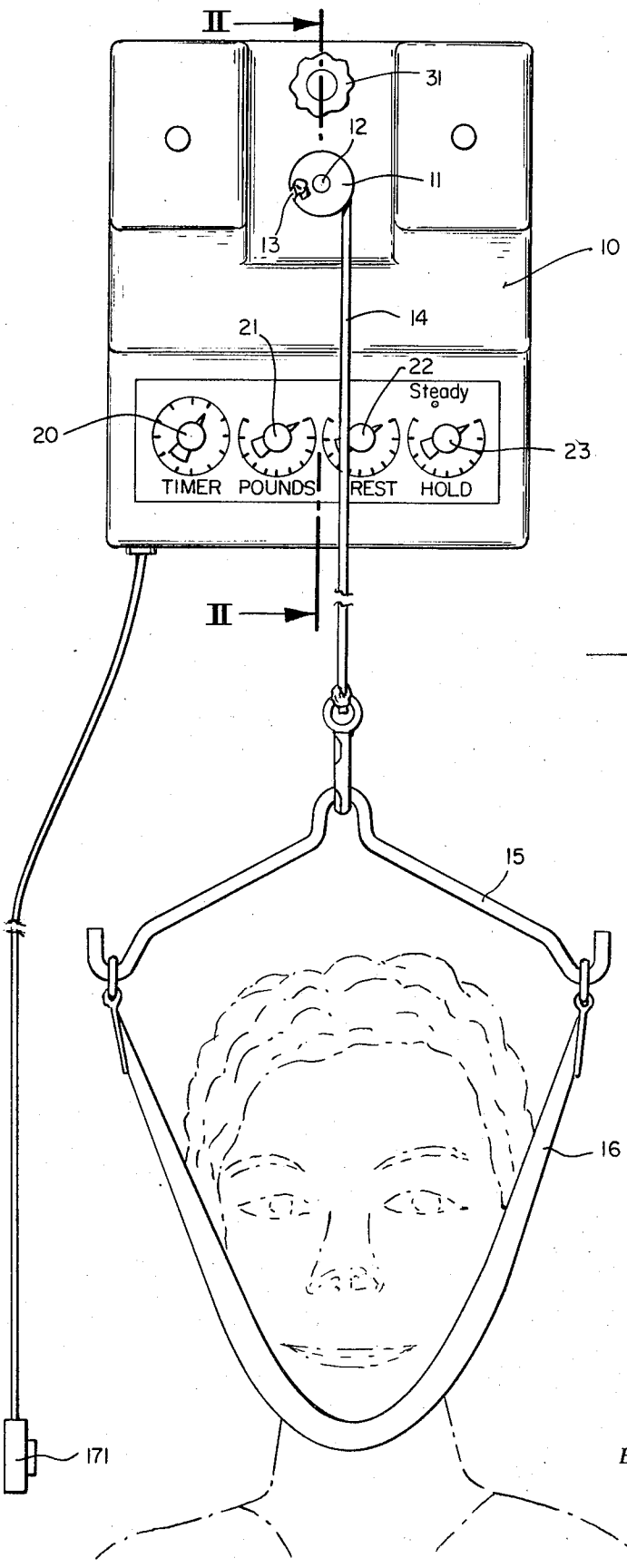



Fig. 1

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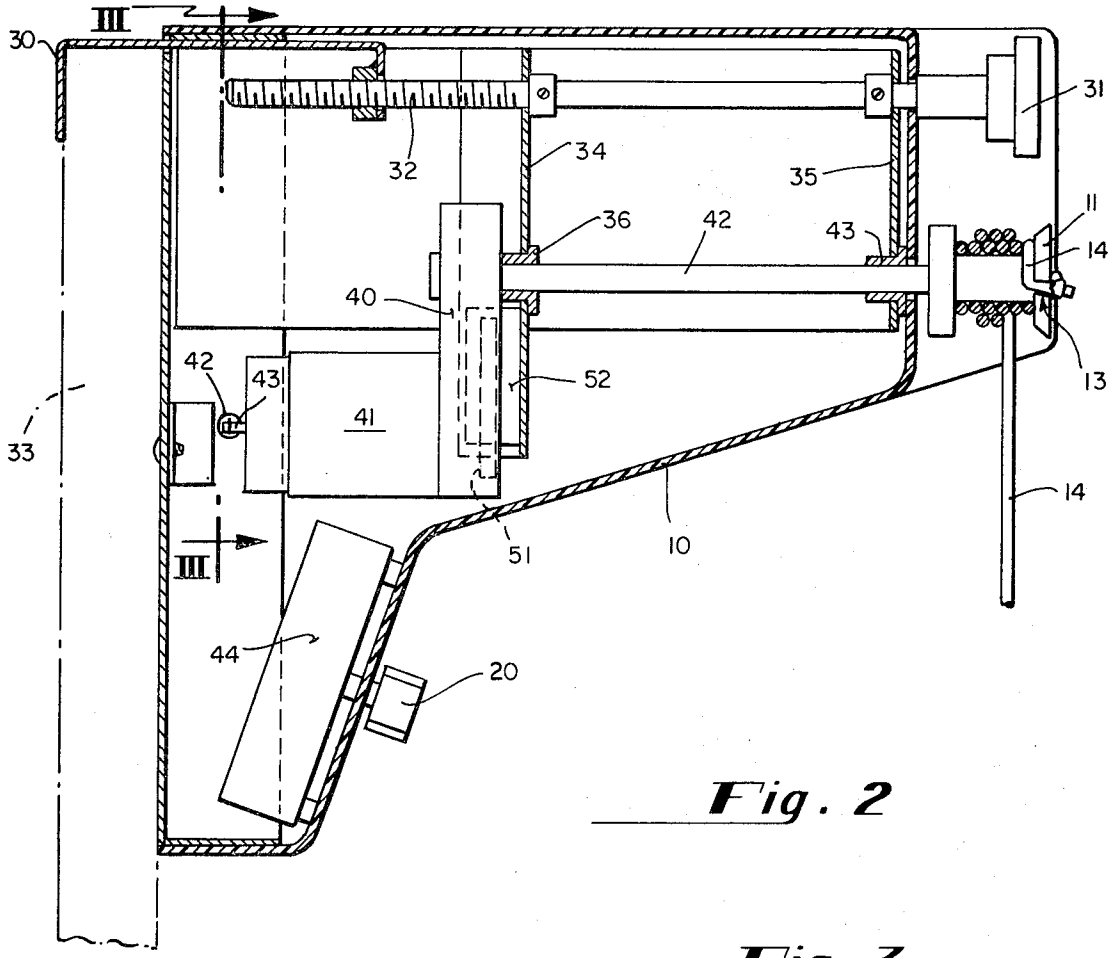
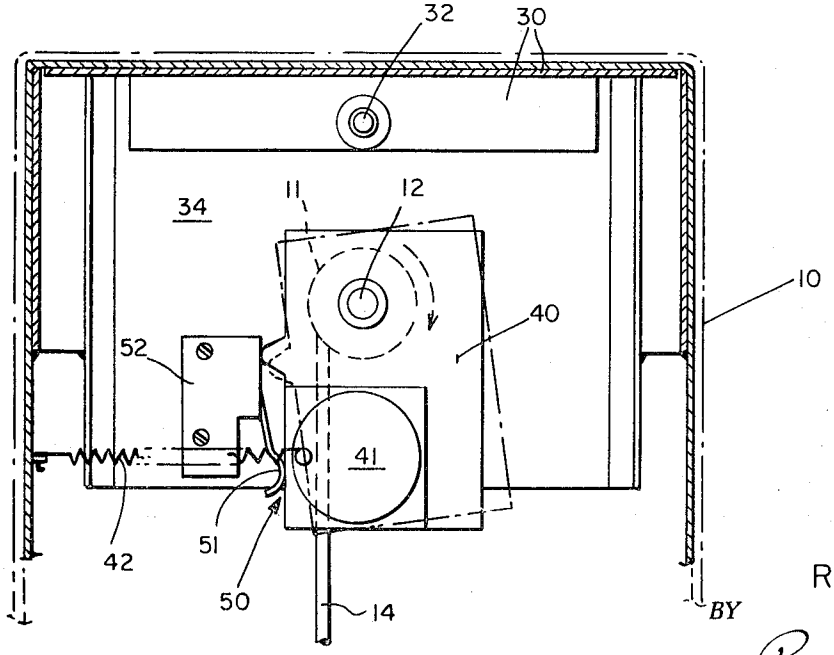



Fig. 2

Fig. 3




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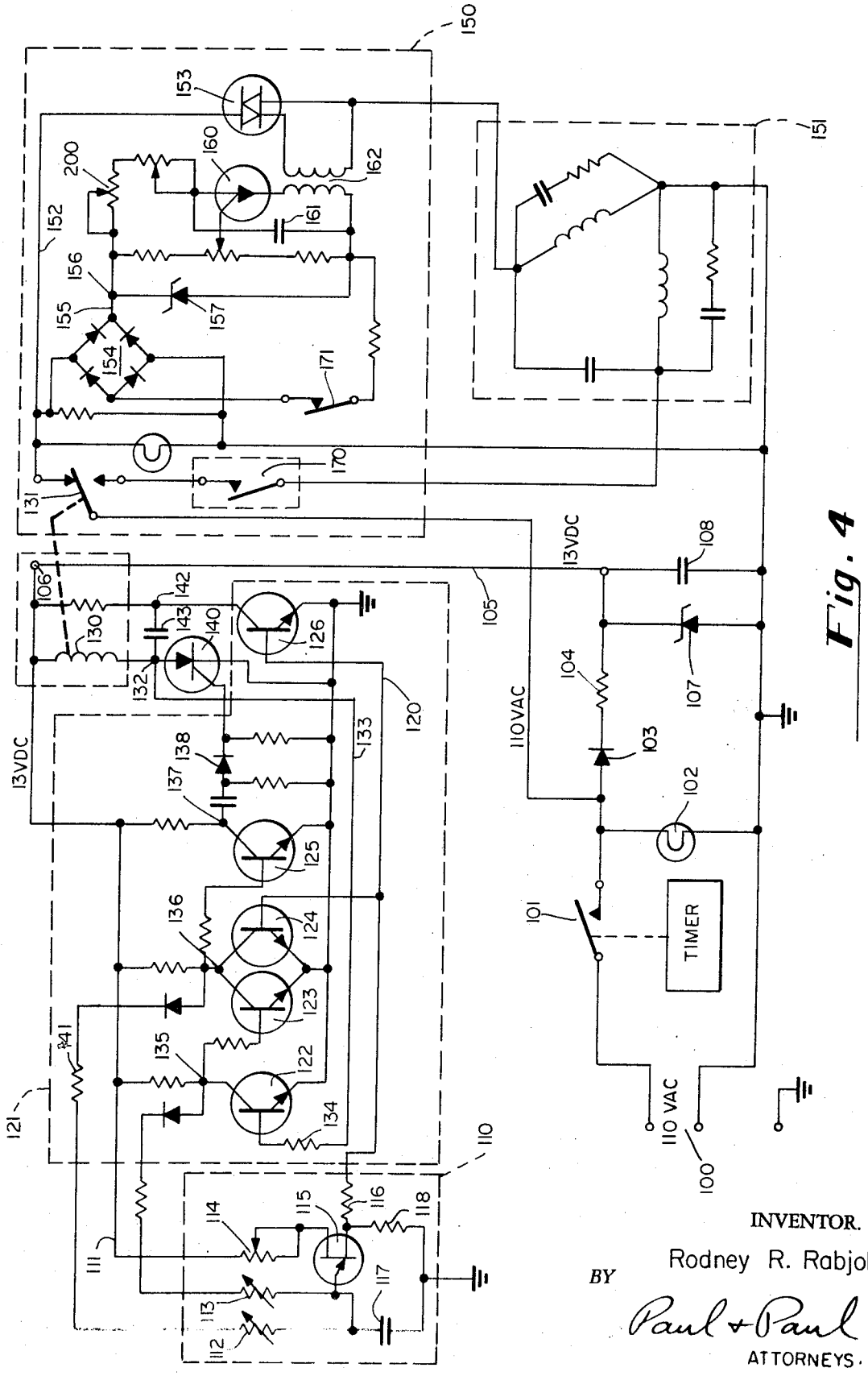



Fig. 4

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# INTERMITTENT TRACTION APPARATUS

## DESCRIPTION OF THE PRIOR ART

Various devices have been devised for the purpose of applying intermittent traction to human patients. Typical patents describing such devices are U.S. Pat. Nos. Yellin 2,633,125, Richards 2,811,965, Siltamaki 3,168,094, Herzmark 2,282,653, Black 2,475,003, LaPierre 2,861,565, Zur Nieden 2,773,499 and Robinson 2,712,820. The use of timers is generally well known, as shown by Finch U.S. Pat. No. 2,958,510

I have heretofore obtained U. S. Pat. No. 2,910,061 relating to an intermittent traction device. However, to the best of my knowledge the only cervical traction devices of which I am aware have many disadvantages including the fact that when the driving motor is operated in reverse for the purpose of relieving the tension applied to the patient, this reverse movement is generally controlled by a timer such that an excessive amount of slack is provided in the rope or cord through which the tension is applied. Indeed, in some cases the cord can even be released completely, depending upon the particular spacial relationship between the traction device and the patient. Further, those traction devices of the prior art which have been controlled by means of an electronic circuitry have been excessively expensive because of the utilization of great numbers of highly expensive electronic components in the circuits. Further, the element of safety in the use of intermittent traction devices, particularly in view of the fact that these are often applied to patients who are elderly or in delicate physical condition, is of paramount importance.

## SUMMARY OF THE INVENTION

In accordance with this invention an intermittent traction device is provided wherein a winch is mounted on a support, for the purpose of applying a rope or cord for example to the patient, and an electric motor which is operable forwardly and in reverse is connected to rotate the winch. A circuit means is provided including an electric circuit connecting electric current to drive the motor, and control means is provided in the electric circuit for controlling the amount of electric current conducted to the motor to control the amount of torque applied by the winch. The motor is mounted in such a manner on its shaft or on the support, so that the motor automatically turns physically to and fro in response to the exertion and release of torque. A switch means is arranged to close the circuit in response to the turning movement of the motor in the forward direction, and to open the circuit when the motor is rotated in reverse for a time sufficient to release the torque, thus shutting off the motor as soon as the torque has been substantially completely released, without permitting the rope or cord to slack to any appreciable extent.

Novel circuitry is provided for intermittently operating the traction motor, including a holding circuit which causes torque to be applied for the purpose of providing tension to the patient, and a resting circuit during which period no torque is applied to the patient. The timer is connected to a gate circuit which automatically switches back and forth between the holding circuit and the resting circuit, pursuant to the instructions received from the timer.



## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view showing the face of one form of apparatus embodying features of this invention, showing how it is applied to a patient for the purpose of providing intermittent traction therapy;

FIG. 2 is a sectional view of the traction apparatus, taken as indicated by the lines and arrows II—II which appear in FIG. 1;

FIG. 3 is a sectional view showing certain internal components of the apparatus, taken as indicated by the lines and arrows III—III which appear in FIG. 2; and

FIG. 4 is an electronic wiring diagram showing one form of circuitry which is applied for the purpose of controlling the operation of the intermittent traction device.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 of the drawings, the intermittent traction device generically designed **10** includes a motor driven winch **11** which rotates about shaft **12** either forwardly or in reverse, as driven by an electric motor (not shown in FIG. 1).

The winch **11** has a slot **13** accommodating a rope or cord **14** which is adapted to be wound and unwound upon the winch **11**. At the lower end of the cord **14** it is attached to a yoke **15** which in turn carries a harness **16** adapted to be fitted beneath the jaw of the patient, or to any other desired portion of the patient's body.

It will be noted in FIG. 1 that four dials are provided on the face of the traction device **10**, permitting manual control of the device by the doctor, the patient, or an attendant. The timer dial **20** is connected to a switch which electrically activates the timer so that it can control the intermittent application of tension to the patient. The "pounds" dial **21** is connected to an electrical component to be described in detail hereinafter, which controls the amount of current flowing to the drive motor and thus controls the amount of tension that is applied to the patient. The "rest" dial **22** is connected to an electric circuit to determine the duration of the period during which tension is not applied to the patient. Conversely, the "hold" dial **23** is connected to an electrical component which controls the duration of time in each cycle, during which tension is applied to the patient.

Turning now to FIG. 2, it will be observed that the traction device **10** is provided at its upper end with a slidably adjustable bracket **30** which is adjustable by means of knob **31** and threaded shaft **32** to connect the entire portable traction device to any support such as the top of a door **33**, for example. The threaded shaft **32** is maintained in position by supports **34** and **35**.

Also supported by support **34** is a bearing **36** upon which a gear train **40** is secured. Gear train **40** is thus free to rotate about the axis of the bearing **36**. Affixed to the gear train **40**, and eccentrically located thereon, is an electric motor **41** which is the drive motor for the intermittent traction device. The drive motor **41** has an output shaft, not shown in FIG. **2**, connected to drive the gears in the gear train **40**, and the number **12** designates the output shaft of the gear train, which output shaft is supported by the bearing **36** heretofore described and also by a bearing **43** which is supported

by the support 35. The output shaft 12 is connected to drive the winch 11 heretofore described. The number 42 designates a helical spring which is continuously in tension and which is connected between the supporting frame of the apparatus and the peg 43 mounted on the motor 41. The number 44 designates an electronic control box containing the electronic components which are shown in detail in FIG. 4 and will be described in detail hereinafter.

Referring to FIG. 3, it will be apparent that the spring 42 biases the motor 41 in a generally clockwise direction as indicated by the arrow in FIG. 3, toward the solid line position there shown. In such solid line position, the contacting surface 50 of the motor housing contacts the movable element 51 of an electrical switch 52 which is normally open, and closes the switch. Similarly, when the motor 41 is operated in such a direction as to turn the winch 11 in a manner to apply tension to the cord 14, the torque of motor 41 similarly urges surface 50 in the same direction, thereby keeping the switch 52 closed and permitting current to continue to flow into the motor 41. However, when the motor 41 is operated in reverse the tension on the cord 14 is released and the torque of the motor operates in opposition to the spring 42, thus tilting the motor housing to the dot-dash line position appearing in FIG. 3 and permitting the switch 52 to open, thus cutting off the current and shutting down the motor 41. This permits a release of tension on the cord 14 but prevents overrunning of the motor 41 in a manner to permit any excessive unwinding of the cord 14 from the winch 11 which would provide excessive slack in the cord 14.

It is to be emphasized that the presence of excess slack in the cord 14 would seriously interfere with the carefully predetermined timing of the intermittent traction device, because once the "hold" circuit becomes reactivated, it actuates the winch 11 causing it to turn in a forward direction, but if the winch 11 is required to wind up a considerable quantity of cord 14 before it can apply a tension, a considerable time delay is experienced before tension is actually applied. Thus, any excessive unwinding of the cord 14 during the reverse cycle seriously interferes with the predetermined timing of the subsequent cycle.

Referring now particularly to FIG. 4 of the drawings, the number 100 represents a 110 volt AC supply which is connected through a mechanical timer 101 which may be actuated by the doctor or nurse or patient and functions as a total cycle timer. The number 102 designates a neon lamp which serves as an indicator that the power has been turned on. The number 103 represents a half wave rectifier in the form of a 400 volt PIV diode. Connected in series with the diode 103 is a 1,200 ohm, ten watt resistor 104 producing a supply power of 13 volts DC which through the wire 105 to the B+ terminal 106 of the electronic timer. The number 107 designates a 13 volt Zener diode which regulates the power supply to the required voltage. A filter capacitor 108 is provided to smooth out the direct current by filtering the peaks in a conventional manner.

The number 110 generically designates a timer which is an important element of the apparatus according to this invention. The 13 volt direct current power supply enters the timer through the line 111. The timer includes a pair of potentiometers 112, 113. Each potentiometer 112, 113 has a resistance rating of 1.250 megohms. The potentiometer 112 is connected into a circuit arranged to cause the motor of the traction device to apply a given tension and to continue to apply that tension throughout the period prescribed by the timer. The potentiometer 113 is wired into a circuit designed to cause the motor to rest and to provide for the traction patient an intermittent period of zero tension applied by the traction device; both such circuits will be described in detail hereinafter. The potentiometer 114 is a trim potentiometer for the purpose of matching the parameters of the semi-conductor device with which the timer is associated.

The semi-conductor device 115 is connected to receive current from either the "hold" potentiometer 112 or the "rest" potentiometer 113, but not both at the same time as will further become apparent hereinafter. The device 115 is a uni-junction transistor; it has a peak point firing level such that it can be charged only to a certain limit and upon exceeding that limit immediately discharges all of the potential contained, through the resistors 116 and 118. The capacitor 117 is, of course, charged by the voltage coming from either potentiometer 112 or 113. Upon firing of the transistor 115 the discharge of the capacitor 44 through the resistor 118 creates a potential which causes a current pulse to flow through the 1K resistor 116 and through the line 120.

The number 121 generically designates gate circuitry which switches automatically back and forth between the "hold" circuit and the "rest" circuit of the traction device. Included in the gate circuit are five transistors 122, 123, 124, 125 and 126. These are connected in a manner to control the timer output relay 130 to switch between "hold" and "rest," the contacts of which relay are designated by the number 131. When power is first applied by closing the "on" switch for the machine (the patient timer 101), 13 volt DC is applied through the point 106 and this energizes the point 132 which is the anode of the silicon controlled rectifier 140 and which always has a voltageof approximately 13 volts DC.

The number 133 designates a feeder line which connects into the base of transistor 122 through a 27K resistor 134. The collector point 135 of transistor 122 is wired through a 100K resistor to the base of transistor 123. Transistor 124 is wired (as shown) to the transistor 123, and to ground. Collector point 136 is connected to the transistors 123, 124 and through a 100K resistor to the base of transistor 125. Collector point 137 of transistor 125 is connected to a one-tenth microfarad capacitor and through diode 138 into the gate of the silicon controlled rectifier 140.

Accordingly, it will be appreciated that when the power is applied to the point 106, certain points are energized so that they have a potential referred to as "-high" (13 volts DC), as distinguished from ground. The points which are "high" are points 132, the base of 122 and the collector 136. The "low" points (connected to ground) are 135 and 137.

When the machine is energized initially, the relay switch 131 is on "hold." It should be assumed that the operator of the traction device will set the potentiometer 112 to determine the desired time duration of the "-hold" cycle and will similarly set the potentiometer 113

to determine the duration of the "rest" cycle. Another potentiometer **200**, in the torque control circuit to be described in detail hereinafter, is set in order to predetermine the number of pounds of pull to be applied by the traction device. When the point **132** has a high voltage high potential (13 volts), point **135** is connected to ground because transistor **122** is conducting. At this time it is desired to block the voltage applied to the "rest" potentiometer **113** and this is accomplished by turning on the transistor **122** thus connecting point **135** to ground.

The fact that point **135** is connected to ground means that the transistor **123** is not conducting and the point **136** is high; this fact allows a charging current to pass through the 39K resistor **141** to the "hold" potentiometer **112** and this is why the switch **131** is positioned on "hold."

Because the point **136** is at high potential the transistor **125** is conducting and this means that the point **137** is low potential (ground) and therefore at that time it cannot feed current into the silicon control rectifier **140** in order to trigger the same.

With the passage of a predetermined amount of time, a charge is gradually built up in the capacitor **117** and after this predetermined interval of time the uni-junction transistor **115** fires, causing a momentary pulse of current to flow through the 1K resistor **116**, feeding the base of transistor **124** and also the base of transistor **126**. The turning on of transistor **124** connects point **136** to ground, thus turning off transistor **125** which allows point **137** to attain high potential and this causes current to flow through the one-tenth microfarad condenser to trigger the silicon control rectifier **140**, triggering the relay **130** and throwing the relay switch **131** from the "hold" position to the "rest" position.

With the turning on of the transistor **126** the point **142** becomes connected to ground. At this juncture both points **132** and **142** are connected to ground and thus nothing happens with respect to the transistor **126**.

After the relay has been thrown to the "rest" position, in view of the fact that point **132** has now become connected to ground, the base of transistor **122** is turned off, thus permitting point **135** to become high potential and allowing a charging current to pass through the "rest" potentiometer **113** to cause a charge to build up in the capacitor **117**. Also, when point **135** becomes high potential it turns on the transistor **123** thus connecting point **136** to ground which turns off the transistor **125** permitting point **137** to become high potential. Point **137** is high potential but this has no effect upon the silicon control rectifier **140** which is already turned on. After the passage of a suitable and predetermined time as determined by the setting of "rest" potentiometer **113**, the uni-junction transistor **115** again fires through the 1K resistor **116** which is connected to the base of transistor **124**, but this is ineffective because the point **136** is connected to ground. This also turns on the transistor **126** which connects the point **142** to ground and diverts the current from silicon control rectifier **140** through the one microfarad capacitor **143** to ground. The failure of current to flow through the silicon control rectifier **140** causes it automatically to reset itself to its original position. Thus, the point **132** again reaches a high potential and conditions have returned to the conditions existing originally at the time the apparatus was first put into operation.

The number **150** generically designates a torque control circuit which functions to apply a limited and controllable amount of torque from the motor to cause the application of a controlled tension to the patient using the traction device of this invention. In this connection, the number **151** generically designates the motor which is driven through the torque control circuit. When the "hold" portion of the cycle is in operation, 110 volt AC passes through the line **152** into a "triac" semi-conductor **153** which is the important controlling device for regulating the amount of current which is passed to the motor **151**. The triac semi-conductor **153** is well known in the art per se and has the characteristic of controlling both positive and negative cycles of a sinusoidal wave. The remaining circuitry in the torque control circuit **150** is provided for the purpose of regulating the amount of current that is passed by the triac **153** to the motor **151**.

As will be seen from the drawing, 110 volt AC is passed to a full wave bridge **154**, the output of which is a pulsating direct current and which passes through the line **155** to the connecting point **156**. A Zener diode **157** clips the pulsating DC output to 51 volts which is fed to both the anode and gate of a programmable uni-junction transistor **160**. The uni-junction transistor **160** fires in response to the potential between the gate and the anode. The anode voltage is controlled by setting the potentiometer **200** and the capacitor. This functions in conjunction with the capacitance of the 0.1 microfarad condenser **161**.

The output of programmable uni-junction transistor **160** provides a pulse in the transformer **162**, injecting a direct current pulse into the gate of triac semi-conductor **153**. This pulse turns on the semi-conductor triac **153** to the corresponding degree in order to regulate the quantity of current that is passed through the triac **153**.

A microswitch **170** is provided which is mechanically actuated by the motor **151**, such that when the motor is providing torque this causes the microswitch **170** to be closed, the mechanical aspects of which have heretofore been described. The microswitch **170** is a normally open switch. Thus, throughout the period of the "hold" cycle, the torque exerted by the motor **151** has assured that the microswitch **170** is closed. When the switch **131** is switched to the "rest" position, a circuit is completed through the microswitch **170** causing the motor **151** to run in its reverse direction. However, with the reversing of the motor **151** the traction connection to the patient is relieved of its tension because the reverse driving of the motor automatically releases the torque and permits the normally open switch **170** to open. This opening prevents the motor from running in reverse direction to an excessive degree and prevents it from allowing the traction line to unwind beyond the desired amount. The apparatus remains, of course, in a "rest" position until the timer control circuit again throws the relay switch **131** back to the "hold" position, at which time the cycle previously discussed is again repeated.

The switch **171** is a "panic button" conveniently available to the patient so that in the event the patient experiences apprehension of any kind, he can simply open the switch **171** which deactivates the pulsating DC voltage to the programmable uni-junction transistor **160**, cutting off all source of power to the motor **151**.

It will be appreciated that, in addition to the many advantages already discussed herein, this invention has the advantage of great reliability since it utilizes only one timer but provides a gating function to cause the same timer to control both the "rest" and the "hold" cycles alternately.

In operation, the yoke **15** and sling **16** are properly positioned with respect to the patient, and the desired number of pounds of tension are predetermined by adjusting the dial **21**. Similarly, the desired periods of time for rest and for hold are set by adjusting dials **22** and **23**. Then, the timer **20** is turned to the "on" position whereupon the motor **41** is automatically energized with a controlled amount of current which is precisely the right amount of current to provide the number of pounds of tension desired. Operating through the "rest" circuit heretofore described, the tension is applied for a predetermined period of time and is then released without providing excessive slack in the cord **14**, and the cycle is repeated for the total period of time as predetermined by the setting on the timer **20**. In the event that the patient should shift his position during the "hold" period, and in the event that this results in a slackening of the tension on the cord **14**, this is immediately sensed by the motor since the current input seeks a natural balance against the torque output of the motor. Thus, any reduction of torque output results in rotation of the motor causing rotation of the capstan, immediately bringing the tension back up to the predetermined value. Similarly, if any force is applied to the cord **14** which is in excess of the predetermined torque, this provides additional torque overriding the limited current that may be fed to the motor, thus permitting a lengthening of the cord **14** without exceeding the predetermined tension provided by the motor.

In operation, the apparatus is outstanding with respect to safety since only a limited current can be fed into the motor and since the motor can only produce a limited torque. Thus, the danger of accidentally applying an excessive torque to the patient is effectively eliminated. Further, the "panic" button **171** is conveniently available to the patient and may even be held in the patient's hand so that it can be actuated whenever the patient feels a moment of apprehension of any kind.

Although this invention has been described in specific terms in relation to specific embodiments as shown in the drawings, it will be appreciated that many other embodiments may also be employed to advantage within the scope of this invention, as for example by substituting equivalent elements for those shown and described, by utilizing certain features of the invention independently of others, and by reversing parts, all within the spirit and scope of this invention as defined in the appended claims.

The following is claimed:

**1**. In an intermittent traction device, the combination which comprises:

a. a support,

b. a winch mounted on said support,

c. flexible elongated tensioning means arranged to be wrapped around said winch and connected to apply tension to the patient,

d. an electric motor operable forwardly and in reverse connected to rotate said winch,

e. circuit means including an electric circuit connecting electric current to drive said motor,

f. control means in said electric circuit for controlling the amount of electric current conducted to said motor to control the amount of torque applied by said winch to said flexible elongated tensioning means,

g. means turnably mounting said motor on said support whereby said motor has capacity to turn physically to and fro about its axis in response to exertion and release of torque by said winch,

h. switch means arranged to close said circuit in response to said turning movement of said motor in said forward direction,

i. means for reversing said motor to release said torque, and

j. means whereby said motor is turned and said switch means is actuated to open said circuit in response to release of said torque.

**2**. The intermittent traction device defined in claim **1**, wherein said motor is mounted for rotation bodily around its own drive shaft.

**3**. The intermittent traction device defined in claim **1**, wherein means are provided for continuously urging said switch toward its open position.

**4**. The intermittent traction device defined in claim **1**, wherein said circuit includes a holding circuit which energizes said motor to produce torque, and a rest circuit which releases the application of energy to said motor to reduce or release said torque.

**5**. The intermittent traction device defined in claim **4**, wherein gate circuitry is provided for automatically switching back and forth between said holding circuit and said resting circuit.

**6**. The intermittent traction device defined in claim **4**, wherein a timer is connected to said gate circuitry in a manner to control the duration of effectiveness of said holding circuit and said resting circuit.

**7**. The intermittent traction device defined in claim **4**, whereing a torque control circuit is provided in combination with the holding circuit for controlling the amount of torque applied by the motor.

**8**. The intermittent traction device defined in claim **7**, wherein a normally open switch is provided in said torque circuit, and is closed by the motor under the influence of its own torque, and wherein means are provided for reversing the direction of the motor, whereby the motor releases said normally open switch and the traction connection to the patient is relieved automatically of its tension.

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