A device for monitoring the inactivity of a user, which device finds particular use in the prevention of deep vein thrombosis in airline passengers and other travellers. The device comprises a carrier (20) for positioning adjacent a user, a motion sensor (10) mounted on the carrier (20) and adapted to detect the user performing motion, a timer (12) connected to the motion sensor (10) and reset when the predefined motion is detected, and an alarm (14) operated should the timer (12) count a preset time period without being reset. The carrier (20) is preferably a small container that can be strapped around the limb of a wearer. Failure to undertake the required motion will cause the alarm (14) to be activated, thus notifying the wearer of the omission.
Yes

Yes

Does motion match
determined criteria?

Reset Timer

Counter begins timing
cycle

Yes

Is motion detected?

Yes

Does motion match
determined criteria?

No

Timer reaches end of
predetermined time
period

Yes

Has Exercise started?

No

Activate alarm

Keep activating the
alarm

Yes
reset device

Monitoring of inactivity for 56 minutes begins

Has exercise been achieved

yes

Count number of valid movements and deduct from final 180 to arrive at number needed to be achieved, before acknowledgment is given

no

Give three distinct buzzes of vibration motor to wearer

Monitor exercise being done for four minutes

Has sufficient exercise been done

yes

Give one long buzz for 5 seconds as acknowledgment of success

no

Change LED flash rate to two flashes every fifteen seconds

Flash LED when rate is achieved
ACTIVITY MONITORING DEVICE

[0001] This invention relates to a device for monitoring activity. More specifically, it relates to a device for monitoring the activity of a person and notifying that person, or another person, of a specified duration or type of activity or inactivity.

[0002] The present invention finds a particular use in the prevention of deep vein thrombosis (DVT), which is often caused by extended periods of inactivity, and it will be primarily described with reference thereto. However, other uses for the device are anticipated which do not relate to the prevention of DVT, so the application is not limited thereto. Examples of specific other uses will be described later in the specification.

[0003] Deep vein thrombosis is a condition resulting from the lack of blood flow in the veins and the condition is related primarily, but not exclusively, to the legs. Blood flow tends to slow down or stop when there is prolonged inactivity, especially when seated, as would happen on a plane or any long journey in a cramped space. More specifically, deep vein thrombosis occurs when a clot forms in the deep veins within the calf or thigh muscles. It is usually a spontaneous condition that occurs in people especially at risk, such as those with heart disease, those who smoke or take alcohol and those that are generally overweight. The elderly in nursing homes may be particularly prone, as they tend to be liable to sit for long periods of inactivity.

[0004] Any period of prolonged inactivity can generally trigger the condition and medical research suggests that those over forty years of age are at ever-increasing risk. Warning signs are pain and tenderness in the leg muscles, redness and swelling of the skin. If the blood clot moves to the lung (a pulmonary embolus), then breathing difficulties can occur. The clot travelling on to the heart can cause death or if it travels to the brain a stroke is a possibility. There are well-documented cases of people suffering from this condition during long-haul plane journeys and there have been some deaths attributed to DVT. In recent times a number of airline passengers have taken legal action against airline companies relating to this condition, and some companies are now putting warnings on their tickets.

[0005] The more cramped the condition, such as would occur in the economy class area of a plane, the more likely a person is to suffer from DVT, but recent medical research shows that the condition can occur to any class of traveller who does insufficient exercise.

[0006] It is to be expected that on a long haul flight lasting several hours that people will sleep for extended periods of this time. This cannot be prevented on an individual basis and this is where a problem may arise. Furthermore, due to the cramped conditions, people may at other times, for one reason or another remain essentially motionless. This inactivity reduces the blood flow in the legs and the potential problem of DVT becomes a factor.

[0007] Regular use of the legs during a journey dramatically reduces the risk of DVT. However, the airline operators have no way of ensuring that suitable exercise is done by their passengers, despite the fact that the health and safety of those passengers is at least partially the airline operator’s responsibility. The problem of DVT is not limited to airline travel, but is also encountered in other forms of transport such as coaches and trains wherein prolonged periods of sedentary inactivity occur.

[0008] At present, the onus maybe on travel operators to ensure that their paying passengers do not get DVT. However, the present type of traveller on long haul flights will clearly fit many of the conditions associated with DVT and as such can expose the travel operators to significant risk of negligence claims.

[0009] This present invention aims to provide a mechanism by which the motion or lack of motion of a person may be monitored and remedial action taken by the person or another person if deemed appropriate. In the context of DVT prevention it aims to reduce the risk of DVT occurring and move responsibility from the travel operators to the individual passenger by providing them with a device that will warn of lack of sufficient and suitable movement/exercise of the limbs.

[0010] According to the present invention there is provided a device for monitoring the activity of a user, comprising a carrier for positioning adjacent a user, a motion sensor mounted on the carrier and adapted to detect the user performing a predefined type or amount of motion, a timer connected to the motion sensor so as to be reset should the predefined motion be detected, and an alarm connected to the timer for triggering thereby, should the timer count a preset time period without being reset.

[0011] It is preferred that the timer and the alarm are also mounted on the carrier, as this allows convenient integration and construction of the device.

[0012] As mentioned above there are other uses for the device according to the present invention, which make use of its ability to monitor and report the lack of or type of activity detected by the device. These include the monitoring of a driver to check that he/she has not drifted off to sleep while driving a vehicle such as a long haul truck. For example, a device could be mounted on the leg of a driver (or on one of the pedals) and failure to regularly use the leg (or press the pedal) would set off the alarm. This could wake a driver or prevent them going to sleep.

[0013] People who have lost the use of a limb are encouraged to move the limb by way of rehabilitation using others as this can encourage the recovery of the limb. The problem is that such limbs can be forgotten about by the patient due to their lack of nerve sensation - therefore meaning that the exercise is not carried out, and worse that the mental concept of the limb diminishes. A further use of the present invention could be the connection to the limb of a person who has lost the use thereof, to remind the person of the inactivity of that limb.

[0014] The device may be used to compliment other types of DVT prevention equipment. It is known to use an air bag exercise apparatus which can be used by a seated person to reduce risk of developing DVT. This apparatus relies on the user to undertake the exercise and does not ensure that they are reminded to do so. The present invention also provides an exercise apparatus provided with an activity monitoring device as previously described which is adapted to monitor the correct use of the exercise apparatus and sound the alarm if insufficient or incorrect use is made of the
apparatus. The apparatus could be a two chamber inflatable device, and this could also be provided with pump for inflation thereof.

[0015] The device can monitor the inactivity of a specific limb and in order to monitor such activity it is essential that the sensor be positioned so that it may detect the movements of that limb. It is preferred that the sensor is held against the user and more particularly the limb of a user, and so the carrier may include an attachment means to permit removable attachment of the device to a user. Those attachment means may take any suitable form, but for attachment to a limb, they may comprise a strap that is adapted to pass around that limb. Such a strap may be made such that it may be stretched to pass over the hand or foot and then grip the limb once fastened. Alternatively the strap may be in two parts, the free end of each part being provided with means for inter attachment, such as a two part hook and loop fasteners (for example that sold under the trade name Velcro®), or a buckle. Releasable adhesive could also be used to fix the device to a limb or clothing.

[0016] The motion sensor may be adapted to detect various patterns of movement, and different intensities of motion. This allows the device to discern between different types of activity and only to reset the timer if the correct activity is performed. This prevents the resetting of the timer by insufficient or inappropriate movement. The type of motion that the motion sensor is adapted to monitor may be preset during manufacture, as may the time period before activation of the alarm. Such manufactured settings could adapt the device to a particular type of use. Alternatively, the type of predetermined motion and indeed the preset time period may be adjusted to allow the device to be swapped between different uses. This adjustment may be conducted by reprogramming the devices between different modes, using controls on the device or by control remotely from the device.

[0017] The alarm must be able to notify the user or another person or persons of the period of inactivity, and may therefore dependent on the end use take several different forms. The alarm may include at least one of an audible signal generator such as a speaker, a light source such as a flashing LED, a vibrator such as is used in mobile phones and a transmitter connected to a remote notification system. Such a transmitter might be used when it is additionally, or alternatively, desired to notify a person other than the user (wearer) of the device.

[0018] To integrate the motion sensor, timer and alarm it is preferred that the device includes a controller (such as a microprocessor) adapted to receive information from the timer and the motion sensor and to operate the alarm accordingly. This controller may include software and/or hardware that allow the reprogramming of the device for different operation. Indeed the timer, motion sensor and control may be integrated within a single, suitably programmed micro-controller. Means for transmitting and receiving data may be included, either as part of the alarm, or in addition to the alarm, and these can allow remote control and monitoring of the device.

[0019] The carrier on which the motion sensor is mounted may comprise a mattress, and it may be adapted to monitor the movement of a person lying thereon. The alarm can be located remotely from the mattress so that the sleep pattern, or movement of a person on the mattress, may for example be monitored by a nurse, without the alarm disturbing that person or any other.

[0020] The device according to the present invention may in one embodiment find a particular application in the prevention of DVT, therefore it is preferred that the device is adapted for attachment to a leg of a passenger on a transportation vehicle, and the type of predetermined motion of the sensor and the preset time period of the timer are set so that the alarm is triggered if the leg is not exercised often enough to reduce the risk of deep vein thrombosis.

[0021] A further proposed use of the present invention is in the prevention of sleep by drivers of vehicles. Therefore the device may be adapted for attachment to a leg of a vehicle driver or to a pedal operated by that leg of the driver, and the type of predetermined motion and the preset time period of the timer may be set so that the alarm is triggered if the pedal is not regularly operated by the driver's leg.

[0022] The device may be adapted for attachment to a person who desires to correctly carry out a specific exercise. In such an embodiment, the type of predetermined motion may be set to the pattern generated by the correct completion of the specific exercise routine, and the preset time period of the timer is set so that the alarm is triggered if the exercise is not correctly performed at the requires frequency by the person wearing the device.

[0023] The device can be adapted for use in the monitoring of athletes and sporting animals. Several embodiments of the device could be provided on each limb of, for example, a racehorse and each would have a transmitter. The transmitter would provide details from the timer and the motion sensor of the type and regularity of the motion of those limbs, which data would be transmitted to a control unit provided with a recording medium such as a hard disc, and a receiver. When used on a racehorse, the control unit could be mounted on the saddle, and the monitoring devices could be placed in boots attached to the ends of the racehorse legs.

[0024] In a more sophisticated version of the invention a microprocessor is used in conjunction with the earlier agreed principles of operation. The microprocessor will be programmed to allow for the following sequence to happen.

[0025] A wearer will be given an alert on activation of the device. The alert might comprise the flashing of the LED or a buzz from a vibration motor. The microprocessor will allow for the LED to flash in time with an exact exercise being achieved, in so doing it in effect trains the wearer to visually do a Specific regime of exercise. The LED will be allowed to flash every fifteen seconds to show its wearer that it is functioning correctly.

[0026] In a further use of the LED, it could be that should the wearer refuse to do the exercise on any one or more period of monitoring, then the flash rate of the LED could be changed by the microprocessor to 2 flashes every fifteen seconds to indicate this. This has the function of alerting cabin staff in an airline that the wearer refused to do the agreed predetermined exercise regime of the airline.

[0027] The timer can monitor activity over suitable period such as fifty to sixty minutes and if insufficient/inappropriate
exercise is detected in that period then it will cause three distinct buzzes of the vibration motor to warn a user to do the exercise regime.

[0028] On completion of the exercise e.g. 180 foot taps in four minutes then another buzz will be sent to the wearer via the vibration motor, indicate to the wearer that they can stop doing exercise. The device then resets its clock and continues to monitor for a further fifty or sixty minutes.

[0029] In order that the present Invention may be better understood, but by way of example only, various embodiments of the present Invention will now be described In more detail with reference to the following drawings. In which:

[0030] FIG. 1 is a simplified block schematic view of one embodiment of device according to the present invention;

[0031] FIG. 2 is a perspective view of further similar embodiment in a form ready for use;

[0032] FIG. 3 is a simplified block schematic view of a further embodiment of device wherein the alarm comprises a low power transmitter in communication with a remote monitoring station;

[0033] FIG. 4 is a flow chart to demonstrate operation of the embodiment of FIG. 1;

[0034] FIG. 5 is an alternative more sophisticated embodiment of the invention; and

[0035] FIG. 6 is a flow chart to demonstrate the embodiment of the embodiment of FIG. 5.

[0036] FIG. 1 shows a simple schematic view a first embodiment of the present invention. The device comprises a motion sensor 10 position so that it may detect the movement of a user (not shown); a timer 12 connected to the sensor 10 and an alarm 14. The timer counts down a time period from a preset time 1 to zero, and when it reach zero it cause operation of the alarm through a controller 16. In the context of DVT prevention in airline passengers there may be 36 minutes. The motion sensor is adapted to detect a suitable level or type of motion and when that is detected, the timer 12 is reset to t. A power source In the form of a battery 18 powers the various components. The alarm may take several forms and indeed a device may include several different types in combination. For example a silent vibrating alert might be appropriate for a passenger on a plane to prevent annoyance so to others.

[0037] A more practical embodiment of device operating essentially as described with reference to FIG. 1 is shown in FIG. 2. In this embodiment the timer, motion sensor, battery and controller are housed inside a carrier 20 which can be affixed to a wearer using the straps 22 and 24. The straps are passed around the leg (if using for DVT prevention) of a user and connected using a two part hook and loop fastener, one part of which 26 can be seen on the inner face of the strap 24. The carrier 20 is provided on its outer face 28 with an LED 30 which forms part of the alarm, and with an LCD screen 32 indicating operative information about the device such as the time until activation of the alarm or the number of alarm activations.

[0038] The device shown in FIG. 2 is intended for use by a passenger on a long journey, such as a long-haul airline flight. The device will be strapped to the ankle of a passenger using the straps 22 and 24 and the predetermined motion and time period will be set so as to detect regular motion suitable to reduce the chance of the passenger developing DVT. An example of predetermined motion might be the tapping of the foot on the floor more than 180 taps in 3 minutes period to cause resetting of the timer. The length of the time period (t) that the timer counts down can vary, but for the prevention of DVT the exercise may comprise 180-240 foot taps in a three to four minutes period and repeated at least every 30 minutes to 1 hour (t=30 to 60 minutes). Dorsiflexion suggests the aforementioned range of taps is sufficient as in use on post op rehabilitation.

[0039] As long as the wearer performs the correct exercise regularly enough the timer will be reset and the alarm will not sound. Should correct movement NOT be detected then the timer will reach zero and trigger the alarm, thereby reminding the passenger to make the necessary exercise. The time period and type of exercise can be set by medical recommendation.

[0040] The device could also detect other types of exercise that meet the criteria such as around walking and would also reset the counter in response to these. This minimises unnecessary activation of the alarm and prevent annoyance to the wearer. A range of devices could be provided on a plane with different preset values. Devices with different preset values could be colour-coded to allow the crew to make a distinction between different types of people. For example people who could be at greater risk of DVT might be given a device with a shorter time period than those who are at low risk. It is envisaged that these devices with varying preset timing values could be distributed to the passengers at commencement of the flight. During pre-flight safety demonstration their use could be described and demonstrated.

[0041] Simple embodiments of the device are automatic and require no adjustment or button pressing from either staff or passengers, as once they are preset the airline staff could literally hand them out in the same way, as for example, headphones are given out for onboard entertainment.

[0042] The LCD screen 32 could display the number of times the device has been reset by exercise. This information could be logged by the airline manually or automatically and then correlated to the seat position and passenger name. This would give the airline company a record of a particular passenger’s compliance with the recommended exercise regime.

[0043] In practice, each passenger could be given this device and requested to wear it for their safety. Should they refuse or simply not use it then the airlines would have compiled with the principle of providing as safe as possible a journey and the onus would Shift on to the individual passenger.

[0044] This device is in no way limited to airline passengers, rather it can be used wherever there is a threat of DVT or other problems from lack of movement of any kind, such as may follow a serious operation in a hospital or where movement monitoring is desirable. A small transmitter could be used in conjunction with the device and this is shown in FIG. 3. The embodiment of device in FIG. 3 is essentially similar to that shown in FIG. 1 and therefore like parts will be given like reference numerals. The difference between the two embodiments is that the alarm in FIG. 3 comprises a transmitter 36 in wireless communication with a receiver at a remote monitoring station 38. In this way the alarm signal may be transmitted to a remote location for monitoring by a third party An example of the use of this would be in a
hospital where it could be used to alert medical staff that a patient’s limb had not moved recently and now needed to be moved immediately. The transmitter could use low power radio waves or ultrasound to communicate with the remote monitoring station.

[0045] Use of multiple devices with a single remote monitoring station could provide complex movement data about a single person. Each device uniquely identified could communicate its data to a computer that would correlate the information for study by for example medical staff.

[0046] FIG. 4 is a flow diagram showing a simplified version of how an embodiment of device might operate. The device is initially attached to a wearer and reset at stage 40. The timer then begins counting down at step 41, whilst monitoring movement at step 42. If movement is detected, the type of movement is analyzed at step 43, and if it meets the criteria the timer is reset at stage 40. If the correct motion is not detected, the timer reaches the end of the time period at step 44, and the alarm is activated at step 45. The motion sensor continues to monitor for activity at step 46, and whilst none is detected, the alarm continues to activate at step 47. If exercise is detected, it is analyzed at step 48, and if it meets the criteria the timer is reset at stage 40 to restart the cycle. If the exercise is not correct, the alarm will continue to be activated, unless it is manually cancelled.

[0047] The embodiment in FIG. 5 comprises a microprocessor 49 on which driver electronics are run, and to which is fed motion data from the sensor 10. An alarm comprising a sounder/vibration motor 14 and an LED 30 are driven by decisions made by software 51 running in the microprocessor 49. The LED 30 is used to alert wearer that the device is functioning properly and also to alert that exercise over at least one period has not been cycled. This is achieved by changing the LED flash pattern. A battery 50 provides power to the device.

[0048] The flow chart in Figure shows how the device in FIG. 5 might operate.

1. A device for monitoring the activity of a user, comprising a carrier for positioning adjacent a user, a motion sensor mounted on the carrier and adapted to detect the user performing a predefined type or amount of motion, a timer connected to the motion sensor so as to be reset should the predefined motion be detected, and an alarm connected to the timer for triggering thereby, should the timer count a preset time period without being reset.

2. A device as claimed in claim 1, in which the timer and alarm are also mounted on the carrier.

3. A device as claimed in claim 1 or claim 2, in which the carrier includes attachment means to permit removable attachment of the device to a user.

4. A device as claimed in claim 3, in which the attachment means comprise a strap that passes around a limb of a user.

5. A device as claimed in claim 4, in which the strap is elasticated and is passed over the extremity of a limb.

6. A device as claimed in claim 4, in which the strap is in two parts each part being provided with one part of a two part hook and loop fastener, and is attached around the limb.

7. A device as claimed in any of the preceding claims, in which the type of predetermined motion that the motion sensor is adapted to detect, and consequently reset the timer, may be adjusted.

8. A device as claimed in any of the preceding claims, in which the preset time period that the timer counts to before operating the alarm is adjustable.

9. A device as claimed in any of the preceding claims, in which the alarm includes at least one of an audible signal generator, a light source, and a vibrator.

10. A device as claimed in any of the preceding claims, in which the device includes a controller adapted to receive information from the timer and the motion sensor and to operate the alarm in response thereto.

11. A device as claimed in any of the preceding claims, in which the sensor can detect predetermined patterns of movement over a time frame and will reset the timer only in response to a completed pattern.

12. A device as claimed in any of the preceding claims, which also includes means for transmitting and receiving data which allow the device to be remotely monitored and/or controlled.

13. A device as claimed in any of the preceding claims, in which the timer, motion sensor, and alarm are included in or are controlled by a suitably programmed microcontroller.

14. A device as claimed in any of the preceding claims, in which the carrier comprises a container formed from plastics material within which the timer, motion sensor, alarm, and controller if present, are located.

15. A device as claimed in claim 1, in which the carrier comprises a mattress and the sensor is therein to monitor the activity of a person lying thereon, and the alarm is located remotely from the mattress.

16. A device as claimed in any of the claims 1 to 14, which is adapted for attachment to a leg of a passenger on a transportation vehicle, and the type of predetermined motion and the preset time period of the timer are set so that the alarm is triggered if the leg is not exercised often enough to reduce the risk of deep vein thrombosis.

17. A device as claimed in any of claims 1 to 14, which is adapted for attachment to a leg of a vehicle driver or to a pedal operated by a leg of the driver, and the type of predetermined motion and the preset time period of the timer are set so that the alarm is triggered if pedal is not operated by the driver’s leg.

18. A device as claimed in any of claims 1 to 14, adapted for attachment to person exercising, in which the type of predetermined motion is set to the pattern generated by the correct completion of a specified exercise routine, and the preset time period of the timer is set so that the alarm is triggered if the exercise is not correctly performed by the person wearing the device.

19. A device as claimed in any of claims 1 to 14, which is adapted for attachment to an athlete and monitors and records movement data for later analysis.

20. A device as claimed in any of claims 1 to 14, in which the device is adapted to be attached to the legs of an animal such as a racehorse, whereby monitoring of the movement of the legs is achieved by remote transmission of data from the device to a recorder on the saddle or other remote location.

21. A device as claimed in claim 20, in which the device is adapted to be mounted on the back of the animal.

22. A device as claimed in any of the preceding, in which the device is controlled by a microcomputer embedded in the carrier, which microcomputer is reprogrammable to allow for multiple uses of the device.