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Williams et al.

[11] **3,919,704**

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[54] **SYSTEM AND METHOD FOR DETECTING UNAUTHORIZED REMOVAL OF GOODS FROM PROTECTED PREMISES, AND MAGNET DETECTING APPARATUS SUITABLE FOR USE THEREIN**

[75] Inventors: **Allan L. Williams**, Mt. Penn; **Lyle D. Heck**, Reading, both of Pa.

[73] Assignee: **Check Mate Systems, Inc.**, King of Prussia, Pa.

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[52] **U.S. Cl.** ..... **340/280**; 340/258 D; 343/6.5 SS; 343/872; 324/34 D

[51] **Int. Cl.**[2] **G08B 21/00**

[58] **Field of Search** ..... 340/280, 258 R, 258 C, 340/258 D, 224; 325/367, 369, 371; 343/866, 872, 893, 6.5 SS; 324/34 R, **324/34 D, 41**

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Primary Examiner—John W. Caldwell
Assistant Examiner—William M. Wannisky
Attorney, Agent, or Firm—Howson and Howson

[57] **ABSTRACT**

An improvement in systems in which a clip containing a magnet is secured to goods in a store, and in which magnet-sensing means are provided at an exit from the store to give an alarm if one attempts to remove the goods through the exit with the magnet-containing clip still attached; in an authorized removal of the goods, e.g. pursuant to a purchase, the goods with clip attached are taken to a check-out counter where the attendant removes the clip and magnet so the goods can be removed through the exit without sounding the alarm. The improvement comprises a mat-like array of loops of conductor coils disposed flat along a surface of the counter adjacent the attendant, over which array the goods are moved by the attendant in the course of the check-out procedure. If a magnet-containing clip is still attached to the goods, the motion of the magnet will induce currents in the coils to operate an indicator telling the attendant of this fact. If the attendant has failed to find and remove a clip from goods during the check-out procedure, the latter indications will so warn the attendant; upon observing the indication, the attendant then finds and removes the clip and magnet. This eliminates the possibility that the innocent purchaser may be embarassed by causing an alarm when he attempts to remove his purchases through the store exit. Preferably the coil array comprises at least two separate conductor loops of similar configuration, overlapping each other but spacially displaced in a horizontal plane, so that the moving magnet will induce currents in the loops; however the effects of simultaneous similar changes in magnetic flux through the two coils such as may be produced by changes in stray magnetic fields are cancelled out, and do not operate the indicator.

1 Claim, 4 Drawing Figures

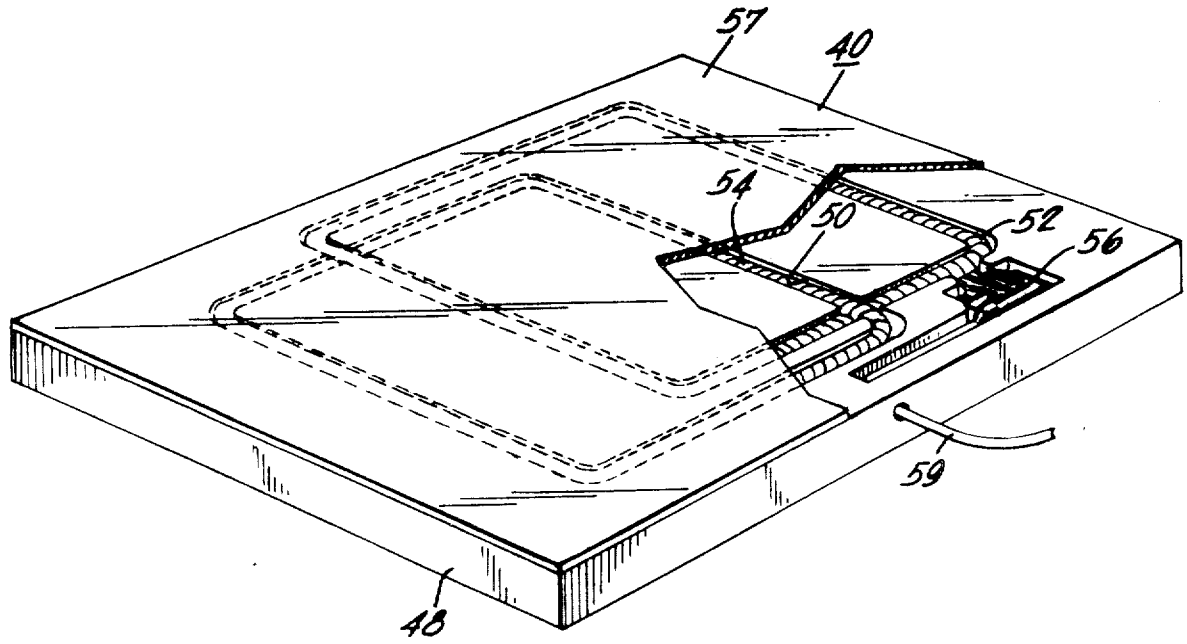


FIG. 1.

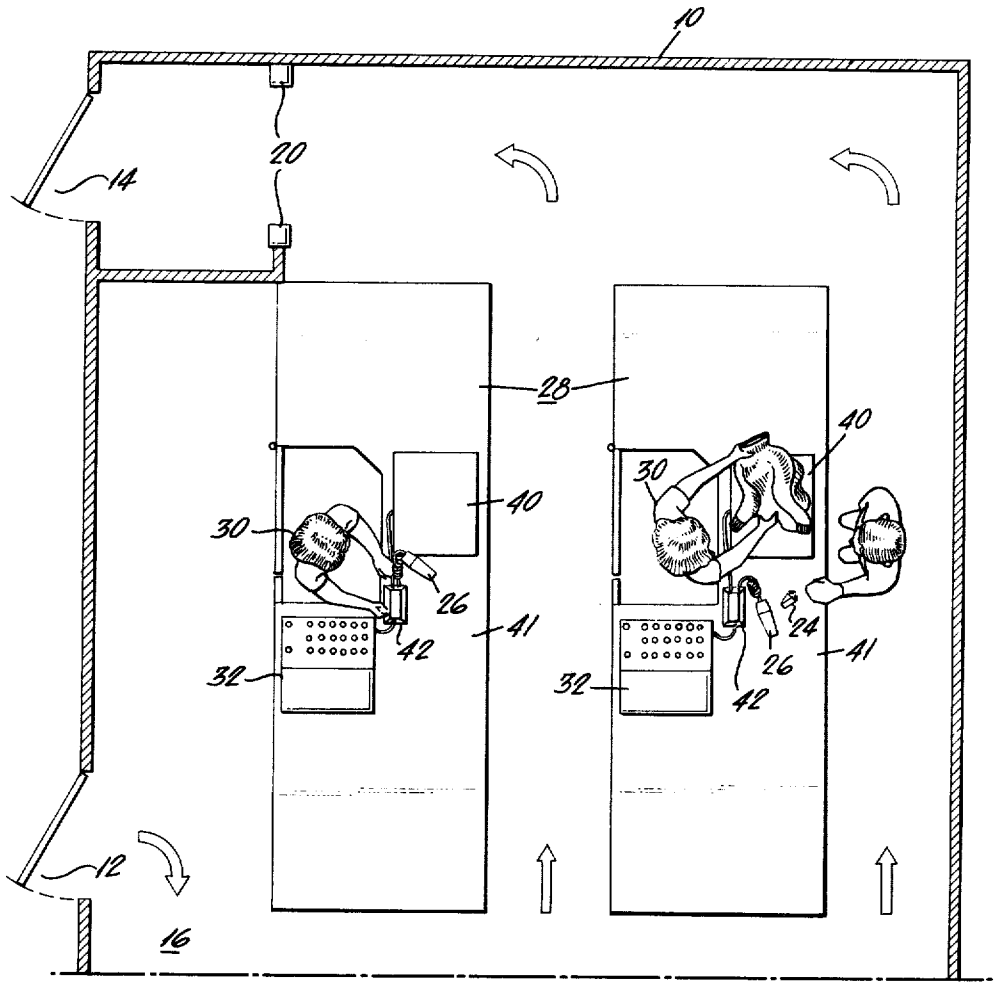


FIG. 2.

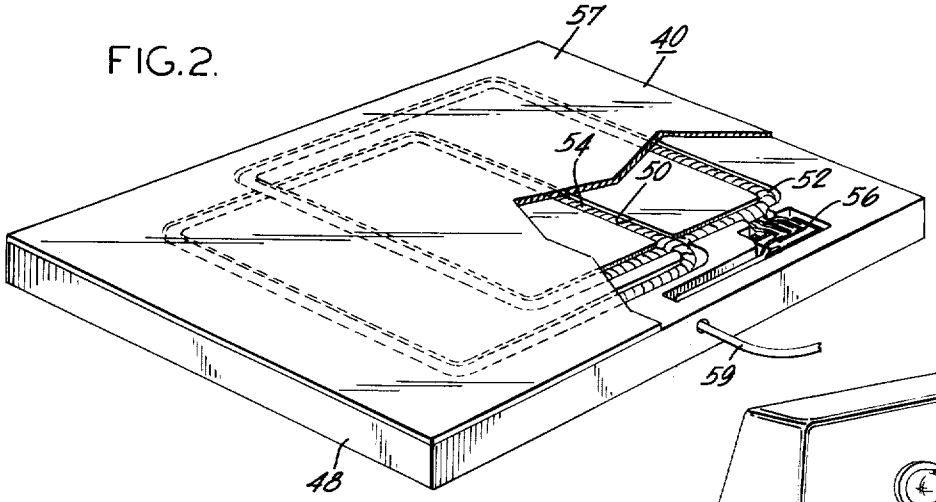


FIG. 3.

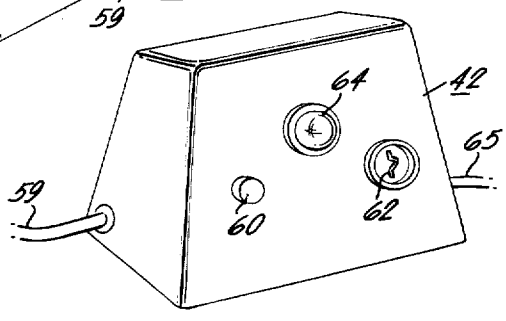
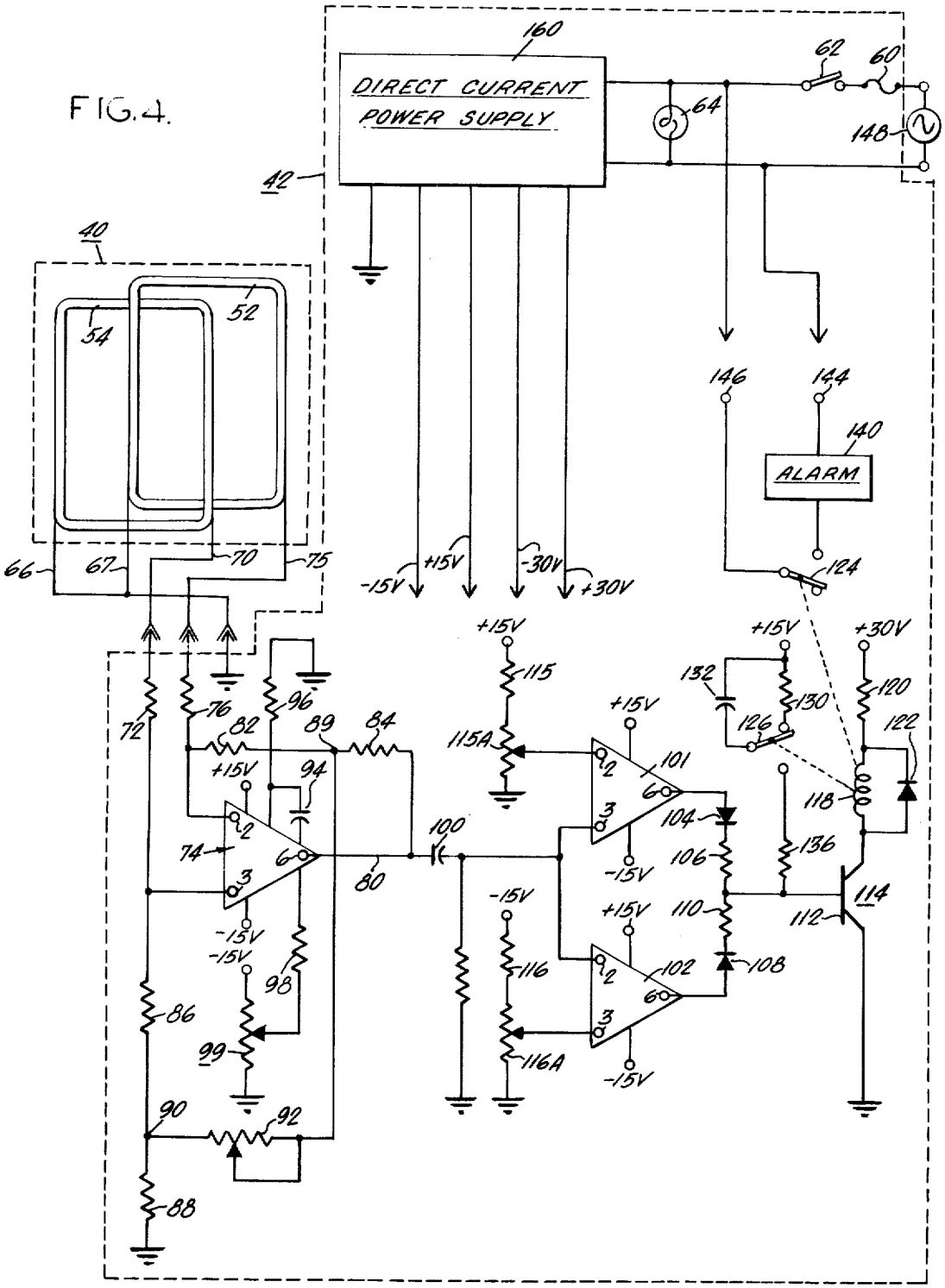


FIG. 4.


160
DIRECT CURRENT POWER SUPPLY
42
62
60
64
148
40
52
54
146
144
140
ALARM
124
66
67
70
75
-15V
+15V
-30V
+30V
72
76
82
89
84
96
94
74
80
100
115
115A
101
104
106
110
108
102
116
116A
98
99
86
90
92
88
132
126
130
120
122
118
136
114
112

SYSTEM AND METHOD FOR DETECTING UNAUTHORIZED REMOVAL OF GOODS FROM PROTECTED PREMISES, AND MAGNET DETECTING APPARATUS SUITABLE FOR USE THEREIN

BACKGROUND OF THE INVENTION

Various systems have previously been proposed which use electrical and magnetic means for detecting the unauthorized removal of goods from protected premises, such as a retail store, as part of an effort to reduce serious financial losses due to theft. In certain of such systems, a magnet is secured to the goods in the store and a magnet-sensing device placed at the exit to the store to detect the presence of the magnet on the goods. Thus, an alarm is sounded when one attempts to conceal goods on or about his person and to remove them from the exit, so long as the magnet is still secured to the goods. When an authorized removal of goods (for example pursuant to a purchase) is to be made, the magnet member is normally removed as part of the purchase procedure, and the goods may be removed from the premises without causing the alarm to operate at the exit.

Such systems, and electrically releasable magnet-containing clips to be secured to the goods, are disclosed and claimed in copending application Ser. No. 112,355 of A. L. Williams and L. D. Heck, filed Feb. 3, 1971 and now U.S. Pat. No. 3,718,922 issued Feb. 27, 1973; and in copending application Ser. No. 299,058, of A. L. Williams and T. A. Keifer, filed Oct. 19, 1972 now U.S. Pat. No. 3,806,910, issued Apr. 23, 1974. In such system, a hinged clip containing a permanent magnet is secured to the goods in a locked condition, and contains a bimetallic element which can be operated to open the clip only in response to an electrified key provided at the check-out counter and applied to the clip by the check-out attendant. Suitable magnetometer or like apparatus adjacent the store exit will detect the removal of unpurchased goods having the magnet-containing clip still secured thereto, and will sound an alarm indicating a theft.

One difficulty which can arise in such a system is that the check-out attendant may overlook removal of a clip, and an innocent purchaser carrying purchased goods through the exit may then cause an alarm to be given, which would not only require returning the goods to the check-out counter to remove the clip, but would also be embarassing to the customer. Failure to remove the clip can result from complete negligence by the attendant in forgetting to locate the clip on each piece of purchased merchandise, or can arise in situations in which not all goods are always provided with clips and the attendant believes that a particular piece of merchandise is of a type not provided with a clip and hence does not search for the clip.

Accordingly, it is an object of the invention to provide a new and useful system and method for preventing false indications of unauthorized removal of objects from protected premises.

Another object is to provide such method and apparatus which will permit detection of unauthorized removal of objects from protected premises by operating an appropriate alarm, but will prevent operation of such an alarm when such goods are removed with authorization, as after purchase for example.

It is also an object to provide a method and system of the type in which magnet means are secured to objects within protected premises and their removal through an exit in the premises is detected by sensing the presence of the magnet, in which assurance is provided that the magnet means has been removed from those goods which have been purchased, prior to their removal through the exit.

Another object is to provide a convenient, inconspicuous magnet detector at the check-out station which will sense movement near it of a magnet associated with goods and produce an indication of the presence of the magnet.

A further object is to provide such magnet-detecting apparatus which is sensitive to the magnet on the goods but insensitive to the effects of usual stray magnetic fields.

It is also an object to provide such a magnet detector which is simple, safe, economical, reliable and does not interfere with usual check-out procedures.

SUMMARY OF THE INVENTION

In accordance with the invention, there is provided a method and system in accordance with which magnet-detecting means is provided along the path of authorized removal of goods from protected premises at a position prior to the location of the magnet-sensing means used to detect unauthorized removal of goods from the premises. Preferably the first-mentioned magnet-detecting means is located at the check-out position for purchased goods, and is such that when any goods having a magnet associated therewith are moved near the magnet-detecting means, an indication is provided to warn that the magnet means should be found and removed before their passage through the exit causes a false alarm. Preferably, the magnet-detecting means at the check-out position is in the form of a mat-like structure lying horizontally along the check-out countertop, where movement of the goods by the check-out attendant adjacent the magnet detector will provide indications to the attendant if a magnet is still present on the goods. Preferably also, the magnet detector comprises at least two separate conductive loops so positioned and configured as to cause a net current in response to motion near them of a magnet, but so as to produce little or no net currents in response to changes in stray magnetic fields. In a preferred embodiment, the at-least-two separate coils are of similar or the same configuration but displaced from each other horizontally, preferably in an overlapping but non-congruent position.

Should the attendant fail to remove a magnet from the goods, the motion of the goods over the mat-like magnet detector on the countertop will produce a warning indication and alert him to the failure to remove the magnet. In this way it is assured that the customer will not be embarassed by a false alarm at the exit due to the presence of a magnet on properly purchased goods.

BRIEF DESCRIPTION OF FIGURES

These and other objects and features of the invention will be more readily understood from a consideration of the following detailed description, taken with the accompanying drawings in which:

FIG. 1 is a plan view of protected premises using the apparatus and system of the invention;

FIG. 2 is a perspective view of a mat-like magnet-detecting coil array in accordance with the invention;

FIG. 3 is a perspective view of the electronics unit for the magnet detector, including the indicator therefor; and

FIG. 4 is an electrical schematic drawing for the magnet-detector apparatus of the invention.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

Referring now to the embodiment of the invention illustrated in the figures, there are represented protective premises within building walls **10** provided with a customer entrance **12** and a customer exit **14.** Entrance **12** leads to a goods storage area **16** for goods and merchandise on sale or display. On either side of the path leading to the exit are located magnetometer devices or the like which will sense the presence of a magnet adjacent to them and provide an alarm, typically an audible alarm. Secured to the goods on sale in the store are magnet-containing clips such as **24,** which may be of one of the types disclosed and claimed in the above-identified copending applications. Each such clip contains a magnet, generally a permanent magnet, and the clip is secured to the goods in a locked condition. The clip is provided with hinged jaws which can only be opened when the clip is supplied with an electrical current from an electrified releasing wand such as **26.** The releasing wand **26** is in this example positioned at the check-out stations such as **28,** the check-out stations being positioned along the path taken by customers on their way to the exit **14.** At each check-out station there is normally an attendant such as **30,** and a cash register **32,** in addition to the electric wand **26.**

As described in the above-identified copending applications, if a customer attempts to leave the premises by way of exit **14** with goods from which the magnet-containing clip has not been removed, the magnet detecting system **20** will sound an alarm indicating a theft. In the course of a normal purchase, the customer or the attendant will bring the goods to one of the check-out stations, the clip will be removed by means of the electrified wand, the financial transaction involved in the purchase will be completed and the goods without the clip are removed by the customer through the exit without any alarm being given, as desired.

However, should an innocent purchaser carry to the magnet-detecting apparatus **20** goods to which a magnet-containing clip is still attached, a false alarm will be given, with considerable embarassment to all parties.

In accordance with the invention in this embodiment, failure to remove a magnet-containing clip during the purchase procedure at the check-out station is detected and indicated to the attendant by means of a mat-like magnet detector **40** positioned adjacent the check-out station, in this example lying flat on the top of the check-out counter **41.** The mat-like detector **40** is electrically connected to an associated electronics unit **42,** which may be housed in the same cabinet as the electronics for the release wand. The electronics unit may be placed on top of, beneath, or in any convenient location with respect to, the check-out counter.

When goods to which a magnet-containing clip is secured are brought to the check-out station and moved adjacent the detector mat **40,** currents induced by such motion produce an indication on the electronics unit **42** of the presence of the magnet. This indication constitutes a warning to the attendant that the magnet-containing clip is still present, so that he may remove it by use of the electrified wand. Preferably the mat-like detector is placed within easy reach of the attendant, so that the above-mentioned motion of the magnet with respect to the mat is produced during the ordinary course of purchase and packaging, or the attendant can consciously move the goods, either before or after packaging, through the region above the mat-like detector as assurance that the clips have all been properly removed. Of course if an indication is obtained in this procedure, the attendant then searches for clips on the goods and removes them with the wand, until motion of the goods near the mat-like detector no longer produces an indication of the presence of a magnet. In this way it is assured that all magnet-containing clips have been removed before the innocent purchaser removes the goods to the exit **14,** and hence false alarms by the magnet detector apparatus **20** are prevented.

The detector **40** contains at least one electrical conductor, and preferably a plurality of separate coils of conductors, each comprising one or more loops. FIG. **2** illustrates one preferred form of the mat-like detector. A flat rectangular base **48,** suitably of a hard plastic material, is machined to provide the various grooves such as **50** in the upper surface of the base, the grooves being sufficiently deep to accomodate the two-multiturn coils **52** and **54** which overlap each other and lie substantially in the same plane. A printed-circuit terminal strip **56** is cemented to the bottom of a recess in the base **48,** the four leads from the two coils being connected to four corresponding tabs of the terminal strip. The terminal strip connects these found leads to three output leads from the coil array as shown in FIG. **2** and in the electrical diagram of FIG. **4.**

As an example only, each coil may be in the form of a generally rectangular loop about 12 inches long and 8 inches across, each loop overlapping the other to about the center line of the other loop, the loops also being slightly displaced from each other in their lengthwise direction. A top cover **57** of plastic material similar to base **48** may be cemented over the top of the base to seal the coils in position and to protect them from damage or deterioration. The complete detector unit may typically be about 1½ feet long and 14 inches in width and about 1 inch in height.

FIG. **3** illustrates a typical form of the electronics unit for the detector, to which the three leads from the mat-like detector are connected by the cable **59.** On its front, facing the attendant, are mounted a line fuse **60,** key-operated on/off power switch **62,** and a pilot lamp **64;** a buzzer alarm providing the indication of the presence of the magnet near the detector mat is contained within the cabinet of the electronics unit. Line power for operating the unit is supplied over line **65.**

Referring now to FIG. **4** showing the electronic circuitry of the magnet detector apparatus, as shown the two coil terminal leads **66** and **67** from the left-hand sides of the two coils **54** and **52** are connected together and to a common ground. The lead **70** from the right-hand side of coil **54** is connected through a resistor **72** to the non-inverting input terminal **3** of the solid-state differential amplifier **74,** while the lead **75** from the right-hand side of coil **52** is connected through resistor **76** to the inverting input terminal **2** of the differential amplifier.

Differential amplifier **74** may comprise, for example, the industry type-number **301** differential amplifier which produces at its output connection **6** an amplified

version of the difference between the signals supplied to its inverting and non-inverting input terminals. Resistors **76, 82** and **84** constitute the gain-determining resistors for the inverting input **2**, while resistors **72, 86** and **88** determine in part the gain for signals supplied to the non-inverting input terminal **3**; preferably resistors **72, 86** and **88** are respectively equal in value to resistors **76, 82** and **84**. In addition, the connection from junction point **89** between resistors **82** and **84**, to the junction point **90** between resistors **86** and **88**, by way of the variable resistance **92**, provides additional feedback for increasing the gain of the amplifier. Resistor **92** is normally set to provide the maximum feedback and maximum gain possible without rendering the amplifier inoperative by causing it to be held in one of its extreme conduction states. A conventional bandwidth control circuit comprising capacitor **94** and resistor **96** limits the bandwidth of the amplifier to a few cycles per second, thereby reducing sensitivity to high-frequency noise or interference, including stray 60-cycle fields. In addition, the connection of resistor **98** to ground through the variable resistance **99** constitutes a conventional offset node adjustment to balance the amplifier so that it produces zero output when the input signals to its inverting and non-inverting terminals are exactly equal. The amplifier output connection **6** is connected to the remainder of the circuit through the AC coupling capacitor **100**, to avoid drift problems sometimes encountered when DC coupling is utilized.

The signal passed through capacitor **100** is supplied to input terminals **3** and **2**, respectively of amplifying comparators **101** and **102**, which again may be standard solid-state devices, such as the industry type-number **741**. Each of these devices has the property that its output signal begins to exceed zero in the positive direction only when the voltage applied to its terminal **3** first exceeds the voltage applied to its input terminal **2**. The output terminals **6** of comparators **101** and **102** are supplied, respectively, through diode rectifier **104** and resistor **106**, and through diode rectifier **108** and resistor **110**, to the base **112** of an NPN transistor **114**. The polarity of connection of the two diode rectifiers **104** and **108** is such that each passes a positive signal to transistor base **112** to turn on transistor **114** only when the output of its corresponding comparator is positive.

Input terminal **2** of comparator **101** is biased positively by the bias voltage supplied thereto through fixed resistor **115** and adjustable divider **115A**; input terminal **3** of comparator **102** is biased negatively by the bias supplied thereto through fixed resistor **116** and divider **116A**. Accordingly, when the signal through capacitor **100** is zero or small, neither comparator produces a positive output; when the signal through capacitor **100** becomes more positive than a value established by the position of the tap on divider **115A**, comparator **101** produces a positive output; and when the signal through capacitor **100** becomes more negative than a value established by the position of the tap on divider **116A**, comparator **102** produces a positive output. Small signals due to noise or interference are thus prevented from turning on transistor **114**.

The emitter of transistor **114** is grounded and its collector is connected through relay coil **118** and resistor **120** to positive supply potential. A conventional transient-suppressing diode rectifier **122** is connected in parallel with the relay coil. Relay coil **118** operates upon its associated contact arms **124** and **126**, and causes them to move from the normal positions thereof shown in the drawing to their opposite positions when a current is passed through the relay coil. In the absence of signal from the comparators **101, 102**, the base of transistor **114** is open-circuited and the transistor substantially cut off, so that no current flows through relay coil **118** and the contact arms **124** and **126** remain in the positions shown.

In the normal condition shown, the contact arm **126** connects a resistor **130** in parallel with a timing capacitor **132**, the opposite upper end of resistor **130** being connected to the positive supply potential; resistor **130** then serves to maintain capacitor **132** normally discharged. However, when relay contact arm **126** is changed to its opposite position, it connects to capacitor **132** in series between the positive supply voltage and the base **112** of transistor **114**, by way of the series resistor **136**. This causes a positive voltage to be applied to transistor base **112**, holding the transistor in conduction, until capacitor **132** becomes charged up by the positive supply. Thus if either of the comparators **101** and **102** supplies only a momentary positive voltage to transistor **114**, turning it on for only a short interval, the action of relay contact arm **126** and capacitor **132** is to maintain the transistor **114** conductive for a predetermined interval, typically a few seconds, even though the positive signal from the comparator has already disappeared. Accordingly, even a momentary output from one of the comparators will cause the transistor **114** to remain turned on for at least a few seconds. Also, when current flows through relay coil **118** contact arm **124** is operated to its opposite position, and an alarm **140** such as a buzzer is connected in circuit with an alternating voltage source supplied over lines **144** and **146**. Therefore, whenever a positive signal is applied to the base **112** of transistor **114** the buzzer will be sounded which will persist for the time required for capacitor **132** to charge.

To provide operating supply voltages for the circuit, an alternating-voltage supply source **148**, such as a standard 110-volt AC wall socket, is provided, one side of the line from source **148** being connected through the fuse **60** and the on/off power switch **62**; pilot lamp **64** is connected between the opposite sides of the alternating voltage supply line, following the fuse and on/off switch, to provide an indication that the switch has been closed. The alternating supply voltage is then supplied to a conventional direct-current power supply **160**, the output of which provides the direct voltages required for operating the circuit. In this example, the DC supply voltages are ground, +15 volts, −15 volts, +30 volts and −30 volts.

In the operation of the circuitry shown, when there is no magnet moving near the sensing coils **52, 54** there will be no input voltage to, or output voltage from, the differential amplifier **74**; transistor **114** will be nonconductive; there will be no current through relay coil **118**; and the relay contacts **124** and **126** will be in the normal position shown. Accordingly, the alarm **140** will not receive operating voltage and the buzzer will not be operated. If there should be a simultaneous change in the magnetic field affecting both sensing coils equally, for example due to changes in the earth's magnetic field or due to changes in other stray magnetic fields, the same current will be induced in both coils, there will be no difference in the inputs supplied to the differential amplifier, and accordingly there will be no output therefrom and the alarm again will not be operated. However, if a magnet-containing clip is moved over the

sensing coils, for example within about one foot thereof, the motion of the magnet relative to the conductors in the coils will induce currents in the coils which, in general, will be unequal in strength. For example, if the magnet is moved from left to right across the sensing coils, first a pulse of current of a given polarity will occur in leads **70,** then a pulse of current of the same polarity will occur in lead **75,** next a pulse of current of opposite polarity will occur in lead **70,** and then a pulse of opposite polarity will occur in lead **75.** Each of these pulses represent an unbalanced input to the differential amplifier which will at least momentarily turn on transistor **114,** and timing capacitor **132** will hold that transistor on for at least a few seconds, during which time the alarm is given to the attendant, indicating a magnet-containing clip is near the detector mat. The attendant then searches for and removes the clip so that the customer may leave with the goods without sounding the alarm at the exit of the premises. Of course, the magnet need not be moved from left to right as described above, any substantial motion of the magnet near the coils generally producing an unbalanced signal to the differential amplifier.

Although the form of coils shown is preferred, other arrangements thereof may also be utilized. As examples only, more loops (such as 4, 6 or 8 loops) may be employed if desired, half of them being connected in parallel with each other and the other half being separately connected in parallel with each other; each coil may itself be formed into several displaced loops if desired. Furthermore, although it is preferred to utilize coils having the same configuration, but spacially displaced from each other, it is possible to use two loops which are of different configurations but which respond in the same way to changes in uniform fields by selecting the number of turns of wire in each to produce the same output in response to the same flux changes. Also, the connections to the two coils may be reversed from that shown so that, instead of producing equal outputs in response to equal changes in uniform fields through them, they produce outputs of the same magnitude but opposite polarity. In this event, the electronic circuitry may be arranged to add algebraically the effects of the currents in the two loops, instead of effectively subtracting them. The coils may also be completely separated from each other, rather than overlapping, although this requires more space and has been found less effective.

While one preferred location for the detector mat is lying flat on the top of the counter, it may be mounted in the counter top, or below it if the counter top is of non-magnetic material such as wood or plastic. It may also, for example, be mounted vertically rather than horizontally, along one side of the counter where the attendant normally carries the goods, so that she may conveniently move the goods across the detector pad to determine if any clips are still on the goods. Also, while it is preferred to utilize an arrangement of coils and associated circuitry which cancels or nulls out the effects of similar simultaneous currents in the two coils, it is possible to use a single coil, or theoretically even a single straight conductor, although in the first case susceptibility to interference and false indications would be increased, and in the second case the sensitivity of the system would be greatly decreased.

Thus while the invention has been shown and described with particular reference to specific embodiments thereof in the interest of definiteness, it may be embodied in a variety of forms diverse from those specifically shown and described, without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. Apparatus for detecting the presence of a magnet secured to goods adjacent a counter, comprising a mat-like housing adapted to lie flat on said counter, at least a pair of similar partially-overlapping electrical conductor coils lying flat within said housing and connected so that current is induced in any of said conductors by said magnet only when said magnet is adjacent said conductors and in motion relative to said conductors, and indicator means connected to said at least pair of conductor coils for producing indications in response to currents induced in said conductors by adjacent movement of said magnet and non-responsive to the effects on said coils of extraneous magnetic fields from remote sources.

* * * * *