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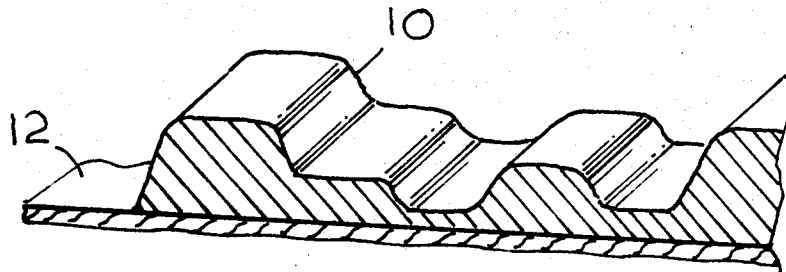
[54] **MAGNETIC AUTHENTICATION OF SECURITY DOCUMENTS HAVING VARYING INK LEVEL CODING**  
**9 Claims, 8 Drawing Figs.**

[52] U.S. Cl. .... **340/149,**  
**235/61.12, 235/61.7**

[51] Int. Cl. .... **H04q 3/00**

[50] Field of Search ..... **340/149 A;**  
**235/61.12 M, 61.7 B**

**ABSTRACT:** A document authentication technique is provided wherein at some predetermined region on the surface of said document there is printed a portion of an image in magnetic ink. The magnetic ink is deposited with predetermined variation of layer thicknesses, as is accomplished using the intaglio process. For readout, the magnetic ink is saturated by a constant magnetic field, and then passed under a magnetic reading head, which produces as its output, a signal having a unique multilevel waveform which is readily associated with the multilevels of magnetic ink which are deposited on the document. This unique waveform can be identified by comparison with a standard.



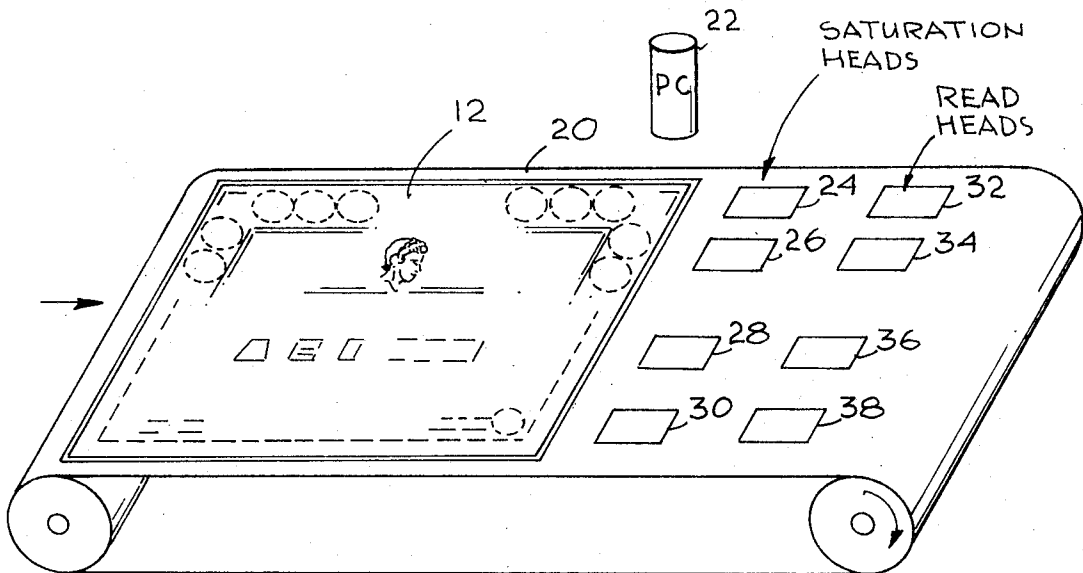
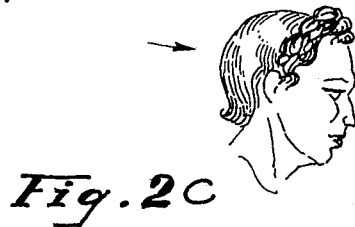
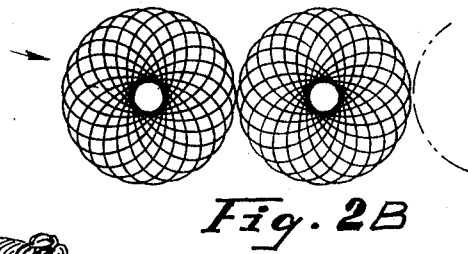
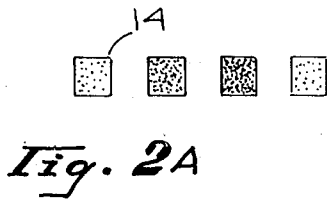
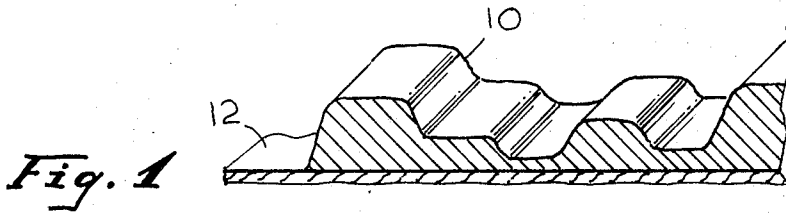


Fig. 3

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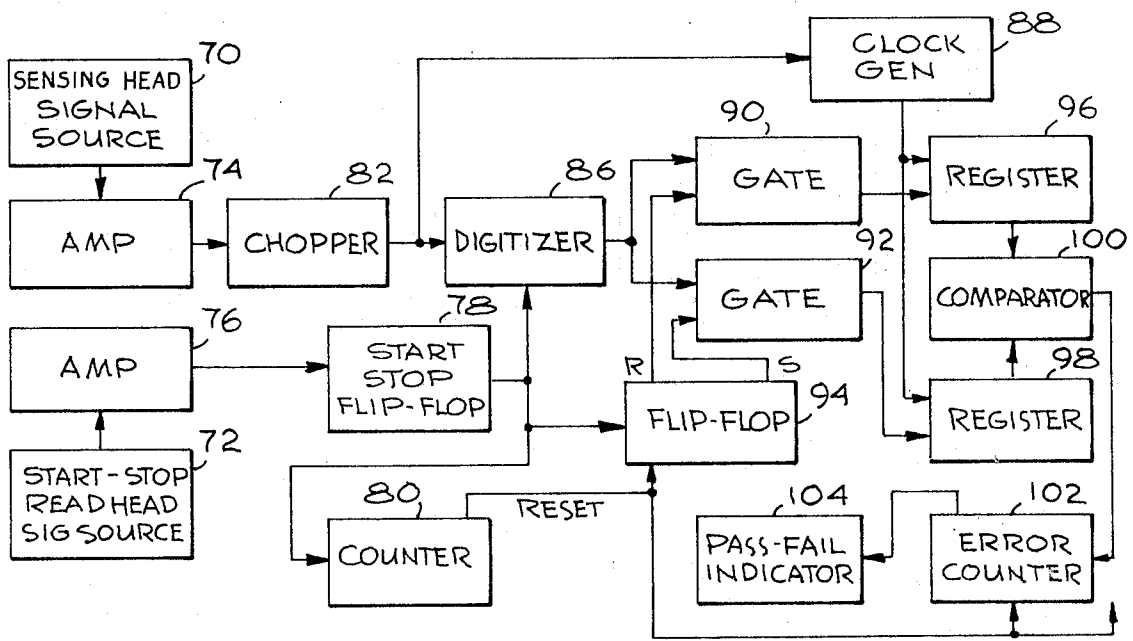
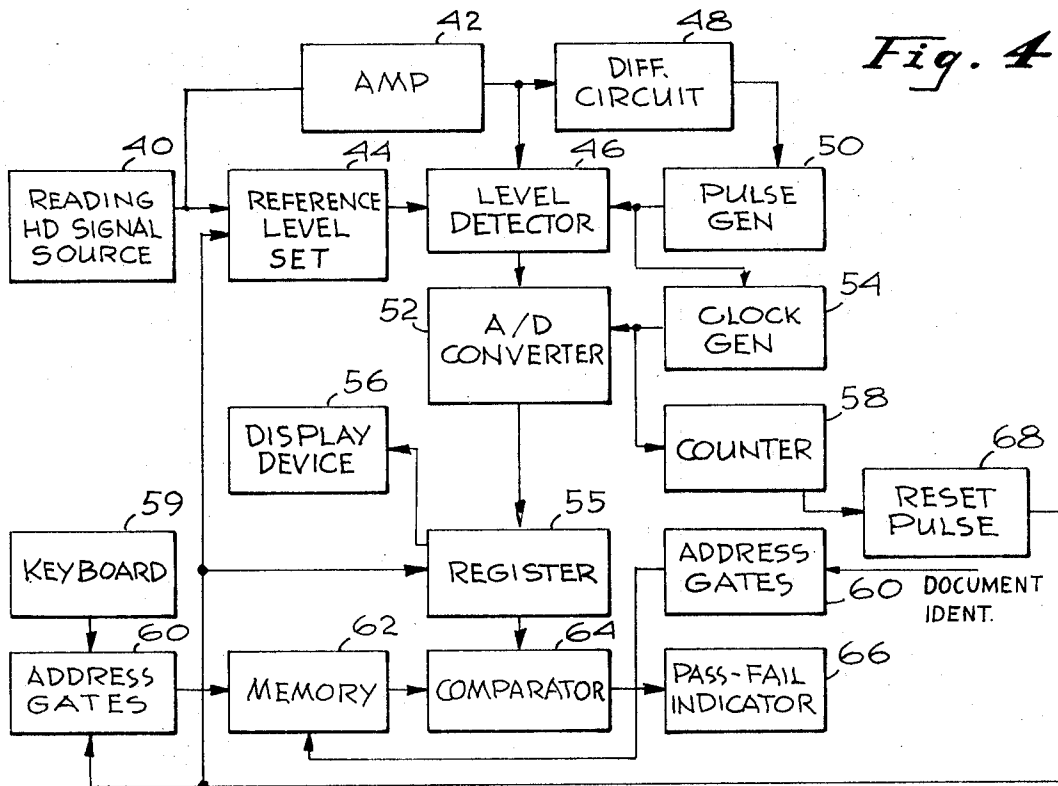


Fig. 5

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## MAGNETIC AUTHENTICATION OF SECURITY DOCUMENTS HAVING VARYING INK LEVEL CODING

### BACKGROUND OF THE INVENTION

This invention relates to document authentication techniques and more particularly to an improved magnetic method for performing said authentication. Means are provided to illustrate the technique.

The problem of insuring that documents, such as stocks, credit cards, travelers checks, bonds, or money are authentic, is an ever present one in view of the fact that the skills of a counterfeiter improve with advancing technology.

### OBJECTS AND SUMMARY OF THIS INVENTION

This invention provides a new method and means for incorporating information into the material printed on a document whereby said document may be authenticated as a reproduction of the intaglio process.

Another feature of this invention is to provide a unique magnetic method and means of determining whether or not a document is authentic whereby the printed information is read and compared to a predetermined, multilevel and unique signature of the document.

Still another feature of the present invention is the provision of an arrangement whereby the above described information is encoded in the document in a manner which renders simulation substantially impossible.

The foregoing features are accomplished in an arrangement wherein a document is printed employing the intaglio process. At predetermined locations on the document, from the making of the intaglio plate, the depth of cut is specifically controlled so that magnetic ink, which is used in the process of printing, is laid down on the document at a predetermined depth representative of a predetermined volume of ink, with the depth and/or volume variations following a desired predetermined pattern. Thereafter, even though a subsequent impression calenders the intaglio printing so as to reduce its height above the substrate document, the volume of ink in said location, although reduced in height, contains a volume component of the original plate depth so as to maintain the original magnetic level or magnetic field density. Thereafter, for the process of recognition or authentication, the document is moved past a first location at which the magnetic ink regions thereof are saturated with magnetic flux. The document thereafter moves past a second location at which there is positioned a magnetic sensing head. The sensing head, in response to the varying magnetic ink depths which are magnetically saturated, generates a signal having a wave form uniquely representative of the original magnetic ink depths. This wave form itself may be normalized and then compared with a previously stored pattern. This wave form may be digitized and likewise compared with previously stored data. Alternatively, the printing with magnetic ink on the document can be made with repetitive patterns over a region thereof. These repetitive patterns can then be read and compared, and if they indicate that they are alike, the document can be then accepted as authentic.

The novel features of the invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in conjunction with the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic representation of a magnetic ink deposition on a surface in accordance with this invention.

FIGS. 2A, 2B, and 2C indicate the appearance of various magnetic ink depositions on a document.

FIG. 3 is a schematic representation of the manner in which a document may be scanned for authentication.

FIG. 4 is a block schematic diagram of a circuit for authenticating a document in which in accordance with this inven-

tion encoding has occurred as a series of successive blocks of varying quantum levels of ink volume and therefore magnetic level.

FIG. 5 is a block schematic diagram of a circuit for authenticating a document in which, in accordance with this invention, encoding has occurred in the repeating rosette pattern on a document.

FIG. 6 is a block schematic diagram in accordance with this invention for authenticating a document in which encoding has occurred on the vignette on the document.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Documents such as stocks or bonds are normally printed using the intaglio process. In this process, the printing plate has a relief image etched over the surface thereof with varying depths of etch in accordance with various shades of the image. The greater the depth, the more ink that is applied and transferred to the paper, and the darker the appearance of the image at that particular location.

In accordance with this invention, over a predetermined region of the document, or, if more than one is desired, over predetermined regions, the depth of etch will be predetermined. The intaglio plate is inked by magnetic ink which is then transferred to the document whose authentication is sought to be determined at a future time. Of course the ink layers in the predetermined region or regions will have a predetermined depth sequence or arrangement. Thus, if one first passes that region of the document under a magnetic head which saturates the region with magnetic flux, and thereafter passes that region of the document under a magnetic sensing head, the output of the magnetic sensing head will constitute an electrical signal having a predetermined wave shape, which can be identified for the purpose of identifying the document.

As far as counterfeiters are concerned, since all of the ink used is magnetic, they will not know what predetermined regions of a document are being used for authenticating purposes. Assuming that it might be possible for them to find this out, then unless they can exactly duplicate the depth of etch sequence together with the distance those depths extend into the plane of the plate, they still cannot duplicate the document. This latter achievement is almost impossible to do.

If a counterfeiter attempts to simulate a document by the use of lithography, then in order to build up successive layers of ink in order to properly simulate the signal of the intaglio document, the forger must achieve almost perfect superimposition of successive lithographic prints. This too, is almost impossible to do.

Referring now to FIG. 1, there may be seen in cross section the appearance of the magnetic ink 10 which has been deposited upon the surface of the document 12. This magnetic ink has a varying height above the surface of the document, which is predetermined by the depth of etch in the intaglio plate. The height represents a fixed volume of ink to be placed under the sensing head area. The magnetic field is thus fixed and even with compression of the volume, maintains a fixed magnetic level.

Now the encoding on a document may be done in any number of ways. As shown in FIG. 2A, the ink may be deposited in the form of a succession of blocks 14, the height of each of which above the surface of the paper 12, differs from the others, in accordance with a predetermined plan. The blocks may be hidden by being dispersed in the lettering on a document, or within the image or figure on the document. The first block of a group of blocks may be given a fixed level which can act as a reference level for adjusting the signals derived from the blocks that follow.

FIG. 2B represents a portion of the rosette which normally borders a fiscal certificate. A reading, for authentication, may be taken through the rosette at the region indicated by the arrow in FIG. 2B and authentication may be established by the requirement that the signals derived from any single rosette pattern are exactly duplicated by the signals derived from the

other rosette patterns which are scanned at the same region. This procedure is a test of the quality of printing which is a determinant of counterfeit detection.

FIGS. 2C represents one portion of a figure or vignette which is normally shown on a fiscal certificate. Scanning may be made through the portion of the vignette indicated by the arrow in FIG. 2C, to determine whether the signals derived as a result of a magnetic reading taking through this region, are in accordance with those established as a standard for authentication of the document.

FIG. 3 indicates an arrangement which may be employed for reading a document for the purposes of its authentication. The document 12 may be placed on a conveyor belt 20, using any of the well-known forms of alignment, either mechanical, such as mechanical etch guides, or electrical, such as photocells placed so that the belt will not move until the light reaching the photocell indicates that the document is in proper alignment on the belts. A photocell 22 is placed above the belt to indicate when the document 12 reaches the region of a plurality of magnetic saturation heads respectively 24, 26, 28 and 30, which extend across the document for the purpose of biasing the magnetic ink thereon to magnetic saturation. The document then passes under a plurality of magnetic sensing heads respectively 32, 34, 36, 38, which respond to the magnetic fields produced by the magnetic ink. One of the heads 24 may be placed near the border of the document to respond to the magnetic flux pattern of the rosette. The second head 24 may be placed in the region of the image or vignette on the document in order to respond to the magnetic field present there. A third magnetic reading head 36 is placed over the region of the document which contains numbers or characters, to respond to the magnetic fields present there. A fourth reading head 38 (or even more), may be positioned at various locations over the document for the purpose of detecting guidance marks, reference marks, or a signal pattern for the purpose of indicating to the circuitry connected to the other reading heads when the time to commence reading has occurred. In brief, as many magnetic reading heads are employed as are required for the function of authentication, reference level signal detecting, and alignment control. These heads are made wide enough to insure that the volume of ink to be sensed will pass under all of the head.

FIG. 4 is a block schematic diagram of an arrangement which may be used for detecting the information contained in magnetic ink blocks, such as represented in FIG. 2A. The magnetic sensing head which reads the magnetic ink blocks, here represented as a reading head signal source 40, applies the signals derived from the magnetic ink blocks to an amplifier 42, and to a reference level setter 44. The first block of any group is always used for the purpose of setting a reference level signal, and this is achieved by always employing a fixed depth of etch for the region on the intaglio plate which will print the first block. The first block signal is detected by the reference level detector 44, which establishes the threshold of a level detector circuit 46.

The output of the amplifier 42 besides being applied to the gated level detector circuit 46 is also applied to a differentiating circuit 48. The output of the differentiating circuit 48 is applied to a pulse generator 50, in order to synchronize its output with the beginning of each block signal which is read. The pulse generator 50 applies its output to the gated level detector in order to chop the signal into discrete signal areas. These discrete signal areas of varying signal levels are applied by the gated level detector to an analog-to-digital converter 52.

A clock generator 54, clocks the analog-to-digital converter which converts the level of each signal to a digital number. This digital number is then entered into a holding register 55, which stores all of the digital numbers for a group of blocks. These digital numbers may be displayed by a display device 56, which is connected to the holding register.

From an external keyboard 59 or from other electronic sensing of the document by methods well known in the art, an identification code is applied to the gates 60, representative of

an address. The gates 60 address a memory 62 with their outputs. The memory address causes a readout of a sequence of digital numbers from memory which should correspond with the sequence of digital numbers entered into the register 55. The readout from the memory 62, as well as that of the register 55 are applied to a comparator 64. Should there not be correspondence between the output of the memory 62 and that of the register 55, then a pass-fail indicator 66, is energized to indicate this fact. The pass-fail indicator may be any device which is actuated by an electric signal which the comparator provides as an output when its two inputs do not compare favorably.

When the counter 58 has finished its count, its last count is applied to a reset pulse generator 68. This generates a reset pulse which can reset the gates 60, and the register 55, and the reference level set 44, so that the circuit may be reset for a new reading.

FIG. 5 is a block schematic diagram of an arrangement effecting authentication of a document by reading the magnetic fields of its rosette pattern. It will be remembered that, as shown in FIG. 2B, the rosette pattern consists of a series of repeated patterns. Authentication may be achieved by insuring that, for example, all or a predetermined number of these rosette patterns provide an identical output signal train. Accordingly, this requires a knowledge of the length of the rosette pattern being read since the pattern length can vary from document to document. The length information may be recorded on the document being authenticated adjacent to the reading location either by block signals, as above, or by register marks providing the physical length of the pattern. These will be designated as the start and stop signals, and are read by a magnetic sensing head assigned thereto.

In FIG. 5, the information signals from the saturated magnetic elements of the rosette are generated by a sensing head signal source 70, and the information signals as to the starting and stopping of the rosette pattern are generated by a "start-stop reading head signal source," 72. The outputs from both of these heads are applied to respective amplifiers 74, 76. The output of the amplifier 76 is applied to a start-stop flip-flop. The start output pulse from the flip-flop causes a count to be entered into a counter 80. One count is entered for each rosette pattern which is to be read. The end of each rosette is detected and applied to the start-stop flip-flop 78 causing it to be reset. The start of each rosette therefore enables the start-stop flip-flop to provide another output pulse to the counter 80.

A chopper 82, chops, or samples the signals received from the amplifier 74, and applies them to a digitizer 86, as well as applying synchronizing pulses to a clock generator 88. The digitizer 86 is enabled to function only in response to the start signal produced at the output of the start-stop flip-flop 78.

The chopper 82 samples the input signals at a predetermined rate, and the digitizer 86 converts these signals to binary digit signals. The output of the digitizer is applied to two gates respectively 90, 92. One or the other of these two gates is enabled by the set or reset output of a flip-flop 94. Flip-flop 94 is driven from its set to its reset state successively in response to start signals from the output of the start-stop start-stop flip-flop 78. Accordingly, the output of the digitizer 86, which is applied to these two gates 90, 92, during the reading from one rosette pattern is transferred by gate 90 into a register 96. At the reading of the next rosette pattern, the output of the digitizer, consisting of a train of binary signals, is applied to a register 98 by the gate 92.

The clock generator 88 shifts the registers 96, 98 to enable them to enter the digits received from the digitizer 86. At the commencement of a reading of a rosette pattern, register 96 is filled. At the second rosette pattern reading, register 98 is filled. The comparator 100 then can operate to compare the outputs of the two registers 96, 98 for identity. It provides an output pulse when its inputs are not identical. The output of the comparator 100 is entered into an error counter 102. The error counter counts the number of errors detected by the

comparator 100. When they exceed a predetermined value, it can energize a pass-fail indicator 104, to indicate that the rosette patterns do not pass the authentication test.

The counter 80 counts the number of signals received from the flip-flop 78, and when they attain a predetermined count value indicative of the predetermined number of rosette patterns to be compared, the counter overflow output 80 resets the flip-flop 94, the error counter 102, and the registers 96, 98.

An alternative method of authenticating a document by using the rosette pattern can be accomplished with the detection of a variation of etch depth superimposed on the border comprising the rosettes. The protection provided by this method lies in the identical visual appearance of the repeated rosettes, but a magnetic level difference between patterns. Specifically, a photographic reproduction or visual examination would not indicate a rosette-to-rosette variation, but the use of intaglio printing and magnetic sensing would disclose a predetermined variation. This variation, extracted from the pattern, could in itself be encoded and compared with data obtained from a memory addressed by that particular document class, or compared to data extracted by other means from the document.

FIG. 6 is a block schematic diagram illustrating an arrangement for effecting authentication by sensing the magnetic field pattern derived from a vignette, such as illustrated in FIG. 2C. Signals from a sensing head signal source 110 are applied to an amplifier 112, whose output is applied to a start-stop signal detector 111 and to a level detector 114. The start-stop signal detector detects a start signal pattern or amplitude at the beginning of a vignette and a stop signal pattern at the end of a vignette. A pulse output at the start energizes the clock circuit 116. A pulse signifying stop deenergizes the clock circuit. The level detector 114 samples the signals received from the amplifier at a rate which is established by a clock circuit 116. The clock circuit 116 is also used to advance a counter 118, and after a delay by delay circuit 117, it advances an address counter 119. The level detector 114 output is applied to a tapped delay line 120. A summing circuit 122 sums the output of all of the taps. When the counter 118 reaches its full count, which is established by the time required for the first of a sequence of signals from the level detector to reach the last tap of the delay line and the last of the sample signals to be at the first tap of the delay line, the output of the counter 118 at that time energizes a sample and hold circuit 123, which operates to hold the sum of all of the signals which are applied to the delay line taps, at that time.

The output of the tapped delay line, which is a sequence of the signal samples from the level detector, thereafter reaches a divider circuit 124 which divides each of the signals by the sum signal held in the sample and hold circuit 123. All of these samples are normalized by the technique described, namely dividing the sum of all samples into each sample, and therefore random variations in the document to head distance and deterioration of the ink height is compensated for.

An amplifier 126 receives the outputs from the divider 124. The gain of the amplifier 126 is controlled by reference level signals on the document. These are ready by a reference level reading head 128, whose output is detected by a reference mark detector 130. The reference mark level detector output controls the gain of the amplifier 126 in response to the gain of the reference signal which it has received.

The output of the amplifier 126 is applied to an analog-to-digital converter 132, which converts each level to a digital number. Each one of these digital number signals is entered into a register 134, and is also displayed by a display device 136.

Initially, the address counter 119 has a start address for the memory entered thereinto from an address signal source 138. This may be a keyboard or read from the document by another reading head. This start address also identifies the document.

It will be recalled that the address counter 119 had the output of the clock circuit 116 applied thereto. This output is applied through the delay circuit 117, whose function it is to delay the count sequence of the counter 119 until digital signals can be entered in the register 132. The output of the address counter 119, which is a sequence of counts, constitutes address information for a memory 140. This memory accordingly can read out a sequence of digital numbers into a comparator 134, which sequence should correspond with the sequence of numbers applied to the comparator by the register 130. In the event these numbers do not agree, then the output of the comparator can energize a pass or fail indicator 136.

As previously indicated, authentication of a document may be achieved by any one or any combination of the three methods shown above.

Accordingly, there has been shown and described herein a novel, and useful arrangement of encoding for authentication of a document, which is extremely difficult, if not impossible to be duplicated by unauthorized persons.

What I claim is;

1. A document encoding for authentication technique comprising depositing on the surface of said document a layer of magnetic ink, the volume of said layer varying above the surface of said document in a predetermined manner for producing predetermined magnetic fields.

2. A technique as recited in claim 1 wherein said magnetic ink is deposited as part of a pattern on said document surface.

3. A method of document encoding for authentication comprising printing on the surface of said document with magnetic ink whose volume above the surface of said document varies in a predetermined manner, saturating with magnetic flux said magnetic ink on said document, moving said document under a magnetic reading head to pass said magnetic ink thereunder, and checking the output signals from said magnetic sensing head against a standard for determining document authenticity.

4. An authenticated document comprising a document having printing over the surface thereof, a predetermined portion of said printing constituting magnetic ink extending above the surface of said document in a predetermined sequence of different ink volumes for providing an authenticating encoding.

5. Apparatus for determining the authenticity of a document having an authenticating encoding in the form of a predetermined portion thereof printed with magnetic ink extending above the surface of said document with predetermined different thicknesses comprising:

means for saturating with magnetic flux, said predetermined portion of said document,

means for moving said predetermined portion of said document under a reading head for producing a characteristic waveform at the output thereof representative of the predetermined different thicknesses of said magnetic ink on said document,

means for generating waveforms representative of an acceptable standard, and means for comparing the waveforms produced by said reading head with said generated waveforms to produce an output indicative of the merits of said waveform comparison.

6. Apparatus as recited in claim 5 wherein there is included means for normalizing the signal output of said reading head, means for sampling said normalized output, means for producing digital numbers representative of each of said samples, memory means for producing a sequence of acceptable digital numbers, and means for comparing the sequence of numbers from said memory means with the output of said means for converting the samples to digital numbers for indicating acceptance or nonacceptance of said document.

7. An authenticated document comprising a document having printing over the surface thereof, a predetermined portion of said printing constituting magnetic ink extending above the surface of said document in a predetermined sequence of dif-

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ferent ink thicknesses above the surface of said document to provide an authenticating encoding.

8. Apparatus for determining the authenticity of a document having successive predetermined regions thereof printed with magnetic ink extending above the surface of said document with predetermined ink thicknesses comprising:

means for saturating said successive predetermined regions of said document with magnetic flux,

means for moving said successive predetermined regions of said document under a magnetic reading head for successively producing from each region characteristic waveforms representative of the predetermined different thicknesses of said magnetic ink,

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means for separately storing the waveforms produced by said magnetic reading head from a first and a second of said successive predetermined regions, and

means for comparing said stored waveforms to produce an output indicative of the results of said comparison.

9. Apparatus as recited in claim 7 wherein there is included means for converting the waveforms produced by said magnetic reading head into a representative sequence of digital numbers, and

said means for separately storing separately stores the digital numbers representative of the waveforms produced from each successive predetermined region.

UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,599,153 Dated August 10, 1971

Inventor(s) Jerry Lewis et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 29, "24" should read -- 26 --; line 58, between "The" and "of" insert -- output --. Column 4, line 60, cancel "start stop"; line 69, "commencement" should read -- end --. Claim 9, line 1, "7" should read -- 8 --.

Signed and sealed this 20th day of August 1974.

(SEAL)  
Attest:

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Attesting Officer

C. MARSHALL DANN  
Commissioner of Patents