

[54] **MAGNETICALLY ENCODED DOCUMENT**

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[58] Field of Search: 346/74 M; 235/61.12 M; 340/149 A

[56] **References Cited**

UNITED STATES PATENTS

3,015,087	12/1961	O'Gorman	346/74 M
3,452,358	6/1969	Zehner	235/61.12 M
3,189,732	6/1965	Russell	235/61.12 M

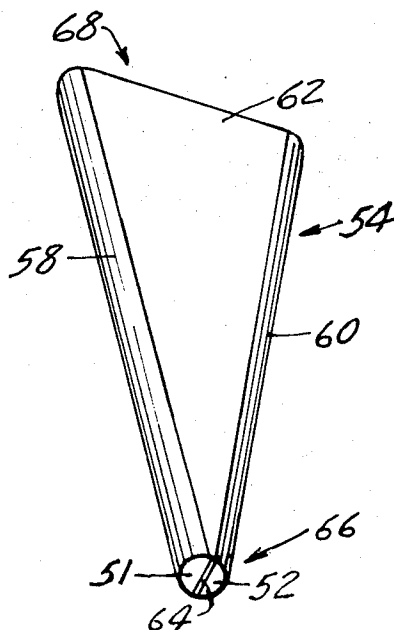
Primary Examiner—Howard W. Britton

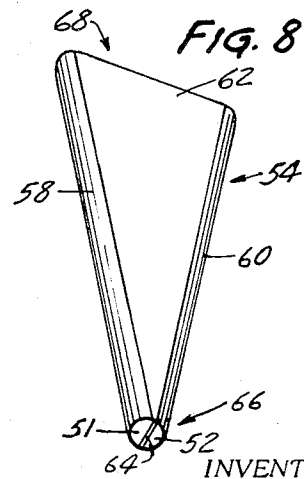
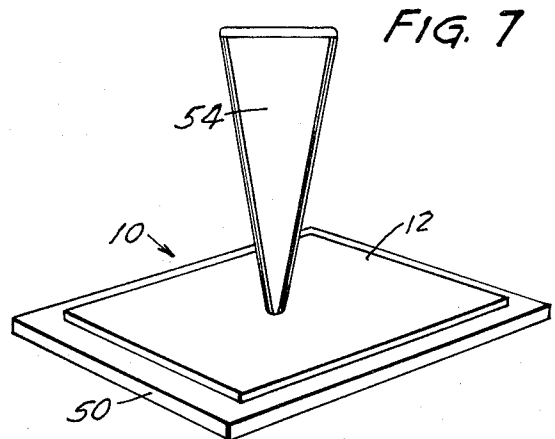
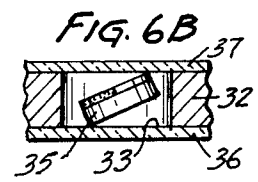
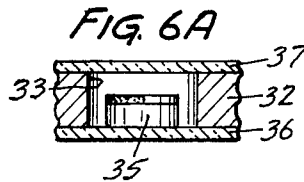
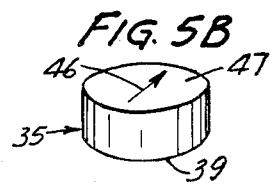
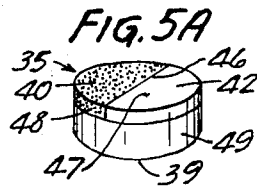
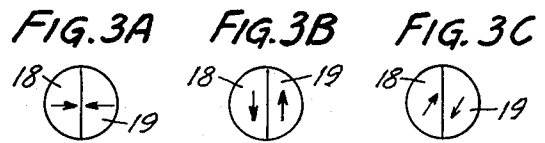
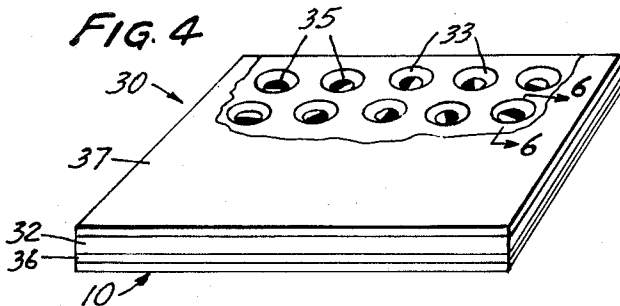
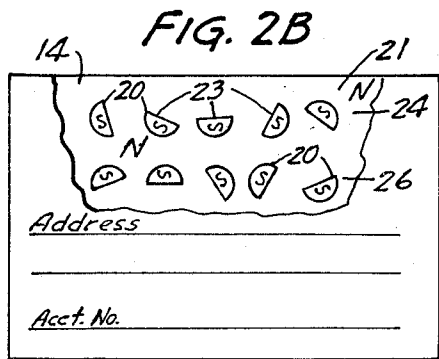
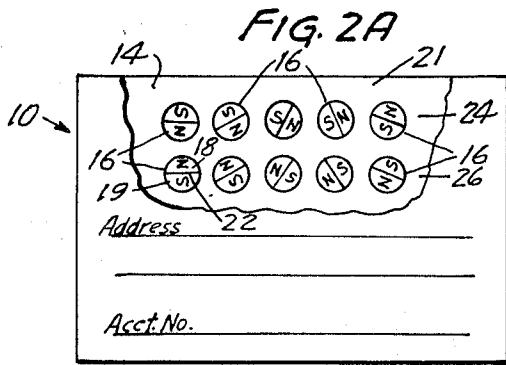
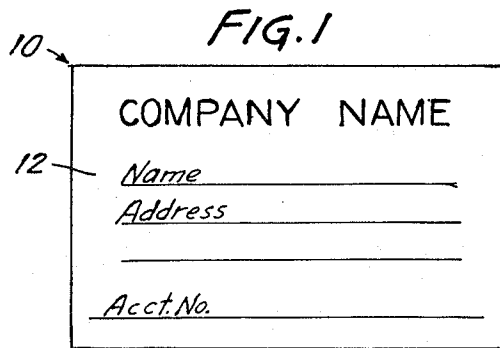
Attorney—Kinney, Alexander, Sell, Steldt & Delahunt

[57] **ABSTRACT**

A magnetically encoded document including a broad stratum containing magnetically hard material which is magnetized to represent encoded data as a plurality of disparate magnetized regions of various polarity alignments defining a fixed two-dimensional pattern in the document, wherein upon at least one broad surface of the stratum each magnetized region has magnetized sections of opposite polarities having a narrow boundary therebetween, wherein the angles to which the boundaries extend breadthwise in the stratum of the document represent encoded data, with any given angle being unique to certain data. The document may be magnetically encoded by contacting the document with a pair of oppositely magnetized pole piece faces of a magnetizer key, which magnetizer key includes a tapered permanent magnet and two pole pieces disposed on opposite polarity sides of the permanent magnet, with the pole piece faces being separated by a narrow gap adjacent the narrow end of the permanent magnet.

10 Claims, 13 Drawing Figures





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MAGNETICALLY ENCODED DOCUMENT

CROSS REFERENCE TO RELATED APPLICATION

The , Ser. No. O'Gorman 52-12-to 33-25-19-57-

This application is related to my copending application entitled "Magnetic Viewer And Display Device", filed on Nov. 12, 1970.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

The present invention pertains to magnetically encoded documents, such as magnetically encoded credit cards, and to a method of magnetically encoding such documents.

2. Description of the Prior Art

Examples of magnetically encoded documents are described in U. S. Pat. No. 3,015,087 to O'Gorman at column 2, lines 52-69, and at column 12, lines 12-25; U.S. Pat. No. 3,430,200 to Barney at column 4, line 33, through column 5, line 63; U.S. Pat. No. 3,453,598 To Schweizer at column 1, lines 33-39; U.S. Pat. No. 3,465,307 to Schmidt at column 2, lines 25-42, at column 2, line 59, to column 3, line 16, and at column 3, line 63, to column 4, line 9; and U.S. Pat. No. 3,471,862 to Barney at column 5, lines 29-47, and at column 11, lines 57-66. The magnetically encoded documents described therein contain magnetic material. The documents are encoded either by discretely magnetizing the magnetic material to provide magnetized regions of various polarity alignments defining a fixed two-dimensional pattern in the card, or by the discrete placement of magnetized material to provide a fixed two-dimensional pattern of magnetized regions.

The documents described in the aforementioned Barney patents contain barium ferrite particles in a rubber or plastic base that can be magnetized and will retain such magnetism sufficiently to be characterized as a magnetically hard material.

Magnetically hard material is defined as a material having a high coercive force and therefore a strong resistance to demagnetization.

The methods of encoding these magnetically encoded documents are described in the aforementioned patents. Generally, these methods require the operation of complex systems as therein described.

SUMMARY OF THE INVENTION

The present invention is a magnetically encoded document which comprises a broad stratum containing magnetically hard material magnetized to represent encoded data as a plurality of disparate magnetized regions of various polarity alignments defining a fixed two-dimensional pattern over the stratum. Upon at least one broad surface of the stratum, each of the magnetized regions comprises a pair of magnetized sections of opposite polarities having a narrow boundary therebetween. The boundary does not necessarily extend completely through the stratum, although it is preferable that it do so. The angles to which the boundaries extend breadthwise in the stratum represent certain data, with any given angle being unique to certain data.

In the magnetically encoded document of the present invention, a first magnetized region comprises a first pair of magnetized sections of opposite polarities hav-

ing a first boundary therebetween extending breadthwise in the stratum at a first angle, with a given orientation of polarities with respect to the first boundary to represent a first datum; and a second magnetized region comprises a second pair of magnetized sections of opposite polarities having a second boundary therebetween extending breadthwise in the stratum at said first angle, but with the orientation of the second pair of magnetized section polarities with respect to the second boundary being opposite to the given orientation of the first pair of magnetized section polarities with respect to the first boundary to represent a second datum different from said first datum.

The document preferably includes a continuous stratum of uniaxially anisotropic magnetically hard barium ferrite particles in a binder or matrix of rubber, plastic, or other nonmagnetic material. Preferably, the uniaxially anisotropic magnetically hard material is oriented to have an easy axis of magnetization perpendicular to the plane of the stratum; and the stratum is magnetized in the direction of this easy axis. Therefore, the magnetized regions in the document are not easily erased or altered, and they are generally insensitive to magnetic field components in the plane of the document.

The magnetized sections of opposite polarities having a narrow boundary therebetween may be magnetized by the following method. The document is contacted with a pair of oppositely magnetized pole piece faces which are separated by a narrow gap. Upon the pair of pole piece faces making contact with the document, the magnetic material is magnetized to contain two oppositely magnetized sections. The angle of the boundary between the sections breadthwise in the stratum corresponds to the angle of the narrow gap between the pole piece faces with respect to the breadth of the stratum upon the pole piece faces making contact with the document, and the areas of the magnetized sections correspond to the areas of the pole piece faces which make contact with the document. This magnetizing method is enhanced by placing a sheet of iron or soft steel on the opposite side of the document from the pole piece faces during the contacting step.

The pole piece faces may be provided by a magnetizer key having a pair of pole pieces disposed on opposite polarity sides of a tapered permanent magnet which is wide at one end and relatively narrow at the opposite end, with each pole piece having a face adjacent the narrow end of the permanent magnet, which faces are separated by a narrow gap shaped for simultaneously contacting a document.

It is readily seen that the document of the present invention provides considerably more versatile encoding possibilities at each magnetized region than are available in the documents described in the aforementioned patents to Barney, Schweizer and Schmidt. In contrast with the document described in the O'Gorman patent, the document of the present invention is not as easily erased or altered. Because each magnetized region of the document of the present invention comprises two oppositely magnetized sections having a boundary therebetween, the application of a magnetic field to alter the angle of the boundary breadthwise in the stratum, unless applied with an encoder such as the

magnetizer key discussed above, would probably change the shape of the sections in the region and would probably either eliminate or change the position of the boundary with respect to the center of the region. Thus, if any boundary remains, its angle breadthwise in the stratum probably would not be readily detected by means for providing an indication of the orientation thereof. Also, the orientation of the boundary between the oppositely magnetized sections is more sharply defined than the orientation of a dipole in the circular section of the O'Gorman type document, and thereby enhances more precise alignment of magnetic polarity alignment detecting means, such as is described in the aforementioned patents and in my above-referenced copending application.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevational view of a magnetically encoded document such as a credit card having printed thereon a company name and the name and address and account number of the person to whom the document is issued.

FIG. 2A is an elevational view of the document of FIG. 1 with a surface layer thereof cut away to expose a broad stratum containing magnetically hard material which is magnetized to represent encoded data as disparate magnetized regions of various polarity alignments, which magnetized regions are shown schematically in FIG. 2A, although they preferably are not visible to the naked eye.

FIG. 2B is an elevational view drawn to show the same features as are shown in FIG. 2A, but illustrating an alternative embodiment of the magnetically encoded document of FIG. 1.

FIGS. 3A, 3B and 3C illustrate embodiments of magnetized regions in the documents of FIGS. 2A and 2B, showing alternative orientations of the magnetic fields at the oppositely magnetized sections having a boundary therebetween.

FIG. 4 is a perspective view of a magnetic viewer for providing a visual indication of data encoded in a magnetically encoded document such as is shown in FIGS. 1 and 2A or 2B. In this view, a portion of a transparent cover is cut away. The magnetic viewer is shown in registration with the document of FIG. 2A.

FIG. 5A is a perspective view of a disk which is used in the viewer of FIG. 4. This disk has oppositely magnetized sections and a boundary therebetween on one broad surface thereof, and a visual indicator corresponding to this boundary, which visual indicator consists of a color change in a coating of reflex-reflective material on the opposite broad surface of the disk.

FIG. 5B is a perspective view of a disk of the type shown in FIG. 5A which may also be used in the viewer of FIG. 4. This disk has a visual indicator consisting of an arrow placed on the disk at a predetermined angle with respect to the boundary.

FIG. 6A is a cross-section taken along lines 6—6 of FIG. 4 of a portion of the magnetic viewer of FIG. 4 containing a single socket containing a magnetized disk of the type shown in FIG. 5A and showing the flat orientation of the magnetized disk in the socket when positioned over a boundary between sections of opposite magnetic polarities.

FIG. 6B is a cross-section also taken along lines 6—6 of FIG. 4 (as in FIG. 6A) and showing the skewed orientation of the magnetized disk in the socket when positioned over a magnetized region of a single magnetic polarity.

FIG. 7 is a perspective view illustrating a method of using a magnetizer key for magnetically encoding a document such as is shown in FIGS. 2A and 2B to have magnetized sections of opposite polarities having a boundary extending therebetween.

FIG. 8 is a perspective view of the magnetizer key shown in FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In its preferred embodiment, the document of the present invention is a credit card 10 having an outward appearance such as is illustrated in FIG. 1. The name of the company issuing the credit card and the name, address and account number of the person to whom the credit card is issued are set forth as visible indicia on a surface layer 12 of the credit card 10. Preferably, such visible indicia are placed on the credit card 10 by printing, although embossing or a combination of printing or embossing may also be used.

Referring to FIG. 2A, the card 10 includes a substratum 14 including magnetically hard material. This substratum 14 is a continuous stratum of uniaxially anisotropic magnetically hard barium ferrite particles in a binder or matrix of rubber, plastic, or other non-magnetic material, such as the permanent magnet material which is described in a brochure entitled "Plastiform Brand Permanent Magnets", which brochure is available from the Dielectric Materials & Systems Division of Minnesota Mining and Manufacturing Company, St. Paul, Minn. The stratum 14 includes permanent magnet material which is oriented to have its easy axis of magnetization perpendicular to the broad plane of the stratum 14; and the permanent magnet material is magnetized in the direction of this easy axis.

The thickness of the document is approximately 30 mils (0.75 mm). The residual induction B_r of the magnetized material at the magnetized regions 16 of the document 10 is approximately 2,000 gauss. The magnetic attractive forces provided at the magnetized regions 16 of the document 10 can be increased if the surface of the stratum 14 opposite to the surface 21 thereof is backed with steel.

A fixed two-dimensional pattern is defined by a plurality of disparate magnetized regions 16 in the stratum 14. The magnetized regions 16 comprise pairs of magnetized sections 18 and 19 which are labeled "N" and "S" for North and South magnetic polarities, respectively, at the surface 21 of the stratum 14. The sections 18, 19 preferably would not be visible to the naked eye if one were to view the stratum 14 directly.

In the document of FIG. 2A, the stratum 14 is not appreciably magnetized except in those sections 18, 19 which are labeled either "N" or "S".

In the document of FIG. 2B, the sections 20 are magnetized to have a magnetic South polarity at the surface 21 of the stratum 14. The remainder of the stratum 14 has a North polarity at the surface 21.

In both of the documents shown in FIGS. 2A and 2B, because the permanent magnet material is magnetized in the direction of its easy axis of magnetization which is perpendicular to the stratum 14, the magnetic polarity at the surface 21 of the stratum 14 is opposite to the magnetic polarity at the surface of the stratum 14 opposite to the surface 21 thereof.

Each oppositely magnetized pair of sections 18, 19 has a boundary 22 therebetween which extends breadthwise in the stratum 14. The angles to which the boundaries 22 extend breadthwise in the stratum 14 represent data, with any given angle being unique to certain data.

For purposes of illustration, the boundaries 22 are shown to extend at five different angles breadthwise in the stratum 14. Comparing the top row 24 of magnetized regions 16 with the bottom row 26 of magnetized regions 16, it is seen that although the angles of extension of the boundaries 22 are the same in the adjacent magnetized regions 16 of the two rows 24 and 26, the orientations of the magnetized section polarities N and S with respect to the boundaries 22 are different. Therefore, by variation in the orientation of the magnetized section polarities N and S with respect to the boundaries 22 therebetween, the number of different data which may be represented is double the number of different angles of extension which may be encoded in the stratum 14. In the document of FIG. 2A, the boundaries 22 extend at five different angles and, because of the variation in the orientation of the magnetized section polarities N and S with respect to the boundaries 22, represent ten different data.

Referring to the document of FIG. 2B, the straight line portions of the semi-circular shaped sections 20 are the boundaries 23 which bisect the magnetized regions defining the fixed two-dimensional pattern.

Assuming that the angles of extension of the boundaries 22 and the orientation of the magnetized section polarities N and S with respect thereto as illustrated in FIG. 2A represent the numerals 1 2 3 4 5 6 7 8 9 0, when reading from left to right in rows 24 and 26 sequentially, then the angles of extension of the boundaries 23 and the orientations of the magnetized sections 20 with respect to the boundaries 23 in the document of FIG. 2B represent the numerals 4 5 6 8 0 2 1 9 3 7.

Still in accordance with the present invention, it is envisioned that at certain, but not all, of the magnetized regions the document might not contain magnetized sections of opposite polarities having a boundary extending therebetween extending breadthwise in the stratum, but rather the document might be magnetized to contain a magnetized region of only one magnetic polarity, such as North or South, at a given surface of the stratum, or, alternatively, might be unmagnetized. Such envisioned variations may provide further coding complexities.

It is also envisioned that in accordance with the present invention the magnetically hard material of the stratum 14 may be uniaxially anisotropic material which is oriented with its easy axis of magnetization in the broad plane of the stratum 14; may be other than uniaxially anisotropic, or even if such, may be unoriented in the stratum; and/or that the magnetically hard material of the stratum 14 may be magnetized in

the plane of the stratum 14, rather than perpendicular thereto, to have oppositely magnetized sections 18, 19 such as are illustrated in FIGS. 3A, 3B and 3C, wherein the arrows represent the directions of the magnetic fields.

A visual indication of the data encoded in the document of the present invention may be provided through use of a magnetic viewer 30 such as is described in my copending application entitled "Magnetic Viewer And Display Device" filed on even date herewith. This viewer 30 (an embodiment of which is shown in FIG. 4) is a device for providing a visual indication of data represented by the magnetic polarity alignments at each of a plurality of disparate magnetized regions defining a two-dimensional pattern, and comprises a transparent board 32 containing a plurality of sockets 33 positioned in the fixed pattern, and a plurality of disks 35 containing magnetically hard material which is magnetized to have a given magnetic polarity alignment. Each disk 35 also contains a visual indicator for providing an indication of the magnetic polarity alignment of the disk. Each magnetized disk 35 is restrained from movement within the socket 33 by only the dimensions of the socket 33 and is movable within the socket 33 to assume an orientation corresponding to the magnetic polarity alignment at a magnetized region 16.

The magnetized disks 35 are restrained in the sockets 33 by a transparent back layer 36 and by a transparent cover 37. Because the viewer of FIG. 4 is transparent, it is possible to read visible indicia printed on the credit card, such as the name and account number, while viewing the magnetically encoded data.

The disks 35 are made of the same type of uniaxially anisotropic magnetically hard permanent magnet material of which the stratum 14 of the card 10 is made. The permanent magnet material in the disks 35 is oriented to have an easy axis of magnetization perpendicular to the flat surfaces 39 of the disks 35.

Alternative embodiments of the magnetized disks 35 are shown in FIGS. 5A and 5B.

The disks 35 are magnetized to contain upon the surface 39 opposite to differently colored areas 40 and 42 a pair of magnetized sections of opposite polarities having a boundary therebetween. A visual indicator 46 corresponding to the boundary is provided on each disk 35 on the surfaces 47 opposite to the surface 39 having the boundary to indicate the orientation of the boundary and the orientation of the oppositely magnetized sections with respect to the boundary. For the disk of FIG. 5A, a two-colored layer 48 of reflex-reflective material provides the visual indicator 46 of the boundary. The visual indicator 46 is the line of color separation which corresponds to the orientation of the boundary. The light-colored reflex-reflective material in area 42 indicates one magnetic surface polarity, such as North, at the underlying portion of the surface 47, and the darker colored reflex reflective material in area 40 indicates the opposite magnetic surface polarity, such as South, at the underlying portion of the surface 47. That is to say, the light-colored material, by indicating a North polarity beneath area 42 at the surface 47 of the disk covered by a reflex-reflective material area 42, conversely indicates a South polarity at the section of the flat surface 39 which is opposite to area 42.

Referring to the disk shown in FIG. 5B, the orientation of the boundary and the orientations of the oppositely magnetized sections with respect thereto are indicated by an arrow 46. The arrow 46 is preferably either parallel (as shown in FIG. 5B) or perpendicular to the boundary.

The magnetized disk shown in FIG. 5A may be produced in the following manner. The visual indicators are affixed on a sheet of magnetically hard magnet material having an easy axis of magnetization perpendicular to its broad plane. This sheet is placed between and in contact with a serpentine pattern of copper wire and a steel sheet, with the copper wires registered with the visual indicators. A pulse of electrical current is sent through the wire by discharge of a charged capacitor bank, thereby producing alternately polarized magnetized sections, with boundaries coinciding with the copper wire locations. Disks are then stamped from the sheet so that they have oppositely magnetized sections upon their broad surfaces on opposite sides of the visual indicators.

When the document 10 of the present invention is interfaced with the viewer 30 above described so that the magnetized regions are correctly registered with the sockets 33, those disks 35 in sockets 33 registered with the document magnetized regions 16, whereat there is a boundary 22 between oppositely magnetized sections 18, 19, will seek a directional orientation wherein the disks 35 lie flat in the sockets 33 and the visual indicators 46 of the disks 35 are parallel to the boundaries 22 in the stratum 14. The orientation of the disks 35 in the viewer 30 corresponds to the alignment thereof which occurs when the viewer 30 is registered with the document of FIG. 2A.

Referring again to FIGS. 6A and 6B, it is seen that the sockets 33 are of such dimensions that the disks 35 cannot flip over. Referring to FIG. 6A, a disk 35 assumes a flat position in the socket 33 when positioned over a boundary 22 between sections 18, 19 of opposite polarities at the surface of the stratum 14 of the document 10, whereas in FIG. 6B, the disk 35 is seen to assume a skewed orientation in the socket 33 when positioned over a magnetized region of a single magnetic polarity at the surface of the stratum 14 of the document 10.

Referring again to FIG. 4, while the number of magnetic regions 16 in the document 10 need not necessarily correspond to the number of sockets 33 in the magnetic viewer 30, and while the number of each which is chosen is arbitrary, the fixed pattern of magnetized regions 16 must correspond to the fixed pattern of sockets 33.

A preferred method for magnetically encoding the sections 18, 19 to have opposite magnetic polarities is as follows. Referring to FIGS. 7 and 8, the document 10 is placed on a sheet 50 of iron or soft steel and a pair of oppositely magnetized pole piece faces 51, 52 of a magnetizer key 54 is contacted with the surface layer 12 of the document 10. The key 54 is made of two iron or soft steel pole pieces 58 and 60. Between the pole pieces there is disposed a tapered permanent magnet 62 such as may be used in the stratum 14 and in the disks 35. When the key 54 is contacted with the document 10, the surface 21 of the stratum 14 is magnetized to contain two oppositely magnetized sections 18, 19

having a boundary therebetween corresponding to the gap 64 between the faces 51, 52 which make contact with the document 10.

The same method may be used to encode the document of FIG. 2B, provided the stratum 14 is first uniformly magnetized in a direction perpendicular to the stratum.

This magnetizing step can also be performed without the use of a sheet of iron or soft steel in contact with the document 10.

What I claim is:

1. A magnetically encoded document, comprising a broad stratum containing magnetically hard material magnetized to represent encoded data as a plurality of disparate magnetized regions of various polarity alignments defining a fixed two-dimensional pattern over the stratum, wherein upon at least one broad surface of the stratum each magnetized region comprises a pair of magnetized sections of opposite polarities having a narrow boundary therebetween, wherein the angles to which the boundaries extend breadthwise in the stratum of the document represent encoded data, with any given angle being unique to certain data.

2. A magnetically encoded document according to claim 1, wherein the stratum includes uniaxially anisotropic magnetically hard material oriented to have an easy axis of magnetization perpendicular to the plane of the stratum, in the direction of which axis the magnetically hard material is magnetized.

3. A magnetically encoded document according to claim 1, wherein a first magnetized region comprises a first pair of magnetized sections of opposite polarities having a first boundary therebetween extending breadthwise in the stratum at a first angle with a given orientation of polarities with respect to the first boundary to represent a first datum; and wherein a second magnetized region comprises a second pair of magnetized sections of opposite polarities having a second boundary therebetween extending breadthwise in the stratum at said first angle, but with the orientation of the second pair of magnetized section polarities with respect to the second boundary being opposite to the given orientation of the first pair of magnetized section polarities with respect to the first boundary to represent a second datum different from said first datum.

4. A magnetically encoded document according to claim 1, wherein a face of the document contains visible indicia.

5. A magnetically encoded document according to claim 1 wherein the broad stratum is a continuous stratum of magnetically hard material.

6. A magnetically encoded document according to claim 1 wherein the broad stratum containing magnetically hard material comprises uniaxially anisotropic magnetically hard barium ferrite particles in a binder or matrix of rubber, plastic, or other non-magnetic material.

7. A method of magnetically encoding a document comprising a broad stratum containing magnetic material to provide a plurality of disparate magnetized regions of various polarity alignments defining a fixed two-dimensional pattern over the stratum, which method comprises the step of magnetizing the magnetic material at a plurality of locations to provide at each lo-

cation a pair of magnetized sections of opposite polarities having a narrow boundary therebetween extending breadthwise in the stratum to provide magnetized regions wherein the angles to which the boundaries extend breadthwise in the stratum represent encoded data, with any given angle being unique to certain data. 5

8. A method of magnetically encoding a document according to claim 7, wherein the magnetizing step comprises contacting the document with a pair of oppositely magnetized pole piece faces which are separated by a narrow gap to provide a pair of magnetized sections of opposite polarities having a boundary therebetween extending breadthwise in the stratum at an angle corresponding to the angle of said narrow gap with respect to the breadth of the stratum upon the pole piece faces making contact with the document. 10 15

9. A method of magnetically encoding a document according to claim 8, wherein the contacting step further comprises placing a sheet of iron or soft steel on the opposite sides of the document from the pole piece faces. 20

10. A magnetizer key for use in encoding a document comprising a broad stratum containing magnetic material by a process wherein the magnetic material is magnetized to provide a pair of magnetized sections of opposite polarities having a boundary therebetween ex- 25

tending breadthwise in the stratum, which magnetizer key comprises

a tapered permanent magnet having

a first side of one polarity and a second oppositely disposed side of the opposite polarity, and

a wide first end and a narrow second end wherein the wide first end of the permanent magnet is substantially wider than the narrow second end of the magnet; and

a pair of pole pieces contacting the first and second sides of the permanent magnet respectively, each pole piece having a face adjacent the narrow second end of the permanent magnet, which faces are shaped for simultaneously contacting a said document and are separated by a narrow gap; 10 15

whereby when said document is contacted by the pair of pole piece faces with the narrow gap extending at an angle with respect to the breadth of the stratum, the stratum is magnetized to provide a pair of magnetized sections of opposite polarities having a boundary therebetween extending breadthwise in the stratum at an angle corresponding to the angle of said narrow gap with respect to the breadth of the stratum upon the pole piece faces contacting the stratum. 20 25

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