

Sept. 2, 1941.

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2,254,931

CONTROL RECORD FOR ACCOUNTING MACHINES

Filed May 27, 1937

2 Sheets-Sheet 1

FIG.1A.

OBLITERATING MAGNET

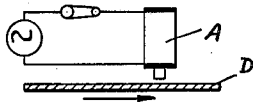


FIG.1B.

RECORDING MAGNET

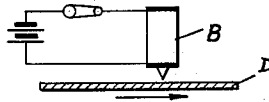


FIG.1C.

READING MAGNET

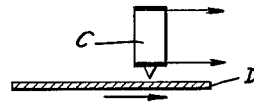


FIG.2.

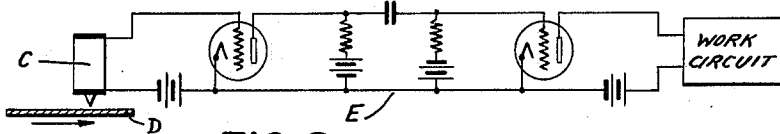


FIG.3.

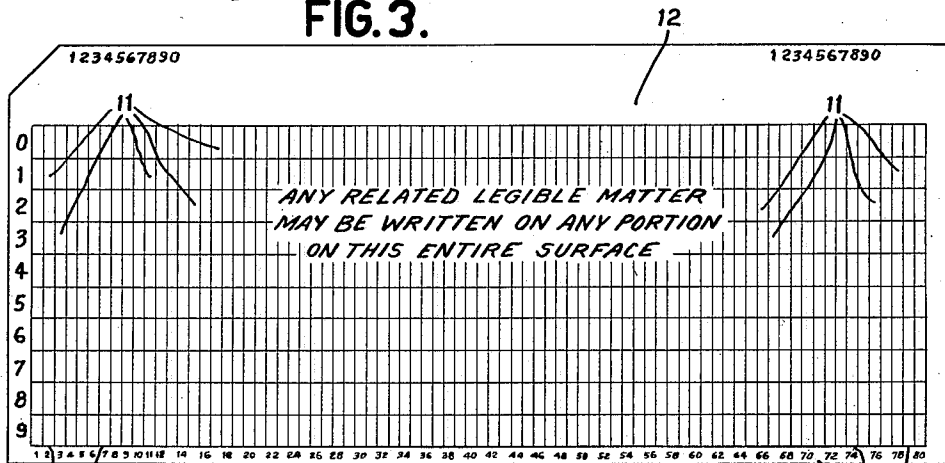


FIG.4.

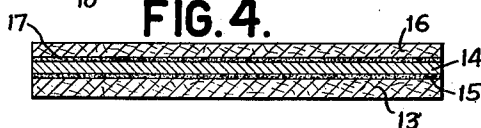


FIG.5.



FIG.6.



FIG.7.

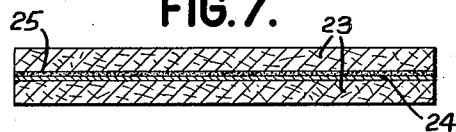


FIG.8.

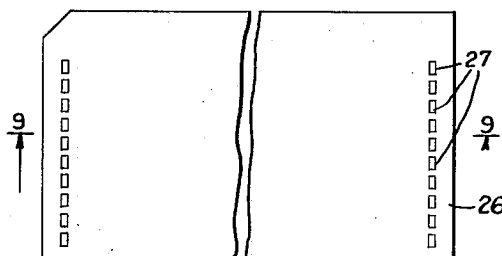


FIG.9.



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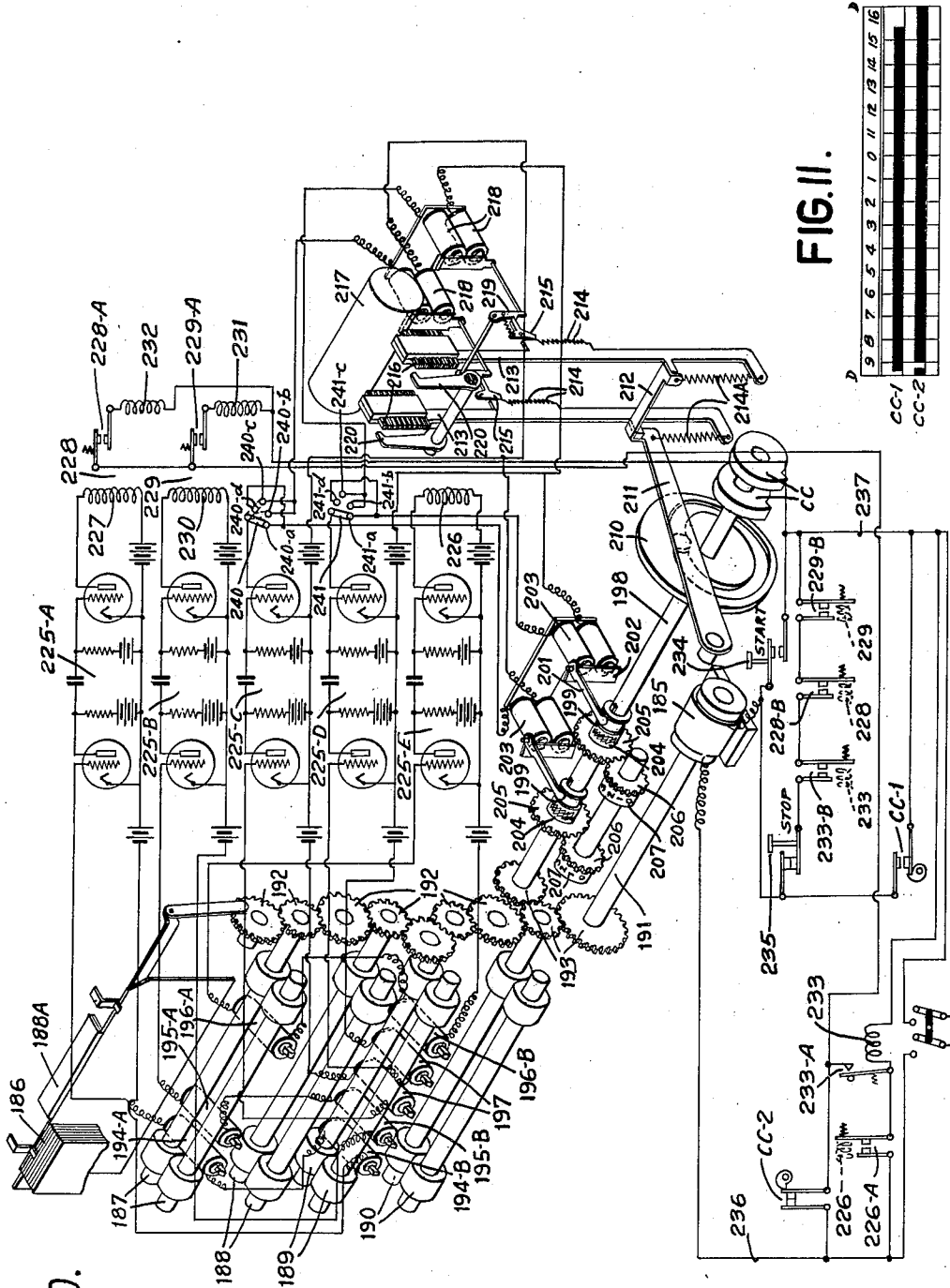
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CONTROL RECORD FOR ACCOUNTING MACHINES

Filed May 27, 1937

2 Sheets-Sheet 2



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2,254,931

CONTROL RECORD FOR ACCOUNTING
MACHINES

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Application May 27, 1937, Serial No. 145,031

1 Claim. (Cl. 235—61.12)

This invention relates to accounting systems, and has for one of its objects the provision of a control system utilizing machine control elements comprising plane surfaces capable of receiving permanent effects from an electric action which effects subsequently are translated into electrical energy to control or operate the machine.

More specifically, an object of the present invention is to provide a system of accounting in which control elements or records are provided with magnetic conditions representing various characterizations and data, and are adapted to be presented to a machine to convert the magnetic conditions on the control elements into electrical currents or impulses to control the machine in accordance with the magnetic indications.

Another object of the invention is to provide a record medium having magnetic conditions disposed thereon in the form of discrete magnetic impressions. In accordance with this provision the data representations to be retained on the control elements may comprise coded discrete magnetic impressions such as differentially positioned magnetic impressions thereon.

Another object of the invention is to provide control elements of the character described having sufficient rigidity, durability, and like characteristics adapting the elements for handling in accounting machines, or, expressed in other words, the control elements must be adapted for and capable of being electromechanically segregated, sorted, and tabulated.

Another object of the invention is to provide control elements having discrete magnetic conditions disposed thereon representing the desired data and having a surface for, or including material for, or comprising material for the reception of legible characters or marks. In accordance with this provision, the invisible index control conditions disposed in the various control areas of the control elements may be identified by corresponding characters or marks legibly recorded on the control elements.

Another object of the present invention is to provide control elements upon which data comprising various characterizations may be recorded in different identifying areas of the elements and capable of permitting the obliteration of the recorded data without affecting or altering the physical appearance of the control elements. In accordance with this provision, various and different data may be recorded on the same control elements repeatedly without deterioration thereof and without impairing the utility of the said

elements, thus, materially increasing the flexibility and adaptability of the control elements in their applications to accounting systems.

Other objects of the invention will be pointed out in the following description and claim and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Figs. 1—A, 1—B, and 1—C show diagrammatically the obliterating, recording, and reading means for detecting magnetic conditions on a record.

Fig. 2 shows an amplifier system including magnetic reading means in the input circuit.

Fig. 3 shows a detailed view of a control element.

Figs. 4 to 9 show detail sections of different forms of control elements.

Fig. 10 shows a perspective view of a tabulating system.

Fig. 11 is a timing diagram for the tabulating system.

Introduction

Before describing the elements of the present system, it is believed advisable briefly to outline the theory of magnetic recording as applied to the control systems in the present invention.

The process of magnetically recording data in the form of discrete magnetic conditions or impressions depends essentially on the phenomenon of magnetic hysteresis and on the associated property that when changes of magnetomotive force are made upon a magnetizable substance a certain remanent flux density is retained by the magnetized substance which is termed "remanence." The intensity of the resultant field in the magnetizable substance depends precisely on the magnitude of the magnetic field acting thereon and the substance of the magnetizable element. The magnetizable substance of the control record for the present purposes should be chosen so that its retentivity characteristic is such that the remanent flux will be retained for an indefinite period of time.

The remanent flux densities retained by the control records may then be effective at a subsequent period to initiate electrical current conditions or impulses which are impressed upon various control circuits to control the operation of the different machines of the present system.

In order to obliterate or efface the recordings on a control record in the form of magnetic impressions, so that new data may be impressed

upon the said record, another property peculiar to magnetizable substances is depended upon, namely, that the conditioned control records are presented to and influenced by an alternating magnetic field of suitable intensity so that not only are the discrete magnetic impressions on the records obliterated but the magnetizable substances of the records are restored to a non-magnetized state so that the remanent flux density throughout the record is reduced to zero value.

It is evident then from the statements just set forth that if the non-magnetized records are subjected to a constant magnetic field so as to impress discrete magnetic impressions thereon, such impressions may be retained thereon for any desired period and that the control records may be employed in that state to control selectively the various accounting machines, and that at any subsequent desired period the recordings may be obliterated without impairing the utility of the control records so as to be in a state or condition so that new magnetic influences may be impressed thereon to represent new characterizations of the desired data.

Referring now to Figs. 1—A, 1—B, and 1—C of the drawings, the method of preparing and utilizing the control records is shown diagrammatically. The first step is to present the control record D to a changing magnetic field created by the magnet A, termed the obliterating magnet. It is preferred in the present case to subject all the record elements to the magnetic field of the obliterating magnet before the data is recorded or impressed thereon; in this manner, it is assured that the magnetizable substances of the elements are restored to a normal, non-magnetized condition. The second step is then to present the control record D to one of the recording magnets B of the record preparing device. It will be described later herein that the record preparing or conditioning device is provided with a plurality of magnets positioned at definite index point positions or areas and that the definite portions of the control record are presented to the recording magnets, so that a selected magnet, upon energization thereof, is effective to create a constant magnetic field which is directed to a particular control area on the record so as to excite the selected or desired identifying area and thus impress thereupon or therein magnetic impressions or influences which are retained by the record.

One of the recording magnets B is shown disposed in close proximity to the record so that a particular identifying area thereof is subjected to the excitation field of the particular recording magnet and thereby impressing upon the record a discrete magnetic impression. Upon removal of the record D from the constant excitation field created by the recording magnet, the control record will retain a certain remanent magnetization, the value of which depends on the magnitude of the magnetic field acting upon the record.

The disposition of the discrete magnetic impression on the record is indicative of a certain characterization of the data desired to be recorded. A plurality of such discrete magnetic impressions may be disposed in a number of various identifying areas to represent various characterizations. It is preferred to arrange the different control or magnetizable areas in columnar arrangement so that each column may be conditioned by magnetic impressions differently positioned in the individual columns.

In order to utilize the records prepared in the manner just described, it is necessary to describe the associated elements adapted to detect the magnetic impressions representing the recorded data, convert the said differentially disposed and discrete magnetic impressions into electrical impulses, and direct the differentially timed impulses by various control circuits to control devices adapted to translate and interpret the various characterizations impressed on the control records. The specific control devices will not be described at this time but a brief description of the method of converting the magnetic influences to electrical currents will be set forth.

Referring now to Figs. 1—C and 2, the conditioned control record D is presented to one of the electromagnets C which will be termed a reading or sensing magnet. As the record is presented to the magnet C and upon detection of a magnetic impression, the remanent flux of the impression is effective to induce a flow of electric current in the magnet itself and the associated circuit. The flow of current induced in the magnet is then conducted to the input circuit of an amplifying system, generally designated at E, and comprises a plurality of thermionic devices of which two are shown connected in cascade employing the resistance coupling type of connection which is well known and need not be described in further detail. The grid circuits of the devices are maintained at a suitable negative bias, and indicated as such by the conventional battery, so that normally no current flows in the output circuit of the system and accordingly the associated work circuit remains normally deenergized. The flow of current induced in the reading magnet and impressed upon the input circuit of the amplifier is of such value so as to reduce the grid bias and thus permit the devices to operate so that the current flow in the output circuit thereof is effective to energize the work circuit.

The work circuit is deenergized immediately when the sensed magnetic impression is positioned away from the reading magnet. In this manner, it is possible to convert the discrete magnetic impressions into distinct current impulses, and depending upon the disposition of the magnetic impressions, the current impulses are created or initiated, as the record is presented to the reading magnet, at various and different times or time intervals.

The specific details of control records suitably adapted for the reception of discrete magnetic impressions representing the data desired to be recorded will now be described, and then followed by the description of various accounting machines suitably adapted to be controlled by the magnetic control records. In order to simplify the following description as much as possible, the principle of the present invention will be applied to various elements which are standard and used at present in the known accounting systems.

Control records

The control records to be described and shown in Figs. 3 to 9 must fulfill certain requirements in order to be adaptable to accounting system processes. The records, of course, must comprise suitable magnetizable substances which, when subjected to controlling magnetic fields and removed therefrom, retain suitable remanent fluxes therein which will be effective to create or initiate current impulses when presented to suitable detecting or sensing devices.

The magnetizable material may be incorporated in or form part of the control record in various ways, for example, (1) the said material may be in the form of a metallic wafer or strip, or individual wafers or strips; (2) or may be in the form of metal powder or filings suitably fixed upon a carrier or base; (3) or a form of colloidal metal and sprayed or coated upon a carrier or base as a metallic coating; (4) or a form of coating or layer of material deposited on a carrier by an electrolytic process; (5) or may be in the form of a granular material such as filings and mixed in suitable paper used as a carrier; (6) or a form of finely divided metal powder incorporated in the pulp before manufacturing the paper carrier or base.

Irrespective of the method employed to form the control records, it is imperative that the records produced be capable of withstanding the stresses to which they are subjected by the rapid and repeated handling of the records in the various accounting machines. It is necessary that the records have sufficient rigidity and durability to be adapted for and capable of being electro-mechanically segregated, sorted and tabulated and withstand the exigencies of repeated operations.

It is also necessary to form the control records so as to be provided with at least one surface to readily receive legible matter such as various characters or marks formed by writing, printing, or typewriting. This requisite is quite important in view of the fact that the magnetic influences impressed on the control records are not visually discernible and therefore the appearance and configuration of the control records remain unchanged; that is, the records appear exactly the same after recording the data thereon as they appeared before recording of the data was effected. In this manner, it is possible to identify the various discrete magnetic influences impressed on the records. Not only is it possible to identify the various recordings by the corresponding characters written or printed on the surface of the records, but also the entire surface, or any part thereof, is free to be used for reception of additional data which it might be desired to include thereon. The latter feature is possible since the surface of the record is not altered or mutilated for the purpose of recording the particular data.

It is evident, too, that subsequent entries of the legible characters may be made upon the surface of the record from time to time. This makes it possible to delete or strike out any of the printed or written characters as desired or add thereto, particularly in view of the fact that the magnetic influences impressed on the records may be obliterated and substituted by new recordings from time to time. Sufficient space on the surface of the card should be available to receive the additional printed or written recording identifying matter in the event it is desired merely to strike out the irrelevant legible matter.

With reference now to the figures, particularly Fig. 3, the control record D represents, in the present instance, a control element of standard size, that is, similar in size to the records for use with accounting machines of the well known Hollerith type, and comprising magnetizable material and having a surface capable of receiving legible characterizations.

The surface of the control record D in the figure is shown to be divided into a plurality of individual index point positions. In practice, it is

to be understood that the index point positions need not be indicated as shown in the figure and that the illustration used is merely for descriptive purposes, since it is impossible to show graphically the magnetic influences impressed in the various control areas.

It is seen that a plurality of columnar areas 10 are provided along the minor axis of the control record D and that each columnar area is subdivided into a plurality of code or index point positions 11, each position representing a certain value or characterization. For example, each columnar area, as shown, is divided into ten index point positions, the values of which increase in value from the top to the bottom of the record. In this respect, the positions are arranged and identified similarly as is the customary and well known arrangement of the Hollerith record. It is to the specific positions 11 where the discrete magnetic influences are directed and impressed in accordance with the data desired to be recorded.

It is evident, therefore, that the statistical information or data are arranged in the form of arbitrary indications coded according to their positions on the record.

The magnetic material may be in such a form or state that it will not readily receive writing or printing, and it is obvious that such a surface must be provided so as to enable the identification of the records and interpretation of the data impressed thereon. The term "writing surface" is meant to include a surface which will readily take impressions from a pencil, pen, typewriter, hand stamp, printing press, or other kindred instrument. In Fig. 3, the entire plan surface of the control record is adapted to be capable of receiving such legible impressions, and, as indicated on the record, the legible indications may be arranged at the head of the columns to interpret the code impressions in the corresponding columns. In addition to the columnar code indications, the remaining surface of the record is available and capable of receiving legible impressions, since the magnetic influences impressed on the record in the various positions do not alter the configuration of the record, and the legible impressions in no way disturb or alter the effects of the magnetic impressions.

It should be mentioned at this time, that in addition to the different positions 11, a space 12 is provided available for the reception of additional magnetic impressions which can be used for various control purposes or in combination with the impressions disposed in the positions 11 to expand the number of code combinations on the records. It is well known that for certain control purposes "11" and "12" index point positions are provided on a control record and in such cases where this is desirable it is possible to impress the discrete magnetic influences to be utilized for control purposes in the "11" and "12" positions for any columnar area 10, in the space 12 designated on the record in the figure.

Referring now to Figs. 4 to 9, different forms of control records comprising magnetizable material will be described, and it is to be understood that each record described hereinbelow can be conditioned in the manner just described and the arrangement of the magnetic influences and legible impressions can be made in accordance with the description set forth in conjunction with the record D in Fig. 3.

In Fig. 4, the record is shown to comprise a carrier or base 13 which may be of paper stock,

although other material, preferably non-magnetic, may be used as a support or backing as long as it is strong and durable and capable of withstanding the stresses to which it is subjected. A wafer or foil of magnetic material 14 is shown secured to the carrier 13 by any suitable bond or cementitious material 15, such as glue. In order to protect the foil or wafer of magnetic material, and also to provide a writing surface for the record, a layer of suitable paper 16, such as mentioned hereinbefore, is provided and secured to the magnetic wafer 14 by a layer of cementitious material 17. The wafer or foil of magnetic material referred to must be made extremely thin, so that recording of discrete magnetized areas can be effected on the homogeneous magnetizable material. It has been found that magnetic recordings of the character referred to herein must be made on relative thinner homogeneous material rather than relative thicker material.

It should be mentioned at this time that it has been found that magnetic lines of force, when suitable coils are used and the proper voltages are applied thereto (depending upon the materials used in the record), will travel through non-magnetic material and cementitious layers generally without hindrance or interruption.

Referring now to Fig. 5, a record is shown to comprise a sheet of suitable non-magnetic material 18 such as paper, which is impregnated with granular magnetic material, generally indicated at 19, such as iron filings. Or, if preferred, the carrier 18 may be made by depositing finely divided metal powder in the paper pulp so as to be incorporated therein before the manufacture of the magnetizable paper stock. The impregnated paper may then be treated and coated on both sides with layers of ink retaining varnish 20. The layers of varnish serve two purposes; (1) to protect the impregnated carrier 18, and (2) to provide a writing surface on the record.

In Fig. 6, the impregnated sheet 18 is shown to be covered with layers of suitable plain paper stock 21 secured to the impregnated stock by cementitious material 22. One of said layers of plain stock 21 should be capable of receiving printing or legible character marks.

In Fig. 7, one of the plies of paper stock 23 is coated with a metallic coating 24 and secured to the other by cementitious material 25. To this end, suitable metal powder or filings may be suspended in any suitable binder and sprayed or coated on one of the plies of paper stock. Colloidal iron may be used and sprayed thereon as a metallic coating.

In Figs. 8 and 9, still another modification is shown to comprise two plies of suitable paper stock 26 and upon one layer individual magnetizable portions 27 are applied thereto. These portions may be coated on the paper stock similarly to the coating 24 described in conjunction with Fig. 7. A stencil plate may be used to cover the paper stock when the coating of the magnetizable material is to be applied thereto, or the portions 27 may be printed thereon similarly as ordinary printed matter. The magnetizable portions are positioned to correspond to the positioning of the fields 11 (Fig. 3). The plies of stock 26 are then secured by the cementitious material 28.

It has been determined, by experiment, that, in cases where homogeneous magnetizable materials are used in control records of the character described (with the exception of the type shown in Figs. 8 and 9), the magnetized index

points or marks cannot be recorded as closely as when powdered or granular magnetizable materials are used. For this reason the last mentioned types of materials are preferred.

It has been shown from the description just set forth how to form control records suitable for use in present day accounting systems and having suitable characteristics such as rigidity, durability, etc., so as to be adapted for and capable of being electro-mechanically segregated, sorted, and tabulated, and comprising (1) suitable magnetizable material so that magnetic influences directed to certain positions thereof are retained by the records, and (2) that a suitable writing surface is provided on the records, the entire surface of which may be utilized for the reception of the legible characterizations.

Tabulating mechanism

The principle of operation of the tabulating mechanism now to be described is based on the fact that the records having discrete magnetic impressions representing the data are presented to suitable reading magnets and the said impressions are detected while the records are in motion to initiate timed impulses in accordance with the disposition of the impressions on the record to control either data accumulating mechanism or data printing mechanism or both; said accumulating and printing mechanisms are adapted to be operated in synchronism with the feeding and sensing of the records so that upon initiation of the timed impulses which control the operation of said mechanisms, the data entered in the accumulating mechanism and the data recorded by the printing mechanism correspond to the coded magnetic data representations sensed.

The tabulating mechanism shown diagrammatically in Fig. 10 comprises generally three units, namely, the record feeding and sensing unit, the accumulating unit, and the printing unit. Each unit is shown diagrammatically as well as the connections between all the units; however, the operation of the units are shown to be operated in synchronism exactly as they are operated in practice at the present time. The disclosure and brief description to follow are believed to be sufficient, in view of the fact that the said units and method of operation thereof are predicated upon the structures shown in U. S. Patent No. 1,976,617, issued to Lake et al., and wherein the units and their operation are explained and described in detail.

In addition to detecting the magnetic impressions on the records, converting them into differentially timed impulses to control the accumulating and listing mechanisms in accordance with the sensed data, it will be shown as the description progresses how the magnetic control elements or records are effective to control the machine in a predetermined manner, for example, preventing further tabulating operations, without physically engaging the control records, whenever the following conditions are existing: (1) the presentation of records to the machine having classification data on successive records which are dissimilar, (2) the presentation of blank or inverted records to the machine, (3) the presentation of records to the machine without specific control indications disposed thereon, and (4) failure of presentation of records to the machine.

Referring now to the figure, and assuming that the control circuits are conditioned so that the circuits to the motor 185 are maintained ener-

gized; records 186 having discrete magnetic impressions disposed differentially in the various columnar areas, are presented singly to the continuously rotating feed rollers 187 by the card picker 188—A, so that the leading edges are moved in cooperation with the rollers and thence downwardly in succession past pairs of feed rollers 188, 189 and 190 to a discharge hopper suitably disposed with respect to the last mentioned rollers. The gearing connecting the feed rollers to the main drive shaft 191 are generally indicated at 192 and 193.

Between the pairs of rollers 187 and 188, a plurality of reading or sensing magnets 194—A, 195—A, etc., are suitably disposed and this reading or sensing position will be referred to as the upper record sensing position; and between rollers 189 and 190, a plurality of sensing magnets 194—B, 195—B, 197, etc., are suitably disposed and will be referred to as the lower record sensing position. The set of magnets 194, 195 and 196 are provided for various machine operation control purposes, whereas the magnets 197 are provided to control the operation of the accumulating and listing mechanisms directly.

The continuously rotated shaft 198 has slidably mounted thereon, but keyed for rotation therewith, a plurality of clutch elements 199, there being one for each denominational order position of the accumulator. The element 199 is provided with a groove in which fits the end of an arm 200 of a suitably pivoted lever 201. The lever 201 is normally held in the position shown by armature 202 of a magnet 203. Upon energization of the magnet, the said armature is attracted thereto, thereby releasing the lever 201 and permitting the clutch element 199 to move into engagement with cooperating teeth 204 integral with a gear 205 loosely mounted on shaft 198. Gear 205, when thus coupled to shaft 198, will rotate a gear 206 which meshes therewith and displace the accumulator index wheel 207.

It is to be understood that the magnets 203 may be energized at various points in the cycle of the machine, depending upon the disposition of the magnetic impressions in the corresponding columnar areas of the record detected by the reading magnets 197. This energization may take place in response to a detection of a magnetic impression in any of the index point positions represented by the accumulator. For example, a magnetic impression in the "9" position will cause the clutch element 199 to be tripped to position the index wheel 207 nine steps before a declutching operation is effected by the machine and an impression in the "1" position will cause the clutch element to be tripped to position the index wheel 207 one step before being declutched. The manner in which the circuits controlled by the magnets 197 in the lower sensing position control the operation of magnet 203 will be set forth hereinbelow. For further detailed description of the accumulating mechanism, reference should be made to the said Lake patent and wherein such well known accumulator operations as, denominational order transfer, restoration of the clutch elements and magnet armatures to normal position, and resetting of the accumulator mechanism, are specifically described.

The printing or listing unit comprises a printing cam 210 shown associated with the shaft 198 and is rotated in synchronism with the record feed mechanism making one revolution for each record fed and analyzed. The member 211 is shown to cooperate with and actuated by a cam

groove in the printing cam so that the printing ball or member 212 is effective to impart an upward movement to the type bars 213 by means of the resilient connection such as springs 214—A between the type bars and the printing member. The type bars 213 are provided with a plurality of ratchet teeth 214 which cooperate with stopping pawls 215 so that the type bars may be interrupted at various positions to present any of their type elements 216 to the printing platen 217 for cooperation therewith.

By virtue of the spring connections 214—A, the bars 213 may be interrupted without interfering with the upward movement of the printing member 212 which has an invariable extent of movement controlled by the cam 210. Energization of any one of the magnets 218 is effective to rock the spring-pressed pivoted latch releasing the associated pawl 215 so that it may swing into engagement with teeth 214 and interrupt the further upward movement of the corresponding type bar 213. The energization of the magnets 218 is controlled by the reading magnets 197 disposed in the lower sensing position which, upon detection of magnetic impressions on the records, will control the energization of the magnets, and due to the synchronization of the type bar travel with the passage of the records by the reading magnets, will present the type elements 216, corresponding to the controlling magnetic impressions, in printing position.

Associated with each type bar 213 is a printing hammer 220 which is positioned to strike the type elements 216 which are in printing position to effect printing therefrom. The printing hammers are actuated immediately after the positioning of the member 211 to the upper extremity of its movement. The detailed operation of the printing mechanism just described is well known and also is completely described in the said Lake patent, so that further disclosure of this unit is deemed unnecessary.

Now as to the method of converting the discrete magnetic impressions into electrical conditions, a complete explanation has been given hereinbefore, that it is deemed sufficient merely to state at this point that during the passage of the record carrier of the magnetic impressions by the reading magnet, the detected impressions induce electrical currents in the magnet, which are then impressed on the input circuit of the resistance coupled amplifier unit, (normally arranged so that no current flows in the output circuit thereof) to initiate current impulses in the output circuit of the amplifier. The amplifiers generally designated 225—A to E in this figure are similar in all respects to the amplifier unit described hereinbefore and the operation of which is now understood.

The different automatic control circuits of the machine governed in their operation by the magnetic records will now be explained. Let it be assumed now that each record presented to the machine is provided with a specific control magnetic impression. It is preferred that this control impression is disposed in the blank space 12 of the record shown in Fig. 3, namely, in the "11" or "12" index point position. It is immaterial which position is chosen, but it is necessary that all the records are consistently provided with the control impression in the chosen position.

As to the columnar area in which the control impression is disposed, any of the said areas on the record may be utilized for this purpose. In the present example, one of the columnar areas

near the edge of the record is used for control purposes, and the associated reading magnets 196—A and B provided to detect solely the control impressions are shown disposed in both the upper and lower sensing positions. In practice, it is preferred not to impress data recordings in either of the columnar areas at the edges of the record, therefore, either columnar area will always be available for the control impressions. However, only one of the columnar areas is to be used for control purposes. It is to be observed that the said reading magnets are connected in series in the input circuit of the associated amplifier unit 225—E and the output circuit thereof is connected to the coil of relay 226.

The purpose of the series connection of the reading magnets 196—A and B is that in order for the amplifier unit to operate so that the connected relay 226 can be energized, it is necessary for both magnets to detect the control magnetic impressions on the record simultaneously. That is, the biasing of the grid circuits of the amplifier 225—E is so arranged that the electrical currents induced by only one reading magnet, either 196—A or 196—B, is not of sufficient value to overcome the grid bias to permit current to flow in the output circuit of the unit. But, the electrical energy induced in the said input circuit by the simultaneous detection of magnetic impressions on the records in both sensing positions is of sufficient value to overcome the grid bias provided to permit current to flow in the output circuit and consequently to energize the relay 226.

Therefore, it is evident that if control records are presented to both sensing positions, and if only one record is provided with a magnetic impression in the chosen control index point position, that electrical energy would be induced in only one of the reading magnets, which, of course, is not of sufficient value to render the amplifier unit operative, and thus the relay 226 would remain unoperated. But, in the event that the records presented in both sensing positions are provided with control impressions in the specified control area, sufficient energy is induced in both the recording magnets to overcome the grid bias, thus permitting current to flow in the output circuit to energize the relay 226.

It is obvious now from the description just set forth that if a blank record is presented to the sensing unit, or if a record having data impressions disposed thereon but not provided with a control impression, that the energy induced in the input circuit of the amplifier unit is not sufficient to render it operative so that under such conditions the relay 226 remains inoperative. Similarly, if an inverted record having a control impression is presented to the machine, one of the recording magnets would remain deenergized during the analyzing cycle, so that relay 226 would under such conditions remain inoperative. It is remembered that it is preferred to maintain the columnar areas near the edges of the records devoid of data recordings, so that whichever area is chosen for the control impressions, the other area will always remain blank, so that in the event inverted records are fed to the machine, no magnetic impressions will be present at any time in the columnar area of the inverted record presented to the control reading magnets. And, of course, it is seen that if further feeding of records to the sensing positions is not effected that the grid bias would maintain control of the

circuit and thus maintain the relay 226 in an inoperative condition.

The reading magnets 194—A and B and 195—A and B are also shown connected in series, respectively, similarly as the magnets 196—A and B. The said magnets 194 and 195 are connected to individual amplifier units 225—A and B respectively in exactly the same manner as the magnets 196 are connected to amplifier 225—E. The operation of the amplifiers 225—A and B is also effected in the same manner as described hereinabove, namely, that if either one of the magnets 194—A or B detects a magnetic impression the energy induced in the input circuit of the unit 225—A is insufficient to overcome the grid bias thereof and thus the coil 227 of relay 228 remains deenergized to maintain the relay 228 inoperative. But, whenever the magnets 194—A and B detect magnetic impressions on the record carriers at the same time the relay 228 is rendered operative. Similarly with the magnets 195—A and B, simultaneous detection of magnetic impressions in the same index point positions renders the associated relay 229 operative, but whenever one or the other of the said magnets detects a magnetic impression, the relay 229 is maintained inoperative. The magnets 194—A and B and 195—A and B control the automatic control circuits which are adapted to keep the machine in operation as long as certain classification data on successively analyzed records are the same.

Let it be assumed that the columnar areas which are adapted to be sensed by the sets of magnets 194 and 195 are provided with the magnetic impressions representing the classification data, and that it is desired to stop further machine operations whenever the classification data in the successively analyzed records are dissimilar. It is seen from the description just set forth hereinabove that whenever the classification data is similar in the said columnar areas of the successively analyzed records, the reading magnets 194 and 195 in both the upper and lower sensing positions detect the coded magnetic impressions and thus cause the relays 228 and 229 to be operated, respectively. However, in the event that the classification data is dissimilar, either, none of the said relays or only one of them is rendered operative. Thus, it is seen that as long as the classification data on successively analyzed records are the same, both the relays 228 and 229 are rendered operative. The purpose and effects of the said relays will be understood as the description progresses.

The motor control and starting circuits will now be explained. It is assumed that the machine is at rest at the normal and well known "D" position and that no records are present in the machine. The start key 234 is now momentarily depressed to establish a circuit to the motor from one side of the line 236 to motor 185, and start key 234 to the other side of the line 237. Shortly after the energization of motor 185 (see timing chart in Fig. 11) the CC—I cam operated contacts (the cams CC are shown to be mounted on shaft 198 rotated directly by the motor) are closed to maintain the motor energized for one cycle, during which the record picker mechanism 188 is effective to feed a single record to the feed rolls 187. The machine comes to rest at the "D" position after this first record feeding cycle, due to opening of the CC—I contacts, with the first record about to pass the upper reading magnets. A second manually initiated cycle then is

effected by depression of the start key, similarly as in the first cycle, the machine is operated for one cycle by virtue of the operation of the CC—1 contacts. At the end of this cycle, the leading record will be about to pass the lower reading magnets and a second record is presented to the first set of rollers 187 by the picker mechanism so that this card is about to pass the reading magnets in the upper sensing position. Now upon initiation of the third cycle by momentary depression of the start key, the leading record will be positioned past the lower reading magnets and the second record will be fed past the upper reading magnets and a third record will be presented to the feed rollers 187 by the picker mechanism. Assuming that the records presented to the sensing positions are all properly conditioned with the specific control impressions and similar classification data impressions, during this cycle and succeeding cycles, it is seen that the relays 226, 228, and 229 are rendered operative by the associated detecting magnets and amplifier units. It should be mentioned at this point that the relays 228 and 229 are each provided with two coils 227 and 232 and 230 and 231, respectively. The coils 227 and 230 acting as the pickup coils of the relays and coils 232 and 231 being the holding coils.

Therefore, upon energization of relay 226, the contacts 226—A are closed to permit the coil of relay 233 to be energized closing the contacts 233—A. A holding circuit is then established from one side of the line 236 through cam operated contacts CC—2, contacts 233—A and coil of the relay to the other side of the line 237. It is seen that cam contacts CC—2 will maintain this holding circuit for the remaining part of the cycle. This relay also closes the contacts 233—B.

Energization of relays 228 and 229 also close the contacts 228—A and 229—A respectively to establish holding circuits for the relays through the cam contacts CC—2 and the holding coils 232 and 231, respectively, to maintain the said relays energized for the entire cycle. Energization of the said relays also closes the contacts 228—B and 229—B, so that now the three contacts connected in series are closed to establish a circuit therethrough and shunting the start key contacts to maintain the motor 185 energized the entire cycle.

As long as the records have the special control impressions properly positioned and similar classification data impressions, the motor remains energized by the circuits described. Near the end of the cycle, cam contacts CC—1 open, but since the said contacts shunt the three contacts in series which are closed at this time, namely 233—B, 228—B and 229—B, the motor circuit is unaffected. The said series contacts are maintained in the operated position by virtue of the CC—2 contacts continuing the holding circuits for relays 228, 229 and 233 during the time CC—1 contacts are open. CC—2 contacts are opened momentarily to deenergize the relays 228, 229 and 233; however, during this timed interval CC—1 contacts are closed and remain so until the relays 228, 229 and 233 are energized to regain control of the motor circuit.

As mentioned hereinbefore the reading magnets 197 provided to detect the coded amount data magnetic impressions are disposed in the lower sensing position, and as the records are fed past these magnets, the differentially positioned magnetic impressions are effective to induce electrical energy in the corresponding reading magnets at the different times the impres-

sions are detected. These currents are then impressed upon the associated amplifiers 225—C and D to energize the connected work circuits. It is to be noted that selectively positionable switch arms 240 and 241 are included in the said output circuits and when positioned so that the contacts —a are engaged the accumulator control magnets 203 are energized. In this manner the magnets 203 are energized at different times in accordance with the differentially positioned amount data magnetic impressions so that the data represented by the impressions are entered into the accumulator.

If, however, the switch arms are positioned to engage contacts 240—b and 241—b, the printing control magnets 218 are energized by the initiated impulses in accordance with the amount data impressions to release the pawls so that the upward movements of the type bars 213 are interrupted to present the type elements 216 to the printing platen corresponding to the data represented by the magnetic impressions.

If it is desired to enter the amount data in the accumulator concurrently with interrupting of the type bars so that accumulation of the data and printing of the data are effected simultaneously during the cycle, the switch arms 240 and 241 are positioned to a third position so as to engage the contacts 240—c and d and contacts 241—c and d respectively. This switching arrangement connects the printing control magnets 218 in parallel with the accumulator control magnets 203 so that the concurrent energization thereof is controlled by the coded amount data magnetic impressions.

Now let it be assumed that a control record properly conditioned with data impressions but with an improperly positioned control impression or devoid of the control impression; due to this condition the control reading magnet 196—A would not have any energy induced therein and thus permit the grid circuits of the amplifier unit 225—E to regain control thereof preventing current flow in the output circuit and causing the relay 226 to be deenergized. Deenergization of the said relay opens the contacts 226—A so that at the time CC—2 contacts open the relay 233 is deenergized to open the contacts 233—B. With the last mentioned contacts open, the motor circuit is deenergized upon opening of the cam contacts CC—1, thereby preventing further machine operations. It is obvious that the operations just mentioned would occur exactly as described, in the event that an inverted record would be presented to the machine for under this condition the control magnet 196—A would not have any energy induced therein and the relay 226 would be rendered inoperative; similarly, if no records would be presented to the machine or more specifically the upper sensing position, this said magnet would remain uninfluenced by any magnetic field so that relay 226 would be rendered inoperative.

In accordance with the customary practice, a stop key 235 is provided so that continued depression of this key too would be effective to deenergize the motor circuit and prevent further machine operations.

It is evident, in case the records presented to the machine have dissimilar classification data, impressions disposed thereon, that either relay 228 or 229 is rendered inoperative, or both may

be deenergized depending upon the disposition of the impressions in the classification columnar areas, so that either contacts 228—B or 229—B or both are opened to render the motor circuit inoperative upon opening of the CC—1 contacts at the end of the cycle, thus preventing further machine operations.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It

is the intention therefore to be limited only as indicated by the scope of the following claim.

What is claimed is as follows:

5 A record element for controlling statistical machines possessing sufficient flexibility and rigidity to render it capable of being handled by statistical machine handling and feeding means, said record comprising a non-magnetic body portion having a plurality of index point positions
10 and carrying discrete areas of magnetizable material at each of said index point positions and having the said discrete areas surrounded by non-magnetic areas.

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