July 4, 1944. C. D. LAKE ET AL 2,353,046

CARD PUNCHING MACHINE

Filed July 29, 1943 13 Sheets-Sheet 1

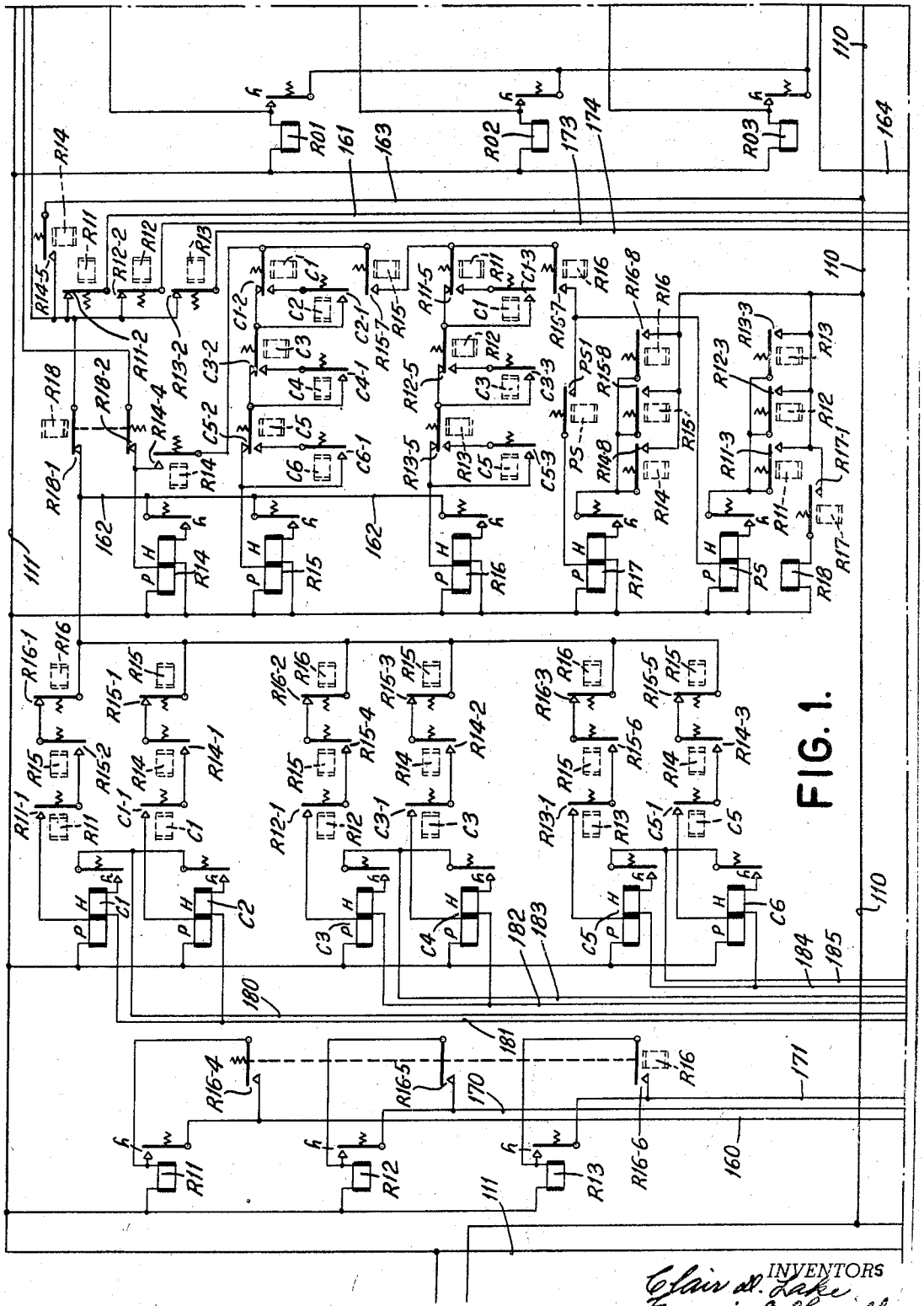

FIG. 1.

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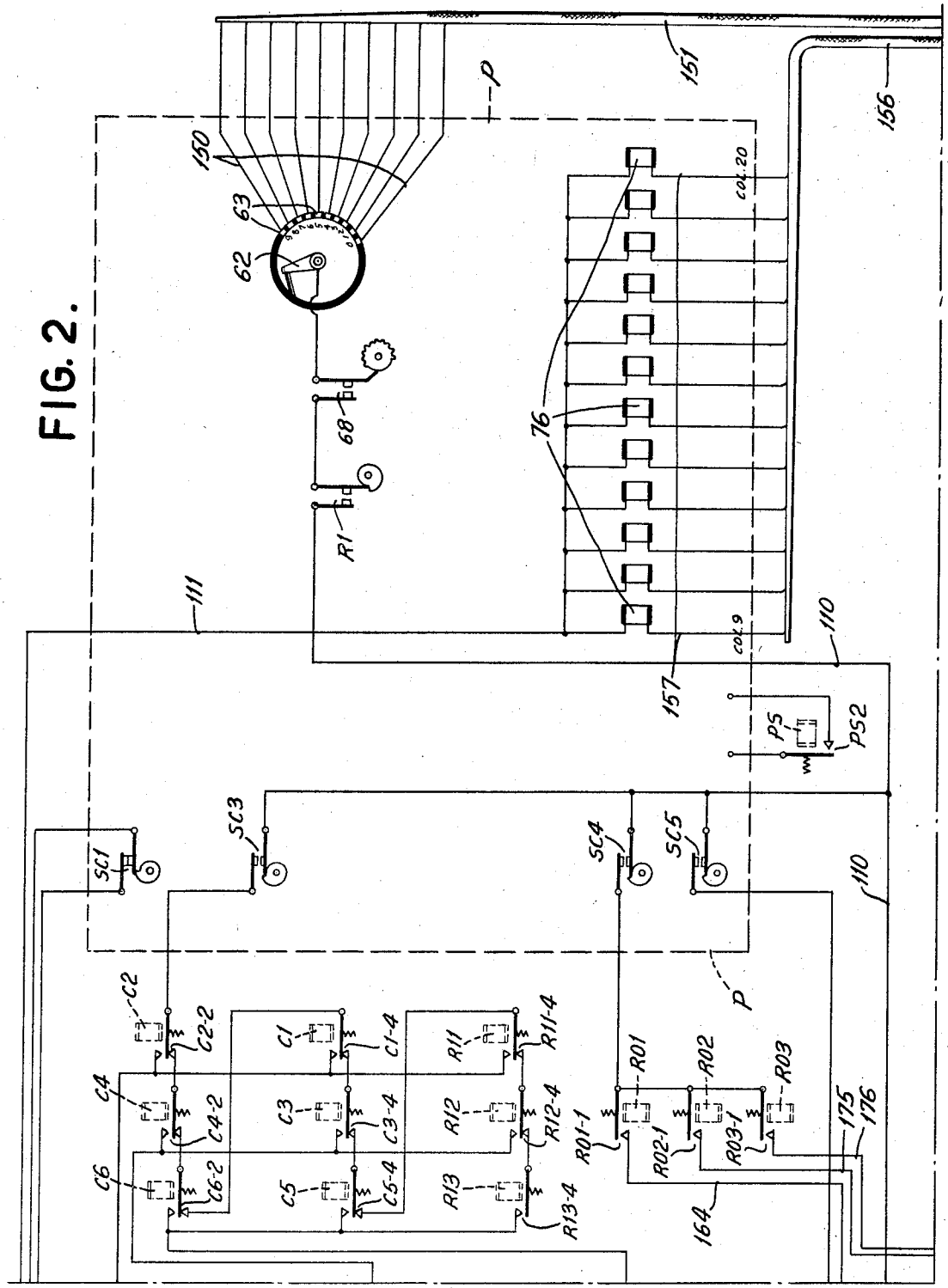
CARD PUNCHING MACHINE

Filed July 29, 1943 13 Sheets-Sheet 2

FIG. 2.



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CARD PUNCHING MACHINE

Filed July 29, 1943 13 Sheets-Sheet 3

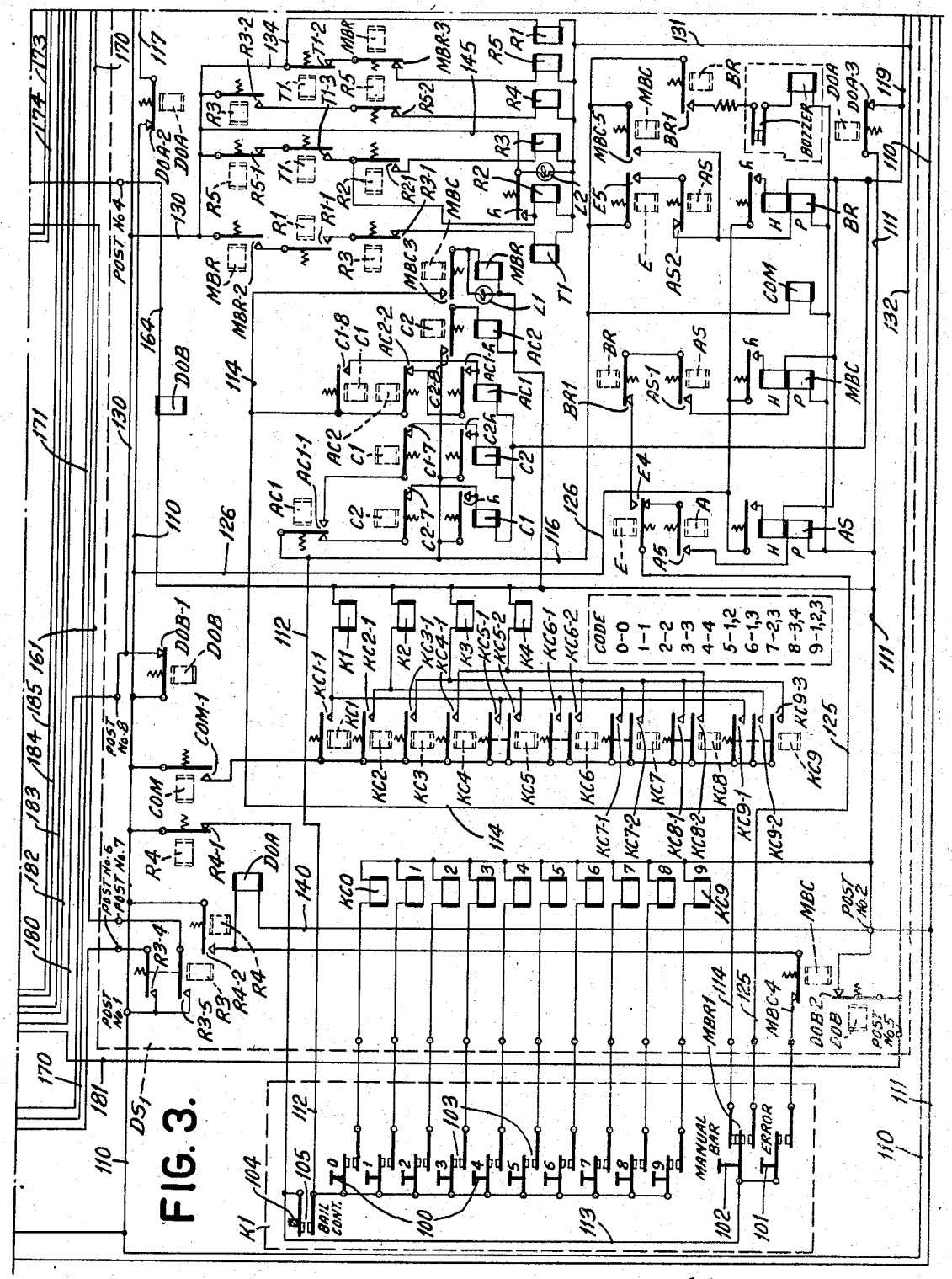

FIG. 3.

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CARD PUNCHING MACHINE

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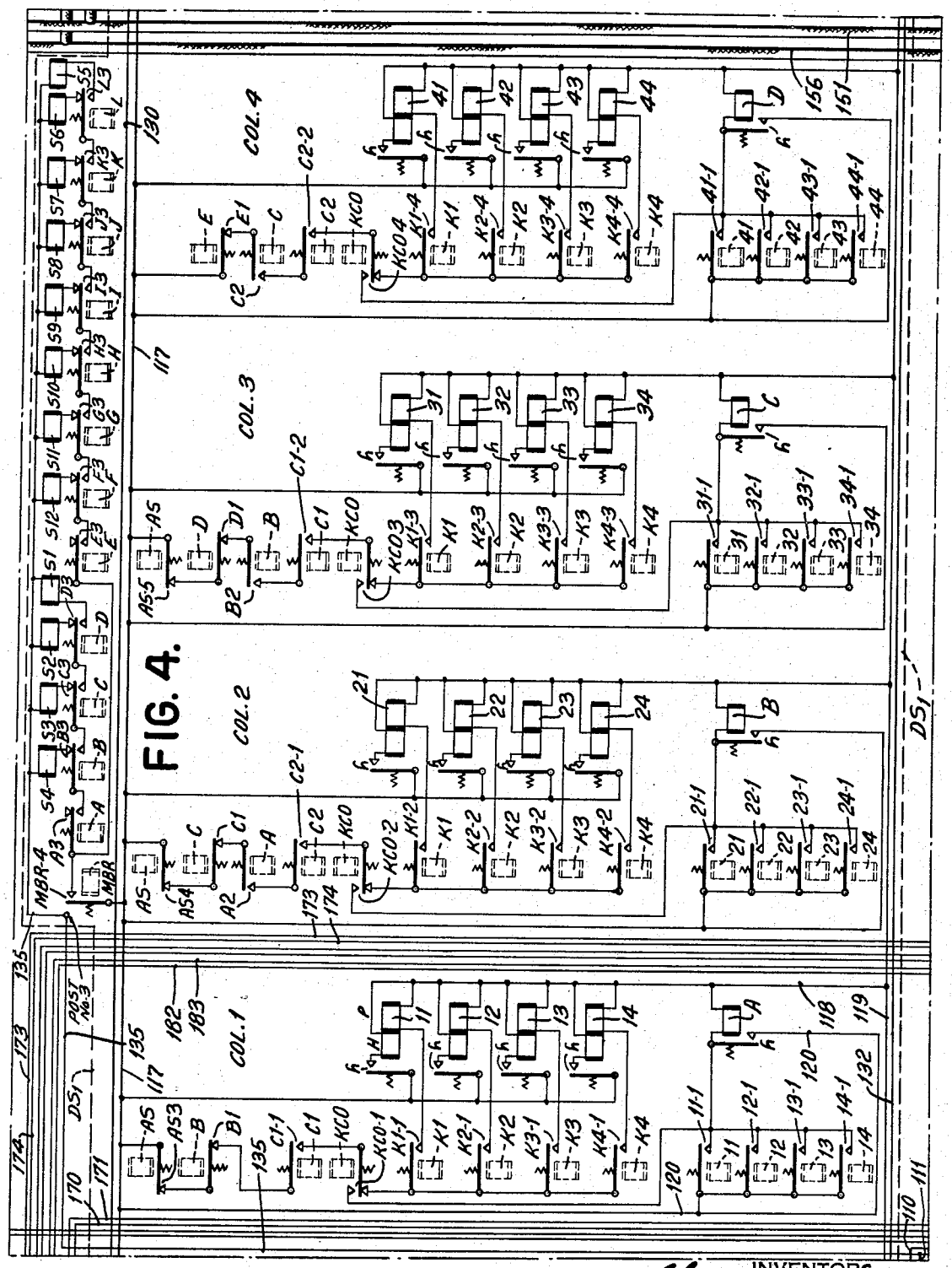

FIG. 4.

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CARD PUNCHING MACHINE

Filed July 29, 1943 13 Sheets-Sheet 5

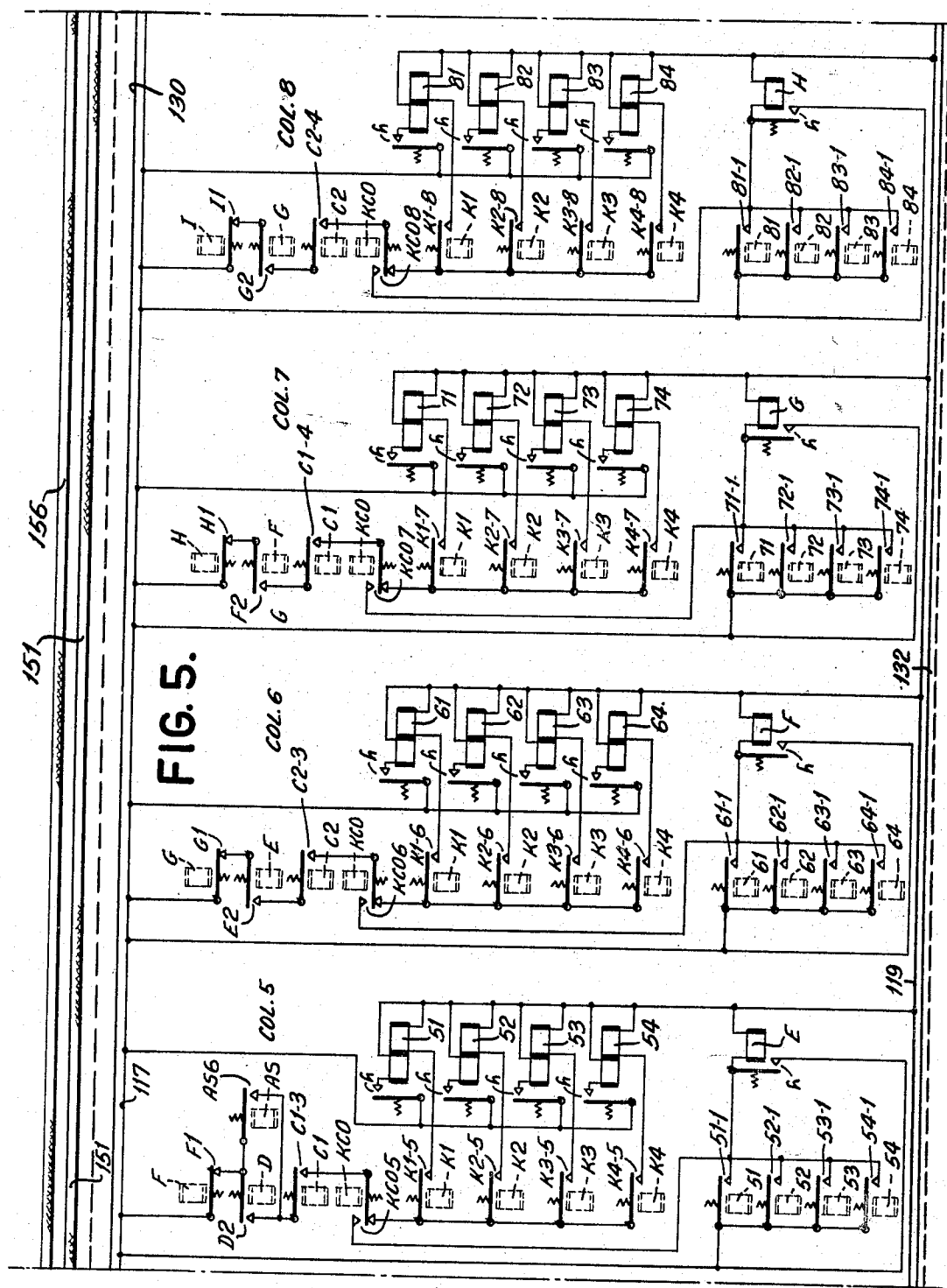

FIG. 5.

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CARD PUNCHING MACHINE

Filed July 29, 1943 13 Sheets-Sheet 6

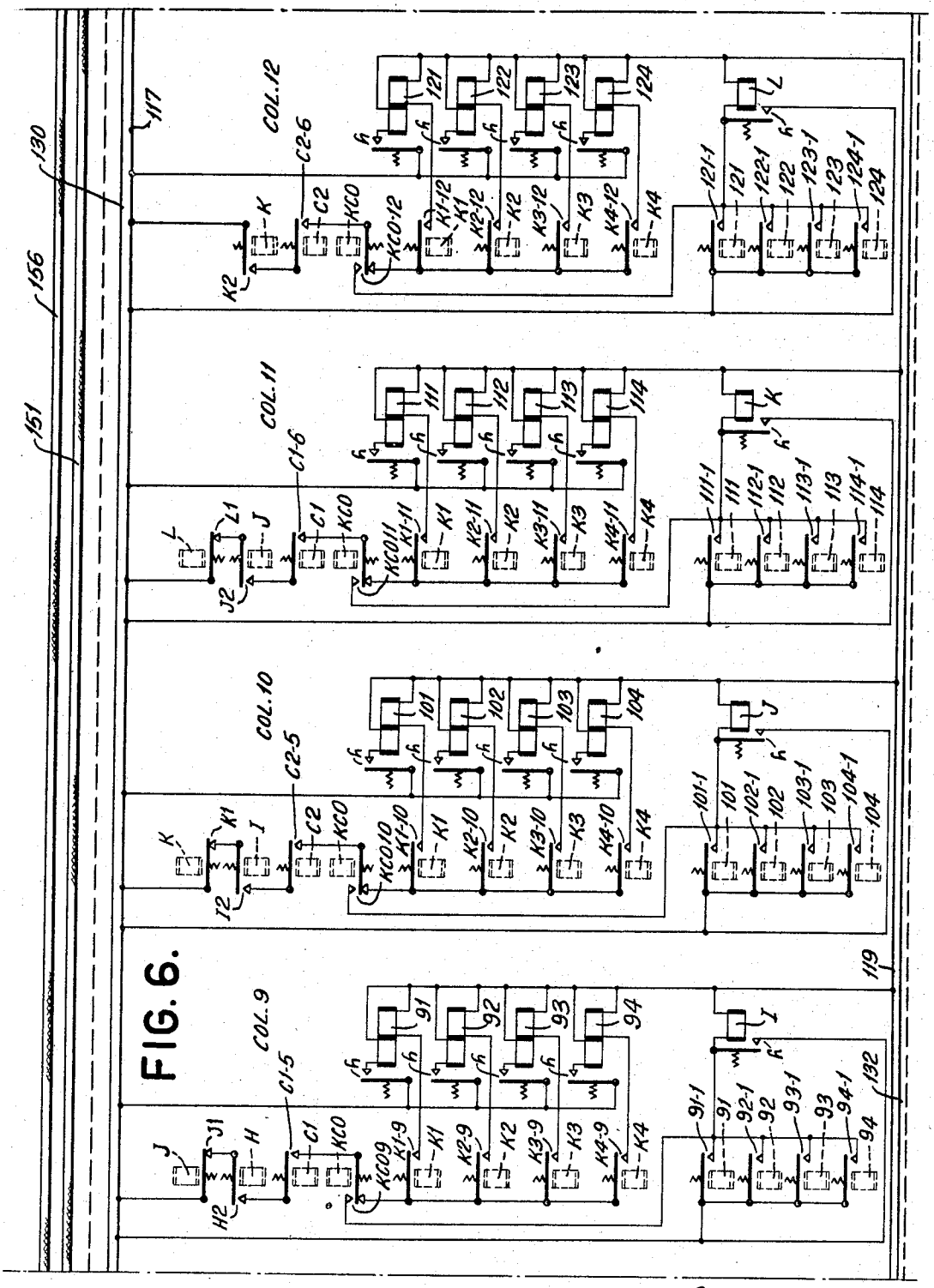

FIG. 6.

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CARD PUNCHING MACHINE

Filed July 29, 1943 13 Sheets-Sheet 7

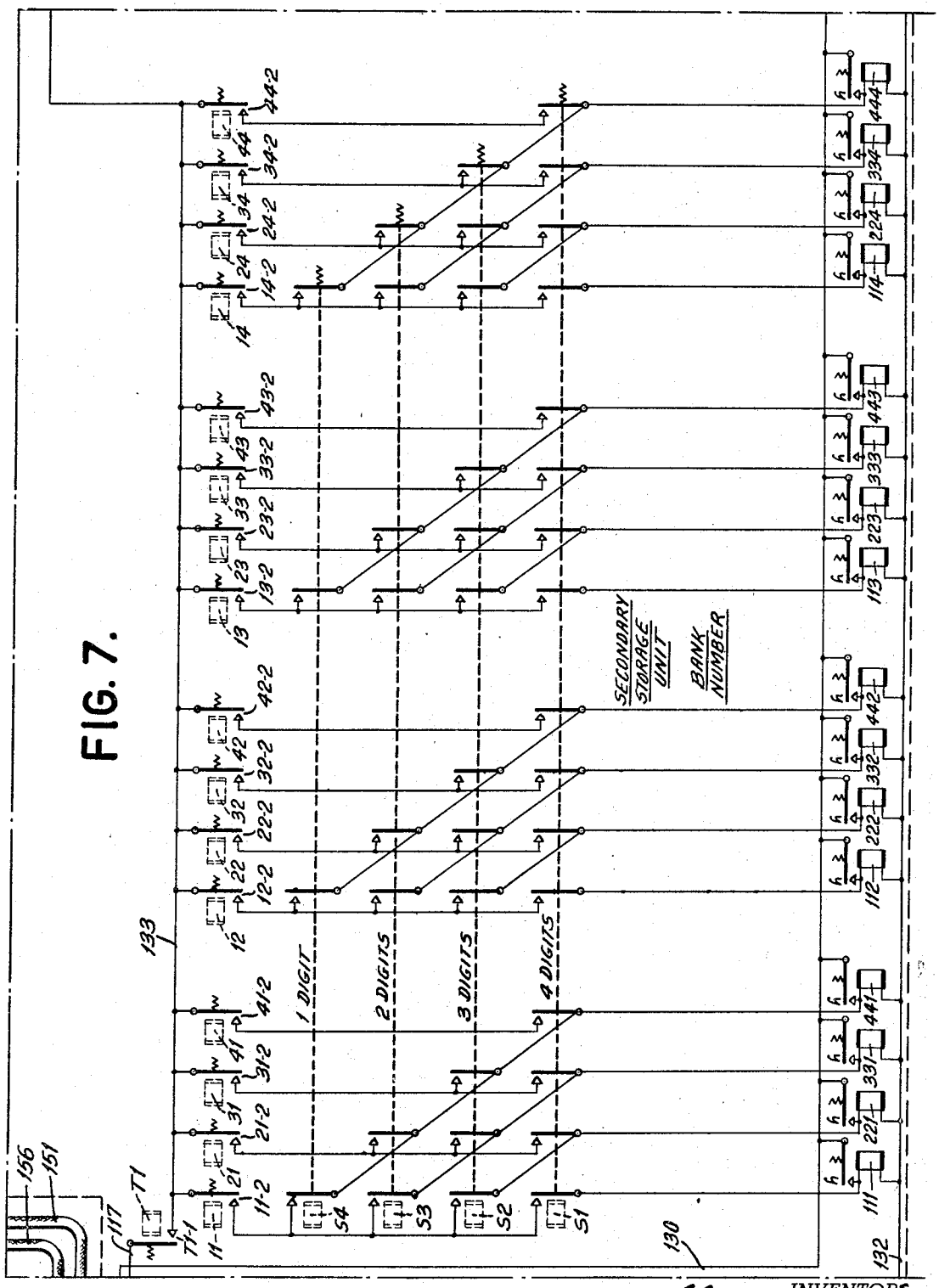

FIG. 7.

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CARD PUNCHING MACHINE

Filed July 29, 1943 13 Sheets-Sheet 8

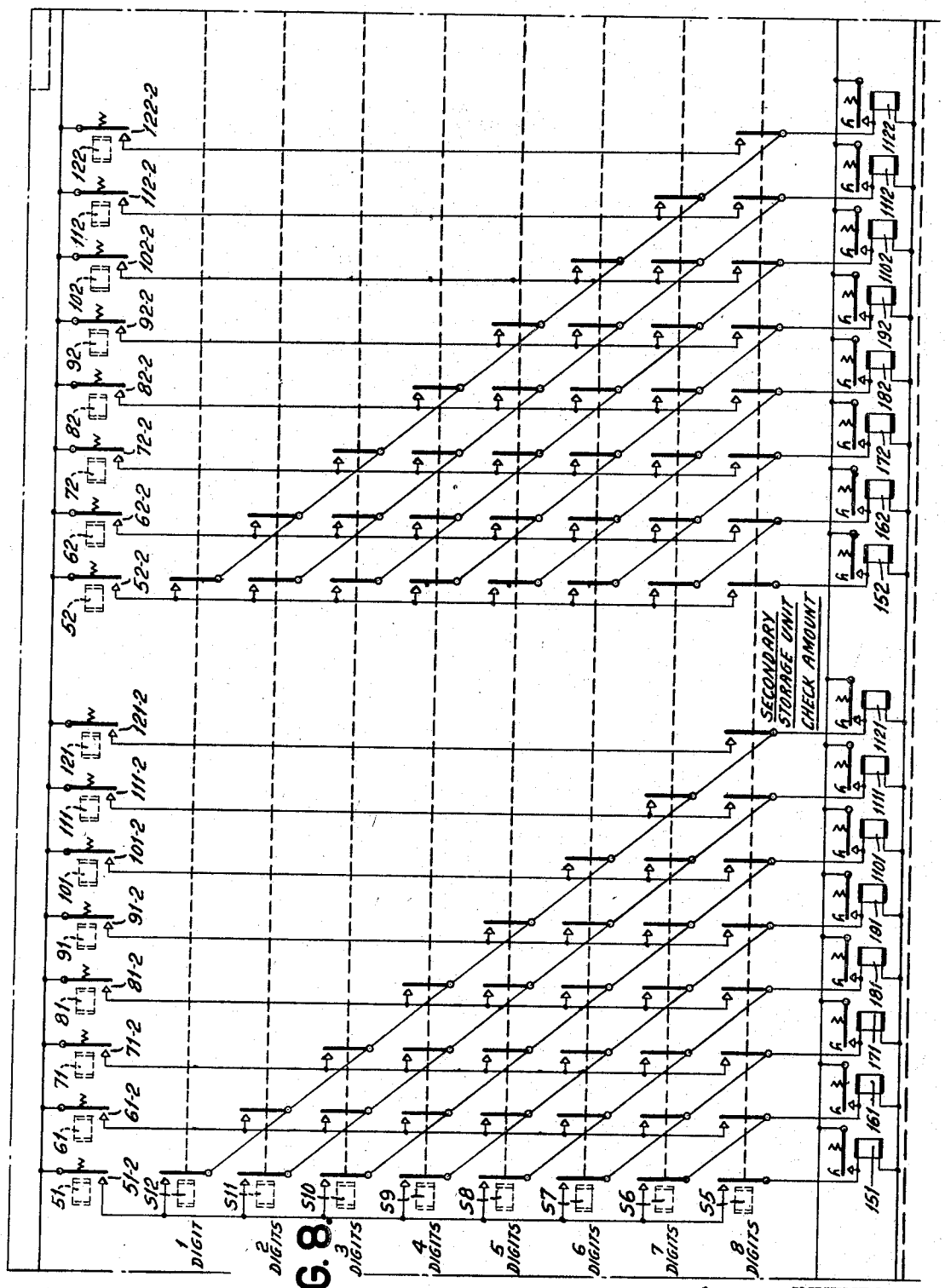

FIG. 8.

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July 4, 1944. C. D. LAKE ET AL 2,353,046

CARD PUNCHING MACHINE

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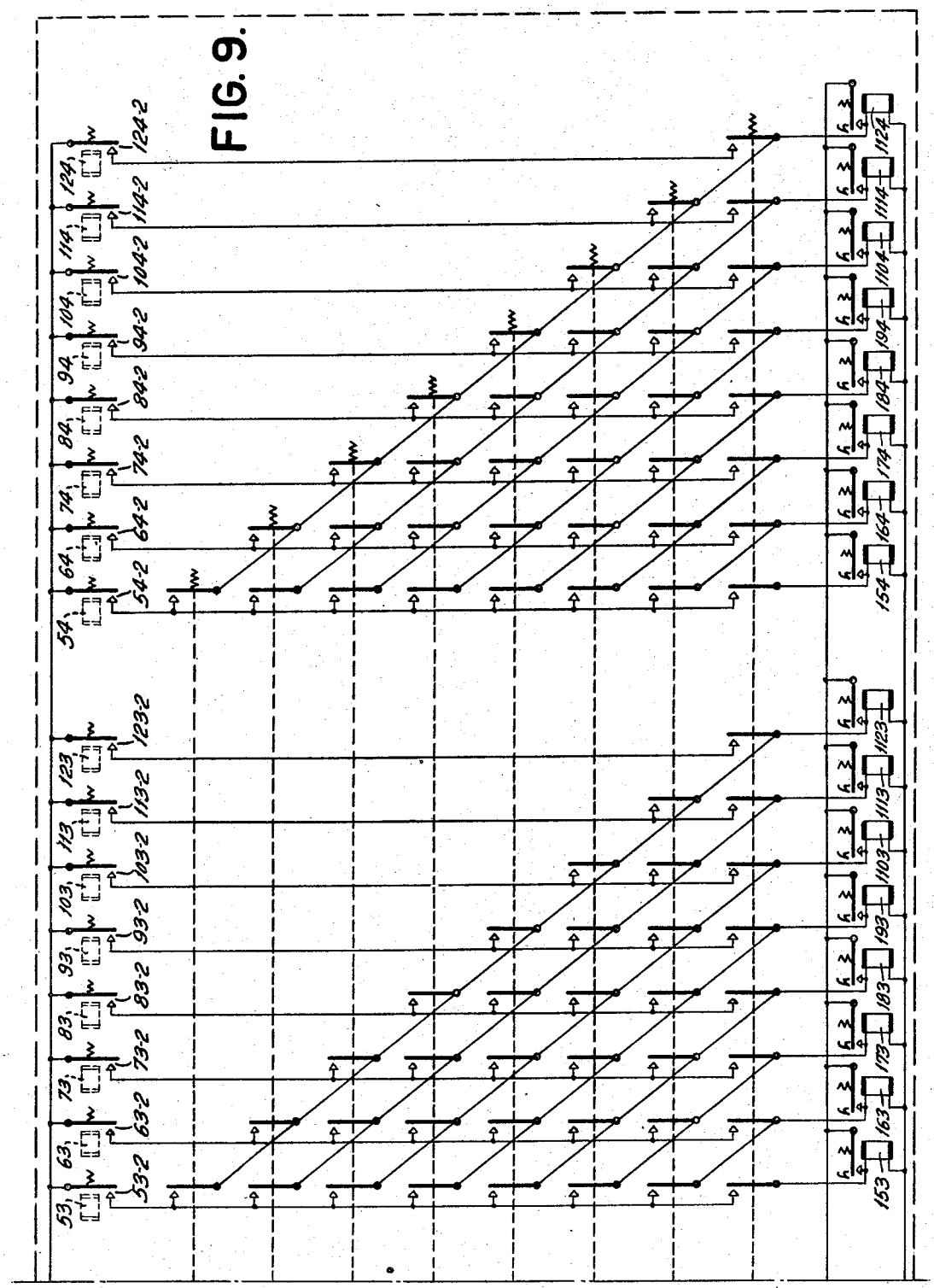
FIG. 9.



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CARD PUNCHING MACHINE

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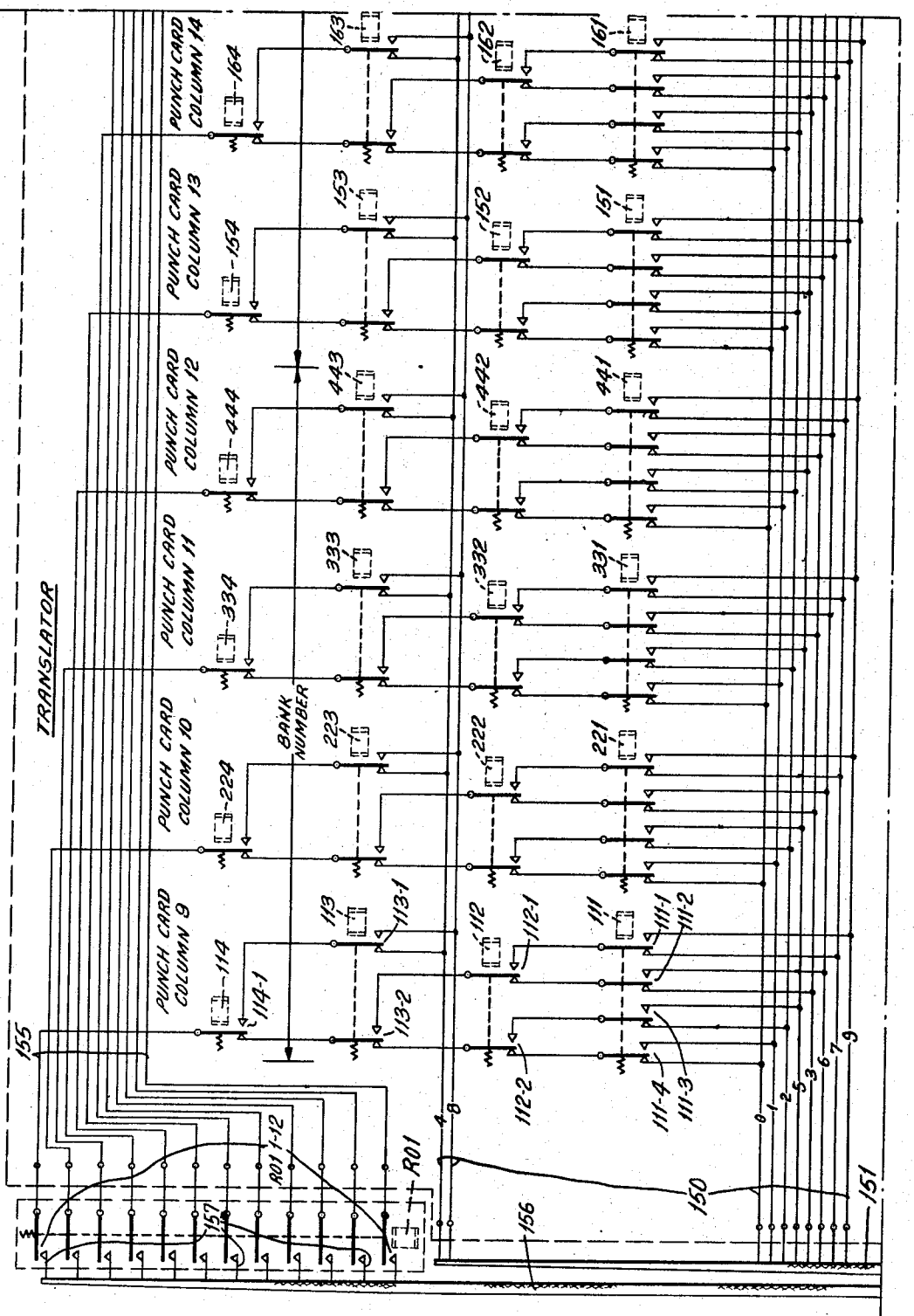
FIG. 10.



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July 4, 1944. C. D. LAKE ET AL 2,353,046

CARD PUNCHING MACHINE

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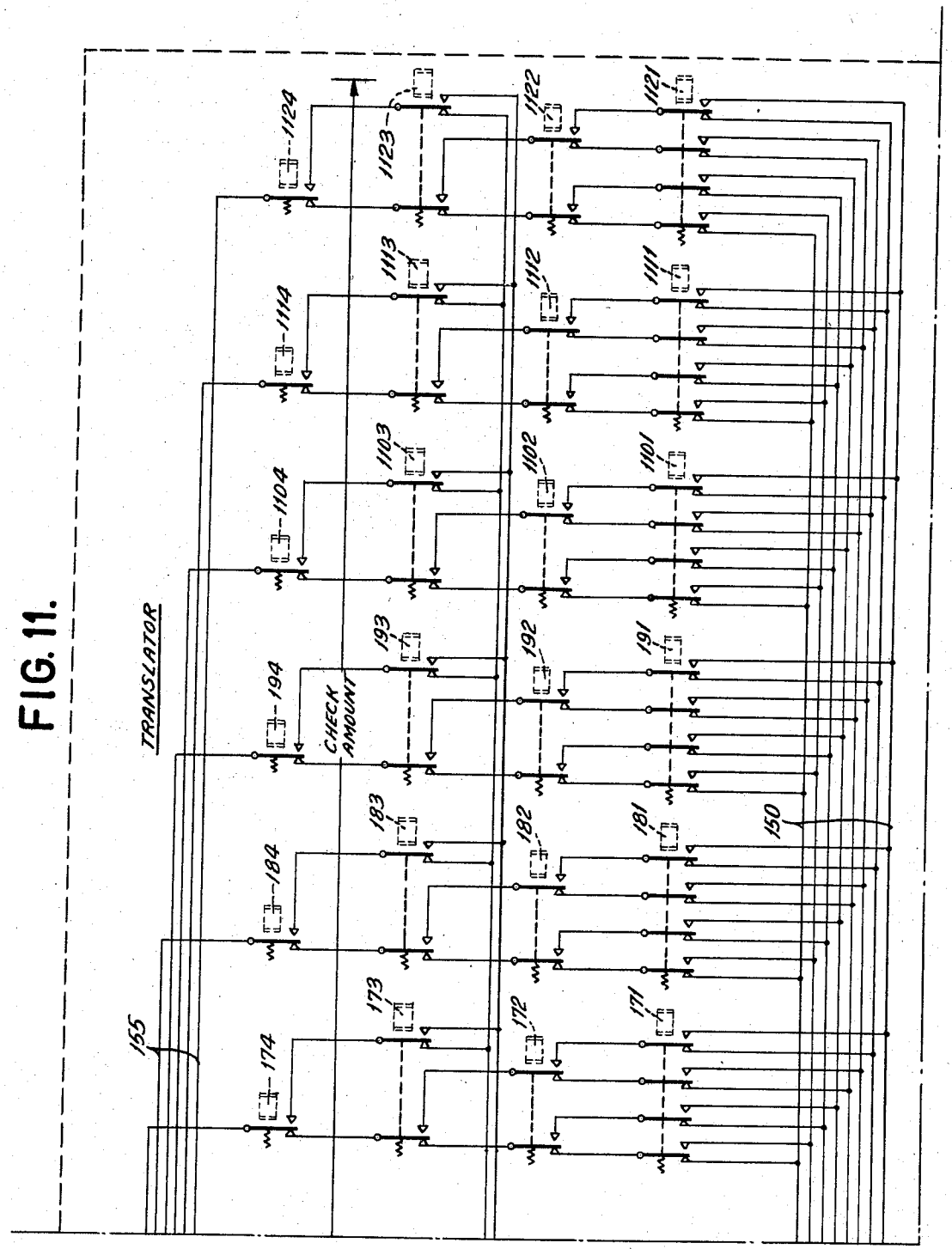
FIG. 11.



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CARD PUNCHING MACHINE

Filed July 29, 1943 13 Sheets-Sheet 12

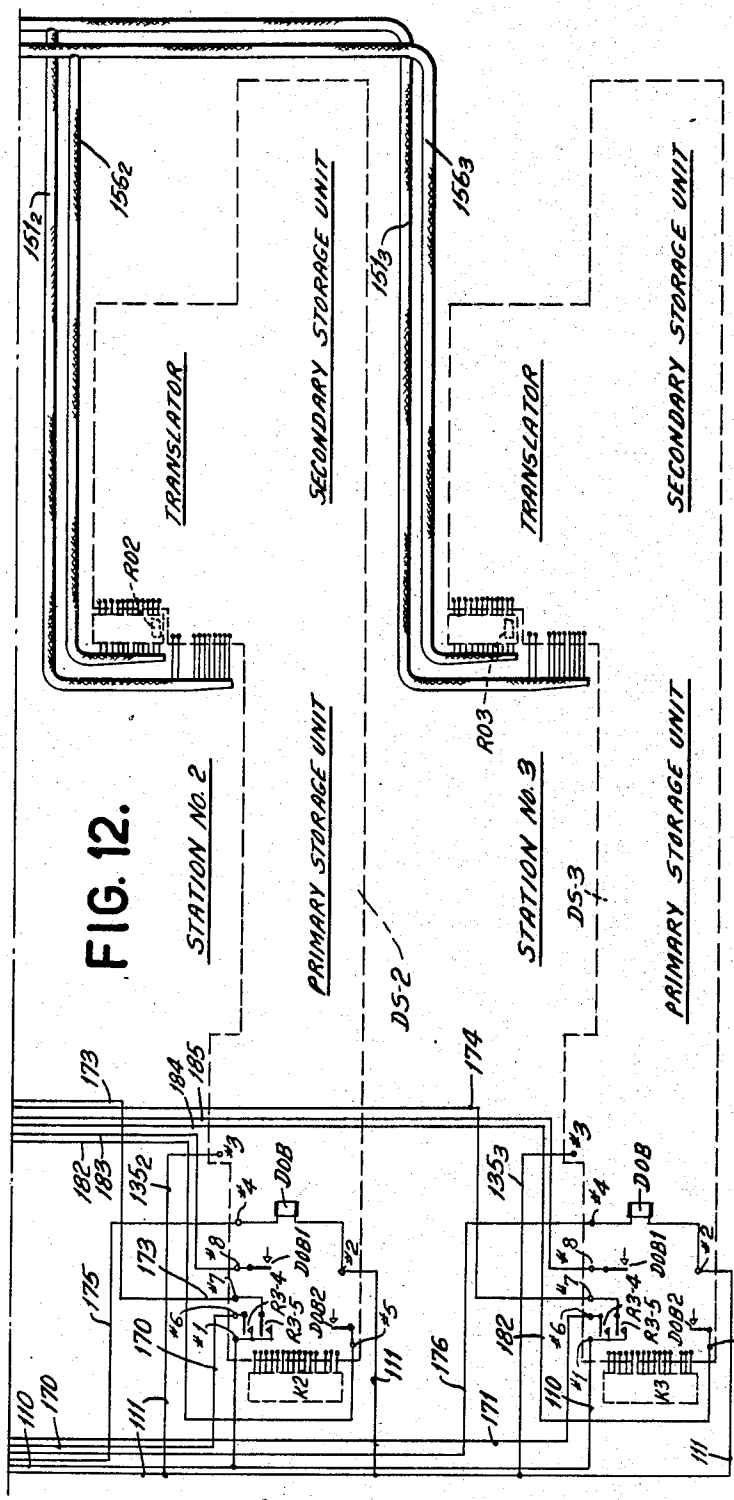

FIG. 12.

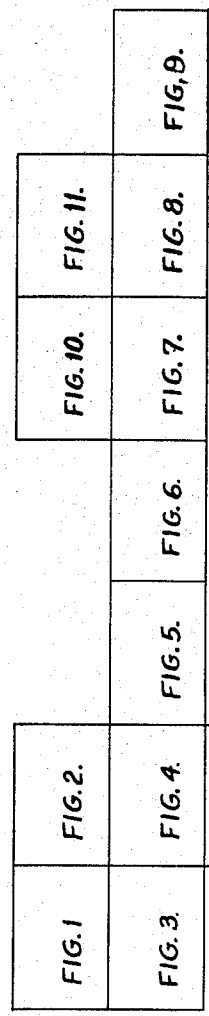

FIG. 13.

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July 4, 1944. C. D. LAKE ET AL 2,353,046

CARD PUNCHING MACHINE

Filed July 29, 1943 13 Sheets-Sheet 13

FIG. 14.

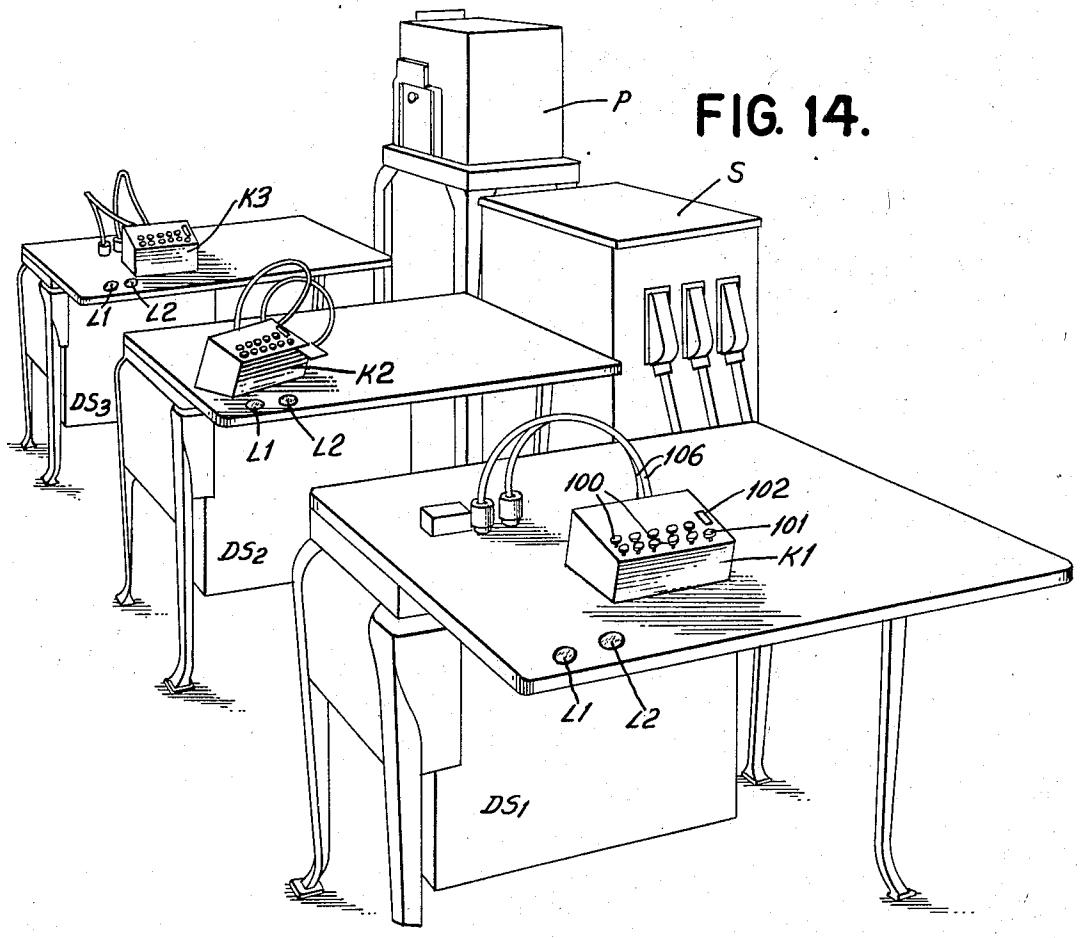


FIG. 17.

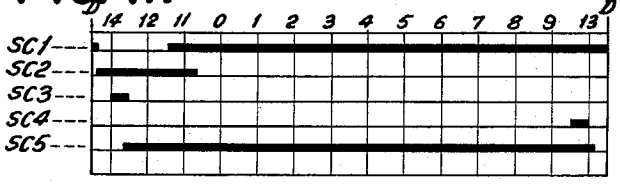
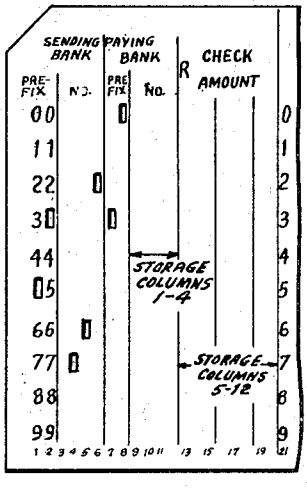


FIG. 16.



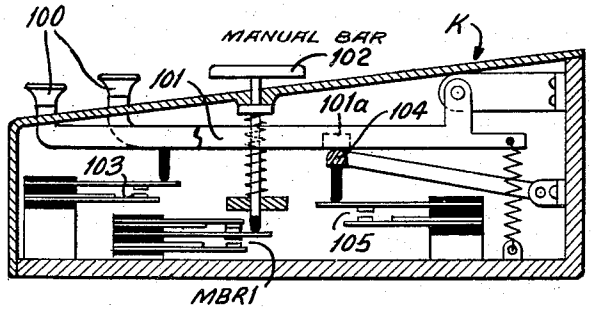


FIG. 15.

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Patented July 4, 1944 2,353,046

UNITED STATES PATENT OFFICE

2,353,046

CARD PUNCHING MACHINE

Clair D. Lake, Binghamton, and Francis E. Hamilton, Endicott, N. Y., assignors to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application July 29, 1943, Serial No. 496,562

19 Claims. (Cl. 164—113)

This invention relates to punching machines and more particularly to the type adapted to punch cards for controlling tabulating and statistical machines.

The main object of the invention is to provide a punching system in which a single punching machine is capable of fulfilling the sequential punching requirements of more than one operator.

A still further object of the invention is to selectively call the punching machine into operation in a sequence that corresponds to the operators' completion of their digit registrations. This increases the efficiency of output of the operator since the operator may immediately recommence setting up digit registrations of the next data without awaiting completion of punching operations.

Another object of the invention is to coordinate with a plurality of operators' keyboard digit registration stations a punching machine with such high speed punching capabilities and characteristics that it is able to complete punching of cards under control of two or more stored digit registrations without holding up any operator. More specifically this object is attained by utilizing a punching machine in which the cyclic operation thereof is constant irrespective of the number of denominational card columns which are punched.

In the present system the punching machine shown is capable when in commercial use of punching cards at the rate of one hundred per minute and the cyclic operation of the machine is so short relative to the time for digit setting that punching operations are completed without holding up the operators.

In connection with the sequential operation of the punching machine, a more specific object of the invention is attained by causing each operator's station to transmit a signal to the sequencing unit which stores up the signals in the same sequence they are received from the operators' stations, when they are transmitted dissimultaneously. The sequencing unit then causes the reading out of the digit registrations to the punching machine in the same sequence that they are completed to thereby punch cards in the same sequence the signals are stored up. The sequencing unit also provides for punching out of the digit registrations in a predetermined order in the event that two or more signals are transmitted simultaneously.

Another object of the invention is the provision in each operator's station of two digit storage devices, one of which, the primary, is always associated with the keyboard of the associated station and is set up to represent the digit key depressions. The other storage device, or secondary, is associated with the punching machine through the sequencing unit when the latter calls it into operation and means is further provided to effect a digit transfer from the primary storage device to the secondary storage device. This transfer operation clears out the primary storage device and it is then in condition for the reception of digit representations of the next data.

A still further object of the invention is to concomitantly transmit a signal to the sequencing unit upon such digit transfer operations, giving an indication that when the punching machine has terminated its cyclic operation the digit registrations of a secondary storage device may be read out if the sequencing unit determines that such registrations should be picked up and read out.

A still further object of the invention is to effect a denominational shift when digit registrations are transferred from the primary storage devices to the secondary storage devices. The primary storage devices may be set up to represent two different numbers which vary in denominational size and in registrations of the numbers beginning at the higher denominational digit of the number, the units digit will be entered in an order of the storage devices which varies with the size of the number. The secondary storage devices are associated with the punch selecting elements in such a way that the different denominational orders of the punch selecting elements are always correlated with the same denominational order of the secondary storage devices. The machine is provided with a denominational shift mechanism which is variably operated in order that the digits transferred from the primary storage devices will be transferred to the proper orders of the secondary storage devices so that the number may be punched in the correct denominational columns of the card. A denominational shift mechanism correlated with the primary and secondary storage devices obviates the necessity of making a denominational shift between the secondary storage devices and the punching machine.

Further objects of the invention which relate more to details of construction but which should be considered as relatively important objects is to provide the operator with signal devices which indicate erroneous operations and the condition of the primary and secondary storage devices.

One of such devices consists of a signal light

which indicates whether the secondary storage device has been cleared and is now in condition for reception of a digit transfer from the primary storage device.

A second signal is provided to indicate to the operator that the secondary storage device has not yet been cleared out and such signal light is illuminated for signal purposes each time that the operator attempts to make a transfer from the primary storage devices to the uncleared secondary storage devices. A further signal which has audible characteristics sounds each time that the operator attempts to make further key depressions after setting up the digits of the bank number without depressing a manual bar.

A more specific object of the invention relates to the skip circuit arrangement provided which eliminates the necessity of the operator of punching the 0 key for denominational orders to the left of the first significant digit. In this respect, the operators' speed is increased because unnecessary key depressions are eliminated, although as will be more apparent later on, such higher denominational columns are, nevertheless, punched to represent zeros.

In devising the improved punching system, particular attention has been stressed to the elimination of operations by the operator which, if performed, would decrease the efficiency of the system. The automatic operation of the punching machine including all of the incidental operations performed therein such as card feeding, punching, card ejection, etc., the operation of the sequencing unit in accordance with the order in which signals are transmitted therein, elimination of unnecessary 0 key strokes, the provision of necessary signals, all facilitate and cause the automatic operation of the system without attention to such automatic operations by the operator. In this system, all that is necessary for the operator to do is to read the data, depress the necessary digit keys, the manual bar and to note the condition of the signals. The rest of the operations are automatically performed. By means of the high speed characteristics of the punching machine the operators are not held up for a moment and continue with their key depressions one after the other for successive data derived from original records, such as checks herein. The speed of output is high and the work progresses in an orderly manner without favoring any particular operator, enabling their output to be equal if they possess the same degree of personal efficiency.

Other objects of the invention will be pointed out in the following description and claims 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 appended drawings:

Figs. 1 to 12 inclusive when assembled according to the diagram of Fig. 13 show the complete wiring diagram for the machine.

Fig. 13 is a diagram showing the manner of assembling Figs. 1 to 12 of the wiring diagram.

Fig. 14 is a perspective view showing the units comprising the improved system. This view shows the three operator keyboard stations, their related keyboards K1, K2, K3, the associated digit setup units DS1, DS2, DS3, the sequencing unit S, the punching machine P, the coordination and details of which will be described hereinafter.

Fig. 15 is a sectional view of a simplified form of keyboard which may be adopted for digit setup purposes.

Fig. 16 is a plan view of a fragmentary portion of a tabulating card showing the particular columns which are previously gang punched and those which are punched by the punching machine P under control of the digit setup units DS1, DS2, DS3.

Fig. 17 is a timing diagram of electrical contacts in the punching machine.

General Description

The primary purpose of the present arrangement is to increase the output of punching cards under control of an operator by providing a digit setup arrangement which will enable the operator to make a subsequent digit setup in one storage unit while the punching machine is punching a card under control of the previous digit set up in the other digit setup unit. This increases the output of an operator by enabling the operator to be busy while the punching machine is in operation for punching a card and further eliminates delays caused to the operator by feeding cards to the punching machine, ejecting punch cards, and incidental operations which are effected in punching machines. The above objective is obtained by dissociating the operators from the punching machine, storing the key depressions in a relay circuit storage unit. In order that the operator need not wait for completion of a punching cycle to commence the setting up of the digit representations for a new card, two storage circuits are provided, comprising a primary storage unit which sets up the digit representations by the keyboard depressions, and a secondary storage circuit which controls the punching machine and to which the digit representations in the primary unit are transferred. Hence the operator may immediately store information in the primary unit after the information has been transferred to the secondary storage unit and without waiting for the latter to control the punching machine and to be cleared thereafter.

The above description is confined to the arrangement for a single keyboard operator's station but the keyboard stations are preferably duplicated so that the high punching speed capabilities of the punching machine may be economically utilized. The punching machine adopted for the present system when in commercial use is capable of producing punched cards at the rate of one hundred cards per minute and in order to utilize as much as possible the full punching speed capacity of the machine the single punching machine is used to punch all the information set up by the operators. Of course, with fewer digit columns to be set up the time occupied by the operator will be diminished and therefore the high speed capabilities of the punching machine can be most efficiently utilized by having more keyboard stations. In other words, there is a proportion between the punching speed capabilities of the machine and the number of storage columns which are to be set up by each operator. The proper proportion will result in the most efficient operation of the system.

The complete system may be visualized as consisting of the following units, all interconnected by cable connections; the three operator assemblies each consisting of a table supporting a ten key keyboard K (Fig. 14) and a primary and

secondary digit setup unit DS for each operator; a sequencing unit S to which all the digit setup units of the three operators' stations are connected by cables, and a high speed punching machine P controlled by the secondary storage units of the three operators' stations, when selectively called into operation by the sequencing unit.

The obvious difficulties involved in causing a single punching machine to punch under control of digit representations stored in the secondary units in any random sequence without causing the operator confusion and undue delay or hesitation requires the provision of the aforementioned sequence unit. This unit receives signals from the completely set up storage units and determines the sequence that the storage units are to be coordinated with the punching machine. Therefore, when signals are received at random and in an invariable sequence, these signals are stored up and the punching machine punches cards in the same order that the signals are received. The possibility of receiving signals simultaneously is also provided for in the sequencing unit by arranging the latter to cause punching of the cards in an invariable order determined by the specific circuit connections made in the sequencing unit. The simultaneous reception of three signals from stations Nos. 1, 2 and 3 will, in the present system, cause punching out in this named order.

The provision for sequencing punching operations in the sequential order that signals are received enables punching of cards in the same order the operators finish their digit setup operations. Hence, no operator is favored and there is little or no waiting by the operators for the clearing out of the secondary storage units related to his or her station. This enables the maximum output and speed of card punching.

A consideration of the card form shown in Fig. 16 indicates that it consists of a number of fields. There are three separately identified fields; one field comprising columns 1 to 8 and such columns represent common information and they are previously gang punched. The remaining card columns to be punched consist of two fields, one which represents the bank number and the other the check amount. The bank number and amount are on the checks received by the bank and such checks are read by the operator to determine the key depressions which should be made for punching a card to represent this information on the check.

A special circuit arrangement is provided which eliminates the necessity of the 0 key depressions in columns to the left of the first significant digit of both the bank number field and the check amount field. It will be obvious in those instances where the denominational size of the number is smaller than the denominational columns provided in the storage circuit that the units position of the number will consequently be placed in some variable position in the primary storage circuit. In order that the number may be correctly punched it is obviously necessary to provide some means for shifting the number in columnar relation so that the units position of the number enters the units position of the card, the tens in the tens position, etc., in addition to which it is desirable to punch zeros in the blank columns to the left of the significant digit in the highest denominational order.

Various means may be provided to effect this but in the present arrangement the variable denominational shift is effected in the digit transfer from the primary to the secondary storage unit to set up the number in the proper columns in the secondary unit, following which a readout may take place from the secondary storage unit without the necessity of a further denominational shift.

The above is a general outline of the system and the description of the various units which make up the system will now be described with a chapter devoted to each of the separate units, the description being presented in an orderly manner so that the complete operation of the machine will be visualized by understanding the detailed description of the construction, coordination, and operation of the units.

Keyboard

The structure of the keyboard for each operator's station is identical and the arrangement will be described in connection with only one, referring particularly to Figs. 3, 14 and 15. The keyboard is of the ten-key keyboard arrangement and any conventional arrangement will suffice for the purposes. Referring to Fig. 15 the key caps 100 of the keyboard levers project outside of the keyboard casing for manipulation by the operator and the keyboard includes the digit keys designated 0–9 for effecting corresponding digit setups. In addition to the digit keys 0–9 the keyboard is provided with an "error key" 101 and a "manual bar" 102 (Fig. 3). When each digit key is depressed it closes its related contacts 103 and by means of a bail 104 underlying all of the digit keys 0–9, bail contacts 105 are closed upon each depression of the digit keys. The contacts closed by the manual bar and the error key will be referred to as the description proceeds. The keyboards of the three stations are designated K1, K2 and K3 in Fig. 14 and the electrical instrumentalities of each keyboard K1, for example (see Fig. 3), comprise those enclosed by the dotted lines and designated K1 in Fig. 3.

By means of cables 106 (Fig. 14), electrical connections are made between the electrical instrumentalities of the keyboard and other instrumentalities provided in the related control digit setup unit DS.

When each digit key is depressed it closes a circuit to be subsequently described to energize a related relay KC0–KC9 (Fig. 3). Current for the electrical instrumentalities of all units is provided by lines 110 and 111.

In starting, the first key depression causes a circuit to be closed from line 110 through R4—1 contacts now closed, through bail contacts 105 then by a line 112 through the contacts AC1—1 now in the position shown, through relay contacts C2—7 now closed, to relay coil C1, through DOA3 contacts, to the line 111. Relay contacts C1 close the stick contacts *h* to provide a stick circuit back to the line 110, the stick circuit extending through *h* contacts, wire 112, bail contacts 105, contacts R4—1 to line 110. Relay C1 opens contacts C1—7 and closes contacts C1—8. The closure of contacts C1—8 picks up relay AC1 by a circuit from line 110, relay contacts R4—1, wire 113, through MBR1 contacts now in the position shown, wire 114, through relay contacts C1—8, AC1 relay, through DOA3 contacts, to line 111. Relay AC1 now being energized transfers its contacts AC1—1 but since contacts C1—7 are now open, the circuit to the C2 relay coil is open and the latter is not energized during this key depression, whereas relay coil AC1 is and remains energized by reason of its *h* stick contacts, which stick circuit extends through *h*

contacts AC2—2 relay contacts now closed, wire 114, relay contacts MBR1, wire 113, R4—1 contacts to line 110. Hence, when the bail contacts open upon the release of the depressed key, relay C1 deenergizes but relay AC1 remains energized.

Upon the next key depression the circuit extends from line 110, through R4—1 contacts, bail contacts 105, wire 112, through AC1—1 contacts now transferred, C1—7 contacts now closed, to relay coil C2, DOA3 contacts, to line 111. Relay coil C2 closes its *h* stick contacts to provide a stick circuit back to line 110 by the stick circuit previously traced for C1. Relay coil C2 closes its contacts C2—8 to pick up AC2 relay coil. Relay coil AC2 opens its contacts AC2—2 to open the stick circuit of relay coil AC1 but as contacts AC1—1 transfer back to normal position the closure of the left contacts will tend to complete a circuit to relay C1, which, however, is now prevented by the opening of contacts C2—7. It is thus seen that upon odd key depressions relay coil C1 is energized while upon all even key depressions relay coil C2 is energized. As will be later explained, relays C1, C2 have additional contacts in alternate columns of the primary storage unit with contacts of C1 in all odd columns and with contacts of C2 in all even columns. Thus, upon the first key depression, closure of contacts C1—1 (Fig. 4) provides an impulsing circuit to column 1 of the primary storage unit.

The key contacts 103 (Fig. 3) are closed by the respective digit keys and upon closure a circuit is extended from line 110 through R4—1 contacts, through bail contacts 105, through the respective key contacts 103 to the related relay KC0—KC9, one relay for each key, which relays are connected at their other side to the line 111 so that a depression of a key will energize its KC relay and close its respective KC contacts shown in Fig. 3.

When bail 104 closes its contacts 105, a circuit is extended from line 110, R4—1 contacts, contacts 105, wire 112, joining wire 116 to relay COM, to line 111. Relay COM transfers its contacts COM1 (Fig. 3) and thus a circuit is completed from line 110 through contacts COM1, through the KC contact or contacts now closed, to energize relays K1, K2, K3 and K4, singly or in combination, which relay coils, it will be noted, are commonly connected at their other side to the line 111. It will be noted that some of the KC relays close only one pair of contacts, whereas others close two or three pairs of contacts and such contacts are wired to the K1—K4 relays to energize the K1—K4 relays singly or in combination, according to the code shown in Fig. 3. Hence, the KC1—1 to KC9—1 and 2 and 3 contacts energize the K1—K4 relays singly or in combination. The depression of the "0" key energizes a KC0 relay but the latter does not close any contacts to energize a K1 to K4 relay. Its function will be later described. However, the "0" key does close bail contacts 105 to energize relays C1, or C2, depending upon whether the key depression is an odd or even number key depression.

It will be noted that to illustrate the present invention twelve storage columns 1–12 for the primary unit are shown but the number may be varied. It will be observed then that by the depression of the "1" digit key, for example, relay K1 is energized to close its contacts in the impulse circuit of each storage column, closing K1—1 contacts (Fig. 4) for column 1, to K1—12 contacts (Fig. 6) in column 12. The same is true for the other K2, K3, K4 relays so that for each key depression contacts closed by the selected relays will be closed in all of the twelve columns of the storage units upon each key depression.

It will be seen from Fig. 4 that for column 1 relays 11, 12, 13 and 14 are selected for energization by closure of respective contacts K1—1, K2—1, K3—1, K4—1. Similar relays are provided for each column of the primary storage unit, the relays 21—24 for column 2 being provided, 31—34 for column 3, etc. The tens (and hundreds) digit is provided to indicate the column number and the units digit to indicate the relay number in that column. Hence, 52 indicates relay 2 in column 5; 114 indicates relay 4 of column 11. Therefore, closure of K1—K4 relay contacts in the storage column energizes relays 1—4 singly or in combination but only in the storage column selected for a digit setup are such contacts effective for digit setup. Upon the first key depression C1—1 (Fig. 4) contacts are closed so that an energizing circuit for relays 11—14 of storage column 1 is provided from line 110 through relay contacts DOA2 now closed (Fig. 3), wire 117, through AS3 contacts (Fig. 4) now closed, B1 contacts now closed, C1—1 contacts now closed, KCO1 contacts now in the position shown, to the particular K1—K4 contacts now closed, to the selected 11—14 relays, to wire 118, wire 119, thence through DOA3 contacts now closed (Fig. 3), to the line 111.

Having been energized, the relays 11—14 are held energized as follows: It will be noted that relays 1—4 in each unit are of the double type, consisting of a pickup coil P and a hold coil H, with the contacts in series with the H coil marked *h* being the conventional stick contacts which are closed when the pickup winding is energized. The stick circuit for relays 11—14 extends through the hold coil, its *h* contacts, wire 117, through DOA2 contacts, back to line 110.

It will be noted that from the line 117 a wire 120 (Fig. 4) is connected to one side of each of the relay contacts 11—1, 12—1, 13—1 and 14—1 and with one of such contacts closed a circuit will be closed to energize a column relay A. Column relay A, being energized, closes its *h* stick contacts to close a stick circuit for relay A which extends back to line 110 through *h* contacts, wire 120, wire 117, DOA2 contacts, back to line 110. Relay coil A closes its contacts A2 and prepares storage column 2 for entry of a storage impulse upon the second key depression, the impulse now being directed through K1—2, K4—2 contacts to energize relay coils 21—24. It will be noted that the stick circuit for these relays also extends by wire 117 back to line 110 through DOA2 contacts.

While relay contacts A2 in storage column 2 are closed the digit impulse on the first key depression cannot be transmitted to energize relays 21—24 of the column 2 even though K1—2, K4—2 contacts of storage column 2 are closed because the C2—1 contacts of storage column 2 are now open. However, on the second key depression relay coil C2 energizes to close contacts C2—1 and the second storage column will be set up and in this case relay coil B energizes by a circuit similar to that previously described to open B1 contacts of the first storage column to prevent erroneous setting up of column 1 on subsequent odd key depressions. Relay coil B closes its B2 contacts in column 3 of the storage unit, preparing it to receive the third digit setup. Relay coil C energizes upon the digit setup in

column 3, opening contacts C1 to prevent a digit setup in column 2 and closing contacts C2 preparatory to a digit setup in column 4. In the same manner digit setup ensues for the twelve storage columns.

It should be noted that when the 0 digit key is depressed, relay KCO is energized as previously described and this will result in the transfer of its contacts, such as KCO1 (Fig. 4) for column 1 and the impulse for storage column 1 will not be directed to any of the relays 11—14 because none of the contacts K1—1 to K4—1 are closed but such impulse will be directed to relay coil A, due to the transfer of contacts KCO1. Hence, relay coil A will function in the same manner as it does when there is a digit setup for the relays 11—14. A similar circuit closure is made in any storage column upon the depression of the 0 digit key, resulting in the energization of its related storage column relay A—L, inclusive.

A spacing procedure may then be generalized by saying that as one column is set up it partially completes the pickup circuit to the column of the next higher order and breaks the pickup circuit to the column previously set up. The purpose of the alternating relays C1 and C2 is to prevent the previously described closure of an A, B, C, etc., contact in the next lower column from causing an undesired progression in that column. It should be noted that for column 12 (Fig. 6) the impulse is directed from the wire 117 through K2 contacts now closed, C2—6 contacts now closed because this is an even numbered column, thence through the KCO12 contacts now in the position shown, to select relay coils 121—124 for energization, depending upon the particular K1—K4 relays energized. In this storage column, relay coil L is energized to open contacts L1 to prevent an undesired digit setup in column 11 when column 12 is being set up.

Card Form

A consideration of the card form illustrated in Fig. 16 shows that a portion of the card to be punched consists of twenty card columns of which columns 1 to 8, inclusive are prepunched, preferably by gang punching to indicate common data for a series of cards. The remaining card columns 9 to 20, inclusive are punched under control of the storage columns 1 to 12 of each station. Card columns 9 to 20, inclusive, are subdivided into two fields, columns 9, 10, 11 and 12 presenting the paying bank number which is indicated on the check. The amount of the check which, of course, is taken from the check is punched on the card in columns 13 to 20 under control of storage columns 5 to 12.

Of course, the bank number and the check amount may vary in the number of significant digits which comprise each amount, and by the present novel digit shift arrangement it is possible to punch the numbers in the correct denominational relationship on the card and in the proper columns thereof without requiring the operator to punch the zeros at the left. Thus, if the bank number consisted of only two digits these are set up in denominational columns 1 and 2 but by a denominational transfer means to be subsequently described card columns 11 and 12 are punched to represent the tens and units of this two-digit number. Depression of the 0 digit key is unnecessary and therefore time is saved in this elimination. Correspondingly, for the amount field which may vary in the number of digits, if the amount is $80.26, for example, the operator omits punching of the four zeros ahead of the amount and sets up only 8026. Later when the amount is transferred to a secondary storage unit the denominational transfer means shifts the amount to the proper position in the secondary storage unit and when punching is effected under control of this unit the digits will be punched on the card in the proper column position.

In the event that the bank number consisted of less than four digits the operator depresses the manual bar 102 after the last digit key depression. This automatically conditions the impulsing circuits and upon the next key depression storage column 5 will be set up. Hence, intervening storage columns will not be set up. There will now be described the circuits which are operative upon depressing the manual bar 102 after the bank number has been set up in the storage columns when it consists of one, two or three digits.

When the manual bar is depressed, contacts MBR1 (Fig. 3) are transferred, closing a circuit from line 110, through R4—1 contacts now closed, wire 113, MBR1 contacts now transferred, wire 125, E4 contacts now in the position shown because storage column 5 has not yet been set up to energize relay E (see Fig. 5), thence through the A5 contacts now closed, to the pickup coil of relay coil AS, to line 111. The A5 contacts are closed because column 1 has already been set up to energize relay A and such contacts are safety contacts to prevent unwanted energization of the relay coil AS in the event that the manual bar is accidentally depressed prior to setting up storage column 1. The pickup coil of AS closes the stick or *h* contacts of the AS relay and a stick circuit is provided back to the line 110 through such contacts and a wire 126. It should be noted that the other side of the hold coil of AS relay is connected to the line 111 through the DOA3 contacts, causing AS relay to be held energized until the DOA relay is energized to break the stick circuit for such relay. As will be subsequently described the purpose of the AS relay is to advance the digit impulsing circuit to storage column 5 or the first column of the amount field and to prevent such digit impulses from being transmitted to one or more of the storage columns pertaining to the bank number field which have not been set up so that subsequent digits will not be set up therein.

Depression of the manual bar has the capability of conditioning the relays C1 and C2 to the end that they can be energized in the proper alternating sequence upon setting up the diigt in column 5 in the event that the last digit setup in storage columns 1 to 4 would not permit the proper sequence. This will be made clear when it is assumed that the bank number contains three digits and after the third digit setup in storage column 3 relay AC1 (Fig. 3) would be in an energized condition. If relay AC1 was permitted to remain energized the next operation of a digit key for storage column 5 would be treated as an even setup and relay C2 would energize. If there had been two digits in the bank number field, relay AC1 at the end of the two-digit setup would be in a deenergized state. It is thus seen that an inconsistency could result if it were not for the fact that relay AC1 is returned to a deenergized condition before the start of setting up of digits in the amount representing storage columns. Hence, the depression of the manual bar 102 transfers the MBR1 contacts and by opening

the upper contacts it will be observed that the stick circuit for the AC1 relay is broken and such relay is therefore deenergized and upon the next key depression C1 relay coil will be picked up, which is proper for storage column 5. Hence, upon the depression of the digit key after depression of the manual bar, the impulse circuit will be directed by wire 117 (Fig. 5) through F1 contacts now closed, AS6 contacts now closed because AS relay was previously energized and held energized, thence through C1—3 contacts now closed, and the impulse will be transmitted to relays 51—54 in accordance with the particular K1—K4 relays energized upon the depression of the digit key.

It will be seen, therefore, that the energization of the AS relay opens contacts AS3, AS4 and AS5 (Fig. 4). Taking the extreme case where only storage column 1 has been set up the depression of the manual bar after such digit setup will cause contacts AS4 and AS5 to open. Therefore, the impulse transmitted by the depression of the digit key following depression of the manual bar will be transmitted to storage column 5 as just explained but due to the opening of contacts AS4, and AS5, this impulse cannot be transmitted to either storage column 2 or storage column 3. Of course, since relay coil C2 has not been energized because C1 is energized when storage column 5 is set up as just explained, C2—2 contacts for storage column 4 will be open and therefore storage relays 41—44 cannot be energized when storage column 5 is set up. Further, it will be seen that when the operator depresses one of the digit keys for setting up storage column 6, this impulse cannot be transmitted to storage column 4 because while the C2 relay coil is energized to close contacts C2—2 when digit setup is made in column 6, relay coil E has been previously energized in effecting the digit setup for column 5. Hence with E1 contacts in storage column 4 now open, the impulse cannot be transmitted to storage column 4 and only storage column 6 will be set up.

Summarizing, it is only necessary for the operator to effect key digit setup operations for those storage columns of the bank number field which correspond to the significant digits. The depression of the manual bar will skip the intervening columns and condition the circuit so that the next digit setup will be in column 5. An improper digit setup of the storage columns of the bank number field which have not been set up will be prevented. Of course, the greatest saving in time transpires when the digit setup for the bank number consists of only one digit and hence three key strokes will be saved even though the time saved will be decreased by the time consumed in the stroke for the manual bar. However, when a large number of storage columns are allocated for the bank number field and only a relatively few digits are necessary to be set up, a much greater saving in time results.

Setting up Digits of Amount Representing Field

Upon setting up of the first digit in the amount representing field beginning at storage column 5, the operator depresses the digit keys in succession, making a digit setup in the successive storage columns corresponding to the significant digits of the amount. However, as previously explained, digit keys corresponding to the significant digits of the amount are only depressed. After the last digit of the amount is stored, a second manual bar depression is made which signifies the completion of the storage operation and conditions circuits now to be described.

With E4 contacts now transferred because a digit setup has been made in column 5, the second depression of the manual bar 102 will complete a circuit from its lower MBR1 contacts, wire 125, relay contacts E4 now transferred, through BR1 contacts now closed, through AS1 contacts now closed because the first depression of the manual bar has energized the AS relay, to the pickup coil of relay MBC, through DOA3 contacts, to line 111. The pickup coil of MBC closes the *h* stick contacts and the stick circuit is extended from such contacts to line 110 by wire 126. Energization of relay MBC will close the MBC3 contacts and when manual pressure on the manual bar has been released MBR1 contacts will come to normal, thereby closing a circuit from the upper contacts, wire 114, through MBC3 contacts to the MBR relay to line 111. At this stage of the operation relays AS, MBC and MBR are held energized.

Transfer to Secondary Relay Storage Circuit

The foregoing describes the manner in which the desired information has been completely stored in the storage columns to set up the digits of the bank number and amount of the check. Due to the fact that punching requires an appreciable time, if it should be arranged that punching operations take place under control of the storage columns and particularly by reason of the delays incident to the use of the same punching machine by three operators as in the present embodiment, it is desirable that a storage circuit be immediately available to the operator for effecting a digit setup for the next data without the necessity of waiting for punching of the card of the last digit setup. In the present machine, to make a primary storage circuit immediately available to the operator, a secondary relay storage circuit is provided and the latter is adapted to control the punching machine whereas the primary storage circuit is always utilized to effect the digit setup under control of the digit keys operated. In general, after completion of a digit setup in the primary storage circuit a digit transfer takes place to the secondary storage circuit which then retains the digit setup, following which the primary storage circuit may be deenergized and made available for digit setup of the next data.

When MBR relay is energized upon the second depression of the manual bar to attempt a digit transfer it closes its contacts MBR2 (Fig. 3), closing a circuit from line 110, through DOB1 contacts now closed, wire 130, through MBR2 relay contacts now closed, R1—1 contacts now closed, R3—1 contacts now closed, relay T1, thence by a wire 131, a wire 132, through DOB2 contacts now closed, to the line 111. This same impulse is directed by wire 134 to the R1 relay to energize the same to close the R1—1 contacts. The circuit for energizing T1 is completed, however, only if a certain requirement has been met; that is, the secondary storage circuit must have been cleared of previously stored information and the storage relays thereof should have been deenergized. If the secondary storage circuit is cleared out and if it is not in the course of being deenergized to be cleared out, then the closure of contacts R1—1 and R3—1 in the energizing circuit of relay T1 will permit the energization of the latter. The energizing circuits for relay

R3 which through its contacts controls the energizing circuit for relay T1 will be more clearly described later on.

The secondary storage unit for receiving a digit transfer from columns 1, 2, 3 and 4 of the primary storage unit to designate the bank number is shown completely in Fig. 7. Each storage column of the primary storage unit closes contacts in the circuits of the storage relays of the secondary storage unit and in the secondary storage unit for the bank number there are four columns of four storage relays, each corresponding to the relays in the primary storage circuit. For example, for storage column 1 in the primary storage unit there are relays 11, 12, 13, 14 and in the secondary storage unit there are relays 111, 112, 113, 114 which will be energized under control of the corresponding relays in the primary storage unit provided that four significant digits have been set up in the primary storage unit. As will be made clear later on, this is not always the case because, since the four groups of storage relays in the secondary storage unit are always allocated for controlling the recording of the same card columns, this is not necessarily true of the storage columns of the primary storage unit. The number of storage columns in the primary storage unit that are set up is dependent upon the number of digits set up. Of course, in setting up the digits in the primary storage unit, the units position of the number will consequently be placed in some variable position in the primary storage circuit since the operator in depressing the keys depresses them in an order beginning with the digit of the highest denominational order. For example, in setting up a 4-digit number, storage column 4 represents the units whereas in setting up a 2-digit number, storage column 2 represents the units, etc. Therefore, in order that the number may be punched in the correct denominational position in the card, it is obviously necessary to provide some means for shifting the number in columnar relation so that the units position of the number enters the units position of the card. This denominational shift is effected during the transfer operation between the primary and storage units, following which recording operations may take place under control of the secondary storage unit without the necessity of any denominational shift between the secondary storage unit and the punching mechanism.

As the storage relays in the primary storage unit are energized and held energized, their related "2" contacts in the secondary storage circuit (see Fig. 7) will be closed. That is to say, for storage column 1 in the primary storage unit, relays 11, 12, 13, 14 will close their respective contacts 11—2, 12—2, 13—2, 14—2 (Fig. 7) and in accordance with the energization of the relays singly or in combination, the "2" contacts will be closed singly or in combination so that when later an impulse is directed to the secondary storage circuit, such contacts will transmit impulses to the corresponding relays 111, 112, 113, 114, if four digits are set up. Therefore, after a storage column in the primary storage unit has been set up the related contacts in the secondary storage unit will be closed and held closed. Upon the second depression of the manual bar, provided the conditions previously described are obtained, T1 relay will be closed to close its T1—1 contacts (Fig. 7), thereby completing a circuit from line 110, through DOA2 contacts (Fig. 3) wire 117 (Fig. 7) T1—1 contacts, to an impulse line 133. One side of all the "2" contacts of all primary storage relays are connected to this impulse line 133 and impulses will be directed under control of the previously closed "2" contacts to the corresponding relays of the secondary storage with which latter are connected to the other line side 110 by line 132 (Figs. 7, 6, 5, 4, 3 in the order named), through DOB2 contacts now closed to line 111. The relays of the secondary storage unit when energized provide a stick circuit for retaining them energized until they have been utilized to control punching operations through their respective stick contacts *h*, the stick circuit then extending back to the line 110 by wire 130 (Figs. 7, 6, 5, 4, 3 in the order named), through DOB1 contacts, back to line 110.

In like manner, and at the same time, every storage column of the secondary storage unit will have its relays energized to correspond with the storage relays previously energized in the primary storage unit. Thus, shortly after the energization of the T1 relay there will be standing in the secondary storage unit exactly the same information as that standing in the primary storage unit. A different condition is obtained, however, in the setting up of the secondary storage unit when less than four digits are set up in the primary storage unit and the aforesaid denominational transfer operations take place and are variably effected in accordance with the number of digits set up in the primary storage unit. This can best be illustrated by reference to the following table:

DENOMINATIONAL TRANSFER FOR BANK NUMBER

No. of digits set up in primary storage columns	S relay energized	Relays set up in primary storage unit	Relays set up in secondary storage unit	To punch card columns
4 Thousands	S1	11–14 thous.	111–114	9 thous.
4 Hundreds	S1	21–24 hund.	221–224	10 hund.
4 Tens	S1	31–34 tens.	331–334	11 tens.
4 Units	S1	41–44 units	441–444	12 units.
3 Hundreds	S2	11–14 hund.	221–224	10 hund.
3 Tens	S2	21–24 tens.	331–334	11 tens.
3 Units	S2	31–34 units	441–444	12 units.
2 Tens	S3	11–14 tens.	331–334	11 tens.
2 Units	S3	21–24 units	441–444	12 units.
1 unit	S4	11–14 units	441–444	12 units.

From the preceding table it will be observed that when three digits are set up the units digit is represented in relays 31—34 and occupies a different position in the primary storage unit than when four digits are set up therein. When two digits are set up in the primary storage unit, the units digit position is determined by a different set of relays and, of course, when a single digit is set up in the primary storage unit the first set of relays 11—14 represents the units position. With such variable position of the units digit and, of course, the tens and hundreds digit, under control of such primary storage relays the secondary storage relays which cause punching in the proper denominational position should be selected. Hence, it will be seen that for setting up 1, 2 and 3 digits in the primary storage columns the relays set up in the primary storage unit select through their closed contacts relays of the secondary storage unit different from those which would have been selected if four digits were set up. This variable selection is necessary because the relays in the secondary storage unit have a predetermined and unchangeable relation to the instrumentalities for punching the card columns and when a storage relay in the secondary unit is selected it will

cause punching in the denominational position corresponding to the denomination of the secondary storage relay.

The selection of the relays of the secondary storage unit is determined by a series of selecting relays S1, S2, S3 and S4 (Fig. 7) which, when energized, close their respective contacts.

Referring to Fig. 4 the circuit for energizing the S relays is shown and when four digits are set up, column relays A, B, C and D are energized and hence with MBR4 contacts now closed the circuit will be closed from line 110, through DOA2 contacts now closed, wire 117, MBR4 contacts, thence serially through the A3, B3, C3, D3 contacts now transferred to select the S1 relay for energization, thence from such relay, by a wire 135, to line 111. With the S1 relay energized, all of its contacts shown in Fig. 7 will be closed and relays in the secondary storage unit will be selected which will cause the card to be punched in the proper denominational position. However, if three digits are set up, only the A, B and C column relays (Fig. 4) will be energized and the S2 relay will be selected for energization. Hence, the relays set up in the primary storage unit will, by virtue of the now closed contacts of the S2 relay, select other relays of the secondary storage unit in accordance with the preceding table.

When two digits are set up the S3 relay will be energized and the relays to the secondary storage unit will be selected according to the previous table so as to punch the digits in the tens and units order in the proper card column positions. With only one digit set up in the primary storage unit, the S4 relay will be selected and by virtue of its "2" contacts the 11—14 relay will select the 441—444 relay of the secondary unit and this, of course, will always cause punching in column 12 which is the card column for representing the units digit.

Secondary Storage Unit for Check Amount

As illustrated in Figs. 8 and 9, the secondary storage unit for the check amount includes eight groups of secondary relays corresponding to the eight groups of primary storage relays for the digit setup of the check amount. The primary storage relays close their respective "2" contacts shown in the upper part of Figs. 8 and 9 and in accordance with the particular contacts which are closed, the corresponding secondary storage relays will be energized by the same impulse circuit described in connection with the secondary storage unit for the bank number. Whenever a secondary storage relay is energized it will close its *h* contacts and the energized storage relay will be held energized.

Summarizing, upon the second depression of the manual bar a corresponding check amount digit setup will also be effected in the secondary storage relays to represent the digits of the check amount set up in storage columns 5 to 12.

Denominational Transfer in Transferring Digits of Check Amount from Primary Storage Unit to Secondary Storage Unit

In the same manner as described for transfer operations for the bank number, a denominational transfer will be effected when the digit setup of the check amount is made in the secondary storage relays, due to the fact that a variable number of digits may be set up in the primary storage relays and because the storage relays of the secondary unit have an unchanged denominational relationship with the punch recording magnets for punching columns 13 to 20 of the card (see Fig. 16).

From a comparison of Fig. 7 with Figs. 8 and 9, it will be observed that the circuit arrangement for effecting this variable denominational transfer is the same as has been previously described in detail except that for the denominational transfer for the secondary storage relays the shift circuit is extended due to the fact that eight digits may be set up in the primary storage relays. In accordance with the number of digits set up in the primary storage unit the S5 to S12 relays are energized by the selective circuit arrangement shown in Fig. 4 and in accordance with the particular column relays E—L which are energized, depending upon the number of digits set up, one or more of the "3" contacts will be transferred to thereby cause the energization of a selected relay S5—S12 by the circuit connection previously described. For example, when eight digits are set up in the primary storage relays, all of the "3" contacts of the column relays E—L will be transferred to energize S5 relay and when a single digit is set up only E column relay will be energized and by transferring its contacts will select the S12 relay. The intervening relays will be selected for energization when digits between 1 and 8 are set up in the primary storage unit. The particular manner in which the contacts closed by the S5—S12 relays cause the denominational transfer has been previously described in detail for the S1—S4 relays, and the operation in Figs. 8 and 9 is precisely the same. It is thought that further explanation is unnecessary at this point and by reference to the following table the variable denominational transfer from the primary storage relays to the secondary storage relays to punch the proper card columns will be apparent from a consideration of the following table:

Check Amount Denominational Transfer

No. of digits set up in primary storage columns	S relay energized	Relays set up in primary storage unit	Relays set up in secondary storage unit	To punch card columns
Tens mil.	S5	51–54 tens mil.	151–154	13 tens mil.
Millions		61–64 millions	161–164	14 millions.
Hds. th.		71–74 hds. th.	171–174	15 hds. th.
8 Tens th.		81–84 tens th.	181–184	16 tens th.
Thous.		91–94 thous.	191–194	17 thous.
Hundreds		101–104 hds.	1, 101–1, 104	18 hunds.
Tens		111–114 tens	1, 111–1, 114	19 tens.
Units		121–124 units	1, 121–1, 124	20 units.
Millions	S6	51–54 millions	161–164	14 millions.
Hds. th.		61–64 hds. th.	171–174	15 hds th.
Tens th.		71–74 tens th.	181–184	16 tens th.
7 Thous.		81–84 thous.	191–194	17 thous.
Hundreds		91–94 hds.	1, 101–1, 104	18 Hunds.
Tens		101–104 tens	1, 111–1, 114	19 tens.
Units		111–114 units	1, 121–1, 124	20 units.
Hds. th.	S7	51–54 hds. th.	171–174	15 hds. th.
Tens th.		61–64 tens th.	181–184	16 tens th.
6 Thous.		71–74 thous.	191–194	17 thous.
Hundreds		81–84 hds.	1, 101–1, 104	18 hunds.
Tens		91–94 tens	1, 111–1, 114	19 tens.
Units		101–104 units	1, 121–1, 124	20 units.
Tens th.	S8	51–54 tens th.	181–184	16 tens th.
Thous.		61–64 thous.	191–194	17 thous.
5 Hundreds		71–74 hds.	1, 101–1, 104	18 hunds.
Tens		81–84 tens	1, 111–1, 114	19 tens.
Units		91–94 units	1, 121–1, 124	20 units.
Thous.	S9	51–54 thous.	191–194	17 thous.
4 Hundreds		61–64 hds.	1, 101–1, 104	18 Hunds.
Tens		71–74 tens	1, 111–1, 114	19 tens.
Units		81–84 units	1, 121–1, 124	20 units.
Hundreds	S10	51–54 hds.	1, 101–1, 104	18 hunds.
3 Tens		61–64 tens	1, 111–1, 114	19 tens.
Units		71–74 units	1, 121–1, 124	20 units.
2 Tens	S11	51–54 tens	1, 111–1, 114	19 tens.
Units		61–64 units	1, 121–1, 124	20 units.
1 unit	S12	51–54 units	1, 121–1, 124	20 units.

Summarizing, upon the second depression of

the manual bar there is a transfer of the digit representations in the primary storage unit to the secondary storage unit and such digit representations are properly allocated in a denominational respect.

Deenergization of Primary Storage Relays for Subsequent Setup

Immediately following the transfer of the digit representations in the primary storage unit to the secondary storage unit, the relays of the former can now be deenergized and brought to their normal deenergized condition preparatory to subsequent storage operations effected by depressions of the digit keys according to the next data. The circuits for bringing about this status will now be described:

A repetition of the previously described circuits will facilitate understanding of these newly described circuits. It will be recalled that upon the second depression of the manual bar 102 the MBC relay is energized and is still energized when the manual bar is released. This release of the manual bar picks up the MBR relay for energization because the MBC3 contacts (Fig. 3) are now closed. With the MBR2 contacts now closed the relay T1 is energized providing R3—1 contacts are closed.

In the newly described circuit, the energization of the T1 relay closes its T1—3 contacts and since the R5—1 contacts are now closed it will be observed that a circuit is closed from the line 110 through DOB1 contacts, wire 130, through R5—1 contacts, through T1—3 contacts to the R2 relay, wire 131, wire 132, DOB2 contacts to the line 111. A stick circuit for the R2 relay is provided by its *h* contacts and the stick circuit extends back to the line 110 by wire 145, wire 130, and DOB1 contacts now closed. Relay R2 now closes its R2—1 contacts and by the circuit just described for picking up the R2 relay the R3 relay is now energized. The R3 relay opens its contacts R3—1, deenergizing the T1 relay which terminates the impulse for transferring the digit representations from the primary storage unit to the secondary storage unit. The sequential energization of relays R2 and R3 provides a delayed impulse to deenergize the T1 relay, providing a transfer impulse of sufficient duration to completely energize the secondary storage relays, such relays now being held energized by virtue of their *h* stick contacts. With the assurance that the secondary storage relays are energized and now held energized, the primary storage relays can now be deenergized by removing the current source from the stick circuits of the primary storage relays and the column relays A—L and other control relays whose stick circuits are controlled by the DOA2 and DOA3 contacts (Fig. 3).

When R3 relay is energized after the delayed energizing impulse, its contacts R3—2 are closed to effect the energization of the R4 relay through the R3—2 contacts and R5—2 contacts which are now closed. R4 relay opens R4—1 (Fig. 3) contacts to render the keyboard inoperable during digit transfer operations. The R4 relay closes its R4—2 contacts (Fig. 3) and a circuit is closed from the line 110, through R4—2 contacts, the DOA relay and by a wire 140 to the line 111. DOA relay opens its contacts DOA2 and DOA3. The DOA2 contacts open the stick circuit line 117 for the column relays A—L, inclusive and also for the holding coils of the primary storage relays. The opening of the DOA3 contacts (bottom of Fig. 3, right hand) breaks the stick circuits of the AS (AC1 relay if energized), and MBC relays and since contacts MBC3 will now open, the MBR relay is deenergized.

Deenergization of the T1 relay will cause its T1—2 contacts to close and such contacts are closed when MBR relay deenergizes. The latter enables its contacts MBR3 to close and upon such closure by an obvious circuit the R5 relay will be energized. R5 relay now opens its R5—2 contacts to deenergize R4 relay and upon the deenergization of the latter, R4—2 contacts open to deenergize the DOA relay. Hence, the DOA2 and DOA3 contacts close to normally condition the impulsing and holding circuits for the primary storage relays, conditioning the latter for subsequent digit storage setups.

The stick circuit for the R2 relay was previously described and it was stated that the R2 relay is held indefinitely by the aforesaid stick circuit as long as the DOB1 contacts remain closed. The *h* or stick contacts for R2 relay is the instrumentality for retaining the R3 relay energized for this duration and the stick circuit for R3 is from the line 111 through DOB2 contacts, wire 132, wire 131, relay coil R3, R2—1 contacts now closed, the *h* contacts of the R2 relay, thence by wire 145 and wire 130, through the DOB1 contacts to the line 110. Hence, relays R4 and R2 are held energized. While the energization of R3 relay closes R3—2 contacts, the R4 relay cannot be picked up for energization because the deenergization of the T1 and the MBR relays has closed the respective T1—2 and MBR3 contacts to energize the R5 relay. The latter opens its R5—2 contacts so that while the R3—2 relay contacts do close the opening of R5—2 contacts prevents R4 relay from being picked up. Hence, the DOA relay after its deenergization remains deenergized.

Punching Mechanism

Any suitable punching mechanism may be provided for digit punching so that upon the completion of the setting up of the primary storage units of any of the keyboard stations the punching mechanism may be placed into operation for punching on a card the digit representations set up in the secondary storage unit. The punching mechanism P outlined in Fig. 14 is of a form which is well known and fully shown and described in Patent No. 2,032,805, issued to C. D. Lake, March 3, 1936, modified according to the subsequent patent to C. D. Lake, No. 2,104,542, dated January 4, 1938. The necessary electrical instrumentalities of the punching machine involved in this invention are shown in Fig. 2 within the dotted line designated P, but for full details of operation of the punching machine reference may be had to the aforementioned patents. Later on a description of the electrical instrumentalities shown herein will be given in connection with the wiring diagram to set forth the manner in which the punching machine is coordinated with the present invention.

A feature of the punching machine shown in the aforementioned patents is the provision of feeding the record cards past the punches in the order of the index point positions 9, 8, 7–0, and as successive index point positions pass by the punches the energization of a punch magnet at a differential time will cause the operation of the punch to place a perforation in the related column of the card. Since the time necessary for punching all columns of a card is not de-

pendent upon the number of column positions, the punching mechanism shown in this patent is capable of high speed and in actual practice its speed was found to be sufficient to keep up with the digit storing by three keyboard operators. As will be later described, when a storage unit is completely set up and it is to control the punch, a signal arrangement initiates the operation of the punching machine and a card will then be fed from the supply hopper past the punches.

It is to be understood that the machine in the Lake patents punches cards, according to the Hollerith system, whereas digit setups effected in the primary and secondary storage units are according to a combination code. For this reason, the combinational setting of the relays must be translated to a single digit representation. Such forms of translators are well known and for the twelve sets of storage relays herein there are twelve translator contact arrangements shown in Figs. 10 and 11 for converting a combinational setting of the relays to a single representation for each digit. Taking, for example, the storage relays 111, 112, 113 and 114 which are set up singly or in combination in the secondary storage unit for punching card column 9, it will be observed that such relays having been energized and retained energized keep their "1, 2, 3 and 4" contacts closed singly or in combination in accordance with the original code (see Fig. 3). These contacts being interconnected in a certain way select one of a series of ten digit lines 150, which are marked 0–9, inclusive. The digit lines 150 are conveniently grouped in a cable 151 (Figs. 7, 6, 5 and 2 in the order named) and then branch out to be individually connected to digit segments 63 (Fig. 2) of an emitter of a well known form, which emitter also includes a rotatable brush 62 driven synchronously with the passage of the card by the punches. From Fig. 2 it will be seen that from the line 110, cam contacts R1 and circuit breaker contacts 68 are in series connection with the brush 62 of the emitter. Contacts R1 and 68 are identical in function to those similarly designated in the Lake patent, No. 2,104,542, and cam contacts R1 are closed by the punching machine during the period that the index point positions of the card pass by the punches and the circuit breaker 68 transmits through the emitter differentially timed impulses to the digit lines 150. The particular contacts of the relays 111, 112, 113 and 114 which are closed singly or in combination will select one of the digit lines. For example, the digit line 1 is selected by the energization of the relay 111 alone, the impulse circuit passing through 114—1, 113—2, 112—2 now in normal position and through 111—4 now transferred, to the "1" digit line. The 7 digit line is selected by the energization of relays 112 and 113, the line being closed through 114—1, 113—2 now transferred, 112—1 now transferred, through 111—1 now in normal position, to the 7 digit line.

It will be noted that from the 1 contacts of relays 114—1124, there are output wire connections to wires 155 to direct the impulses to the punch selecting magnets 76 (Fig. 2) of the corresponding card column position. When the DS1 unit of the No. 1 keyboard station is selected to control the punching machine the RO1 relay will be energized to close its RO1, 1—12 contacts in the manner to be subsequently described and the impulses transmitted to the wires 155 pass through such relay contacts. Wires 157 from the other side of the relay contacts are joined in the cable 156 (Figs. 10, 7, 6, 5 and 2) and the wires 157 thereof are connected to the punch selecting magnets 76, the common side of the latter being joined to the other side of the line 111. Therefore, according to the particular contacts of the translators which are open and closed, one of the digit lines 150 will be selected to select an impulse for the energization of the related punch selecting magnet 76. The punch selecting magnets 76 correspond to those similarly identified in the aforementioned patent to Lake, No. 2,104,542, and when energized cause the operation of a punch at the time that the index point position of the card is presented to the punch. It should also be noted that in the event that none of the digits 1–9 is stored in a particular storage column, as for example higher order columns for representing zeros at the left and columns representing intermediate zeros, all of the relay contacts of the translator relating to that storage column will be at normal position and normally the punch selecting magnet of that column will be energized at the time that the "0" index point position is presented to the punch. Taking, for example, the translator contact arrangement for punching card column 9, the "0" impulse is selected by a circuit passing through 114—1, 113—2, 112—2, 111—4, to the "0" line 150, all of said contacts being in normal position.

A complete circuit for energizing a punch selecting magnet 76 at a differential time is from the line 110, through cam contacts R1, impulse distributor contacts 68, brush 62 of the readout, a selected digit segment 63, through a related line 150, contacts closed by the relays 111, 112, 113 and 114, singly or in combination, to the output line 155 related to such contacts, RO1 contacts, wire 157, to a punch magnet 76 associated with the particular translator, thence to the line 111.

Summarizing, when a secondary storage unit of a particular station is selected for operation, its readout or RO relay will be selectively energized by a circuit to be subsequently described, the punching machine will be initiated in operation as will be subsequently described, and the emitter 62, 63 will transmit digit impulses to the lines 150. The translators will select digit lines to energize the punch selecting magnets 76 at differential times to thereby punch all card columns during a passage of the card by the punches. In the present example card columns 9–20 will be punched in a single passage of the card by the punches, the punched card then being fed by suitable rollers shown in the patent to Lake No. 2,104,542 to be fed into a storage hopper. Also as will be subsequently described, after relays of a secondary storage unit have been utilized to control digit punching operations, the stick circuits for such relays are then broken to normally condition the secondary storage unit to receive a subsequent transfer from the primary storage unit of the same station.

Error Key Operation

In the event the operator becomes aware of an error in a digit setup in the primary storage unit, it is possible to clear out the digit setup prior to its transfer to the secondary storage setup. The clearing out operation is effective for all storage columns previously set up. After an error key op-

eration the operator recommences the digit setup.

For this purpose, a key 101 which is similar to the digit keys is provided and is designated "error." This key is similar to the digit keys but has a notch 101*a* (Fig. 15) over bail 104 so that it does not close bail contacts 105. When depressed by the operator key 101 closes a circuit from the line 110 (Fig. 3) through R4—1 contacts now closed, wire 113, through the contacts closed by the error key 101, thence through the MBC4 relay contacts now closed, to the DOA relay coil, thence to the line 111. It will be recalled that the energization of DOA relay releases all the stick circuits for the column relays and the storage relays of the primary storage unit. Thus, if an operator is setting up information into the primary storage unit and an error occurs, depression of the error key will operate DOA relay which will completely clear out all information which has been set up in the primary storage unit and permit the operator to start anew.

Visible Warning Signals

The machine includes warning signals which will indicate to the operator the condition of the primary and storage units.

These warning signals consist of lamps L1 and L2 which it will be observed from Fig. 14 are mounted upon the tables of the keyboard stations. The illumination of each has a particular significance.

The lamp L1 is shunted across the MBR relay (Fig. 3) and is illuminated concurrently with the energization of such relay. It will be recalled that this relay is energized upon the second depression of the manual bar to transfer the digit setting from the primary storage unit to the secondary storage unit. The digit transfer is momentary and in the normal course of events the duration of the flash of the lamp L1 would be very short and need have no significance to the operator. Therefore, upon the second depression of the manual bar, and if the transfer is properly effected, the L1 lamp will be lighted and then extinguished.

If, for some reason, the transfer cannot be effected such as, for example, when the secondary storage unit has not been cleared out, the L1 lamp will not be extinguished even though the manual bar is held depressed. Therefore, for each successive release of the manual bar, the MBR relay will be energized and lamp L1 lighted and will not be extinguished until the digit transfer can be completed.

The additional lamp L2 serves as a warning to the operator that the digit transfer from the primary storage unit to the secondary storage unit has been completed but the secondary storage unit has not yet been cleared out. This visible signal comprising lamp L2 is shunted across the relay R2 and as long as a digit setting remains in the secondary storage unit, L2 lamp will remain lighted. This serves as a warning to the operator not to depress the manual bar to effect a transfer of the digit setting from the primary storage unit to the secondary storage unit because the latter has not been cleared out and is not in condition to receive such digit transfer.

Audible Signals

While the above mentioned visible signals are effective, it is desirable to provide an audible signal in the event that the operator attempts to depress the digit keys when the previously set information in the primary storage unit has not yet been transferred to the secondary storage unit.

Upon the second depression of the manual bar, it will be recalled that relay MBC is energized and held energized and retains its contacts MBC5 closed (Fig. 3). This relay is held energized until a transfer is effected from the primary storage unit to the secondary storage unit and if the operator depresses a digit key to attempt a new setup before this relay is deenergized, a buzzer will be sounded. When a digit key is depressed, a circuit will be closed from the line 110, through R4—1 contacts now closed, bail contacts 105, wire 112, wire 116, thence through the MBC5 contacts now closed, to the pickup coil of the BR relay, thence to line 111. The latter closes its *h* or stick contacts and the stick circuit extends back to line 110 through such contacts and wire 126. The BR relay closes its BR1 contacts which are in series with a buzzer unit shown in the lower right hand corner of Fig. 3. This buzzer is of a conventional construction. Therefore, for each key stroke effected under the above conditions, the impulse from wire 116 will also be directed through the BR1 contacts to the buzzer, thereby sounding the buzzer as long as a digit key is held down and for each succeeding key depression. In this case the deenergization of the BR relay cannot be corrected by the depression of the "error" key because the MBC relay has opened the contacts MBC4 in the error circuit. Therefore, it will be necessary for the operator to wait until the digit transfer can be effected from the primary storage unit to the secondary storage unit which, when effected, causes MBC relay to deenergize and open MBC5 contacts in the BR relay circuit. With the opening of the BR1 contacts by deenergization of the latter, the buzzer circuit is brought to its normal inoperative condition.

With the present arrangement it is, of course, essential that the motor bar be depressed following the setting up of digits of the bank number field so that the control circuits will be operative upon the second depression of the manual bar. The above described warning circuit for sounding the buzzer is also effective if the operator should neglect to depress the motor bar following the setting up of the digits of the bank number. That is, if five key depressions are made without a manual bar depression intervening before the fifth key depression, a circuit will be closed from the line 110 through the R4—1 contacts, bail contacts 105, wires 112 and 116, through the E5 contacts now closed, through the AS2 contacts now closed to the pickup coil of the BR relay. Hence, the fifth and each succeeding key depression will cause the sounding of the buzzer by the aforementioned buzzer circuit, indicating to the operator the failure to effect a manual bar depression after setting up the desired number of digits of the bank number.

In this case the condition is corrected by depressing the "error" key which it will be recalled, upon its depression, energizes the DOA relay and deenergizes all the stick circuits of the primary storage unit, as well as the stick circuit for the BR relay. Subsequently the operator may start over and proceed storing information as before.

Sequence Unit

Following the transfer of the digit setup into the secondary storage unit, further operation of the machine causes punching of this digit setup from the secondary unit as soon as the digit setup

is made, provided the punching machine is not in operation. Utilizing the maximum capacity of the machine, three operators are storing digit information in any random sequence and to cause punching operations to ensue as quickly as possible a sequencing unit has been provided which determines the sequence that the secondary storage units are utilized to control punching without entailing any undue delay to any particular operator.

The electrical instrumentalities of the sequencing unit are located in the sequence unit designated S in Fig. 14. The electrical instrumentalities of the sequencing unit are shown in all of Fig. 1 and the left hand portion of Fig. 2 and such instrumentalities are wired to the digit setup units DS1, DS2 and DS3. It is pointed out that the electrical instrumentalities for the punching machine are shown in Fig. 2 within the confines of the dotted line box designated P. In view of the fact that it will be easier to visualize the operation of the sequence unit when only one storage unit is set up at a time, the operation of the circuits will be given with this taken into consideration. It will be assumed that the operator at station 1 has set up digit information in the primary unit and has transferred this data to the secondary storage unit whereupon the sequencing unit discerns this fact and initiates the operation of the punching machine under control of the secondary storage unit.

It will be recalled that when a digit transfer is made from the primary storage unit to the secondary storage unit relay 3 will be energized and the energization of the latter is the signal instrumentality which indicates that punching operations may now proceed under control of the secondary storage unit. This signal indication is effected by the closure of contacts R3—4 and R3—5 (Fig. 3) which are within the digit setup unit DS1 and have suitable wire connections to electrical elements in the sequence unit. When contacts R3—4 close, it will be noted that an attempt will be made to close a circuit to R11 relay, the circuit being from the line 110 through contacts R3—4, wire 160, through relay contacts R16—4 now open to the R11 relay which is connected to the line 111. Hence, the R11 relay circuit will be open at this point. However, the closure of R3—5 contacts closes a circuit from the line 110 through such contacts, thence by a wire 161 to contacts R11—2 which are now closed, and thence through cam contacts SC1 which are in the punching machine, thence through R18—2 contacts to the pickup coil of R14 relay to the line 111. SC1 cam contact is driven by a cyclically operable shaft in the punching machine and closes its contacts at the desired time (see Fig. 17) and the purpose of this contact is to prevent sequence indications from being set up during that portion of the punching cycle devoted to the selection of the digit setup unit under control of which punching is to be performed. R14 relay closes its *h* contacts and provides a stick circuit by the line 162 through relay contacts R18—1 now closed, R14—5 contacts now closed and a wire 163 back to the line 110. R14 relay closes its contacts R14—4 so that the impulse circuit from the contacts R18—2 is extended through R14—4 contacts, thence serially through the C1—2 contacts, C3—2 contacts, C5—2 contacts to the pickup winding of the R15 relay, thereby energizing the latter and it, in turn, closes its *h* contacts to provide a stick circuit for the relay by the stick circuit line 162. R15 relay, in turn closes its relay contacts R15—7 and the impulse is extended from the R14—4 contacts through the R15—7 contacts, thence serially through R11—5, R12—5 and R13—5 contacts, all of which are in the normal position shown, to the pickup winding of R16 relay to the line 111. R16 relay, in turn, closes its *h* stick contacts to provide a stick circuit for R16 relay by the stick circuit line 162. The R16 relay closes the R16—4 contacts, thereby energizing the R11 relay and the stick circuit for the latter extends back to the line 110 through its *h* stick contacts, wire 160 and the R3—4 contacts. R16 relay closes its R16—7 contacts and the aforementioned impulse is now directed to the punch start relay PS, the pickup winding of which is connected to the line 111. The PS relay closes its PS1 contacts, thereby extending the impulse to the pickup winding of the R17 relay. The R17 relay closes its *h* contacts and the stick circuit extends back to line 110 through the R14—8 contacts which are now closed, whereas the PS relay closes its *h* contacts and the stick circuit extends back to the line 110 through the R11—3 contacts.

When R17 relay energizes, it closes its R17—1 contacts to pick up the R18 relay. The opening of the R18—1 contacts opens the stick circuit for the R14, R15 and R16 relays. R14, R15 and R16 relays now being deenergized open their respective contacts R14—8, R15—8 and R16—8 to break the holding circuit for the R17 relay. R17 relay now being deenergized opens its R17—1 contacts to deenergize R18 relay. At this stage of the operation in the sequence unit, R14, R15, R16, R17 and R18 relays are now deenergized. However, the R11 relay is still held energized by its stick circuit since the latter is still closed by its *h* contacts and the R3—4 contacts which are still closed. The PS relay is also held energized by reason of the continued closure of the R11—3 contacts. The function of the punch start relay PS will now be explained.

In Fig. 2 it will be observed that the PS relay closes the PS2 contacts and in function such contacts correspond to the P12 contacts shown in Fig. 7 of Patent No. 2,104,542. The purpose of the P12 contacts in the patent and PS2 contacts herein is to transmit an impulse to the motor relay magnet 136 of the patent by precisely the same circuit connections as shown in the patent. The energization of the motor relay magnet 136 as described in the patent completes the circuit to the punch driving motor M and the punching machine will thus be placed in operation and the card feeding mechanism will advance a blank card from the supply hopper past the punches.

By circuit connection now to be described, an operative connection is made between the punch selecting magnets 76 and the translators of the digit setup unit DS1. The engagement of the clutch in the punching machine causes the rotation of a shaft which drives parts of the punching machine and also the shaft which rotates the cams for closing the SC cam contacts shown in Fig. 2. Cam contacts SC3 close early in the punching cycle so as to complete a circuit from the line 110 through the SC3 cam contacts and a chain circuit passing serially through the C2—2, C4—2, C6—2, C1—4, C3—4, C5—4, all now in the normal position in the example assumed, thence through R11—4 contacts now transferred, to the R01 relay to the line 111. R01 relay closes its *h* contacts and a stick circuit back to line 110 is provided through such contacts and the SC5 cam

contacts. The latter are timed to hold the R01 relay energized during the time all of the digit impulses are transmitted by the emitter 62—63. The R01 relay, it will be recalled, when energized closes its R01, 1—12 contacts (Fig. 10), establishing an operative connection between all translator columns and the punch selecting magnets 76. Hence, the setting of the translator columns will select predetermined impulses transmitted by the emitter 62—63 and such impulses will be transmitted to the punching magnets 76 at times in synchronism with the presentation of successive index point positions to the punches. Hence, the card will be punched to represent in the Hollerith code the digits originally set up under control of the keys and stored in the digit setup unit DS1.

At the close of the punching cycle, cam contacts SC4 will transmit an impulse from the line 110 through such cam contacts, the R01—1 contacts (Fig. 2) and the impulse will then be directed by a wire 164 (Figs. 2 and 3) to the DOB relay to the line 111. Opening of the DOB1 and DOB2 contacts breaks the holding circuit for the storage relays of the secondary unit and likewise the opening of the DOB1 contacts opens the circuit for the R2 relay and the R3 relay which deenergizes and the opening of its contacts will break the holding circuits for the R11 relay. Of course, the deenergization of the R2 relay will likewise cause the L2 signal light to be extinguished, indicating to the operator that a card has been punched under control of the secondary storage unit pertaining to the related operator station and hence if a digit setup has been made in the primary storage unit it can now be transferred to the secondary storage unit.

Multiple Keyboard Stations

The punching machine disclosed herein is capable of punching cards at a rate of 100 cards per minute and in order to utilize as much as possible the full capacity of the machine the punch has coordinated therewith three keyboard stations, as outlined in Fig. 14. The circuit arrangement for No. 1 keyboard station has been set forth in the previous description and in view of the duplication of the construction of the keyboards and the digit setup units of the other stations, a repetition of this circuit description is believed to be unnecessary. Hence, all the duplicate wiring connections and electrical instrumentalities are not fully shown for keyboard stations Nos. 2 and 3 and by reference to Fig. 12 it will be seen that these are merely outlined, DS—2 indicating that within the outline the electrical instrumentalities utilized for the digit setup unit for No. 2 keyboard station are included. DS3 is the designation of the digit setup arrangement for the No. 3 station. It will be understood that within the confines of such dotted outlines the same circuit arrangement shown for keyboard station No. 1 in Figs. 3–11, inclusive is included. Of course, the keyboard arrangement for such stations, identified by K2 and K3 in Fig. 12, corresponds to the electrical keyboard arrangement shown fully in Fig. 3 for station No. 1. Some of the external wiring connections will now be described to more fully understand the coordination of keyboard stations No. 2 and No. 3 with the sequencing unit S.

From Fig. 3 it will be seen that the supply line 111 provides the current supply for station No. 1 by juncture to post No. 2. From Fig. 12 it will be observed that the line 111 is also connected to similar numbered posts for stations No. 2 and No. 3. The current supply line 110 for station No. 1 connects at post No. 1, as shown in Fig. 3, and for the other keyboard stations No. 2 and No. 3 there are provided wire connections from line 110 to similarly numbered posts. (See Fig. 12.) It will be recalled that there is a wire connection 135 (Fig. 4) for a current supply from the line 111 to the post No. 3 (Fig. 4). Similarly, there are wire connections 135_2 and 135_3 (Fig. 12) from the line 111 to similarly numbered posts for stations No. 2 and No. 3. This latter wire connection provides current for energizing the shift relays S4 to S12, inclusive, it being understood, of course, that the other keyboard stations have similar electrical column shift arrangements.

It will be noted that for stations No. 2 and No. 3 the digit set units DS2 and DS3 have the same arrangements of digit setup relays for the primary storage unit and the secondary storage unit, and the control relays R1—R5, T1, etc., shown at the right hand of Fig. 3 for station No. 1 are duplicated for the other keyboard stations.

From Figs. 4 and 12, it will be observed that the impulses directed by the emitter 62—63 and transmitted by wires in the cable 151 are also transmitted by branch cable connections 151_2 and 151_3 to the impulse lines for the translators of stations No. 2 and No. 3. Branch cable connections 156_2 and 156_3 for stations No. 2 and No. 3 also connect the punch selecting magnets 76 to contact points of the respective relays R02 and R03. Of course, the energization of the R02 relay will make an operative connection between the punch magnets 76 and the column wires of the translators for station No. 2 when station No. 2 has been selected for reading out of the digit representations of DS2. In all respects the manner in which the digit representations on the translators of stations No. 2 and No. 3 are read out to control the energization of the punch selecting magnets 76 at differential times is precisely the same as has been explained for station No. 1.

There will now be described the circuit arrangement whereby the translator of station No. 2 controls the punching machine for punching information on a card corresponding to the digit set up by the keyboard operator for station No. 2. For simplicity in explanation and for a better understanding of the complex circuit arrangement it will be assumed that after a card has been punched to represent a digit setup of station No. 1 the secondary storage unit of station No. 2 then receives a transferred digit representation, which is now set upon the corresponding translator. When a transfer of digit representation is effected from the primary storage unit to the secondary storage unit for station No. 2, a relay R3 in the DS2 unit (Fig. 12), corresponding to the R3 relay of Fig. 3, is energized and the energization of such relay is a signal that punching may now proceed under control of station No. 2. From the R3—4 contacts of station No. 2 there is a wire connection 170 leading as shown in Figs. 12, 4, 3 and 1 in the order named to the R12 relay but such relay is not energized due to the opening of R16—5 contacts. Relay R3 in station No. 2 also closes its contacts R3—5, corresponding to the R3—5 contacts in Fig. 3, thereby connecting the line 110 through such contacts and wire 173 (Figs. 12, 4 and 1 in the order named) to the R12—2 contacts now closed.

By the circuit description previously outlined, this circuit connection is continued through SC1, through R18—2 contacts, to cause the energization of the R14 relay which, in turn, causes the energization of the R15 relay which, in turn, causes the energization of the R16 relay and the latter closes its R16—5 contacts to energize the R12 relay. After R16 has been energized, the latter, in turn, causes the energization of the R17 relay and the punch start relay PS, and R17 relay, in turn, picks up the R18 relay for energization. The detailed circuit description for energizing these relays has been given previously. However, the stick circuit for the PS relay is through the R12—3 contacts in this instance.

The punching machine is initiated into operation by the closure of the PS2 relay contacts in the manner previously described and during the initial cyclic operation of the punching machine SC3 contacts close, completing a chain circuit through the aforementioned contacts C2—2, C4—2, C6—2, C1—4, C3—4, C5—4 and R11—4, all of which contacts are in normal position, the circuit then extending through R12—4 contacts now transferred and in this case to the R02 relay. The latter energizes to connect the translator for keyboard station No. 2 to the punch selecting magnets 76 and the digit representation on such translator now controls the punching machine to punch a card corresponding to the digit set up for station No. 2.

Likewise, the R02—1 contacts close so that when SC4 cam contacts close an impulse will be directed to R02—1 relay contacts and by wire 175 (Figs. 2, 4 and 12 in the order named) to post No. 4. This will transmit an impulse to the DOB relay for the DS2 unit, thereby conditioning the secondary storage unit for such station to normal.

If, after completion of this card punching operation the operator at station No. 3 has made a digit transfer to the secondary storage unit of such station, its corresponding R3 relay will be energized and this will be a signal to indicate that punching may now proceed under control of the translator for station No. 3. The wire connection 174 from the R3—5 contacts of station No. 3 transmits an impulse through the R13—2 contacts to cause the sequential energization of the R14, R15, R16, R17 and R18 relays and also the punch start relay PS. The R16 relay in this instance when it closes its R16—6 contacts will select the R13 relay for energization, this, of course, being afforded because there is a wire connection 171 from the R16—6 contacts (Figs. 1, 4 and 12 in the order named) to the R3—4 contacts of station No. 3. The SC3 contacts (Fig. 2) will, in this instance, transmit an impulse through the previously described chain circuit but through the R13—4 contacts to energize the R03 relay. This will select the translator for station No. 3 for controlling the punching of a card representing the digits set up by the operator at station No. 3. Closure of the R03—1 contacts will transmit an impulse by wire 176 (Figs. 2, 4 and 12 in the order named) to the DOB relay of station No. 3, breaking all the holding circuits of the secondary storage relays, thus conditioning the secondary storage unit of station No. 3 to normal.

In the preceding description it was explained for the sake of simplicity that the operators finish their digit setups in sequence and that punching of a card was completed before the transference of a digit set up from a primary storage unit to a secondary storage unit was effected by an operator at another keyboard station. However, in actual practice, the operators will not terminate their digit setups in such sequence and the digit setups will be completed at random and may occur during a card punching operation. In this case, to prevent undue delay to the operator and to provide an equitable distribution between the several operators the circuit arrangement is such that the sequence unit senses the sequence in which operators complete digit transfer operations and controls the punching machine so as to punch from the stations in the same sequence. By such sensing the flow of output is performed in the proper manner without favoring any particular operator, enabling each operator to perform the maximum amount of work precisely in accordance with the same amount of work that an operator could perform if she was provided with her own punching machine. This circuit arrangement will now be described in detail:

Sequence of Punching Operations When Digit Setups Are Completed in Irregular, Overlapping Sequence

For a further understanding of the operation of the sequencing unit, it will now be assumed that signals are received from stations Nos. 1, 2 and 3 in succession in the named order and so rapid that all signals are received before the first operation of the punching machine can take place. In this case cam contacts SC1 are normally closed (Fig. 17) because the punching machine has not yet been initiated into operation. The impulse transmitted from the No. 1 station will energize the R11 relay by the circuit previously described in detail but since no other stations are waiting to control punching operations, none of the C1—C6 signal storing relays will be energized at this time. Immediately after the energization of the R11 relay and PS relay and with all of the R14, R15, R16, R17 and R18 relays now in normal deenergized condition, the second impulse transmitted from the No. 2 station will be initiated by closure of its R3—5 contacts and be directed by a line 173 (Figs. 12, 4 and 1), through the R12—2 contacts, thence through the SC1 cam contacts while they are closed, through R18—2 contacts, pickup winding of R14 relay. R14—4 contacts now close to pick up the R15 relay, the energizing circuit being serially through C1—2, C3—2 and C5—2, all of which are now at normal. R15 relay now energizing will close the R15—2 contacts and concurrently open the R15—1 contacts. Thus, when contacts R14—5 close, a circuit will be closed from the line 110, wire 163, relay contacts R14—5, R18—1 contacts, R16—1 contacts, R15—2 contacts now closed, R11—1 contacts now closed because of the previous energization of the R11 relay, to the pickup winding of C1 relay coil to the line 111. The pickup winding of C1 relay closes its *h* contacts and the stick circuit extends back by a wire 180 (Figs. 1 and 3), thence through the DOB1 contacts (Fig. 3) of station No. 1 now closed, to the line 110. Thus, C1 relay energizes and is held energized. Of course, since R15—1 contacts are opened when the C1—1 contacts are closed by the C1 relay, this impulse cannot be transmitted at this time to the C2 relay. The C1 relay coil transfers its contacts C1—2 and closes C1—3 and they remain transferred and closed. The closure of the R15—7 contacts directs the transmission of the impulse through R11—5 contacts now transferred, C1—3 contacts now closed, thence serially through R12—5, R13—5 to the pickup winding of R16 relay which is held by the stick circuit previously described

in detail. R16 relay now closes its contacts R16—5 to cause the R12 relay to be picked up. From post No. 6 of station No. 2 (Fig. 12), to which post the R3—4 contacts of the R3 relay of station No. 2 are connected and the wire 170 (Figs. 12, 4, 3 and 1), the circuit extends by wire 170 through the R16—5 contacts to the R12 relay which energizes and is held energized by the closure of its *h* contacts, the stick circuit extending back to the line 110 by wire 170 and relay contacts R3—4 of station No. 2.

In the same manner previously described, closure of R17—1 contacts causes the R18 relay to energize and the latter opens its 18—1 contacts to deenergize the R14, R15, R16 and R17 relays. Since R12 is now energized, it will be observed that the stick circuit for the PS relay is also closed by the R12—3 contacts for the purpose of automatically effecting a second cyclic operation of the machine for reading out the digit representation of station No. 2 after the first cycle is completed and R11—3 contacts open.

It will also be assumed that a third signal immediately follows the reception of the second signal from station No. 2 and that this signal emanates from station No. 3. In the same manner previously described the R14 relay is energized.

The third impulse to energize the R14 relay comes from the R3—5 contacts of the R3 relay pertaining to station No. 3 which contacts are connected to a post No. 7. Wire 174 (Figs. 12, 4 and 1) connected to this post extends the impulse through the R13—2 contacts to the R14 relay by the circuit previously explained. R14 relay by the R14—4 contacts picks up the R15 relay. However, the impulse for energizing the R15 relay directed from the R14—4 contacts, now passes through the C1—2 contacts now transferred, C2—1 contacts now closed, then serially through C3—2 and C5—2 contacts now in normal position, to the R15 relay. It will be observed that the impulse for energizing the R14 relay now passes through the R15—1 contacts which are now closed, thence through the R14—1 contacts now closed, the C1—1 contacts previously closed, to the C2 relay.

C2 relay having been energized closes its *h* contacts and the stick circuit extends back by wire 181 (Figs. 1 and 3) through the DOB2 contacts of station No. 1 to the line 111. So far in the circuit description the R14, the R15 and the C2 relays are energized. When the R15 relay energizes it closes its contacts R15—4 and an impulse is transmitted from the R16—2 contacts, the R15—4 contacts now closed, R12—1 contacts closed due to the previous energization of the R12 relay, to the pickup winding of the C3 relay. The latter closes its *h* contacts and the stick circuit extends back to the DOB2 contacts of station No. 3 by wire 182. When the R15—7 contacts close the impulse is directed through the transferred R11—5 contacts, C1—3 contacts now closed, thence through the R12—5 contacts, C3—3 contacts, the R13—5 contacts to the R16 relay. R16 relay now energizing closes its R16—6 contacts to energize the R13 relay. From Fig. 12 it will be observed that post No. 6 of station No. 3 has connected thereto the R3—4 contacts of R3 relay pertaining to this station and with relay contacts R3—4 closed the impulse is transmitted by the wire 171 (Figs. 12, 4, 3 and 1) through the R16—6 contacts to the R13 relay. The latter closes its *h* contacts and the R13 relay is held energized through such contacts and R3—4 contacts of station No. 3 back to the line 110 by wire 171. With the energization of the R13 relay it will be observed that the closure of the R13—3 contacts closes the stick circuit for PS relay and provides for the third cyclic operation of the punching machine to punch the digit representations under control of station No. 3. At this stage in the operation of the machine the C1, C2, C3, R11, R12, R13 relays are energized and the punch start relay PS was energized immediately upon the reception of the first signal. It will now be assumed that following the reception of the three signals cam contacts SC3 close during the first operation of the punching machine and the latter will transmit an impulse to the RO selection circuit.

The condition of the RO selection circuit shown in Figs. 1 and 2 is now such that the contacts controlled by the C3, C2, C1, R13, R12 and R11 relays are all transferred and others normal. Therefore, the first impulse transmitted by the SC3 contacts is directed to the C2—2 contacts now transferred, to the R01 relay. Therefore, in the manner previously described there will be a readout of the digit representations of station No. 1 thence it was from this station the first signal was received and set up. Upon punching of a card for station No. 1, R11 relay deenergizes as well as relays C2 and C1. The punch start relay PS, however, is still energized because of the continued closure of the R12—3 and the R13—3 contacts and a second cyclic operation of the punching machine ensues and SC3 cam contacts again transmit an impulse which now goes through the normalized C2—2 contacts, C4—2 contacts, C6—2 contacts, the C1—4 contacts now in normal position, to the C3—4 contacts which are now transferred, and thus the impulse is directed to the R02 relay. During the second cycle of operation of the punching machine which automatically follows the digit representations of station No. 2 will be read out and a card correspondingly punched. At the end of the second cycle of operation of the machine the R12 and C3 relays deenergize and now only the R13—4 relay remains energized so that the impulse directed by the SC3 cam contacts goes through serially all of the C relay contacts which are now in normal position, thence through R11—4, R12—4 contacts now in normal position, through the R13—4 relay contacts which are now transferred, thence to the R03 relay and hence the digit representations of station No. 3 will be read out to control the punching of a card. At the end of the third cyclic operation of the machine the R13 relay deenergizes and opens its R13—3 contacts to deenergize the punch start relay PS, causing the punching machine to stop. However, before the R13 relay is deenergized other impulses may be transmitted from station No. 1 or No. 2 and if a signal from station No. 1 was received before station No. 2 the next cyclic operation of the punching machine will cause a readout of digit representations of station No. 1. If a signal was received from station No. 2 before a signal from station No. 1 then station No. 2 would take precedance. Hence, when signals are received successively, punching operations for the stations take place in the same order that the digit setups therein were finished and card punching operations follow automatically and in the same order the signals are received.

It is, of course, apparent that with the possibility of receiving three signals from the three stations in many different orders, it would be equally impossible to describe the operation of the sequencing circuit for all the possible permutations of reception of signals. However, the purpose of the relays, particularly the manner in which they are set up to represent stored up signals will be described to understand the principle of operation of the sequencing unit. At this point it should be observed that the C relays are utilized to store up signals received to control the punching machine in a particular sequence and the latter will punch out the digit representations from the stations in the same order they are received. This is carried out by having the "2" and "4" contacts controlled by the C relays, as well as "4" contacts controlled by the R11, R12 and R13 relays (Fig. 2) determine the sequence of energization of the R0 relays each time the SC3 cam contacts transmit a selection impulse.

It should be observed that if no stations are awaiting their turn to control the punching machine then the first signal transmitted energizes only the particular relay R11—R12—R13 related to the station sending the first signal. That is, a signal from station No. 1 energizes R11, one from No. 2 energizes R12 and one from No. 3 energizes R13. The closure of the related "1" contacts (Fig. 1) determines whether C1, C3 or C5 is to be energized if a successive signal is sent. Thus, C1 is always the signal receiving relay for receiving the second signal if station No. 1 sent a preceding signal to energize R11. C3 picks up for the second signal if R12 was energized by the first signal, and C5 picks up for the second signal if R13 was energized by the first signal.

As to the setup for the third signal, the energization of C2, C4, C6 is determined by the previous closure of the "1" contact of the previously energized C1, C3 and C5 relays. There is also a concurrent energization of the C1, C3 and C5 relays dependent upon the station sending the second signal.

Consider the following examples:

Punch in order 1—2—3

R11 energized on first signal.
C1 energized on second signal and R12.
Third signal energizes R13 and C2 and C3 because R12 is set up for second signal.
Relays energized—R11, R12, R13, C1, C2, C3.
First cycle—R01 picked up by C2—2. Relays C1, C2, R11 drop out.
Second cycle—R02 picked up by C3—4. R12, C3 drop out.
Third cycle—R03 picked up by R13—4. R13 drops out.

Punch in order 1—3—2

R11 energized on first signal.
C1 energized on second signal and R13.
Third signal energizes R12, C2 and C5 because R13 is set up for first signal.
Relays energized—R11, R12, R13, C1, C2, C5.
First cycle—R01 picked up by C2—2. C1, C2, R11 drop out.
Second cycle—R03 picked up by C5—4. R13, C5 drop out.
Third cycle—R02 picked up by R12—4. R12 drops out.

Punch in order 2—1—3

R12 energized on first signal.
C3 set up for second signal and R11.
Third signal energizes R13, C4 and C1.
Relays energized—R11, R12, R13, C1, C3, C4.
First cycle—R02 picked up by C4—2. R12, C4, C3 drop out.
Second cycle—R01 picked up by C1—2. R11, C1 drop out.
Third cycle—R03 picked up by R13—4. R13 drops out.

Punch in order 2—3—1

R12 energized on first signal.
C3 set up on second signal and R13.
Third signal energizes R11, C4, and C5.
Relays energized—R11, R12, R13, C3, C4, C5.
First cycle—R02 picked up by C4—2. R12, C3 and C4 drop out.
Second cycle—R03 picked up by C5—4. C5 and R13 drop out.
Third cycle—R01 picked up by R11—4. R11 drops out.

Punch in order 3—2—1

R13 energized on first signal.
C5 set up on second signal and R12.
C6 set up on third signal; also C3 and R11.
Relays energized—R11, R12, R13, C3, C5, C6.
First cycle—C6—2 picks up R03. C6, C5 and R13 drop out.
Second cycle—C3—4 picks up R02. C3 and R12 drop out.
Third cycle—R11—4 picks up R01. R11 drops out.

Punch in order 3—1—2

R13 energized on first signal.
C5 set up on second signal and R11.
C6 set up on third signal and R12; also C1.
Relays energized—R11, R12, R13, C1, C5, C6.
First cycle—C6—2 picks up R03. C6, C5 and R13 drop out.
Second cycle—C1—4 picks up R01. C1 and R11 drop out.
Third cycle—R12—4 picks up R02. R12 drops out.

Sequencing for Signals Received Simultaneously

If impulses are received from two or three stations simultaneously, or very nearly simultaneously, the sequencing unit will cause punching to be effected from the stations in a predetermined sequence. For example, signals from stations Nos. 1 and 2 may be received simultaneously and R11 and R12 will both be energized. However, upon transmission of the selection impulse by SC3, R01 will be energized first because of the precedence in order that R11—4 contacts take with respect to R12—4 contacts. Three simultaneous signals from stations Nos. 1, 2 and 3 will cause readout from such stations in the named order.

The particular order in which recording is effected is also influenced and controlled by the stick circuits for R11, R12, R13 relays. Upon completion of punching a card under control of the stations the respective R3 relays of such stations deenergize to open their R3—4 contacts and deenergize their related R11, R12 and R13 relays. By similar wire connections the R11 relay is deenergized when the R3—4 contacts of station No. 1 open, R12 deenergizes when the R3—4 contacts of station No. 2 open and R13 deenergizes when the R3—4 contacts of station No. 3 open. Thus, the normalizing of R13—4, R12—4, R11—4 contacts in the RO selection circuit also control the order of readout of the stations.

FURTHER OBSERVATIONS OF SEQUENCING CIRCUIT

As the C relays which are utilized to set up received signals are deenergized, they also enable the normal positioning of their "2" and "4" contacts to control the punching sequence. The C1 and C2 relays are deenergized upon the opening of the DOB1 and DOB2 contacts of station No. 1. By similar wire connections DOB1 and DOB2 contacts of station No. 2 deenergize the C3 and C4 relays, and also DOB1 and DOB2 contacts of station No. 3 deenergize the C5 and C6 relays.

The continued cyclic operation of the machine is held by the R11—3, R12—3 and R13—3 contacts in the stick circuit of the PS relay (Fig. 1) and as long as one of the R11, R12, R13 relays is energized the punching machine continues its operation.

Another observation that should be made is the relative timing of the SC1 and SC3 contacts. In prior examples it was assumed that one or more signals are received when the punching machine is at rest, with SC1 contacts normally closed. This is not always the case but to prevent signals received from any of the stations from affecting the selection circuit when SC3 cam contacts close to determine the sequence of recording of previously received signals, cam contacts SC1 are open at this time. (See Fig. 17.) Thereafter, when a sequence of punching has been determined, cam contacts SC1 close for the duration of the punching cycle and any previously received signals, or subsequently received signals, may set up the R11, R12, R13 and C relays for determining the sequence of subsequent punching.

It is also unnecessary to terminate punching after three signals are received, as might be interpreted from the previous examples because in the third punching cycle another one or more signals can be received and effect a still further cyclic operation of the punching machine. This signal may even be derived from the last station utilized to control the punching machine because upon completion of punching from a station the R11, R12, R13 relays can again be set up and a repetition of punching under control of the same station follows. For example, if punching takes place from station No. 1, R11 is energized to open R11—2. If R12 and R13 are energized from previously received signals R12—2 and R13—2 are also open. Upon completion of punching from station No. 1 R11 deenergizes and a signal may again be sent from this station. Its R3—5 contacts close and through R11—2 energizes R14, and other relays in the manner previously explained to set up a sequence signal for station No. 1.

It should also be observed that relays C1, C2, C3, C4, and C5 and C6 are energized in sequence in pairs. First C1, and then C2, C3 if selected then C4, C5 if selected and then C6. Simultaneous energization for one signal is prevented because as one pair of R15 contacts close in the circuit of the odd numbered C relay the other R15 contacts in the even numbered C relay opens. Note: R15—2 closes as R15—1 opens. The even numbered C relay is picked up by the "1" contacts of the odd numbered C relay and the second signal before R15 energizes. The energization of R15 is held up to take care of this by the contacts controlled by the C relays which are in the R15 energizing circuit. C1—2 transfers after R15 energizes on the first signal. The second signal energizes C2 before R15 due to the opening of C2—1. When C2 energizes C2—1 closes and then R15 is picked up. This same sequence occurs for other pairs of relays C3, C4, and C5, C6 due to the similar positioning of their contacts in the R15 energizing circuit.

As for the energizing circuit for the R16 relay the impulse from R15—7 passes through the "5" contacts of all of the previously energized R11, R12, R13 relays, if any are energized, and through such transferred contacts if any are, and C1—3, C3—3, C5—3 contacts when they close.

As for the R17 relay the latter is held energized as long as any of the R14, R15, R16 relays are energized because the stick circuit for R17 is through R14—8, R15—8 and R16—8 contacts. Of course as long as R17 is energized R17—1 contacts are closed to keep R18 energized.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a single embodiment, 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 claims.

What is claimed is as follows:

1. In a punching system having a single punching machine for punching digit representations derived from a plurality of control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each station for invariably setting up digit representations in one storage device and upon completion of digit setups therein for transferring the digit representations to the other storage device of the same station, and sequencing means for causing the punching machine to successively punch digit representations under control of the storage devices which receive the transferred digit representations.

2. In a punching system havng a single punching machine for punching digit representations derived from a plurality of punch control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each station for always setting up digit representations in one storage device and upon completion of digit representations therein for transferring the digit representations to the other storage device of the same station, and sequencing means for effecting the operation of the punching machine under control of the storage devices receiving the transferred digit representations and in the same order that the storage devices receive transferred digit representations.

3. In a punching system having a single punching machine for punching digit representations derived from a plurality of punch control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each station for always setting up digit representations in one storage device, manual means operative upon completion of digit representations in said keyboard controlled storage device for transferring the digit representations from the keyboard controlled storage device to the other storage device of the same station and clearing said keyboard controlled storage device, and means for effecting the operation of the punch-

ing machine in succession under control of the storage devices receiving transferred digit representations.

4. In a punching system having a single punching machine for punching digit representations derived from a plurality of punching control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each station for always setting up digit representations in one keyboard controlled storage device and upon completion of digit representations therein for transferring the digit representations to the other storage device of the same station and clearing out the keyboard controlled storage device, sequencing means to connect the storage devices receiving the transferred digit representations to said punching machine in the same order that the storage devices receive transferred digit representations and to operate said punching machine under control of the connected storage device, and means operative when said storage devices have been utilized to control digit punching by the punching machine to clear the storage devices of their digit representations.

5. In a punching system having a single punching machine for punching digit representations derived from a plurality of punching control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each station for always setting up digit representations in one storage device, manual means operative upon completion of digit registrations in the keyboard controlled storage device for transferring the digit representations to the other storage device of the same station, and means initiated in operation upon completion of a storage device receiving the transferred digit representations for connecting the punching machine with the storage devices receiving the transferred digit representations, said last named means comprising sequencing means to connect the punching machine to the storage devices in the same order the latter receive the transferred digit representations.

6. In a punching system having a single punching machine for punching digit setups derived from a plurality of punching control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each station for always setting up digit representations in one storage device and upon completion of digit registrations therein for transferring the digit representations to the other storage device of the same station and for clearing out the keyboard controlled storage device, and sequencing means for connecting the storage devices receiving the transferred digit representations to said punching machine to punch under control of the storage devices in succession and in the same order that the storage devices receive transferred digit representations.

7. In a punching system provided with a single punching machine for punching digit representations derived from a plurality of keyboard stations, the combination of a plurality of storage devices at said stations, means under control of the keyboard at each station for setting up said storage devices to represent digit representations, and means to connect the storage devices receiving completed digit representations with said punching machine comprising sequencing means to connect said storage devices with said punching machine in the same sequence that digit representations are completed in the storage devices, whereby in order of seniority and completion of digit representations the plurality of storage devices control the punching machine.

8. In a punching system provided with a single punching machine for punching digit representations derived from a plurality of keyboard stations, the combination of a plurality of storage devices at said stations, there being only one storage device at each station to control the punching machine, means under control of the keyboard at each station for setting up said storage devices to receive completed digit representations at the stations, said digit settings for the plurality of storage devices being completed in a variable sequence, and means to connect the storage devices receiving completed digit representations to said punching machine, comprising sequencing means set in operation upon completed digit representations of the storage devices to cause said storage devices to be utilized to control said punching machine in the same sequence that digit representations are completed in the latter, whereby in order of seniority and completion of digit representations the plurality of storage devices control the punching machine.

9. In a punching system provided with a single punching machine for punching digit representations derived from a plurality of keyboard stations, the combination of a plurality of storage devices at said stations, only one at each station for controlling said punching machine, means under control of the keyboard at each station for setting up said storage devices, the setting of said storage devices at the plurality of stations being completed dissimultaneously or simultaneously, and sequencing means to connect said storage devices to said punching machine in the same sequence digit representations therein are completed when digit representations are completed dissimultaneously, and for causing said storage devices to be connected with said punching machine in a predetermined order when digit representations therein are completed simultaneously.

10. In a punching system provided with a single punching machine for punching digit representations derived from a plurality of keyboard stations, the combination of a plurality of storage devices at said stations, means under control of the keyboard at each station for setting up one of said storage devices, said storage devices at the plurality of stations being completed in their digit representations in an invariable sequence, and means to connect the storage devices receiving completed digit representations with said punching machine comprising sequencing means set in operation upon completion of digit representations in the storage devices to cause the cyclic operation of the punching machine under control of the storage devices connected thereto, and the continued cyclic operation of the punching machine by connecting the latter with the storage devices receiving completed digit representations always in the same order the storage devices receive completed digit representations.

11. In a punching system having a single punching machine for punching digit representations derived from a plurality of control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each station for always setting up digit representations in one storage device and upon

completion of digit representations therein for transferring the digit representations to the other storage device, sequencing means for effecting the operation of the punching machine under control of the storage devices receiving the transferred digit representations and for successively connecting such storage devices to the punching machine, upon completion of their digit representations, a plurality of signals at each station, means for causing one of said signals to be responsive when a digit transfer is effected from one storage device of the related station to the other storage device of the same station to indicate completion of a transfer, and other means for causing the other signal to be responsive when a storage device of the related station has received a digit transfer and has not yet been connected to control said punching machine.

12. In a punching system having a single punching machine for punching digit representations derived from a plurality of control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each station for always setting up digit representations in the keyboard controlled storage device in a variable number of orders dependent upon the number of digits to be set up, which orders vary denominationally, means for transferring the digit representations from the keyboard controlled storage device to the other storage device, the orders of which do not vary denominationally, compensating means variably operated according to the number of digits set up in the keyboard controlled storage device for diverting the digit entry to said other storage device to cause the orders thereof to receive a digit transfer in corresponding orders, and means for connecting said other storage devices when they receive the transferred digit representations to said punching machine to cause the latter to punch cards with digit representations in perforated card columns which may vary in number from card to card but remain alike in the denominational representation of digits.

13. In a punching system having a single punching machine for punching digit representations derived from a plurality of control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each sttaion for always setting up digit representations as a combinational setting in the keyboard controlled storage device but in a variable number of denominational orders dependent upon the number of digits to be set up, means for transferring the digit representations from the keyboard controlled storage device to the other storage device in the same combinational setting, compensating means variably operated according to the number of digits set up in the keyboard controlled storage device for diverting the digit entry to said other storage device to cause the orders thereof to receive a digit transfer of corresponding orders, translator means set under control of said other storage device to convert the combinational setting to another code representation, and means for connecting said translator means at each of said stations to said punching machine to cause the latter under control of the translator means to punch cards with digit representations in perforated card columns which may vary in number from card to card but remain alike in the denominational representation of digits.

14. In a punching system having a single punching machine for punching digit representations derived from a plurality of control stations, the combination of a plurality of keyboards, one at each station, a plurality of storage devices at each station, means under control of the keyboard at each station for always setting up digit representations in the keyboard controlled storage device in a code representation different from the keyboard code but in a variable number of denominational orders dependent upon the number of digits to be set up, means for transferring the digit representations from the keyboard controlled storage device to the other storage device but effecting a representation in the same code setting as the keyboard controlled storage device, compensating means variably operated according to the number of digits set up in the keyboard controlled storage device for diverting the coded digit entry to said other storage device to cause the orders thereof to receive a coded digit transfer of corresponding orders, decoding means at each of the aforesaid stations and controlled by the storage device receiving the coded digit transfer, and means for connecting said decoding means at each station to said punching machine in succession to cause the latter to punch cards with digit representations in another code and in perforated card columns which may vary in number from card to card but remain alike in the denominational representation of digits.

15. In a punching system having a punching machine for punching digit representations, the combination of a keyboard, a plurality of storage devices, means under control of the keyboard for setting up digit representations in the storage device in a variable number of denominational orders dependent upon the number of digits to be set up, means for transferring the digit representations from the keyboard controlled storage device to the other storage device, compensating means variably operated according to the number of digits set up in the keyboard controlled storage device for diverting the digit transfer to said other storage device to cause each of the orders thereof to receive a digit of the corresponding denominational order, and means for connecting said storage device receiving the digit transfer to said punching machine to cause the latter to punch cards with digit representations in perforated card columns which may vary in number from card to card but remain alike in the denominational representation of digits.

16. In a punching system provided with a single punching machine of the type having a single punch selecting instrumentality for each card column for operating the punches at differential times during the passage of the card past said punches, the combination of a plurality of storage devices at said stations, only one at each station for controlling said punching machine, a plurality of keyboards one at each station, means under control of the keyboard at each station for setting up said storage devices, sequencing means for coordinating the storage devices with the punch selecting instrumentalities of the punching machine when each storage device has received a digit transfer and in the sequence that the storage devices at the stations receive the digit transfers, and means for operating the punch selecting instrumentalities of the punching machine under control of the storage devices as the

latter are selected for control by the sequencing means.

17. In a punching system provided with a single punching machine of the type having a single punch selecting instrumentality for each card column for operating the punches at differential times during the passage of the card past the punches, the combination of a plurality of storage devices, a keyboard for each station, means under control of the keyboard at each station for setting up one of said storage devices to represent digits and for transferring digit representations to the other storage device of the same station, sequencing means for coordinating the storage devices with the punch selecting instrumentalities of the punching machine as each storage device receives a digit transfer and in the same sequence that the storage device at the stations receive the digit transfers, and means for operating the punch selecting instrumentalities of the punching machine under control of the storage devices as the latter are selected for control by the sequencing means.

18. In a punching system having a punching machine for punching digit representations, the combination of a keyboard, a plurality of storage devices, means under control of the keyboard for setting up digit representations in the storage device in a variable number of denominational orders dependent upon the number of digits to be set up, means for transferring the digit representations from the keyboard controlled storage device to the other storage device, compensating means variably operated according to the number of digits set up in the keyboard controlled storage device for diverting the digit entry to said other storage device to cause the orders thereof to receive a digit of the corresponding denominational order, and means for connecting said storage device receiving the digit transfer to said punching machine to cause the latter to punch cards with digit representations in perforated card columns which may vary in number from card to card but remain alike in the denominational representation of digits.

19. In a punching system provided with a single punching machine for punching digit representations derived from a plurality of keyboard stations, the combination of a plurality of storage devices, there being one storage device at each station to control the punching machine, means under control of the keyboard at each station for setting up said storage devices, said storage devices having digit representations therein completed in a variable sequence, and means to connect the storage devices receiving completed digit representations with said punching machine, comprising sequencing means set in operation each time there is a completed digit representation in one of the storage devices and to cause the operation of the punching machine under control of the storage devices in the same sequence that digit representations are completed in the latter, whereby in order of seniority and completion of digit representations the plurality of storage devices controls the punching machine and the cyclic operation of the latter continues until the last storage device receiving a completed digit registration controls the punching machine.

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