

Oct. 31, 1933.

A. F. SMITH

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AUTOMATIC CONTROL SYSTEM FOR TABULATORS

Filed April 22, 1927

2 Sheets-Sheet. 1

Fig. 1.

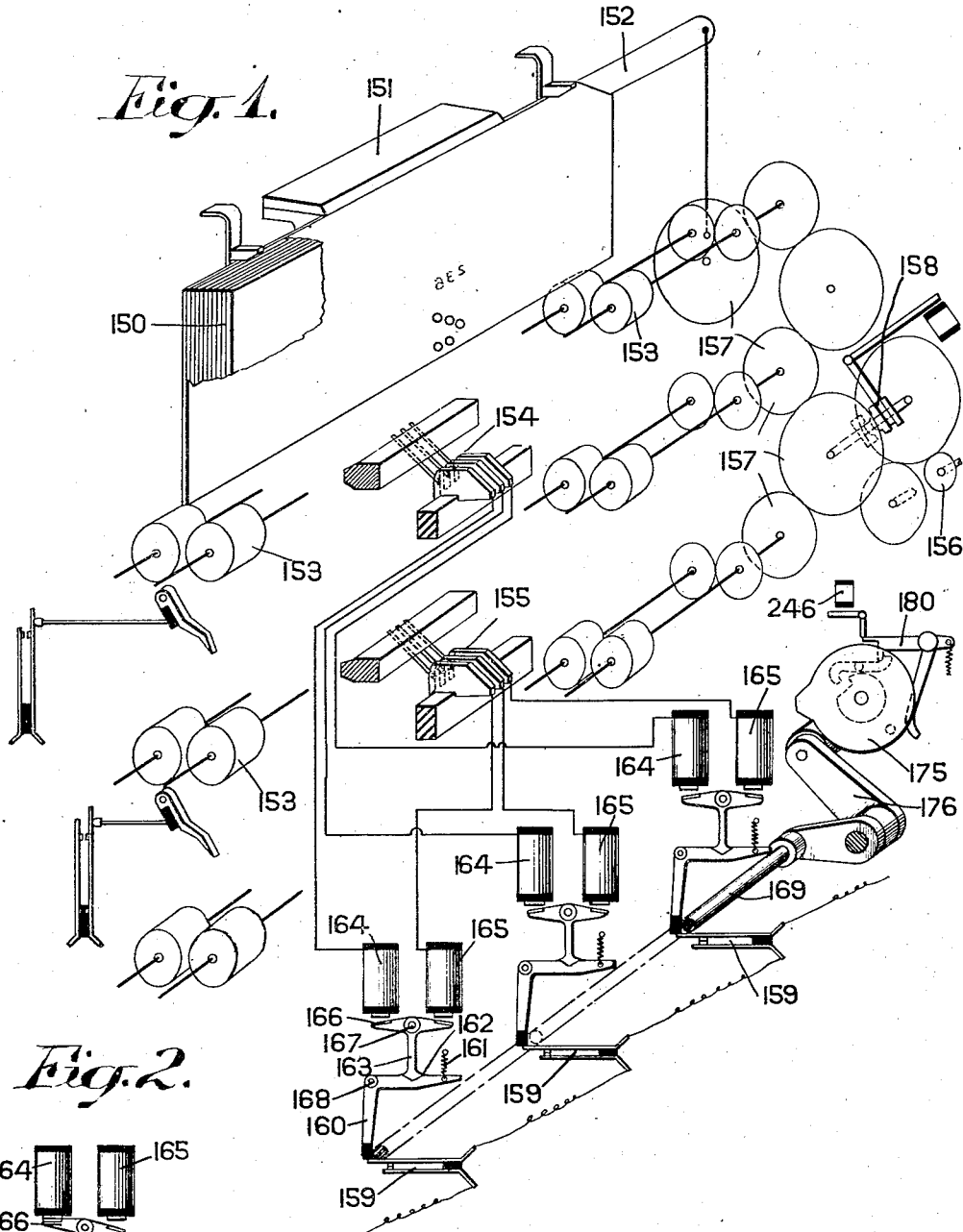
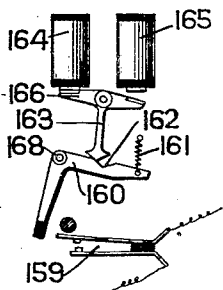


Fig. 2.



Inventor
ARTHUR F. SMITH

By *his Attorney*

W. W. Wilson

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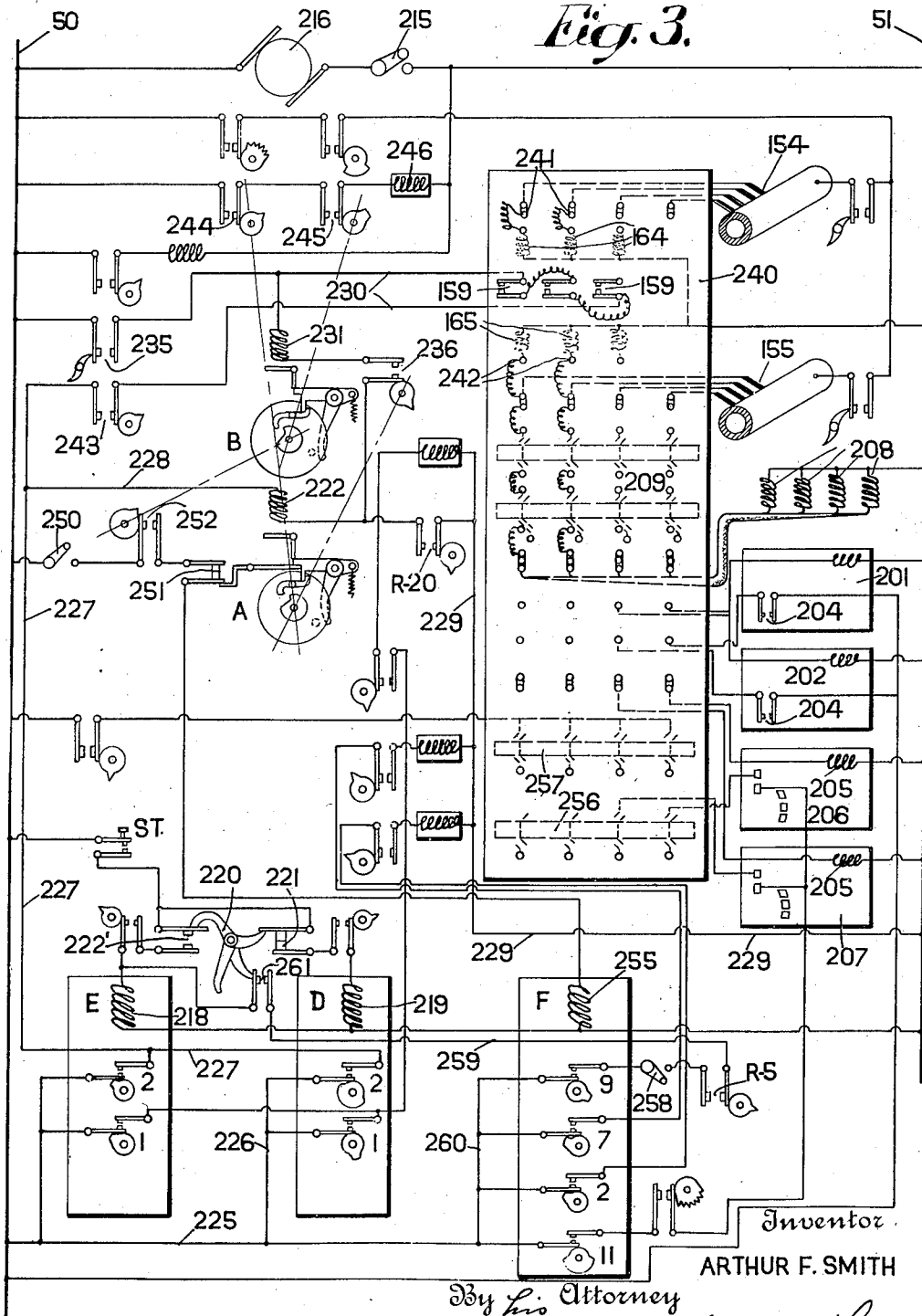
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2 Sheets-Sheet. 2



UNITED STATES PATENT OFFICE

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AUTOMATIC CONTROL SYSTEM FOR
TABULATORS

Arthur F. Smith, Brooklyn, N. Y., assignor, by
mesne assignments, to International Business
Machines Corporation, New York, N. Y., a cor-
poration of New York

Application April 22, 1927. Serial No. 185,718

7 Claims. (Cl. 235-92)

The invention concerns accounting machines and more particularly automatic control systems for record controlled tabulators.

Record controlled accounting machines are designed to add, list and print totals of items automatically entered into the machine from control records on which the items are represented by index point perforations located in differential positions in the several card columns, each column ordinarily representing one character which may be either a number or a letter. There are two systems of representing characters in the card columns. The simpler one consists of representing each character by a single perforation in a column in which case, obviously, the number of characters which may be designated is limited to the actual number of index point positions in the card column. The other system consists in representing a single character by one or more index points in which case the capacity of the card column is enormously increased as each index point position may represent a character by itself and may also enter into combination with any other index point or points in the column to represent a different character.

The cards are fed through the machine automatically and analyzed by suitable mechanism which in turn controls the accumulating and printing devices of the machine, to enter into them the data represented by the perforations on the card. The cards may be analyzed either while they are at rest or while they are in motion, and while the present system is designed for either type of analysis and for either single or combinational perforation systems, it is particularly concerned with combinational perforation analysis while the cards are in motion.

The controlling records are usually divided into groups, the group being represented on each card by similarly located perforations and it is desirable to continue the automatic feeding of the records to the analyzing mechanism as long as the group does not change but to interrupt the card feed for the purpose of taking totals or performing other operations when the group changes. This is ordinarily accomplished by providing two sets of analyzing devices which are spaced apart so that one card feeds to one of them as the preceding card feeds to the other so that the same index point positions on successive cards are under the two analyzing mechanisms simultaneously.

Tabulators which analyze and control with the records in motion are ordinarily of the electrical type and the analyzing mechanism consists of

brushes cooperating with individual contacts. The cards are fed between the brushes and their cooperating contacts to hold an electric circuit open as long as there are no perforations in the card but to permit engagement of each brush with its cooperating contact through the card when it encounters a perforation on the card.

In machines of the moving card type a single row of brushes usually suffices to completely analyze each card, these brushes, of course, searching the several index point positions at differential times and differentially controlling the adding and printing mechanism to enter items therein according to the differential time at which the circuit is made at the analyzing brushes. The automatic control system may consist of a circuit including the two sets of analyzing brushes in series and if the cards under the two sets of brushes contain identical controlling perforations this circuit will be closed at some time in the machine cycle serving to keep the card feed active to feed another card during the succeeding card feeding cycle. If the controlling perforations are not identical in successive cards, this series circuit fails to make and the machine either stops or automatically takes a total of the data entered into the accumulators. This system, however, is limited ordinarily to the simpler system of character designation in which each character consists of a single index perforation.

The present invention contemplates a system of automatic control which may be used to analyze cards either in motion or at rest and of either a single or combinational system of character designation. The control circuit which determines whether or not the machine shall feed cards during the succeeding card feeding cycle is controlled from a system of magnets, two magnets being provided for each controlling card column one of which is wired independently to each of the analyzing brushes for a given card column. These magnets cooperate with a balanced armature construction which serves to hold contacts in the control circuit closed if both magnets are energized at the same time or if neither are energized but effects opening of the contacts if one magnet is energized while the other is deenergized. As the cards feed beneath the analyzing brushes the controlling contacts associated with each controlling card column will remain closed as long as the card column is identical on successive cards as in this case at every instant during the cycle the two magnets will either both be energized or both be deenergized.

If the controlling perforations are different in the given column of two successive cards, at some time in the cycle the circuit of one of the magnets will be closed through a card perforation while the circuit of the other remains open, thus permitting shifting of the balanced armature structure to open the contact in the control circuit. The machine will thereupon either stop after entry of the data from the card under the lower brushes or institute total taking.

The two sets of control brushes according to the present invention may furthermore be of the same electrical polarity whereby either set may be used for printing or adding control if desired.

The principal object of the invention is to provide an automatic control system for record controlled accounting machines which is adapted to control machine operation either in accordance with a single or combinational hole character designations and to provide new and improved construction and arrangement of parts for this purpose.

Another object of the invention is to provide an automatic control system for record controlled accounting machines which is adapted to control machine operation in accordance with either a single or combinational hole system while the records bearing the designations are in motion.

Another object of the invention is to provide an automatic control system for record controlled accounting machines in which a single row of analyzing devices is provided in each analyzing mechanism for analyzing either single or combinational hole designations.

Another object of the invention is to provide an automatic control system for record controlled accounting machines which is adapted to control the machine operation from single or combinational hole designations on records in which each analyzing mechanism consists of a single row of analyzing devices which successively search each index point position for possible controlling designations.

A further object of the invention is to provide an automatic control system for accounting machines which is adapted to control machine operation from cards in motion by making an absolute comparison of the cards and controlling the operation in accordance with like or unlike card columns.

These and other objects which will be pointed out hereinafter will be clear from the following detailed description which should be read in connection with the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of the control system in combination with a tabulator card feed.

Fig. 2 is a detail of the balanced armature structure with its cooperating magnets and

Fig. 3 is a circuit diagram of a machine to which the automatic control system has been applied.

While as stated above the system is applicable to existing machines operating either on stationary or moving cards and in connection with single or combinational index point designations, it has been shown as applied to a machine of the combinational index point type in which the cards are adapted to be analyzed while in motion. The particular machine utilized for the purpose of illustration is that disclosed in the copending application of Carroll Serial No. 185,711 filed April 22, 1927, now Patent No.

1,726,539, dated September 3, 1929, to which reference should be had for a full explanation. The particular type of machine does not enter into the present invention as any other machine in which combinational hole cards are analyzed while in motion would serve the purpose of explanation equally well.

Referring now to Fig. 1 of the drawings, a stack of cards to be analyzed is indicated at 150 which are adapted to be advanced by a picker 151 operated by an arm 152 into cooperative relationship with feed rolls 153. The picker feeds one card at a time to the rolls 153 which advance it during one machine cycle to the upper or control analyzing brushes 154 and during a later machine cycle to the lower or adding analyzing brushes 155. The rolls and feed mechanism are driven from a shaft 156 rotated by a suitable motor (not shown) and a gear train indicated generally at 157. A card feed clutch mechanism indicated diagrammatically at 158 is interposed in the system to effect card feed only at given times as is customary in machines of this nature.

The automatic control circuit of the machine includes a plurality of series connected contacts 159 any number of which may be connected in series to control from any desired card columns. Each pair of contacts 159 is normally held closed by a pivoted bell crank 160 urged to circuit closing position by a spring 161. The bell crank 160 is provided with a notch 162 into which fits the end of an extension 163 on the common armature structure for two magnets 164 and 165. As long as both magnets 164 and 165 are energized or both are deenergized, the armature structure 166 remains in neutral position as shown in Fig. 1 being held here by the action of spring 161.

Energization of either magnet 164 or 165 without coincident energization of the other causes the armature structure 166 to turn about its pivot 167 removing the end of extension 163 from the notch 162 and rotating the bell crank 160 about its pivot 168. When so rotated the arm or bell crank releases the contacts 159 permitting them to open under their own resiliency as shown in Fig. 2. The energization of the magnet which causes this action is instantaneous but the bell crank 160 cannot reengage over the upper contact 159 as will be clear from the location of parts in Fig. 2. The control circuit when opened at any one of the contacts 159 then remains open until it is restored by a common ball 169 which is rocked through a cam 175 and bell crank 176 one of whose arms carries the ball.

The cam 175 may be made to rotate when the restoring action is necessary by a one revolution clutch or similar mechanism illustrated diagrammatically at 180. This clutch is controlled by a magnet which will be energized after all necessary operations have been performed in connection with the last card of the group which is now under the lower brushes. Consequently all the contacts 159 will be closed at the beginning of each cycle in which cards are actually fed.

The magnets 164 are connected directly to the upper analyzing brushes 154 and the magnets 165 are connected directly to the lower analyzing brushes 155. As long as the perforations in the card columns agree or even if there is no perforation in a given card column of the cards under the upper and lower brushes, the magnets 164 and 165 in connection with that column will either by deenergized or energized at the same

time permitting the armature structure 166 to remain in the position shown in Fig. 1 closing the corresponding contacts 159. As soon as one of the analyzing brushes 154, 155 encounters a perforation at a time when the other does not encounter a perforation one or the other of the magnets 164 or 165 will be energized to rock the armature structure 166 opening the corresponding contacts 159. The automatic control circuit is thus opened and remains open until restored by the bail 169 causing the machine either to stop or begin automatic totaling as desired.

The application of the automatic control system to a combination hole machine, in which cards are analyzed while in motion, will now be explained in connection with Fig. 3 of the drawings. The circuit diagram is a simplified version of that shown in the copending application and patent of Carroll, referred to above, and as it is merely used to illustrate the cooperation of the control system with a combinational hole machine will be very briefly described, except in so far as the operation affects the automatic control system. One card in this machine is fed to the lower brushes 155 during one machine cycle and its hole or perforation combinations are analyzed and set up in translators 201 and 202, which are suitably plugged to the lower brushes for this purpose. The card feed is then automatically suspended for two machine cycles. Three printing cycles correspond to these card cycles for each card, during each of which set ups for certain definite characters effect closure of translator contacts 204. These contacts may be plugged to the counter magnets 205 of accumulators 206 and 207 and to printing control magnets 208 through the usual adding and listing switch bar 209 and the closure of the contacts for each combinational set up is timed to enter numbers corresponding to the set ups into the accumulators and to energize the printing magnets 208 at the proper time to select the type members for printing either numbers or letters of the alphabet corresponding to the set ups. The use of three machine cycles for printing all characters which may be represented on a card is necessitated by the particular arrangement of machine elements and does not affect the present invention, although this peculiar operation should be borne in mind to aid in an understanding of the control system as applied to this machine.

The machine is started into operation by closing the switch 215 to connect the driving motor 216 directly across the main lines 50 and 51. The motor then starts operating to drive the mechanical elements of the machine. The start key ST is then depressed to initiate card feed. The closure of the start key contacts effects energization of either the E timer starting coil 218 or the D timer starting coil 219. If no card is under the upper brushes an upper card lever 220 will be in the position shown in the drawings, allowing the closing of contacts 221 to select the D timer, while if a card is under the upper brushes the lever 220 will shift to an alternative position opening contacts 221 and closing contacts 222 to select the E timer. These timers comprise a number of contacts which open and close in predetermined sequence to energize the starting control circuits of the machine. If the D timer starts in operation its contacts D—2 close for two full machine cycles closing a circuit to the main or A card feed clutch magnet 222 as follows: From line 50 through wires 225 and

226 to timer contacts D—2, thence through wires 227 and 228 to a card feed clutch magnet 222 and through regular cam contact R—20, closed at the proper time in each cycle, to common return. 229 and back to the other line 51. The energization of the A clutch magnet effects clutching operation of certain card feed clutch mechanism to feed the first card from the magazine to the upper brushes during one machine cycle and to the lower brushes during the following cycle.

If there should be a card under the upper brushes at the time of depression of the start key ST the E timer will start in operation, its starting coil 218 being energized through a circuit similar to that traced above for the D timer. In this case the E timer contact E—2 will close to energize the A card feed clutch magnet 222 during one full card feeding cycle only to feed the first card from the upper to the lower brushes. In either case the control of the A clutch magnet 222 is shifted from the timer contact to the automatic control circuit 230 when the first card reaches the lower brushes.

Before explaining the operation of the latter circuit, however, the function of the auxiliary or B card feed clutch which is controlled by the magnet 231 will be briefly considered. The magnet coil 231 is in series with a pair of upper card lever contacts 235 and a pair of contacts 236 operated by a cam of the shaft of clutch A and closed during the early part of each revolution of this shaft. Whenever there is a card under the upper brushes the contacts 235 close and if the A card feed clutch starts in operation the contacts 236 close and energize the B clutch magnet 231 starting the B clutch in operation. When the A and B card feed clutches operate together the card feed is modified so that each card feeds to the lower brushes during one machine cycle and then card feed is suspended for two cycles, after which the next card feeds to the lower brushes and so on. Furthermore when the B clutch once starts in operation it remains in operation for three machine cycles and causes the A clutch to do likewise, whereupon the cycle during which a card is fed to the lower brushes is always followed by two machine cycles in which no cards feed. This explains briefly the operation of the Carroll machine with the exception of the operation of the automatic control system which will now be explained in detail.

The magnets 164 and 165 and their contacts 159 are mounted on the main switchboard 240 of the machine. One terminal of each magnet is connected to the line 51 and the other terminals are connected to individual sockets 241 and 242, respectively, so that any magnet 164 may be plugged to any upper brush 154 and the coacting magnet 165 to the corresponding lower brush 155. In the drawings the two left hand pairs of magnets Fig. 3 are shown plug connected to the two right hand pairs of upper and lower brushes to control from the two card columns traversed by these brushes. The control contacts 159 each terminate in individual sockets whereby any number of them may be connected in series in the automatic control circuit 230 and in the drawings the contacts operated by the two left hand pairs of magnets are so connected.

When the control of the A card feed clutch magnet 222 shifts from the starting timers to the automatic control circuit, as is the case when the machine attains normal running conditions, the energizing circuit of this magnet extends as follows:

from line 50 through upper card lever contacts 235 and automatic control circuit 230, including the contacts 159 in series, to CFA contacts 243, closed at the proper time in each machine cycle as long as the A clutch is engaged, thence through wire 228 to clutch magnet 222 and through cam contacts R—20 and common return 229 to the other line 51. The B clutch is independent of the automatic control circuit, its starting pulse every three cycles as before being controlled by the upper card lever contacts 235 and the CFA contacts 236. As long as the cards under the upper and lower brushes agree in their control perforations the contacts 159 remain closed and the A clutch magnet is energized at the proper time to feed each new card of the group to the upper brushes. When the card group changes the new card feeding under the upper brushes does not agree in its control perforations with the last card of the old card group now under the lower brushes and consequently one or more pairs of the series connected contacts 159 opens and remains open until positively restored. The B clutch as explained above provides for two blank machine cycles during which the data on the last card of the group may be accumulated and printed. At the end of these two cycles the automatic control circuit being still open the A clutch magnet 222 fails to energize and the A and B clutches disengage interrupting the normal card feed.

Toward the end of each third cycle during the operation of the A and B clutches CFA contacts 244, controlled from the A clutch shaft, and CFB contacts 245, controlled from the B clutch shaft, close concurrently and energize magnet 246 which controls the one revolution clutch 180 (see Fig. 1) rotating the cam 175 to operate the bail 169 and restore any open control contacts 159. This restoring action is timed, of course, after the opening of the cam contacts R—20 in the circuits of the A and B clutch magnets 222 and 231 so that the card feed ceases at the end of the cycle although the contacts 159 are closed for automatic control on a subsequent card group.

Automatic totaling at the end of each card group may be provided for by closing automatic total switch 250. Shortly before the A clutch shaft comes to rest the contacts 251 close and remain closed, and shortly after this the CFB contacts 252 controlled from the B clutch shaft close and open again. The instantaneous closing of these CFB contacts energize the starting coil 255 of the total timer F whereupon the contacts of the latter close in proper sequence and control the total switch bars 256 and 257 to effect total printing from the accumulators as fully explained in the copending Carroll application.

Accumulating and listing from the cards of the succeeding group may be automatically resumed at the end of total taking by closing the automatic start switch 258. After completion of the total taking operations the total timer contacts F—9 close and establish a circuit through the E timer starting coil 218 as follows: From line 50 through wires 225, 260 and contacts F—9 to switch 258, thence through regular cam contacts R—5 and wire 259 to contact 261, closed by upper card lever 220 as long as there is a card under the upper brushes, and thence through E starter coil 218 to the other line 51. The energization of the E timer starter coil starts this timer in operation to initiate operations on the next card group as explained above.

The invention has now been described in con-

nection with a single operative embodiment thereof but it will be understood that many modifications will readily occur to those skilled in the art without departing from the spirit of the invention. For example, the system could readily be applied to a combinational hole machine in which each card was analyzed and the data thereon accumulated and printed in a single machine cycle in which case the restoring bail could be made operative to restore the automatic control contacts at the end of each machine or card feeding cycle instead of at the end of three card cycles as in the present case. I intend to be limited, therefore, only as indicated by the scope of the following claims.

What is claimed is as follows:

1. An automatic control system for a record controlled machine comprising analyzing mechanism including a single brush for successively sensing index points in a column of a controlling record and a single brush for synchronously sensing index points in a column of a succeeding record, a separate circuit controlled by each brush and a magnet in each circuit, a common armature structure associated with the cores of the magnets, mechanical means for balancing the armature, and means operated by said balancing means when one magnet alone is energized to determine a different type of machine operation.

2. An automatic control system for a record controlled machine comprising analyzing mechanism including a single brush for successively analyzing index points in a column of a controlling record, and a single brush for synchronously sensing index points of a column of a successive record, a separate circuit controlled by each brush and a magnet in each circuit, a common balanced armature structure associated with the cores of the magnets, and mechanical means for holding said armature in balanced position and shifted in the same direction by said armature irrespective of either of which magnet is energized alone.

3. In a machine of the class described, a plurality of card reading circuits, a magnet in each circuit and both energized when perforations in successive records agree and only one energized when there is a disagreement in the perforations of successive records, an armature correlated with both magnets and shiftable in one direction when one magnet is energized alone and shiftable in another direction when the other magnet is energized alone, machine controlling contacts, mechanical means for holding said armature in balanced position and controlling said contacts, and means intermediate said holding means and armature for shifting said holding means in the same direction irrespective of the direction of movement of the armature.

4. In a machine of the class described, a plurality of magnets, record controlled means whereby either magnet is energized alone when designations of successive records disagree, a mechanically balanced armature correlated with both magnets and arranged to be shifted in either of two directions depending upon which magnet is energized alone, and a machine control device operated in a single direction by either directional movement of the armature.

5. In a machine of the class described, a plurality of magnets, means under control of successive records for effecting energization of either of said magnets alone when record perforations disagree, a balanced armature structure associated with said magnets, mechanical means for balancing said armature, and a machine control

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device operated by the balancing means when either magnet is energized alone.

7. In a machine of the class described, a pair of magnets, an armature pivotally balanced between said magnets and having a depending portion provided with diagonal cam edges, an arm having a diagonal notch received by the cam edges, and record controlled means for controlling the energization of said magnets either singly or collectively.

ARTHUR F. SMITH.

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