United States Patent [19]

Nathans

[11] **3,713,133**

[45] **Jan. 23, 1973**

[54] **RF AND SONIC SYSTEMS FOR PREVENTING SHOPLIFTING OF GOODS AND UNAUTHORIZED REMOVAL OF CAPSULES AFFIXED THERETO FOR PROTECTING GOODS**

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[52] **U.S. Cl.** **340/280,** 340/224, 340/408

[51] **Int. Cl.**.....**G08b 13/18**

[58] **Field of Search**...340/280, 258 D, 258 B, 258 C, 340/224, 405

[56] **References Cited**

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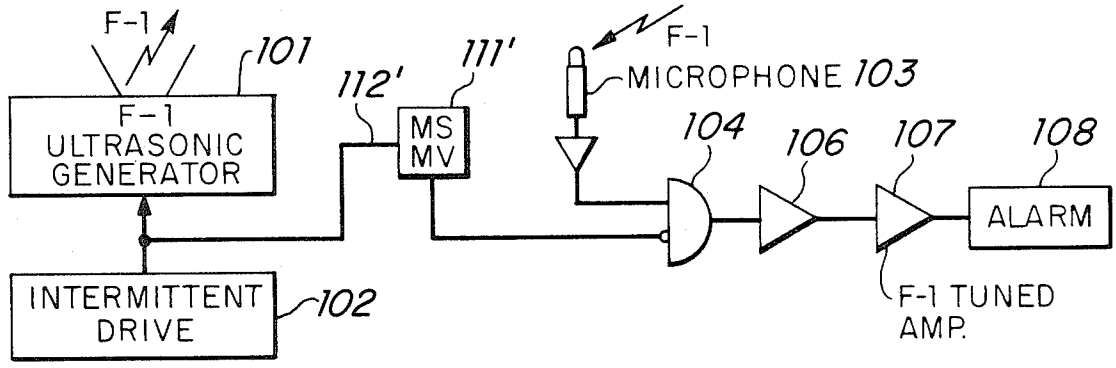
3,577,136	5/1971	Wolf	340/280
2,774,060	12/1956	Thompson	340/280
3,493,955	2/1970	Minasy	340/224
3,117,277	1/1964	Magondeaux	340/408

Primary Examiner—John W. Caldwell
Assistant Examiner—Glen R. Swann, III
Attorney—Robert L. Nathans

[57] **ABSTRACT**

Capsules or tags are affixed to a plurality of goods kept within a storage area, which capsules produce an alarm indication upon unauthorized removal of the goods through an exit area. The capsules or tags bear the designation "Don't Remove-Electronic Alarm" and contain first and second resonant devices and are affixed to the goods by means of an ordinary safety pin. The first resonant device actuates an article removal alarm when the goods pass through the exit area, whereas the unauthorized opening of the safety pin in an attempt to remove the capsule in the storage area to defeat the system enables the second resonant device which in turn produces a capsule removal alarm in the storage area and as a result a greater deterrent is present with respect to theft of the goods and special unwieldy fastening devices such as rivets, requiring special measures for application and removal are eliminated. Additionally small and/or delicate goods may be protected, which goods would not be protected owing to the aforementioned rivets or special fastening devices. Sonic systems which may or may not produce a capsule removal alarm operate preferably in the ultrasonic range. An extended range capsule is particularly well adapted for protecting goods stored in a warehouse.

13 Claims, 13 Drawing Figures



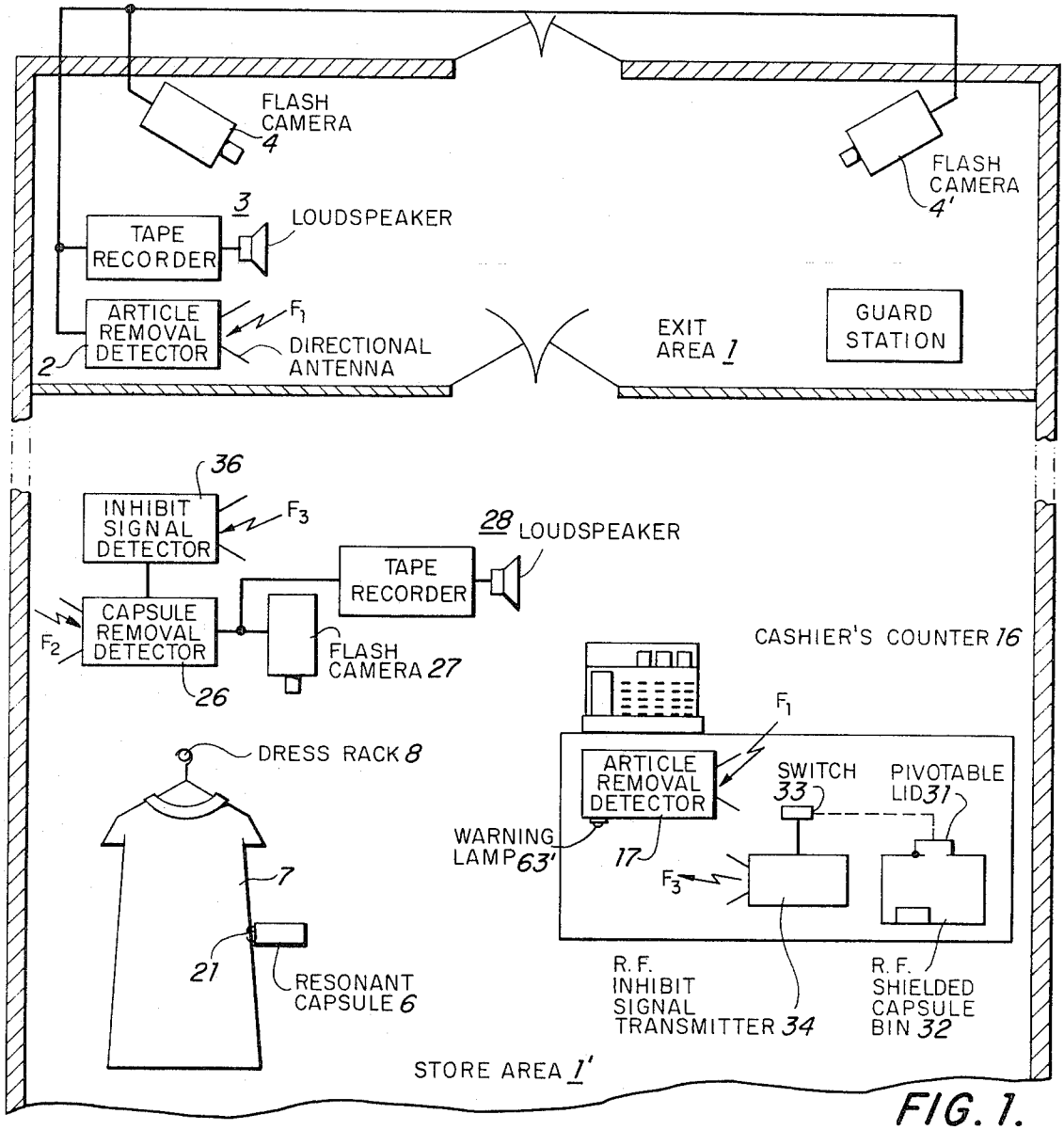


FIG. 1.

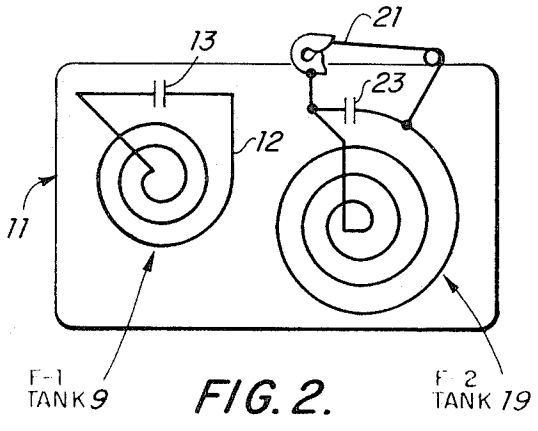


FIG. 2.

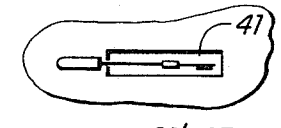


FIG. 2B.

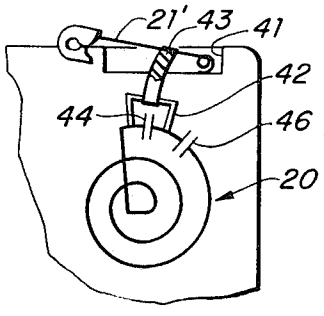


FIG. 2A.

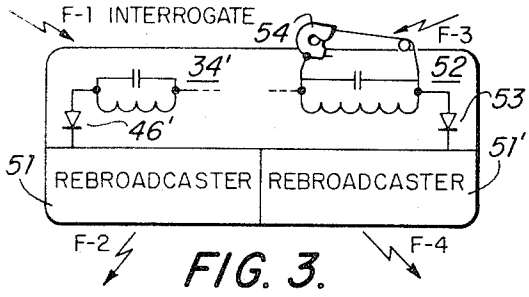


FIG. 3.

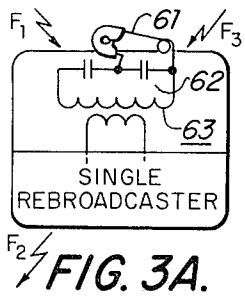


FIG. 3A.

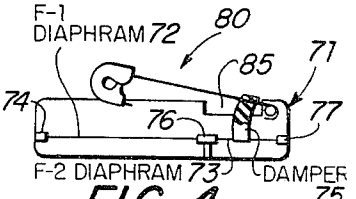


FIG. 4.

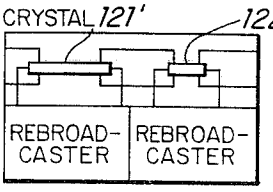


FIG. 4A.

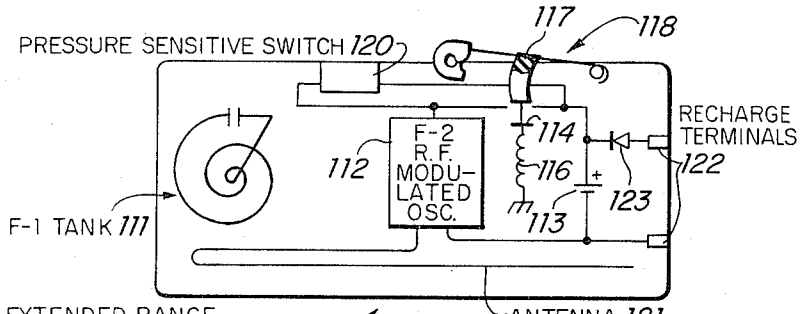


FIG. 7.

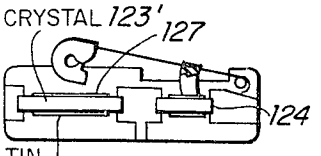


FIG. 4B.

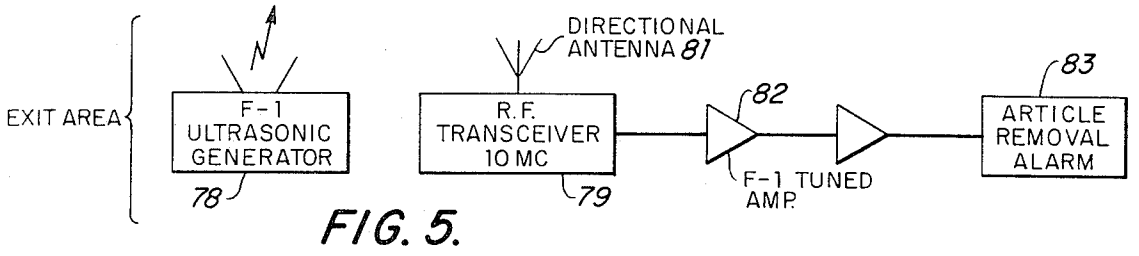


FIG. 5.

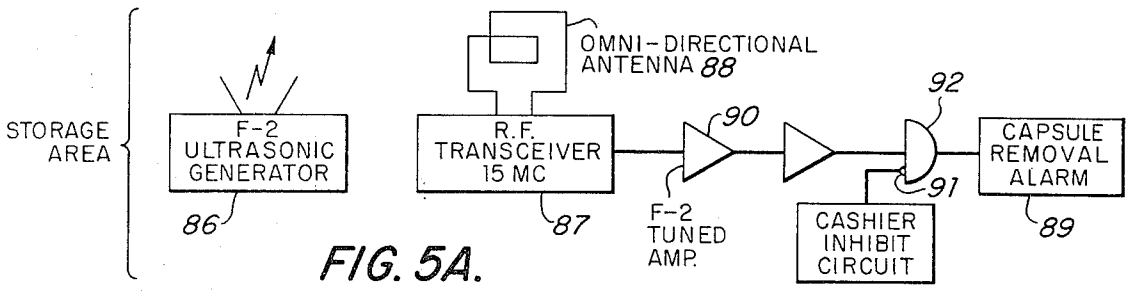


FIG. 5A.

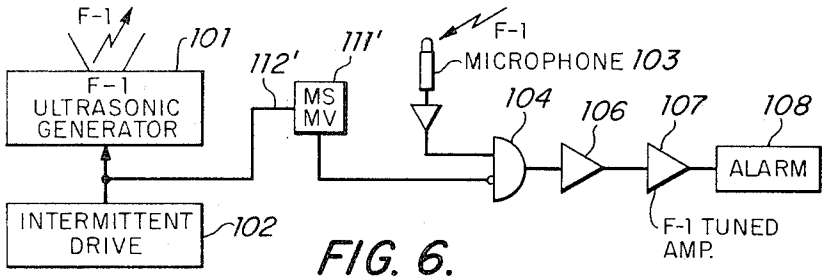


FIG. 6.

RF AND SONIC SYSTEMS FOR PREVENTING SHOPLIFTING OF GOODS AND UNAUTHORIZED REMOVAL OF CAPSULES AFFIXED THERETO FOR PROTECTING GOODS

BACKGROUND OF THE INVENTION

This invention relates to the field of theft prevention systems and more particularly to such systems utilizing special tags or capsules affixed to the goods.

It is estimated that shoplifting losses in the United States are well over 5 billion dollars per year, to say nothing of losses due to thefts from warehouses, etc. In the case of stores, numerous detectives, closed circuit television, mirrors and other devices have been employed but the staggering losses per year continue to increase.

Two clever electronic systems are now on the market which utilize special tags which are affixed to the goods. A midwestern manufacturer is marketing an electronic system similar to the system covered by a U.S. Pat. to Thompson, No. 2,774,060, issued Dec. 11, 1956. In this system an article removal alarm circuit is situated at an exit area and comprises an RF oscillator radiating at a carrier frequency of F–1. If a shoplifter carries a secreted article through the exit area, a special tag containing a resonant circuit resonant at F–1 loads the oscillator to produce an exit alarm. These tags are affixed to goods, typically dresses, by a plastic thread which is normally cut by the cashier upon payment of the goods to remove the tag.

An eastern manufacturer is currently marketing a system similar to the system covered by a U.S. Pat. to Minasy, No. 3,493,955, issued Feb. 3, 1970. A rigid 2″ × 3″ tag is riveted to the goods to be protected and contains a rebroadcasting device which is actuated by an F–1 RF interrogation signal generated at the exit area and produces in response thereto an F–2 RF signal which triggers an alarm in the exit area.

While these systems represent important initial steps in the production of truly effective electronic theft prevention systems, they are somewhat wanting in various respects. The shoplifters will readily ascertain that the tags of both systems are responsible for triggering the alarm. In the case of the "Thompson" systems it will be an easy matter to cut the plastic threads which couple the tag to the goods by means of, for example, a toe nail scissors. The manufacturer of Thompson's system suggests putting a "dummy" tag on the outside of the article and secreting a "live" tag in an inconspicuous place on the article. Shoplifters will soon appreciate that all tags must be removed from the goods before they are stolen and thus a serious drawback is seen in connection with the current "Thompson" system. While the rivets utilized in the current "Minasy" system are more difficult to sever, it is believed that the use of a small pair of pincers, particularly in the hands of professional shoplifters and teenagers, will constitute an effective countermeasure. Additionally these rivets require the use of special machines for application and removal which is time consuming and somewhat unwieldy. If one were to protect small and/or delicate items such as hats, delicate lingerie, scarves, sweaters, shirts, hoisery, gloves, ties, belts, pocketbooks, fancy pillows, blankets, and objects of art, the use of such rivets would be very unsuitable. Losses of these items are very heavy.

The use of the foregoing systems for protecting goods such as television sets and numerous other items of considerable value stored in a warehouse is even more questionable because a dishonest employee is free, is an unpopulated warehouse area, to destroy the rivets, or other sturdy fasteners at his leisure by such tools as a pair of shears to remove the capsules before stealing the goods.

Thus it is desirable to provide a capsule which is quickly and easily applied to and removed from the goods to be protected without special equipment or special techniques. It is also desirable to utilize ordinary safety pins to affix the capsules to the goods so that the abovementioned small and/or delicate goods may be readily protected. It is particularly desirable to employ a protective capsule which immediately produces a capsule removal alarm (e.g. a chime or light) in the storage area upon the opening or cutting of the safety pin. It is of the utmost importance to protect expensive goods in a warehouse by not relying on "brute force" fastening devices such as steel bands for affixing the capsules to the goods, since such fasteners may be readily cut by a dishonest employee, by shearing, in unpopulated warehouse areas at his leisure. In the "warehouse" market it is especially important to produce a capsule removal alarm upon the removal of the capsule and again it is desirable to quickly and easily affix and remove the capsules without special power tools. Particularly for warehouses where it usually would be impractical to utilize numerous pickup antennas, an extended range capsule is desired. Additionally in view of the market potential for all of these alarm systems it is thought desirable to develop other approaches which might be more inexpensive or reliable than tags utilizing printed circuitry therein. It is also desirable to employ ultrasonic generators, presently utilized in many facilities for intrusion alarm purposes, to activate theft prevention capsules having mechanically resonant devices therein. Systems which will function in conjunction with very wide exit areas are also desirable.

SUMMARY OF THE PRESENT INVENTION

In accordance with one embodiment of the invention, a capsule is affixed to the goods by means of an ordinary metallic safety pin, which safety pin enables one resonant device which coacts with a "Thompson" type oscillator to produce a capsule removal alarm upon the unauthorized opening of the safety pin, the other resonant device contained within the tag or capsule functioning in the same manner as Thompson. In accordance with another embodiment of the invention, when the safety pin is opened, the Minasy rebroadcaster is enabled so as to produce a capsule removal alarm upon the receipt of an interrogation signal in the storage area; the rebroadcaster otherwise functioning to produce an article removal alarm in the exit area in the manner of Minasy. In accordance with another embodiment, the Minasy rebroadcaster is triggered by the application of ultrasonic energy thereto. Another embodiment employs extended range capsules particularly well suited for protecting goods stored in warehouses. Further embodiments employ the use of sonic energy, already available from installed intrusion alarms, which produces mechanical resonance of

devices within the capsules to actuate article removal alarms or capsule removal alarms or both.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages relating to the invention will become apparent upon study of the specific description taken in conjunction with the drawings in which:

FIG. 1 schematically illustrates the general layout of a store area;

FIG. 2 schematically illustrates a tag or capsule which contains a first tank circuit for actuating an article removal alarm and a second tank circuit for actuating a capsule removal alarm;

FIG. 2A illustrates the first and second resonant device having a common reactive element;

FIG. 2B is a top view of a portion of the device shown in FIG. 2A;

FIG. 3 illustrates a capsule including two rebroadcasters;

FIG. 3A illustrates a variation of FIG. 3 which utilizes a single rebroadcaster;

FIG. 4 illustrates a capsule useful in sonic embodiments;

FIG. 4A illustrates a variation of FIG. 3;

FIG. 4B illustrates a capsule having piezoelectric transducers;

FIGS. 5 and 5A schematically disclose theft prevention systems involving sonic energy utilized in conjunction with RF energy;

FIG. 6 illustrates an alarm system employing sonic energy without RF energy; and

FIG. 7 illustrates an extended range "warehouse" capsule including an active and passive element.

SPECIFIC DESCRIPTION

In FIG. 1, exit area 1 is disclosed having an article removal detector 2 coupled to alarm device 3 which could comprise a tape recorder for actuating a loudspeaker. Flash cameras 4 and 4' may be employed if desired. Obviously, other alarm indication devices may be triggered by the article removal detector 2 such as a lighted sign instructing the customer to have the "inventory control" tag removed. Exit area 1 need not actually be the physical exit from the store but could also consist of the area at the bottom of an elevator or escalator or an area in a larger store representing the boundary of a given department.

FIG. 2 discloses a passive capsule which is utilized in conjunction with the aforementioned Thompson U.S. Pat. No. 2,774,060 incorporated by reference herein. Article removal detector 2 would correspond to FIGS. 2 or 3 of the Thompson patent and each resonant printed circuit shown in FIG. 2 may be similar to the resonant circuits of Thompson. The resonant capsule or tag 6 disclosed in FIG. 1 is affixed to an object to be protected such as dress 7 suspended from dress rack 8 shown in FIG. 1. As shown in FIG. 2, F–1 tank circuit 9 is laminated within resonant tag 11 and consists of inductor 12 and capacitor 13. If a shoplifter removes dress 7 having resonant capsule 6 attached thereto without paying for the article and passes through exit area 1, the F–1 tank circuit 9 will load the oscillator in article removal detector 2, all as described in the aforesaid Thompson patent, thereby to activate the alarm indication devices. The cashier removes the capsule associated with the article paid for and inhibits the capsule removal alarm as explained in detail below. If the shoplifter pays for one item at cashier's counter 16 but secretes another item bearing the capsule on her person, article removal detector 17 will light a warning lamp so that countermeasures may be taken. In this special situation the warning lamp will only have significance if other customers are not at the cashier's counter within range of the article removal detector and the shoplifter has already had the first capsule removed from the article paid for. In this case the cashier's counter is the "exit area." Article removal detector 17 at the cashier's counter is similar in construction to detector 2.

Now let it be assumed that a shoplifter removes the capsule 6 from dress 7 by either opening the safety pin or cutting the upper portion of the pin with a pair of wire cutters. The right hand portion of the capsule of FIG. 2 has an F–2 tank circuit 19 laminated within the tag or otherwise positioned within the capsule. A safety pin 21 which is normally in the closed position as illustrated will generally be opened by the shoplifter in an attempt to defeat the system by removing the capsule. This pin does not have a lower segment unlike a regular safety pin and is electrically coupled across capacitor 23 of the F–2 tank circuit 19. A safety pin may be easily affixed to a tag, etc. by passing a pair of resilient wires through the plastic tag sheet and which are soldered to the tank circuit laminated therein. A safety pin head or equivalent catch is welded to one wire and the other may be bent over to be resiliently held by the catch. Obviously many other approaches may be utilized to join a suitable fastener to a laminated tag or capsule upon manufacture. Normally when the pin is closed, capacitor 23 is short circuited and tank circuit 19 will not resonate at the F–2 frequency. When the shoplifter opens pin 21 or cuts it with wire cutters, capacitor 23 is now enabled and will complete the F–2 tank circuit. Capsule removal detector 26 of FIG. 1 is similar to article removal detector 2 except that the oscillator therein oscillates at a frequency of F–2 rather than F–1 as in the case of the article removal detector 2. Capsule removal detector 26 is preferably connected to at least one elongated antenna several feet in length which may be vertically oriented within a circular dress rack or upon a pillar for example. In the alternative, a horizontally oriented antenna(s) could be positioned along the length of a counter or along the ceiling or under a rug. These antennas would be coupled to capsule removal detector 26. The aforementioned opening or cutting of safety pin 21 will immediately enable the F–2 tank circuit 19, the oscillator within capsule removal detector 26 oscillating at F–2 will be loaded, and capsule removal alarm indicators such as 27 and 28 will be activated and thus unauthorized removal of resonant capsule 6 is immediately detected, and swift countermeasures may be taken if desired, although the actuation of chimes, etc. should stop the shoplifter. In addition, an ordinary safety pin is utilized in the place of the aforementioned rivet devices or nylon threads currently being utilized which greatly eases the task of attaching the capsules to the article to be protected and the removal of such capsules by the cashier. Furthermore, the safety pins lend themselves to use in conjunction

with small and/or delicate articles to be protected, unlike the aforementioned rivet devices as previously discussed.

In the more usual case of an honest customer, the dress is carried to cashier's counter **16**. The cashier rotates pivotable lid **31** and drops the capsule into an RF shielded capsule bin **32**. The opening of lid **31** actuates switch **33** which in turn inhibits a capsule removal alarm for the brief period during which the lid is opened. This may be performed in a sophisticated system by activating an RF transmitter **34** which transmits an F–3 radio signal to activate inhibit signal detector **36** which is tuned to an RF carrier having a frequency F–3. The inhibit signal produced by this detection temporarily inhibits an alarm indication which would be otherwise produced by capsule removal detector **26**. The F–3 radio link could be eliminated in certain situations by directly wiring switch **33** to capsule removal detector **26** and particularly where the capsule removal detector is positioned at the cashier's counter which is often feasible. Lid **31** is open for a 5 or 10 second period which is necessary so that the cashier may open safety pin **21** and deposit capsule of FIG. **2** within bin **32**. The lid is thereafter closed and the capsule removal detector **26** is again enabled. Methods of preventing the cashier from ringing up the sale without first removing the capsule form no part of the present invention and will be covered elsewhere.

In FIG. 2A, a capsule contains a single tank circuit **20**. In this configuration the aforementioned type of safety pin **21'** is positioned within slot **41**. A short circuiting control member **42** is coupled to the heel of the pin by coupling means **43** thereby to short circuit capacitor **44** so that only capacitor **46** is coupled in series with the inductor. Under these circumstances the tank circuit of FIG. 2A will resonate at frequency F–1 thereby to activate article removal detector **2** or **17** positioned in the exit areas as previously described. If the pin is opened by a shoplifter, capacitor **44** is no longer short circuited and tank circuit **20** will resonate at F–2 and load down capsule removal detector **26**. This will also occur if the pin is cut by wire cutters because the heel of the pin will spring up. In this embodiment only a single tank circuit may replace the twin tank circuit configuration of FIG. **2**. This movable short circuiting element might also be practicable in the case of a laminated tag having two holes in one of the outer sheets for receiving the two legs of the short circuiting element **42**. Of course the "double capacitor" single tank circuit could be utilized in an arrangement such as described in connection with FIG. **2**, i.e., no movable short circuiting element. Also an inductor portion may be short circuited.

In accordance with another embodiment of the invention, the capsules illustrated in FIGS. **3** and 3A may be utilized in conjunction with alarm devices described in U.S. Pat. No. 3,493,955 of Minasy. Minasy's capsules include a rebroadcasting (reradiating) device such as illustrated in FIGS. **2** and **6** of his patent. The rebroadcasting device is laminated within plastic tags which are riveted to the goods to be protected. In FIG. 2 of Minasy, an interrogation signal identification circuit comprises a resonant tank circuit **34** which is coupled to capacitor **44** of Minasy via diode **46**. When the tag is in the exit area, an F–1 interrogation signal causes tank circuit **34** to resonate and a DC voltage is produced across capacitor **44** which in turn activates a transistorized oscillator which resonates at a different frequency F–2. This F–2 frequency is detected by an RF receiver positioned in the exit area and an article removal alarm indication is produced, all as explained in Minasy's patent.

In the left hand portion of FIG. **3** the aforementioned signal identification circuit is labelled **34'** to correspond with tank circuit 34 of Minasy. Likewise diode **46'** corresponds with diode 46 in the Minasy patent. Rebroadcaster **51** shown in FIG. **3** includes circuitry shown in the upper portion of FIG. 2 of the Minasy patent. Thus, when the tag of FIG. **3** is introduced into the exit area by a shoplifter, the F–1 interrogation signal radiated by article removal detector **31** producing the aforementioned DC voltage which in turn causes the rebroadcaster to retransmit an RF signal of frequency F–2 which produces the alarm indication as described in the Minasy patent. In other words, article removal detector **2** in the present embodiment corresponds to the Minasy transmitter 18 and receiver 26. In accordance with an embodiment of the present invention, a second rebroadcaster **51'** is coupled to tank circuit **52** via diode **53**. A safety pin **54** having its lower segment removed, as shown, is electrically coupled across tank circuit **52**. Capsule removal detector **26** positioned at the cashier' s desk or in the storage area is similar to Minasy's article removal detector but preferably, but not necessarily, transmits an RF signal of frequency F–3 and tank circuit **52** is tuned to the F–3 frequency when safety pin **54** is opened. Thus in response to the unauthorized removal of resonant capsule **6** by a shoplifter, rebroadcaster **51'** is activated and rebroadcasts an RF signal at frequency F–4. Capsule removal detector **26** in this embodiment has an RF receiver channel which is tuned to detect a radio frequency of F–4 and a capsule removal alarm indication is produced as previously described. The laminated tag or capsule of FIG. **3** might utilize two rebroadcasting devices in each tag. In FIG. 3A, a single rebroadcaster is utilized having a tank circuit including two serially connected capacitors in the manner of FIG. 2A previously described. However, a single rebroadcaster might share two separate input tank circuits. If a shoplifter introduces the tag of FIG. 3A into the exit area **1**, safety pin **61** will be closed, capacitor **62** will be shunted and tank circuit **63** will resonate at F–1 to produce an article removal alarm. If the shoplifter opens the safety pin to discard the capsule, capacitor **62** will now change the resonant frequency of tank circuit **63** so that it resonates at F–3 which is the capsule removal detector interrogation frequency and a capsule removal alarm indication will be produced as previously described.

In the embodiments of FIGS. **2**, 2A, **3** and 3A, or for that matter any embodiment described herein, it might be feasible to have the exit area interrogation signal and the store area interrogation signal both be of the same frequency if the dress rack area is sufficiently separated from the exit area (out of range) of if the directional antenna associated with article removal detector **2** does not pick up the capsule removal (rebroadcaster) signal. Thus with the embodiments of FIGS. **3** and 3A it is feasible to eliminate the unwieldy

thumbtack rivets which are now commercially utilized in conjunction with the Minasy system. Ordinary safety pins may be readily utilized to apply or remove the FIG. 3 capsules. Obviously the movable short circuiting structure of FIG. 2A could also be readily utilized in FIGS. 3 and 3A (although it is believed preferable to short circuit the capacitor or inductor by utilizing the conductivity of the safety pin directly). This is true even though a laminated tag is utilized rather than a slotted capsule since holes could be drilled in the tag surface of the plastic tag sheet to receive the legs of movable short circuiting element **42**. The aforementioned embodiments could employ a rebroadcaster, including a "wristwatch" battery, such as shown in FIG. 7 of Minasy and in this case the capsules could be considerably smaller than the 2" × 3" tags now in commercial use in the Minasy system as pickup coils of 7/8" in diameter will suffice. See Col. 7 of Minasy. Such a small capsule having a safety pin would render Minasy's system more practical in connection with affixing the capsules to small and/or delicate items such as belts, hosiery, pocketbooks, sweaters, gloves, blouses, pillows, hats, delicate lingerie, etc. It is obviously impractical to utilize the riveted, rigid, 2" × 3" tags of Minasy on these items. It should be understood that if a single tank circuit shown in FIGS. 2A and 3A is employed, each tank circuit includes a first and second resonant device although each resonant device has a common inductive and/or capacitive element. Obviously the safety pin could short circuit a portion of the inductor instead of providing two capacitors.

Referring now to FIG. 4, another embodiment is disclosed which utilizes first and second resonant devices which mechanically resonate, preferably by directing sonic energy at said devices. A hollow capsule **71** contains an F–1 diaphragm **73** and an F–2 diaphragm **73** both of which could consist of thin metallic membranes supported by support elements **74**, **76** and **77**. In the exit area, article removal detector **2** would comprise an ultrasonic generator radiating sound at a frequency F–1 together with an RF transceiver **79**, (FIG. 5). The F–1 diaphragm **72** would have a fundamental frequency of vibration equal to the frequency of the sound generated by ultrasonic generator **78**. Typically F–1 would be 20 kilocycles which is for practical purposes beyond the hearing range. RF transceiver **79** directs an RF carrier of say 10 megacycles at the FIG. 4 capsule, positioned in the exit area, via directional antenna **81**. This transceiver could take many forms as is well understood by those skilled in the art and would preferably, although not necessarily, operate in the continuous wave mode.

If the FIG. 4 capsule or tag is positioned in the exit area, ultrasonic generator **78** will cause diaphragm **72** to resonate. A portion of the RF energy directed at diaphragm **72** by directional antenna **81** would be reradiated or returned to transceiver **79** which includes an ordinary FM receiver. This returned RF signal will be frequency modulated at F–1 by the vibration of diaphragm **72** and would be detected and amplified by an F–1 sharply tuned amplifier **82** coupled to the FM receiver output to produce an input signal to article removal alarm circuit **83**. In other words, alarm **83** would only be activated upon the receipt of an RF signal of 10 megacycles which is frequency modulated at the resonant frequency of diaphragm **72**.

In the storage area an F–2 ultrasonic generator **86** together with RF transceiver **87** would function as capsule removal detector **26** of FIG. **1**. The capsule of FIG. **4** with the safety pin closed would have no effect on capsule removal detector **26** because the F–2 diaphragm **73** is dampened by a rubber damper **75** coupled to the heel of safety pin **80** as shown in FIG. **4**. Slot **85** is similar to the slot described in connection with FIGS. 2A and 2B and functions to prevent tampering with the damper. Unlike directional antenna **81**, omnidirectional antenna **88** is utilized in connection with transceiver **87** and again comprises an elongated wire or wires running along a counter or ceiling or vertically oriented conductor(s).

Now let it be assumed that the FIG. **4** capsule is removed by a shoplifter by opening pin **80** or cutting it. The heel portion of the pin pops up and damper **75** permits F–2 diaphragm **73** to resonate at frequency F–2 generated by ultrasonic generator **86** in the storage area. The 15 megacycle RF signal frequency modulated at F–2 is detected as before and tuned F–2 amplifier **90** actuates capsule removal alarm **89**.

In the case of an honest customer, the cashier causes an inhibit signal to be applied to inhibit terminal **91** of gate **92** during the 10 second period when the FIG. **4** capsule is removed from the dress being paid for.

The systems disclosed herein utilizing mechanically resonating devices could, if desired, be utilized in the manner of the aforementioned system of Thompson and Minasy presently in use. That is, the capsules could be riveted or otherwise affixed to the goods and only a single diaphragm would be utilized for producing an alarm at the exit area.

In FIG. **6**, a system is illustrated which does not employ RF energy. An F–1 ultrasonic generator **101** is controlled by intermittent driving means **102** and produce bursts of sonic energy having a frequency F–1. A frequency selective microphone **103** having a high "Q" would be positioned at the exit area to detect the sound reradiated by F–1 diaphragm **72**. This signal would be amplified and fed through inhibit gate **104** and would be amplified by sharply tuned amplifiers **106** and **107** to actuate alarm circuit **108**. Although the sound detected by microphone **103** would be a weak signal, it would be reamplified by a series of sharply tuned amplifiers which would amplify and pass the received signal only of frequency F–1. Just before the transmission of a particular burst of ultrasonic sound at F–1, mono-stable multivibrator **111'** is actuated and inhibit gate **104** prevents a signal picked up by microphone **103** from being applied to the tuned amplifier channel so that the transmitted sound burst has no effect on the alarm system. However, multivibrator **111** has an R-C time constant such that it reverts back to its original state at a time after cessation of the first burst and before the instant of transmission of the following burst, and thus sampling gate **104** is opened during a time interval between bursts but is closed during bursts. Input lead **112'** of the multivibrator would be coupled to intermittent drive circuit **102** so that the multivibrator would be triggered just before an actual burst of sound is produced.

A second "F–2" arrangement similar to the system of FIG. **6** could be utilized in the store area for capsule removal detection where the FIG. **4** capsule is employed.

In FIG. 4A mechanically resonating transducers such as microphone crystals could be utilized to power the aforementioned rebroadcasters. Crystal **121'** would resonate at F–1 in the exit area by directing an F–1 sonic signal thereon while crystal **122'** would resonate at the F–2 interrogation signal generated by a capsule removal detector. A damper such as damper **75** previously described would dampen crystal **122'**, when the safety pin is closed. Again if rivets, etc. are utilized, the second crystal may be dispensed with. The AC electrical signal produced by the vibrating crystal would be rectified by the aforementioned diodes such as **46'** and **53** in FIG. **3** and would be applied across the previously mentioned capacitor **44** of Minasy to power the rebroadcaster.

FIG. 4B is similar to FIG. **4** except that piezoelectric crystals **123'** and **124** are utilized in place of diaphragms **72** and **73**. It appears that if an RF signal having a frequency equal to the resonant frequency of crystal **123'** were directed at the crystal that an oscillating electrical field gradient would be produced across the face of crystal **123'** at the radiated RF frequency by virtue of tin foil members **126** and **127**. In such a case, the resulting vibration of the foil clad crystals could be detected by microphone **103** as before. It is believed that F–2 diaphragm **73** would be roughly the size of a dime because the calculated wave length of a resonant body at 30 kilocycles is roughly 1/3 of an inch.

In accordance with another embodiment of the present invention, FIG. **7** illustrates a capsule which is believed to be particularly well suited for protecting articles stored in a warehouse. Because of the structural characteristics of a large warehouse it may be impractical to provide a large number of antennas coupled to one or more capsule removal detectors since the support girders of a warehouse may be widely separated from one another or the ceilings might be quite high. Since a warehouse exit area may be relatively confined, an F–1 tank **111** shown in FIG. **7** will serve to produce the exit area alarm as described hereinabove. However, to extend the "range" of the capsules (i.e. the distance from the capsule to the nearest capsule removal antenna), the capsule of FIG. **7** utilizes a radiant energy source such as an active RF oscillator which becomes powered by a wristwatch battery, etc. upon the opening of the fastening means. Likewise such a capsule may be employed in shoplifting operations if the extended "range" is deemed useful.

Oscillator **112** is in series circuit relationship with battery **113** and switch **114** which is spring biased to close by means of spring **116**. A fastening device **118** prevents the switch from closing by means of coupling member **117** and thus when the capsule is affixed to the goods, the series circuit remains open, power is not applied to RF oscillator **112**, and a signal is not radiated by antenna **121**. Thus under normal circumstances, no power is being drained from power source **113**. If desired, the RF oscillator may generate a carrier having a frequency indicative of the location of the protected article, to facilitate counter measures against the theft or theft pattern. In the alternative, or additionally, the oscillator may be modulated by a signal having a characteristic such as frequency pulse repetition rate, etc. to perform this function.

Upon the opening of fastener **118** or the attempted destruction of the fastener or coupling means **117**, spring **116** closes the power circuit and an RF signal is radiated by antenna **121**. This signal may be detected by an RF receiver tuned to the carrier frequency of oscillator **112**, the receiver in turn being coupled to a threshold device as described hereinabove in connection with FIGS. **5** and **6**. Obviously the receiver could have a detector and filter channel for identifying the predetermined modulation of the RF carrier if it is modulated.

Particularly in the case of protecting a warehouse, containing expensive articles, the manufacturer of this capsule could afford to make a capsule having at least a partially hollow configuration for housing one or more "wristwatch" batteries for generating an RF capsule removal signal detectable at a range of say 100 yards. The shell of the capsule could be fabricated of a tough plastic material and the capsule could be potted by standard techniques so that it would be very difficult for a warehouse employee to destroy the capsule in attempting to mash it. In order to further deter such mashing, a wide area pressure activated switch could be formed upon the inner surface of the plastic shell which would independently power the oscillator regardless of the state of the fastening means. Such a pressure sensitive switch **120** is coupled in parallel with switch **114** as shown. Such switches are known in the art and form no part of the present invention.

Since the battery is not normally being drained, it would probably last for at least a couple of years. However, a pair of recharging terminals **122** are optionally provided for externally recharging the battery. An asymmetrical conductor, which could comprise a diode **123**, is coupled between one of the recharging terminals and battery **113** as shown. If an attempt is made to short circuit the battery by externally shorting the terminals, such an attempt will be ineffective since diode **123** presents a very high impedance in the reverse direction of current flow.

It is also believed that the capsule of FIG. **7** may be utilized for extended range shoplifting applications since the power source is normally not being drained. It is apparent that since tampering with the fastener **118** will activate the spring biased switch it appears that such fastening devices such as steel bands, rivets, etc. can be replaced by a simple light weight device such as, or somewhat similar to, a safety pin which does not require special tools and procedures for application and removal. As stated previously in connection with other embodiments, rebroadcasters, diaphragms, crystals, etc. could replace F–1 tank circuit **111**. A self triggering blocking oscillator could generate a **10** millisecond burst of RF every 2 seconds to further conserve power if desired as the oscillator would only be radiating 0.5 percent of the time.

It is to be understood that the term "exit area" includes any area within which one desires to activate an alarm if a capsule is present. For example, article removal detector **17** at the cashier's counter would be an exit area for detecting a secreted article positioned at the cashier's counter. The term "alarm indicator" encompasses any device which produces a signal which is useful in connection with apprehending a shoplifter or a thief in another protected area such as a warehouse. The term "resonant device" encompasses electrical tank circuits, diaphragms, transponders,

rebroadcasters, crystals or other devices having periodic or non-periodic modes of vibration, e.g. blocking oscillators. The term "capsule" encompasses any support member supporting the devices described such as tags, hollow or semi-hollow shells (potted or not) or integrated circuits positioned within conventional lead frames.

In summary, the present invention illustrates a plurality of systems which differ from the commercially marketed systems of Minasy and Thompson and may be adapted to produce capsule removal alarm indications and may be utilized in conjunction with an ordinary safety pin rather than rivets, etc. which require special machines for application and removal and which are inappropriate for protecting small and/or delicate articles.

While the present invention has been described in specific terms hereinabove it is to be understood that the invention in its broadest sense is limited only by the following claims:

1. A method of deterring the unauthorized removal of goods through a given exit area by attaching a capsule to each of the goods to be protected, said capsule including a resonant device for mechanically operating at at least one predetermined frequency of vibration comprising the steps of:

a. causing said resonant device to mechanically resonate at a predetermined frequency of vibration at said given exit area by directing sonic energy thereat;

b. detecting the mechanical resonance of said resonant device at said given exit area by detecting at least a portion of wave energy reradiated by said resonant device; and

c. producing an article removal alarm indication in response to the detection of said wave energy reradiated by said resonant device at said given exit area.

2. The method of claim 1 wherein the step of detecting the mechanical resonance of said resonant device includes selectively detecting a resonant frequency of sound generated by said vibrating resonant device.

3. The method of claim 1 wherein said step of causing said resonant device to mechanically resonate at said predetermined frequency includes directing sonic energy at the capsules attached to said goods within said given area, said sonic energy having a frequency which induces mechanical vibration of said resonant device.

4. The method of claim 3 wherein said step of detecting the mechanical resonance of said resonant device includes directing radio frequency energy at said capsules and detecting the modulation of the returned portion of said radio frequency energy produced by the vibration of said resonant device.

5. The method of claim 3 wherein the step of detecting the mechanical resonance of said resonant device includes selectively detecting a resonant frequency of sound generated by said vibrating resonant device.

6. The method of claim 5 wherein sonic energy is directed at said capsules in bursts and the selective detection of the sound generated by the vibrating resonant device is performed between said bursts.

7. A method of deterring unauthorized removal of an article from a storage area through an exit area comprising the steps of:

a. attaching a capsule to a protected article stored within said storage area, said capsule including a first and second resonant device, each resonant device including a vibrating body which mechanically resonates in response to the receipt of sonic energy;

b. causing said first resonant device to resonate within said exit area by directing sonic energy at said capsule generated outside of said capsule;

c. detecting the resonance of said first resonant device within said exit area and producing an article removal signal in response to the detection of the resonance of said first resonant device in said exit area but not in said storage area;

d. interrogating said second resonant device in said storage area by directing sonic energy at said capsule generated outside of said capsule capable of causing said second resonant device to resonate;

e. inhibiting the resonance of said second resonant device when said capsule is attached to said article to be protected;

f. enabling the resonance of said second resonant device upon the unauthorized removal of said capsule from said article to be protected;

g. detecting the resonance of said second resonant device produced by said unauthorized removal; and

h. producing a capsule removal indication signal in response to the last named step.

8. The method of claim 7 wherein said vibrating body is a piezoelectric body and resonance thereof is produced by directing sonic energy thereon.

9. An externally activated capsule specifically designed to deter unauthorized removal of an article from a storage area through an exit area upon being activated at said exit area, said capsule being attached to said article and said capsule comprising:

a. a support member;

b. a first passive resonant device positioned upon said support member;

c. a second passive resonant device comprising a vibrating body which mechanically resonates at a particular frequency positioned upon said support member;

d. fastening means for attaching said support member to said article to be protected; and

e. control means including a damper for damping said vibrating body when said fastening means assumes a first state and for undamping said vibrating body when said fastening means assumes a second state.

10. The capsule of claim 9 wherein said vibrating body comprises a thin metallic diaphragm.

11. A device for use in a theft prevention system for preventing the unauthorized removal of goods from a given area, said device being attached to said goods within said given area and comprising:

a. a mechanical diaphragm designed to mechanically vibrate at a given frequency of vibration;

b. coupling means for attaching said mechanical diaphragm to said goods to be protected; and

c. control means positioned between said coupling means and said mechanical diaphragm for selectively damping the vibrations of said mechanical diaphragm when said coupling means assumes a first state and for undamping the vibrations of said

mechanical diaphragm when said coupling means assumes a second state.

12. An externally activated capsule specifically designed to deter unauthorized removal of an article from a storage area through an exit area upon being activated at said exit area, said capsule being attached to said article and said capsule comprising:

a. a support member;

b. a resonant device positioned upon said support member for coacting with an article removal alarm device associated with said exit area for producing an article removal alarm when said capsule is positioned at said exit area but not within said storage area;

c. a radiant energy source positioned upon said support member for generating a radiating signal capable of being detected by a capsule removal alarm device;

d. a power source for activating said radiant energy source;

e. a fastener for coupling said capsule to said article to be protected;

f. power control means for causing said power source to activate said radiant energy source upon the actuation of said fastener; and

g. a pair of recharging terminals coupled to said power source to enable the external recharging of said power source.

13. The capsule as set forth in claim 12 further including a device having an asymmetrical current conducting characteristic coupled between one of said terminals and said power source for enabling external charging thereof and at the same time for preventing external short circuiting of said power source by an individual tampering with said capsule.

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