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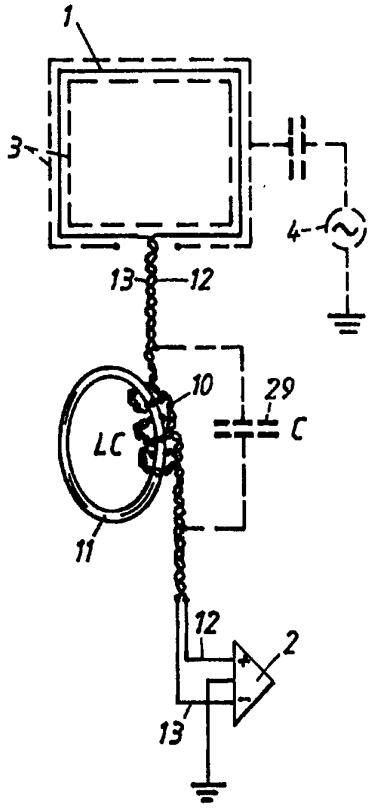
(57) Abstract

An arrangement for preventing disturbances in electronic alarm systems of the kind used in merchandise security systems, wherein the system includes an alarm element which is adapted to receive a magnetic alternating field transmitted by a transmitter and also to retransmit a magnetic alternating field, wherein a receiver is adapted to receive and detect the retransmitted alternating field. The invention is characterized by a resonance circuit LC which is located in at least certain pairs of electric conductors (5; 12, 13; 20, 21; 25, 26) in the system between the system electronics (2; 19) and receiver coil (1; 24) and alternatively also the transmitter coil (14), and which is tuned to the working frequency or frequencies of the system so as to produce a high impedance on the conductor pair for current directed in the same direction in the conductors, thereby heavily dampening disturbance sources coupled capacitively, inductively or resistively to the system.



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AN ARRANGEMENT FOR PREVENTING DISTURBANCES IN ELECTRONIC ALARM SYSTEMS

The present invention relates to an arrangement for preventing disturbances in electronic alarm systems of the kind used in merchandise security systems.

Many different types of merchandise security alarm systems are described in the patent literature. These arrangements are intended to prevent merchandise from being removed from shops and stores without having been paid for. Normally, such merchandise security arrangements, or theft prevention systems, include some type of alarm element which is secured to the merchandise to be protected, and a detector device which is installed in the vicinity of the store exit and which delivers an alarm through the medium of remote detection control when an alarm element is brought into the vicinity of the store exit.

Remote detection of the alarm element is normally achieved by transmitting a magnetic alternating field, wherewith the presence of an alarm element can be detected through a change in the alternating field characteristic of the alarm element.

The alarm element may have the form of an elongated, narrow thin strip of highly permeable material whose characteristic property is to transmit high order harmonics when subjected to the effect of a magnetic alternating field. This known basic principle enables small and inexpensive alarm elements to be detected with the aid of complicated and relatively expensive detection systems. This type of merchandise alarm is particularly well-suited for protecting everyday commodities or merchandise and is described, inter alia, in European Patent Specification EP 0,153,286.

Also known to the art are alarm elements comprised of a simple electric resonance circuit. In this case, the detec-

tion system can be made simple and inexpensive when the coil in the resonance circuit is relatively large, so that a good Q-value can be readily obtained at the same time as the coupling to external fields will be large. In this case, the coil is mounted in an alarm plate which is secured to the merchandise to be protected with the aid of some suitable fastener means. As before mentioned, the detection systems which operate with this type of alarm can be made relatively uncomplicated at a relatively low cost, although it is difficult to avoid the problem of triggering false alarms, because the store environment will often include loops of conductive material which give rise to resonances similar to the resonances obtained from the alarm elements.

Another problem resides in coupling of current in the receiver and transmitter coils and current on the alarm system cables that extend between the transmitter and receiver equipment and the detection system. By current on conductors is meant that a net current flows in a pair of conductors between which an alternating voltage prevails, i.e. the current in one conductor of the conductor pair is greater than the current in the other conductor of said pair. Cable current means that the sum of the currents in all conductors of the cable differ from zero, when taking into account the direction of the current in each conductor.

By pairs of conductors is meant above and below, and also in the Claims, a pair which consists in two simple conductors and a cable including two or more conductors, of which one or more conductors can be comprised of a shield around one or more other conductors.

When the transmitter gives rise to a current on conductors other than those conductors which form the actual coil, an alarm can be triggered by an alarm element that is in the close vicinity of a conductor but far away from the coil itself. This is most undesirable.

Current on conductors other than those which form the receiver coil can give rise to a signal in the receiver as a result of the receiver taking in disturbances that originate from electromagnetic fields that couple to the conductor concerned, for instance as a result of the conductor passing an electrical apparatus.

If a transmitter coil or a receiver coil is touched by a person, and in particular if both coils are touched at the same time, marked signal variations will occur in the receiver. This can give rise to a false alarm and also reduce the detection efficiency of the system.

A known solution which reduces, but does not eliminate, the problems of coupling between different disturbance source and the system is to balance transmitter and receiver to earth and to balance and screen the coils. This solution is described in Swedish Patent Specification SE 445,498.

The present invention eliminates the problems of coupling between different units in the system and coupling between the system and external disturbance sources of different kinds.

The present invention thus relates to an arrangement for preventing disturbances in electronic alarm systems of the kind used in merchandise security systems, wherein the system includes an alarm element which is adapted to receive a magnetic alternating field transmitted from a transmitter and to retransmit a magnetic alternating field, wherein a receiver is adapted to receive and detect the retransmitted alternating field, wherein the arrangement is characterized in that there is provided in at least given pairs of electric conductors in the system between the electronics and the receiver coil of said system and alternatively also the transmitter coil of said system a resonance circuit which is tuned to the working frequency or working frequencies of the

system such as to produce a high impedance on the pair of conductors for current directed in the same direction in said conductors and thereby markedly dampen disturbance sources that are coupled capacitively, inductively or resistively to the system.

The invention will now be described in more detail with reference to exemplifying embodiments thereof and also with reference to the accompanying drawings, in which

- Figure 1 illustrates a first embodiment of the invention;
- Figure 2 illustrates a second embodiment of the invention;
- Figure 3 illustrates the use of the invention in a manner different to that shown in Figure or Figure 2; and
- Figure 4 illustrates a third embodiment of the invention.

The present invention relates to an arrangement for preventing disturbances in electronic alarm systems of the kind used in merchandise security systems, said systems including an alarm element which is adapted to receive a magnetic alternating field transmitted by a transmitter and also to retransmit a magnetic alternating field, wherein a receiver is adapted to receive and detect the retransmitted alternating field.

In order to illustrate the problem that exists with known systems, reference is made to Figure 1, which shows a receiver coil 1. Also shown in the Figure is a receiver of a front-end circuit in the present type of alarm system, namely a differential amplifier 2. It is assumed that the coil is screened with a screen or shield 3 and that a two-conductor screened transmission conductor extends between the receiver coil 1 and the receiver 2. In the known technique this conductor is not wound in the form of a coil as shown in Figure 1.

When an alarm element is located in an investigation zone in which the receiver coil is located, the magnetic alternating

field transmitted by the alarm element will induce an electromotive force (EMF) in the coil 1. This EMF is sensed by the receiver 2.

One problem is that the receiver coils of existing systems are subjected to electrical disturbances which are coupled capacitively to the receiver coil. This is illustrated in Figure 1 in broken lines. A disturbance source in the locality is referenced 4 and in the illustrated case has the form of an oscillator. This disturbance source is coupled capacitively to the screen 3 of the receiver coil 1. This capacitive coupling is illustrated with a capacitor corresponding to the capacitance CS that prevails between the disturbance source and the receiver coil. The current that arises in the screen 3 as a result of the capacitive coupling CS gives rise to a voltage on the receiver input through transformer output. This may cause the receiver to understand the signal as originating from an alarm element and to trigger an alarm.

The current originating from the disturbance source 4 flows on the screen 3, clockwise on the screen 3, through the conductor 8, on the conductor 5 associated with the screen, and through the conductor 9 to earth. This current induces in the coil 1 an electromotive force which gives rise to a voltage difference between the positive terminal and the negative terminal of the amplifier 2.

This problem and other corresponding problems are solved in accordance with the invention in that at least given pairs of electric conductors in the system, between the electronics and the receiver coil of the system and alternatively also the transmitter coil, there is provided a resonance circuit which is tuned to the working frequency or working frequencies of the system so as to produce a high impedance in the conductor pair for current directed in the same direction in said conductors, thereby markedly dampening disturbance

sources that are coupled capacitively in the system.

This results in a very high net current impedance, i.e. when the sum of the currents in the two conductors differ from zero while taking into account the direction of the currents. However, the impedance of such a resonance circuit will be small when the net current is equal to zero, i.e. when the front-end circuit 2 has a low impedance the current passing through the receiver coil and the front circuit will not be influenced by the resonance circuit.

When a cable containing two or more conductors is to be connected to a resonance circuit in accordance with the invention, the whole of the cable is wound to a coil form.

When an alarm element is detected, the two-conductor cable will ideally receive a zero net current. On the other hand, the net current differs from zero when current flow originates from the capacitive coupling.

According to one preferred embodiment of the invention, the resonance circuit is formed by winding the pair of conductors 5 concerned to provide a coil 6 of inductance L, and forming the capacitance in the resonance circuit from the stray capacitances C between the conductors in said coil, and optionally other stray capacitances. The stray capacitance is illustrated by a capacitor 7 shown in broken lines.

According to a first embodiment of the invention, the pair of conductors extend from the receiver coil, and alternatively also to the transmitter coil, in the form of solely one screened two-conductor cable which is wound to form a coil of inductance L and includes the stray capacitance C. This embodiment is illustrated in Figure 1.

Thus, according to this embodiment, the receiver coil is connected to a screened two-conductor cable 5 which is wound

to form a coil having the inductance L and including the stray capacitance C. The screen of the two-conductor cable can be connected to the screen 3 of the receiver coil and also to the differential amplifier and to earth.

When the capacitance CS is essentially equal to the stray capacitance C, the impedance across the resonance circuit LC will be in the order of ten times the impedance across the capacitance CS. The bandwidth is then approximately +/- 10%. This means that the disturbing current originating from the disturbance source will be reduced by a factor of 10, whereby disturbance sensitivity will be reduced to the same extent. On the other hand, current originating from an alarm element will not be dampened to any appreciable extent. Higher damping effects can be obtained with narrower bandwidths.

According to one embodiment of the invention, a capacitor is connected in parallel across each two-conductor screen, with respective connecting points located on respective sides of the coil, i.e. in the manner in which the broken-line capacitor of Figure 1 is connected. Thus, in this case, the total capacitance is comprised of the capacitor capacitance and the stray capacitance.

The parallel coupling of a capacitor across the coil 6 affords the advantage of requiring a fewer number of coil turns to achieve the same damping effect on net currents, although it has a drawback in the form of reduced bandwidths.

Two or more different working frequencies occur in some systems of the present kind. A large bandwidth is therefore sometimes an advantage. However, it may be necessary to include in such systems several series-connected resonance circuits coupled to the two-conductor cable. In these cases, each resonance circuit is a separate LC-circuit.

A single resonance circuit is sufficient in other systems

having only one working frequency.

However, it is desirable for C to have the smallest possible capacitance, since the desired damping of net currents is hereby maximized. Because of this, the capacitance C is preferably comprised of the stray capacitance of the coil 6 and optionally other stray capacitances.

Since the resonance circuit effectively reduces the flow of net current through the conductors 8, 9 connected to the screen of the two-conductor cable, these conductors can be omitted.

Neither is it necessary to use a screened two-conductor cable. The same effect is achieved with the use of a well-twisted, unscreened two-conductor cable.

According to one highly preferred embodiment of the invention, a pair of unscreened conductors 12, 13 extend from the receiver coil, and alternatively also to the transmitter coil, wherein the conductors are twisted around one another and in one twisted part are wound to form a coil 10 having the inductance L and including the stray capacitance C. This embodiment is illustrated in Figure 2.

In the case of this embodiment, the stray capacitance may be essentially smaller than the capacitance CS, therewith providing highly effective damping of disturbances. In this case, the screen 3 around the receiver coil may be removed to no great detriment, therewith reducing the cost of the receiver coil.

The second embodiment may also include a capacitor 29 which is connected in parallel across one of the two conductors of said conductor pair, with its connection point on respective sides of the coil, as illustrated in broken lines in Figure 2.

According to one preferred variant of the two aforedescribed embodiments shown in Figures 1 and 2 respectively, the coil 6; 10 is wound around a ferrite core 11 so as to increase the inductance of the coil.

When only disturbances from outer disturbance sources are to be dampened, it is sufficient to provide a resonance circuit between the receiver coil and the receiver. The resonance circuit therewith prevents conductor-carried disturbance signals from reaching the receiver coil via its capacitance to earth.

However, it is also desirable to provide the conductors from the transmitter to the transmitter coil with a resonance circuit. This will prevent the presence of an alarm element in the close proximity of these conductors, or in the close proximity of a system current supply conductor or in the close proximity of other conductors, from resulting in an alternating field in the system characteristic of the alarm element.

Figure 3 illustrates a third embodiment of the invention which includes a receiver coil 1 and a transmitter coil 14. This exemplifying embodiment also includes adjacent the transmitter coil 14 an electric contact unit 15 for connection of an electronic unit 16 to the transmitter coil, via a conductor 21. The electronic unit 16 includes a voltage unit, oscillators for generating the magnetic alternating fields to be transmitted, a receiver for receiving an alternating field in the receiver coil, a microprocessor for processing a received signal, etc. The electronic unit is connected to mains voltage via a conductor 17 and is provided with an output 18 on which an alarm signal is delivered. An electric contact unit 19 for connecting conductors to the receiver coil 1 is also provided adjacent the receiver coil 1. The electrical contact unit may include certain electronic components. In the illustrated embodiment, a conductor 20

extends between the receiver coil contact unit 19 and the transmitter coil contact unit 15. The receiver coil is thus connected to the electronic unit 16 via the contact unit 15 of the transmitter coil. Each of the conductors 20, 21 may include a plurality of electric conductors, depending on the construction of the receiver coil among other things. The component referred to as a receiver coil may, in fact, consist in a plurality of different, mutually separated coils.

According to this embodiment of the invention, each of the conductors 20, 21 is wound to form a coil form around a ferrite core 22, 23, thereby to avoid net currents in the conductors. The conductors 20, 21 are either screened or twisted in the aforesaid manner. In the case of this embodiment, the stray capacitances of the formed coils are used as capacitance C in the resonance circuits. In the case of this embodiment, it is important that the resonance circuits are placed so that the stray capacitances, which determine the resonance frequency, will not vary appreciably with normal variations in the positioning of the conductors 20, 21.

The inventive arrangement also prevents problems arising due to inductive coupling between coil 1 or the coil 14 in a set-up according to Figure 3 and a conductor belonging to the alarm system.

Problems caused by resistively coupled disturbance sources are also prevented, such as when a person touches both coils 1; 14 simultaneously, which is illustrated in Figure 3 with a resistor R.

Figure 4 illustrates an inventive arrangement which is advantageous in practice and which includes a receiver coil or transmitter coil. The conductors leading to the coil of the Figure 4 embodiment are two twisted single-conductors 25, 26 which have been wound to form a coil 27 along one twisted

part thereof. The conductors 25, 26 are connected to a coaxial cable 28, with one of the conductors connected to the cable screen.

The sensitivity of the system, or system response, in indicating an alarm is such that net currents that have been dampened by means of the resonance circuit will have, subsequent to being dampened, an amplitude which is too low to have an unfavourable affect on the function of the system.

In this regard, the resonance circuit or circuits is/are dimensioned to achieve sufficiently high damping of occurrent disturbances, i.e. net current, while the damping of a signal will be small when the net current is zero. The person skilled in this art will be quite capable of dimensioning the capacitance C and the inductance L of the resonance circuit to correspond to relevant working frequencies in each individual case.

It is therefore apparent that the problems described in the introduction are eliminated by means of the present invention.

CLAIMS

1. An arrangement for preventing disturbances in electronic alarm systems of the kind used in merchandise security systems, said system including an alarm element which is adapted to receive a magnetic alternating field transmitted by a transmitter and also to retransmit a magnetic alternating field, wherein a receiver is adapted to receive and detect the retransmitted alternating field, **characterized** by a resonance circuit LC which is located in at least certain pairs of electric conductors (5; 12, 13; 20, 21; 25, 26) in the system between the system electronics (2; 19) and receiver coil (1; 24) and alternatively also the transmitter coil (14), and which is tuned to the working frequency or frequencies of the system so as to produce a high impedance on the conductor pair for current directed in the same direction in the conductors and thereby heavily dampening disturbance sources coupled capacitively, inductively or resistively to the system.

2. An arrangement according to Claim 1, **characterized** in that the resonance circuit LC is comprised of said conductor pair (5; 12, 13; 20, 21; 25, 26) wound to form a coil having the inductance L; and in that the capacitance in the resonance circuit is comprised of stray capacitances C.

3. An arrangement according to Claim 1 or Claim 2, **characterized** in that said pair of conductors extend from the receiver coil, and alternatively also to the transmitter coil, in the form of solely one screened two-conductor cable (5) which is wound to form a coil (6) having the inductance L and including the stray capacitance C.

4. An arrangement according to Claim 1 or Claim 2, **characterized** in that a pair of unscreened cables (12, 13; 25, 26) extend from the receiver coil, and alternatively also to the transmitter coil, wherein the conductors of each pair of

conductors are twisted around one another and, in a twisted part, are wound to form a coil (10; 27) having the inductance L and including the stray capacitance C.

5. An arrangement according to Claim 1, 2, 3 or 4, **characterized** in that said coil (5; 10; 27) is wound around a ferrite core (11; 22; 23).

6. An arrangement according to Claim 3 or Claim 5, **characterized** in that a capacitor (7) is connected in parallel across the screen of the two-conductor cable (5) with respective capacitor connection points located on respective sides of the coil (11).

7. An arrangement according to Claim 4 or Claim 5, **characterized** in that a capacitor (29) is connected in parallel across one of the conductors (12, 13) in each conductor pair, with the capacitor connection points located on respective sides of the coil.

Fig.1

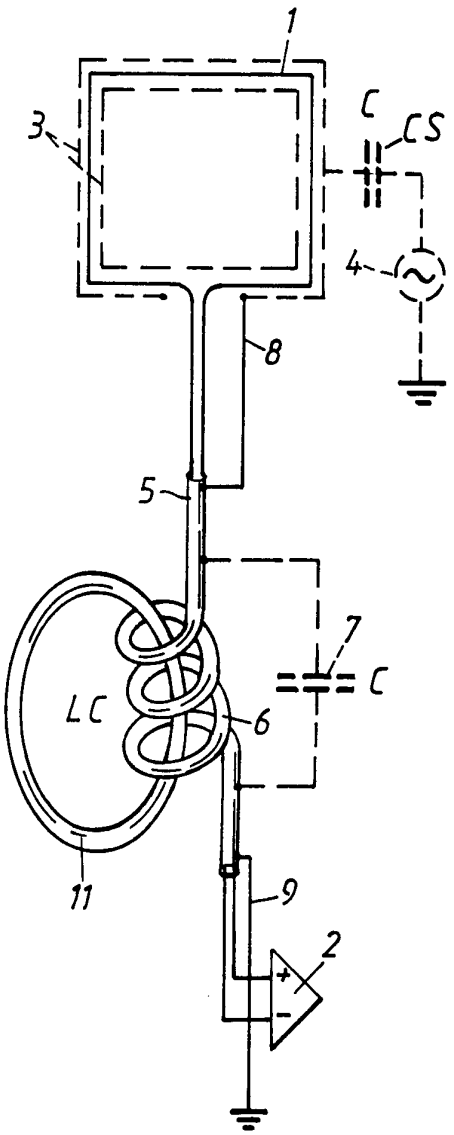


Fig.2

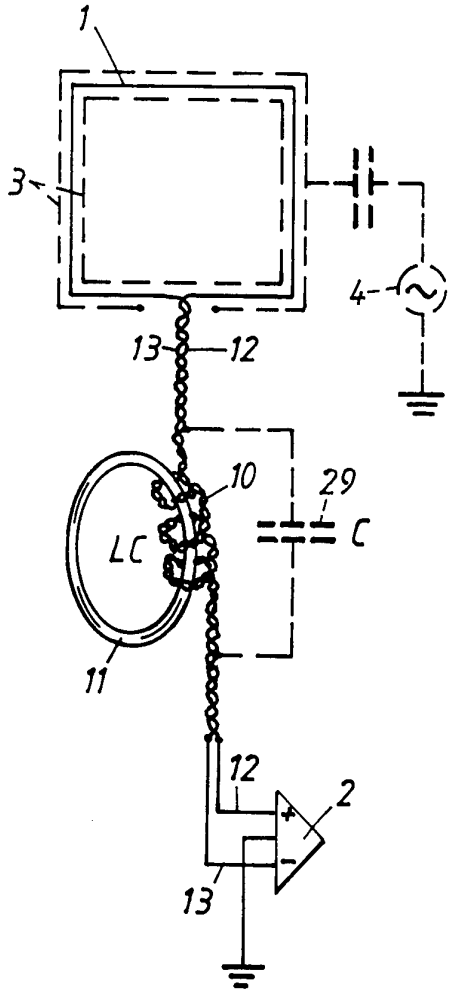


Fig. 3

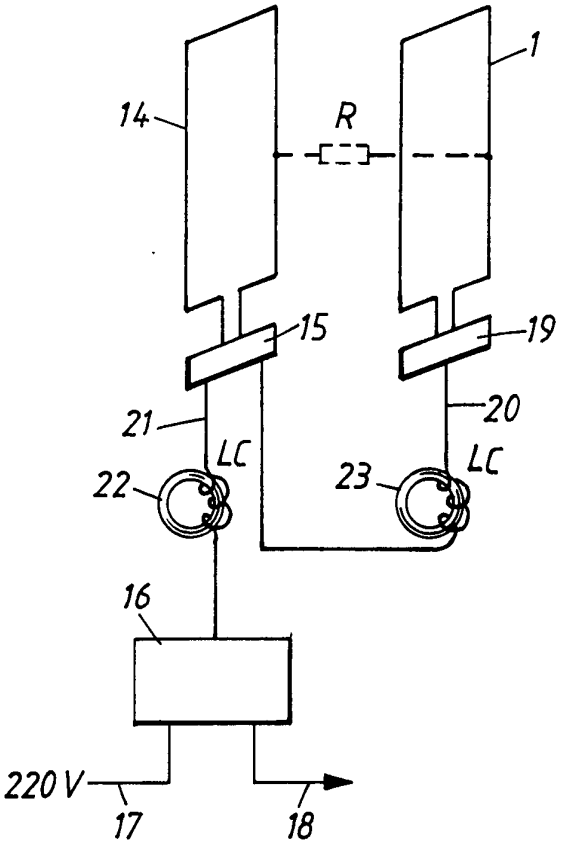
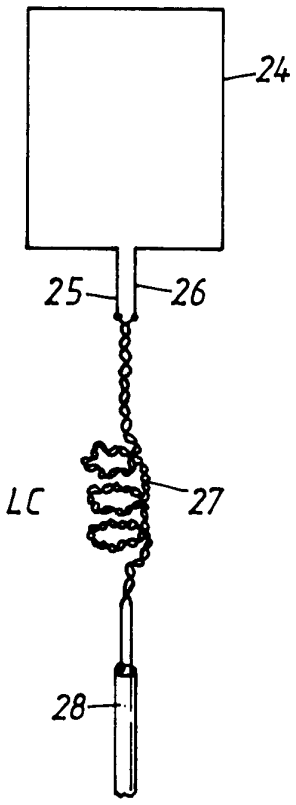


Fig. 4



INTERNATIONAL SEARCH REPORT

Int. ational application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04B 1/10, G08B 13/24
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G08B, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG: WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 5111186 A (D. NARLOW ET AL.), 5 May 1992 (05.05.92), column 8, line 11 - line 24 --	1-7
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X	US 3810147 A (GEORGE JAY LICHTBLAU), 7 May 1974 (07.05.74), column 3, line 25 - line 41 --	1-7

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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