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## **RECORDING TAG AND READING SYSTEM**

The present invention relates to a system that includes a sensing and recording tag and a reader/writer that can instruct the tag and can read data created during use of the tag. The system will be utilized primarily in the transport and storage field to detect changes in the environment pertaining to products that are being shipped or stored.

### **BACKGROUND OF THE INVENTION**

Tags, strips or badges which will detect a condition change are well known. For example, people working around nuclear reactors, laboratories, factories, hospitals, etc. where nuclear radiation may be present wear badges which will change colour if the badge is exposed to dangerous levels of radiation. They may progressively change colour as the radiation builds up or they may change colour dramatically if they are exposed to a sudden potentially lethal dose of radiation. Other badges or tags are provided with chemical detecting material so that they will change colour in the presence of a potentially dangerous chemical or gas, such as chlorine. Yet other badges or tags may change colour as the result of a change in temperature over or below a set threshold. These tags may be worn by an individual or they may be stuck to or placed within a product or package or container so that someone later on can ascertain whether the product, package, or container was subjected to inappropriate environmental conditions, including inappropriate temperatures. Such tags may have importance with respect to products whose quality or shelf life, as in the case of foodstuffs, could be adversely affected by inappropriate environmental conditions.

Tags such as those described above are generally inexpensive as they are designed to record a single event or condition. Generally they cannot be reused once they have recorded the significant event but that is not a problem given that they are inexpensive. They may be termed as being disposable tags or detectors.

There are instances where it is desirable to be able to trace and record multiple events during the transport of a product or load and/or during the storage of such a load. Sensing and recording devices which will accomplish this are available; they include multiple sensors, a clock, a battery, a memory in which sensed data is recorded, and some form of output mechanism whereby the recorded data can be read

for interpretation by an interested party. These devices, unfortunately, tend to be large in size in comparison to the disposable tags mentioned above, being as large as a cigarette package or even larger. They also tend to be very expensive, on the order of \$200 each in comparison to the \$1 cost of a disposable tag. On the other hand these devices are reusable which tends to offset their high initial cost.

It is apparent from the foregoing that there is a need for a multi-use sensing and recording tag that benefits from the small size of a disposable tag, which will perform the functions of the large-size multi-function device, and which will be much closer in cost to that of the disposable tag.

## **SUMMARY OF THE INVENTION**

The present invention overcomes the problems of the prior art and meets the criteria set forth hereinabove. The invention contemplates in one aspect a reusable tag that can be attached to the exterior of a product, article, package or container or can be incorporated therewithin. The tag makes use of current and emerging technology relating to thin film power supplies, possibly including rechargeable thin film batteries, as well as thin film integrated circuit technology. A tag of this invention might be used to sense a plurality of environmental conditions, including but not limited to, temperature, atmosphere, and shock; it could have a built-in timing function so that the exact time that an event takes place would be recorded; it would have sufficient memory to ensure that all events would be recorded; and it would have means for transmitting recorded data or for permitting recorded data to be downloaded from its memory for later use. The tag could also be programmable and could be provided with an identifier to aid in assuring that the information therein pertains to a particular task.

In another aspect the present invention would contemplate a single-use tag initially programmed to sense a specific event. After sensing and recording the event the tag could be read by a reader to obtain therefrom the data relating to the event and then the tag would be discarded as it could not be re-used at all. A single use tag could also be programmed to record a series of events relating to, for example, temperature changes, the tag being discarded after the recorded data was obtained therefrom.

The system of the invention will include a reader that can be programmed to read and display information gathered by the tag during its use. The system could also include a reader/writer that would be used to reset the tag to "zero" so that it would be ready to record data for another project or task and could also be used to recharge the tag's battery if necessary. A reader/writer could also be used to program the tag for its particular task, depending on the data that will be needed at the end.

### **DESCRIPTION OF THE INVENTION**

In its most basic form the system of the present invention includes a sensing/recording tag used to acquire data and a reader that is used to download data from the tag. A more sophisticated system would use a reader/writer for downloading and displaying recorded data and which could be use to either reset a used tag or to program the tag so that it can acquire data as desired. The tag itself will be of a small size, comparable to the size of a credit card, or even smaller. It will be very thin and light, and it can be rigid, semi-rigid or flexible. Preferably it will be formed from a material that is very strong, will offer considerable resistance to cutting or tearing, and will be resistant to the deleterious effects of heat, cold, magnetism, chemicals and radiation. Such materials already exist and are well within the knowledge of skilled materials engineers. The material should also be capable of being adhered to the inside or the outside of a shipping container or a package. It would be possible as well be build an external casing, such as a plastic sleeve, envelope, box, etc. to further extend the lifespan of the tag. It is also conceivable that such a box or protective enclosure might be reused for several life-cycles of successive tags.

The tag will be provided with a thin film battery as a power supply. Such thin film batteries already exist and are being further developed at a prodigious rate. A disposable tag would include a single or limited use battery whereas a reusable tag would use a rechargeable battery. It would be expected that a disposable tag would be less expensive to produce than a reusable tag.

The tag would also be provided with a programmable integrated circuit connected to the battery and which would include a timing device such as a clock, a series of sensors, and a memory for storing data derived from the sensors. The

sensors could be programmed either at the factory or by the reader, if the reader is provided with a writing capability, to react to changes in temperature, position, atmosphere, impact, etc. with each change being recorded in the memory only if, for example, it exceeded a pre-set threshold. Whenever a recordable event is detected it would be recorded in the appropriate section of the memory relating to such events and the time that the event took place would be recorded as well, being associated with that particular event. It would not be necessary that the clock record the exact time that the recordable event took place; it would be sufficient for the clock to identify the nearest quarter hour, for example. It is likely that for tasks taking a long time, of days or weeks, the event timing can be coarser than for tasks of short duration. In the latter case it would be more desirable to record the exact time, say to the closest minute, at which an event took place. The accuracy of the timing can be pre-set from a list of criteria whenever the tag is programmed.

Included in the integrated circuit will be a specific identifier code for each tag so that the tag can be identified by a reader or a reader/writer used by the people interested in the data developed by the tag. Generally speaking, the tag would be programmed at the factory for the recordal of specific data. The supplier of tags could prepare multiple tags for each customer, custom prepared to that customer's requirements. Alternatively, a reader/writer could be used to initially program the tag using a number of selectable criteria and the reader/writer would also be provided with reading means for downloading the data from the tag at the end of a job. For this, the tag will also be provided with output means that can be coupled directly or indirectly to the reader or the reader/writer whereby the data recorded in memory can be transferred to the reader or the reader/writer for display and/or later use. A reader/writer can also be provided with means for recharging the battery of the tag if it is provided with a rechargeable thin film battery.

A disposable tag in accordance with this invention would likely cost in the vicinity of \$3, a little more than existing single use tags. A reusable tag would be more expensive, perhaps in the vicinity of \$8 each. Conceivably if a food merchant, for example, were to purchase reusable tags and several readers or reader/writers in order to monitor shipments of produce from a country of origin to his warehouse in

Canada he would have no need to purchase additional tags once his initial supply had been obtained. This would mean that the supplier of tags and readers and reader/writers would have a limited market for tags, since once each of his customers had acquired its initial supply there would be no requirement for the customers to purchase more tags, except as replacements for lost or destroyed tags, or to accommodate an increase in business.

It is therefore an additional feature of the tags of this invention, in particular for the reusable tags, that each such tag could be "licensed" rather than sold to the customer so that the tag manufacturer can be assured of continuous income therefrom. Each tag or each licensed reader or reader/writer would be preprogrammed with a countdown register so as to permit only a limited number of uses before the identified tag could no longer have its recorded data downloaded by a reader or a reader/writer. The number of uses would be associated with the particular identifier given to the particular tag at the factory and each reader or reader/writer would have an identifier associated therewith known only to the manufacturer. When a tag has reached the end of its preprogrammed "life" the customer would contact the manufacturer and would "buy" another packet of uses for that tag. The manufacturer would provide the customer, after payment, with a special code that could be transmitted to the tag by the customer's reader/writer system or to the reader itself and which would then "reactivate" that tag for the specific number of uses then purchased by the customer. In this manner the manufacturer would be assured of continuous income from reusable tags.

The manufacturer could alternatively manufacture non-programmable tags having sufficient battery power to meet a customer's requirements for, say, ten jobs of the same nature. The battery and the sensors would lie dormant until the customer's reader/writer is used to activate the tag, the activated tag then being used until it reaches the end of its preprogrammed life. The tag could not be reactivated and it would then be necessary for the customer to purchase a new tag as a replacement for the dead tag.

The tags can be provided with passive or active data transmission means, including RF (radio frequency) transmission, as is known in the art.

As another alternative to having an activatable tag, the initial software operating the reader or the reader/writer would have a limited number of downloads available to it. Once any one tag, identified as, say, a ten-use tag, has been read ten times, the software would not permit any further downloads without being recharged by a code available only from the supplier for a fee. In this case the tag might be capable of recording a vast number of events or groups of events but it could only be read a limited number of times by a reader or a reader/writer before the software would have to be updated or recharged so that the tag could be read again. Recharging of the customer's software could easily be done by way of the Internet, for example, once payment had been confirmed. In this way tags and reader/writers could be part of a licensing scheme using an encryption data protocol which would allow the tag's log only to be accessed by an authorized base station or reader-based software. With this proposal, the "reactivation" would not necessarily have to be written to the tag, further reducing the unit cost of operating such tags.

In this way the manufacturer would have the ability to license the software that controls the reader/writer in order to exercise control over the activities of the licensees to thereby thwart unauthorized use of the tags or the reader/writers. The software would be developed so as to be adapted to the customer's particular needs, whether those needs call for simple results, such as whether a particular temperature threshold was passed, or more complex results, such as a timed log of environmental conditions including vibration, etc.

The foregoing has broadly described the present invention as currently contemplated, it being understood that a skilled person in this art could undoubtedly effect changes thereto without departing from the spirit of the invention itself.