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Description

The invention pertains to anti-theft devices and methods for consumer product racks.

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BACKGROUND OF THE INVENTION

A fundamental requirement of product display racks used in a retail environment is that they present the product in an aesthetically pleasing and readily accessible manner in order to promote product sales. However, in order to minimize loss of revenue due to shoplifting, the rack should also provide some means of indicating when products have been removed from the rack for the purpose of theft rather than for purchase.

Approaches to the problem of shoplifting from display racks include placing the product behind transparent barriers with apertures that are large enough for the human hand but too small to remove a product displayed in the rack. When a consumer chooses a product, he or she is required to request the aid of a salesperson to unlock the transparent barrier allowing removal of the product. The barrier may present an unacceptable aesthetic impression of the product which will result in lost sales. Also, requiring a customer to request assistance in choosing a product will also result in lost sales.

Often, transparent barriers are provided on display racks which allow stacked products to be removed one at a time from the bottom of the stack. The products are removable only through a slot or the like in the transparent barrier aligned with the bottom of the stack of products. Requiring products to be removed only one at a time clearly discourages multiple product purchases.

Other approaches display products on a rack with the products being captured by a slidable retainer or the like. If the slidable retainer is removed without proper authorization, an electrical circuit is interrupted and an alarm is sounded. Once again, this display rack requires intervention of a salesperson in order to deactivate the alarm system for legitimate product removal.

Therefore, product display racks which provide protection against shoplifting either present an intimidating display by enclosing the product in a protective barrier, or require the intervention of a salesperson to facilitate legitimate removal of product, or both. These anti-theft features combine to necessarily reduce product sales.

US-A-4108363 describes a vending machine which has a means for monitoring the weight of items within the vending machine. Removal of one or more items from the vending machine results in a change of weight, which is detected. The vending machine also has means for calculating the number of items removed corresponding to a detected change in weight. An alarm device is also described which may be sounded if a calculated number of items removed is greater than a predetermined limit. This document does not however disclose a means whereby the number of items removed is calculated separately from the detection of a weight change. In addition, this document does not disclose means whereby the calculations may be made over a predetermined time interval and alarms are generated where limits are over-reached within the time interval. There is also no disclosure of means for determining if swapping of items has occurred or the vending machine and/or the items within it have been disturbed.

The present invention seeks to avoid the above-identified failings by providing a display rack which detects theft while providing no physical barrier to product removal, and while requiring no sales-person intervention for legitimate product removal.

According to a first aspect of the present invention, a method of indicating removal of product units from a product unit rack is provided including the steps of: monitoring the weight of the rack; detecting changes in the weight; and calculating the number of product units corresponding to each of the changes detected; characterised by the further step of providing an indication of removal if the sum of the number calculated of product units is greater than a limit during a time period.

In addition, or alternatively, the present invention seeks to detect rack tampering such as the "swapping" of other products for product units in the rack in an attempt to defeat the system by providing a method of indicating disturbance of a product rack containing product units including the steps of:

monitoring the weight of the rack; and

detecting changes in the weight; characterised by the further steps of:

determining the number of weight changes which are less in magnitude than a weight change corresponding to removal of a product unit; and providing an indication of disturbance if the number determined is greater than a limit during a time period. Alternatively, the present invention provides a method of indicating disturbance of a product rack containing product units including the steps of: consecutively sampling the weight of the rack; and calculating differences between consecutive samples;

characterised by the further step of providing an indication of disturbance if a successive number of differences calculated, greater than a limit number, are each greater than a first threshold and less than a second threshold.

The present invention also provides a method of indicating theft of product units from a product unit rack including the steps of: monitoring the weight of the rack including the product units; detecting changes in the weight; calculating the number of product units removed corresponding to each of the changes detected; and providing a first indication of theft if the number calculated of product units removed is greater than a first limit; characterised by the further steps of: providing a second indication of theft if, during a first time period, the number calculated of product units removed is greater than a second limit; providing a third indication of theft if the number of consecutively detected weight changes, not corresponding to product unit removal, exceeds a third limit; and providing a fourth indication of theft if the number of detected weight changes, not corresponding to product unit removal, exceeds a fourth limit during a second time period. Alternatively, the present invention also provides a method of indicating unauthorised removal of product units from a product unit rack including the steps of: monitoring the weight of the rack; detecting a disturbance of the rack, according to the monitored weight; characterised by the further step of: separately calculating the number of product units removed from the rack, in response to the detection of a disturbance, corresponding to the difference in monitored weights before and after the disturbance; and providing an indication of unauthorised removal if the number calculated of product units removed from the rack is greater than a programmable limit.

In a second aspect, the present invention provides an anti-theft apparatus for use in a product unit rack, or the like comprising: a weight sensor for sensing the weight of the rack having product units therewith; means for detecting changes in the weight; means for calculating the number of product units removed from the rack for each detected change in the weight; and means for indicating theft if the calculated number for a given change is greater than a first limit; characterised in that there is further provided; means for calculating the sum of the numbers calculated of product units removed for a series of detected changes in the weight; and means for indicating theft if the sum is greater than a second limit during a time period.

Alternatively, the present invention provides an anti-theft apparatus for use in a product unit rack, or the like, including: means for measuring the weight of a group of product units; means for detecting changes in the weight; and means for calculating the number of product units removed from the group of product units for each of the changes detected according to the magnitude of each of the changes detected; characterised in that there is further provided: means for calculating the sum of the numbers calculated of product units for each of the changes detected occurring during a time period; and means for indicating theft if the sum is greater than a limit.

The present invention also provides an anti-theft apparatus for use in a product unit rack, or the like, including: means for measuring the weight of a group of product units; and means for detecting changes in the weight; characterised in that there is further provided: means for detecting the number of weight changes detected having magnitudes less than a predetermined value corresponding to removal of one product unit from the group of product units; and means for indicating product unit theft if the number detected is greater than a limit during a time period. Alternatively, the present invention provides an apparatus for detecting theft of product units from a group of product units characterised in that there is provided: means for sampling the weight of a group of product units at a substantially constant rate; means for calculating differences between successive weight samples; means for indicating theft of product units from the group of product units if the number of the differences calculated between successive weight samples exceeds a limit. Also the present invention provides an anti-theft apparatus for use in a product unit rack, or the like including: means for measuring the weight of a group of product units; and means for detecting disturbance of the group of product units, responsive to said means for measuring; characterised in that there is further provided: means for separately calculating the number of product units removed from the group of product units according to a difference between the measured weight of the group of product units before a detected disturbance and the measured weight of the group of product units after the detected disturbance, responsive to said means for detecting disturbance; and means for indicating theft if the number calculated of product units removed from the group of product units exceeds a limit.

The number of product units that must be removed in order to sound either the instantaneous or periodic alarm is variable, as are the time periods required for periodic removal and for detection of disturbances. Therefore, the present invention is applicable to retail environments having high sales volume or low sales volume by simply reprogramming the various limits.

The fact the rack of the present invention is alarmed at all can be made completely transparent to the consumer because no physical barriers appear between the consumer and the product. In addition, the product is not restrained in any way from removal by a legitimate consumer. Also, intervention of a sales

person is not required for the removal of products.

In addition to sounding a local alarm if removal of product units is detected in excess of the programmable limits, the present invention can also sound a remote alarm by wire or radio link. The invention also provides a local acknowledge tone when product units, less in number than the alarm limit, are removed from the rack. The local acknowledge tone notifies the customer that the display is monitored further discouraging theft. The acknowledge tone may be used in addition to or replaced by a synthesized voice which repeats a suitable salutation upon product removal. The local alarm and acknowledge tone or voice may be silenced so that only the remote alarm sounds.

The display rack can be used with a key lock switch which allows the theft prevention feature of the invention to be disabled for restocking of the rack. The key lock switch may also be used to place the display rack in a lock-up mode in which the display rack will cause an alarm if any disturbance of the rack is sensed. This serves to reduce employee theft during periods when a store is closed but employees are present. Finally, the key lock switch may be used to place the display rack in a normal operating mode.

The key lock switch may be replaced by, or used in addition to, a switch controllable by a real-time clock. The real-time clock controls the switch to modify the various programmable alarm limits, and to automatically place the system in the lock-up mode dependent upon time of day.

The present invention is also applicable to warehouse racks, such as palets and the like, upon which products are stored. The present invention allows such warehouse racks to be protected from product theft without providing expensive anti-theft measures such as lockable cages, and the like.

The present invention seeks to provide therefore a rack for consumer product units that reduces loss of revenue due to shoplifting or employee theft, but that does not discourage legitimate product purchases.

This invention also seeks to prevent consumer product theft from a product rack by monitoring the weight of the rack holding the consumer products, and by providing an indication, such as an alarm, that a number of product units, in excess of a programmable number of units, have been removed from the rack.

In addition, the present invention seeks to provide a consumer product rack that provides an indication, such as an alarm, that a number of product units, in excess of a programmable number of units, have been removed from the rack during a programmable time period.

The present invention also seeks to deter "swapping" of other merchandise for product units contained in a consumer product rack by providing an indication, such as an alarm, that the rack has been disturbed continuously for more than a programmable time period, or that the rack has experienced a number of disturbances, in excess of a programmable number of disturbances, during a programmable time period.

These and other objects, features and advantages of the present invention will be seen more clearly by reference to the following detailed specification and to the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an isometric view of a consumer product rack according to the present invention.

Fig. 2 is a partial sectional view of the base of the rack shown in Fig. 1, showing the mechanical details of a weight sensor used in the present invention.

Fig. 3 is a block diagram of the electrical schematic of the present invention.

Fig. 4A-4D are a flow chart detailing the computational steps of the theft detection routine of the present invention.

Fig. 5 is a flow chart of the computational steps of the alarm routine of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Fig. 1, a consumer product rack 10 according to the present invention is shown. Rack 10 includes a number of individual compartments 11, each compartment holding a plurality of consumer product units 12 such as, for example, cartons of cigarettes. While rack 10 of the preferred embodiment is a display rack intended for placement in a retail establishment, it will be understood that the present invention is equally applicable to other product racks, such as warehouse palets, and the like. Rack 10 rests on base 13 which is supported by a plurality of feet as shown in detail in Fig. 2.

Referring to Fig. 2, which is a sectional view of a portion of base 13, the detail of the placement of weight transducers used in the present invention is disclosed. Each transducer 16 is placed between a foot 17 and bracket 18. Bracket 18, in turn, is connected to base 13 by appropriate attachment means 19 such as screws or rivets.

In practice, a plurality of weight transducers 16 are placed at a plurality of points beneath base 13 so that the entire weight of rack 10 (Fig. 1) can be accurately sensed by the plurality of weight transducers. Each weight transducer is connected to the weight signal processing circuitry of the present invention (shown in detail in Fig. 3) by conductor 21 and connector 22.

Weight transducers 16 are preferably of the highly accurate vibrating wire-type which produce a voltage signal having a frequency which varies in proportion to the weight sensed by the transducer.

Referring to Fig. 3, the hardware embodiment of the present invention is shown. The invention uses a central processing unit (CPU) 31 to perform the calculations and to control the various input/output operations of the present invention. Processor 31 can be, for example, a type 8031 microcomputer available from Intel Corporation.

Connected to processor 31 are data bus 32 and address bus 33. Buses 32 and 33 allow processor 31 to communicate with the various other hardware components of the present invention. Processor 31 communicates with read only memory (ROM) 34 and random access memory (RAM) 36. ROM 34 is used to store the control program of the present invention shown in Figs. 4A-4D and 5, while RAM 36 is used as a scratch pad memory. ROM 34 can also store the synthesized voice of the acknowledge salutation. It should be noted that both ROM 34 and RAM 36 may be located within processor 31, such as, for example, in a type 8051 microcomputer available from Intel Corporation.

The individual weight sensors 16 are connected by conductors 21 to respective frequency counters 37 which, in turn are connected to data bus 32 and address bus 33. The individual frequency counters 37 count the frequency of the voltage produced by respective weight sensors 16, and produce a binary word indicative of sensed weight which is placed on data bus 32 when interrogated by processor 31 via address bus 33. A typical accumulation period for counters 37 is 0.25 seconds. At the end of a particular accumulation period, counters 37 are reset and a new count is begun. Although Fig. 3 shows only three sets of frequency counters and weight sensors, any number of sensors and counters can be used in the present invention. Frequency counters 37 can be, for example, type 8253 frequency counters manufactured by Intel Corporation.

Also connected to data bus 32 and address 33 is input/output controller 38 which can be, for example, a type 8155 controller available from Intel Corporation. Controller 38 is connected to ganged switches S1 and S2 which allow a user of the system to program the system for a specific application. Details of this programmability will be discussed below.

Also connected to controller 38 is amplifier 39 which powers alarm speaker 41. Speaker 41 produces both a local acknowledge tone and a local alarm. Alternatively, a synthesized voice signal may be stored in ROM 34 and may be played instead of, or in addition to, the acknowledge tone. The volume of the acknowledge tone or voice is controlled by potentiometer 42, and the volume of the local alarm signal is controlled by potentiometer 43.

The tone and duration of the acknowledge signal and the local alarm are adjustable by use of potentiometers 45-48. One end of each potentiometers 45-48 is connected to a voltage source + V, and the other ends are grounded. The wiper of each potentiometer is connected to analog-to-digital converter 49 which, in turn, is connected to controller 38. Analog-to-digital converter 49 can be, for example, a type ADC0844 converter manufactured by National Semiconductor Corporation.

Three position key lock switch 50 is also connected to controller 38. When switch 50 is in a first position, the display rack is in a normal mode with all features active. In a second position, key lock switch 50 disables the theft prevention features of the present invention to allow restocking. Switch 50 can also be positioned in a third position which places the rack in a night lock-up mode. In the night lock-up mode, any disturbance of the rack will cause an alarm.

Processor 31 is also connected to data output bus 51 which can be used to drive a display or printer (not shown) for the purpose of monitoring the weight of the system or monitoring the disturbance activity or purchase activity of the system. Processor 31 is also connectable to remote alarms 52 through individual links 53. Alarms 52 can be located far from the product display rack for remote monitoring of the system. If desired, the local alarm can be reduced to zero volume and the product display rack can be monitored using only remote alarms 52. Once again, it will be understood that while only two alarms 52 are shown in Fig. 3, this disclosure is offered by way of example rather than limitation and any number of remote alarms may be used.

Links 53 are preferably wire or radio link. A preferred radio link may use, for example, a type D-24A transmitter 54 and a type D-67 receiver manufactured by linear electronics of Carlsbad, California. Since this preferred transmitter 54 is powered by an internal battery and sends a signal when its control contact is open, this allows an alarm signal to be sent to remote alarms 52 when the display rack becomes unpowered or if the connection between processor 31 and links 53 is severed. Links 53 can also be used to

actuate a video camera which will record activity in the vicinity of the protected rack.

If links 53 are wire, elements 54 in Fig. 3 can be appropriate line drivers.

Switch S1, S2 are used by a system operator to manually program various system parameters as described in detail below. The manual settings of switches S1 and S2 may be overridden by contacts within switch S3. Switch S3 is controlled by real-time clock 55. Clock 55, in combination with switch 53 allows one or more of the various parameters to be automatically programmable dependent upon time of day. Clock 55 and switch S3 can also be used to automatically place key-lock switch 50 in the lock-up mode, for example, when a store is closed.

Referring to Figs. 4A-4D, the individual processing steps of the present invention will be described. After the routine is started, the states of switches S1 and S2 are interrogated and parameters K0, K1, K2, K3 and K5 are set according to the following Tables:

TABLE I

K0: Weight Limit For Instability

<u>S1-7</u>	<u>Limit</u> (100ths of Units)
closed	30
open	40

TABLE II

K1: Instantaneous Removal Limit

<u>S1-1</u>	<u>S1-2</u>	<u>S1-3</u>	<u>No. of Product Units</u>
closed	closed	closed	1
open	closed	closed	2
closed	open	closed	3
open	open	closed	4
closed	closed	open	5
open	closed	open	6
closed	open	open	7
open	open	open	8

TABLE III

K2: Unstable Episode Limit

<u>S1-8</u>	<u>Limit</u>
closed	10
open	20

TABLE IV

K3: Periodic Removal Limit

<u>S1-4</u>	<u>S1-5</u>	<u>S1-6</u>	<u>No. of Product Units</u>
closed	closed	closed	3
open	closed	closed	4
closed	open	closed	5
open	open	closed	6

	closed	closed	open	7
	open	closed	open	8
5	closed	open	open	9
	open	open	open	10

TABLE V

K5: Time Period			
<u>S2-4</u>	<u>S2-5</u>	<u>S2-6</u>	<u>Time (min.)</u>
closed	closed	closed	1
open	closed	closed	2
closed	open	closed	3
open	open	closed	4
closed	closed	open	5
open	closed	open	6
closed	open	open	7
open	open	open	8

25 In the present embodiment, parameter K4, which is the periodic unstable episode limit is set equal to 5. However, this limit could also be programmable with the addition of additional switches.

The remaining switches (1-3 of S2) are used to designate the number of weight transducers on a particular display rack. This allows the same theft detection hardware to be applied to various sizes of racks using various numbers of weight transducers. Also, it allows the system to detect if a weight transducer has
30 been disconnected. The number of valid transducers is set according to the following Table.

TABLE VI

Valid Transducers				
35	<u>S2-1</u>	<u>S2-2</u>	<u>S2-3</u>	<u>Valid Tranducers</u>
	closed	closed	closed	tone test
	open	closed	closed	1
	closed	open	closed	1, 2
40	open	open	closed	1, 2, 3
	closed	closed	open	1, 2, 3, 4
	open	closed	open	1, 2, 3, 4, 5
45	closed	open	open	1, 2, 3, 4, 5, 6
50	open	open	open	invalid setting

When switches S2-1, S2-2 and S2-3 are all closed, the local alarm or voice is turned on thereby allowing the tone and volume to be set as described earlier. When switches S2-1, S2-2 and S2-3 are all
55 open, this state is ignored as an invalid setting. Therefore, according to the preferred embodiment, at least one and up to six weight transducers may be used. Once again, this should not be considered a limitation of the present invention. Additional transducers can be obviously accommodated by adding additional switches.

After the parameters are set by interrogation of switches S1 and S2 in block 56, control is transferred to block 57 where the first weight reading, WTRDG1, is taken. The weight is determined by interrogating the individual weight sensors 16 via frequency counters 37 (both shown in Fig. 3), and by summing the individual sensed weights. In this manner, the entire weight of the display rack is sensed. The units of variable WTRDG1 are in 100ths of product units. Therefore the actual weight sensed by sensors 16 must be multiplied by a predetermined factor in order to convert the actual sensed weight into a weight in 100ths of product units. If, when taking weight reading WTRDG1, the system detects weight signals are being produced by less than the number of transducers set by switches S2-1, S2-2 and S2-3 according to Table VI, an alarm is sounded.

Control is then transferred to block 58 where variables WTRDG2, WTRDG3 and PREWT are all set to WTRDG1.

The program then enters the main loop of the routine beginning with block 59 where, with operation identical to that of block 57, the weight WTRDG1 is again sensed, and it is determined if the number of transducers is less than that indicated by switches S2-1, S2-2 and S2-3 according to Table VI. Control is then transferred to block 61 where cycle counter CYCLCNT is incremented by 1 and counter OLDCYCL is set equal to counter CYCLCNT less K5.

Control is then transferred to motion detection decision blocks 62-64. In these decision blocks, the three stored weight readings WTRDG1, corresponding to the present weight, WTRDG2, corresponding to the last sensed weight, and WTRDG3, corresponding to the penultimate sensed weight, are each subtracted and the differences are compared with parameter K0. If the difference between any two of the sensed weights is greater than parameter K0, flag MOTFLAG1 is set equal to "1" in block 66. Otherwise, flag MOTFLAG1 is set equal to "0" in block 67. Control is then transferred to decision block 68 where the state of MOTFLAG1 is detected. If flag MOTFLAG1 was set in block 66, counter MOTCNT is incremented by 1 in block 69. Otherwise, counter MOTCNT is set to 0 in block 71, counter MOTCNT keeps track of the number of consecutive cycles wherein motion is detected.

The value of counter MOTCNT is compared with parameter K2 in decision block 72. If counter MOTCNT is greater than parameter K2, indicating that the number of consecutive unstable episodes is greater than the desired limit, control is transferred to block 73 where variable ALARM is set equal to "2", counter MOTCNT is reset in block 74 and the alarm is sounded in block 76 (processing steps described in detail with reference to Fig. 5). This ends the motion detection portion of the routine.

Control is then transferred to decision block 77 where detection of the number of product units removed is begun. In block 78, variable PREWT is set equal to the last sensed weight, WTRDG2, if MOTFLAG1 is equal to "1" and if flag MOTFLAG2 is equal to "0" as determined in decision block 77. In other words, decision block 77 determines if motion is detected during the present cycle when none was detected during the previous cycle.

Control is then transferred to decision block 79 where it is determined if no motion was detected during the present cycle, but that motion was detected during the previous cycle. This is accomplished in decision block 79 which interrogates flags MOTFLAG1 and MOTFLAG2. If true, control is transferred to block 81 where the integer number of product units removed is determined by the rounding formula shown. Using this formula, weights less than 0.49 units are rounded down, weights between 0.50 and 1.49 units are rounded to 1, and so forth. Control is then transferred to decision block 82 where it is determined if any product units were removed. If so, the local acknowledge tone is sounded, or the stored synthesized voice is played back, in block 83 and control is transferred to block 84 to determine if the number of product units removed is greater than parameter K1. In other words, block 84 determines if the detected number of units removed from the rack is greater than the instantaneous removal limit. If so, control is transferred to block 86 where variable ALARM is set equal to "1" and the alarm is sounded in block 87. This ends the instantaneous removal detection portion of the routine.

Control is then transferred to block 88 where the routine for determining the number of unstable episodes occurring during time period K5 is determined. In block 88, counter N is set equal to "0" and control is transferred to a loop beginning with block 89 where counter N is incremented.

In decision block 91, all entries in motion vector MOTPER(N) are discarded if the entries are greater than counter OLDCYCL. Motion vector MOTPER(N) is a time stamp vector in which the individual entries record the cycle number when motion was detected when that motion was determined not to be a removal of an integer number of product units.

By this means, only time stamps less than K5 old are retained in vector MOTPER(N). Counter N is incremented in block 93 and the checking loop is traversed until N equals 10. It should be emphasized that although only 10 time stamps are retained in vector MOTPER(N), this is once again by way of example only and not by way of limitation.

Control is then transferred to decision block 94 where if there has been no motion detected during the present cycle and if there was motion detected during the past cycle, and if the number of product units removed is less than 1, control is transferred to block 95 where counter N is set equal to "0". In the loop beginning with block 96, counter N is incremented and consecutive entries of vector MOTPER(N) are
 5 interrogated and determined if equal to 0 in block 97. When the first 0 element is detected, control is transferred to block 98 where the individual element of MOTPER(N) is set equal to the present cycle, CYCLCNT, in block 98 thereby recording a time stamp of the detected motion. The loop including block 97 is not exited unless a zero element is found in vector MOTPER(N), or unless the end of the vector is detected in decision block 99.

10 Control is then transferred to block 101 where counters Q and N are both set equal to "0" and another checking loop is entered. In this loop, counter N is incremented in block 102 and individual entries of vector MOTPER(N) are interrogated by decision block 103. If any entry is greater than 0, counter Q is incremented by 1 in block 104. The loop is retraced until the end of vector MOTPER(N) is detected in decision block 106. Thus, counter Q is set equal to the number of non-zero entries in motion vector MOTPER(N).

15 Control is then transferred to decision block 107 where it is determined if counter Q is greater than parameter K4. If so, control is transferred to block 108 where variable ALARM is set equal to "4" and the alarm is sounded in block 109. In other words, the alarm is sounded if counter Q indicates that there has been a number of unstable episodes greater than parameter K4 during a period set by parameter K5. This ends the periodic unstable episode detection portion of the routine.

20 Control is then transferred to block 111 where counter N is set equal to 0. Block 111 begins a routine which detects the number of product units removed during a time period set by parameter K5.

In block 112, counter N is incremented and a loop is started in which the individual entries of counter vector CNTREM(N) that are greater than counter OLDCYCL (as determined by decision block 113), are set equal to 0 in block 114. Count vector CNTREM(N), similar in format to motion vector MOTPER(N), is a time
 25 stamp vector in which the individual entries record the cycle number when each product unit was removed. The loop is retraced until all entries of vector CNTREM(N) have been interrogated as determined by decision block 116. After this loop, all entries of counter vector CNTREM(N) will be set to 0 if the counts are equal to counter OLDCYCL (i.e., older than time period K5). In decision block 117 it is determined if any product units have been removed by interrogation of counter CNTREM. If not, no further action is taken and
 30 control is transferred to block 118 (Fig. 4D). If true, control is transferred to block 119 where counter N is set equal to "0" and a loop is begun with block 121 where counter N is incremented.

In the loop beginning with block 121, count vector CNTREM(N) is interrogated for 0 entries in block 122, and counter CNTREM is compared with "0". If a zero entry is detected and if CNTREM is greater than zero, control is transferred to block 123 where the vector entry detected as 0 in block 122 is set equal to
 35 counter CYCLCNT, and counter CNTREM is decremented by 1. The interrogation loop is continued until decision block 124 determines that the last entry in count vector CNTREM(N) has been interrogated. As a result of this loop, time stamps equal to the present cycle count are entered into vector CNTREM(N) for each product unit removed. It should be noted that if more than one product unit is detected as being removed during a single cycle, several of the entries in count vector CNTREM(N) will have the same value.

40 Control is then transferred to block 126 where counter Q and N are both reset. In block 127, counter N is incremented and a loop is begun wherein the individual entries of counter vector CNTREM(N) are interrogated in decision block 128. For each non-zero entry in vector CNTREM(N), counter Q is incremented by 1 in block 129. The loop is retraced until decision block 131 determines that each element of vector CNTREM(N) has been interrogated. As a result of this loop, counter Q indicates the number of non-
 45 zero entries in count vector CNTREM(N).

In decision block 132, counter Q is compared with parameter K3 to determine if the periodic unit removal limit has been exceeded. If so, variable ALARM is set equal to "3" in block 133 and the alarm is sounded in block 134. Control is then transferred to block 118 where the flag MOTFLAG2 is updated as are weight readings WTRDG3 and WTRDG2. Control is then transferred back to block 136 (Fig. 4A) where the
 50 loop is once again begun.

Referring back to Fig. 4A, in block 136, which operates identically to block 56, the states of switches S1 and S2 are again sensed. This is in order to detect any changes in the states of switches S1 and S2 under action of switch S3 (Fig. 3).

55 Next decision blocks 137, 139 and 140 are used to detect the position of key-lock switch 50 (Fig. 3). If key-lock switch 50 is in the lock-up mode (or if switch S3 has placed key-lock switch 50 in the lock-up mode), block 137 directs control to block 138 where appropriate parameters are minimized in order to place the rack at its highest theft prevention sensitivity. Control is then transferred to block 59 where the entire loop is retraced.

If block 139 does not detect lock-up, control is transferred to block 138 where normal mode is detected. If key lock switch 50 is in the normal mode position, control is transferred to block 59, and the loop is retraced.

If block 139 decides key lock switch 50 is not in the normal mode, control is transferred to decision block 140 where, if key lock switch 50 is in the restock mode, block 136 is again reentered without retracing the main loop. Otherwise, the main loop is retraced by entering block 59.

Referring now to Fig. 5, the alarm routine will be described. In block 141, it is determined if variable ALARM is equal to "3" or "4". If not, control is transferred immediately to block 146. If so, counter N is reset in block 142, and a loop comprising blocks 143-145 is traversed a sufficient number of times to reset all entries of vectors CNTREM(N) and MOTPER(N). Then the alarm is sounded in block 146.

In summary, switches S2-2 and S2-3 are positioned by the user of the system as shown in Table VI to accommodate the number of weight transducers in the rack in use. Parameter K1, the instantaneous removal limit, is set by positioning switches S1-1, S1-2 and S1-3 as shown in Table II, and is variable from 1 to 8 product units.

Switches S1-4, S1-5 and S1-6 are used to set the number of product units which must be removed over a time period to cause an alarm. This is called the periodic removal limit, K3, and is adjustable from 3 to 10 product units as shown in Table IV. The time period, K5, for the periodic removal limit is set by positioning switches S2-4, S2-5 and S2-6, as shown in Table V. In addition, an alarm will sound if the display rack is disturbed continuously for a number of cycles settable by switch S1-8 (parameter K2) as shown in Table III. Finally, rack tampering or "swapping" of other merchandise for product units contained in the rack is detected if five unstable episodes (parameter K4) occur within the time period set by parameter K5.

The product rack will acknowledge removal of product units (when not in excess of an alarm limit) by an adjustable local tone or synthesized voice which can be set to zero volume. The separately adjustable local alarm tone can also be set to zero volume if local alarm is not desired. The alarm signal can be transmitted to a remote receiver, over wire or radio link, which will sound an alarm at a remote location. The local tones are both adjustable in volume, tone and duration.

A principal factor in determining how restrictive the various programmable alarm criteria for periodic removal should be is the extent to which legitimate purchases cause false alarms. This would of course occur during peak traffic hours. The following is a table displaying the results of a computer simulation which was based on the following assumptions:

1. During peak traffic hours, ten customers remove one product unit and five customers remove two product units for total sales of 20 product units during a peak hour.

2. The purchases occur at random times.

3. The predicted false alarm rate is the number of false alarms which would occur during 200 such peak hours.

TABLE VII

Predicted False Alarms Per 200 Peak Hours

40

Alarm Limit	Time Period K5							
K1	1	2	3	4	5	6	7	8
3	5	13	17					
4	5	12	17	29				
5	1	1	1	6	8	10	12	16
6	1	1	3	5	8	10	12	16
7	0	0	0	0	2	4	5	6
8	0	0	0	0	2	4	5	6
9	0	0	0	0	1	2	3	3
10	0	0	0	0	1	2	3	3

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It should be noted that odd numbered settings for the product unit alarm limit permit more restrictive settings without significantly higher incidence of false alarms. When time period and alarm limit settings are restricted to the lowest values which do not cause intolerable false alarm activity, the maximum protection against shoplifting is afforded. While theft of very few product units over an extended period of time may go undetected because this mimics plausible normal activity, the monetary loss of this type of theft is minimal.

Claims

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1. A method of indicating removal of product units (12) from a product unit rack (10) including the steps of:

monitoring the weight of the rack (58);
detecting changes in the weight (62-64); and
calculating the number of product units corresponding to each of the changes detected (81);
characterised by the further step of providing an indication of removal (134) if the sum of the number calculated of product units is greater than a limit during a time period.

2. A method of indicating disturbance of a product rack (10) containing product units (12) including the steps of:

monitoring the weight of the rack (58); and
detecting changes in the weight (62-64); characterised by the further steps of:
determining the number of weight changes (72) which are less in magnitude than a weight change corresponding to removal of a product unit; and
providing an indication of disturbance (109) if the number determined is greater than a limit during a time period.

3. A method of indicating disturbance of a product rack (10) containing product units (12) including the steps of:

consecutively sampling the weight of the rack (58); and
calculating differences between consecutive samples (62-64); characterised by the further step of providing an indication of disturbance (76) if a successive number of differences calculated, greater than a limit number, are each greater than a first threshold and less than a second threshold.

4. A method according to any one of claims 1 to 3, wherein the indication is an alarm (41;52).

5. A method according to claim 4, wherein the alarm is a local alarm (41) audible in the vicinity of said rack (10).

6. A method according to claim 4, wherein the alarm is a remote alarm (52) audible at a location remote from the rack (10).

7. A method according to claim 6, further comprising the step of:
transmitting the indication to the remote location over a wire (53).

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8. A method according to claim 6, further comprising the step of:
transmitting the indication to the remote location by radio link (53).

9. A method according to any one of claims 1 to 3, further comprising the steps of:
locking in a restock mode wherein at least said step of providing an indication is bypassed; and
locking in a normal mode wherein said step of providing an indication is performed.

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10. A method according to any one of claims 1 to 3, further comprising the step of:
locking in a lock-up mode wherein the limit or limit number is set to a predetermined minimum.

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11. A method according to claim 10 further comprising the step of:
selectively activating and deactivating said locking step.

12. A method according to claim 11, wherein said step of selectively activating and deactivating is controlled manually.
13. A method according to claim 11, wherein said step of selectively activating and deactivating is controlled automatically by a real-time clock (55).
14. A method according to claim 3, wherein the second threshold is a weight change corresponding to removal of a product unit.
15. A method of indicating theft of product units (12) from a product unit rack (10) including the steps of:
monitoring the weight (58) of the rack (10) including the product units (12);
detecting changes in the weight (62-64);
calculating the number of product units removed corresponding to each of the changes detected (81); and
providing a first indication of theft if the number calculated of product units removed is greater than a first limit (87); characterised by the further steps of:
providing a second indication of theft (134) if, during a first time period, the number calculated of product units removed is greater than a second limit;
providing a third indication of theft (76) if the number of consecutively detected weight changes, not corresponding to product unit removal, exceeds a third limit; and
providing a fourth indication of theft (109) if the number of detected weight changes, not corresponding to product unit removal, exceeds a fourth limit during a second time period.
16. A method according to claim 15 further comprising the step of:
generating an audible acknowledgement (83) if the number calculated of product units removed is greater than one and less than the first limit.
17. A method according to claim 16, wherein the acknowledgement is a tone.
18. A method according to claim 16, wherein the acknowledgement is a synthesized voice.
19. A method according to claim 15 further comprising the steps of:
sounding at least one alarm (41; 52) in response to the first, second, third or fourth indications of theft.
20. A method according to claim 19, wherein at least one of the at least one alarm is a remote alarm (52) audible at a location remote from the rack (10).
21. A method according to claim 19, wherein at least of the at least one alarm is a local alarm (41) audible in the vicinity of the rack.
22. A method according to claim 15 further comprising the steps of:
locking in a restock mode wherein said steps of monitoring, detecting and calculating, and said steps of providing the first, second, third and fourth indications are not performed; and
locking in a normal mode wherein said steps of monitoring, detecting and calculating, and said steps of providing the first, second, third and fourth indications of theft are performed.
23. A method according to claim 15 further comprising the step of:
locking in a lock-up mode wherein at least one of the first, second, third and fourth limits is set to a predetermined minimum.
24. A method according to claim 23, wherein said locking step is manually controllable by a rack operator.
25. A method according to claim 23, wherein said locking step is automatically controllable according to a time of a real-time clock (55).
26. A method of indicating unauthorised removal of product units (12) from a product unit rack (10) including the steps of:

- monitoring the weight (58) of the rack (10);
 detecting a disturbance of the rack (62-64), according to the monitored weight; characterised by the further step of:
 separately calculating the number of product units removed (81) from the rack, in response to the
 5 detection of a disturbance, corresponding to the difference in monitored weights before and after the disturbance; and
 providing an indication of unauthorised removal (87) if the number calculated of product units removed from the rack is greater than a programmable limit.
- 10 **27.** A method as claimed in claim 3, wherein the limit number is a programmable limit number.
- 28.** A method as claimed in either of claims 1 or 2, wherein the limit is a programmable limit and the time period is a programmable time period.
- 15 **29.** An anti-theft apparatus for use in a product unit rack (10), or the like comprising:
 a weight sensor (16) for sensing the weight of the rack (10) having product units (12) therewith;
 means for detecting changes in the weight;
 means for calculating the number of product units removed from the rack for each detected change
 in the weight; and
 20 means for indicating theft if the calculated number for a given change is greater than a first limit;
 characterised in that there is further provided;
 means for calculating the sum of the numbers calculated of product units removed for a series of detected changes in the weight; and
 means for indicating theft if the sum is greater than a second limit during a time period.
- 25 **30.** Apparatus according to claim 29, further comprising:
 means for locking (50) the rack in a first mode wherein each of said means for indicating theft is disabled, for locking the rack in a second mode wherein each of said means for indicating theft is enabled, and for locking the rack in a third mode wherein at least one of the first and second limits is
 30 set to a predetermined minimum.
- 31.** Apparatus according to claim 30, wherein said means for locking (50) is a key lock switch.
- 32.** Apparatus according to claim 29 further comprising:
 35 means for locking the rack in a mode wherein at least one of the first and second limits is set to a predetermined minimum.
- 33.** Apparatus according to claim 32, wherein said means for locking is a manual key lock switch.
- 40 **34.** Apparatus according to claim 30 further comprising:
 a real-time clock (55) for selectively activating and deactivating said means for locking (50) according to a time of said clock.
- 35.** Apparatus as claimed in any one of claims 29 to 34 further comprising:
 45 means for providing an indication of theft if the number of changes in the weight, having respective magnitudes indicating removal of no product units, exceeds a third limit during a second time period.
- 36.** An anti-theft apparatus for use in a product unit rack (10), or the like, including:
 means for measuring (16) the weight of a group of product units (12);
 50 means for detecting changes in the weight; and
 means for calculating the number of product units removed from the group of product units for each of the changes detected according to the magnitude of each of the changes detected; characterised in that there is further provided:
 means for calculating the sum of the numbers calculated of product units for each of the changes
 55 detected occurring during a time period; and
 means for indicating theft if the sum is greater than a limit.
- 37.** An anti-theft apparatus for use in a product unit rack (10), or the like, including:

means for measuring (16) the weight of a group of product units (12); and
 means for detecting changes in the weight; characterised in that there is further provided:
 means for detecting the number of weight changes detected having magnitudes less than a
 predetermined value corresponding to removal of one product unit from the group of product units; and
 5 means for indicating product unit theft if the number detected is greater than a limit during a time
 period.

38. An apparatus for use in a product units rack (10) or the like characterized by
 means for sampling (16) the weight of a group of product units at a substantially constant rate;
 10 means for calculating differences between successive weight samples:
 means for indicating theft of product units from the group of product units if the number of the
 differences calculated between successive weight samples exceeds a limit.

39. An anti-theft apparatus for use in a product unit rack (10), or the like including:
 15 means for measuring (16) the weight of a group of product units (12); and
 means for detecting disturbance of the group of product units, responsive to said means for
 measuring; characterised in that there is further provided:
 means for separately calculating the number of product units removed from the group of product
 units according to a difference between the measured weight of the group of product units before a
 20 detected disturbance and the measured weight of the group of product units after the detected
 disturbance, responsive to said means for detecting disturbance; and
 means for indicating theft if the number calculated of product units removed from the group of
 product units exceeds a limit.

25 40. An anti-theft apparatus as claimed in claim 39, wherein the limit is a programmable limit.

41. An anti-theft apparatus as claimed in either of claims 36 or 37, wherein the limit is a programmable limit
 and the time period is a programmable time period.

30 42. An anti-theft product unit rack comprising apparatus as claimed in any one of claims 29 to 41.

Revendications

35 1. Un procédé d'indication d'enlèvement d'unités de produit (12) d'une étagère d'unités de produit (10)
 incluant les étapes de :
 surveillance du poids de l'étagère (58);
 détection de variations dans le poids (62 à 64); et
 calcul du nombre d'unités de produit correspondant à chaque variation détectée (81); caractérisé
 40 par les étapes supplémentaires de fourniture d'une indication d'enlèvement (134) si la somme des
 nombres calculés d'unités de produit excède une limite au cours d'une période de temps.

2. Un procédé pour indiquer la perturbation d'une étagère (10) de produits contenant des unités de
 produits (12) incluant les étapes de :
 45 surveillance du poids de l'étagère (58); et
 détection des variations dans le poids (62 à 64); caractérisé par les étapes supplémentaires de :
 détermination du nombre de variations de poids (72) qui sont plus petites en amplitude qu'une
 variation de poids correspondant à l'enlèvement d'une unité de produit; et
 fourniture d'une indication de perturbation (109) si le nombre déterminé est plus grand qu'une
 50 limite au cours d'une période de temps.

3. Un procédé d'indication de perturbation d'une étagère de produits (10) contenant des unités de produit
 (12) incluant les étapes de :
 échantillonnage séquentiel du poids de l'étagère (58); et
 55 calcul des différences entre les échantillons successifs (62 à 64), caractérisé par l'étape supplé-
 mentaire de fourniture d'une indication de perturbation (76) si un nombre successif des différences
 calculées, plus grand qu'un nombre limite, sont chacune plus grandes qu'un premier seuil et plus
 petites qu'un second seuil.

4. Un procédé selon l'une quelconque des revendications 1 à 3, dans lequel l'indication est une alarme (41; 52).
- 5 5. Un procédé selon la revendication 4, dans lequel l'alarme est une alarme locale (41) audible dans le voisinage de ladite étagère (10).
6. Un procédé selon la revendication 4, dans lequel l'alarme est une alarme à distance (52) audible en un lieu éloigné de l'étagère (10)
- 10 7. Un procédé selon la revendication 6, comprenant de plus l'étape de :
transmission de l'indication à un lieu éloigné par fils (53).
8. Un procédé selon la revendication 6, comprenant de plus l'étape de :
transmission de l'indication à un lieu éloigné par liaison radio (53).
- 15 9. Un procédé selon l'une quelconque des revendications 1 à 3, comprenant de plus les étapes de :
verrouillage dans un mode réapprovisionnement dans lequel au moins ladite étape de fourniture d'une indication est évitée; et
verrouillage dans un mode normal dans lequel ladite étape de fourniture d'une indication est
20 exécutée.
10. Un procédé selon l'une quelconque des revendications 1 à 3, comprenant de plus l'étape de :
verrouillage dans un mode d'interdiction dans lequel la limite ou le nombre limite est fixé à un
minimum prédéterminé.
- 25 11. Un procédé selon la revendication 10 comprenant de plus l'étape de :
activation et désactivation d'une manière sélective de ladite étape de verrouillage.
12. Un procédé selon la revendication 11, dans lequel ladite étape d'activation et de désactivation sélective
30 est commandée manuellement.
13. Un procédé selon la revendication 11, dans lequel ladite étape d'activation et de désactivation sélective
est commandée automatiquement par une horloge en temps réel (55).
- 35 14. Un procédé selon la revendication 3, dans lequel le second seuil est une variation de poids
correspondant à l'enlèvement d'une unité de produit.
15. Un procédé pour indiquer le vol d'unités de produit (12) à partir d'une étagère d'unités de produit (10)
incluant les étapes de:
40 surveillance du poids (58) de l'étagère (10) contenant les unités de produit (12);
détection des variations dans le poids (62 à 64);
calcul du nombre d'unités de produit enlevées correspondant à chaque variation détectée (81); et
délivrance d'une première indication de vol si le nombre calculé d'unités de produit enlevées est
plus grand qu'une première limite (87); caractérisé par les étapes supplémentaires de :
45 délivrance d'une seconde indication de vol (134) si, au cours d'une première période de temps, le
nombre calculé d'unités de produit enlevées est plus grand qu'une seconde limite;
délivrance d'une troisième indication de vol (76) si le nombre des variations de poids détectées de
manière consécutive, et ne correspondant pas à l'enlèvement d'unités de produit, excède une troisième
limite; et
50 délivrance d'une quatrième indication de vol (109) si le nombre des variations de poids détectées,
ne correspondant pas à l'enlèvement d'unités de produit, excède une quatrième limite au cours d'une
seconde période de temps.
16. Un procédé selon la revendication 15 comprenant de plus l'étape de :
55 production d'un avertissement audible (83) si le nombre calculé d'unités de produit enlevées est
plus grand que un et plus petit qu'une première limite.
17. Un procédé selon la revendication 16, dans lequel l'avertissement est une tonalité.

18. Un procédé selon la revendication 16, dans lequel l'avertissement est une voix synthétisée.
19. Un procédé selon la revendication 15 comprenant de plus les étapes de :
déclenchement d'au moins une alarme (41; 52) en réponse à la première, la seconde, la troisième,
5 ou la quatrième indication de vol.
20. Un procédé selon la revendication 19, dans lequel au moins une des au moins une alarme est une alarme à distance (52) audible en un lieu éloigné de l'étagère (10).
- 10 21. Un procédé selon la revendication 19, dans lequel au moins une des au moins une alarme est une alarme locale (41) audible dans le voisinage de l'étagère.
22. Un procédé selon la revendication 15 comprenant de plus les étapes de :
verrouillage dans un mode réapprovisionnement dans lesquels les dites étapes de surveillance,
15 détection et calcul, et les dites étapes de fourniture de la première, la seconde, la troisième et la quatrième indication ne sont pas exécutées; et
verrouillage dans un mode normal dans lequel les dites étapes de surveillance, détection et calcul, et les dites étapes de fourniture de la première, la seconde, la troisième et la quatrième indication de vol sont exécutées.
- 20 23. Un procédé selon la revendication 15 comprenant de plus l'étape de :
verrouillage dans un mode d'interdiction dans lequel au moins une de la première, la seconde, la troisième et la quatrième limite est fixée à un minimum prédéterminé.
- 25 24. Un procédé selon la revendication 23, dans lequel ladite étape de verrouillage peut être commandée manuellement par un opérateur d'étagère.
25. Un procédé selon la revendication 23 dans lequel ladite étape de verrouillage peut être commandée de manière automatique selon une heure d'une horloge en temps réel (55).
- 30 26. Un procédé d'indication d'enlèvement non autorisé d'unités de produit (12) à partir d'une étagère d'unités de produit (10) comprenant les étapes de :
surveillance du poids (58) de l'étagère (10);
détection d'une perturbation de l'étagère (62 à 64), en fonction du poids surveillé; caractérisé par
35 l'étape supplémentaire de :
calcul d'une manière séparée du nombre d'unités de produit enlevées (81) de l'étagère, en réponse à la détection d'une perturbation, correspondant à la différence dans les poids surveillés avant et après la perturbation; et
40 délivrance d'une indication d'enlèvement non autorisé (87) si le nombre calculé d'unités de produit enlevées de l'étagère est plus grand qu'une limite programmable.
27. Un procédé selon la revendication 3, dans lequel le nombre limite est un nombre limite programmable.
28. Un procédé tel que revendiqué dans l'une ou l'autre des revendications 1 ou 2, dans lequel la limite est
45 une limite programmable et la période de temps est une période de temps programmable.
29. Un appareil anti-vol pour une utilisation dans une étagère d'unités de produit (10) ou analogue comprenant :
un capteur de poids (16) pour détecter le poids de l'étagère (10) contenant des unités de produit
50 (12);
des moyens pour détecter des variations dans le poids;
des moyens pour calculer le nombre d'unités de produit enlevées de l'étagère pour chaque variation de poids détectée; et
des moyens pour indiquer le vol si le nombre calculé pour une variation donnée est plus grand
55 qu'une première limite; caractérisé en ce qu'il est procuré de plus :
des moyens pour calculer la somme des nombres d'unités de produit enlevées pour une série de variations de poids détectées; et
des moyens pour indiquer le vol si la somme est plus grande qu'une seconde limite au cours d'une

période de temps.

30. Appareil selon la revendication 29, comprenant de plus :
des moyens pour verrouiller (50) l'étagère dans un premier mode dans lequel chacun des dits
5 moyens pour indiquer le vol est désactivé, pour verrouiller l'étagère dans un second mode dans lequel
chacun des dits moyens pour indiquer le vol est activé et pour verrouiller l'étagère dans un troisième
mode dans lequel au moins l'une de la première et de la seconde limite est fixée à un minimum
prédéterminé.
- 10 31. Appareil selon la revendication 30, dans lequel ledit moyen pour verrouiller (50) est un interrupteur à
verrouillage par clé.
32. Appareil selon la revendication 29 comprenant de plus :
des moyens pour verrouiller l'étagère dans un mode dans lequel au moins l'une de la première et
15 de la seconde limites est fixée à un minimum prédéterminé.
33. Appareil selon la revendication 32, dans lequel ledit moyen pour verrouiller est un interrupteur manuel
à verrouillage par clé.
- 20 34. Appareil selon la revendication 30 comprenant de plus :
une horloge en temps réel (55) pour l'activation et la désactivation de manière sélective du dit
moyen pour verrouiller (50) selon une heure de ladite horloge.
- 25 35. Appareil tel que revendiqué dans l'une quelconque des revendications 29 à 34 comprenant de plus :
des moyens pour fournir une indication de vol si le nombre des variations dans le poids ayant des
amplitudes t respectives indiquant un enlèvement ne correspondant à aucune des unités de produit,
excède une troisième limite pendant une seconde période de temps.
- 30 36. Un appareil anti-vol pour utilisation dans une étagère d'unités de produit (10), ou analogue, incluant :
des moyens pour mesurer (16) le poids d'un groupe d'unités de produit (12);
des moyens pour détecter des variations dans le poids; et
des moyens pour calculer le nombre d'unités de produit enlevées du groupe d'unités de produit
pour chacune des variations détectées en fonction de l'amplitude de chacune des variations détectées;
caractérisé en ce qu'il est procuré de plus :
35 des moyens pour calculer la somme des nombres calculés des unités de produit pour chacune des
variations détectées se produisant au cours d'une période de temps; et
des moyens pour indiquer le vol si la somme est plus grande qu'une limite.
- 40 37. Un appareil anti-vol pour utilisation dans une étagère d'unités de produit (10), ou analogue, incluant :
des moyens pour mesurer (16) le poids d'un groupe d'unités de produit (12); et
des moyens pour détecter des variations dans le poids; caractérisé en ce qu'il est procuré de plus :
des moyens pour détecter le nombre des variations de poids détectées ayant des amplitudes plus
petites qu'une valeur prédéterminée correspondant à l'enlèvement d'une unité de produit du groupe
d'unités de produit; et
45 des moyens pour indiquer le vol d'unités de produit si le nombre détecté est plus grand qu'une
limite pendant une période de temps.
38. Un appareil pour utilisation dans une étagère d'unités de produit (10), ou analogue caractérisée par :
des moyens pour échantillonner (16) le poids d'un groupe d'unités de produit à un rythme
50 pratiquement constant;
des moyens pour calculer des différences entre des échantillons de poids successifs :
des moyens pour indiquer le vol d'unités de produit du groupe d'unités de produits si le nombre
des différences calculées entre des échantillons de poids successifs excède une limite.
- 55 39. Un appareil anti-vol pour utilisation dans une étagère d'unités de produit (10), ou analogue, incluant :
des moyens pour mesurer (16) le poids d'un groupe d'unités de produit (12); et
des moyens pour détecter la perturbation du groupe d'unités de produit, en réponse aux dits
moyens de mesure; caractérisé en ce qu'il est procuré de plus :

des moyens pour calculer d'une manière séparée le nombre d'unités de produit enlevées du groupe d'unités de produit en fonction d'une différence entre le poids mesuré du groupe d'unités de produit avant une perturbation détectée et le poids du groupe d'unités de produit après la perturbation détectée, en réponse aux dits moyens de détection de perturbation; et
 5 des moyens pour indiquer le vol si le nombre calculé d'unités de produit enlevées excède une limite.

40. Un appareil anti-vol tel que revendiqué à la revendication 39, dans lequel la limite est une limite programmable.
- 10 41. Un appareil anti-vol tel que revendiqué dans l'une ou l'autre des revendications 36 ou 37, dans lequel la limite est une limite programmable et la période de temps est une période de temps programmable.
- 15 42. Une étagère anti-vol d'unités de produit comprenant un appareil tel que revendiqué dans l'une quelconque des revendications 29 à 41.

Ansprüche

- 20 1. Verfahren zur Anzeige der Entnahme von Produkteinheiten (12) von einem Produkteinheiten-Ständer (10), welches die (folgenden) Schritte umfaßt:
 das Gewicht des Ständers (58) wird überwacht;
 Änderungen des Gewichts (62 bis 64) werden detektiert; und die Anzahl der Produkteinheiten, welche
 25 jeder der detektierten Änderungen (81) entspricht, wird berechnet;
 gekennzeichnet durch den weiteren Schritt, daß eine Anzeige einer Entnahme (134) geliefert wird, wenn die Anzahl der berechneten Produkteinheiten während eines Zeitintervalls größer ist als ein Grenzwert.
2. Verfahren zur Anzeige einer Störung an einem Produktständer (10), welcher Produkteinheiten (12) enthält, welches die (folgenden) Schritte umfaßt:
 30 Das Gewicht des Ständers (58) wird überwacht; und Änderungen des Gewichts (62 bis 64) werden detektiert; gekennzeichnet durch die (folgenden) weiteren Schritte:
 Die Anzahl der Gewichtsänderungen (72), welche eine geringere Größe haben als eine Gewichtsänderung, die der Entnahme einer Produkteinheit entspricht, wird bestimmt; und...
 es wird eine Anzeige für eine Störung (109) geliefert, wenn die bestimmte Anzahl während eines
 35 Zeitintervalls größer ist als ein Grenzwert.
3. Verfahren zur Anzeige einer Störung an einem Produktständer (10), welcher Produkteinheiten (12) enthält, welches die (folgenden) Schritte umfaßt:
 Das Gewicht des Ständers (58) wird fortlaufend abgetastet; und
 40 die Unterschiede zwischen aufeinanderfolgenden Abtastwerten (62 bis 64) werden berechnet; gekennzeichnet durch die (folgenden) weiteren Schritte:
 Es wird eine Anzeige für eine Störung (76) geliefert, wenn eine aufeinanderfolgende Anzahl von berechneten Differenzen, die größer ist als eine Grenzwert-Anzahl, jeweils größer als ein erster Grenzwert und kleiner als ein zweiter Grenzwert ist.
- 45 4. Verfahren nach einem der Ansprüche 1 bis 3, bei dem die Anzeige ein Alarm (41; 52) ist.
5. Verfahren nach Anspruch 4, bei dem der Alarm ein örtlicher Alarm (41) ist, der in der Umgebung des Ständers (10) hörbar ist.
- 50 6. Verfahren nach Anspruch 4, bei dem der Alarm ein Fernalarm (52) ist, der an einer von dem Ständer (10) entfernten Stelle hörbar ist.
7. Verfahren nach Anspruch 6, welches ferner den Schritt umfaßt, daß die Anzeige zu der entfernten Stelle
 55 über einen Draht (53) übertragen wird.
8. Verfahren nach Anspruch 6, welches ferner den Schritt umfaßt, daß die Anzeige zu der entfernten Stelle über eine Funkverbindung (53) übertragen wird.

9. Verfahren nach einem der Ansprüche 1 bis 3, welches ferner die (folgenden) Schritte umfaßt:
Verriegelung in der Betriebsart Auffüllen, wobei zumindest der Schritt der Lieferung einer Anzeige umfassen wird; und
Verriegelung in der Betriebsart Normalbetrieb, wobei der Schritt der Lieferung einer Anzeige durchgeführt wird.
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10. Verfahren nach einem der Ansprüche 1 bis 3, welches ferner (folgende) Schritte umfaßt:
Verriegelung in einer Betriebsartverriegelung, wobei der Grenzwert oder die Grenzwertzahl auf ein vorgegebenes Minimum gesetzt wird.
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11. Verfahren nach Anspruch 10, welches ferner den Schritt umfaßt, daß der Verriegelungsschritt selektiv aktiviert und deaktiviert wird.
12. Verfahren nach Anspruch 11, bei dem der Schritt des selektiven Aktivierens und Deaktivierens von Hand gesteuert wird.
15
13. Verfahren nach Anspruch 11, bei dem der Schritt des selektiven Aktivierens und Deaktivierens automatisch durch eine Echtzeituhr (55) gesteuert wird.
- 20 14. Verfahren nach Anspruch 3, bei dem der zweite Grenzwert eine Gewichtsänderung ist, die der Entnahme einer Produkteinheit entspricht.
15. Verfahren zur Anzeige des Diebstahls von Produkteinheiten (12) von einem Produkteinheitengerstell (10), welches die (folgenden) Schritte umfaßt:
25 Das Gewicht (58) des Gestells (10) einschließlich der Produkteinheiten (12) wird überwacht;
Gewichtsänderungen (62 bis 64) werden detektiert;
die Anzahl der Produkteinheiten, welche jeder der detektierten Änderungen (81) entspricht, wird berechnet; und
es wird eine erste Diebstahlsanzeige geliefert, wenn die berechnete Anzahl von entnommenen Produkteinheiten größer ist als ein erster Grenzwert (87); gekennzeichnet durch die (folgenden) weiteren Schritte:
30 Es wird eine zweite Diebstahlsanzeige (134) geliefert, wenn während eines ersten Zeitintervalls die berechnete Anzahl von entnommenen Produkteinheiten größer ist als ein zweiter Grenzwert;
es wird eine dritte Diebstahlsanzeige (76) geliefert, wenn die Anzahl von nacheinander entdeckten Gewichtsänderungen, die nicht einer Produktentnahme entsprechen, einen dritten Grenzwert überschreitet; und
35 es wird eine vierte Diebstahlsanzeige (109) geliefert, wenn die Anzahl von detektierten Gewichtsänderungen, die nicht der Entnahme einer Produkteinheit entspricht, während eines zweiten Zeitintervalls einen vierten Grenzwert überschreitet.
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16. Verfahren nach Anspruch 15, welches ferner den Schritt umfaßt, daß ein hörbares Quittungssignal (83) erzeugt wird, wenn die berechnete Anzahl von entnommenen Produkteinheiten größer als 1 und geringer als der erste Grenzwert ist.
- 45 17. Verfahren nach Anspruch 16, bei dem das Quittungssignal ein Ton ist.
18. Verfahren nach Anspruch 16, bei dem das Quittungssignal ein synthetisches Sprachsignal ist.
19. Verfahren nach Anspruch 15, welches ferner die (folgenden) Schritte umfaßt:
50 In Abhängigkeit von der ersten, der zweiten, der dritten oder der vierten Diebstahlsanzeige läßt man mindestens einen Alarm (41; 52) ertönen.
20. Verfahren nach Anspruch 19, bei dem mindestens eines von den mindestens ein Alarmsignal umfassenden Alarmsignalen ein Fernalarm (52) ist, der an einer von dem Gestell (10) entfernten Stelle hörbar ist.
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21. Verfahren nach Anspruch 19, bei dem mindestens eines von den mindestens ein Alarmsignal umfassenden Alarmsignalen ein örtlicher Alarm (41) ist, der in der Umgebung des Gestells hörbar ist.

22. Verfahren nach Anspruch 15, welches ferner die (folgenden) Schritte umfaßt:
Es erfolgt eine Verriegelung in der Betriebsart Auffüllen, wobei die Schritte des Überwachens, Detektierens und Berechnens und die Schritte der Lieferung einer ersten, zweiten, dritten und vierten Anzeige nicht durchgeführt werden; und
5 es erfolgt eine Verriegelung in der Betriebsart Normalbetrieb, in der die Schritte des Überwachens, Detektierens und Berechnens und die Schritte der Erzeugung der ersten, zweiten, dritten und vierten Diebstahlsanzeige durchgeführt werden.
23. Verfahren nach Anspruch 15, welches ferner den Schritt umfaßt, daß eine Verriegelung in einer Betriebsartverriegelung erfolgt, in der mindestens einer von den den ersten, zweiten, dritten und vierten Grenzwert bildenden Grenzwerten auf ein **Minimum** gesetzt wird.
24. Verfahren nach Anspruch 23, bei dem der Verriegelungsschritt von Hand durch eine Gestell-Bedienungsperson steuerbar ist.
- 15 25. Verfahren nach Anspruch 23, bei dem der Verriegelungsschritt automatisch in Abhängigkeit von einer Zeit (einem Zeitpunkt) einer Echtzeituhr (55) steuerbar ist.
26. Verfahren zur Anzeige der nicht autorisierten Entnahme einer Produkteinheit von einem Produkteinheiten-Gestell (10), welches die (folgenden) Schritte umfaßt:
Das Gewicht (58) des Gestells (10) wird überwacht;
gemäß dem überwachten Gewicht wird eine Störung des Gestells (62 bis 64) detektiert, gekennzeichnet durch die (folgenden) weiteren Schritte:
Die Anzahl der von dem Gestell entfernten Produkteinheiten wird separat in Abhängigkeit von der Detektierung einer Störung berechnet, welche der Differenz der überwachten Gewichte vor und nach der Störung entspricht; und
25 es wird eine Anzeige für eine nicht autorisierte Entnahme (87) geliefert, wenn die berechnete Anzahl der aus dem Gestell entnommenen Produkteinheiten größer ist als ein programmierbarer Grenzwert.
- 30 27. Verfahren nach Anspruch 3, bei dem die Grenzwertzahl eine programmierbare Grenzwertzahl ist.
28. Verfahren nach Anspruch 1 oder 2, bei dem der Grenzwert ein programmierbarer Grenzwert ist und bei dem das Zeitintervall ein programmierbares Zeitintervall ist.
- 35 29. Anti-Diebstahl-Vorrichtung zur Verwendung in einem Produkteinheiten-Gestell (10) oder dgl., umfassend:
einen Gewichtssensor (16) zum Erfassen des Gewichts des Gestells (10) einschließlich der in diesem befindlichen Produkteinheiten (12);
Einrichtungen zum Detektieren von Gewichtsänderungen;
40 Einrichtungen zum Berechnen der Anzahl von aus dem Gestell entnommenen Produkteinheiten für jede detektierte Gewichtsänderung; und
Einrichtungen zur Anzeige eines Diebstahls, wenn die berechnete Anzahl für eine gegebene Änderung größer ist als ein erster Grenzwert; dadurch gekennzeichnet, daß ferner vorgesehen sind:
Einrichtungen zum Berechnen der Summe der berechneten Zahlen von entnommenen Produkteinheiten für eine Serie von detektierten Gewichtsänderungen; und
45 Einrichtungen zum Anzeigen eines Diebstahls, wenn diese Summe während eines Zeitintervalls größer ist als der zweite Grenzwert.
30. Vorrichtung nach Anspruch 29, welche ferner umfaßt:
50 Eine Einrichtung (50) zum Verriegeln des Gestells in einer ersten Betriebsart, in der jede der Einrichtungen zum Anzeigen eines Diebstahls außer Betrieb ist, zum Verriegeln des Gestells in einer zweiten Betriebsart, in der jede der Einrichtungen zum Anzeigen eines Diebstahls aktiviert ist, und zum Verriegeln des Gestells in einer dritten Betriebsart, in der mindestens der erste oder der zweite Grenzwert auf ein vorgegebenes Minimum gesetzt ist.
- 55 31. Vorrichtung nach Anspruch 30, bei der die Einrichtung (50) zum Verriegeln ein Tasten-Verriegelungsschalter ist.

32. Vorrichtung nach Anspruch 29, welche ferner eine Einrichtung zum Verriegeln des Gestells in einer Betriebsart umfaßt, in der mindestens der erste oder der zweite Grenzwert auf ein vorgegebenes Minimum gesetzt ist.
- 5 33. Vorrichtung nach Anspruch 32, bei der die Einrichtung zum Verriegeln ein Hand-Tasten-Verriegelungsschalter ist.
34. Vorrichtung nach Anspruch 30, welche ferner eine Echtzeituhr (55) zum selektiven Aktivieren und Deaktivieren der Einrichtung (50) zum Verriegeln gemäß einer Zeit (einem Zeitpunkt) der Uhr umfaßt.
- 10 35. Vorrichtung nach einem der Ansprüche 29 bis 34, welche ferner umfaßt:
Einrichtungen zum Liefern der Anzeige eines Diebstahls, wenn die Anzahl von Gewichtsänderungen, welche entsprechende Größen haben, um nicht die Entnahme von Produkteinheiten anzuzeigen, während eines zweiten Zeitintervalls einen dritten Grenzwert übersteigt.
- 15 36. Anti-Diebstahl-Vorrichtung zur Verwendung in einem Produkteinheiten-Gestell (10) oder dgl. umfassend:
Einrichtungen (16) zum Messen des Gewichts einer Gruppe von Produkteinheiten (12);
Einrichtungen zum Detektieren von Gewichtsänderungen;
und
20 Einrichtungen zum Berechnen der Anzahl von von den Gruppen von Produkteinheiten entnommenen Produkteinheiten für jede der detektierten Änderungen gemäß der Größe jeder der detektierten Änderungen, dadurch gekennzeichnet, daß ferner vorgesehen sind:
Einrichtungen zum Berechnen der Summe der berechneten Anzahlen von Produkteinheiten für jede der detektierten Änderungen, die während eines ersten Zeitintervalls auftreten; und
25 Einrichtungen zum Anzeigen eines Diebstahls, wenn diese Summe größer als ein Grenzwert ist.
37. Anti-Diebstahl-Vorrichtung zur Verwendung in einem Produkteinheiten-Gestell (10) oder dgl., umfassend:
Einrichtungen (16) zum Messen des Gewichts einer Gruppe von Produkteinheiten (12); und
30 Einrichtungen zum Detektieren von Gewichtsänderungen; dadurch gekennzeichnet, daß ferner vorgesehen sind:
Einrichtungen zum Detektieren der Anzahl von detektierten Gewichtsänderungen mit einer unterhalb eines vorgegebenen Wertes, welcher der Entnahme einer Produkteinheit von der Gruppe von Produkteinheiten entspricht, liegenden Größe; und
35 Einrichtungen zur Anzeige des Diebstahls einer Produkteinheit, wenn die detektierte Anzahl während eines Zeitintervalls größer ist als ein Grenzwert.
38. Vorrichtung zur Verwendung in einem Produkt-einheiten-Gestell (10) oder dgl., gekennzeichnet durch:
40 Einrichtungen (16) zum Abtasten des Gewichts einer Gruppe von Produkteinheiten mit einer im wesentlichen konstanten Rate;
Einrichtungen zum Berechnen der Differenzen zwischen aufeinanderfolgenden Gewichtsproben;
Einrichtungen zum Anzeigen des Diebstahls von Produkteinheiten von der Gruppe von Produkteinheiten, wenn die Anzahl der zwischen den aufeinanderfolgenden Gewichtsproben berechneten Differenzen einen Grenzwert überschreitet.
- 45 39. Anti-Diebstahl-Vorrichtung zur Verwendung in einem Produkteinheiten-Gestell (10) oder dgl., umfassend:
Einrichtungen (16) zum Messen des Gewichts einer Gruppe von Produkteinheiten (12); und
50 Einrichtungen zum Detektieren einer Störung der Gruppe von Produkteinheiten in Abhängigkeit von den Meßeinrichtungen;
dadurch gekennzeichnet, daß ferner vorgesehen sind:
Einrichtungen zum separaten Berechnen der Anzahl der von der Gruppe von Produkteinheiten entnommenen Anzahl von Produkteinheiten entsprechend einer Differenz zwischen dem gemessenen Gewicht der Gruppe von Produkteinheiten vor einer festgestellten Störung und dem gemessenen Gewicht der Gruppe von Produkteinheiten nach der ermittelten Störung in Abhängigkeit von den Einrichtungen zum Detektieren einer Störung; und
55 Einrichtungen zum Anzeigen eines Diebstahls, wenn die berechnete Anzahl von von der Gruppe von Produkteinheiten entnommenen Produkteinheiten einen Grenzwert übersteigt.

40. Anti-Diebstahl-Vorrichtung nach Anspruch 39, bei der der Grenzwert ein programmierbarer Grenzwert ist.

5 41. Anti-Diebstahl-Vorrichtung nach Anspruch 36 oder 37, bei der der Grenzwert ein programmierbarer Grenzwert ist und das Zeitintervall ein programmierbares Zeitintervall.

42. Anti-Diebstahl-Produktseinheiten-Gestell, welches eine Vorrichtung nach einem der Ansprüche 29 bis 41 umfaßt.

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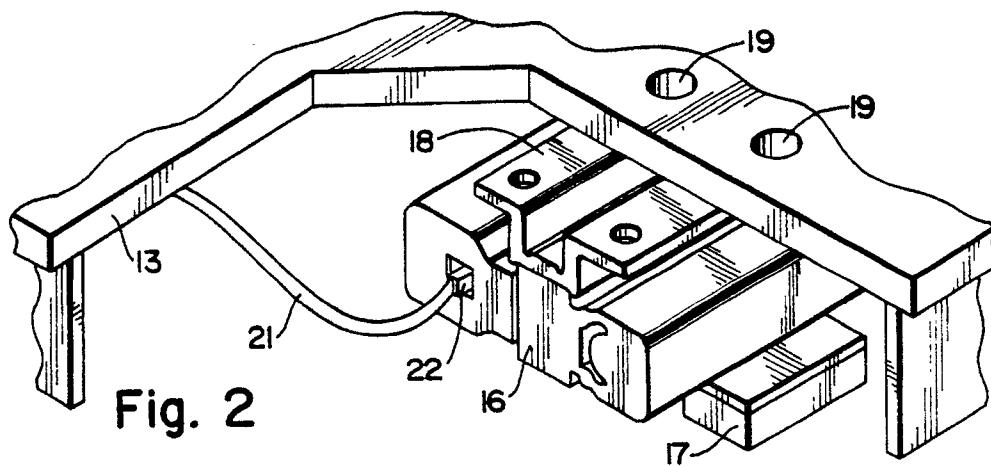
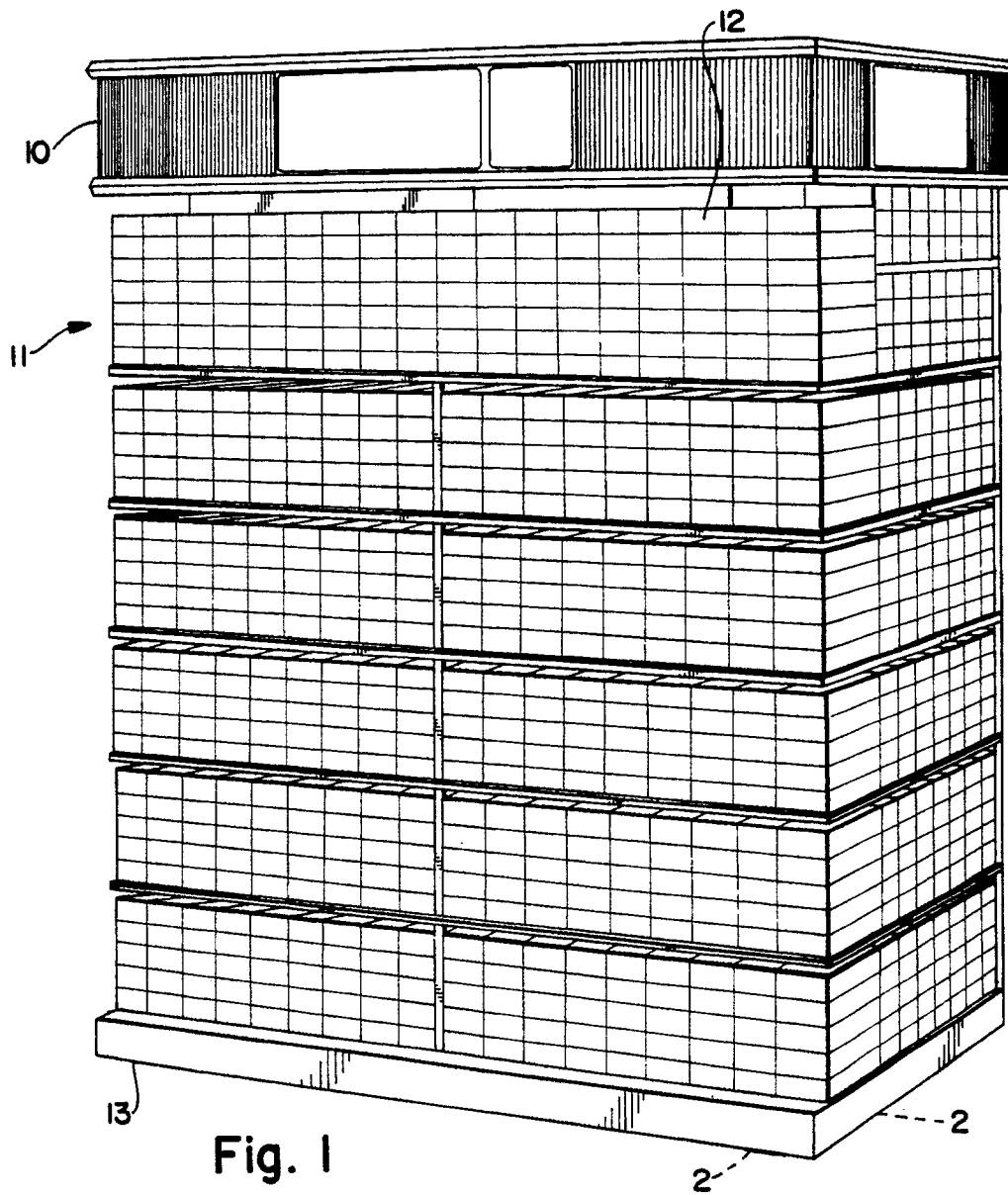


Fig. 3

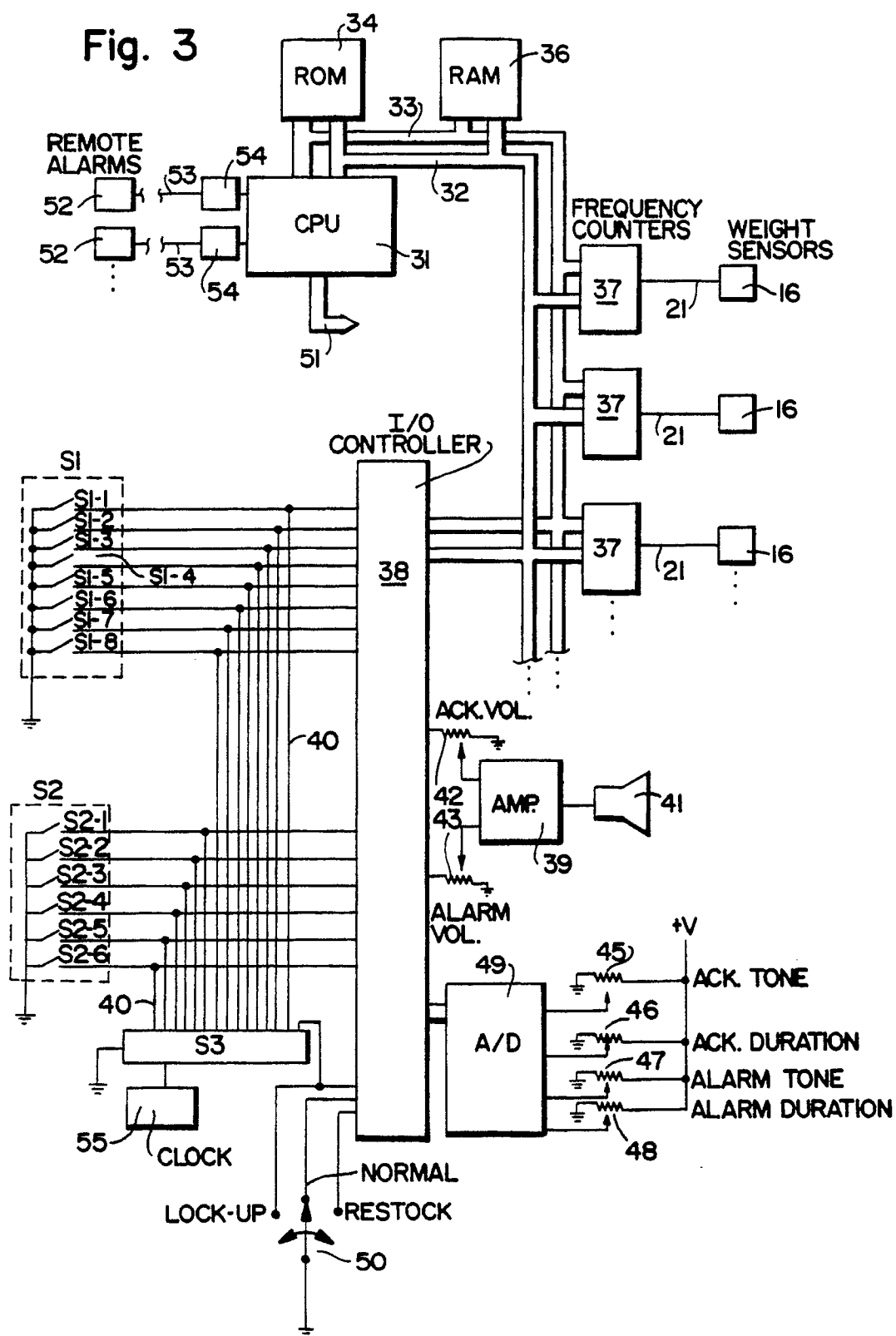


Fig. 4A

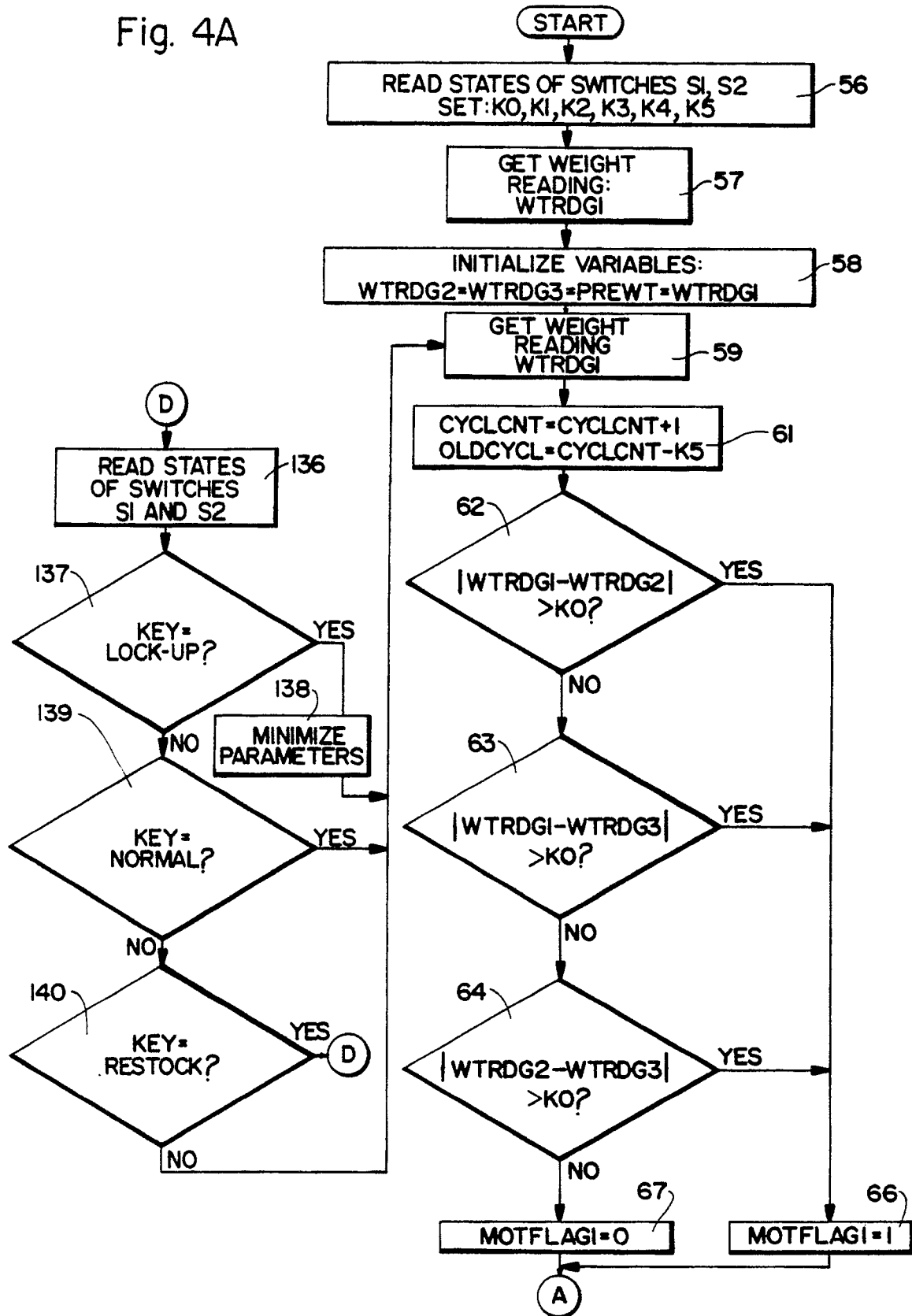


Fig. 4B

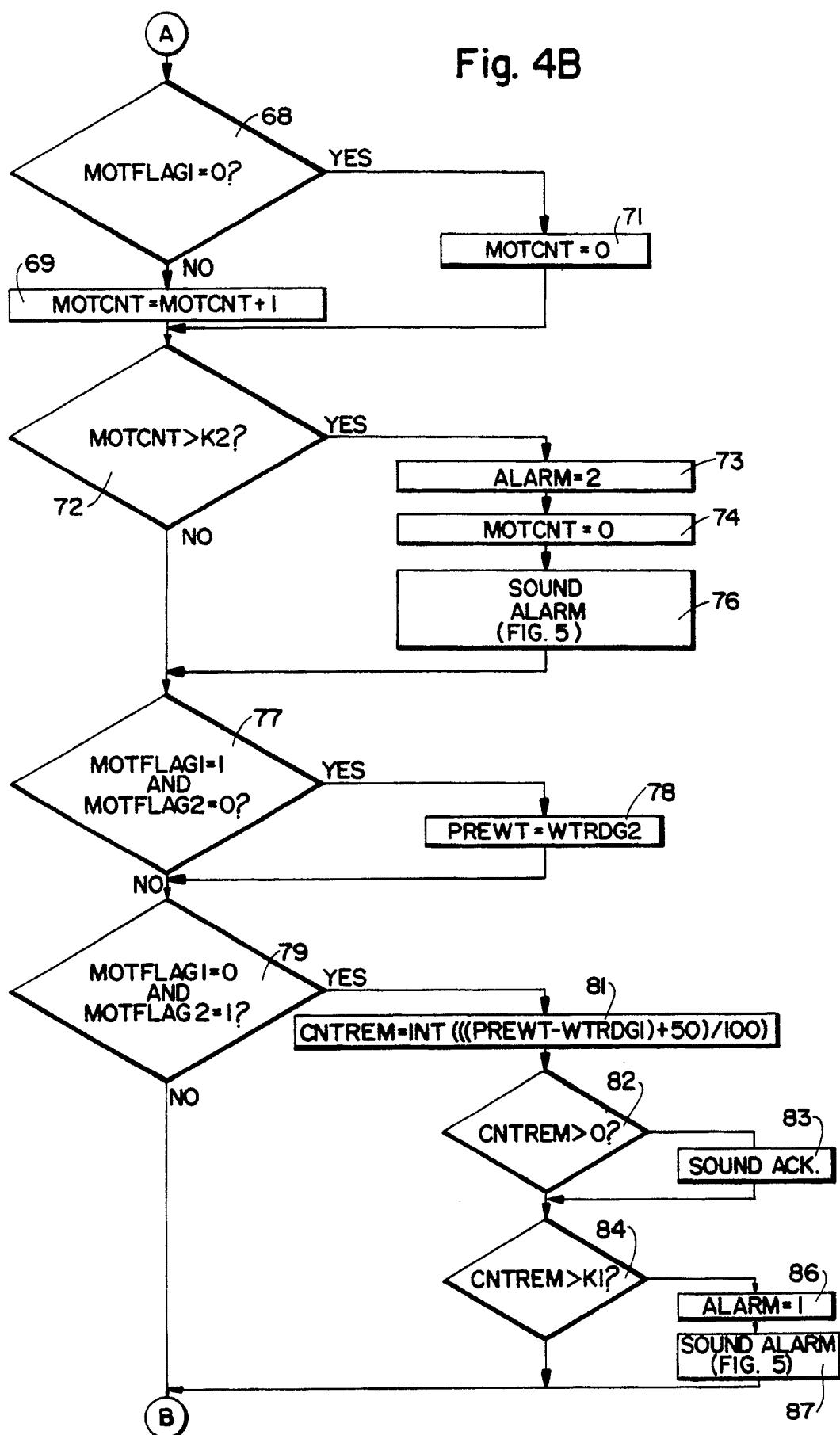


Fig. 4C

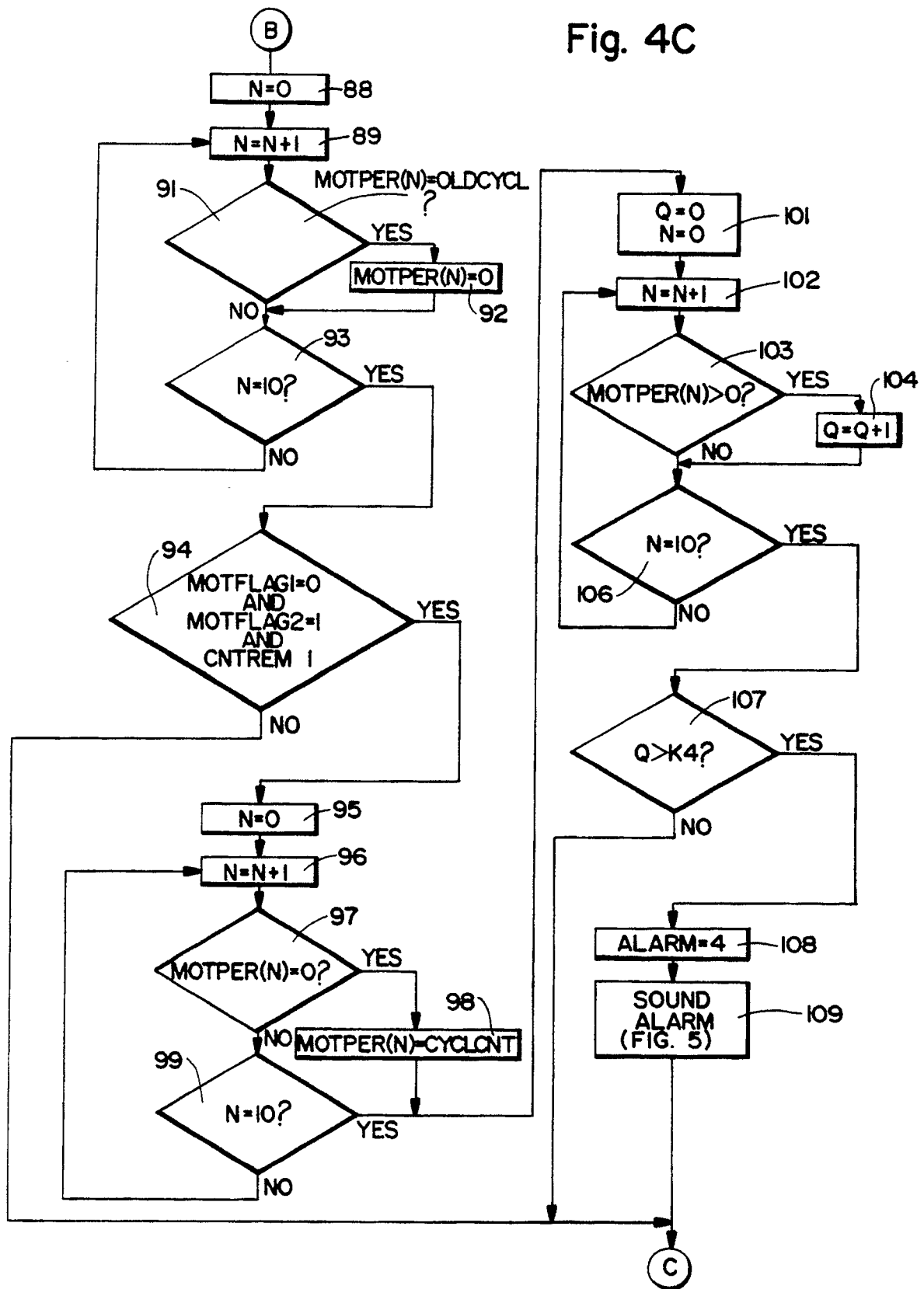


Fig. 4D

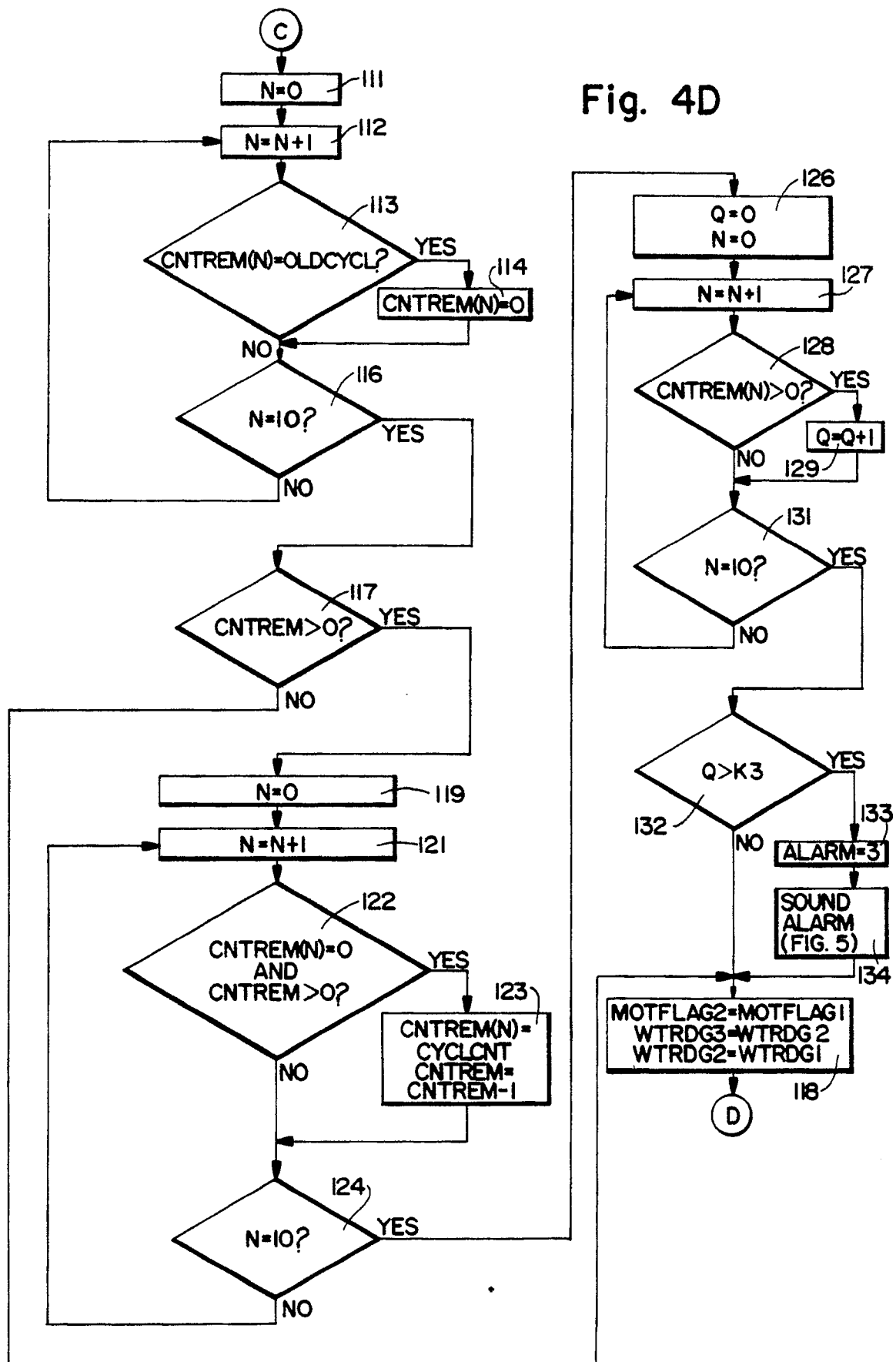


Fig. 5

