A magnetic tape cartridge assembly comprises a cartridge housing (10) containing at least one tape reel (12) having a spool of magnetic recording tape (16). A solid state cartridge status memory (20) within the housing contains electronically readable information concerning the cartridge. Connection pads (22) at an exterior surface of the cartridge housing (10) enable external electrical connections to be made to the solid state cartridge status memory (20) from cartridge handling equipment (59) when the cartridge is loaded by the cartridge handling equipment (59), in a tape drive (60) or a tape library bay (56).
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MAGNETIC TAPE CARTRIDGE SYSTEM WITH CARTRIDGE STATUS MEMORY

Field of the Invention

The present invention relates to magnetic tape recording. More particularly, this invention relates to a magnetic tape cartridge having an electronically readable solid state cartridge memory, and a tape handling system employing the cartridge memory to determine cartridge identification and other information.

Background of the Invention

Information is typically recorded on magnetic tape in a linear fashion as the tape is drawn past a stationary head structure, or it may be recorded at an azimuth angle by a rotating head structure. The tape is typically fed from and collected on tape reels. For convenience of handling, tape cartridges containing at least one, and frequently two reels and an internal spool of magnetic tape, have proliferated.

It has been an established practice to record unique information concerning a tape cartridge at e.g. leading and trailing ends of the magnetic tape within the cartridge. There are several drawbacks to this approach. First, the tape may be intentionally or accidentally degaussed or erased, and the unique information may be lost. Second, the unique information can be recovered only by playback of the tape within a tape drive apparatus configured and adapted to handle the particular cartridge. Third, if the tape is passed through a misadjusted tape drive, attempts to read the tape at properly adjusted tape drives may prove unsuccessful. Forth, the recorded information may relate to particular setup/format data needed by the tape drive before the information can be recovered and used to adjust the tape drive, requiring initial calibration cycles to be performed by the tape drive before the information is read, and slowing tape drive operations.

It is known to provide sensible physical features on the tape cartridge, such as a "write-protection" or "recording density" tab, switch, or window, which, when activated and sensed by the tape drive, protects the tape from being overwritten with any new information, or sets up the tape drive for the particular recording density. These switches, however, affect and concern
all of the recorded information within the cartridge and not just some portion of it.

It is also known to secure a label, such as a bar coded label, to an exterior wall of the cartridge. The bar code thereby provides a unique cartridge identifier which may be read by optical sensing equipment, either within or external of a tape drive, or tape library, cartridge loader mechanism. One drawback of the bar coded label is that, once printed, its information content remains fixed, necessitating replacement of the label in order to update the bar coded information. Another drawback of the bar coded label is that the information is only read as the tape cartridge is passed by a bar code scanner within the tape loader or tape library structure. For example, the bar code scanner may be attached to a transfer mechanism or "elevator" within the tape loader apparatus which is targeted at the bar code labels affixed to facing walls of the columns of cartridges accessed by the mechanism. As the mechanism traverses each of the cartridges, the bar code of the cartridge may be scanned and read. The time required for this mechanism to traverse each cartridge may be a substantially limiting time factor in bringing a tape library system up to an operational state, as during a power-on system initialization or reset when an inventory of all cartridges within the system is conducted and recorded by a library system embedded controller. Also, as the number of cartridges in a library system increases, a probability that duplicate bar codes may be encountered also increases, resulting in confusion and possible mis-location and loss of valuable user data.

Consequently, as cartridge library systems designed to handle an increased number of magnetic tape cartridges proliferate, a hitherto unsolved need has arisen for an improved mechanism for identifying and updating magnetic tape cartridges independently of the recording tape itself.

Summary of the Invention with Objects

A general object of the present invention is to provide an improved magnetic tape cartridge including a solid state memory in a manner overcoming limitations and drawbacks of previous tape cartridge identification and status reporting methods and structures.
In one aspect of the present invention, a magnetic tape cartridge assembly comprises a cartridge housing, at least one tape reel rotatably contained within the cartridge housing, a spool of magnetic recording tape coiled about the tape reel, a solid state cartridge status memory within the housing containing electronically readable information concerning the cartridge, and connection pads appearing at an exterior surface of the cartridge housing enabling external electrical connections to be made to the solid state cartridge status memory by cartridge handling equipment for reading the information when the cartridge is within the cartridge handling equipment.

In another aspect of the present invention, a magnetic tape cartridge library system comprises a tape loader. At least one bay of cartridge receptacles within the loader holds a plurality of magnetic tape cartridges. Each receptacle has a plurality of electrical contact fingers. A tape loader controller controls tape cartridge identification and movement within the tape loader. An internal bus structure connects the tape loader controller to the plurality of electrical contact fingers at each receptacle. The electrical contact fingers are aligned to connect with contact pads of a cartridge when the cartridge is located at the receptacle. The tape loader controller queries each cartridge via the internal bus structure to determine presence of the cartridge at a receptacle, and the identification of a cartridge having a solid state cartridge status memory recorded with a cartridge status number. The tape loader further includes a cartridge elevator under the control of the tape loader controller for moving selected cartridges to a tape drive physically associated with the tape loader. The tape loader controller has an external bus connection to the tape drive.

In this aspect of the present invention the cartridge electrical contact pads may comprise an electrical bridge connection path denoting that the cartridge does not include a cartridge status memory, such that the tape loader controller can determine the presence of the cartridge at a receptacle, but not identity of the cartridge. In this event the tape loader controller causes the cartridge to be moved to and read by the tape drive to determine cartridge identity which is returned by the tape drive to the tape cartridge controller via the external bus connection.
In one more aspect of the present invention a method is provided for determining status information regarding a magnetic tape cartridge without reading information magnetically recorded on tape reeled within the cartridge. The method comprises the steps of:

- providing a solid state cartridge status memory within a cartridge housing, prewritten with at least a cartridge identification number,
- loading the cartridge within cartridge handling equipment such that an electrical connection is made between the equipment and the solid state cartridge status memory, and
- electrically reading the solid state cartridge status memory with controller circuitry within the equipment to obtain at least the cartridge identification number.

In this third aspect of the present invention, the solid state cartridge status memory comprises a read/write memory, and the method comprises the further steps of writing cartridge status information to the cartridge status memory by the controller circuitry within the cartridge handling equipment. The status information comprises at least one of cartridge bit error rate, cartridge tape accumulated usage, tape recording density, tape recording format, and tape drive set-up parameters such as recording and playback azimuth angle.

These and other objects, advantages, aspects and features of the present invention will be more fully understood and appreciated by those skilled in the art upon consideration of the following detailed description of a preferred embodiment, presented in conjunction with the accompanying drawings.

**Brief Description of the Drawings**

In the Drawings:

Fig. 1 is a diagrammatic plan view of a single reel magnetic tape cartridge including an electronically readable cartridge memory in accordance with principles of the present invention.

Fig. 2 is a diagrammatic view in side elevation of the Fig. 1 cartridge.
Fig. 2A is a diagrammatic view in side elevation of a conventional tape cartridge which has been modified so that principles of the present invention facilitate some backward compatibility with such conventional cartridges.

Fig. 2B is a diagrammatic view in side elevation of a conventional tape cartridge which has been modified by external addition of a cartridge memory module following principles of the present invention.

Fig. 3 is an electrical block diagram of the electronically readable cartridge memory within the Fig. 1 tape cartridge.

Fig. 4 is a diagrammatic view of a tape library including an elevator mechanism and equipped to read the electronically readable cartridge memories associated with respective magnetic tape cartridges of the type depicted in Fig. 1.

**Detailed Description of Preferred Embodiments**

The present invention is particularly useful in applications such as tape libraries. Each tape cartridge storage location within the tape library has a unique location number. With the present invention, each cartridge is also provided with a unique, electronically readable identification number. When interrogated by a tape library controller, the storage location number may be quickly correlated to the tape serial number of the cartridge presently in residence at the location. This arrangement thereby provides the tape library system with an automatic electronic method for locating and identifying a particular tape cartridge. By inclusion of a cartridge information memory within each cartridge other useful information about the cartridge may be stored separately from the tape. Such additional information may include cumulative user data error rate, tape usage, format, density, drive set-up parameters, etc.

Fig. 1 depicts a single reel magnetic tape cartridge 10, generally of a type marketed by the assignee of the present invention under the brand name CompacTape. Certain structural features of a single reel magnetic tape cartridge reel and tape system using the same are illustrated in commonly
assigned U.S. Patent No. 5,474,253 to Kasety et al. entitled: Wedged Reels in Streaming Tape Drives and Tape Cartridges", the disclosure thereof being incorporated herein by reference. The cartridge includes a supply reel 12 and hub 14, and a coiled pancake 16 of magnetic recording tape fed from the reel via a leader 18 and tape buckling mechanism (illustrated for example in commonly assigned U.S. Patent No. 4,572,460) which is engaged when the cartridge 10 is loaded into a tape drive. Fig. 1 also shows that the cartridge 10 includes an electronically readable cartridge memory 20 which is internally connected to a contact array 22 having at least two electrical connection pads formed in and facing outwardly of a side wall 24 of the cartridge 10. The double headed arrow at the left of Fig. 1 denotes a load/unload locus of movement of the cartridge 10 relative to a tape drive and relative to tape storage locations within a tape library or loader. Fig. 2 illustrates the contact array 22 facing outwardly from the side wall 24 of the cartridge. In Fig. 1, a set of spring-loaded electrical contact fingers 26 make electrical contact with the contact array 22 when the cartridge 10 is stored in the tape library, when the cartridge 10 is engaged by an elevator of a tape loader apparatus, and when the cartridge 10 is loaded into a tape drive.

While a single reel cartridge forms a preferred embodiment of tape cartridge 10, other cartridge designs, including dual reel tape cartridges and cassettes, may be improved by inclusion of the tape cartridge 20 following principles of the present invention.

As shown in Fig. 3, the electronically readable cartridge memory 20 includes e.g. a serial port interface 30, an address counter 32, and a cartridge memory 34, preferably implemented as a read only memory (ROM) and most preferably as an electrically erasable programmable read only memory (EEPROM). Most preferably, these electronic circuit functions are formed within a single application specific integrated circuit (ASIC) 20. When power is applied to the memory 20, the serial port interface 30 is able to receive and decode requests for cartridge information stored in the memory array 34. The decoded command is used to clock the address counter 32 which serially addresses storage locations of the memory array 34, enabling selected cartridge information values to be put out over an internal data bus 35 within the memory chip 20 to the serial interface 30. The stored values are then delivered externally via a standard serial signaling convention over
external bus structure 48, as shown in Fig. 4. A command may be received and decoded for writing information to the memory array 34. In this case an internal control line 37 enables the memory array 34 to be written with new, updated, or replacement cartridge information as may be desired during loader operations involving a particular cartridge.

In the present example there are e.g. five terminals of the contact array 22. These terminals of the array 22 provide the following connections: power supply 38, serial data 40, serial clock 42, read/write control 44, and ground 46. These connections are made through the electrical contact fingers 26 extending from a side wall of a receptacle within a vertical bay 56 of tape cartridge receptacles. Each set 26 of contact fingers is connected electrically to a cartridge information bus 48 within a tape library 50. Fewer contacts may be used at the expense of increased circuit complexity within the memory chip 20 for equivalent functionality.

A more simplified memory chip employing serial number Touch Memory™ technology may be provided as a read-only memory array, for returning a cartridge serial number. Touch memory devices are those which return a prewritten serial number following momentary contact. Operating current is supplied via a pull-up resistor at a controller end of a single wire bus. Following a reset pulse from a master or controller device, the two-terminal device serially reads out a prerecorded number which may include a serial number, a family number, and a cyclic redundancy code. This number is resolved by sync pulses sent out on the one wire bus by the controller. Examples of solid state serial number devices include type DS1990A Touch Serial Number and type DS2401 Silicon Serial Number devices offered by Dallas Semiconductor Corporation.

One presently preferred example of a structure implementing the tape library 50 is provided by the disclosure of U.S. Provisional Patent Application Serial No. 60/008,028, filed on October 27, 1995 for "A Multi-Drive, Multi-Magazine Mass Storage and Retrieval Unit for Tape Cartridges", the disclosure thereof being incorporated herein by reference. The tape library 50 includes at least one cartridge bay 56. Each cartridge bay 56 includes a vertical column of cartridge storage receptacles, and each receptacle has e.g. a set 26 of contact fingers positioned and aligned for
contacting the contact array 22 of a tape cartridge 10 when it is stored in the particular receptacle.

As shown diagrammatically in Fig. 4, the tape library 50 includes a tape cartridge library controller 52, such as a programmed microprocessor, having an interface structure 54 extending to the cartridge information bus 48. The interface structure 54 enables each cartridge memory 20 to be selectively powered and polled by the controller 52, so that the active cartridge memory 20 may be read or written, as needed.

The tape library 50 also typically includes an elevator mechanism 57 which includes a carriage 58 which is moved vertically and laterally by the mechanism 57 in the sense of Fig. 4 in order to engage and move a particular cartridge 10 between a storage receptacle location and a tape drive 60 within the library 50. When a cartridge 10 is withdrawn by the elevator carriage 58, a set 59 of contact fingers engages the contact array 22 of the withdrawn cartridge. The finger set 59 is also preferably included within the bus structure 48, so that the library controller 52 may read/write electronically the information stored in the cartridge memory 20.

In the Fig. 4 example, three tape drives 60A, 60B, and 60C are provided within the tape library 50, and each one of these tape drives 60 is adapted and sized to receive in turn each cartridge 10 into an interior tape well 62. When a cartridge 10 is loaded into the tape well 62, another set 64 of contact fingers enables the particular tape drive 60 to read/write the information in the tape cartridge memory 20. The tape drives 60A, 60B and 60C are connected to the library controller 52 via a bus structure 66, so that information about cartridges 10 to be loaded/unloaded to/from a particular drive 60, or cartridge information to be read/written to/from a particular cartridge memory 20 can be transferred between each drive 60 and the controller 52.

During use of the tape library 50, in particular during library system initialization, the tape cartridge library controller 52 electronically poles each cartridge receptacle location within each bay 56 via power and signals distributed over the bus 48 to determine the presence or absence of a cartridge 10. If a cartridge 10 is present at a particular receptacle when
power is applied, the cartridge memory 20 will generate and return an
acknowledge signal to the controller 52. The cartridge response to the
controller 52 may further include a unique cartridge serial number and other
information. The controller 52 collects and stores the cartridge information
in a resource directory maintained within the controller 52.

The drives 60 and library controller 52 appear e.g. as separate small
computer system interface (SCSI) targets, and the bus 66 functions as a
SCSI bus. The bus 66 extends to a host computer (not shown). The host
computer therefore has direct access to the resource directory maintained
within the controller 52, and can direct that a particular tape cartridge 10 be
delivered to a particular tape drive 60 for tape recording/playback
operations.

For conventional tape cartridges, such as cartridge 10A shown in Fig.
2A, not including cartridge information memory 20, some level of backward
compatibility may be provided by a small conductive foil strip 23. The strip
23, which may be an integral portion of a larger pressure sensitive label 25
sized to align along longitudinal side wall edges of the cartridge 10, may
thereby be securely affixed to the cartridge side wall and aligned to be
contacted by selected fingers of the contact array 22. Electrical contact
between the selected fingers and the strip 23 is made when the cartridge 10A
is loaded into a storage receptacle of a bay 56, such that e.g. the power
supply line 38 and data line 40 become interconnected. In this manner, the
controller 52 can readily determine, by checking for a continuous logical
high level on the data line 40 that a conventional cartridge 10A is actually
present. In this event, the conventional cartridge may then be loaded into a
tape drive 60 and cartridge information fields which have been magnetically
recorded may be read and transferred from the tape drive 60 via the bus 66
to the library controller 52 (e.g. acting as a SCSI initiator). In this manner,
conventional cartridge sensing switches for sensing presence of a cartridge
within each receptacle of the bay 56 may be eliminated within the
library/cartridge loader mechanism 50 and replaced by using the set 26 of
conductive fingers to contact the bridge foil 23.

Conventional cartridges, such as the cartridge 10B shown in Fig. 2B,
may be modified to include a cartridge memory information module 70
secured to the exterior sidewall 24. In this embodiment, a thin plastic substrate 70 carries the array of connection pads 22 and supports an encapsulated integrated circuit 72 incorporating the cartridge memory structure and functions described hereinabove in connection with the memory 20. In this example, the encapsulated chip 72 is connected to the connection pads 22 via a plurality of circuit traces also formed on the substrate 70. The thin plastic substrate 70 may be secured to the sidewall 24 by any suitable securement, such as an adhesive, plastic solvent welding, or thermo-bonding, for example. By forming the module 70 as a very thin and flat structure, its presence on the side of a cartridge would not interfere with tape cartridge handling operations of handling equipment not having contact fingers for reading the memory. Thus formed and installed, the embodiment of Fig. 2B permits retrofitting conventional cartridges, and enables improvement of new cartridges, at very low cost. Also, by providing the cartridge memory module 70 as a discretely separate unit, it may be replaced in the field with minimum tools and skills and at relatively low cost, should module replacement be needed.

To those skilled in the art, many changes and modifications will be readily apparent from consideration of the foregoing description of a preferred embodiment without departure from the spirit of the present invention, the scope thereof being more particularly pointed out by the following claims. The descriptions herein and the disclosures hereof are by way of illustration only and should not be construed as limiting the scope of the present invention which is more particularly pointed out by the following claims.
What is claimed is:

1. A magnetic tape cartridge assembly comprising:
   a cartridge housing,
   at least one tape reel rotatably contained within the cartridge housing,
   a spool of magnetic recording tape coiled about the tape reel,
   a solid state cartridge status memory associated with the housing containing electronically readable information concerning the cartridge, and
   connection means appearing at an exterior surface of the cartridge housing enabling external electrical connections to be made to the solid state cartridge status memory by cartridge handling equipment for reading the information when the cartridge is within the cartridge handling equipment.

2. The magnetic tape cartridge assembly set forth in claim 1 wherein the solid state cartridge status memory comprises a read only memory (ROM) prewritten with a cartridge serial number.

3. The magnetic tape cartridge assembly set forth in claim 2 wherein the solid state cartridge status memory comprises an electrically erasable programmable read only memory (EEPROM) array which may be written and read by the cartridge handling equipment.

4. The magnetic tape cartridge assembly set forth in claim 3 wherein the solid state cartridge status memory further comprises a serial port interface connected to the connection means, and address generation means responsive to control signals received at the serial port interface for generating and applying address sequences to the EEPROM array.

5. The magnetic tape cartridge assembly set forth in claim 4 wherein the serial port interface includes command recognition circuitry for recognizing and decoding commands received from the cartridge handling equipment for writing information to, and reading information from the EEPROM array.

6. The magnetic tape cartridge assembly set forth in claim 1 wherein the connection means includes a contact array having at least two electrical connection pads, each pad being exposed through an exterior wall of the
housing, and wherein the cartridge handling equipment includes at least two
electrical contactors for contacting each connection pad of the contact array.

7. The magnetic tape cartridge assembly set forth in claim 6 wherein
the electrical connection pads are adjacently arranged in a side wall of the
cartridge housing, and wherein the electrical contactors comprise an
assembly of contact fingers aligned to contact the adjacently arranged
connection pads when the cartridge is within the cartridge handling
equipment.

8. The magnetic tape cartridge assembly set forth in claim 1 wherein
the cartridge handling equipment comprises a cartridge tape drive.

9. The magnetic tape cartridge assembly set forth in claim 1 wherein
the cartridge handling equipment comprises a cartridge loader including at
least one bay of cartridge receptacles, each receptacle having contact fingers
for contacting each connection pad of the cartridge, the cartridge loader
including a cartridge controller for connecting to the cartridge status
memory of each cartridge within the loader via a loader bus structure and
the contact fingers at each receptacle.

10. The magnetic tape cartridge assembly set forth in claim 9 wherein
the cartridge loader further includes a cartridge engagement and positioning
mechanism for moving a selected cartridge from a receptacle to a cartridge
tape drive, and wherein the cartridge engagement and positioning
mechanism includes mechanism contact fingers for contacting pads of a said
cartridge within the mechanism, the mechanism contact fingers being
connected to the cartridge controller via the loader bus structure.

11. The magnetic tape cartridge assembly set forth in claim 9 wherein
the cartridge controller determines that a said cartridge is at a cartridge
receptacle connecting to the cartridge status memory, and without use of a
separate cartridge sensor at the receptacle.

12. The magnetic tape cartridge assembly set forth in claim 1 wherein
the solid state cartridge status memory comprises a pre-programmed read
only memory device prewritten with a cartridge serial number.
13. The magnetic tape cartridge assembly set forth in claim 1 wherein the solid state cartridge memory is formed within a thin module affixed to the exterior surface of the cartridge, and wherein the module also contains the connection means appearing at the exterior surface.

14. A magnetic tape cartridge library system comprising:
a tape loader,
at least one bay of cartridge receptacles within the tape loader for holding a plurality of magnetic tape cartridges,
each receptacle having a plurality of electrical contact fingers,
a tape loader controller for controlling tape cartridge identification and movement within the tape loader,
an internal bus structure connecting the tape loader controller to the plurality of electrical contact fingers at each receptacle,
the electrical contact fingers being aligned to connect with cartridge electrical contact means of a cartridge when the cartridge is located at the receptacle,
the tape loader controller for querying each cartridge via the internal bus structure to determine presence of the cartridge at a receptacle, and the identification of a cartridge having a solid state cartridge status memory recorded with a cartridge identification value,
the tape loader further including a cartridge elevator for moving selected cartridges to a tape drive physically associated with the tape loader,
the tape loader controller having an external bus connection to the tape drive.

15. The magnetic tape cartridge library system set forth in claim 13 wherein the electrical contact means of the cartridge comprise an electrical bridge connection path, denoting that the cartridge does not include a cartridge status memory, such that the tape loader controller can determine the presence of the cartridge at a receptacle, but not identity of the cartridge, whereupon the tape loader controller causes the cartridge to be moved to and read by the tape drive to determine its identity, the tape cartridge identity being supplied by the tape drive to the tape cartridge controller via the external bus connection.
16. A method for determining status information regarding a magnetic tape cartridge without reading information magnetically recorded on tape reeled within the cartridge, comprising the steps of:
   
   providing a solid state cartridge status memory within a cartridge housing, prewritten with at least a cartridge identification value,
   
   loading the cartridge within cartridge handling equipment such that an electrical connection is made between the equipment and the solid state cartridge status memory, and
   
   electrically reading the solid state cartridge status memory with controller circuitry within the equipment to obtain at least the cartridge identification value.

17. The method set forth in claim 16 wherein the providing step includes the step of writing the cartridge identification value into a read/write memory as the the solid state cartridge status memory, and comprising the further step of writing cartridge status information to the cartridge status memory by the controller circuitry within the cartridge handling equipment, wherein the status information comprises at least one of cartridge bit error rate, cartridge tape accumulated usage, tape recording density, tape recording format, and tape drive set-up parameters such as recording and playback azimuth angle.

18. A cartridge memory module affixed to an exterior surface of a magnetic tape cartridge, the module including a solid state cartridge memory containing cartridge information and a plurality of connection pads appearing at an exterior surface of the module and engageable by tape cartridge handling equipment thereby to enable the equipment to make connection to the cartridge status memory to read the cartridge information in the cartridge memory.
### INTERNATIONAL SEARCH REPORT

#### A. CLASSIFICATION OF SUBJECT MATTER

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<th>US CL</th>
<th>According to International Patent Classification (IPC) or to both national classification and IPC</th>
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<td>360/132, 071</td>
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#### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

- **U.S.**: 360/132, 71, 92, 69, 27, 98.05

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

- **None**

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

- **APS**
  - Search terms: cassette, library, cartridge, memory, bin, receptacle, contact, pad, sensor

#### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>X,Y</td>
<td>US 5,455,409A (SMITH ET AL) 03 October 1995 (03/10/95) See entire document, especially column 15, lines 25-29</td>
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<td>Y,P</td>
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#### Further documents are listed in the continuation of Box C. **See patent family annex.**

- **X** Special category of cited documents:
  - **'A'** document defining the general state of the art which is not considered to be of particular relevance
  - **'E'** earlier document published on or after the international filing date
  - **'L'** document which may throw doubts on priority claim and/or which is cited to establish the publication date of another citation or other special reason (as specified)
  - **'O'** document referring to an oral disclosure, use, exhibition or other means
  - **'P'** document published prior to the international filing date but later than the priority date claimed

- **'T'** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

- **'X'** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

- **'Y'** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

- **'A'** document member of the same patent family

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<th>Date of the actual completion of the international search</th>
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<td>27 AUGUST 1997</td>
<td>09 SEP 1997</td>
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Name and mailing address of the ISA/US Commissioner of Patents and Trademarks

- **Box PCT**
- **Washington, D.C. 20231**
- **Facsimile No.**: (703) 305-3230

Authorized officer

- **ANDREW L. SNIZEK**
- **Telephone No.**: (703) 308-0956

Form PCT/ISA/210 (second sheet)(July 1992)*
<table>
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<td>US 4,338,644A (STAAR) 06 July 1982 (06/07/82), see entire document, especially figure 4</td>
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**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/US97/08863

**Box I  Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.:
   - because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.:
   - because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claims Nos.:
   - because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II  Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

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<td>As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.</td>
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<td>No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:</td>
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**Remark on Protest**

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Form PCT/ISA/210 (continuation of first sheet(1))(July 1992)
BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s) 1-13 and 16-18, drawn to a magnetic tape cartridge classified in 360/132.
Group II, claim(s) 14-15, drawn to a cartridge library system classified in class 360/071.

The inventions listed as Groups I and II do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

claims 1-13 and 16-18 drawn to a relationship between a solid state memory that is attached to a magnetic tape cartridge;
claims 14 and 15 drawn to a library system that identifies the type of cassette inserted and positions the cartridge in a tape drive.