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(54) HEART PULSE DETECTOR WITH SPEED CONTROL FOR TREADMILL

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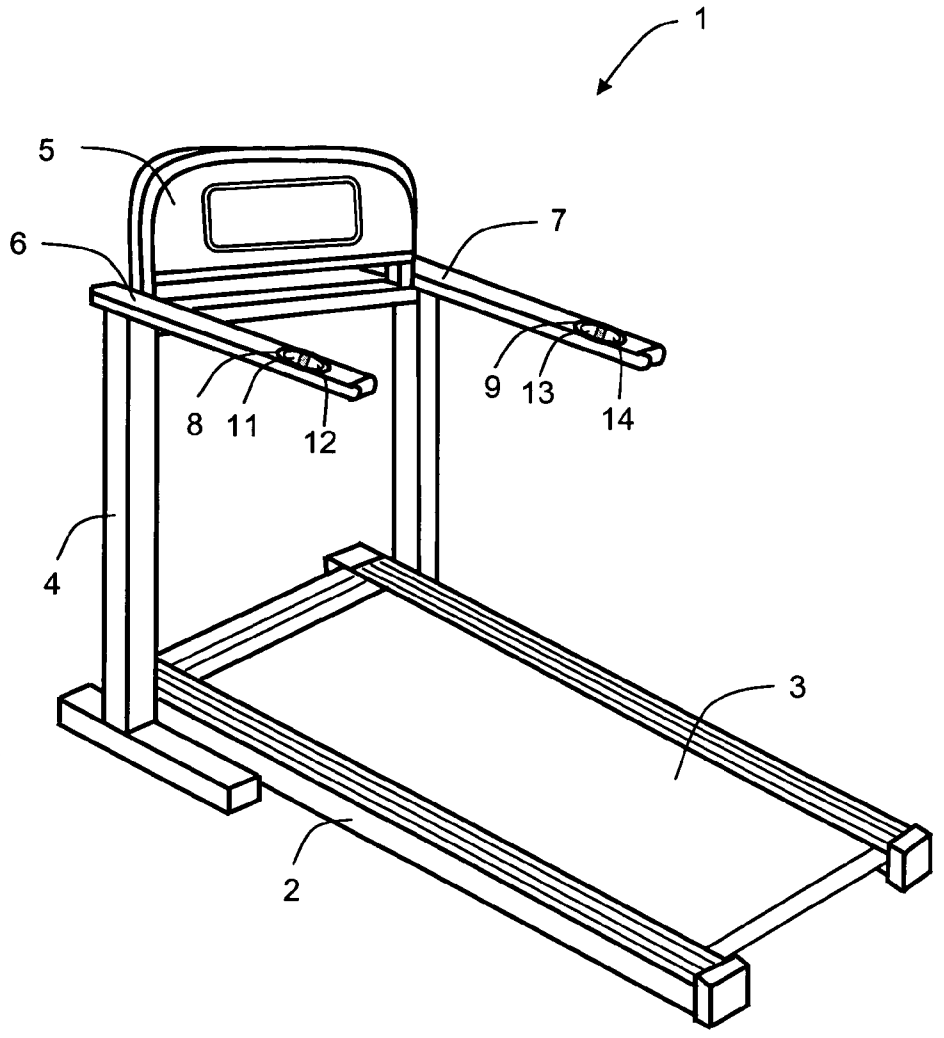
(57) **ABSTRACT**

The present invention offers a heart pulse detector. Two pairs of contact electrodes mounted on each handrail of treadmill separately. A electrocardiography heart pulse detector built in the control panel of the treadmill has input terminal which electrically connected to the contact electrodes. A front end circuit within the heart pulse detector receives the electrical cardio signals of a user from the input terminal and preprocesses the electrical cardio signals for later processing by the reminder functional blocks of the heart pulse detector. A hand touching detection circuit assembly in the heart pulse detector is also connected to the input terminal. The hand touching detection circuit sense the signals from the input terminal and send out hand on/off data for using to control the speed of the treadmill and to control the operation of the heart pulse detection.



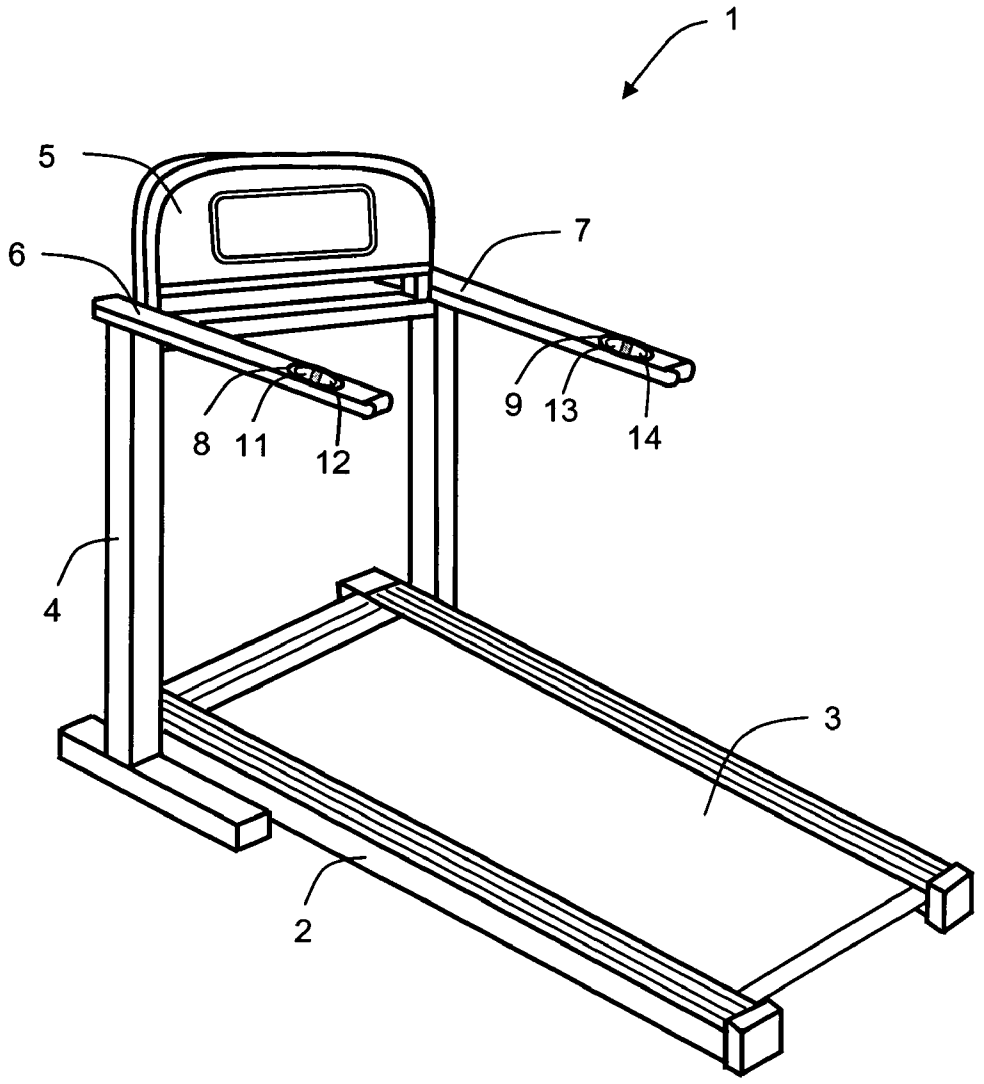


FIG. 1

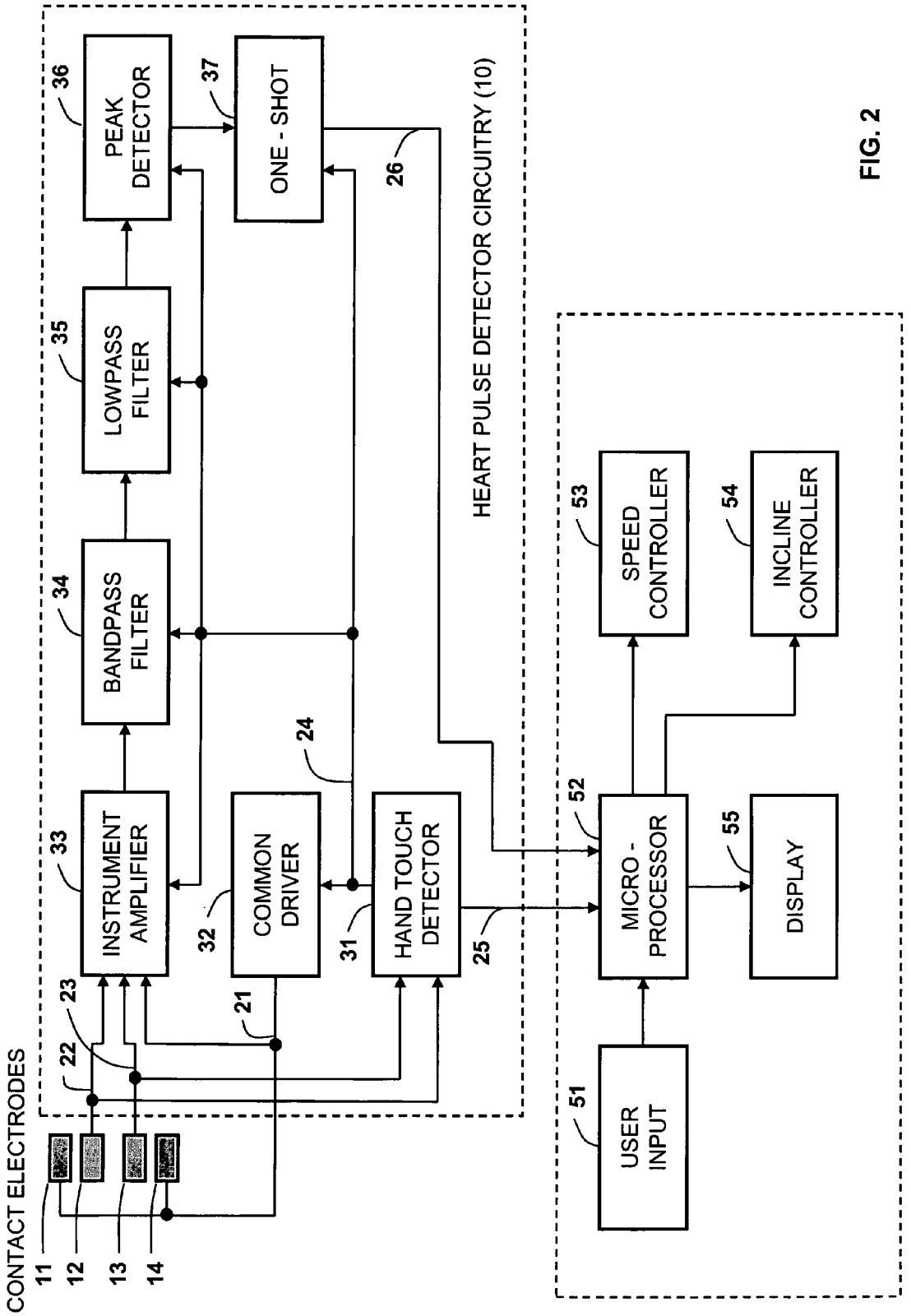

CONTACT ELECTRODES
11
12
13
14
22
23
21
HEART PULSE DETECTOR CIRCUITRY (10)
INSTRUMENT AMPLIFIER
33
BANDPASS FILTER
34
LOWPASS FILTER
35
PEAK DETECTOR
36
ONE - SHOT
37
26
COMMON DRIVER
32
24
HAND TOUCH DETECTOR
31
25
MICRO - PROCESSOR
52
SPEED CONTROLLER
53
INCLINE CONTROLLER
54
DISPLAY
55
USER INPUT
51

FIG. 2

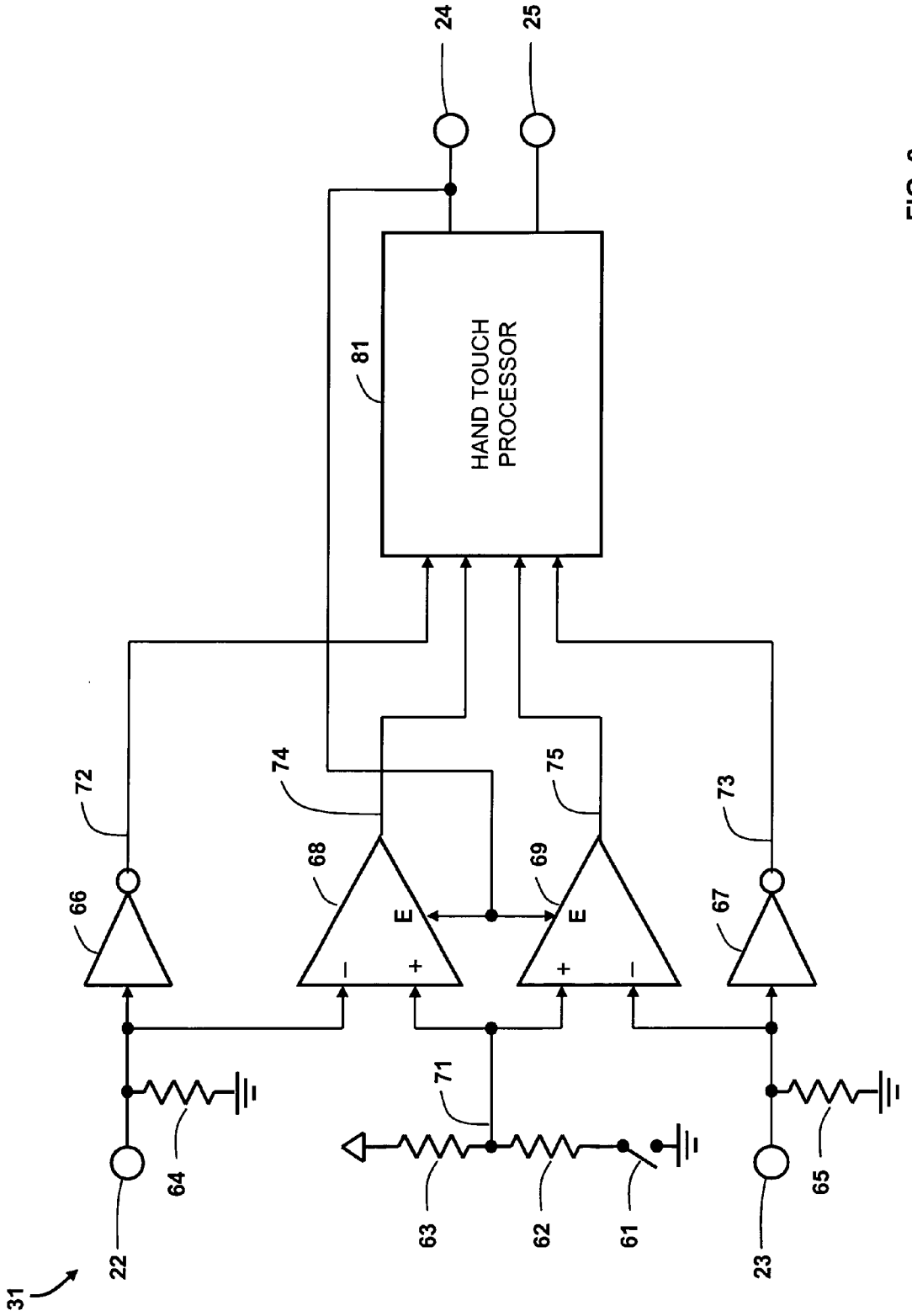

24
25
HAND TOUCH PROCESSOR
81
72
74
75
73
68
69
66
67
E
E
71
64
65
63
62
61
22
23
31

FIG. 3

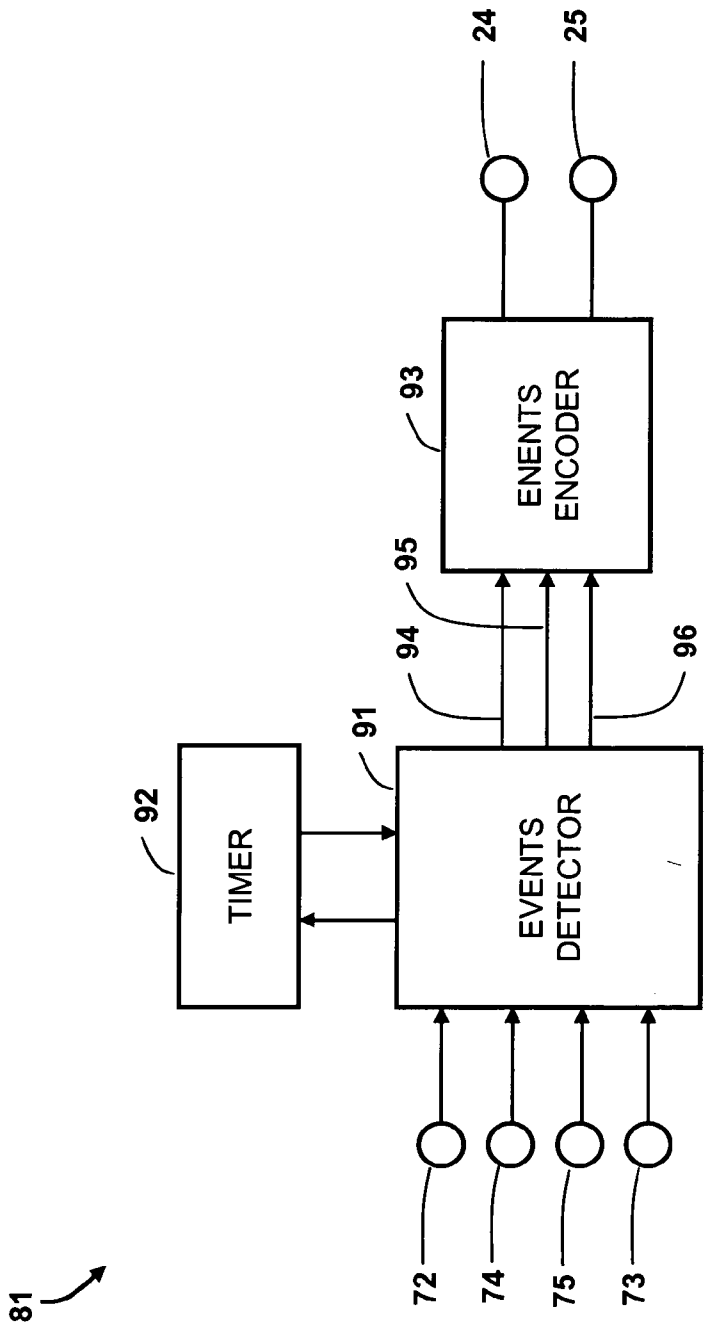

81
72
74
75
73
TIMER
92
EVENTS DETECTOR
91
94
95
96
ENENTS ENCODER
93
24
25

FIG. 4

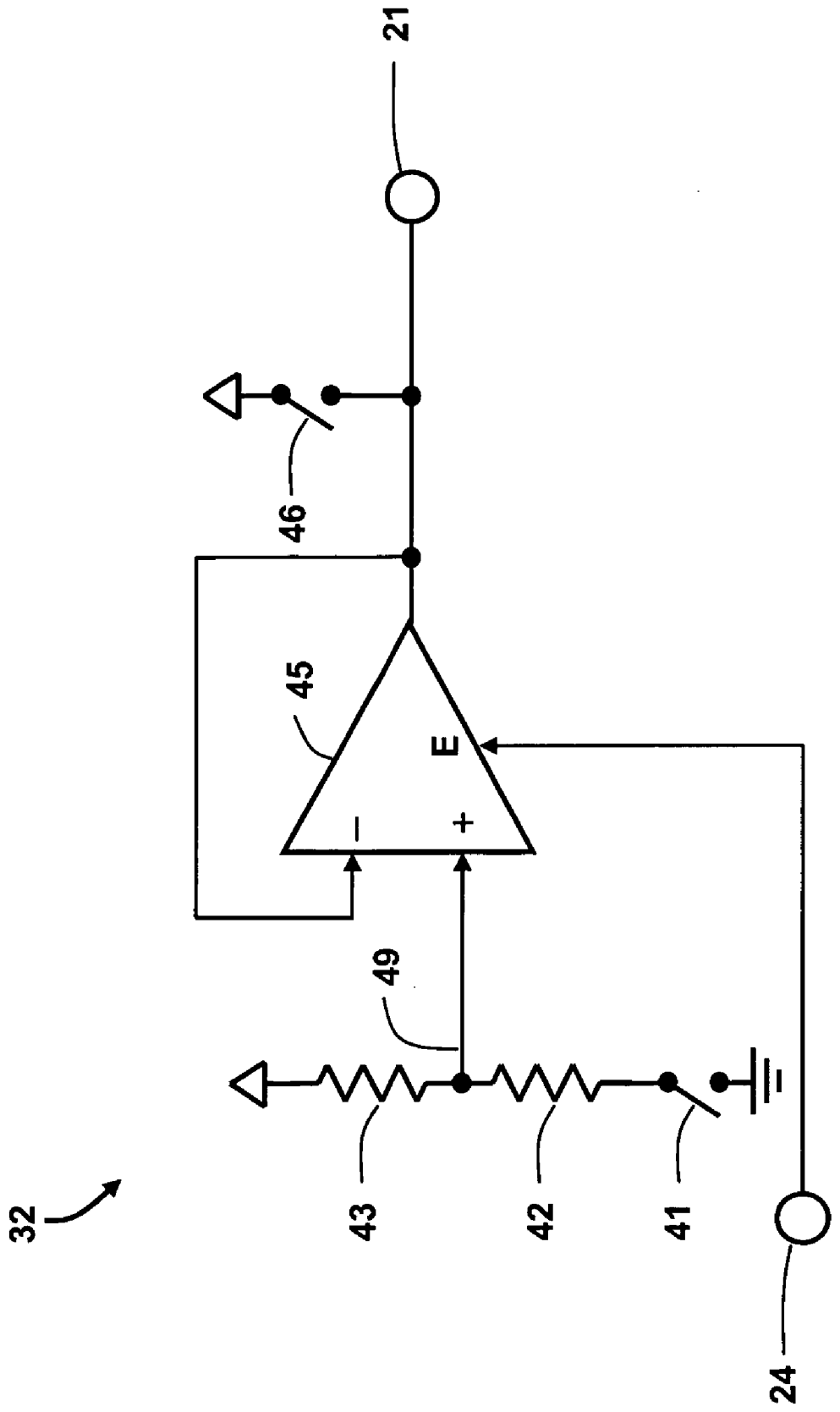


FIG. 5

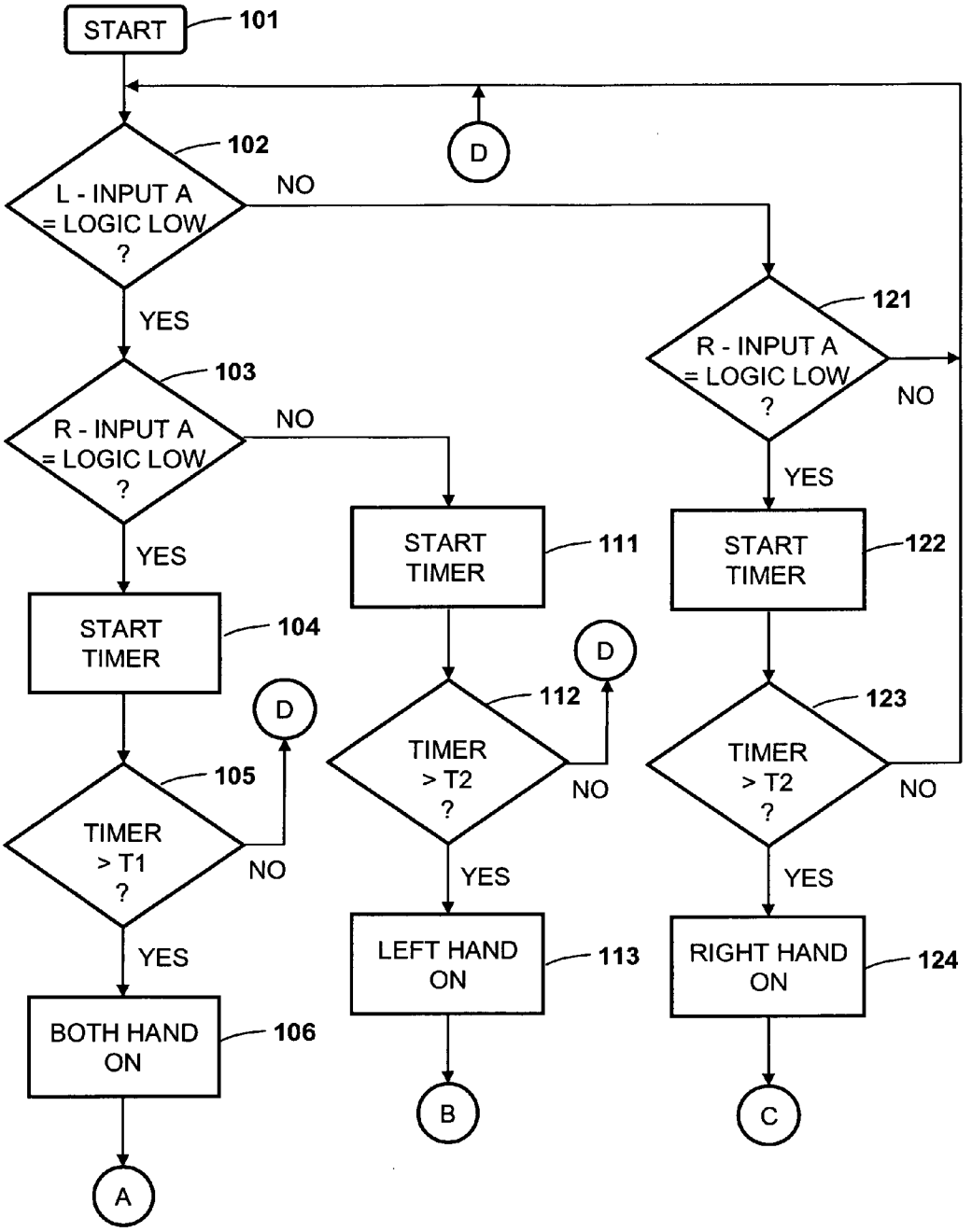

START
101
D
102
L - INPUT A = LOGIC LOW ?
NO
YES
121
R - INPUT A = LOGIC LOW ?
NO
YES
103
R - INPUT A = LOGIC LOW ?
NO
YES
START TIMER
111
START TIMER
122
START TIMER
104
D
D
112
123
TIMER > T2 ?
NO
TIMER > T2 ?
NO
105
TIMER > T1 ?
NO
YES
YES
YES
LEFT HAND ON
113
RIGHT HAND ON
124
BOTH HAND ON
106
B
C
A

FIG. 6A

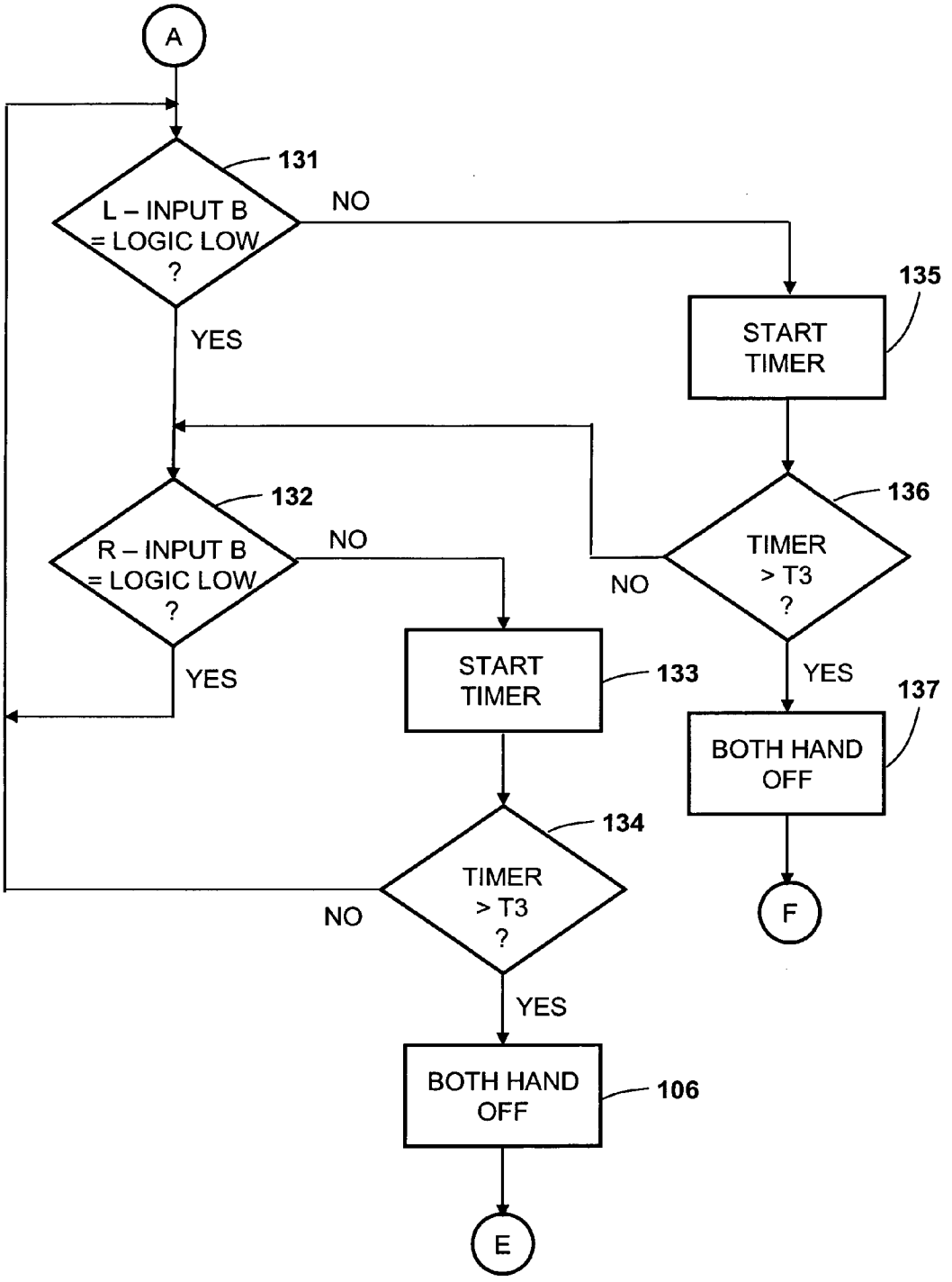

A
131
L – INPUT B = LOGIC LOW ?
NO
YES
135
START TIMER
132
R – INPUT B = LOGIC LOW ?
NO
YES
136
TIMER > T3 ?
NO
YES
START TIMER
133
137
BOTH HAND OFF
134
TIMER > T3 ?
NO
YES
F
BOTH HAND OFF
106
E

FIG. 6B

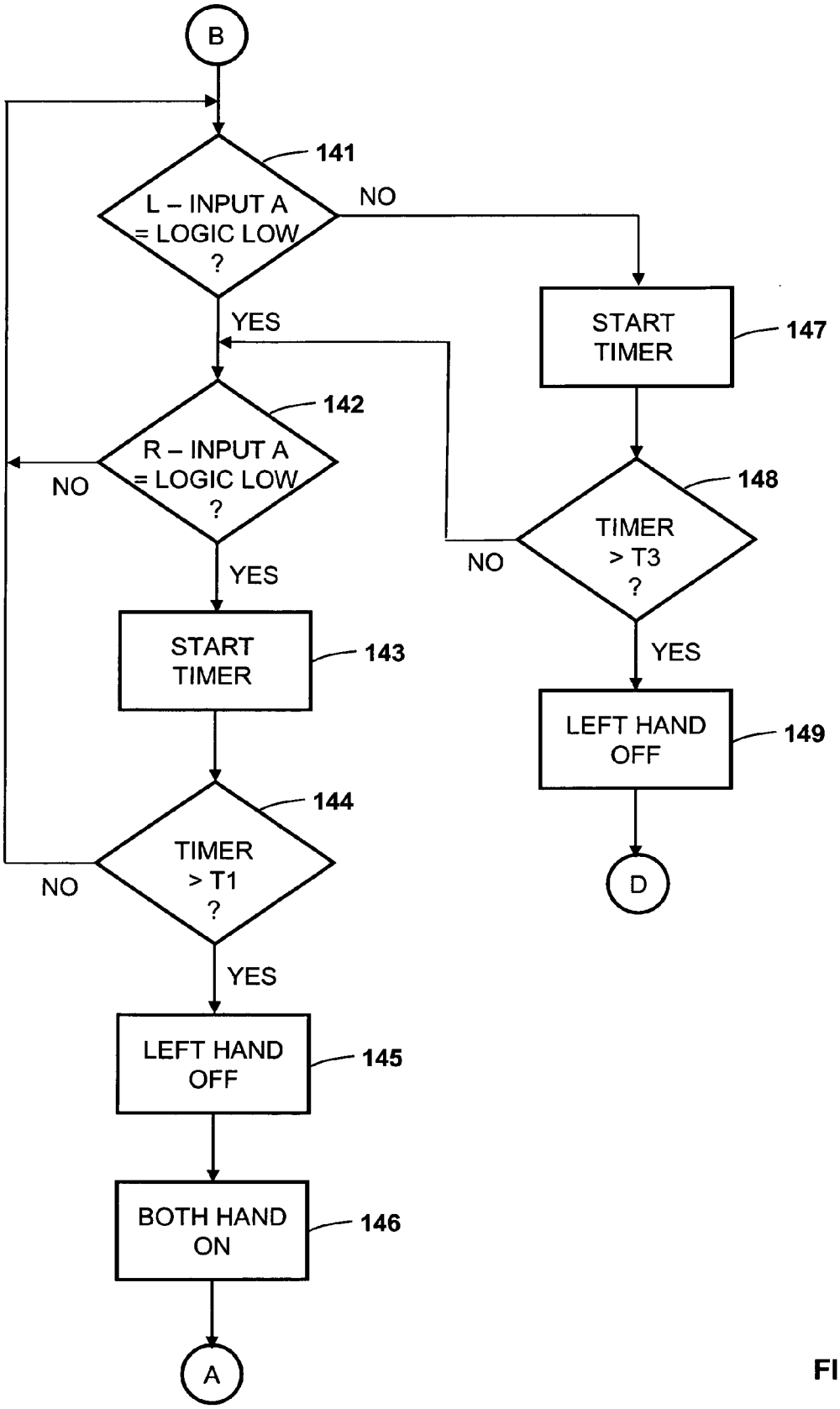

B
141
L – INPUT A = LOGIC LOW ?
NO
YES
START TIMER
147
142
R – INPUT A = LOGIC LOW ?
NO
YES
148
TIMER > T3 ?
NO
YES
START TIMER
143
LEFT HAND OFF
149
144
TIMER > T1 ?
NO
YES
D
LEFT HAND OFF
145
BOTH HAND ON
146
A

FIG. 6C

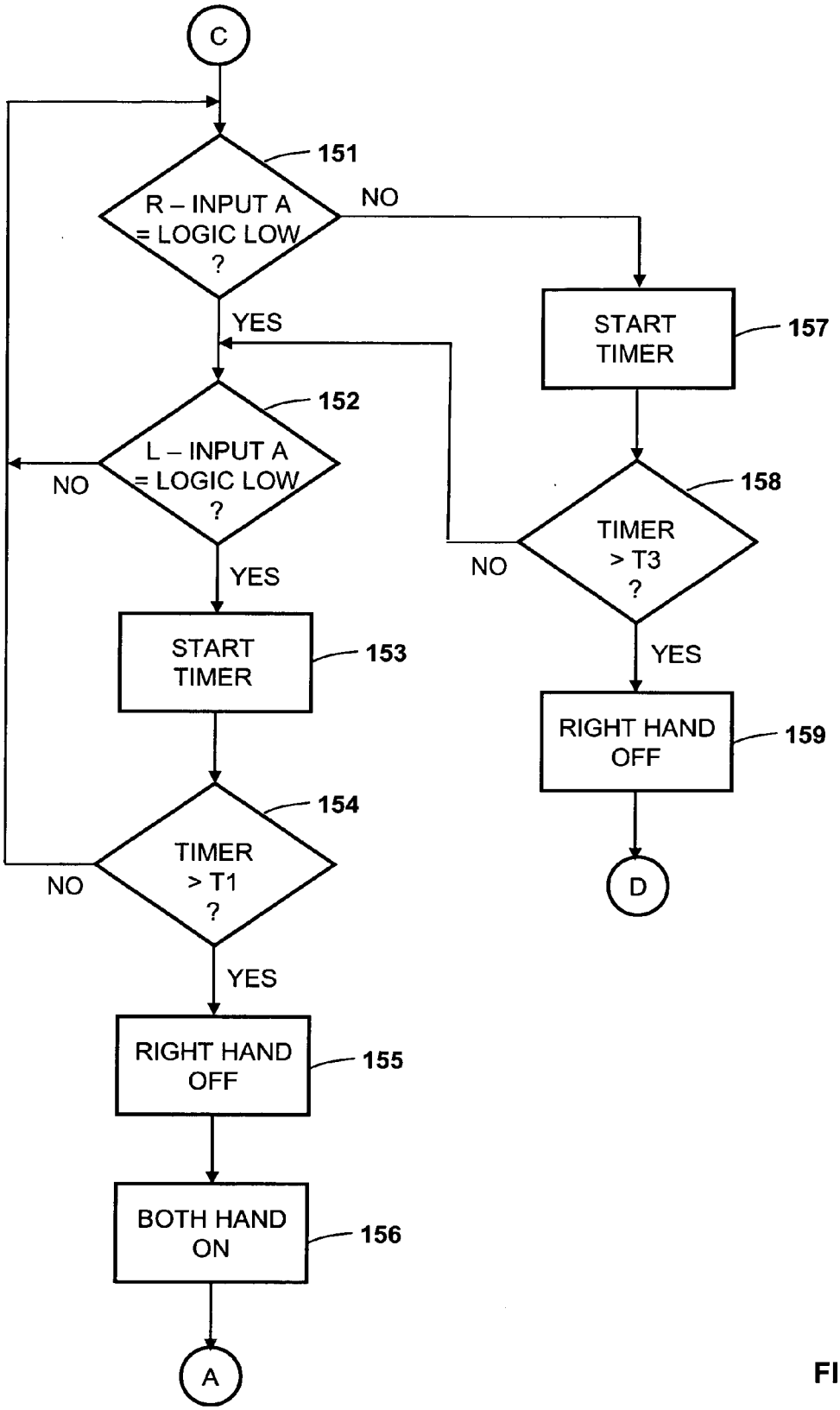

C
151
R – INPUT A = LOGIC LOW ?
NO
YES
START TIMER
157
152
L – INPUT A = LOGIC LOW ?
NO
YES
158
TIMER > T3 ?
NO
YES
START TIMER
153
RIGHT HAND OFF
159
D
154
TIMER > T1 ?
NO
YES
RIGHT HAND OFF
155
BOTH HAND ON
156
A

FIG. 6D

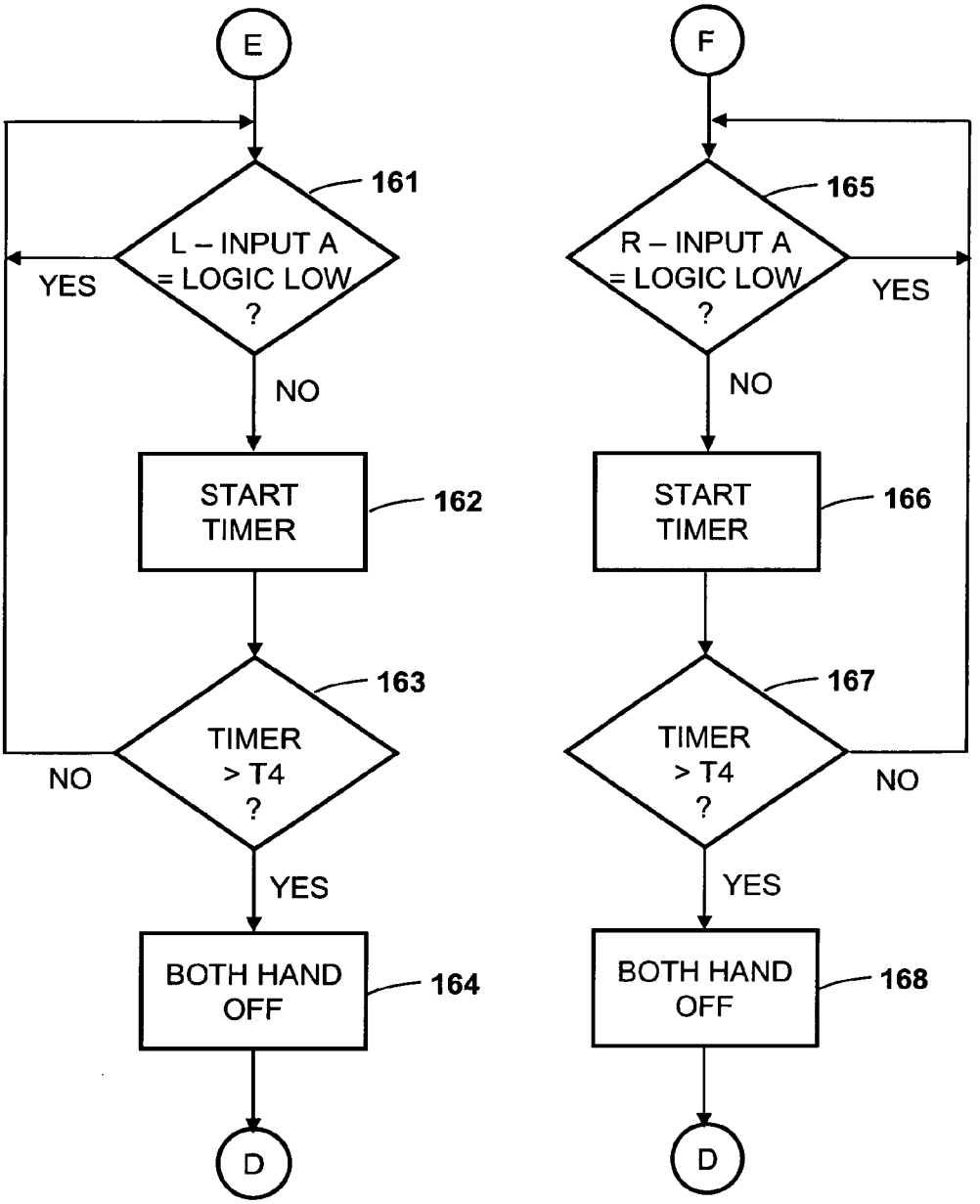

E
161
L – INPUT A = LOGIC LOW ?
YES
NO
START TIMER
162
163
TIMER > T4 ?
NO
YES
BOTH HAND OFF
164
D
F
165
R – INPUT A = LOGIC LOW ?
YES
NO
START TIMER
166
167
TIMER > T4 ?
NO
YES
BOTH HAND OFF
168
D

FIG. 6E

HEART PULSE DETECTOR WITH SPEED CONTROL FOR TREADMILL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a heart pulse detector, and more particularly to a heart pulse detector which detects a user's heart pulse signal as well as the touching action style of the user's hands via the same contact electrodes and outputs heart pulse data and hand touch signals for controlling the speed of a treadmill accordingly.

[0003] 2. Description of the Related Art

[0004] For electrical treadmill with electrocardiography heart pulse monitor needs contact electrodes which are usually mounted on the handrails of treadmill to derive the electrical cardio signals from the user when the hands of the user grasp or touch on the electrodes. In some cases, there may be circuits in the heart pulse monitor to sense the presence of the user's hands contacting with the electrodes and then to control the operation of functions of heart pulse monitor itself only.

[0005] For conventional electrical treadmill, there should have an extra apparatus to provide a user input means for user to input the commands to control the speed of the treadmill when the user is running or walking on it. There are varieties of user input apparatus for using to control the speed of a treadmill. For example, keypad or key switches are commonly user input apparatus for speed control of a treadmill. The technology is used in U.S. Pat. No. 6,830,541, to Wu, the system uses this technology consists of at least a movable switch mounted on an arm of the main flame and includes a holder secured on the arm. Some other examples are using different kind of sensors such as contact switch to sense the touching of user and control the speed of a treadmill. For example, the U.S. Pat. No. 6,761,688, to Chang, the system use one contact switch mounted on a corresponding one of the arms of the treadmill to cause an analog signal to control the speed. Some other sensors are using photoelectric device to sense the motion of hands of a user or the position of a user and generate commands to control the speed of treadmill. For example, the U.S. Pat. No. 6,135,924, to Gibbs, et al, the system use an optical sensor monitors the position of a user on the treadmill and automatically varies the speed of the treadmill. Some other sensors are using ultrasonic device to sense the motion of hands of user or the position of user and generate commands to control the speed of a treadmill. For example, the U.S. Pat. No. 6,719,668, to Huang, the system use two ultrasonic transmitter receiver units respectively installed in the upright support of the house flame at two sides. Another example is the U.S. Pat. No. 5,368,532, to Farnet, the system use sensors located below an upper run of the belt for sensing the position of a user, and a controller for controlling the speed of the belt in accordance with the position of the user relative to the sensors, causing the belt to accelerate, decelerate.

[0006] All extra apparatus mentioned above for speed control of treadmill increase the complexity of manufacture and then increase the cost of treadmill.

OBJECTS OF THE INVENTION

[0007] It is therefore an object of the invention to provide a heart pulse detector which detects a user's heart pulse signal as well as the touching action style of the user's hands via the same contact electrodes and outputs heart pulse data and hand touch signals for controlling the speed of a treadmill accordingly, thus simplify the manufacture of treadmill and save the cost of treadmill.

DISCLOSURE OF THE INVENTION

[0008] A first aspect of the present invention teaches a heart pulse detector used in a treadmill that including a base frame, a motor driven tread belt, a rightup frame with a left handrail and a right handrail, a control panel, the heart pulse detector including: A plurality of sensor on the left handrail and the right handrail for obtaining electro cardio signal from the user; An instrument amplifier for amplifying the electro cardio signal; A common circuit for providing a common reference voltage to the instrument amplifier; A heart pulse detector for detecting a heart pulse signal in response to the amplified electro cardio signal from the output of the instrument amplifier and for producing a digital pulse that is synchrony with the heart pulse signal and is transmitted to the microprocessor in the control panel for calculating the heart pulse rate of the user; A plurality of sensor comprising a first pair of contact electrodes and a second pair of contact electrodes; The first pair of contact electrodes comprising a first contact electrode and a second electrode mounted on the left handrail of the treadmill separately; The second pair of contact electrodes comprising a third contact electrode and a fourth electrode mounted on the right handrail of the treadmill separately; The first contact electrode and the third contact electrode being connected to the inputs of the instrument amplifier; The second contact electrode and the fourth electrode being connected to the output of the common circuit; A hand touch detection circuit for receiving the signals from the first contact electrode and the third contact electrode and for producing a plurality of hand touch signal to indicate whether the first pair of contact electrodes and/or the second pair of contact electrodes are touching with the hand of the user; A plurality of hand touch signal will be transmitted to the microprocessor in the control panel for performing the speed control of the treadmill; The common circuit will output a high level voltage when a plurality of hand touch signal indicate that the first pair of contact electrodes and second pair of contact electrodes are not touching with the hand of the user.

[0009] Another preferred embodiment of the present invention teaches a hand touch detection circuit consist a data encoder for converting a plurality of hand touch signal into a formatted serial data signal for transmitting to the microprocessor in the control panel for performing the speed control of the treadmill.

[0010] The hand touch detection circuit further consists: A first inverter for responding to the signal at the first contact electrode and providing a first left input signal; A first comparator for responding to the signal at the first contact electrode and providing a second left input signal; A second inverter for responding to the signal at the third contact electrode and providing a first right input signal; A second comparator for responding to the signal at the third contact electrode and providing a second right input signal; A circuit for providing reference voltage to the positive input of the first comparator and the positive input of the second comparator; A processor for responding to the first left input signal, the second left input signal, the first right input signal, the second right input signal and providing a first hand touch signal to indicate whether only the first pair of contact electrodes are touching with the hand of the user and providing a second first

hand touch signal to indicate whether only the second pair of contact electrodes are touching with the hand of the user and providing a third hand touch signal to indicate whether the first pair of contact electrodes and second pair of contact electrodes are touching with both hands of the user at the same time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The foregoing and other advantages of the invention will be more fully understood with reference to the description of the best embodiment and the drawing wherein:

[0012] FIG. **1** is a perspective view of a treadmill constructed according to the present invention.

[0013] FIG. **2** is a block diagram of the present invention.

[0014] FIG. **3** is a block diagram of hand touch detector of the present invention.

[0015] FIG. **4** is a block diagram of hand touch processor of hand touch detector of the present invention.

[0016] FIG. **5** is a block diagram of common driver of the present invention.

[0017] FIG. **6** is a flow chart illustrating the operation of hand touch processor of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] The foregoing and other advantages of the invention will be more fully understood with reference to the description of the best embodiment and the drawing as the following description.

[0019] The preferred embodiment of present invention is illustrated in FIGS. **1-6**.

[0020] As shown in FIG. **1**, a treadmill **1** comprises a bass frame **2** having a tread belt **3** which is driven by a motor mounted in the bass frame **2**. A pair of upright frame members **4** on the head side of the base frame **2** support a control panel **5** at an upper portion of the upright frame members **4**, a left handrail **6** and a right handrail **7** are mounted on a respective side thereby. A pair of contact electrodes **11**, **12** are mounted on the left handrail **6** by a holder **8**. Another pair of contact electrodes **13**, **14** are mounted on the right handrail **7** by a holder **9**.

[0021] Referring to FIG. **2**, a heart pulse detector circuitry **10** includes a hand touch detector **31**, a common driver **32**, an instrument amplifier **33**, a band-pass filter **34**, a low-pass filter **35**, a peak detector **36**, and a one-shot circuit block **37**.

[0022] The contact electrode **11** and the contact electrode **14** are electrically connected together to terminal **21** which is connected to the output of the common driver **32** and also is connected to the common input of the instrument amplifier **33**. The contact electrode **12** is electrically connected to terminal **22** which is connected to one of the inputs of the instrument amplifier **33** and also is connected to one of the inputs of the hand touch detector **31**. The contact electrode **13** is electrically connected to a terminal **23** which is connected to other input of the instrument amplifier **33** and is also connected to the other input of the hand touch detector **31**.

[0023] The detail circuits of the hand touch detector **31** are shown in FIG. **3**. The input of the hand touch detector **31** which connected to terminal **22** is connected to an input of inverter **66** and to a negative input of a comparator **68** and to one of the terminals of a resistor **64**. The other input of the hand touch detector **31** which connected to terminal **23** is connected to the input of an inverter **67** and to the negative input of a comparator **69** and to one of the terminals of a resistor **65**. The other terminal of both resistor **64** and resistor **65** are both connected to the ground. In order to keep high impedance at terminal **22** and terminal **23**, the prefer value of the resistor **64** and the resistor **65** is 10M ohm each. The positive inputs of the comparator **68** and the comparator **69** are both connected to a reference voltage terminal **71** which is derived from the resistor **62** and the resistor **63**. The output of the inverter **66** is connected to terminal **72** and is named as "L-INPUT A". The output of the inverter **67** is connected to terminal **73** and is named as "R-INPUT A". The output of the comparator **68** is connected to terminal **74** and is named as "L-INPUT B". The output of the comparator **69** is connected to terminal **75** and is named as "R-INPUT B". Terminals **72**, **73**, **74**, **75** are connected to the inputs of a hand touch processor **81**. One of the outputs of the hand touch processor **81** which connected to terminal **24** is used to control the operation of the heart pulse detection. The other output of the hand touch processor **81** which connected to terminal **25** is used to send out the data of events of hand touch for speed control of the treadmill.

[0024] As shown in FIG. **4**, the hand touch processor **81** includes an events detector **91**, a timer **92**, and an events encoder **93**. The events detector **91** analyze the input signals from terminals **72**, **73**, **74**, **75** and combine with the control of the operation of the timer **92**, then sent out the signals of events of hand touch through terminals **94**, **95**, **96** to the inputs of the events encoder **93**. Terminal **94** is the event signal of "BOTH HAND". Terminal **95** is the event signal of "LEFT HAND". Terminal **96** is the event signal of "RIGHT HAND". The detail operation of the events detector **91** is shown in FIG. **6** by a logic flow chart. One output of events encoder **93** come from buffer of terminal **94** and is connected to terminal **24**. The other output is encoded serial data of events of hand touch and is connected to terminal **25**. The prefer embodiment of events encoder **93** is a three bits Manchester code encoder. There are six event data and named as "LEFT HAND ON", "LEFT HAND OFF", "RIGHT HAND ON", "RIGHT HAND OFF", "BOTH HAND ON", and "BOTH HAND OFF". Referring to FIG. **2**, as the microprocessor **52** receives the data of events of hand touch from terminal **25**, then speed controller **53** or incline controller **54** will receives command sent by microprocessor **52** and the speed or incline of the treadmill is adjusted.

[0025] As shown in FIG. **5**, the common driver **32** is built by an operational amplifier **45**. The positive input of operational amplifier **45** is connected to a reference voltage terminal **49** which is derived from a resistor **42** and a resistor **43**. The output and the negative input of the operational amplifier **45** are connected together and are connected to a switch **46** and terminal **21**. The signal of terminal **24** controls the operation of the common driver **32**. When the state of terminal **24** is at logic low, switch **41** and the operational amplifier **45** are turn off and switch **46** is turn on, then a high level voltage is output to terminal **21**. When the state of terminal **24** is at logic high, switch **41** and operational amplifier **45** are turn on and switch **46** is turn off, then a level of half supply voltage (i.e. ½ VCC) is output to terminal **21**.

[0026] At the start of the heart pulse detector circuitry **10** after power on or function is enable, all the state of terminals **94**, **95**, **96** are set to off (logic low). So the state of terminal **24** is at logic low and the common driver **32** outputs a high level voltage to terminal **21**.

[0027] When all the contact electrodes **11**, **12**, **13**, **14** are not touched by user's hand, then the signals at terminals **22**, **23** are both at low voltage level. The states of terminal **72**, **73** are both at logic high, thus there is no state changed at terminals **94**, **95**, **96**.

[0028] When the contact electrodes **11**, **12** are touched by a user's hand, then a high level voltage is conducted to terminal **22** from terminal **21** through contact electrodes **11**, **12** and the user's hand. The state of terminal **72** is then changed to logic low and timer **92** is started by events detector **91**. As the user's hand keep in touch with contact electrodes **11**, **12** for period larger than a timing T2 (for example, 100 msec), then the state of terminal **95** is set to logic high and a "LEFT HAND ON" signal is sent out to terminal **25**. When the user's hand moves out the contact electrodes **11**, **12**, then signal on terminal **22** goes down to low voltage and the state of terminal **72** comes back to logic high. Timer **92** will be started again by events detector **91**. After a timing T3 (for example, 100 msec) has been passed, the state of terminal **95** is set to logic low and a "LEFT HAND OFF" signal is sent out to terminal **25**.

[0029] When the contact electrodes **13**, **14** are touched by the user's hand, then a high level voltage is conducted to terminal **23** from terminal **21** through contact electrodes **13**, **14** and the user's hand. The state of terminal **73** is then changed to logic low and the timer **92** is started by the events detector **91**. As the user's hand keep in touch with the contact electrodes **13**, **14** for a period larger than a timing T2 (for example, 100 msec), then the state of terminal **96** is set to logic high and a "RIGHT HAND ON" signal is sent out to terminal **25**. When the other user's hand touch on the contact electrodes **11**, **12** following, the state of terminal **72** now is changed to logic low, then the events detector **91** set the timer **92** start. As this state continue for a timing T1 (for example, 200 msec), the state of terminal **96** is set to logic low and a "RIGHT HAND OFF" signal is sent out to terminal **25**. Following, then both the state of terminals **94**, **24** are set to logic high and a "BOTH HAND ON" signal is sent out to terminal **25**.

[0030] Referring to FIG. **3**, as there is logic high state at terminal **24**, the switch **61** and the comparators **68**, **69** are turn on. The voltage at terminal **71** will be far below half of the supply voltage by let the value of resistor **63** far larger than the value of the resistor **62**. So both the state of terminals **74**, **75** is held at logic low when the voltages at terminals **22**, **23** are conducted to the level of half supply voltage. Then the states of terminals **94**, **24** are kept unchanged.

[0031] Referring to FIG. **2**, as the state of terminal **24** is at logic "high", all the functional blocks in the heart pulse detector **10** are turn on. The electrical cardio signals derived from the user's hands through the contact electrodes **11**, **12**, **13**, **14** are conducted to the inputs of the instrument amplifier **33** via terminals **21**, **22**, **23**. The output of the instrument amplifier **33** is connected to the input of the band-pass filter **34** which extracts the so call "R" wave signal from the electrical cardio signals. The output of band-pass filter **34** is connected to the input of the low-pass filter **35** which will filter out the noise whose frequency is higher than the "R" wave signal. The filtered "R" wave signal then come into the peak detector **36** and the peak signal of the "R" wave signal is picked out thereby. When the peak signal of the "R" wave signal is sent into the one-shot circuit **37**, a one-shot heart pulse signal is output to terminal **26** and input to the microprocessor **52**. After receives a sequence of one-shot heart pulse signals from terminal **26**, the microprocessor **52** will perform the processing and counting to calculate out the real heart pulse rate of the user and shows the result at display **55**.

[0032] When the user release one hand or both hands from the contact electrodes **11**, **12** or/and the contact electrodes **13**, **14** for a period longer than timing T4 (for example, 200 msec.), both the state of terminals **94**, **24** are set to logic high and a "BOTH HAND OFF" signal is sent out to terminal **25**. Then the function of heart pulse detection is turn off and the microprocessor **52** will stop the calculation of heart pulse rate of the user. As one of the user's hand continuing touches on the contact electrodes **11**, **12** or the contact electrodes **13**, **14**, the state of terminal **95** or terminal **96** is not changed and no more data of events of hand touch will be sent out to terminal **25**. Only when both of the user's hands are moved out from the contact electrodes **11**, **12**, **13**, **14**, the events detector **91** will go back to its initial state.

[0033] The heart pulse detector of the present invention can be used as a user input apparatus to control the speed of treadmill. It is also can be used as a user input device to change the operation mode of treadmill or to control incline angle of treadmill.

[0034] Although specific embodiments of the invention have been disclosed, it will be understood by those having skill in the art that minor changes can be made to the form and details of the specific embodiments disclosed herein, without departing from the scope of the invention. The embodiments presented above are for purposes of example only and are not to be taken to limit the scope of the appended claims.

What is claimed is:

1. A heart pulse detector used in a treadmill that including a base frame, a motor driven tread belt, a rightup frame with a left handrail and a right handrail, a control panel, the heart pulse detector comprising:

a plurality of sensor on the left handrail and the right handrail for obtaining electro cardio signal from the user;

an instrument amplifier for amplifying the electrocardio signal;

a common driver for providing a common reference voltage to said instrument amplifier;

a heart pulse detector for detecting a heart pulse signal in response to the amplified electro cardio signal from the output of said instrument amplifier and for producing a digital pulse that is synchrony with the heart pulse signal and is transmitted to the microprocessor in the control panel for calculating the heart pulse rate of the user;

said plurality of sensor comprising a first pair of contact electrodes and a second pair of contact electrodes;

said first pair of contact electrodes comprising a first contact electrode and a second electrode mounted on the left handrail of the treadmill separately;

said second pair of contact electrodes comprising a third contact electrode and a fourth electrode mounted on the right handrail of the treadmill separately;

said first contact electrode and said third contact electrode being connected to the inputs of said instrument amplifier;

said second contact electrode and said fourth electrode being connected to the output of said common driver;

a hand touch detection circuit for receiving the signals from said first contact electrode and said third contact electrode and for producing a plurality of hand touch signals to indicate whether said first pair of contact electrodes

and/or said second pair of contact electrodes are touching with the hand of the user;

said plurality of hand touch signal will be transmitted to the microprocessor in the control panel for performing the speed control of the treadmill;

said common driver will output a high level voltage when said plurality of hand touch signal indicate that said first pair of contact electrodes and/or said second pair of contact electrodes are not touching with the hand of the user.

2. The heart pulse detector as recited in claim **1**, wherein said hand touch detection circuit further comprises a data encoder for converting said plurality of hand touch signal into a formatted serial data signal for transmitting to the microprocessor in the control panel for performing the speed control of the treadmill.

3. The heart pulse detector as recited in claim **2**, wherein said hand touch detection circuit further comprises:

a first inverter for responding to the signal at said first contact electrode and providing a first left input signal;

a first comparator for responding to the signal at said first contact electrode and providing a second left input signal;

a second inverter for responding to the signal at said third contact electrode and providing a first right input signal;

a second comparator for responding to the signal at said third contact electrode and providing a second right input signal;

a circuit for providing reference voltage to the positive input of said first comparator and the positive input of said second comparator;

a processor for responding to said first left input signal, said second left input signal, said first right input signal, and said second right input signal, and providing a first hand touch signal to indicate whether only said first pair of contact electrodes are touching with hand of the user and providing a second first hand touch signal to indicate whether only said second pair of contact electrodes are touching with hand of the user and providing a third hand touch signal to indicate whether said first pair of contact electrodes and second pair of contact electrodes are touching with hands of the user at the same time.

4. The heart pulse detector as recited in claim **3**, wherein said processor further comprises a timer for generating a predetermined period of timing signal as a reference for processor itself.

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