

- [54] ELECTRONIC EXERCISE AID
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- [58] Field of Search ..... 272/57 R, DIG. 5, DIG. 6; 128/25, 2 N, 25 R; 340/279; 307/116

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[57] ABSTRACT

Apparatus for motivating a patient, in need of occupational therapy, to exercise his muscles. The invention is characterized in the use of an electrical transducer connected to a harness strapped to a joint of a patient such that as long as the patient induces back and forth joint movement, the transducer will generate an electrical signal which is applied to circuitry which indicates the amount of travel of the joint in both directions and will activate a signal if the correct amount of joint movement does not occur in the proper direction over a first time interval. If the failure to effect the desired movement persists for a second time interval, an electrical motivating appliance, such as a television receiver viewed by the patient, is deactivated.

- [56] **References Cited**
- UNITED STATES PATENTS
- 3,419,732 12/1968 Lanc ..... 307/116
- 3,794,968 2/1974 Hill ..... 340/279
- 3,796,208 3/1974 Bloice ..... 128/25
- 3,877,541 4/1975 Takeuchi et al. .... 340/279

8 Claims, 2 Drawing Figures

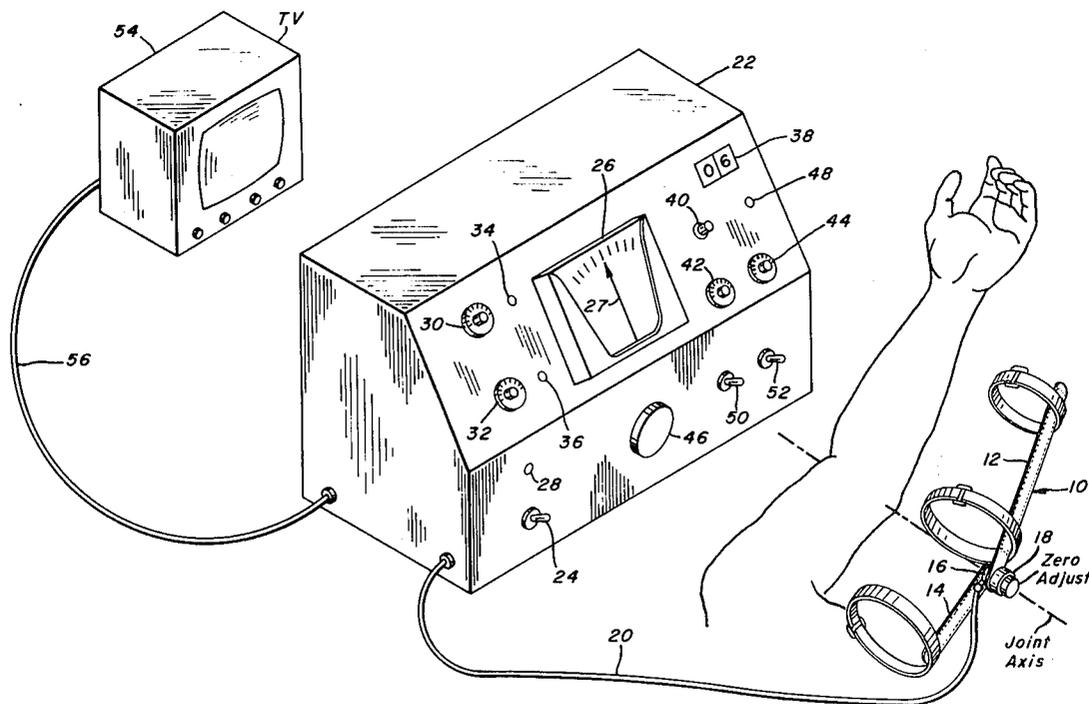
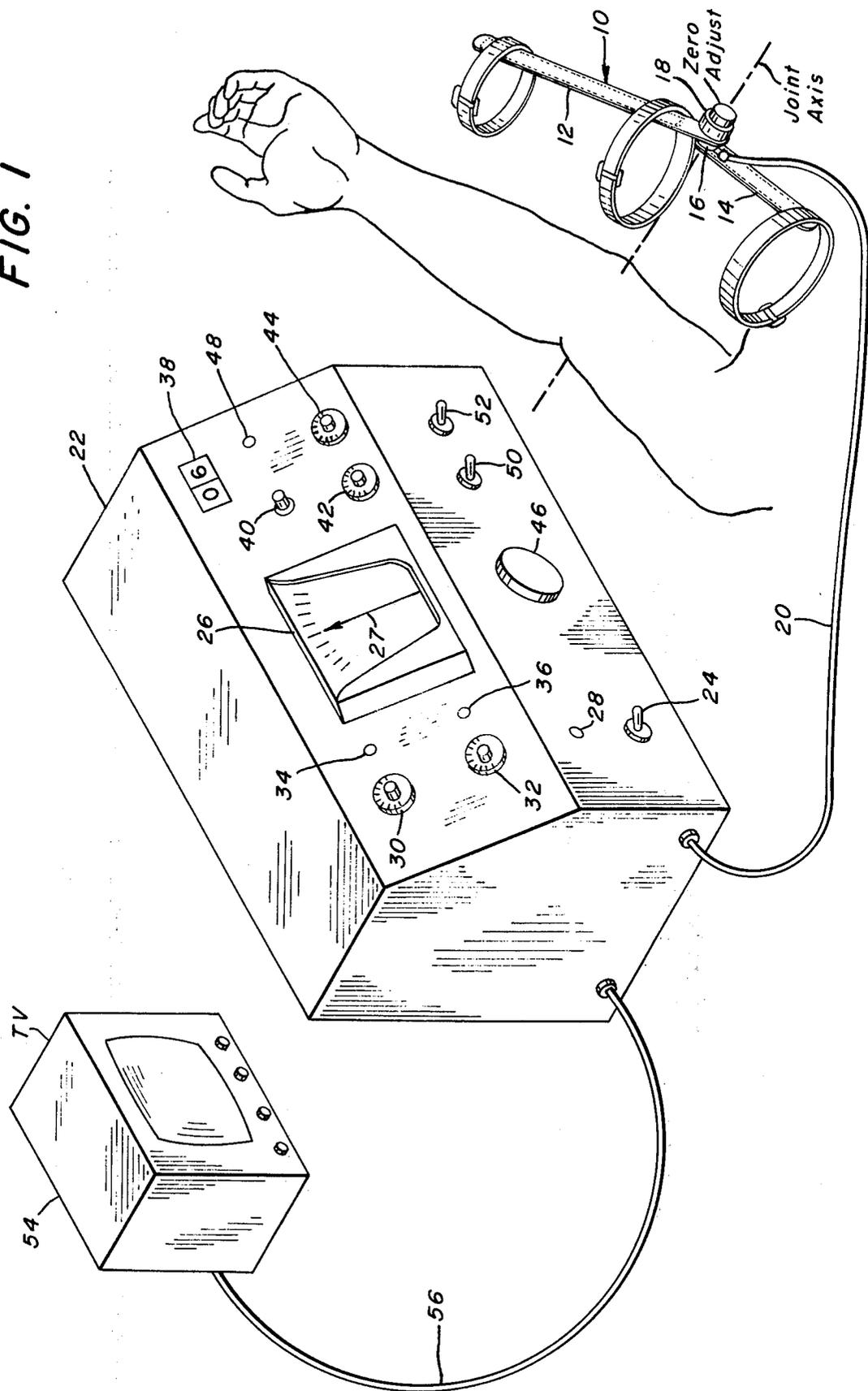


FIG. 1



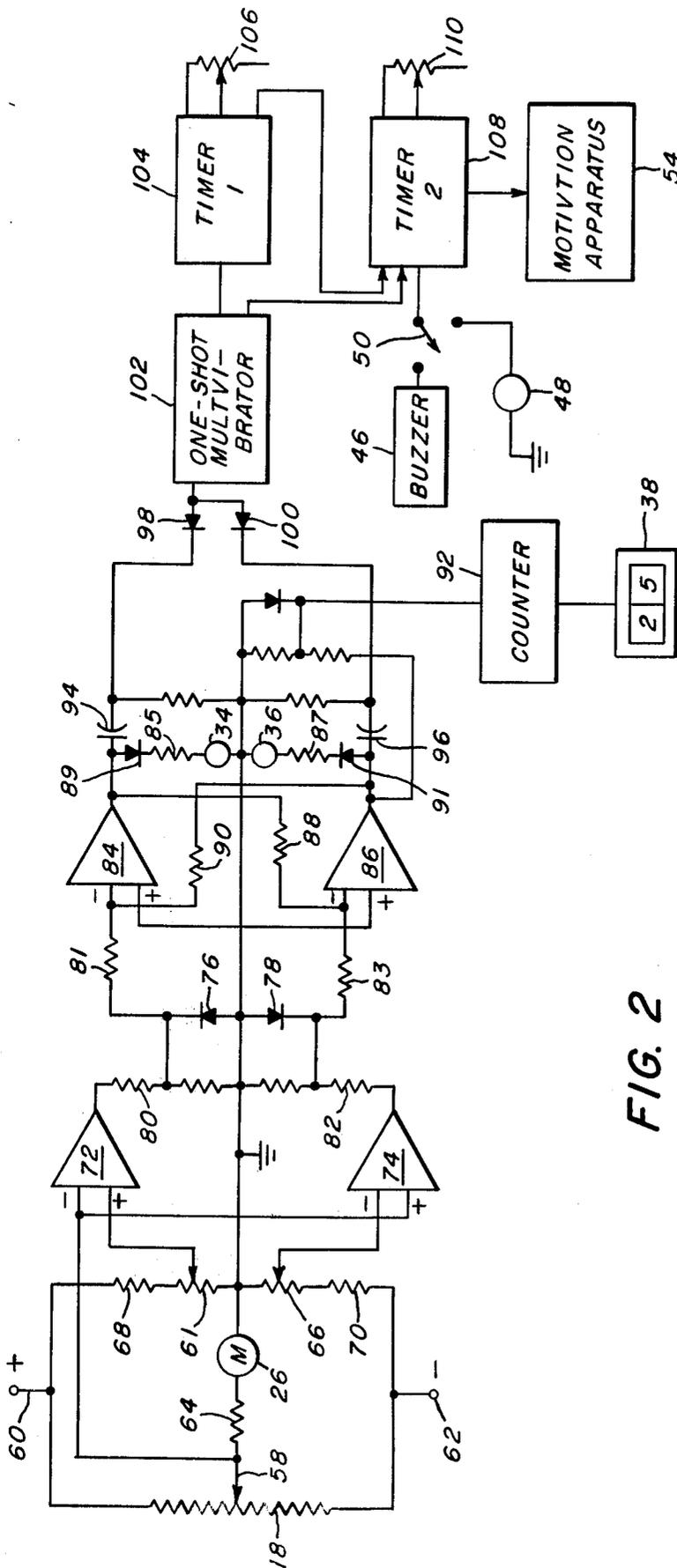


FIG. 2

## ELECTRONIC EXERCISE AID

## BACKGROUND OF THE INVENTION

In the field of occupational therapy, a problem often arises in motivating a patient to exercise his muscles which, in many cases, have been inactive and without exercise for extended periods of time. Occupational therapy is used, for example, in the rehabilitation of patients suffering from strokes, various types of paralysis, and muscular and orthopedic injuries. The exercise of a muscle after a long period of disuse or because of nerve damage (e.g., quadriplegia), is often difficult, boring and tedious to the patient who in many cases must be constantly reminded to continue the exercise. Various devices have been devised to assist the patient in continuing the exercise, one of which is described in U.S. Pat. No. 3,419,732 wherein electrical switch apparatus is operatively connected to exercising apparatus and is arranged to energize motivation apparatus such as a television set for as long as the exercising apparatus is operated correctly over predetermined time intervals.

A system such as that shown in the foregoing patent, while useful, is not entirely satisfactory and does not completely satisfy the requirements for a therapeutic motivation device.

## SUMMARY OF THE INVENTION

In accordance with the present invention, a new and improved therapeutic motivation apparatus is provided wherein the amount and direction of movement of a joint being exercised are indicated as well as whether the amount and direction of movement from a central, null position satisfy predetermined requirements. The required amount of movement in either direction can be adjusted by means of potentiometers and the attainment of this required movement is indicated by means of two light-emitting diodes, although other indicating devices could be used equally as well.

When the device is turned ON, a first timer is energized. If the required amount of movement from the central, null position in the correct direction is not achieved during this first time interval, a second timer is energized along with a buzzer which warns the patient that his motivation apparatus will be deactivated if he does not act quickly. At the end of the second time interval, the buzzer and the motivation apparatus such as a television set are deactivated. However, if the patient resumes the exercise and effects the proper amount of movement in the proper direction from the central, null position during the second time interval, the buzzer is deactivated and the motivation apparatus is not deenergized.

The above and other objects and features of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings which form a part of this specification, and in which:

FIG. 1 is a perspective view of the electronic exercise aid of the invention showing the manner in which a potentiometer may be strapped to a joint of a patient; and

FIG. 2 is a schematic circuit diagram of the motivation apparatus of the invention.

With reference now to the drawings, and particularly to FIG. 1, there is shown a harness 10 strapped, for example, to the elbow of a patient; although the har-

ness could be strapped to any joint on any body limb. It comprises a first harness part 12 strapped to the forearm and a second part 14 strapped to the upper part of the arm above the elbow. The two parts 12 and 14 are pivotally connected as at 16, the pivotal connection being adjacent the point of pivotal movement of the elbow. The pivot 16, in turn, is connected to a potentiometer 18 such that movement of the wiper element of the potentiometer 18 will be proportional to movement of the forearm about the elbow. The potentiometer 18 is connected through conductor 20 to circuitry, hereinafter described, carried within a console 22.

The console 22 has provided on its forward face an OFF-ON switch 24 together with a pilot light 28 which is energized when the power is ON. Also provided on the face of the console 22 is a meter 26 having a pointer 27 which normally assumes a central, null position. As will be seen, the pointer 27 will move to the right or left of the central, null position in an amount proportional to the amount of movement of the forearm about the elbow. A first pair of rheostats or potentiometers is provided having dials 30 and 32 which set the required amount of movement of the hand in either direction from the central, null position. As will be seen, when the required amount of movement in the right direction is achieved, light-emitting diode 34 will be energized and light-emitting diode 36 will be deenergized. When the required amount of movement in the opposite direction is effected, light-emitting diode 36 will be energized and light-emitting diode 34 will be deenergized. A counter is provided within the console and includes a read-out 38 which indicates the number of full cycles of the forearm back and forth about the pivot point 16. This counter may be reset by depressing a pushbutton 40.

Two timers are included within the console, and these are controlled by means of potentiometers having dials 42 and 44 which adjust, respectively, a first time period and a second time period as will hereinafter be explained. Assuming that the first time period expires without the proper amount of movement of the joint in one direction, a buzzer 46 or light-emitting diode 48 will be energized to indicate this condition. Either the buzzer 46 or light-emitting diode 48 may be used, depending upon the position of a switch 50 on the console. A final switch 52 is provided on the console for connecting a source of conventional alternating current power to the motivation device circuit. A motivation device such as a television set 54 is connected to the console 22 through a cable 56.

As was explained above, the operation of the system is such that if a second time period expires after the buzzer 46 or lamp 48 is energized, then the television set 54 or other motivation apparatus will be deenergized. It will be reactivated when the patient makes the required amount of movement in the right direction.

The invention will be better understood by reference to the circuit diagram of FIG. 2. The potentiometer 18 is provided with a movable wiper 58 connected to the pivot point 16 of the harness 10 such that its movement on either side of its central or null position will be proportional to the movement of the forearm about the elbow. Opposite ends of the potentiometer are connected to the positive and negative terminals 60 and 62 of a source of direct current potential, not shown. The movable tap 58 is connected through a resistor 64 and the meter 26, also shown in FIG. 1, to ground. The arrangement is such that as the movable wiper 58

moves back and forth, so also will the pointer 27 (FIG. 1) of the meter 26 to indicate the amount of movement on either side of the central, null position of the pivot 16.

Also connected between the terminals 60 and 62 is a voltage divider comprising potentiometers 61 and 66 in series with resistors 68 and 70. The movable taps on potentiometers 61 and 66 are connected to the negative and positive inputs, respectively, of two operational amplifiers 72 and 74. The positive and negative inputs of the operational amplifiers 72 and 74, in turn, are connected to the movable wiper 58 on potentiometer 18. With this arrangement, operational amplifier 72 will be triggered to produce an output when the wiper 58 moves in one direction from the central, null position by a predetermined amount; while operational amplifier 74 will be triggered to produce an output when the wiper moves in the opposite direction from the central, null position by a predetermined amount. The predetermined amounts by which the wiper brush must move from the central position is determined by the positions of the movable taps on potentiometers 61 and 66 and these, in turn, are controlled by the dials 30 and 32 shown on the console of FIG. 1.

The outputs of the operational amplifiers 72 and 74 are applied through resistors 80, 81 and 82, 83 to a flip-flop circuit comprised of two operational amplifiers 84 and 86. The output of operational amplifier 84 is connected through a resistor 88 to the input of amplifier 86 and, similarly, the output of amplifier 86 is connected to the input of amplifier 84 through a resistor 90. When an output is produced from amplifier 72, operational amplifier 84 is caused to produce an output and the output of amplifier 86 is caused to go to zero. This condition continues until the patient causes amplifier 74 to have an output at which time amplifier 86 is caused to have an output and the output of amplifier 86 is zero. Thus, the patient must attain the required extremes of movement alternately to generate the pulses which activate the timers and the counters. With this arrangement also, one pulse will be produced at the output of amplifier 86, for example, for every cycle of back and forth movement of the hand as shown in FIG. 1. These pulses, in turn, are applied to a counter 92, the count of which is displayed on read-out 38, also shown in FIG. 1.

When an output is produced from operational amplifier 84, the light-emitting diode 34 is energized through voltage dropping resistor 85 and protective diode 89; and whenever an output is produced from operational amplifier 86, the light-emitting diode 36 is energized through voltage dropping resistor 87 and protective diode 91, the two diodes 34 and 36 also being shown on the console of FIG. 1. The change in state of these diodes, therefore, indicates to the user whether or not the correct amount of back and forth movement has been achieved.

At the same time, the pulses at the outputs of operational amplifiers 84 and 86, which occur when amplifiers 72 and 74 are alternately energized, are applied through capacitors 94 and 96 and diodes 98 and 100 to a one-shot multivibrator 102 which produces pulses occurring each time the movable wiper 58 on potentiometer 18 moves alternately through a predetermined distance on either side of center as explained above. The pulses from one-shot multivibrator 102, in turn, are applied to initiate the timing period of a first timer 104 whose time interval can be adjusted by means of a

potentiometer 106 connected to the dial 42 on the console of FIG. 1. The timer 104 is such that each time a pulse is received before the end of its preset time interval  $T_1$ , the timer will be reset. However, if a pulse is not received during the time interval  $T_1$ , indicating that the hand has not attained the required movement in the opposite direction, then the timer 104 runs to the end of its time period and activates timer 108, the time interval of timer 108 being controlled by potentiometer 110 connected to the dial 44 shown in FIG. 1.

At the same time that the second timer 108 is activated, a signal is applied through switch 50, also shown in FIG. 1, to either buzzer 46 or the light-emitting diode 48 to indicate to the user that his hand has not made the required movement and that he has time  $T_2$  available to complete the movement. If the user completes the movement in time period  $T_2$ , the output of the one-shot multivibrator 102 resets both the timers 104 and 108 and deactivates the buzzer 46 or light-emitting diode 48. At the same time, the motivation apparatus such as the television set 54 will continue to be energized. On the other hand, if the exerciser does not complete the movement by the end of the period  $T_2$ , then the television set 54 is switched OFF. The user can only switch the television set back ON by again completing the movement so that a pulse is produced at the output of the one-shot multivibrator 102 to initiate the  $T_1$  and  $T_2$  sequences over again.

It can be seen, therefore, that the present invention provides an electronic exercise aid wherein the user, when not properly exercising a joint, will lose the benefit of some type of enjoyable motivation apparatus. At the same time, the apparatus of the invention instantly indicates to the patient the amount of movement of the joint as well as whether the exercise is being performed properly prior to deactivation of the motivation apparatus.

Although the invention has been shown in connection with a certain specific embodiment, it will be readily apparent to those skilled in the art that various changes in form and arrangement of parts may be made to suit requirements without departing from the spirit and scope of the invention.

I claim as my invention:

1. Apparatus for motivating a patient in need of occupational therapy comprising a hinged device adapted to be operatively associated with a joint of a patient and having a transducer coupled thereto for producing an electrical signal which quantitatively increases on either side of a central, null position of the hinged device, first and second comparator devices for comparing said electrical signal with a pair of bias signals such that an output will be produced from each comparator device when said electrical signal equals or exceeds an associated bias signal upon movement of the hinged device in either direction from said central, null position, an electrically-operated motivation device, and means for deactivating said motivation device in the absence of an output from either of said comparator devices for a predetermined period of time.

2. The apparatus of claim 1 wherein said transducer comprises a potentiometer having a movable wiper element coupled to said hinged device so as to rotate with the hinged device.

3. The apparatus of claim 1 wherein said first and second comparator devices comprise operational amplifiers and including light-emitting diodes coupled to the outputs of said operational amplifiers for indicating

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the correct amount of movement of the hinged device in either direction from a central, null position.

4. The apparatus of claim 3 including a meter connected to said potentiometer for instantaneously indicating the amount of movement of said hinged device about said central, null position.

5. The apparatus of claim 1 wherein said means for deactivating said motivation device includes a first timer which will produce an output at the presence of an output from either one of said comparator devices over a predetermined time interval, and a second timer coupled to the output of said first timer.

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6. The apparatus of claim 5 wherein the time period of said second timer is initiated after the time period of the first timer expires, and including means for deactivating said motivation device at the expiration of the time period of said second timer.

7. The apparatus of claim 6 including means for selectively adjusting the time periods of both said first and second timers.

8. The apparatus of claim 6 including means for signaling expiration of the first time period and the start of said second time period.

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