United States Patent

Irasek

[15] **3,643,241**

[45] **Feb. 15, 1972**

[54] RANDOM-ACCESS INFORMATION STORE SYSTEM

[72] Inventor: **Eugene H. Irasek**, Los Angeles, Calif.

[73] Assignee: **The National Cash Register Company**, Dayton, Ohio

[22] Filed: **Mar. 1, 1960**

[21] Appl. No.: **12,032**

[52] **U.S. Cl.** .....**340/174.1 C**, 179/100.2 Z

[51] **Int. Cl.**.....**G11b 5/78**, G11b 23/12

[58] **Field of Search**.....271/3–6; 209/72, 209/110; 235/61.1; 340/174.1, 174.1 C; 179/100.2 Z, 100.2 P; 346/74, 22, 48, 138; 129/16.1

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Primary Examiner—Terrell W. Fears

Attorney—Louis A. Kline and Joseph R. Dwyer

[57] **ABSTRACT**

A random access memory using flexible strips removably hung in bins which strips are removed for transducing. Also details of the removing and tape transport system.

47 Claims, 20 Drawing Figures

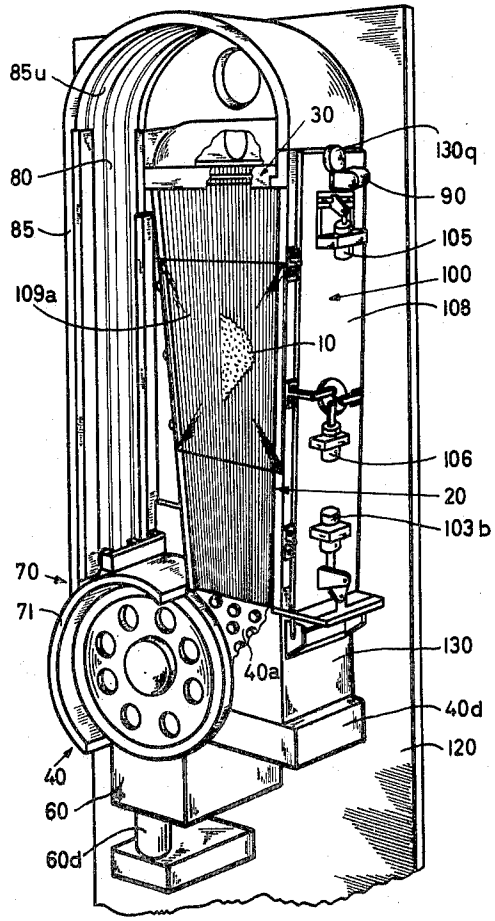
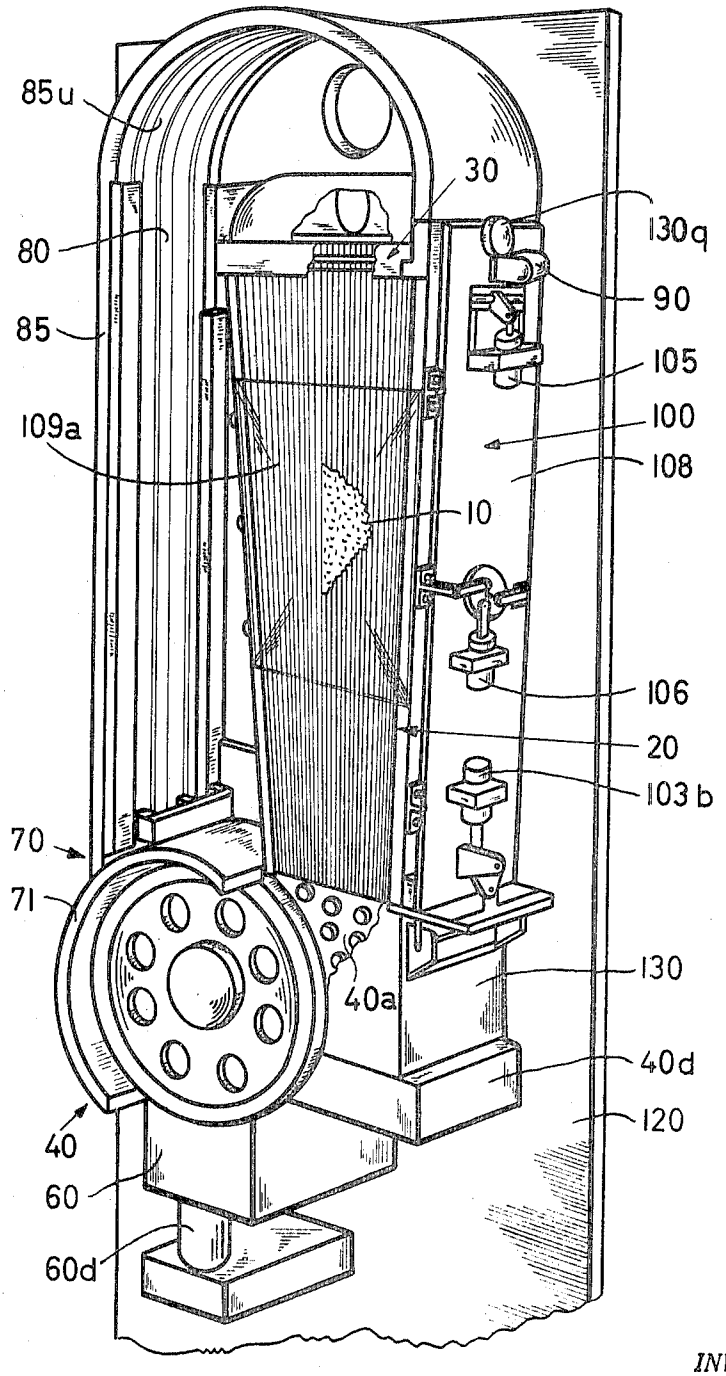
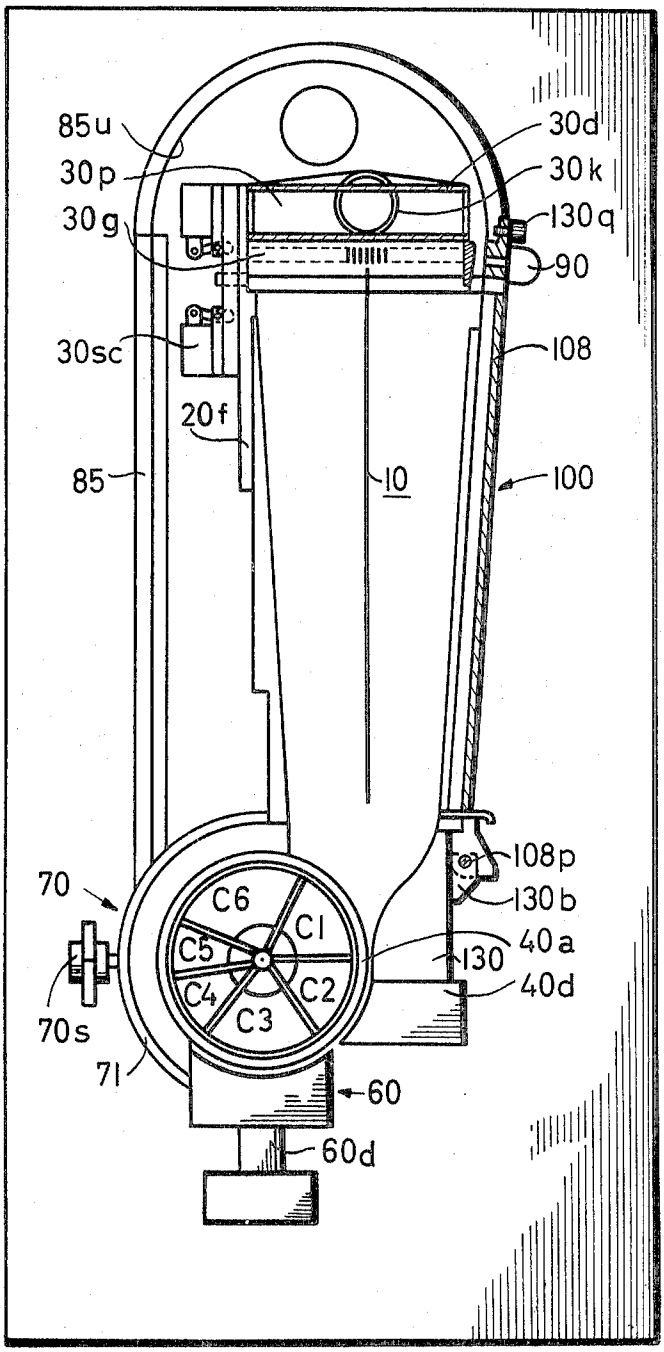


FIG. 1



INVENTOR.
Eugene H. Irasek
BY
Louis A. Kline
John J. Maclago
ATTORNEYS

FIG.2



INVENTOR
Eugene H. Irasek

BY Louis A. Kline
John J. Maclago
ATTORNEYS

FIG. 3a

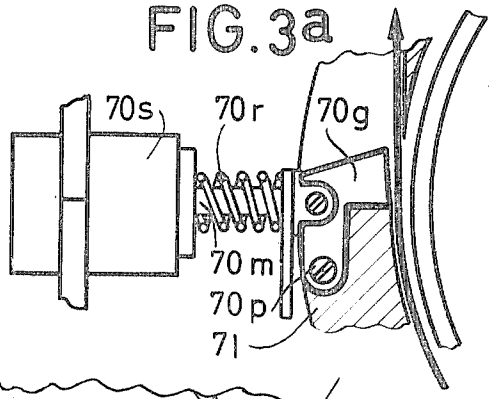
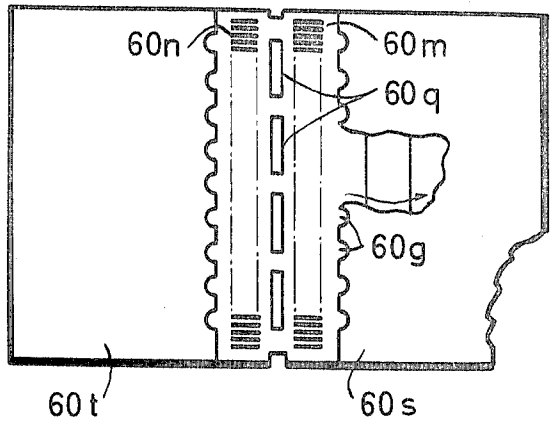


FIG. 3

FIG. 4



INVENTOR
Eugene H. Irasek

BY Louis A Kline
John J. Maclago
ATTORNEYS

FIG.5

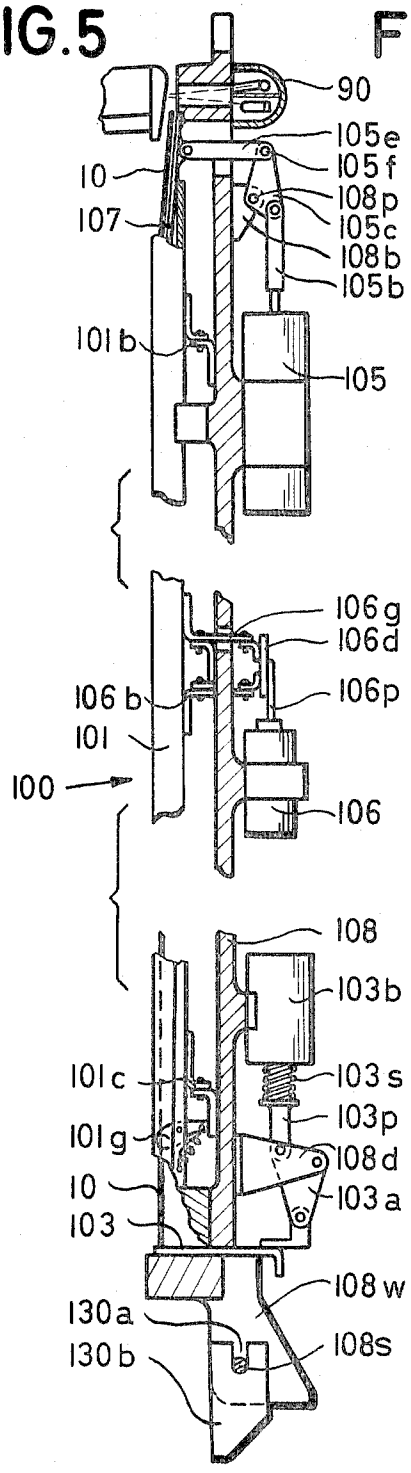


FIG.6

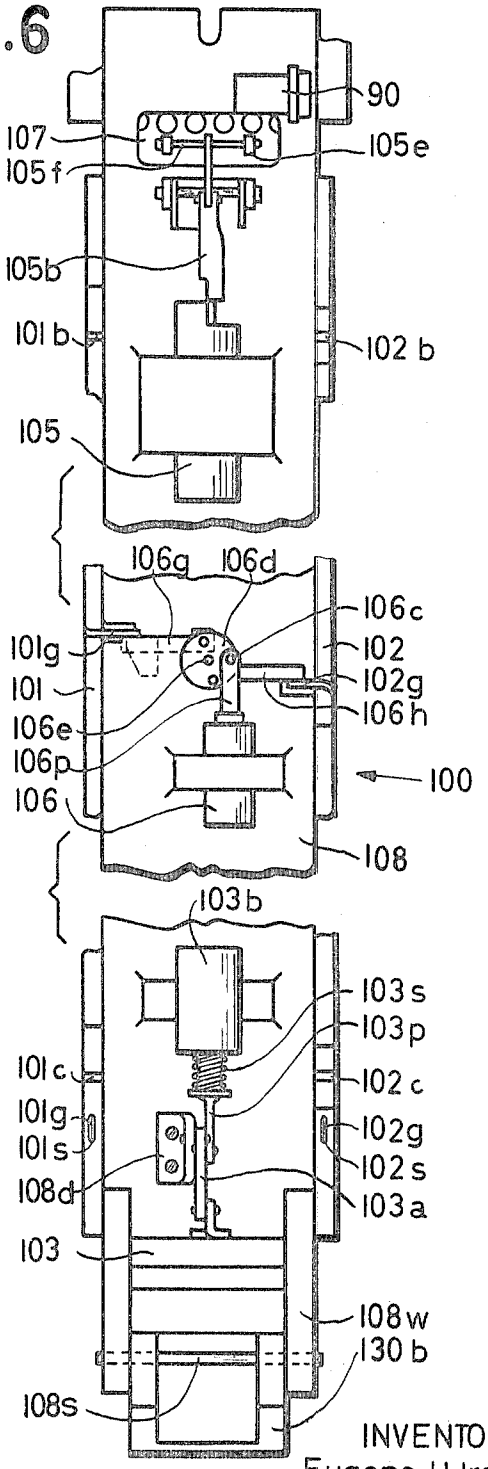
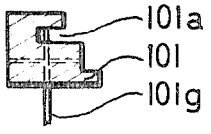


FIG.6a



INVENTOR
Eugene H. Irasek

BY Louis A Kline
John J. Matlago
ATTORNEYS

FIG. 8

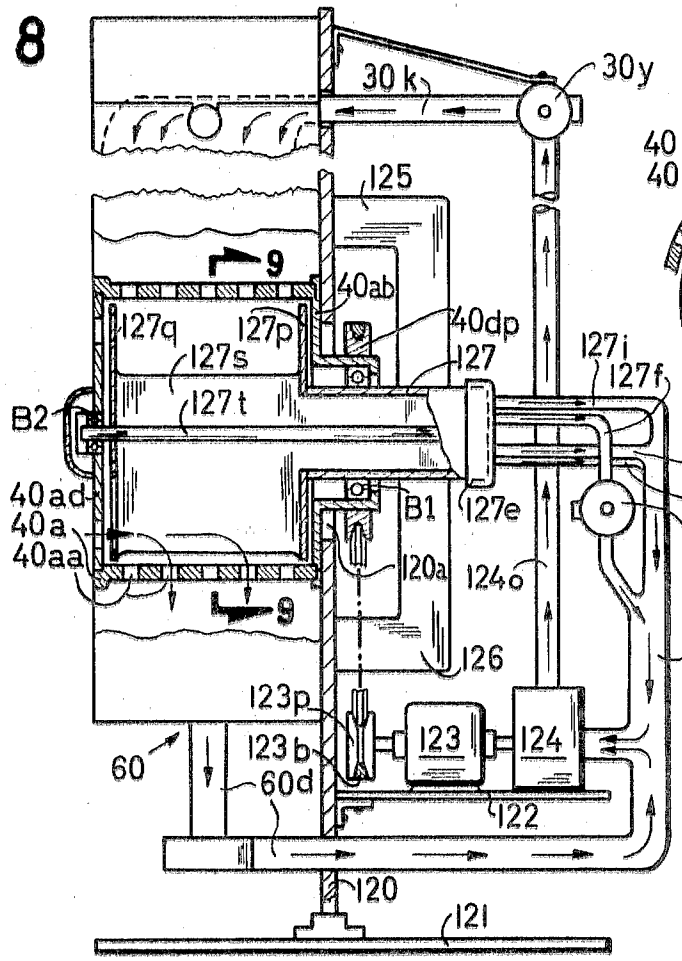


FIG. 9

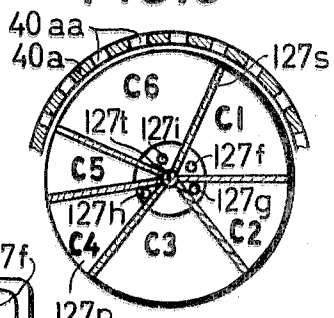


FIG. 7

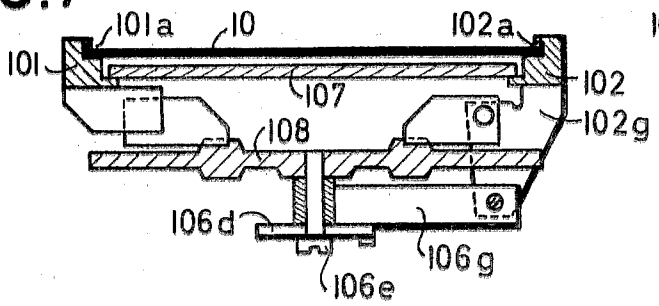
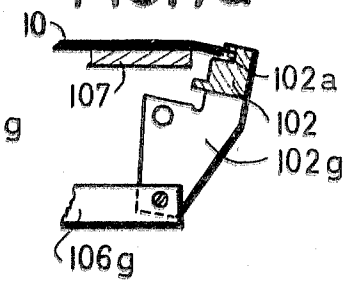


FIG. 7a



INVENTOR
Eugene H. Irasek

BY Louis A. Kline
John J. Maclago
ATTORNEYS

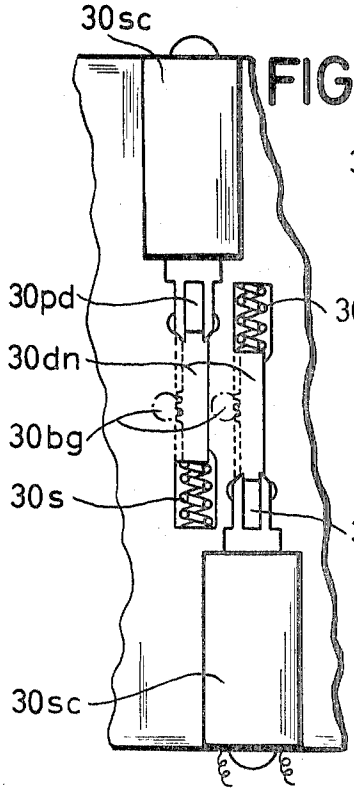


FIG. 11

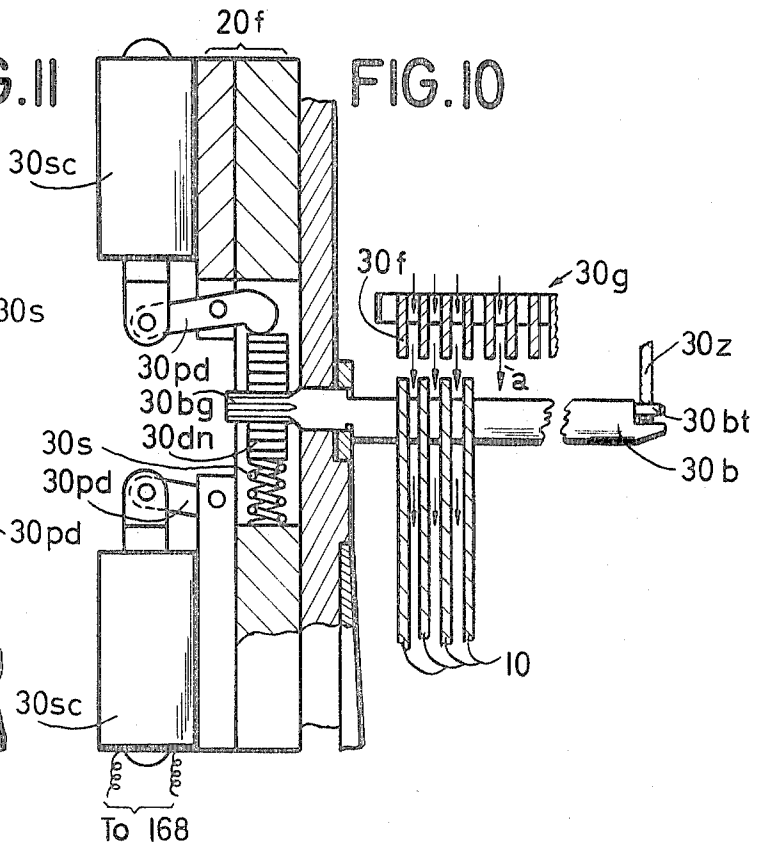
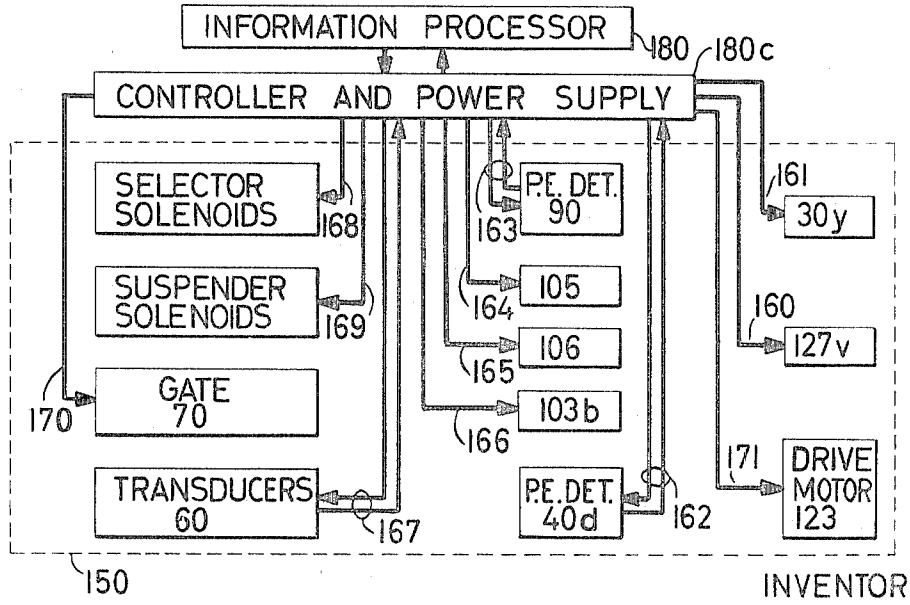


FIG. 10

FIG. 16



INVENTOR
Eugene H. Irasek

BY Louis A. Kline
John J. Matlago
ATTORNEYS

FIG. 12

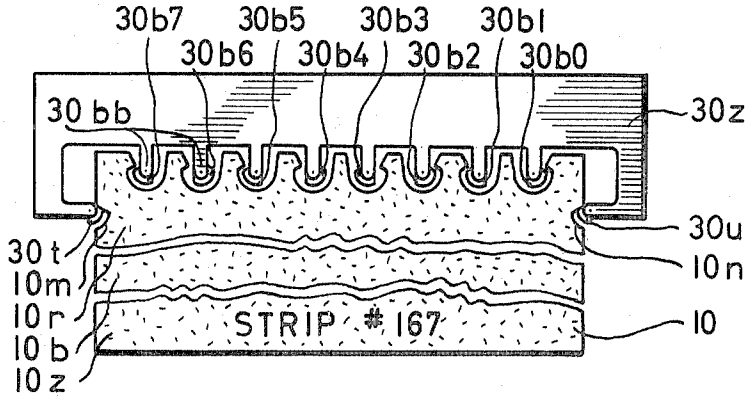


FIG. 13

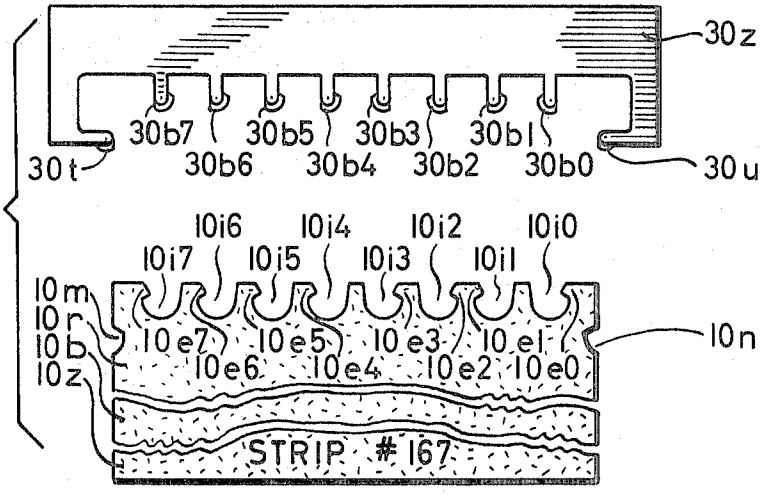


FIG. 14

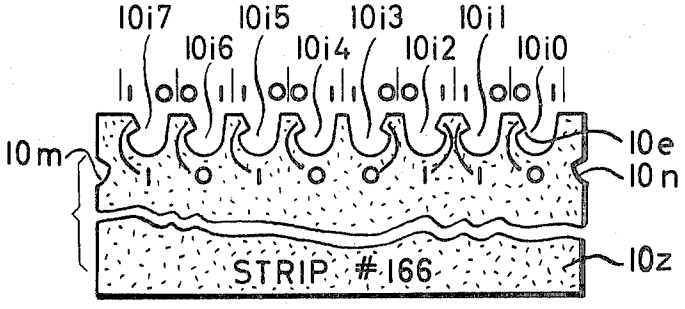


FIG. 15

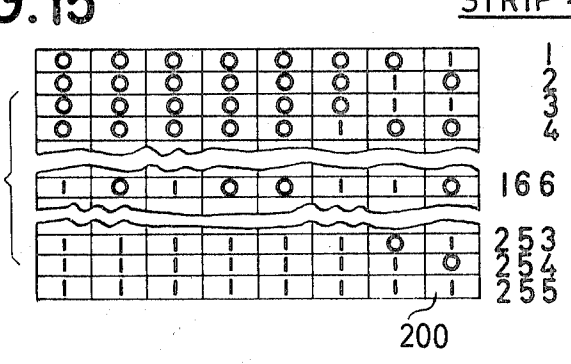
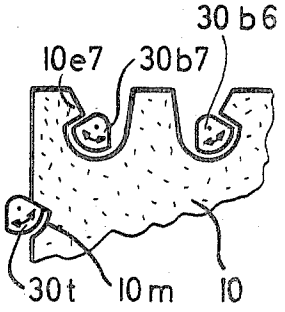


FIG. 12a



INVENTOR
Eugene H. Irasek

BY Louis A Kline
John T. Matlago
ATTORNEYS

RANDOM-ACCESS INFORMATION STORE SYSTEM

This invention pertains to information storage apparatus, and more particularly to apparatus of that class in which a very large number of binary bits of information must be accommodated by the store and in such form and manner as to permit easy and quick access to any bit or group of bits of the stored information.

According to the invention the information is recorded, preferably by magnetic recording techniques, on strips of strong flexible material. The strips are each provided with suspension or retainer means at one end and are suspended to hang in a magazine and are selectively released one at a time to fall into operating means which transports the strip through a transducing region past "reading" and recording or "writing transducer means, and imparts momentum to the strip sufficient to return the strip to the magazine. The operating means is arranged for selective operation according to either of two modes. In the first mode a fallen strip is operated upon in a single passage through the transducing region and immediately thereafter is returned to the magazine via a return path; and in the second mode a fallen strip is recirculated through the transducing region one or more times before being returned to the magazine. During any passage through the transducing region the strip may be "read" by a transducer means, or the strip may have one or more binary bits recorded or "written" thereon at respective specific locations; or both such operations may occur. The retainer means at the upper ends of the strips are so devised as to cooperate with a plurality of specially formed selector and suspender means in such fashion that when a particular combination of selector and suspender means is operated, a single strip corresponding to only that combination is released to fall by gravity into the operating means. Magazine loading means are provided for replacing a returned strip onto the selector and suspender means; and means are provided for insuring that the suspended strips in the magazine are maintained in spaced-apart relationship whereby any selected one of the strips may readily be released and allowed to drop from the magazine irrespective of its position relative to the remainder of the strips. Since by utilizing known magnetic recording techniques and materials a quite large number of binary bits of data or information can be stored (recorded) in each square inch of magnetic surface, a large amount of data or information may be stored on a single strip of, for example, 3¼ inches width and 14 inches length. Such a strip, formed of thin durable filmlike material with a magnetic coating, may, for example, contain six information channels each divided into 1,240 "slabs" each of which slabs is divided into 31 blocks. In such an arrangement, over 200,000 bits of information may be stored on each strip; and if, for example, 255 strips are contained in the magazine, in excess of 58,000,000 bits may be stored therein. And, since according to the invention any desired one of the strips may be selectively released, dropped, operated upon, and returned to the magazine within a small fraction of one second, it is evident that the invention provides a "random-access" information store offering quite large storage capacity with access time greatly reduced from that required, for example, with apparatus utilizing long lengths of magnetic tape as the storage medium. And since a set of the strips may be easily and quickly replaced by any one of other sets of strips sorted in convenient containers, the apparatus provides for great flexibility and extended access to almost any possible amount of stored information. The operations of the several cooperating units of the apparatus are electrically controlled, principally by signals furnished by external means such as a data processor.

With the preceding brief general description of principal features of the invention in view, it is evident that a principal object of the invention is to provide improvements in large storage capacity fast-access information stores. Another object is to provide improvements in random-access multiple-unit data-storage apparatus. An additional object of the invention is to provide means permitting random access to any datum contained in a large number of readily replaceable high-density data storage units with a minimum expenditure of time.

Other objects and advantages of the invention will hereinafter be made apparent or will become apparent upon consideration of the appended claims and the description of a preferred illustrative embodiment of apparatus which is depicted in the drawings forming a part of this specification. In the drawings:

FIG. 1 is a perspective view of principal units of the apparatus in assembled form, with portions broken away and parts including a baseplate removed to facilitate disclosure of certain details;

FIG. 2 is a vertical view partly in section, transversely through the apparatus, with some parts removed and some portions broken away;

FIG. 3 is a partial sectional view of a capstan, a strip gate, and a transducing means, with portions of an information storage strip in operative relationship with the capstan, the gate, and the transducing means, but with transducing means and capstan moved apart to facilitate illustration;

FIG. 3*a* is a fragmentary view of strip gate means in open position, and a gate-operating means;

FIG. 4 is a face view of a multiple-head electromagnetic transducing means with strip-contacting shields in place but with portions broken away, showing air passages;

FIGS. 5 and 6 are a partial-section side view, and a face view, respectively, of a magazine faceplate and strip-loading apparatus, with sections removed to facilitate disclosure;

FIG. 6*a* is a sectional view of a strip guide bar, and a strip-restraining sprag;

FIG. 7 is a sectional view of strip-loading means depicted in FIGS. 1, 5, and 6, illustrating an exemplary information store strip in place ready for loading into a magazine, with parts removed;

FIG. 7*a* is a fragmentary view illustrating the action of guide bar and loading plate means in loading a strip into a magazine;

FIG. 8 is a partly schematic partly sectional diagram of principal support means, a strip-driving capstan and associated apparatus used to drive the capstan, and pneumatic apparatus employed to exhaust and supply air;

FIG. 9 is a partial section view of a capstan and spider means shown in part in FIG. 8, taken on line 9—9 in the latter figure, with parts broken away;

FIG. 10 is a partial section view depicting an air entrance grille, a strip selector rod, the actuating means for the rod, and indicating the spatial relationship of those parts to each other and to a plurality of information store strips;

FIG. 11 is a face view depicting the driven ends of two strip-selecting rods and the respective driving or actuating means for the rods;

FIG. 12 is a view showing strip-suspending and strip-selecting bar and rod means, with a typical information storage strip retained by the bar and rod means, but with upper and lower portions of the strip removed in the interest of conservation of drawing space;

FIG. 12*a* is an enlarged fragmentary view depicting details of strip-selecting and strip-suspending means in operative relationship with an information store unit, with a portion of the latter broken away;

FIG. 13 is a view indicating the relative dispositions of a typical strip and the strip suspending and releasing means, shortly following selection and release of a strip, with portions of the strip broken away;

FIG. 14 is a view of a typical information storage strip, with a part broken away, illustrating the means used for coding individual strips;

FIG. 15 is a binary truth table, with portions removed, indicating the coding configuration or plan for a plurality of information store units or strips; and

FIG. 16 is a schematic circuit and control diagram indicating interconnection of electrically energized components of the apparatus.

In describing the preferred form of the invention and in the claims certain words and terms will be used which terms and words will have special meanings that may or may not be exactly the same as those defined in a standard dictionary; and the intended meanings of these terms will herein be stated or defined. For example, by the term "random access" is meant selective next-in-time accessibility of any desired unit of, for example, an information store comprising many discrete separate data storage units irrespective of the location of the desired unit within the store. The terms **37** data" and "information" are herein considered to be synonymous. In the presently described apparatus each strip comprises a unit of information storage and each unit may store information in several channels each having many subunits (slabs) and each of the latter comprises many other smaller subunits; and the actual presentation of a desired information bit or information address at the transducer region is effected in a plurality of stages of which the first comprises selection and release of the particular strip containing that bit or address. The term "address" is herein used in the usual computer terminology sense.

Referring to FIG. **1**, a plurality of information-storing strips, **10** (hereinafter termed strips) are releasably suspended in a magazine represented generally by the ordinal **20**, by strip suspension, selecting and releasing means indicated generally by ordinal **30**. The magazine **20**, means **30** and other components of the apparatus are supported upon frame means hereinafter described. Means **30** comprise a plurality of rodlike elements, and are constructed and arranged to support a large number of strips **10** and to be operable to select and release any desired one of the strips irrespective of its position in the magazine. The strips are assigned respective binary code numbers and each strip comprises means uniquely representing its number and which cooperate with the rodlike elements, and the rodlike elements are operated in correspondingly coded configurations to release desired strips at the proper times. These means and the mode of operation thereof for selecting and dropping any specified strip will hereinafter be explained in detail. A released strip drops gravitationally into an operating means indicated generally at **40**, and into a position in which its lower end portion engages the periphery of a perforated drum or capstan **40***a* comprised in operating means **40**. Appropriate portions or arcs of the path of the peripheral inner surface of the capstan **40***a* are during appropriate intervals of time pneumatically connected to suction means for provision of a pressure differential between the exterior and interior of the capstan whereby the strip is forcibly held in contact with and is moved by the capstan. During operation of the apparatus the capstan is continuously rotated at a suitable speed by driving means such as an electric motor, whereby the engaged strip is very rapidly driven or transported through the transducing region in which the magnetic transducer means indicated generally at **60**, are situated. The transducer means are hereinafter more fully described. Application of the pressure differential or suction during appropriate intervals and over only certain limited arcs of the peripheral path of the capstan permits the strip to follow a course or path only parts of which are coincident with the surface of the capstan, whereby good contact with transducing means may be secured, and whereby the strip is permitted to be guided away from the capstan for return to the magazine. Electrically controlled and operated switch or gate means indicated generally at **70** are provided to permit, alternatively, the aforementioned immediate return of the strip to the magazine, or one or more additional passes of the strip past the transducer means. The gate, when open, allows the lower or leading end of the strip to enter a raceway formed as part of guide means indicated generally at **80** and extending upwardly and over the magazine. When closed, the gate forces the moving strip to follow a path in which the strip is again drawn by suction into contact with the surface of the capstan and thereby brought around and again passed through the transducing zone. For proper operation of the strip transport means the diameter of the capstan is such as to provide a circumference of sufficient length to preclude overlap of the leading and trailing ends of a strip when the latter is being repassed through the transducing zone.

As previously indicated, when operations with a strip by the operating means comprising transport means **40** and transducer means **60** have been completed and the switch or gate means **70** are open, the strip is propelled upwardly along the guideway in guide means **80** and the strip proceeds by its momentum along the inner surface of the curved upper portion of the guideway, and downwardly past a photoelectric detector means indicated by ordinal **90**, into a loading means indicated generally at **100**. The loading means serves to arrest the strip in proper position for loading onto the suspension means, and to thereafter force the returned strip onto the suspension and releasing devices in means **30**. The detector means **90**, which preferably comprises photoelectric detecting means, senses arrival of the leading end of the returning strip and initiates certain loading means operations, and later senses passage of the trailing (upper) end of the strip and initiates other operations of the apparatus, as will hereinafter be explained in detail. It will be understood that following release of a strip the strip selecting and releasing means may be temporarily rendered inoperative for releasing another strip, and maintained in this inoperative status until the dropped strip is removed from the lower (operating) end of the apparatus. The strip selecting and releasing means **30** include pneumatic means for intermittently supplying and directing narrow streams or currents of air downwardly upon and between portions of the suspended strips during appropriate time intervals, for the purpose of keeping the strips separated so any selected and released strip will readily descend into the operating means without appreciable interference by the other strips.

With the foregoing principal components of the apparatus and their functions and relationships thus generally disclosed, more detailed descriptions of the several enumerated principal means of the apparatus will now be made, commencing with the strip suspension, selecting, and releasing means.

As indicated in FIGS. **13** and **14**, the strips **10** are each provided with a pair of opposed indentations or notches **10***m*, **10***n* disposed at respective upper side margins. The upper inclined edges provided by these notches cooperate with complementary supporting surfaces of respective ones of a pair of rotatable suspender bars **30***t*, **30***u*. The suspender bars are formed of sector-shaped cross section as indicated in FIG. **12***a*, and are mounted for rotation about the axes of the sectors, in a frame **30***z* formed as part of means **30**. The two suspender bars are constructed and arranged for opposite concurrent rotation outwardly from the strips, and inwardly into supportive engagement with the strips, by power means hereinafter described. As indicated in FIGS. **12** and **13** each of the strips comprises a lower end portion **10***z* (hereinafter termed the leading end), a middle or body portion **10***b* and an upper end portion **10***r* in which the supporting notches **10***m*, **10***n*, are located. In the upper marginal edge of each of the strips there is formed a plurality of indentations or notches generally denoted **10***i* and exemplified by notch **10***i***0**, and of which indentations there are eight in the exemplary form; and each individual strip has a unique set of retainer lugs or ears generally denoted **10***e* and exemplified by ear **10***e***7**, formed integral therewith and disposed at one or the other (left or right) side of a respective one of the upper marginal indentations in dependence upon a code notation to be described. The retainer lugs or ears are adapted for cooperation with respective ones of a set of eight rotatable selector rods, such as **30***b***7**, for example, and which bars are similar to the suspender bars in shape, construction and mounting. The selector rods are adapted to be rotated into and out of engagement with retainer ears of the strips for selective release of individual ones of the strips as presently will be explained. Each of the selector rods is individually operable by means hereinafter explained.

The system employed to permit selection of any individual strip by operation of a respective set of selector rods **30***b*, is il-

lustrated in FIGS. 13, 14 and 15. In accord with principles of the binary system of numbers employed in the code designation of strips whereby control of releasing of the strips may be easily effected by a digital information processor, each of the strips is provided with as many upper-margin notches or indentations as there are binary orders in the code numbers used; and occurrence of a binary "1" in a code number is represented by a retainer ear **10***e* in a particular position in the corresponding indentation **10***i* of the strip bearing that code number. In the illustrative or exemplary apparatus there are 255 strips in each set or pack (magazine-full), hence, as indicated in FIG. 13, there are eight upper-margin indentations **10***i*0, **10***i*1,–**10***i*7, each corresponding to a respective binary order 2^0, 2^1, 2^2–2^7. Each marginal indentation has two sides, left and right, and it is evident that either of the sides may be selected to represent the binary value "1" and the other side the value "0." For purposes of securing more uniform retention and suspension of the strips, the binary value "1" is assigned to the right side of each of the alternate indentations, **10***i*0, **10***i*2, **10***i*4 and **10***i*6, and to the left side of each of the other indentations; and the binary value "0" is assigned to the sides opposite those assigned the value "1," all as indicated above exemplary strip No. **166** in FIG. 14. With the described arrangement, the binary numbers corresponding to respective decimal numbers 1 through 255 may be represented by respective configurations or dispositions of retainer ears **10***e* in the upper marginal indentations. Thus, in FIG. 14, the retainer ear configuration for binary number 10100110, corresponding to decimal number 166, is shown as it occurs on the strip of that designation. Therein the retainer ear **10***e* for indentation **10***i*0, that is, for the lowest order position, is at the left or "0" side of the indentation, that for indentation **10***i*1 corresponding to the next higher binary order is at the left or "1" side of the indentation, etc.; and the corresponding binary digit represented by the ear in each of the indentations is thereunder indicated. Thus it is evident that to select strip No. **166**, selector rods **30***b* in each of indentations **10***i*0, **10***i*3, **10***i*4 and **10***i*6 must be in or rotated to "0" attitude or position, and the other selector rods similarly be in or rotated to "1" position. The configuration of retainer ears for any of the set of strips is readily derived from an ordinary "truth table" which lists all the possible combinations of binary digits in representations of any specified number of binary positions. For example, a truth table **200** for the eight binary positions required in the strip coding in the exemplary apparatus, is depicted in fragmentary form in FIG. 15. Therein the code designations for the first four strips, the last three strips, and the aforedescribed exemplary strip No. **166** are indicated; and from the binary values represented in the table the respective retainer ear configurations for the strips of the set are derived for use in punching the several strips.

As indicated in FIG. 12, a typical strip **10** is shown suspended by suspender bars **30***t*, **30***u*, and retained by engagement of selector rods **30***b* engaging respective retainer ears. By reference to FIGS. 13 and 14 it is evident that the ear configuration corresponds to binary number 10100111, or decimal number 167, and hence the strip is identified as strip No. **167**. In the exemplary apparatus the selector rods are spring stressed to the "1" positions, that is, to positions in which they engage retainer ears that are in the "1" sides of indentations. This normal attitude or positional relationship is illustrated in FIG. 12. Thus it is evident that when strip No. **167** is to be selected, selector rods **10***i*0, **10***i*1, **10***i*2, **10***i*5 and **10***i*7 must be rocked or rotated from "1" position to "0" position, and rods **10***i*3, **10***i*4 and **10***i*6 must be left in "1" position. Thus for the selection of this exemplary card, activating current signals will be supplied to the respective actuators for the selector rods to be moved, and no current signals will be supplied to the other selector rod actuators. The actuators will presently be described. Following operation of the required set of selector rods in response to receipt of the respective set of signals from a processor-operated controller, the two suspender bars **30***t* and **30***u* are rocked outwardly and the selected strip drops under the influence of gravity, and the selector rods and suspender bars are then permitted to return to respective normal "1," and strip-supporting positions. It is evident that during the interval in which the suspender bats are rocked outwardly, all strips excepting the selected strip are momentarily suspended from the selector rods.

During operation of the apparatus, with the exception of the brief intervals during which a strip is being loaded into the magazine or is being selected by rotation of the selector rods and released by rotation of the suspender bars, currents of air are directed downwardly against the upper ends of the suspended strips in the magazine. These air currents, which are formed by division of a single air current by a slit-type grille, pass downwardly between upper-end portions of the strips and laterally therefrom, and serve to maintain the strips separated. The grille is formed with n+1 slits or passages, n being the number of strips in a full magazine; and the grille is so disposed as to form thin wide air currents and to direct the currents parallel to the planes of the suspended strips. The effect of each air current is that known as the Bernoulli effect, and serves according to known physical principles. The air supply to the grille is stopped-off during strip selection and release, whereby a released strip may fall without whipping or other undesired action.

As indicated in FIG. 2, air is supplied through a conduit **30***k* into a generally rectangular chamber **30***p* formed by a box **30***d* closed at its top and sides and having as its floor a grille **30***g* formed by a number of closely spaced parallel plates secured together with intervening spacer strips at their ends only, by suitable means such as solder. As indicated in enlarged fragmentary form in FIG. 10, the plates **30***f* of the grille **30***g* are disposed slightly above and transversely of the selector rods **30***b;* and as there indicated, individual thin wide air streams, indicated by downwardly directed arrows *a*, pass down from the grille and between respective pairs of strips **10**. As previously noted, the air is supplied through a conventional tubular conduit **30***k*, which conduit extends from a conventional rotary solenoid operated valve **30***y* (FIG. 8), to which air is supplied by means hereinafter described and explained. The solenoid of valve **30***y* is supplied energizing current at the proper times from means hereinafter described, the valve being so constructed as to be normally spring stressed into position to supply air to conduit **30***k* but arranged to exhaust air into the ambient atmosphere when the solenoid is energized.

The means provided for selectively operating the selector rods **30***b* and suspender bars **30***t* and **30***u* are illustrated in FIGS. 10, 11 and 12. Those means comprise, in the exemplary apparatus, eight similar selector rod actuators and two suspender bar actuators, all of which are sufficiently similar that description of one will suffice for all. As depicted, the front ends of the rods and bars are provided with respective round trunnions **30***bt* which extend into and are supported in aperture bearings, such as **30***bb* (FIG. 12), provided in a front support plate **30***z* formed as part of the grille-mounting frame of means **30**. The rear ends of the rods and bars are formed as (or have secured thereto) small gears such as **30***bg*, which are constructed and arranged to be driven by respective racks, such as **30***dm*. The racks are constructed and arranged to be driven in one direction by respective suitably mounted compression springs such as **30***s*, mounted as indicated and bearing upon or effective against one end of a respective rack; and the racks are arranged to be driven in the opposite direction by respective levers, such as **30***pd* pivoted to magazine frame means **20***f* as indicated and arranged to be rocked in one direction by respective solenoid and core means such as **30***sc*. As indicated in FIG. 11, the solenoid and rack means for alternate rods may be mounted in inverted relationship to the intervening solenoid and rack means, in the interest of good design; and it will be evident that the means for operating the suspender bars are suitably mounted to accommodate the slight difference in elevation of those bars. Thus the bars and rods are by the respective springs normally forced to their "1" position, and may be rotated or rocked to the respective

"0" positions by energization of the corresponding solenoid coils, selectively. Current pulses, or actuating signals, are supplied by a controller and power supply means **180***c* indicated in FIG. **16** and forming part of an information processor, by way of a set of conductors included in lead **168** connecting the solenoids to the controller. It is evident that a set of eight selector rod signals (represented by respective currents, or absence thereof) is supplied through the respective circuits, with a following but concurrent set of suspender bar signals, all of which become effective through the described mechanism to select and release the particular strip whose code designation corresponds to the coded signals supplied to the selector rod solenoids.

During selection, release, and dropping of a strip it is desirable to prohibit the downwardly directed air streams from interfering with the releasing and falling of a strip, and accordingly, as previously indicated, the selector rod signals are preceded by a signal to valve **30***y* (FIG. **8**), whereby to divert the airstream from the grille to the ambient atmosphere; and this diversion continues until the strip has been engaged by the capstan and moved into triggering relationship with a photodector means **40***d* (FIG. **1**), positioned to detect presence of a strip in the capstan engagement sector of the operating zone. Thus, during the free fall of a strip the solenoid of valve **30***y* is energized and the air supply to the grille is cut off (diverted), and the released strip falls into the operating means, which will next be described.

OPERATING AND TRANSDUCER MEANS

As indicated in FIG. **8** the principal support means of the apparatus is an upright plate **120** supported by a laterally extending foot or baseplate **121** to which it is secured. Extending laterally from and supported by upright plate **120** is a shelf plate **122** upon which is mounted driving and blower means which in the interest of simplicity are shown as a single drive motor **123** and a single direct-connected blower means **124**. It will be understood that a plurality of blowers, and separate drive motors, may be used for more economical operation.

Secured to plate **120** is a pair of brackets **125**, **126**. The brackets are constructed and arranged to rigidly support a tubular support **127** with its axis perpendicular to plate **120**. The support **127**, secured to the brackets in any suitable manner, as, for example, by brazing, extends through a large hole or aperture **120***a* formed in plate **120**, as indicated. At its outer end the support is covered with a cap **127***e*, into which extend four ducts or conduits whose function will presently be explained. Support **127** has secured to its interior a plurality of vanelike elements of a spider **127***s* which, as indicated in FIG. **9**, divides the interior of the support and the interior of the capstan into a plurality of separate chambers denoted **C1**, **C2**, **C3**, etc. The spider also comprises an annular flange member **127***p* which is secured to the inner end of the support **127**, a disclike end piece **127***q*, and an axially disposed trunnion shaft **127***t*. Affixed upon the exterior of support **127** as indicated in FIG. **8** is the inner race of an antifriction bearing **B1**, the outer race of which is fitted in a complementary portion of the inner end member **40***ab* of capstan **40***a*. The outer end of the capstan comprises a disc **40***ad* which is rotatably mounted on a second bearing **B2** affixed to and supported by the outer end of trunnion shaft **127***t*. Secured upon end member **40***ab* of the capstan is a pulley **40***dp*, disposed in alignment with the drive pulley **123***p* of motor **123**, whereby the capstan may be driven by a belt **123***b* which is engaged with both pulleys. The capstan is provided with a multiplicity of spirally arranged perforations **40***aa* through which air may be drawn into one or another of the aforementioned chambers **C1**, **C2**, etc.

Shown secured in respective openings in cap **127***e* of tubular support **127**, and thus communicating with respective ones of chambers **C1**, **C2**, **C4** and **C6**, are four exhaust or suction ducts **127***f*, **127***g*, **127***h* and **127***i*. Of these ducts the latter three exhaust directly into intake duct **124***i* of blower **124**; and the other, **127***f* communicates with duct **124***i* through a solenoid-operated valve **127***v*. For simplicity in illustration these ducts have been illustrated as opening into respective chambers through cap **127***e*; however, it is to be understood that in certain embodiments of the apparatus the ducts be larger than shown and may open into respective chambers **C1**, **C2**, etc., by way of apertures formed in the periphery of support **127**. Also connected to the intake duct **124***i* is the transducer means exhaust ducting **60***d*. The outlet port of blower **124** is connected to a duct **124***o* which serves to supply air to duct **30***k* by way of valve **30***y*. Thus when the apparatus is in operation, air is by the described means normally continuously drawn through perforations of the capstan and into and through chambers **C2**, **C4** and **C6**, and through the transducer means into ducting **60***d*. Further, when valve **127***v* is open, air is drawn from chamber **C1**; and air is continuously supplied to valve **30***y* for use in maintaining the strips separated in the magazine. Directions of airflow are indicated by arrows; and it is to be understood that damper-type valves (not shown), may be employed in the several ducts to regulate airflow, dependent upon the physical dimensions and capacities of the pneumatic means. Further, for maximum economy of operation, separate blowers for each exhaust duct may be employed. The power supply to the motor and valve solenoids will hereinafter be explained in connection with FIG. **16**. During operation of the apparatus the drive motor is energized and the capstan rotates at a substantially constant speed. Air is continuously exhausted from within the transducer means **60** and from within chambers of the capstan, and air is supplied to the stream-forming grille above the strips. Contemporaneously with release of a strip **10** from the magazine, suction in chamber **C1** is cut off by valve **127***v*. Thus as the leading edge of the strip engages the capstan it is not violently jerked but is more gently accelerated by frictional contact; and a brief interval thereafter the suction is reapplied and the leading end of the strip is positively driven through the suction zone or sector **C2** and thence into and through the transducing zone opposite chamber **C3**, as indicated in FIG. **2**. After once being engaged by the capstan due to pressure differential, the strip is propelled or driven in an obvious manner by only partial engagement over those sectors at which the pressure differential is evident. Since suction is not applied to chamber **C3** but is in the transducing zone applied from within the transducing means **60**, the strip is induced, by a combination of centrifugal force and downwardly acting pressure differential, to move away from the capstan and into intimate and effective transducing relationship with the transducer means. As the leading edge of the strip moves out of the transducing zone it enters the region or sector opposite chamber **C4** to which suction is applied, and is thus again drawn into driven engagement with the capstan. As the leading edge of the strip approaches the gate means **70**, it enters a zone or sector opposite chamber **C5** in which suction is not evident, and it therefore may move away from the capstan if the gate is open. If the gate is closed, a guide surface on the gate guides the leading edge along a path in which the strip travels substantially in contact with the periphery of the capstan and onward into the zone opposite chamber **C6** in which the suction is effective. If the gate is open, centrifugal force causes the leading edge of the strip to move away from the surface of the capstan and into the lower end portion of guideway **85**. In either case, the leading end and body portions of the strip follow the leading edge; in the first case the strip is drawn or carried on around a generally circular path and again passes through the transducing zone, and in the second case the strip is propelled upwardly into the guideway at high speed with the result that following movement of the trailing edge away from the capstan the momentum of the strip drives the strip around through the upper portion **85***u* of the guideway and down into the magazine loading means. The decision as to whether the strip is to make a single pass through the transducing zone, as for a single "reading" operation, or is to make two or more passes, is made by computer means in, for example, a data processor, as translated by an intermediate apparatus or system herein termed a con-

troller, which furnishes to the gate actuator one or the other of binary signals, one represented by "1" and the other by "0." The "1" signal may, for example, be evidenced by a properly timed pulse of electric current passing through the solenoid 70*s* of the gate actuator, whereby the gate is opened and the strip returned to the magazine, and the "0" signal then being evidenced by absence of such a current pulse whereby the normally closed gate remains closed and the strip is recirculated through the operating zone. The gate means, as indicated in FIGS. 3 and 3*a*, comprises a gate bar 70*g* pivotally mounted on a pivot 70*p* carried upon a fixed shroud 71 which extends part way around the periphery of the capstan. The gate bar is pivotally connected to a spring-stressed actuator link 70*m* which is moved toward gate-closing attitude by a spring 70*r* and drawn into gate-opening attitude by the core of solenoid 70*s* when the solenoid is energized. The solenoid is fixedly secured to shroud 71 as indicated. That part of the operating and transducing means disposed in the transducer zone will next be described.

As depicted most clearly in FIGS. 3 and 4, transducer means 60 comprise a housing including a frame 60*a* in which are adjustably mounted first and second multiple-head electromagnetic transducers 60*b*, 60*c*. The transducers have respective curved and polished upper faces 60*e*, 60*f*, over which strips 10 are propelled and into contact with which the strips are urged by a pressure differential provided between air chamber C3 formed in the interior space within capstan 40*a*, and open air passages formed in the transducer means. Air is admitted to chamber C3 at atmospheric pressure through apertures in the end disc 40*ad* of the capstan, and is exhausted through passages in the transducer means into a conduit 60*d* connected to blower 124 (FIG. 8). As indicated in FIG. 3, wherein sections of the two multiple-unit transducers have been removed, and in FIG. 4 which depicts the active or strip-contacting faces of the transducers, air passages 60*p* and 60*q* are provided, the latter being formed by opposed grooves produced in the abutting faces of the transducers. Outer air passages 60*p*, 60*p* are produced by suitable forming or shaping of the parts comprising frame 60*a* of the transducer means, and these passages lead to small openings 60*g* formed by the scalloped edges of right and left tape-guiding shields 60*s*, 60*t* (FIG. 4) along the lines of contact of the shields with the transducer upper faces 60*e* and 60*f*. The paths of the air currents are indicated by arrow-pointed lines, and it will be evident that due to the pressure differential between opposite faces of a strip as it progresses over the transducer heads, the strip will be urged downwardly into intimate contact with shields 60*s*, 60*t*, and with the faces 60*e*, 60*f* of the transducers. Thus the strip travels in an undulatory path over the transducer means, as indicated in FIG. 3; whereby uniform and excellent transducing action is achieved. As previously indicated, the space within capstan 40*a* is divided into chambers by stationary baffles or partitions some of which chambers are connected to the intake of the blower to provide suction over sectors of the periphery of the capstan, and the others of which chambers are open to the ambient air at atmospheric pressure. Thus within a zone or sector defined by chamber C2 and extending to the curved lip of right-hand shield 60*s*, a strip is subjected to suction applied from within the capstan through apertures 40*aa*, so that the strip is propelled along in contact with the capstan. The suction is relieved at the juncture of the zones defined by chambers C2 and C3, and at that point centrifugal force acts to cause the strip to lose contact with the capstan and to follow a path leading to contact with shield 60*s*. It is under that condition that the strip moves past the air passage openings in the transducer means, and hence the strip may proceed in the aforementioned undulatory path and into contact with shield 60*t*. As the strip is propelled along the surface of shield 60*t* it enters a zone opposite chamber C4, wherein the pressure differential is inward and the strip is thus again drawn firmly into driven contact with the periphery of the capstan 40*a*.

The exemplary transducers depicted comprise respective aligned rows of transducer heads, such as those magnetic pole pieces indicated at 60*m*, 60*n* in FIG. 4. The transducer circuits, (magnetic and electrical) may be of well-known or conventional construction and are not per se of the present invention and hence are not herein further described. The electrical connections to the multiplicity of transducer heads are through conventional insulated leads connected to multiple-contact quick-disconnect plug sockets 60*u*, 60*v* (FIG. 3) which are mounted in a base cap 60*w* secured to frame 60*a*. Complementary multiple-conductor plugs terminating leads 167 (FIG. 16) extending from a controller 180*c* permit easy change of transducer means. From the preceding description it is evident that a strip, progressing from right to left in the direction of the arrow in FIG. 3, may be subjected to a reading (read) operation as it progresses past the gaps of pole pieces 60*m*, and to a recording (write) action as it moves past the gaps of pole pieces 60*n*, and that all or a part of either of these actions or operations may be omitted by suitable switching of the electrical circuits connected to the individual transducer heads. Since those circuits are comprised in an information processor or digital computer which is not per se a part of the present invention, they are not herein disclosed in detail. However, it is to be understood that the present invention may be used with known or conventional digital computers.

The transducing operation and the operations of the strip-moving means having been explained, it will next be explained how a strip 10 which has been selected, released and operated upon is returned to the magazine with its lug or lugs engaged with the proper selector rods and its side notches engaged with the suspender bars. The preceding descriptions have made evident the fact that the position of any strip in the pack of strips in the magazine is immaterial to the operation of the apparatus; hence strips are returned to the "top" of the pack irrespective of their code designations or numbers. Due to the normally flowing air currents passing between the strips, any selected and released strip will drop, regardless of its position in the pack, and upon return of a strip to the pack the air currents directed by grille 30*g* are effective to automatically redistribute the strips in the magazine.

MAGAZINE LOADING

As a strip is carried by its momentum along or through the upper curved portion 85*u* of the raceway 85, its leading edge interrupts the optical path of a photodetector unit 90 (FIGS. 1, 2, 5, and 6). The detector unit thereupon transmits a signal to the controller (FIG. 16), which produces a signal which is employed to arm and initiate action of apparatus used to stop and resuspend the strip on the bars and rods. As the leading edge (bottom end) of the strip passes the photodetector unit it enters a straight guideway defined by opposed longitudinal grooves 101*a*, 102*a* (FIG. 7, 7*1*) produced in respective hinge-mounted guide bars 101, 102 which form part of the magazine-loading mechanism designated generally by ordinal 100. The guide bars are mounted on respective pairs of hinges 101*b*, 101*c*, and 102*b*, 102*c* (FIGS. 5 and 6) secured to the magazine cover plate 108, and have guideway opening and closing movements limited by suitable means such as stops on the hinge elements. As the strip enters and proceeds downwardly in the guideway thus provided by grooves 101 *a*, 102*a*, the guide bars are in closed position as indicated in FIG. 7. Downward motion of the strip is arrested as the lower end thereof strikes a retractable sliding stop plate 103 (FIGS. 5 and 6) which has been moved into stopping position in the path of the descending strip near the bottom ends of the guide bars as shown. The stop plate is moved by a bellcrank lever 103*a* operated by a solenoid-type actuator 103*b*. The solenoid is energized in response to the aforementioned initiation of actions by the controller (FIG. 16) in response to the signal from photodetector means 90 as the leading (bottom) edge of the strip passes the detector. As the strip nears plate 103, its lower end engages a pair of pivoted sprags 101*g*, 102*g*, which are

pivotally mounted in respective slot-apertures **101***s*, **102***s* formed in the guide bars, as indicated. The sprags are urged into strip-engaging attitude by the distribution of mass on opposite sides of their pivots, preferably aided by spring means as indicated in FIG. **6***a*. As a strip engages the sprags, the latter are pivoted slightly and pinch the strip against adjacent portions of respective guide bars, and thus rebound of the strip is prevented. Actuator **103***b* comprises a conventional solenoid having a movable core or plunger **103***p* which is returned by spring means **103***s* as indicated; the plunger being pivoted to lever **103***a* at its lower end and the lever being pivoted to a relatively fixed bracket **108***d* which is secured to or formed integrally with the magazine cover **108**.

As the trailing (top) end of a strip passes the detector means **90**, the latter emits a signal which is used by the controller (FIG. **16**) to (a) initiate operation of means acting to rock the guide bars **101**, **102** on their hinges into strip-releasing position, (b) initiate operation of means whose function is to load or press the upper end of the returned strip onto the suspender bars, and (c) initiate subsequent retraction of stop plate **103**. The signal from detector means **90** is electric, and is employed to trigger means, such as conventional relay means, which (a) close power-supplying circuits to a solenoid-type actuator **106** which rocks the guide bars as presently explained, and to a spring-returned solenoid-type actuator **105** which serves to actuate a loading plate **107** (FIGS. **5**, **6**, and **7**), employed to force a strip onto the selector rods and suspender bars, and (b) open the power-supplying circuit to solenoid **103***b*. As indicated in FIG. **5**, actuator **105** operates, when energized, to force upwardly a link **105***b* which is pivotally secured at its upper end to one arm of a bellcrank lever **105***c*. Lever **105***c* is pivotally mounted on a cross pin **108***p* mounted in outstanding legs of a relatively fixed bracket **108***b* as indicated; and its upper lever arm is pivotally secured to the middle portion of a similar pin **105***f* secured between a pair of push bars **105***e*. Push bars **105***e* are mounted on and adapted to push (to the left in FIG. **5**) the upper end of a long flat generally upright resilient loading plate **107**. Normally the loading plate is retracted outwardly of the magazINE by the spring means comprised in actuator **105**, thus permitting a returning strip to enter the guideway provided by guide bard **101**, **102**, but the plate is pushed inwardly at its upper end immediately prior to and concurrently with rocking of the guide bars outwardly away from the strip, and thus, as indicated in FIG. **7***a*, the upper end of the strip is snapped at its upper outer edges and forced onto the free outer ends of the suspender bars.

The hinged guide bars are spread or rocked outwardly into strip-releasing attitude by linkage moved by an actuator **106** (FIGS. **5** and **6**) which is secured to magazine cover plate **108**. The actuator comprises a spring-stressed solenoid core or plunger **106***p* whose upper end is articulated to a rotatable crank disc **106***d* by a pin **106***c*. The crank disc is pivotally mounted on the magazine cover plate **108** at **106***e* and has pivotally secured thereto by crankpins a pair of drawbars **106***g*, **106***h* which at their outer ends are pivotally secured to respective rocker arms **101***g*, **102***g* secured to respective ones of guide bars **101**, **102**. The structural arrangement is such that the spring means in actuator **106** maintains the linkages in the retracted positions indicated in FIGS. **5** and **6**, and such that upon energization of the solenoid in actuator **106** the plunger is drawn downwardly to thereby rotate crank disc **106***d* and cause the drawbars to rock the guide bars outwardly as indicated by the position of guide bar **102** in FIG. **7***a*. This outward rocking of the guide bars occurs substantially contemporaneously with the inward thrusting of the upper end of loading plate **107**, and thus permits the strip **10** to snap free of its side edge restraints as noted, and thus to be loaded onto the free outer ends of the rods and bars. As previously indicated, actuators **105** and **106** are operated in response to passage of the top end of a returning strip past the detector station at detector means **90**; and shortly thereafter the concurrent deenergization of the solenoid of actuator **103***b* permits the spring **103***s* of that actuator to retract stop plate **103**. The returned strip is by that time fully loaded onto the rods and bars, and actuators **105** and **106** return to their inactive positions, returning loading plate **107** and guide bars **101**, **102** to strip-receiving positions. Entry of the newly returned strip into the pack causes an immediate and automatic adjustment of strip spacing by the airstreams, the result of which is that each strip is separated from its next-adjacent neighbors. The magazine is thus prepared, in a very brief interval of a few milliseconds of time, for selection and release of the next-needed strip.

The loading strip **107**, stop plate **103**, actuators **103***b*, **105** and **106**, and their appertinent linkages, are mounted upon a readily removable magazine cover plate **108** which forms one side of the magazine structure. As indicated in FIGS. **5** and **6**, plate **108** is removable supported at its lower end by a cross pin **108***s* affixed in dependent wings **108***w*, and the cross pin is supported in slots **130***a* formed in a protruding bracket **130***b* comprised in the housing or frame **130** of the apparatus. As indicated in FIGS. **1** and **2**, the upper end of plate **108** is secured in proper relative position to the magazine frame means **130** by conventional quick-disconnect attachment means **130***q*. Thus the plate and loading means forming the front of the magazine may be easily removed for exchange of one set of information strips **10** by a different set from a storage file. To facilitate this operation the side face cover of the magazine is formed as a transparent door **109***a* (FIG. **1**) which may be opened for strip pack replacement. This cover or door is constructed and disposed to leave the upper portion of the magazine open, as indicated in FIG. **1**, so as to permit exhaust of the airstream which pass downwardly between the suspended strips.

ELECTRICAL SYSTEM

Referring now to FIG. **16**, there are schematically depicted within dashline rectangle **150** the electrical components of the described apparatus. These components are individually connected by respective leads or cables, such as **160**, **161**, etc., to a controller and power supply means **180***c* whereby control or information signals may be transmitted to and from the components, and to supply operating power or current to the motor **123** and the other power-consuming elements. Signals originating in an information processor **180** are utilized by the controller to initiate (and terminate) supply of power to motor **123** (FIG. **8**) via cable lead **171**, and thereafter to cause selection, release, reading from a selected strip (and/or recording of information or data thereon), etc. Assuming the motor to be operating, a typical sequence of actions is as follows:

1. A signal is transmitted to the solenoid of valve **30***y* over lead **161**, cutting off air supply to the grille over the strips; and concurrently a signal to the solenoid of valve **127***v* closes that valve to cut off suction within chamber **C1**.

2. Solenoids of a particular set of selector solenoids are energized by coded current signals transmitted over cable lead **168**, followed an instant later by energization of the suspender bar operating solenoids by currents through lead **169**.

3. The released strip falls into engagement with the capstan and by gravitational action combined with frictional contact with the capstan moves to a position in which it interrupts the light beam of the photodetector unit **40***d* (FIGS. **1** and **2**). The photodetector thereupon produces a signal in a circuit of lead **162**, which signal is translated by the controller into signals transmitted via respective leads **161** and **160** to the solenoids of valves **30***y* and **127***v*, permitting valve **30***y* to again supply air to the grille and causing valve **127***v* to restore suction in chamber **C1**. This signal also is normally used by the controller to initiate resetting of the selector rods and the suspender bars. The photocell signal further announces to the controller the incipient reading of information stored on the strip, permitting setting up of buffer or comparison circuits therein for selecting and/or storing the read information signals; and permits the controller to form a gate signal.

4. A signal is transmitted from the controller to the solenoid of the gate means **70** via lead **170**, to selectively cause recirculation of the strip along a path around the upper reaches of the capstan, or return of the strip to the magazine. During the period of the passage of the strip over the transducer heads, signals representing information read from the strip, or signals representing information to be recorded on the strip, or both, may course through the circuits of cables **167**.

5. Following one or more passes of the leading end of a strip across the transducer heads, and opening of gate means **70**, the leading end of the strip triggers photodetector means **90**, which thereupon produces a signal which is translated by the controller into a current signal to the solenoid of actuator **103***b*. The latter responds by moving the stop plate **103** into the path of the descending strip. As the trailing end of the returning strip clears photodetector **90**, the latter produces a "clear" signal to which the controller responds by sending concurrent electric current signals to the solenoids of actuators **105** and **106** over leads **164** and **165** respectively. These signals are applied momentarily and are effective to cause loading of the returned strip onto the rods and bars of the strip suspending and selecting means.

The preceding description of an exemplary random access information store system according to the invention makes evident that there is provided an information store system adapted for use with a digital information processor system having a controller and power supply means, and which information store system is adapted for ready interchange of one group of information store units for any other group comprised in a large number of such groups of information store units, each of the units within a group being uniquely distinguishable from the others of the respective groups and also individually selectable from its group, and each such unit being capable of storing a large number of binary information bits arranged in a desired spatial arrangement within the unit. Further, it is evident that the system provides means for rapidly gaining access to any information store unit comprised in a group within the system by selectively removing the unit from the group, and for transducing binary information to and from any accessed unit in a brief interval of time by operation of operating means including a rotary transport means constructed and arranged to rapidly move any selected unit through a transducing zone and past suitable information-transducing means, and also arranged to return the unit to its group following any selected number of transducing operations. In the exemplary apparatus described, dimensional configurations and numbers have been set which are exemplary only, and it is to be understood that variations therefrom falling within the scope of the appended claims are within the spirit and bounds of the invention. The description further makes evident that the invention provides a system of the named type which is compact, economical to manufacture and to operate, which utilizes reusable information store units, and which is adaptable to use in large information-processing systems in which it is desirable to have a plurality of rapid-action random access information store units connected to a principal processor by way of controller apparatus. While in the exemplary apparatus the information store units may be constructed of polymer film such as that bearing the trade name MYLAR, and of thickness about 6 mils and having an adherent conventional bistable magnetic coating, other suitable materials may be employed. Further, while a particular spiral disposition of peripheral apertures in the strip-transporting capstan has been shown whereby to minimize noise effects, other dispositions and/or means may be substituted to attain the same ends, within the scope of the appended claims.

From the foregoing explanation of the invention and the description of a preferred physical embodiment thereof it is evident that modifications and changes therein will occur to those skilled in the art; and it is accordingly not desired to limit the invention to specific details of the described exemplary embodiment but only as indicated by the scope of the following claims.

What is claimed is:

1. A random access information store system comprising: a first means, comprising a plurality of generally elongate flexible information storage strips each capable of storing a multiplicity of bits of information in binary form; second means, including means for retaining said strips in spaced-apart relationship as an assembled group and for selecting and releasing any particular strip from the group irrespective of its position in the group; third means, including transducing means and operating means, effective to automatically effect movement of any released one of said strips through an operating zone and past said transducing means and to a loading location in alignment with said group of strips; and fourth means, including means responsive to arrival of any strip at said loading location, effective to impress such strip into said group, said operating means including an apertured rotating capstan and directional pneumatic means about which said capstan rotates so as to cause different portions of the capstan periphery to receive pneumatic pressure as the capstan rotates.

2. A system according to claim 1, said second means comprising a plurality of rodlike retaining and suspending means effective to suspend said strips in upright attitude so that a released strip falls under the influence of gravity to said rotating capstan for engagement thereby as a result of pneumatic pressure applied by said pneumatic pressure means.

3. A system according to claim 1, wherein said transducing means also includes directional pneumatic means operative in conjunction with the absence of the application of the directional pneumatic means of said operating means in the region of said transducing means to provide for the proper positioning of a strip in the transducing region as it passes thereby.

4. A system according to claim 3, said third means including position-sensing means for detecting the position of a released strip to permit control of said second means in response thereto.

5. A system according to claim 3, said third means further including means cooperating with said capstan and the pneumatic means of said operating means to permit selective removal of a strip engaged by said capstan, whereby a strip can be selectively recycled past said transducing means a plurality of times.

6. A system according to claim 1, said second means comprising means for suspending said strips at the upper ends thereof and means for directing separate streams of air downwardly between the strips prior to release of a selected one thereof.

7. A system according to claim 1, each of said strips having a plurality of indentations at one end thereof and each strip having a unique respective binary-coded configuration of retaining ear means arranged at respective ones of said indentations; and said second means comprising a plurality of rodlike means having portions complementary to the retaining ear means of said strips and arranged for operation between a first ear-engaging position and a second ear-releasing position, and comprising means for selectively operating any set of one or more of said rodlike means to cause release therefrom of any selected one of said strips.

8. Information store apparatus comprising, in combination: a multiplicity of elongate record strips; first means, including magazine means, for suspending the said strips individually and generally uprightly and for selectively dropping any of said strips; second means, comprising rotary capstan transport means, cooperating with said first means for engaging and transporting a dropped strip through a transducing zone and propelling the strip through a prescribed path to return the strip to said magazine means; third means, including means defining said prescribed path; fourth means, including transducer means disposed in said transducing zone in cooperative relationship with said capstan transport means and past which the transport means transports an engaged strip; fifth means cooperating with said capstan to permit selective removal of a strip engaged thereby so that a dropped strip can selectively remain engaged by said capstan during a plurality of revolutions and be available at a plurality of different times for the

performance of a transducing operation thereon by said transducing means; means for replacing a returned strip in suspension in said magazine; and means for controlling the strip-selecting operations of said first means whereby any strip in said magazine may be individually released for dropping to said second means.

9. Apparatus according to claim 8, said first means including means for producing and directing a multiplicity of air currents at the ends of said strips prior to release of a selected one thereof whereby said strips are separated each from the others by moving air, to facilitate dropping of a released strip.

10. Apparatus according to claim 9, in which the means for directing air currents at the ends of the record strips comprises a multiplicity of spaced-apart plates arranged substantially parallel with the upper end portions of the strips suspended in said magazine.

11. Rapid access information storage apparatus, comprising: a plurality of elongate information store strips; first means to contain the strips in a generally upright position and selectively release any one of said strips to fall under the influence of gravity preparatory to performance of transducing operations therewith; second means, including rotary capstan means, constructed and arranged to receive any released one of said strips and transport the received strip through a transducing zone, said rotary capstan means comprising a perforate rotary cylinder, and suction-applying means arranged inside said cylinder and adapted and arranged to permit a pressure differential between the exterior and the interior of the cylinder over certain restricted peripheral sectors only; means for providing said pressure differential, means constructed and arranged to selectively permit retransport of a released strip through said transducing zone a plurality of times or alternatively induce return of the strip to said first means; and transducer means disposed at said transducing zone and in cooperative relationship with said second means, for performing transducing operations with any of said strips transported therepast by said second means.

12. Random access information store apparatus comprising: a plurality of elongate information store strips n in number and each having a respective unique set of suspender cooperating means; first means, including a plurality of suspender devices, constructed and arranged for suspension therefrom of said strips and selectively actuable for release therefrom of any particular one of said strips; second means, including means for selectively actuating any set of said suspender devices; third means, for providing at least $n+1$ distinct currents of air and for directing the air currents at the upper marginal edges of said strips prior to release of a selected one thereof to thereby by Bernoulli effect separate each of said strips from others thereof by moving currents of air; and fourth means, including means for utilizing any released one of said strips, and including means for returning a released strip to said suspender devices.

13. A random access information store apparatus comprising: means forming a walled generally upright enclosure; and assembly of a plurality of aligned information storage strips supportable each at its upper end by said suspension means, in said enclosure; first means including strip suspension means disposed at the upper end of said enclosure, and including means for selectively releasing individual ones of said strips; second means including gas-directing means disposed above said strips and arranged to direct air between said strips prior to release of a selected one thereof whereby to separate said strips each from the others to permit easy dropout of any released strip; third means including means for supplying gas to said gas-directing means; and fourth means, including means for utilizing a released strip after the strip has dropped, to perform therewith information translation operations included in the group of operations comprising readout and write-in, and said fourth means including means for returning a dropped strip to said assembly.

14. Information storage apparatus comprising, in combination: first means, including a plurality of two-condition retainer keys each movable individually to either from the other of first and second conditions; second means, including a magazine and selector means connected to said retainer keys and constructed and arranged for selective actuation of any of a plurality of combinations of said keys each from either to the other of said first and second conditions; a plurality of information store strips each having an information store portion and a retainer portion for retention of the respective strip in said magazine, strips having in the retainer portions thereof said respective unique key-engaging means arranged in any strip differently than in any other of said strips and arranged for cooperation with a respective combination among said keys, whereby upon selective actuation of a particular combination of said keys the corresponding strip only is released from the first means and the other strips are retained; and means for utilizing any released strip and for returning the utilized strip to said magazine for reuse, said last-mentioned means including a vacuum capstan for engaging a released strip and capable of rotating the engaged strip for a plurality of revolutions, guide means interposed between said capstan and said magazine, and means for controlling the removal of a strip from said capstan such that a removed strip will be transferred into said guide means for travel along said guide means to said magazine.

15. A random access information store system adapted for use with a digital information processor having a peripheral apparatus controller, said system comprising: first means, including an assembled group of similar individually distinguishable information store units each in the form of a long generally rectangular strip of resilient wear-resistant material and each comprising means for cooperation with information-transducing means, said first means including means for retaining and suspending said units as a group each unit by one end thereof in generally upright attitude, and further including means for selectively releasing any single unit from the group thereof for free fall therefrom; second means, including a rotating capstan constructed and arranged to engage any falling one of said units released by said first means and effective to move a released and fallen unit into a rotary path extending through a transducing zone, third means, including transducing means, disposed with the transducing means at the said transducing zone for transducing action with any of said units being moved therepast by said capstan; fourth means including means cooperating with said capstan to permit selective removal of a strip engaged thereby so that an engaged strip can be selectively recycled past said transducing means a plurality of times; guide means disposed between said capstan and said first means so that a strip removed by said fourth means will be impelled into one end of said guide means and travel therethrough as a result of the velocity gained from engagement with said rotating capstan; fifth means, including means adjacent said first means, constructed and arranged to receive a unit from the other end of said guide means and to reunite the received unit with said group; and sixth means, including power means, constructed and arranged to operate said first, second, third, fourth and fifth means.

16. A system according to claim 15, in which said information store units each comprises a distinctive individual set of retainer means arranged for cooperative engagement with a complementary set of retainer means, and a plurality of retainer means comprising all sets of retainer means complementary to the several said units, and said retainer means and said units being constructed and arranged for upright suspension of the said units each from and by its respective set of said retainer means, whereby upon selective actuation of a given set of said retainer means the corresponding retained unit is released for free fall from said first means to said second means.

17. A system according to claim 15, in which said information store units include physical structure means arranged according to a code whereby each unit is thereby physically selectable and distinguishable from all other units of the said

group of units; and in which said first means includes a plurality of physically operable means effective in response to receipt of a set of coded signals corresponding to the coded arrangement of said physical structure means of a unit to be selected to operate to select and release the corresponding unit for free fall to said second means; and means for supplying coded signals to said first means.

18. A system according to claim 15, in which said capstan has a perforated periphery, and means are provided for producing a suction effect within said capstan whereby during rotation said capstan engages any released unit and impels the said unit along the path through said transducing zone.

19. A system according to claim 15, in which said third means includes pneumatic means including means forming air passages in said transducing means, and including means for exhausting air through said transducing means whereby a unit moved by said second means through said transducing zone is drawn into optimum transducing relationship with respect to said transducing means.

20. A system according to claim 15, in which said first means includes a plurality of rodlike elements for retaining and suspending said units in group formation, and in which said fifth means comprises loading means arranged to receive a returned unit from said guide means and means responsive to return thereto of a unit, to reunite the returned unit to the assembled group of units.

21. A system according to claim 15, in which said first means includes as a group of said units a number thereof not in excess of 2^n-1, n being a selected whole number; and in which said first means includes a group of substantially parallel and horizontally disposed selector rods n in number, and a pair of opposed suspender bars; and in which said first means comprises in said group of units, coded sets of means cooperable with complementary sets of said selector rods for release thereby upon actuation of the corresponding set of selector rods, and in which each of said units comprises complementary means cooperable with said suspender bars; and, comprised in said first means, means for actuating any specified set of said selector rods whereby to select for release a single particular one of said units.

22. Information store apparatus in which information is stored in binary form upon a multiplicity of discrete information storage strips, said apparatus being constructed and arranged to provide rapid access to any one of the strips and comprising, in combination with said strips: first means, comprising magazine means, for suspending said strips generally uprightly at the upper end portions thereof and in close but spaced-apart relationship, and including means for selectively releasing any specified one of the strips for dropping of the latter strip; second means, including rotary capstan means for engaging a dropped strip and driving the strip through a transducing zone for read-record operations therewith and for imparting momentum to the strip sufficient to cause the strip to return to a position in said magazine means third means for controlling the removal of a strip from said capstan means so as to selectively permit a dropped strip to be driven through said transducing zone a plurality of times without being returned to said magazine; fourth means, comprising transducer means in and defining said transducing zone, for performing data-transducing operations with respect to one of said strips traversing said zone; and fifth means for automatically returning a strip to said magazine after being released from said capstan means by said third means.

23. Apparatus according to claim 22, in which said strips are provided each with a respective individual set of retainer ear means and in which said magazine means comprises a plurality of rodlike elements engageable with retainer ear means of said strips and selectively operable according to a binary code combination, and means for receiving binary signals and in response thereto selectively operating a corresponding set of said rodlike elements, and said first means comprising means to reengage a returned strip with a respective set of said strip suspenders.

24. In a random access information store system, the combination comprising: first means, including an assembly of information store units formed as resilient elongate strips each having means for storing information in binary form, constructed and arranged for selective operation to move any selected unit from the assembly to an operating region; second means, including means forming an operating region and including cooperative transport means and information-transducing means disposed in said region and effective when operated to receive and transport any specific one of said units received in said region through a path into transducing relation with said transducing means and to automatically return any such unit to said assembly of information store units by a different path, said transport means comprising a rotatable perforated capstan and pneumatic means effective when operated to cause engagement of the capstan and said one of said units, whereby the capstan impels the unit through said path, the circumference of said capstan being such that a strip wrapped around the capstan covers a major portion of the capstan periphery; and third means, including power means, for operating said first and second means and for rotating said capstan.

25. A random access information store system, comprising: first means, including a plurality of strip-form information store units and means to suspend said units as an assembled group of units, and comprising means for selectively releasing any one of the units individually for free fall into a restricted path; second means, including means defining said restricted path, and a rotary capstan effective to receive any released one of said units at a time and impel such unit to move along the restricted path to a returned position adjacent said group of units, and including means to reunite such returned unit into said group said capstan having a circumference such that a strip wrapped around the capstan covers a major portion of the capstan periphery; third means, including transducing means disposed in contiguous relation to said restricted path for transducing cooperation with any of said units moving therepast along said path; and fourth means, including power means, constructed and arranged to operate said first and second means and to supply information signals to said transducing means and to transmit signals transduced by said transducing means from any of said units moved past said transducing means.

26. A random access information store system comprising, in combination: a group of information store strips; first means, comprising a rotary capstan means and information transducing means, constructed and arranged to receive and impel any one of said strips thereby received, through a path past the transducing means for transducing cooperation therewith; second means, including means constructed and arranged to store said strips as a group in a generally upright manner and to selectively transfer any one of said strips to said capstan means by causing a selected strip to fall under the influence of gravity; third means, comprising strip-guiding means, forming a path from said capstan to said group of information store strips; fourth means, including strip gate means, selectively operable to pass a strip from said capstan means to said strip-guiding means or to divert such strip to a recirculation path defined by the periphery of said capstan, whereby a strip may be recirculated about a path encircling said capstan means or may be returned to said group; and fifth means, including power means, for operating said first, second, and fourth means.

27. A random access data storage apparatus comprising in combination a plurality of separate short compliant noncyclic-type record carriers for storing data, means for storing said carriers in an array, a transducer unit mounted in a fixed position and operable to transfer data signal representations to and from a selected record carrier, means for transporting a selected one of said carriers from the array to said transducer unit, and means for translating the carrier relative to said transducer unit in a cyclic manner to present the full length of the carrier to the transducer unit during a single cycle of movement of the carrier.

28. A random access data storage apparatus comprising in combination a plurality of short flexible separate strips for storing data, means for storing said strips in an array, a transducer unit mounted in a fixed position and operable to transfer data signal representations to and from a selected strip, means for removing a selected strip completely from the array and transporting said strip from the array to said transducer unit, and means for translating the strip relative to said transducer unit in a cyclic manner to present the full length of the strip to the transducer unit during a single cycle of movement of the strip.

29. A random access data storage apparatus comprising in combination a plurality of short compliant strips for storing data representations, means for storing said strips in an array, a transducer unit mounted in a fixed position and operable to transfer data representations to and from a selected strip, and means including a mechanism having a device for removing a selected strip completely from the array and a member for rotating said device and said strip in a cyclic manner relative to said unit whereby data representations may be transferred to and from said selected strip over the full length thereof during a single rotation of the member.

30. A random access data storage apparatus comprising: a plurality of elongated flexible strips for storing data; storage means maintaining the strips in a closely packed array; a read-write station for processing data signal representation on a strip, the read-write station including a rotatable drum and a transducer mounted in a fixed position and spaced slightly from the drum; means for transporting a selected strip to the read-write station; and means for attaching the strip to the drum for presenting the full length of the selected strip to the transducer in a cyclic manner to process data thereon.

31. A random access data storage apparatus comprising: a plurality of elongated flexible strips for storing data; storage means maintaining the strips in a closely packed array; a read-write station for processing data signal representations on a strip, the read-write station including a rotatable drum and a transducer mounted in a fixed position and spaced slightly from the drum; means for selecting a desired strip from the array; means for transporting the selected strip to the read-write station; and means for attaching the strip to the drum for presenting the full length of the selected strip to the transducer in a cyclic manner to process data thereon.

32. A random access information store system comprising, in combination: a plurality of flexible information store strips each in the form of a long generally rectangular strip containing magnetic material for the storage of information therein, one end of each strip being provided with unique respective coded means, a magazine having suspending and releasing means for suspending a set of said strips with the long edges of each strip vertical and for maintaining the strips apart from one another prior to release of a selected one thereof, said suspending and releasing means being constructed and arranged to cooperate with the coded means of said strips so as to permit selective release of any one strip at a time to fall under the influence of gravity regardless of its position in said magazine, a rotating capstan located below said magazine and spaced therefrom by a distance sufficient so as not to interfere with the strips in the magazine, engaging means cooperating with said capstan to cause a strip reaching the immediate vicinity of the capstan to be engaged thereby and to be wrapped around the capstan for rotation therewith, a transducing means located adjacent the capstan periphery so that a strip engaged by said capstan will pass therebetween, removing means cooperating with said capstan and operable to remove a strip from said capstan after at least one passage past said transducing means, guide means for receiving a removed strip and guiding the strip to a location adjacent said magazine, and means at said location cooperating with said suspending and releasing means for returning said strip to said magazine so that the strip will again be suspended from said suspending and releasing means.

33. A random access information store system comprising, in combination: a plurality of flexible information store strips each in the form of a long generally rectangular strip containing magnetic material for the storage of information therein, one end of each strip being provided with unique respective coded means, a magazine having suspending and releasing means for suspending a set of said strips with the long edges of each strip vertical and with the major portion of each strip below said coded suspension means hanging free, said suspending and releasing means being constructed and arranged to cooperate with the coded means of said strips so as to permit selective release of any one strip at a time to fall under the influence of gravity regardless of its position in said magazine, a rotating capstan located below said magazine and spaced from the ends by a distance sufficient so as not to interfere with the strips in the magazine, said capstan further being located so that a released strip will fall to the immediate vicinity of said capstan with the flat portion of its uncoded end adjacent the capstan periphery, engaging means cooperating with said capstan to cause a strip reaching the immediate vicinity of the capstan to be engaged thereby and to be wrapped around the capstan for rotation therewith, a fixed transducing means located adjacent the capstan so that a strip engaged by said capstan will pass therebetween, removing means cooperating with said capstan and operable to permit a strip engaged by said capstan to be removed therefrom by centrifugal force after at least one passage past said transducing means, guide means interposed between said capstan and said magazine and spaced from the place where a released strip is first engaged by said capstan, said guide means being constructed and arranged to receive a strip removed from said capstan by said removing means and to guide the removed strip along a guide path which takes the strip above the suspended strips in the magazine and then guides the strip downwardly to a location adjacent the magazine to bring the thus flipped-over strip to a position spaced from but substantially parallel to its original position in the magazine, and means at said location cooperating with said suspending and releasing means for returning said strip to said magazine so as to again be suspended from said suspending and releasing means.

34. A random access information store system comprising, in combination: a plurality of flexible information store strips each in the form of a long generally rectangular strip containing magnetic material for the storage of information therein, one end of each strip being provided with unique respective coded means, a magazine having suspending and releasing means for suspending a set of said strips with the long edges of each strip vertical and with the major portion of each strip below said coded suspension means hanging free, pneumatic means directed at the strips in said magazine so that they are pneumatically maintained apart from one another prior to release of a selected one thereof, said suspending and releasing means being constructed and arranged to cooperate with the coded means of said strips so as to permit selective release of any one strip at a time to fall under the influence of gravity regardless of its position in said magazine, a rotating capstan located below said magazine and spaced from the ends by a distance less than the length of a strip but sufficient so as not to interfere with the strips in the magazine, said capstan further being located so that a released strip will fall to the immediate vicinity of said capstan with the flat portion of its uncoded end adjacent the capstan periphery, engaging means cooperating with said capstan to cause a strip reaching the immediate vicinity of the capstan to be engaged thereby and to be wrapped around the capstan for rotation therewith, the circumference of the capstan being such that when a strip is wrapped around the capstan a major portion of the capstan periphery will be covered, a fixed transducing means located adjacent the capstan periphery so that a strip engaged by said capstan will pass therebetween, removing means cooperating with said capstan and selectively operable to permit a strip engaged by said capstan to either remain engaged therewith for an additional rotation past said transducing means or to be removed therefrom after at least one passage past said trans-

ducing means, guide means interposed between said capstan and said magazine and spaced from the place where a released strip is first engaged by said capstan, said guide means being constructed and arranged to receive a strip removed from said capstan by said removing means and to guide the remove strip along a guide path which takes the strip above the suspended strips in the magazine and then guides the strip downwardly to a location adjacent the magazine to bring the thus flipped-over strip to a position spaced from but substantially parallel to its original position in the magazine, and means at said location cooperating with said suspending and releasing means for returning said strip to said magazine so as to again be suspended from said suspending and releasing means.

35. The invention in accordance with claim 34 wherein said capstan has apertures in its periphery, and wherein said engaging means includes directional vacuum pressure means about which said capstan rotates, said vacuum pressure means being constructed and arranged so that as the capstan rotates vacuum is applied to that portion of the capstan periphery which is adjacent the place where the flat portion of the uncoded end of a strip falls after release, while essentially no vacuum is applied to that portion of the capstan periphery which is adjacent said transducing means.

36. The invention in accordance with claim 34 wherein said capstan has apertures in its periphery, and wherein said engaging means includes directional vacuum pressure means having a plurality of chambers about which said capstan rotates, the chambers of said vacuum pressure means being constructed and arranged so that as the capstan rotates vacuum is applied to that portion of the capstan periphery which is adjacent the place where the flat portion of the uncoded end of a strip falls after release, while essentially no vacuum is applied to that portion of the capstan periphery which is adjacent said transducing means, the chambers of said vacuum pressure means being further constructed and arranged so that as the capstan rotates the portion of the capstan periphery in the vicinity of said removing means has essentially no vacuum applied thereto at least during the time when a strip begins to be removed from said capstan as a result of the operation of said removing means.

37. The invention in accordance with claim 35, wherein said transducing means is disposed closely adjacent the capstan periphery and is provided with vacuum pressure means for applying vacuum to the transducing region so as to properly position each portion of a strip in the transducing region as it passes thereby.

38. Selector apparatus having, in combination, a stack of cards containing information at a predetermined position thereon, said cards having at predetermined regions thereof card-coding elements, said elements defining different patterns for the respective cards, a plurality of card-holding members adjacent corresponding coding elements and having means for releasably coupling the holding members to coding elements of said cards, code-selective operating means for preventing the coupling of coding elements of a selected card with corresponding holding members, whereby the selected card may be separated from said stack, means for automatically guiding the selected card apart from said stack along a predetermined path and thereafter returning the selected card to said stack, and information-sensing means disposed along said path in alignment with said predetermined card position for scanning the information contained on the selected card as the selected card follows said predetermined path.

39. The apparatus of claim 38, said stack being arranged with said cards upright, said card-coding elements comprising notches defined in the upper edge of said cards, said coupling means comprising means for releasably suspending said cards by notches thereof, whereby the selected card may be dropped from said stack, said card-returning means comprising means for positioning the selected card at one end of said stack with the card-coding elements thereof adjacent corresponding card-holding members.

40. The apparatus of claim 38, said information being arranged in a plurality of parallel tracks on said cards, said sensing means having plural scanning elements aligned with corresponding tracks as the selected card is moved along said path past said scanning elements.

41. The apparatus of claim 38, said coupling means being magnetic.

42. The apparatus of claim 38, said information being stored magnetically and said sensing means comprising a magnetically sensitive pickup.

43. A random access information storage system comprising in combination: a plurality of magnetic strips capable of storing binary digital information and each having coded selection notches provided thereon, magazine means for retaining said strips as an assembled group, means cooperating with said coded notches for selectively displacing a strip from said magazine means irrespective of its position in the assembled group, means cooperating with a selectively displaced strip to cause it to travel to said drum, be engaged thereby, and be wrapped therearound for rotation therewith, a magnetic transducing means adjacent the drum periphery for performing a transducing operation on a strip engaged with said drum as the strip passes thereby, a selectively operable gating means adjacent said drum and operable to permit selective removal of a strip from said drum, means guiding a strip removed from said drum by said gating means back to the vicinity of said assembled group by a return path different from the path taken by the strip in traveling to said drum, whereby strips may travel to and from said drum at the same time without interference therebetween, and loading means in the vicinity of said assembled group for receiving a strip from said last-mentioned means and for returning the received strip back to said magazine means.

44. The invention in accordance with claim 43 wherein a strip position sensing means is located in said return path, and wherein said loading means is responsively coupled to said position-sensing means.

45. A random access information storage system comprising in combination: a plurality of long generally rectangular magnetic strips capable of storing binary digital information and each having coded selection notches provided thereon, magazine means for retaining said strips as an assembled three-dimensional group, means cooperating with said coded notches for selectively displacing a strip from said magazine means through an opening therein irrespective of its position in the assembled group, means cooperating with a selectively displaced strip to cause it to travel to said drum, be engaged thereby, and be wrapped therearound for rotation therewith, only one strip being engaged by the drum at a time and the circumference of the drum being such that when a strip is wrapped therearound a major portion of the drum periphery will be covered, means cooperating with said drum and acting at spaced predetermined locations around the drum periphery for maintaining an engaged strip on said drum by urging continuously changing strip portions of an engaged strip against the drum as the strip portions pass thereby, a magnetic transducing means adjacent the drum periphery and located spaced between two of said spaced predetermined locations for performing a transducing operation on a strip engaged with said drum as the strip passes thereby, a selectively operable gating means adjacent said drum between two of said spaced predetermined locations and operable to permit selective removal of a strip from said drum, whereby an engaged strip may be caused to make a selected number of revolutions on said drum, means guiding a strip removed from said drum by said gating means back to the vicinity of said assembled group by a return path different from the path taken by the strip in traveling to said drum, whereby strips may travel to and from said drum at the same time without interference therebetween, and loading means in the vicinity of said assembled group for receiving a strip from said last-mentioned means and for returning the received strip back to said magazine means through an opening different from the opening from which a selected strip leaves the magazine means.

46. A random access information storage system comprising in combination: a plurality of long generally rectangular magnetic strips capable of storing binary digital information and each having coded selection notches provided thereon, magazine means for retaining said strips as an assembled three-dimensional group, means cooperating with said coded notches for selectively displacing a strip from said magazine means through an opening therein irrespective of its position in the assembled group, means cooperating with a selectively displaced strip to cause it to travel to said drum, be engaged thereby, and be wrapped therearound for rotation therewith, only one strip being engaged by the drum at a time and the circumference of the drum being such that when a strip is wrapped therearound a major portion of the drum periphery will be covered, means cooperating with said drum and acting at spaced predetermined locations around the drum periphery for maintaining an engaged strip on said drum by urging continuously changing strip portions of an engaged strip against the drum as the strip portions pass thereby, a magnetic transducing means adjacent the drum periphery and located between two of said spaced predetermined locations for performing a transducing operation on a strip engaged with said drum as the strip passes thereby, a selectively operable gating means adjacent said drum between two of said spaced predetermined locations and operable to permit selective removal of a strip from said drum, whereby an engaged strip may be caused to make a selected number of revolutions on said drum, means guiding a strip removed from said drum by said gating means back to the vicinity of said assembled group by a return path different from the path taken by the strip in traveling to said drum, whereby strips may travel to and from said drum at the same time without interference therebetween, loading means in the vicinity of said assembled group for receiving a strip from said last-mentioned means and for returning the received strip back to said magazine means through an opening different from the opening from which a selected strip leaves the magazine means, and at least one strip position sensing means adjacent the path of travel of a strip for sensing the position thereof.

47. A random access data storage apparatus comprising: a plurality of elongated flexible strips for storing data; storage means maintaining the strips in a closely packed array; means for selecting a desired strip from the array; a read-write station for processing data signal representation on a selected strip, the read-write station including a rotatable drum and a transducer mounted in a fixed position and spaced slightly from the drum means for completely withdrawing the selected strip from drum; array and transporting it to the read-write station; and means for attaching the strip to the drum for presenting the full length of the strip to the transducer in a cyclic manner to process data thereon.

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