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Beebe et al.

[11] **3,858,514**

[45] **Jan. 7, 1975**

[54] **DATA ACCUMULATION SYSTEM PROVIDING MAGNETIC TONER POWDER RECORDING**

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[73] Assignee: **Minnesota Mining and Manufacturing Company,** St. Paul, Minn.

[22] Filed: **Aug. 28, 1972**

[21] Appl. No.: **284,071**

[52] **U.S. Cl.**..... **101/426,** 101/269, 101/DIG. 13, 117/17.5, 346/74 MP

[51] **Int. Cl.**.....**G01d 15/20,** B41m 1/22

[58] **Field of Search**...346/74 ES, 74 M, 346/74 MP; 117/17.5; 118/637; 317/262 A; 101/114, DIG. 13, 426

[56] **References Cited**

UNITED STATES PATENTS

2,633,796	4/1953	Pethick	101/212
2,848,088	8/1958	Shaw	197/1
2,901,374	8/1959	Gundlach	346/74 ES
2,932,278	4/1960	Sims, Jr.	118/637
2,999,275	9/1961	Blume, Jr.	156/243
3,045,587	7/1962	Schwertz	101/1
3,124,725	3/1964	Leguillon	317/158
3,254,626	6/1966	Uemura	346/74 MP
3,299,806	1/1967	Sawada et al.	101/114
3,310,421	3/1967	Flowers	117/76
3,333,334	4/1967	Kuliczkowski et al.	29/604
3,341,854	9/1967	Supernowicz	346/74
3,484,318	12/1969	Neufeld et al.	156/220
3,496,304	2/1970	Nelson	179/100.2
3,526,191	9/1970	Silverberg	101/426
3,530,794	9/1970	Ritzerfeld	346/74 ES
3,608,488	9/1971	Levine	346/74 MP
3,615,993	10/1971	French	156/155
3,641,585	2/1972	Hodges	346/74 MP
3,643,629	2/1972	Kangas	118/637
3,653,066	3/1972	Royse	346/74 MP
3,662,395	5/1972	Doi	346/74 ES
3,714,664	1/1973	Fayling	346/74 M

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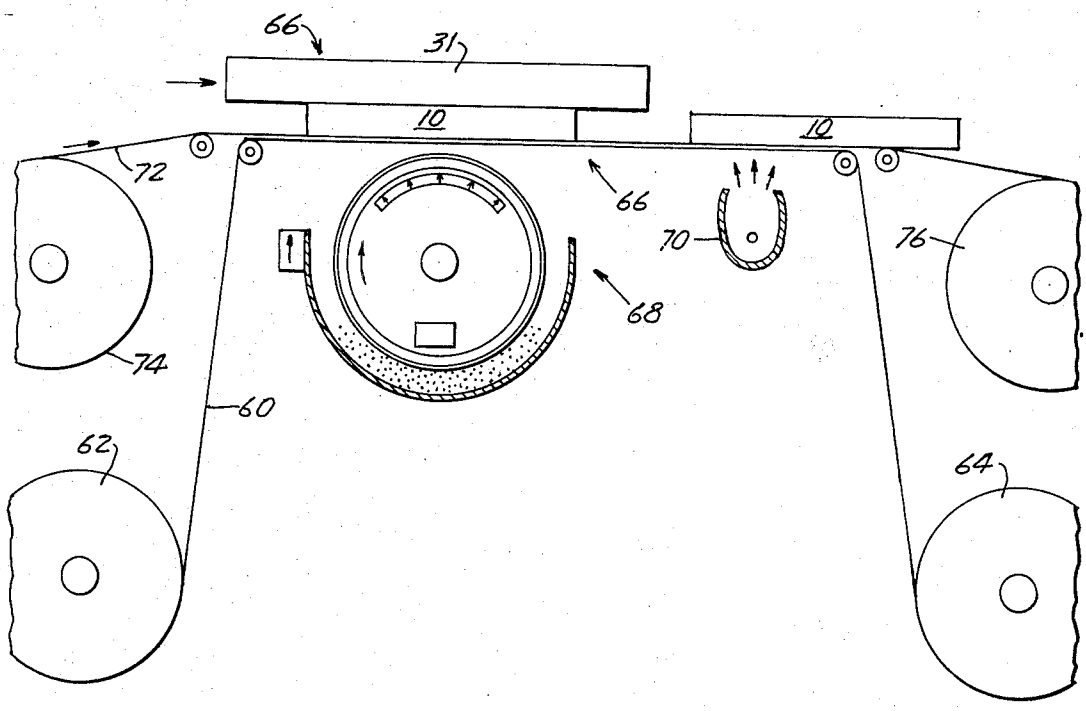
[57] **ABSTRACT**

A system for accumulating data in both human readable and encoded form. The system includes master source documents containing homogeneous permanent magnet material capable of being magnetized throughout in discrete patterns providing intense external magnetic fields representative of encoded data. These fields attract magnetic toner powder to the surface of a transfer sheet to form a visible and machine readable magnetic image of the encoded data. The data is subsequently sensed from the transfer sheet to produce electrical signals for processing in electronic data processing equipment. In one embodiment, both identity and transaction data are presented in the form of discrete patterns providing intense external magnetic fields. In a further embodiment, a duplicate record is simultaneously magnetically recorded onto a magnetic recording medium by contact recording techniques.

23 Claims, 10 Drawing Figures



4 Sheets-Sheet 1

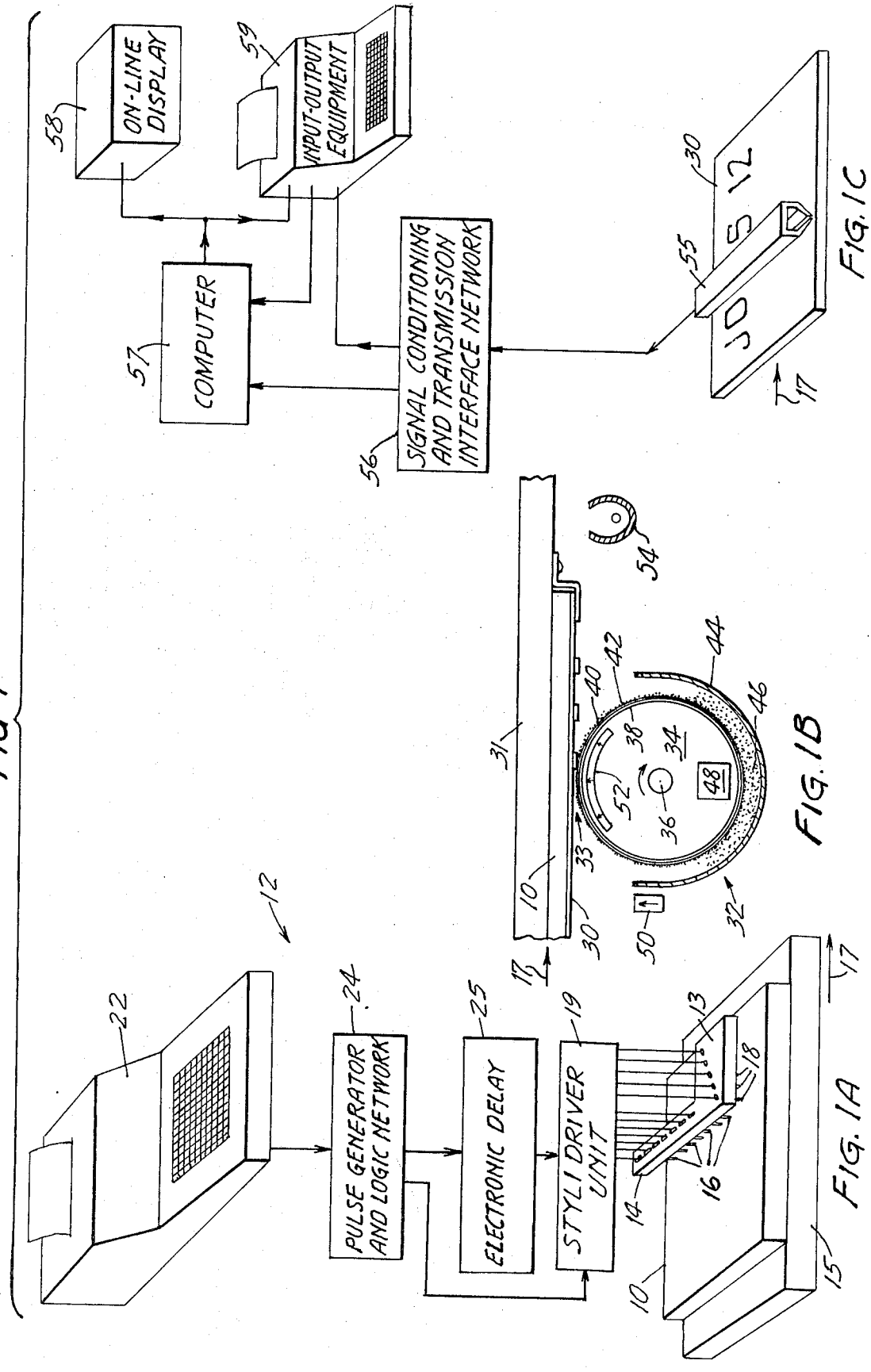


FIG. 2

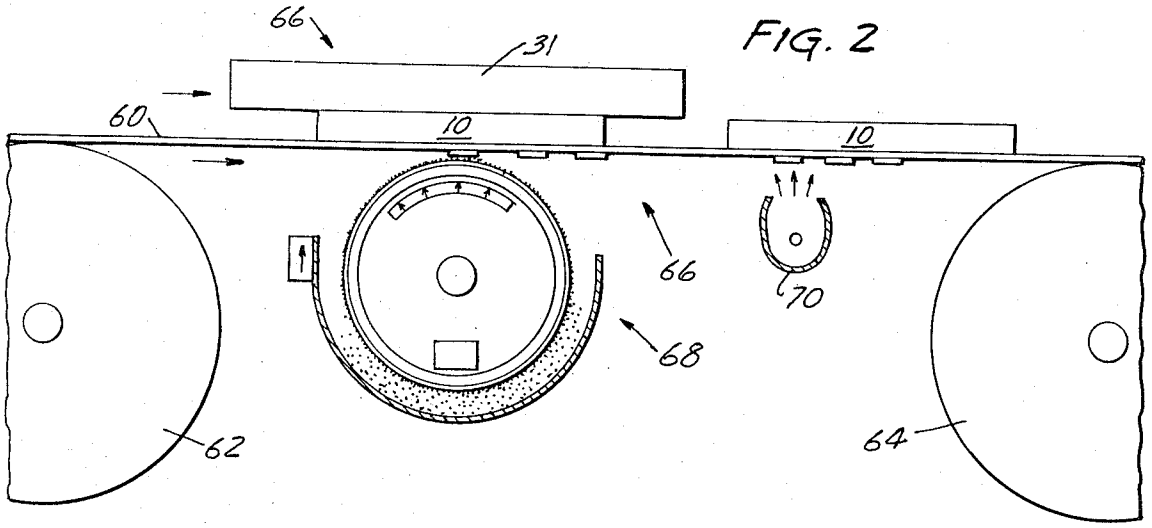


FIG. 3

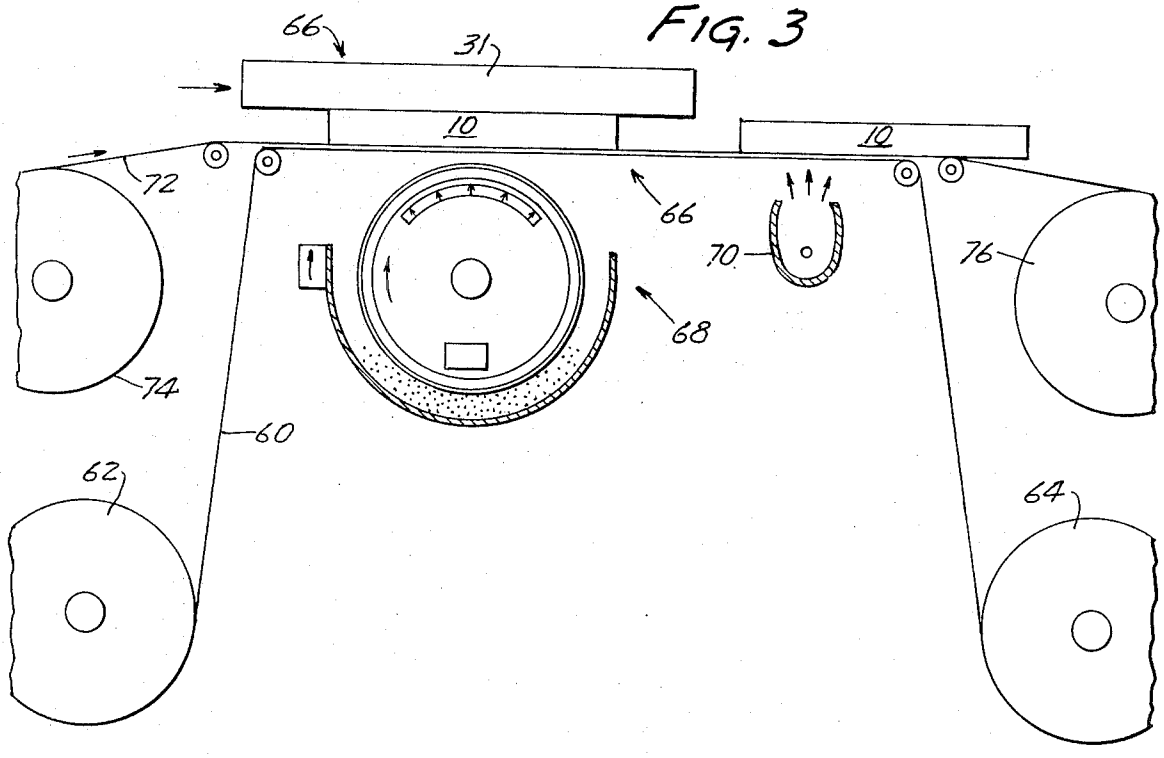


FIG. 4

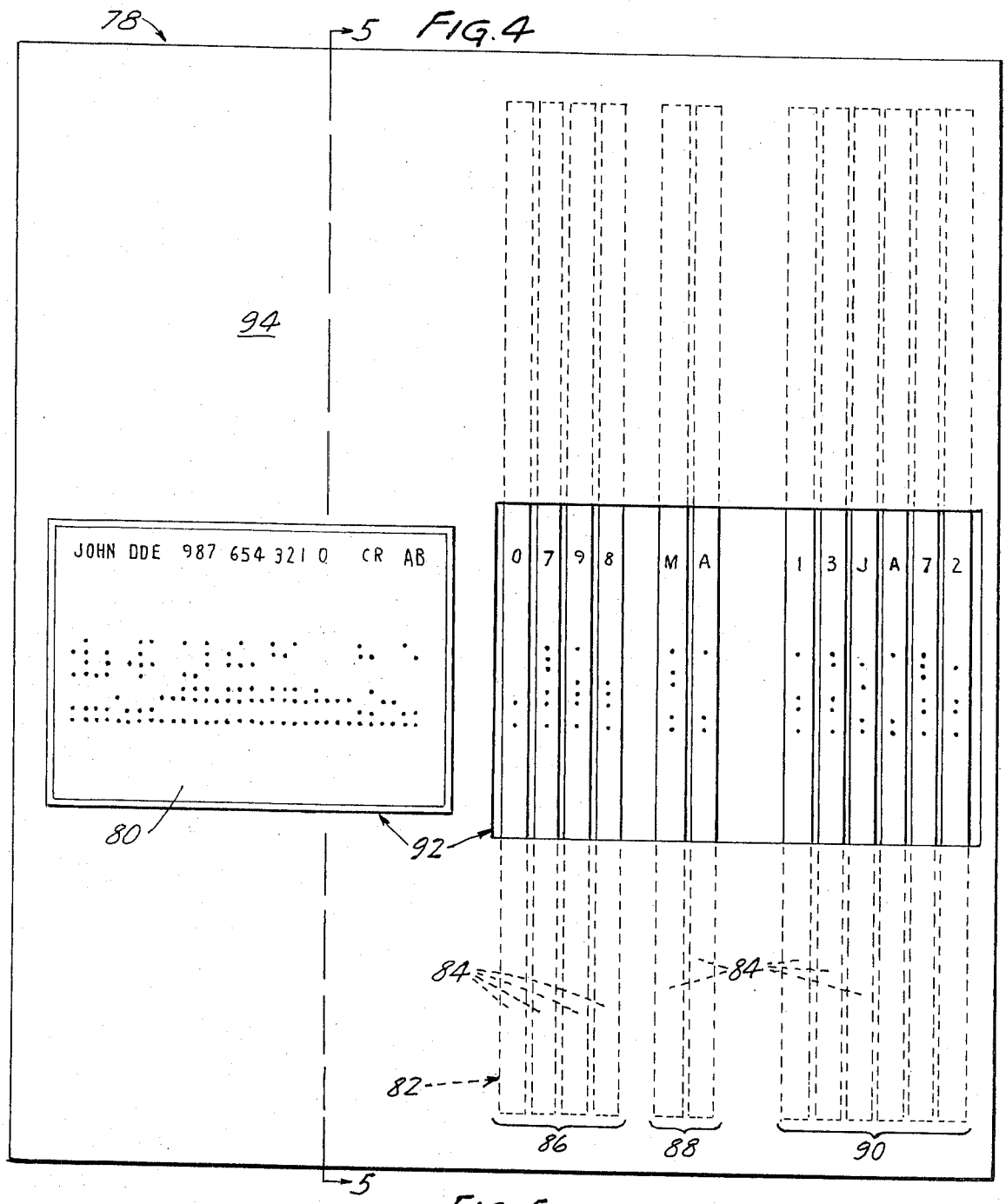

78
5
94
JOHN DOE 987 654 321 Q CR AB
80
92
0 7 9 8 M A 1 3 J A 7 2
84
84
82
86
88
90
5

FIG. 5

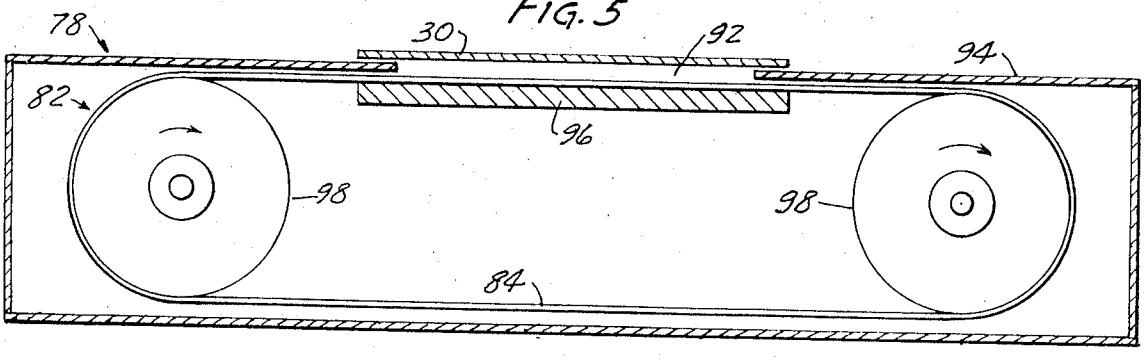

78
30
92
94
82
96
98
98
84

FIG. 6

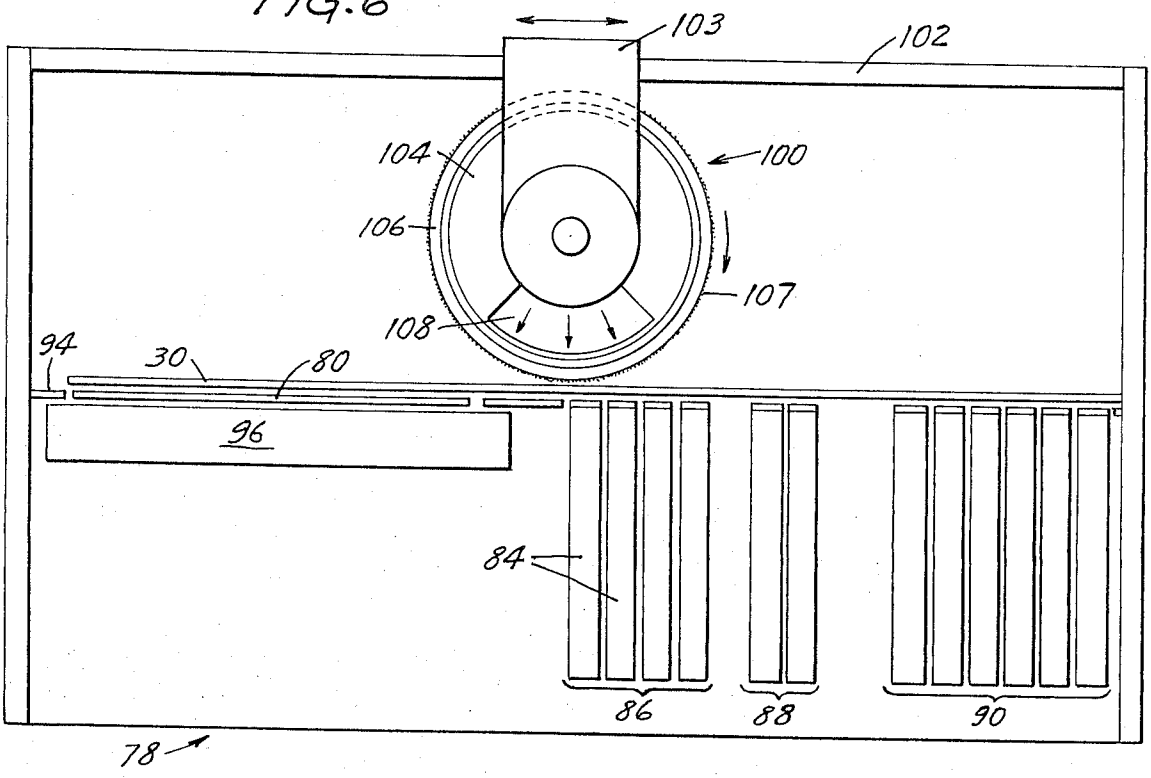
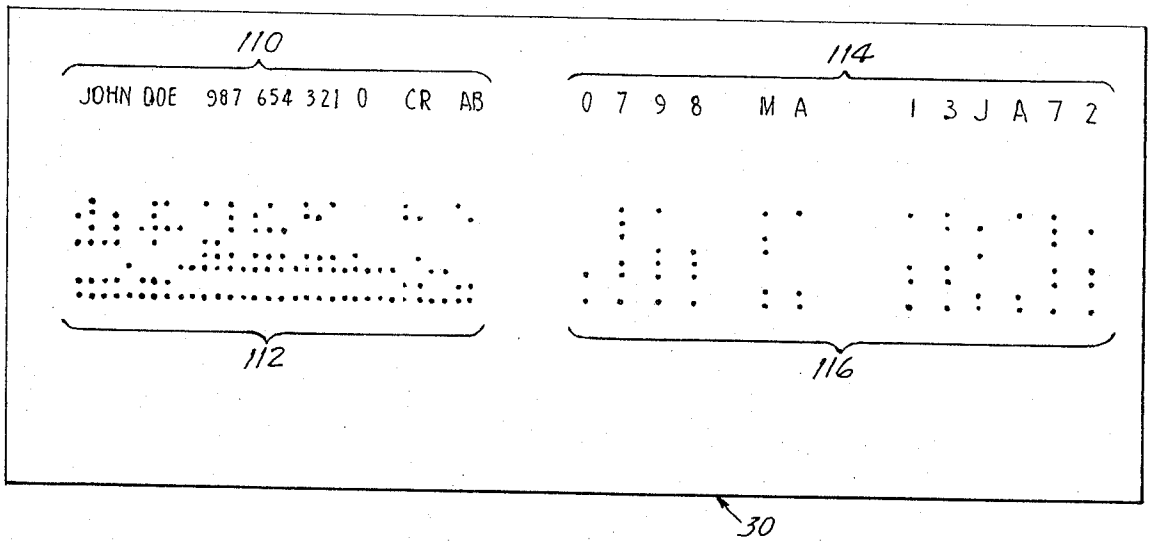

103
102
104
100
106
107
108
94
30
80
96
84
86
88
90
78

FIG. 7


110
JOHN DOE 987 654 321 0 CR AB
114
0 7 9 8 M A 1 3 J A 7 2
112
116
30

DATA ACCUMULATION SYSTEM PROVIDING MAGNETIC TONER POWDER RECORDING

CROSS REFERENCE TO RELATED APPLICATION

This application is related to a patent application entitled "Data Accumulation System" Ser. No. 283,941, filed Aug. 28, 1972 by Richard E. Fayling, a co-inventor herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a data acquisition and recording system for accumulating data contained in a magnetically encoded master source document onto a transfer sheet.

2. Description of the Prior Art

A simple, convenient, inexpensive and reliable transaction recording system capable of simultaneously preparing both a visible record and also an encoded record suitable for subsequent data processing has long been desired. Prior art attempts to accomplish this have usually been based on embossed customer or credit cards and/or transaction register type to provide records suitable for optical reading devices, but such systems are subject to error. For example, the embossed characters on customer cards are subject to rapid wear.

Magnetic techniques for transferring data onto magnetic recording media are described in U.S. Pat. Nos. 3,401,394 and 3,653,066, but such techniques do not provide a visible record. In order to provide a visible record, the latter patent further provides embossed data which is transferred by conventional ink impression techniques. Ferrographic copying and printing techniques are described in U.S. Pat. Nos. 3,161,544, 3,120,806, 3,526,191 and 3,530,794. The materials disclosed in the patents for use as master records are invariably permanently affixed to the copying or printing apparatus. The disclosed materials are either brittle and difficult to fabricate, or produce such weak magnetic fields as to impose undue limits on the duplication operation. Such materials are not readily used in credit card or similar identification providing formats.

SUMMARY OF THE INVENTION

The system of the present invention employs a master source document which may be embossed in the manner of an ordinary credit card to form a visible record, but which need not be. It contains a permanent magnet sheet which can be magnetically encoded throughout in discrete patterns for providing intense distinct external magnetic fields representative of the encoded data. By superimposing an encoded master source document adjacent a transfer sheet and by supplying magnetic toner powder to the exposed surface of the transfer sheet, the toner powder is selectively attracted onto the exposed surface to provide a visible magnetic image which can be electronically sensed with a high degree of reliability compared to records formed from embossed documents.

The system utilizes master source documents comprising homogeneous sheets of particulate permanent magnet material in a flexible binder, each sheet having a coercive force of not less than 1,000 oersteds and a maximum energy product of not less than 5×10^5 gauss-oersteds. Documents containing such sheets are flexible and are readily formed as a credit card suitable for insertion into recording apparatus.

The high coercivity of the sheets renders the encoded patterns insusceptible to being inadvertently or ineptly erased. Unlike the patterns in prior art documents containing embedded slugs or magnets, the patterns in the homogeneous sheet documents of the present invention can be encoded after manufacture by specialized equipment which is ordinarily only available at centralized locations. The same equipment can be used to erase and re-encode to provide an updating capability. Such documents, when used as customer credit cards or similar identification providing documents, may contain quasi-permanent data such as credit rating, account balance and like information which may be updated from time to time.

Receiving the encoded master source document adjacent a surface of the transfer sheet causes the external magnetic fields corresponding to the encoded data pattern to extend through the sheet. Magnetic toner powder supplied adjacent an opposite surface of the transfer sheet is selectively attracted onto the opposite surface by the external magnetic fields corresponding to the patterns to provide a visible magnetic image of the encoded data on the transfer sheet.

The external magnetic fields produced by encoded master source documents permit selective attraction of magnetic toner powders onto a transfer sheet surface even though the document and transfer sheet are separated from the toner powder supply by a slight air gap, thus minimizing smearing of attracted powders by the toner supplying device. The intense nature of the external magnetic fields attracts the toner powders without requiring any external magnetic bias fields. Notwithstanding this capability, in one preferred embodiment described hereinafter, an external single polarity magnetic bias field is used to facilitate recording. This field reinforces the fields produced by the encoded data and bucks any fields emanating from background areas, thereby producing a cleaner record having a higher density of deposited powder than results without the use of such bias fields.

In preferred embodiments the attracted powder is permanently affixed to the transfer sheet or is transferred to a receptor sheet and permanently affixed thereto.

The system may further comprise a device for also receiving an encoded master source document adjacent a magnetic recording medium to subject the magnetic recording medium to the external magnetic fields to magnetically record the encoded patterns onto the magnetic recording medium.

BRIEF DESCRIPTION OF THE DRAWING

FIGS. 1A through 1C sequentially illustrate steps performed in using the system of the present invention;

FIG. 2 is a schematic view in elevation of one embodiment of the present invention wherein the transfer sheet is a continuous web;

FIG. 3 is a schematic view in elevation of another embodiment of the present invention wherein a second transfer sheet in the form of magnetic recording media is employed;

FIG. 4 is a top view of an embodiment of the present invention with the toner powder supplying device omitted, wherein an image of both identity and transaction data is reproduced onto a transfer sheet;

FIG. 5 is a cross sectional view of the embodiment of FIG. 4 taken along lines 5—5 in FIG. 4;

FIG. 6 is a front elevational view of the embodiment of FIG. 4 wherein the front cover is removed and the toner powder supplying device omitted from FIG. 4 is also shown; and

FIG. 7 shows a transfer sheet onto which an image of both identity and transaction data has been produced through use of the embodiment of the present invention shown in FIGS. 4, 5 and 6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention provides a system for recording data in both human readable and encoded form from magnetized areas on a master source document onto a transfer sheet. The record may be subsequently processed in electronic data processing equipment.

FIG. 1A shows a master source document **10** comprising a sheet of a permanent magnet material such as oriented particulate barium ferrite in a flexible binder. Such permanent magnet material is manufactured under the trade name "Plastiform" by Minnesota Mining and Manufacturing Company, Saint Paul, Minnesota. Such materials typically have a coercive force of approximately 1,400 oersteds and a maximum energy product in excess of 10^6 gauss-oersteds. The magnetic field associated with magnetized areas within such a sheet is sufficient to influence the attraction of ferromagnetic toner powders even when the powders are applied to a surface held some distance from the master source document itself. The physical characteristics of such permanent magnet materials allow fabrication of master source documents into credit card formats wherein customer credit and identification data is magnetically encoded within the master source document. Constructions of similar materials having a coercive force ranging between 1,000 and 5,000 oersteds and a maximum energy product in excess of 0.5×10^5 gauss-oersteds and thicknesses ranging between 0.25 to 1.5 mm are suitable for use in the present invention. In one embodiment, the master source document **10** comprises a homogeneous sheet of such a permanent magnet material, wherein the homogeneous sheet extends throughout the length and breadth of the master source document. In another embodiment, such homogeneous sheets are equal in breadth to a major dimension of the master source documents.

A preferred means for encoding the master source document **10**, shown generally as the encoding mechanism **12**, has been invented by R. F. Schmid, and is assigned to Minnesota Mining and Manufacturing Company, patent application Ser. No. 356,320 filed May 2, 1973. The mechanism **12** comprises an array of selectively energizable electromagnets **13**, an input source **22**, and associated electronic circuits **24** and **25**. The array **13** contains a plurality of ferromagnetic pins or wires **16** and **18** mounted in a magnetic housing **14**. Each pin or wire **16** and **18** has associated therewith an electrical coil, not shown, such that upon passage of a pulse of electrical current through a given coil a magnetic field is generated and concentrated in the immediate proximity of the tip of the pin or wire. Passage of a pulse of current through a given coil when a master source document **10** is between the exposed end of the pins or wires **16** or **18** and a flux concentrating base plate **15** causes the magnetization within the portion of the master source document **10** located immediately adjacent the energized coil to be altered. Such alteration can comprise either magnetization of preselected areas leaving an unmagnetized background area, or may comprise reversal of the magnetization in a previously uniformly magnetized master source document. A further description of techniques for uniformly magnetizing and encoding the master source documents is set forth in the co-pending patent application by one of the present inventors, R. E. Fayling, Ser. No. 283,941, filed Aug. 28, 1972.

The configuration of the pins or wires **16** and **18** within the housing **14** may be varied to correspond with desired machine or man readable formats. For example, machine readable Hollerith or ASCII codes may be encoded within the master source document **10** by selective energization of the row of pins **16** positioned according to the standardized dimensions of the respective code systems. Alphanumeric characters may be encoded by the series of pins **18**. In the embodiment shown, each pin is staggered with respect to the adjoining pins along the direction of travel of the master source document **10**. In operation, the document is incrementally moved in the direction indicated by arrow **17** past the row of pins **18** by a stepping mechanism, not shown. Preselected pins are energized at appropriate intervals such that desired magnetization patterns corresponding to preselected alphanumeric characters are produced in the master source document **10**.

Input controls to the encoder **12** are provided from an input source **22**, shown as an electric typewriter. The signals from the input source **22** are coupled to a pulse generator and logic network **24**, which produces signals which are then fed to a styli driver unit **19**, wherein the signals are converted into current pulses of sufficient intensity to produce the required magnetic fields associated with the coils. The current pulses from the network **24** which control the energization of the coils associated with the staggered pins **18**, are fed through an electronic delay network **25** which is positioned prior to the styli driver unit **19**. The delay network **25** operates in conjunction with an incremental card advancing means (not shown) such that the required current pulses are applied to the coils associated with the staggered pins **18** in an appropriately delayed manner so as to produce the desired man readable alphanumeric characters. In contrast, the signals to the coils associated with pins **16** are applied without delay inasmuch as the pins **16** are positioned normal to the direction of travel of the master source document **10**. In a preferred embodiment, the aforedescribed encoding mechanism **12** would be located at a central processing or accounting location and would be utilized to encode the master source document **10** with fixed information representative of customer identification, credit rating and the like. Such a restricted location would preclude unauthorized alteration of the information encoded in the master source document **10**.

In FIG. 1B an encoded master source document card **10** is shown adjacent a transfer sheet **30** together with a device **32** for supplying toner powder to a surface of the transfer sheet **30**. A variety of methods for supplying the magnetic toner powder to the exposed surface of the transfer sheet **30** may be employed. For example, powders may be applied from a liquid suspension, by blowing powders in a gaseous cloud across the surface, by applying powders via a brush technique wherein the

powders are held in place due to electrostatic charges, by mechanical application techniques, wherein the powders are held in place within foams or other nonwoven constructions, and by magnetic techniques such as are disclosed in U.S. Pat. No. 3,643,629.

A highly desirable attribute of the present invention is the relatively high field strength of the magnetized patterns within the master source document **10.** This high signal strength enables formation of a record on a transfer sheet surface, even though the transfer sheet may be positioned at distances from the master source document much in excess of that obtainable within prior art systems. For example, it has been found that images may be deposited on a surface of a transfer sheet positioned parallel to and spaced 0.035 inches from the outer surface of the master source document **10.**

In the embodiment shown in FIG. **1B**, the toner powder supplying device **32** is spaced about 0.25 to 1.25 mm from the outer surface of the transfer sheet **30** such that toner powders present on the surface of the device **32** are attracted across the gap **33** and are selectively deposited in accordance with the external magnetic fields of the master source document **10** positioned above the transfer sheet **30.** A sheet of low reluctance ferromagnetic material such as soft steel **31** supports the assembled master source document **10** and transfer sheet **30** and provides a magnetic flux return path. The soft steel sheet **31** is positioned in a track (not shown) for moving a master source document **10** and transfer sheet **30** secured to the surface thereof past the positioned toner powder supplying device **32.**

The toner powder supplying device **32** is an invention of B. L. Klaenhammer and is assigned to Minnesota Mining and Manufacturing Company, patent application Ser. No. 388,049, filed Aug. 13, 1973. This device **32** comprises a hollow cylindrical drum **34** made of a nonmagnetic material. The drum **34** is carried on an axle **36,** and may be linked to a mechanism (not shown) for transporting the supporting member **31,** and thereby the master source document **10** and transfer sheet **30,** past the toner powder supplying device **32,** such that the surface velocity of the outer portion **38** of the drum **34** is several times faster than the surface velocity of the assembled members **10, 30** and **31** when the members are moved past the toner powder supplying device **32.** The outer portion **38** of the drum **34** may be fabricated from machined aluminum having a smooth outer surface **40** to which is secured a layer **42** for loosely adhering magnetic toner powder **46.** Layer **42** is desired to prevent toner powders applied directly to the smooth aluminum surface **40** from sliding due to gravitational and magnetic forces rather than remaining as applied in a thin uniform layer over the entire surface. The layer **42** may be a layer of adhesive such as provided by double-faced pressure-sensitive adhesive tape on which has been applied a thin layer of fine iron particles. Positioned below the drum **34** is a trough **44** containing a supply of magnetic toner powders **46.** A quantity of powders **46** is magnetically attracted to the layer **42** of the drum **34** by a coater magnet **48** positioned opposite the trough **44** inside the drum **34** in a nonrotating configuration and extending along the length thereof. The magnetic field provided by the coater magnet **48** and concentrated by the iron particles on the layer **42** is sufficient to hold a quantity of toner powders **46** to the layer **42.** As the drum **34** rotates in a clockwise direction, most excess loosely adhered powders **46** are returned to the bottom of the trough **44** by gravitational and magnetic forces. The remainder of the excess powders **46** is attracted off the layer **42** toward an extended wall of the trough **44** by a sweeper magnet **50** positioned outside the extended wall, which magnet **50** is periodically removed in order to cause the excess powder **46** to be returned to the toner powder supply in the bottom of the trough **44.** The sweeper magnet **50** also extends the length of the drum **34,** and promotes spreading of the toner powders on the layer **42** such that the entire layer **42** is uniformly covered with a thin layer of magnetic toner powders **46.** A stationary uniformly magnetized bias magnet **52** is positioned within the drum **34** adjacent the surface thereof which is closest to the positioned members **10, 30** and **31.** The magnetic field of the bias magnet **52** reinforces the magnetic fields of encoded areas of the master source document **10** to attract magnetic toner powders **46** from the outer surface **42** of the drum **34** across the gap to selectively deposit the powders **46** on the transfer sheet **30.**

The relative polarities of the magnetic fields provided by the coater magnet **48** and the sweeper magnet **50** are not critical. If the overall size of the drum requires the magnets **48, 50** and **52** to be positioned sufficiently close together that the fields strongly interact, it may be preferable that the magnets **48, 50** and **52** be oriented so that their respective polarities are substantially in the same direction.

The use of magnets for holding toner powder as disclosed in U.S. Pat. No. 3,643,629 should not be confused with the provision of the bias magnet **52.** It has been found that when the magnetic field of the bias magnet **52** is in the same direction as that of a magnetized code pattern in the master source document **10,** and when the magnet **52** does not itself contribute large field gradients at the code locations in the master source document **10,** a collimation effect occurs, thereby causing the toner powder to deposit as a solid pattern leaving a clean background surrounding the deposit. In contrast, when the field polarity of the bias magnet **52** is opposite that of the magnetization pattern areas of the master source document **10,** the toner powders tend to deposit on the fringes of areas corresponding to the magnetized patterns of the master source document **10.** While the polarity of and the absence of large gradients in the fields associated with the bias magnet **52** are important, the shape and position thereof is not unique, and the bias magnet **52** may be made a part of the support **31.** In order to insure adequate deposition of toner powders **46** on the transfer sheet **30** it has been found desirable that the outer surface of the drum **34** move at a speed which is several times faster than the surface speed of the member **31** supporting the master source document **10** and transfer sheet **30.** In a preferred embodiment, the relative speed of the drum is four times faster than that of the members. As the drum **34** continues to rotate, powder **46** is added to the depleted regions on the layer **42** so that a uniform layer of toner powders **46** is continually presented in the gap **33** between the drum **34** and transfer sheet **30.**

In another embodiment of the present invention, the toner powder may be supplied by a roller device having toner powder mechanically trapped in a mat, fibrous, or foam outer surface, such that when the roller is

rolled against the surface of the transfer sheet positioned adjacent an encoded master source document, powder is attracted by the fields of the document and caused to selectively deposit on the transfer sheet. A nonrotating bias magnet positioned within the roller and extending along the length of the roller provides a magnetic field cooperating with the external magnetic fields of the magnetized patterns on the master source document.

The outer surface of such a roller device is preferably a polyurethane foam. Such foams have been found to mechanically entrap a satisfactory amount of powder which can be controllably released under reasonable applied pressures, while not developing an excess of background. Over 150 copies have been produced without the need for replenishment of powders within such a roll. Replenishment of powder may be effected in any variety of controlled methods, such as magnetic rolls, hoppers and gravity feed systems.

A wide variety of combinations of transfer sheets and toner powder compositions may be utilized in the present invention. Generally, particle diameters in the 30–50 μm range have been found preferable in order to minimize background. Many toner powders are highly insulating, thus the surface conductivity of the paper to be used therewith must be sufficient to allow static charges to bleed off, so as to prevent severe buildup of powder in the background areas. A wide range of surface conductivities has been found satisfactory, whereas highly insulating powders were unsatisfactory.

Toner powders especially suited for use with the toner supplying device **32** are disclosed in U.S. Pat. No. 3,639,245. Such powders are spherodized to promote free flowing characteristics, thereby forming a more uniform layer on the layer **42.** The powders **46** may be made conductive to minimize static electrical charges and the irregular transfer of powder **46** which often results from such charging.

Subsequent to the deposition of toner powders **46** on the surface of the transfer sheet **30,** the powders **46** may be permanently affixed to the surface thereof by known powder fixing techniques. Conventional magnetic toner powder systems such as are disclosed in U.S. Pat. Nos. 3,377,286 and 3,639,245 employ a thermoplastic binder in conjunction with a Fe_3O_4 toner powder, such that heating of the deposited powder **46** from a heat source **54** fuses the binder to make a permanent record.

The heat source **54** may be an infrared lamp, heated bar, roller or other source of heat sufficient to rapidly heat the toner powder **46** on the surface of the transfer sheet **30** to the temperature necessary to fuse the powder **46.** Where powders such as disclosed in U.S. Pat. No. 3,639,245 are employed, useful fusion temperatures are between **100°–150°** C.

Analogously, heat or pressure sensitive adhesives may be embodied with the magnetic toner powder. Passing the transfer sheet **30** together with the deposited toner powder **46** through heat or pressure rolls will activate the adhesive and thereby adhere the deposit to the surface of the transfer sheet **30.**

After the images have been permanently fused to the transfer sheet **30,** they may be machine read with a pickup device **55** and processed by conventional data processing techniques as shown in FIG. **1C.** The pickup device **55** may include optical or magnetic character recognition devices for detecting alphanumeric characters; or magnetic, electrical or optical pickup devices may be used with the machine readable codes. In either event, signal conditioning and transmission interface networks **56** are coupled between the detector device **55** and a computer **57.** A preferred embodiment shown in FIG. **1C** utilizes a plurality of transducer devices such as magnetic pickup heads as the detector device **55,** wherein one head is provided for each row of machine readable code patterns. The output of the detector device **55** may be compared with information previously stored in the computer memory and an output signal produced which is representative of either the information detected on the transfer sheet **30** or of deviations between that information and that stored in the memory. The output signal may be displayed on either an on-line display unit **58** or on input-output terminal equipment **59.** Various other types of data manipulations may similarly be performed according to conventional data processing methods.

FIG. **2** sets forth an embodiment of the present invention wherein the transfer sheet is in the form of a continuous web **60** positioned between supply and takeup reels **62** and **64** respectively, along a transfer station shown generally as **66.** A plurality of master source documents **10** are successively positioned adjacent the web **60** at the station **66.** A toner powder supplying device **68** and powder fusing device **70** are positioned along the station **66** in a manner similar to that shown in FIG. **1B.**

FIG. **3** sets forth a further embodiment of the present invention in which a magnetic recording media **72** is provided as a second transfer sheet positioned along the transport station **66** between supply and takeup reels **74** and **76.** A drive mechanism (not shown) is further provided for periodically advancing the media **72** along a transport path adjacent the transfer sheet **60.** The media **72** may be a coating of gamma Fe_2O_3 and organic binder on a flexible backing such as is conventionally used in magnetic recording. Since the magnetic fields produced by the master source document **10** are sufficiently intense to enable transfer of the toner powder from a toner powder supplying device **68** such as is shown in FIGS. **1B** and **2,** even though the device is spaced some distance from the master source document **10,** it is convenient to place the magnetic recording media **72** between the master source document **10** and the transfer sheet **60.** A record of the external magnetic fields in the master source document **10** will be impressed in the magnetic recording media **72** in the form of altered magnetization patterns as disclosed and claimed in the above referenced co-pending patent application Ser. No. 283,941, filed Aug. 28, 1972. The magnetic record may be immediately utilized for machine input without requiring deposition and fixing of magnetic toner powders **46.** Such a separate record is desirable where visual inspection of the record is not required and where a separate machine readable copy of the transaction record is desired, such as in inventory control applications.

In addition to the embodiments shown in FIGS. **1–3** wherein only fixed data is transferred to a transfer sheet, images representing variable data may be simultaneously transferred to a transfer sheet.

FIG. **4** is a top view of a data recording device **78** wherein fixed data is provided from an encoded master source document **80** and variable data is provided by

a transaction register device **82** comprising a plurality of belts **84** of encoded permanent magnet material such as that used in the construction of the master source document **80.** One such belt **84** is provided for every column of variable information desired to be presented. Each belt **84** has encoded therein as magnetized patterns a sequence of alphanumeric characters and corresponding machine readable codes corresponding to the given character. For example, in the embodiment shown, each of the belts **84** has ten areas along the length of the belt wherein an alphanumeric character and corresponding machine readable code may be encoded, thus accommodating numeric characters **0** through **9** or 10 selected alphabetic characters. Four belts **86** are each encoded with numeric characters **0** through **9,** which may be selectively positioned to indicate a four digit representation of the cost of a transaction. Similarly, two belts **88** are encoded with selected alphabetic characters which may be selectively positioned to allow one hundred coded designations of a particular type of transaction. Six belts **90** represent both numeric and alphabetic encoded characters which may be selectively positioned to indicate the data of a particular transaction. A positioning mechanism (not shown) is coupled to each of the belts **84** allowing any given code pattern on a selected belt to be positioned within a transfer station **92,** in alignment a similarly positioned master source document **80.** The encoded alphanumeric characters and corresponding ASCII machine readable code on the master source document **80** and on the belts **84** positioned at the transfer station **92** are shown to be visible as though viewed through a magnetic viewing device.

FIG. **5** is a sectional side view of the data recording device **78,** with the master source document **80** removed, showing one of the belts **84** positioned between supporting members **98** which are coupled to the positioning mechanism (not shown) for enabling selection and positioning of a desired character and machine readable code corresponding thereto within the transfer station **92.** The station **92,** as is shown in FIGS. **4** and **5,** may comprise an opening within a cover plate **94** exposing the encoded belts **84,** together with a recessed portion for insertion of a master source document **80,** or may comprise a suitable positioning means, not shown, on a thin nonmagnetic outer housing **94.** Positioned below the master source document **80** is a soft iron flux return member **96** which serves to intensify the fields produced by the magnetized areas of the master source document **80** in the region of a transfer sheet **30.**

FIG. **6** is a front elevational view of the data recording device **78** of FIGS. **4** and **5,** additionally showing a magnetic toner supplying device **100** slidably supported on top member **102.** The toner powder supplying device **100** comprises a roller **104** having an outer foam covered surface **106** containing magnetic toner powders **107.** Positioned in a nonrotating configuration within the interior of the roller and extending along the length of the roller is a bias magnet **108.** The roller **104** is rotatably coupled to a supporting carriage **103** such that when the roller device **100** is moved along the top support member **102** parallel to the transfer sheet **30,** the roller **104** rotates and deposits toner powders on the transfer sheet **30** corresponding to the magnetic patterns present in the master source document **80** and belts **84.**

FIG. **7** shows a transfer sheet **30** on which fixed and variable data has been recorded. Identity characters **110** and corresponding machine readable code patterns **112** correspond to information which would conveniently be encoded on a master source document, used as a customer identification or credit card for providing the customer's name, account number, and credit rating and like coded information. Transaction alphanumeric characters **114** and corresponding machine readable code patterns **116** correspond to variable information reproduced on the transfer sheet **30** by means of the variable information providing belts **84** as described in conjunction with the description of FIG. **4.**

The variable information shown in FIG. **7** is intended to be illustrative of only one use for the present invention. Similar transaction data representative of ticket information, such as route, destination, flight number, as well as other applications are similarly encompassed by the present invention. Where such transaction data is further desired for applications such as inventory control, a magnetic recording medium may be received adjacent an encoded identification card and adjacent the transaction register device to subject the magnetic recording medium to both the external fields of the encoded identification card and of selectively positioned data generators to magnetically record the data from the identification card and the transaction data onto the medium in a predetermined spacial relationship.

It should further be recognized that the present invention encompasses systems wherein the magnetic toner powders are transferred to an intermediary transfer sheet such as a thin polished metallic layer whereby the powders may provide a temporary visible indication of the encoded patterns and wherein the patterns may be subsequently transferred to other receptor sheets for fixing to form a permanent powder image.

Having thus described the present invention, what is claimed is:

1. A method for accumulating data for processing in electronic processing equipment, comprising the steps of providing a magnetizable master source document, magnetizing said master source document in a discrete pattern to provide external magnetic fields representative of data related to said document, receiving a transfer sheet adjacent the master source document to cause the external magnetic fields to extend through the transfer sheet to form an image of said pattern on the transfer sheet, and said pattern from the transfer sheet to provide an electrical signal representative of said data for electronic data processing,

wherein the step of providing said magnetizable master source document comprises providing a homogeneous sheet of particulate permanent magnet material in a flexible binder for enabling said magnetization in a discrete pattern throughout the sheet, said sheet having a coercive force of not less than 1,000 oersteds and a maximum energy product of not less than 5×10^5 gauss-oersteds for enabling said document to provide external magnetic fields which can be sufficiently intense to allow the selective attraction of magnetic toner powder onto the surface of the transfer sheet which is opposite to that surface thereof adjacent the master source document even though the transfer sheet is separated from the toner powder supply, and wherein the method further comprises the steps of applying

magnetic toner powder adjacent said opposite surface of the transfer sheet when the master source document is adjacent the transfer sheet to cause the toner powder to be selectively attracted onto said opposite surface by said external magnetic fields to form a visible magnetic image of said pattern on the transfer sheet, of providing a low reluctance ferromagnetic member positioned adjacent a surface of said document away from said transfer sheet to form a low reluctance path for the lines of flux associated with said external magnetic fields to intensify the external magnetic fields which extend through the transfer sheet from the master source document, and of providing a magnetic bias field for reinforcing the external magnetic field patterns of a so magnetized master source document when the document is positioned adjacent said transfer sheet.

2. A method according to claim **1,** comprising the additional step of receiving the transfer sheet adjacent a plurality of master source documents to cause the external magnetic fields associated therewith to extend through the transfer sheet to form an image of said plurality of patterns on the transfer sheet for enabling an electrical signal representative of data related to said plurality of master source documents to be produced from the transfer sheet.

3. A method according to claim **2,** further comprising the steps of providing a tape as the transfer sheet, supporting the tape in a transport path and advancing the tape along the path, wherein a length of the tape within said path is received adjacent a master source document.

4. A method according to claim **1,** further comprising the steps of transferring said visible magnetic image from the transfer sheet to a receptor sheet, permanently affixing said transferred image thereon, and subsequently sensing said transferred image on said receptor sheet to produce an electrical signal for electronic data processing.

5. A method according to claim **1,** further comprising the steps of supplying magnetic toner powder adjacent one surface of said master source document to enable said powder to be selectively attracted to the said one surface by the external magnetic fields corresponding to said patterns to provide a visible magnetic image of the pattern on said one surface and of permanently affixing the attracted powder to said one surface.

6. A method according to claim **1,** further comprising the steps of providing a variable data register having a plurality of selectably positionable magnetic field sources for providing external magnetic field patterns representative of variably selected data, selectively positioning the field sources to select variable data related field patterns for extension through the transfer sheet in a predetermined relationship with said field pattern related to the master source document, receiving the transfer sheet adjacent the register and the master source document, and of applying magnetic toner powder adjacent the surface of the transfer sheet which is opposite to that surface thereof adjacent the master source document and variable data register to cause the toner powder to be selectively attracted onto said opposite surface by said external magnetic fields to form on the transfer sheet a visible magnetic image of the said variable data related patterns in a predetermined relationship with said discrete pattern representative of data related to the source document.

7. A method according to claim **1,** further comprising the step of simultaneously receiving a so magnetized master source document adjacent a magnetic recording medium and said transfer sheet to subject the magnetic recording medium to said external magnetic fields to magnetically record said patterns onto the magnetic recording medium while the toner powder image of the patterns is being formed on the transfer sheet.

8. A method according to claim **1,** further comprising the steps of magnetizing the master source document to provide a said discrete magnetic field pattern of one polarity and a remaining background area in the document of an opposite polarity, and of providing a unidirectional magnetic bias field for reinforcing said one polarity fields and opposing said opposite polarity fields of the master source document when the master source document is adjacent the transfer sheet to enhance the selective attraction of toner powder to form said visible magnetic image on the transfer sheet.

9. A system for accumulating data for processing in electronic processing equipment, comprising a magnetizable master source document, means for magnetizing said master source document in a discrete pattern to provide external magnetic fields representative of data related to said document, means for receiving a transfer sheet adjacent the master source document to cause the external magnetic fields to extend through the transfer sheet to form an image of said pattern on the transfer sheet, and means for subsequently sensing said pattern from the transfer sheet to provide an electrical signal representative of said data for electronic data processing,

wherein the master source document comprises a homogeneous sheet of particulate permanent magnet material in a flexible binder for enabling said magnetization in a discrete pattern throughout the sheet, said sheet having a coercive force of not less than 1,000 oersteds and a maximum energy product of not less than 5×10^5 gauss-oersteds for enabling said document to provide external magnetic fields which can be sufficiently intense to allow the selective attraction of magnetic toner powder onto the surface of the transfer sheet which is opposite to that surface thereof adjacent the master source document even though the transfer sheet is separated from the toner powder supply, and wherein the system further comprises apparatus for applying magnetic toner powder adjacent said opposite surface of the transfer sheet when the master source document is adjacent the transfer sheet to cause the toner powder to be selectively attracted onto said opposite surface by said external magnetic fields to form a visible magnetic image of said pattern on the transfer sheet, a low reluctance ferromagnetic member positioned adjacent a surface of said document away from said transfer sheet to form a low reluctance path for the lines of flux associated with said external magnetic fields to intensify the external magnetic fields which extend through the transfer sheet from the master source document, and a source of magnetic bias field for reinforcing the external magnetic field patterns of a magnetized master source document when the document is positioned adjacent said transfer sheet.

10. A system according to claim 9, wherein the homogeneous sheet comprises particulate barium ferrite oriented such that the easy direction of magnetization of the particulate barium ferrite is normal to a major surface of the master source document.

11. A system according to claim 10, wherein the barium ferrite has a coercive force in excess of 1400 oersteds and the sheet has a maximum energy product in excess of 10^6 gauss-oersteds.

12. A system according to claim 9, further comprising a variable data register having a plurality of selectably positionable magnetic field sources for providing external magnetic field patterns representative of variably selected data, means for selectively positioning said field sources to select variable data related field patterns for extension through the transfer sheet in a predetermined relationship with said field pattern related to the master source document, means for receiving the transfer sheet adjacent the register in a predetermined relationship with the positioning of the master source document, and means for applying magnetic toner powder adjacent the surface of the transfer sheet which is opposite to that surface thereof adjacent the master source document and variable data register to cause the toner powder to be selectively attracted onto said opposite surface by said external magnetic fields to form on the transfer sheet a visible magnetic image of said variable data related patterns in a predetermined relationship with said discrete pattern representative of data related to the source document.

13. A system according to claim 9, further comprising means for simultaneously receiving a so magnetized master source document adjacent a magnetic recording medium and said transfer sheet to subject the magnetic recording medium to said external magnetic fields to magnetically record said patterns onto the magnetic recording medium while the toner powder image of the patterns is being formed on the transfer sheet.

14. A system according to claim 9, further comprising means for magnetizing the master source document to provide a said discrete magnetic field pattern of one polarity and a remaining background area in the document of an opposite polarity and means for providing a unidirectional magnetic bias field for reinforcing said one polarity fields and for opposing said opposite polarity fields of the master source document when the master source document is adjacent the transfer sheet to enhance the selective attraction of toner powder to form said visible magnetic image on the transfer sheet.

15. A method for magnetic printing, comprising the steps of providing a magnetizable master source document, magnetizing said master source document in a discrete pattern to provide external magnetic fields representative of a graphic image, receiving a transfer sheet adjacent the master source document to cause the external magnetic fields to extend through the transfer sheet and supplying magnetic toner powder adjacent the surface of the transfer sheet which is opposite to that surface thereof adjacent the master source document to enable the powder to be selectively attracted onto said opposite surface by said external magnetic fields to provide a visible magnetic image of said pattern on the transfer sheet, wherein the step of providing said magnetizable master source document comprises providing a homogeneous sheet of particulate permanent magnet material in a flexible binder for enabling said magnetization in a discrete pattern throughout the sheet, said sheet having a coercive force of not less than 1,000 oersteds and a maximum energy product of not less than 5×10^5 gauss-oersteds for enabling said document to provide external magnetic fields which can be sufficiently intense to allow the selective attraction of magnetic toner powder onto said opposite surface of the transfer sheet even though the transfer sheet is separated from the toner powder supply, said method further comprising the steps of providing a low reluctance ferromagnetic member positioned adjacent a surface of said document away from said transfer sheet to form a low reluctance path for the lines of flux associated with said external magnetic fields to intensify the external magnetic fields which extend through the transfer sheet from the master source document and of providing a magnetic bias field for reinforcing the external magnetic field patterns of a so magnetized master source document when the document is positioned adjacent said transfer sheet.

16. A method according to claim 15, further comprising the steps of providing a tape as the transfer sheet, supporting the tape in a transport path, advancing the tape along path, and positioning a length of the tape adjacent a master source document when the tape is within said path.

17. A method according to claim 15, further comprising the steps of transferring said visible magnetic image to a receptor sheet and permanently affixing said transferred image thereon.

18. A method according to claim 15, further comprising the steps of supplying magnetic toner powder adjacent one surface of said master source document to enable said powder to be selectively attracted to the said one surface by the external magnetic fields corresponding to said patterns to provide a visible magnetic image of the pattern on said one surface and of permanently affixing the attracted powder to said one surface.

19. A method according to claim 15, further comprising the steps of magnetizing the master source document to provide a said discrete magnetic field pattern of one polarity and a remaining background area in the document of an opposite polarity, and of providing a unidirectional magnetic bias field for reinforcing said one polarity fields and opposing said opposite polarity fields of the master source document when the master source document is adjacent the transfer sheet to enhance the selective attraction of toner powder to form said visible magnetic image on the transfer sheet.

20. A system for magnetic printing, comprising a magnetizable master source document, means for magnetizing said master source document in a discrete pattern to provide external magnetic fields representative of a graphic image, means for receiving a transfer sheet adjacent the master source document to cause the external magnetic fields to extend through the transfer sheet and means for supplying magnetic toner powder adjacent the surface of the transfer sheet which is opposite that surface thereof adjacent the master source document to enable the powder to be selectively attracted onto said opposite surface by said external magnetic fields to provide a visible magnetic image of said pattern on the transfer sheet,

wherein the master source document comprises a homogeneous sheet of particulate permanent magnet material in a flexible binder for enabling said magnetization in a discrete pattern throughout the

sheet, said sheet having a coercive force of not less than 1,000 oersteds and a maximum energy product of not less than 5×10^5 gauss-oersteds for enabling said document to provide external magnetic fields which can be sufficiently intense to allow the selective attraction of magnetic toner powder onto said opposite surface of the transfer sheet even though the transfer sheet is separated from the toner powder supply, said system further comprising a lower reluctance ferromagnetic member positioned adjacent a surface of said document away from said transfer sheet for providing a low reluctance path for the lines of flux associated with said external magnetic fields to intensify the external magnetic fields which extend through the transfer sheet from the master source document and a source of magnetic bias field for reinforcing the external magnetic field patterns of a magnetized master source document when the document is positioned adjacent said transfer sheet.

21. A system according to claim **20,** wherein the homogeneous sheet comprises particulate barium ferrite oriented such that the easy direction of magnetization of the particulate barium ferrite is normal to a major surface of the master source document.

22. A system according to claim **21,** wherein the barium ferrite has a coercive force in excess of 1,400 oersteds and the sheet has a maximum energy product in excess of 10^6 gauss-oersteds.

23. A system according to claim **20,** comprising means for magnetizing the master source document to provide a said discrete magnetic field pattern of one polarity and a remaining background area in the document of an opposite polarity and by means for providing a unidirectional magnetic bias field for reinforcing said one polarity fields and for opposing said opposite polarity fields of the master source document when the master source document is adjacent the transfer sheet to enhance the selective attraction of toner powder to form said visible magnetic image on the transfer sheet.

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