

**Dec. 25, 1945.**

**C. R. DOTY**

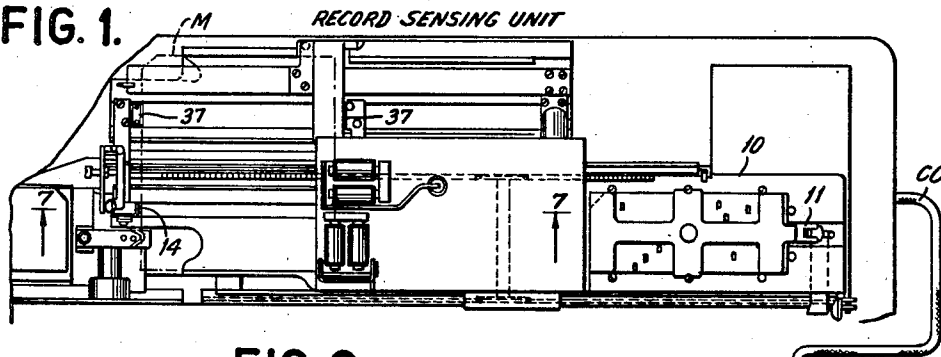
**2,391,773**

## RECORD CONTROLLED TAPE PUNCHING MACHINE

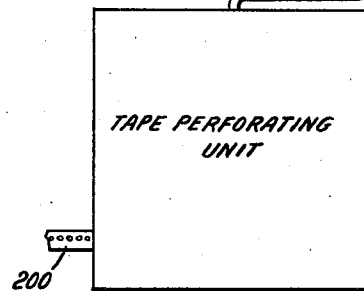
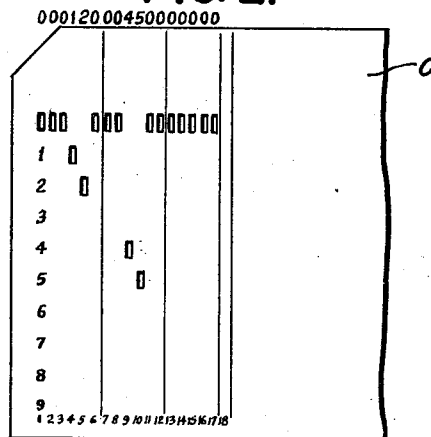
Filed Feb. 15, 1945

6 Sheets-Sheet 1

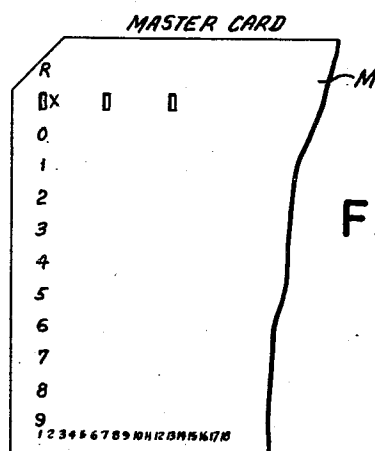
**FIG. 1.**



**FIG. 2.**



**FIG. 3.**



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RECORD CONTROLLED TAPE PUNCHING MACHINE

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FIG. 4.

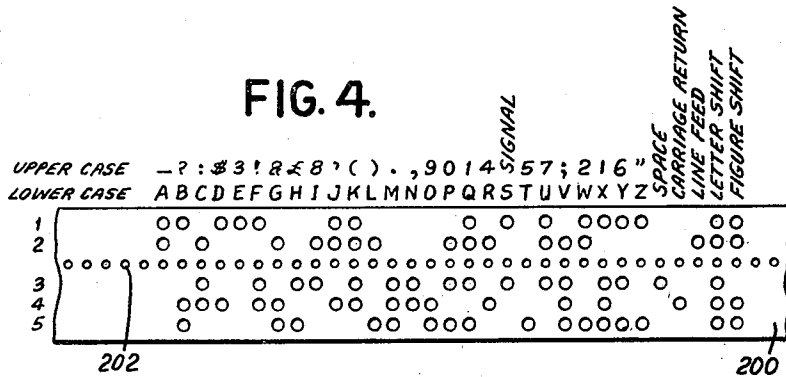


FIG. 5.

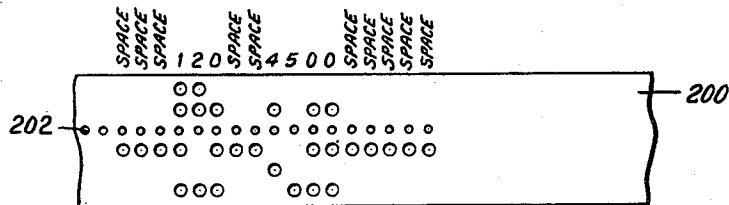
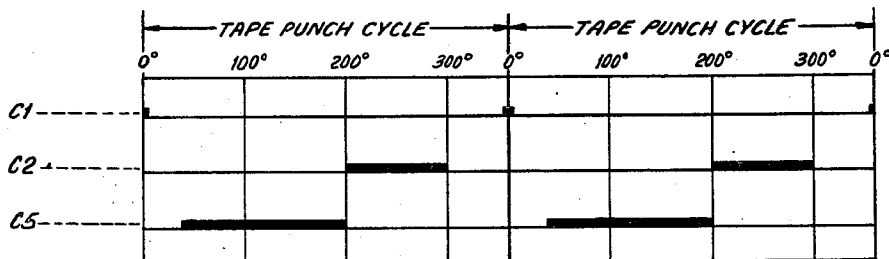


FIG. 6.



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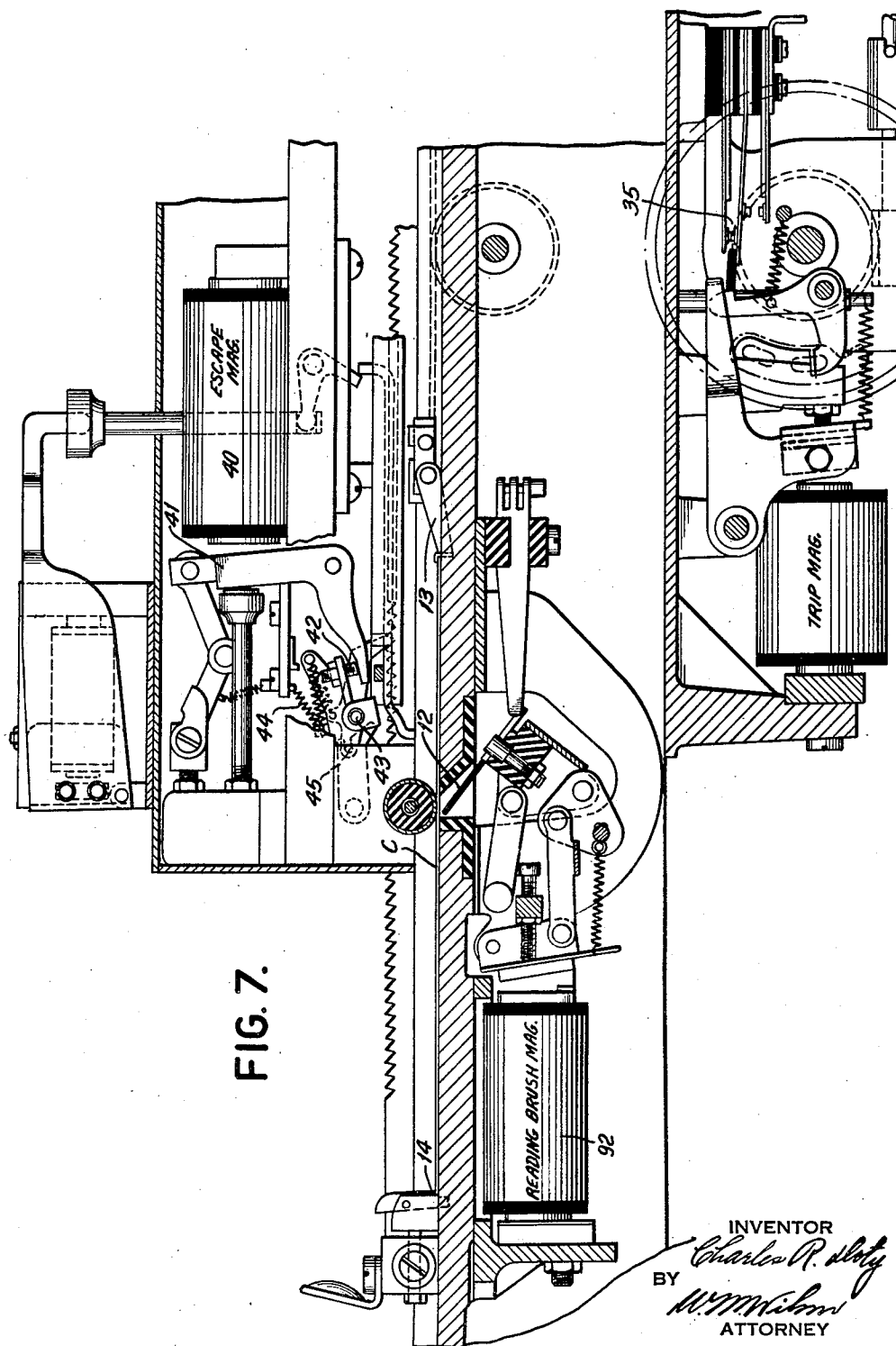
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RECORD CONTROLLED TAPE PUNCHING MACHINE

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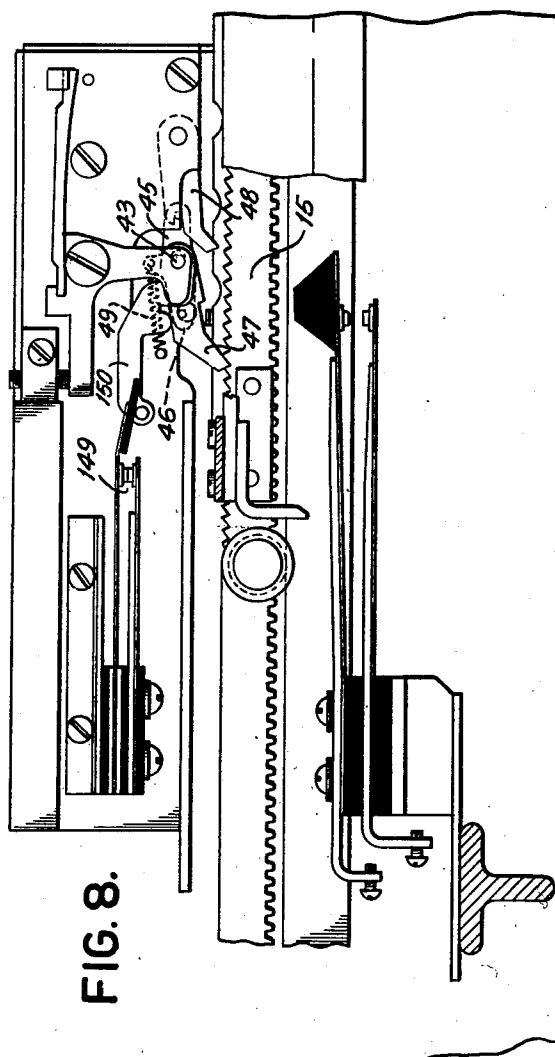
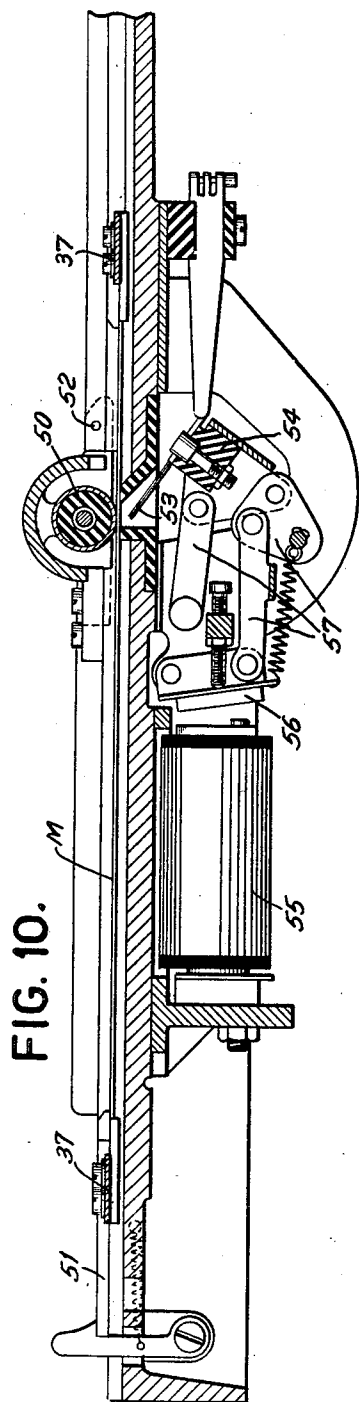
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RECORD CONTROLLED TAPE PUNCHING MACHINE

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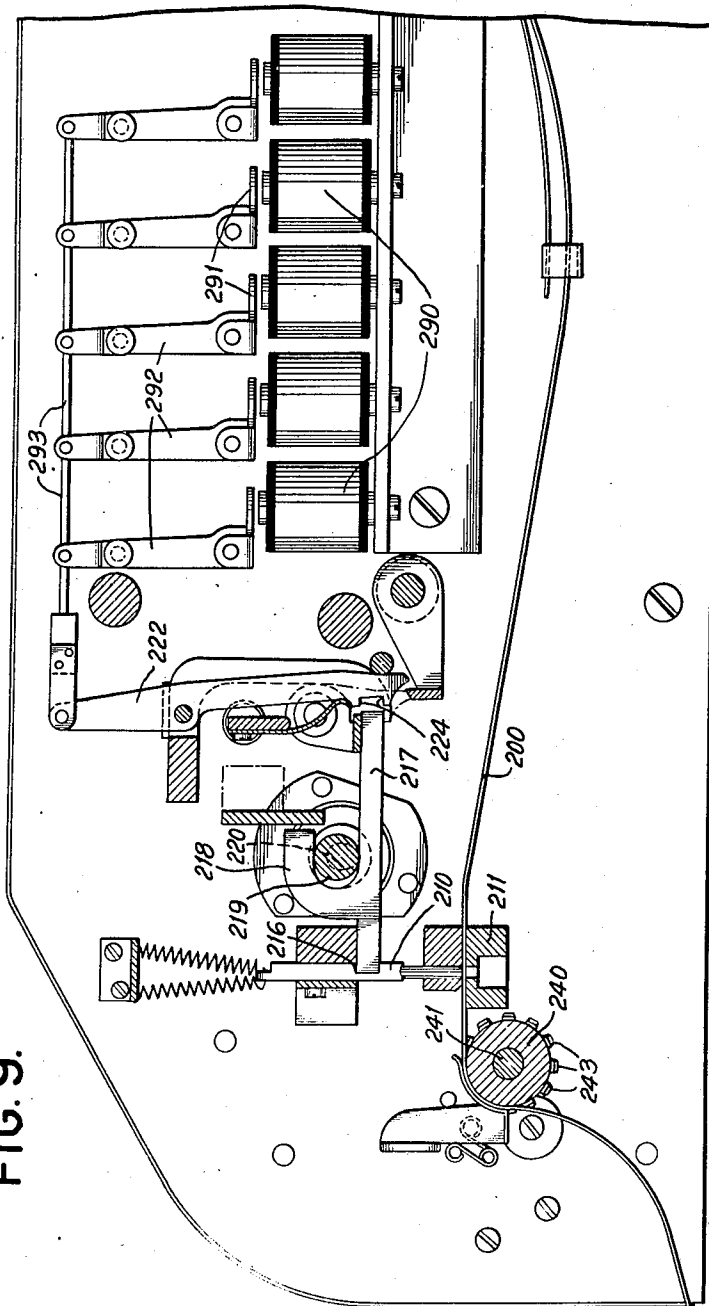
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RECORD CONTROLLED TAPE PUNCHING MACHINE

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FIG. 9.



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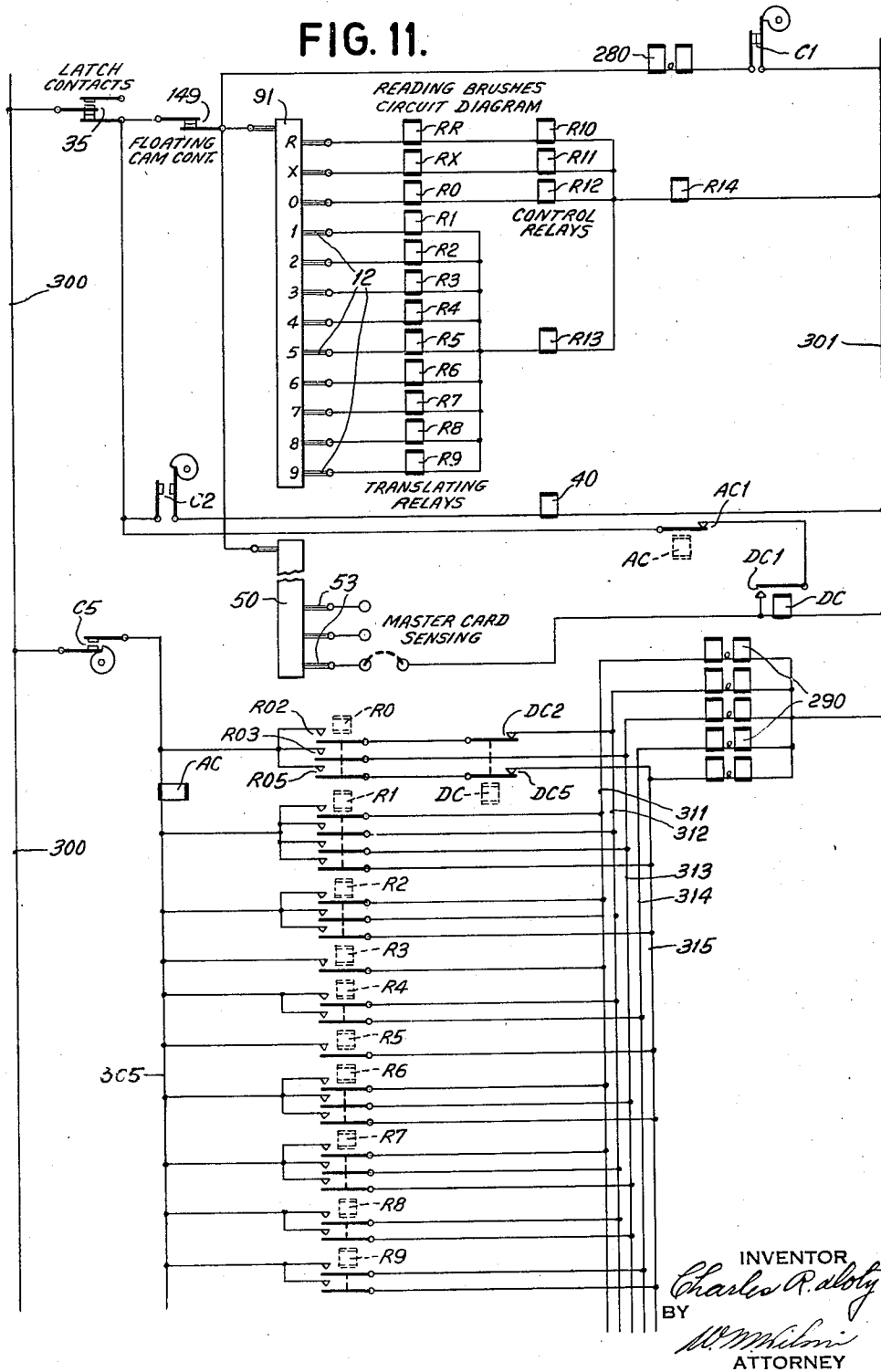
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FIG. 11.



## UNITED STATES PATENT OFFICE

2,391,773

RECORD CONTROLLED TAPE PUNCHING  
MACHINE

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Application February 15, 1945, Serial No. 578,107

15 Claims. (Cl. 164—115)

This invention relates to tape punching machines, and more particularly to the type in which data on a record card punched according to one code is converted to another code and punched on a tape.

The main object of the invention is to record "space" designations on the tape as the latter is being punched under control of "zero" punched record columns which consist of those at the left of the highest ordered significant digit 1-9, in order that when said punched tape is utilized to control a tape-controlled printing machine, such as a typewriter, space designations will appear at such column positions of the tape instead of zeros to thereby separate the successive printed groups on the tape and render the printed result more intelligible.

As an explanation of the above, it is well known that the punching of a tape in the combinational code may be derived from data punched on a record card according to another different or statistical code. Such record card may have previously been utilized to control record-controlled accounting machines and the like and accordingly such cards are made up with a plurality of card columns, one or more making up a card field. Such card fields are usually adjacent and when utilized in tabulating systems it is desirable that the left hand columns of each field which are not perforated to represent any of the significant digits 1-9, inclusive be, however, perforated to represent zeros. This is the customary practice and such zeros are perforated to have each card field completely punched, and since no omissions occur it indicates that all punching operations for a card field have been made. One example would be two adjacent card fields punched to represent 00120/004500. If a record card so perforated controlled a tape perforating unit and left hand zero designations were punched on the tape, it would appear as above and the figures would be run together without the desired separation or demarcation into the numbers when such tape controls a tape-controlled printing machine. In the present machine, when such left hand card columns are zero perforated, the corresponding columns of the tape will be perforated to represent blank spaces. Then, when the tape controls a tape controlled printing or recording machine, such as a typewriter, such positions will not bear any recording because spacing operations of the platen carriage will be effected. Hence, with the above example, the result would be printed as follows: : 120 4500.

A broad object of the invention is to provide

in a record controlled tape punching machine automatic means to punch the tape with one or more space designations between successive data groups.

5 A more specific object of the invention is the provision of means responsive to the sensing of a predetermined position of a supplemental card to condition the machine so that in the event of zero perforations in left hand card columns of the selected field, space designations will be effected on the tape.

10 Another object of the present invention is the provision of means for converting or modifying the normal zero tape punching operations to an operation which will effect punching of space designations instead.

15 However in the broader aspects of the invention the punching of "space" designations is merely illustrative of one form of the invention and for space designations other designations can be substituted such as punctuation marks, or other characters like the asterisk symbol, \$ symbol, etc. Such form of recording at the left of the first significant digit 1-9 will distinguish and separate the printed numbers, just as if spaces were used, and similarly prevent confusion in interpretation of the recording.

20 A still further feature of the invention is to render the above designated punch converting or modifying mechanism ineffective upon the sensing of the first significant digit 1-9 of the number in the field and to maintain such modifying or converting mechanism ineffective so that zeros which appear to the right of the significant digit may be properly recorded on the tape.

25 Additional specific features of the invention consist in the provision of electrical control means under control of a master card which, when perforated at X index point positions, will render the zero tape punch selecting mechanism ineffective when zero perforations are sensed in left hand columns of the record card, and further means under control of the record sensing means when digits 1-9 are sensed to normally condition the tape punch selecting mechanism to be operative to select tape punches which will record zeros in the event that columns at the right of the first significant digit of the record card are so designated.

30 In more detail the apparatus consists of a record sensing unit capable of sensing columns of perforations on a statistical card and also a master card of a well known form. The record sensing unit senses successive columns of the record,

energizing corresponding translating relays which have provision for energizing tape punch selecting magnets according to the Baudot code, thereby converting the punching in the Hollerith or statistical code to the combinational code. Each sensing of a record column effects a cyclic operation of the tape perforator and after each tape perforating operation the tape is spaced to the next column and the record card correspondingly. Repetitions of the above operation are carried out for successive record card columns. The master card is provided with a conventional X index point position and when the initial column of a selected card field is X punched, a conditioning relay is energized which modifies the zero tape punch selecting circuits so that whenever a column of the statistical card is zero perforated, punches will be selected which will effect perforation of the tape at a code position which represents a space. Hence, for each sensing of the initial and successive record columns which are zero perforated, space designations appear on the tape until a column of the record card is sensed which represents a digit 1-9. Sensing of such digits will energize relays which select punches to punch corresponding digit designations on the tape and also will render the conditioning relay ineffective, enabling the energizing of tape punch magnets for perforating a zero representation whenever a card column to the right of the first significant digit 1-9 is zero perforated and sensed. Reconversion of tape punching to the normal manner will then enable tape punching to proceed in the normal and customary manner. It is explained that the zero suppressing and zero insertion operation is completely automatic and is carried out without attention of the operator.

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 drawings:

Fig. 1 is a plan view of the apparatus showing diagrammatically the electrically connected record sensing and tape perforating units.

Fig. 2 is a fragmentary portion of a statistical card shown perforated to represent three numeral data groups in adjacent card fields, two fields having left hand columns zero perforated, and the other field representing all zeros.

Fig. 3 is a fragmentary portion of a pattern or master card shown as a matter of illustration perforated to initiate punching of the tape to represent "spaces" whenever left hand columns, or all columns of a field are zero perforated.

Fig. 4 is a portion of a punched tape showing the coded designations for the characters and functional operations represented.

Fig. 5 is a fragmentary portion of a tape which would be perforated under control of the statistical card of Fig. 2 indicating the manner in which "space" designations appear on the tape instead of zero designations whenever the corresponding card columns at the left of the first significant digit or all columns of a field are perforated to represent zero.

Fig. 6 is a timing diagram of the cam controlled contacts utilized in connection with the electrical wiring.

Fig. 7 is a sectional view taken on the line 7-7 of a well known form of statistical card sensing unit showing principally the instrumentalities

utilized in connection with the present improvement.

Fig. 8 is a detail of the escapement mechanism of the record sensing unit.

Fig. 9 is a view in side elevation of the tape perforating unit.

Fig. 10 is a sectional view of the analyzing means for the pattern or master card, forming part of the record sensing unit.

Fig. 11 is a diagram of circuit connections of the parts of the apparatus comprising the present improvement.

Before describing in detail the construction and operation of the present improvements, it should be observed that for the purpose of illustration the present improvement is shown in connection with a record controlled tape perforating apparatus of the form shown and described in full detail in the patent to C. R. Doty, No. 2,340,800, granted February 1, 1944.

The individual record sensing and tape perforating units shown in detail in this patent are diagrammatically shown in Fig. 1 wherein it will be seen that they are interconnected by a cable connection CC. To understand the operation of such apparatus, a general outline of the functional operations thereof will be set forth briefly.

Individual record cards C (Fig. 2) having columns of either alphabetical or numerical data or both recorded thereon in the Hollerith code are presented to a sensing station by means of a reciprocable card carriage comprising a pusher 13 (Fig. 7). The record card C is fed column by column to the group of individual sensing brushes 12, one sensing brush 12 being provided for each index point position. The sensing brushes 12 (Fig. 11) are electrically connected to individual translating relays of the group RR, RX, RO, R1-R9, which relays are energized selectively in accordance with the sensed data designations on the record cards. A plurality of control relays R10, R11, R12, R13 and R14 are connected to certain ones of the translating relays so as to be energized selectively in accordance with the data sensed on the cards. However, such control relays are not involved in the present invention, and this also applies to the RR and RX relays.

The aforementioned patent discloses in complete detail the translating mechanism controlled by the translating relays which, through their associated contacts, are effective to translate and convert alphabetic, numerical designations in the statistical code to the combinational code but herein the showing is confined to a part of the translating and converting mechanism which controls selectively the energization of the tape punch control magnets 290 in different code combinations, for punching the tape 200 to represent numerals corresponding to the numerical data sensed on the record cards.

The card sensing mechanism will only be described in sufficient detail for a full comprehension of the present invention, since details of the sensing unit are disclosed in the patent to Doty, No. 2,340,800. Furthermore, in view of the fact that the mechanical arrangement of the card feeding and ejecting mechanism is substantially the same as that embodied in the machine known as the "International Duplicating Key Punch" and "Alphabetical Verifier," such as shown, for example, in U. S. Patent No. 1,772,186, dated August 5, 1930, and U. S. Patent No.



2,107,161, dated February 1, 1938, a condensed description is deemed to be sufficient.

Referring to Fig. 1 the record cards C to be sensed or analyzed are placed in the magazine 10 from which they are advanced singly by a picker 11 toward the left, to present the first column of perforations to a card sensing position above the sensing brushes designated 12 in Fig. 7. In this position the reciprocable card carriage comprising a pusher 13 and a guide 14 engages the card and advances it column by column under control of the escapement mechanism to be described later.

The operation of the card feeding mechanism for feeding a card from the magazine 10 and placing it upon the card carriage to the initial sensing position is fully explained in Patent No. 1,772,186, granted to F. L. Lee et al. for Duplicating punching machine.

The escapement mechanism of the record sensing unit is of the same general nature as that disclosed in the Schaaff Patent No. 1,426,223, modified for electrical control as in the Shafer Patent No. 2,315,741, and a brief description thereof will now be given.

When the card is in a position above the sensing brushes 12, the column by column advance of the card carriage is controlled by an escapement mechanism which in turn is responsive to the energization of the escape magnet 40 (Fig. 7). Upon energization of magnet 40 its armature 41 will be rocked about a pivot in a clockwise direction and through a screw 42 secured to an arm secured to rod 43 will rock the rod 43 counterclockwise against the tension of a spring 44. The rod 43 is rocked as an incident to each spacing operation and has secured to one end thereof oppositely extending arms 45, 46 (see also Fig. 8) of which arm 46 is provided with a laterally extending pin for engagement with an enlarged opening in a stepping dog 47 which is loosely pivoted on rod 43. Opposite arm 45 is provided a pin extending into a slot formed in the locking dog 48. When rod 43 is rocked, arm 46 will, through its pin and slot connection with dog 47, lift the latter out of one of the notches of the escapement rack 15 movable with the card carriage and at the same time arm 45 will depress locking dog 48 into a notch between the ratchet teeth. At this time, spring 49 advances the loosely pivoted dog 47 a short distance just sufficient to permit this dog to move over the top of the next tooth. When the locking dog 48 is again raised, stepping dog 47, due to the movement of the rack 15 and the card carriage, will ride down along the next tooth until it strikes the bottom thereof and the spring driven card carriage is thereby arrested. It is sufficient to know thereof that for each energization of the escape magnet 40 the escapement rack 15, and therefore the card carriage, is moved the distance of one card column through the action of the pusher 13 and the forward guide 14 on the statistical card. Also in Fig. 8 are shown the "floating cam" contacts 149 which are well known in the type of machine now being described. One blade of contacts 149 is shifted by an arm 150 which is loosely pivoted on the rod 43 and which has a depending extension resting upon the upper edge of the stepping dog 47 so that during escapement from one column to another the incidental raising of the stepping dog 47 and the elevation of arm 150 will cause the opening of the contacts 149 during the period that the dog 47 is raised. When the card carriage has come to rest after having escaped through the distance of a card

column, contacts 149 will come to normal position in which they are closed.

Incorporated in the record sensing unit shown in Fig. 1 is an additional sensing device adapted to sense the perforations on the master card M as it will be called hereinafter (Fig. 3). The record sensing unit shown in the aforementioned Doty Patent No. 2,340,800 is intended to have such supplemental master card sensing device and since the details thereof are not disclosed in this patent, a description will be given of this arrangement.

The master card sensing device is shown in Fig. 10 and is well known as part of the International Duplicating Key Punch. This master card sensing device is fully shown and described in the U. S. patent to Lee and Daly, No. 1,976,618, granted October 9, 1934 to which reference may be had for further details of construction.

For a general understanding thereof it will be observed that the escapement rack 15 is provided with extensions or arms 37 (Fig. 10) between which the master card M is positioned in columnar alignment with the statistical card C. This comprises, therefore, a card carriage for the master card which is adapted to be moved back and forth with the escapement rack 15. Positioned about the master card M is a contact roller 50 which is insulated from the frame of the machine and supported by a door 51 pivoted at 52. Directly below the roller 50 are brushes 53 carried by a bar 54 which is normally in the position shown in Fig. 10, holding the brushes down out of engagement with the master card M. The magnet 55, upon energization, will attract its armature 56, actuating linkage 57 to cause movement of the brushes 53 into engagement with the master card M.

It is well known that a series of brushes 53 is provided to analyze all the index point positions of the master card M but in Fig. 11 only one sensing brush 53 for analyzing the X index point position of the master card is utilized to cause space designations to be punched on the tape instead of zeros represented in left hand card columns, and which would be normally punched. It should be observed that prior to the beginning of the concurrent analysis of a master card M and a statistical card C, the magnet 55 is energized to elevate the sensing brushes 53 and by circuit connections described in the Doty patent the magnet 92 (Fig. 7) is also energized to elevate the brushes 12 for sensing the statistical card C. Thereafter, there is a concurrent step-by-step escapement of the master card M and statistical card C and whenever the brush 53 encounters a perforation at the X index point positions in which it is aligned, a circuit will be closed through such perforation to effect certain functions in the tape sensing unit, as will be described hereinafter.

#### *The tape perforating unit*

Fig. 9 represents the construction of the tape perforating unit to disclose the elements necessary to understand the present improvement. To secure full details of the construction and operation of this unit, recourse may be had to the aforementioned patent to C. R. Doty, No. 2,340,800. In general, the perforating portion includes individual punch elements 210, one for each unit of the telegraphic code, which punch elements are reciprocable in a die block 211 to perforate the tape 200 according to the punch elements selected for operation. 217 represents interposers individual to punch element 210,

each of which has a strap 218 which is operated by an eccentric cam 219 carried by the drive shaft 220 of the tape perforating unit. Normally, during the rotation of the eccentric cam 219, each interposer is moved downwardly and upwardly by the supporting eccentric about the pivotal connection 216 formed by the end of the interposer engaging the recess of the related punch element.

For each interposer 217 there is provided an individual latch arm 222. Whenever it is desired to select a punch element 210 for operation the related latch arm 222 is rocked in a clockwise direction so that its latch fingers 224 engage and latch the free end of the related interposer 217. Thus, upon latching of an interposer 217 and rotation of the eccentric 219 the said interposer is positioned by the eccentric about the pivotal connection formed by the latch arm 222 and the latched end of the interposer to force the related punch element 210 downwardly, thereby causing the tape 200 interposed between the lower ends of the punch elements 210 and the die block 211 to be perforated.

The control means for selectively positioning the latch arms 222 and thereby select the punch elements 210 for operation consists of the punch selecting magnets 290. The armature 291 of each magnet 290 has connected thereto an arm 292 and the latter has a call wire connection 293 between the related arm 292 and the latch arm 222. Hence, the energization of each magnet 290 positions the related latch arm 222 so as to effect the operation of the related punch element 210.

Other elements shown in Fig. 9 are involved in the punching operation but they are not described herein since full details of their construction and operation may be had by reference to the aforementioned patent to Doty No. 2,340,800.

By means more fully described in the aforementioned patent, substantially centrally located feed perforations 202 (Fig. 4) are formed as the tape is perforated. The paper tape 200 is drawn from a supply roll (not shown) to the punching station by a feed roll 240 secured to a drive shaft 241. Said feed roll 240 is formed at its periphery with teeth 243 which cooperate with the feed perforations 202 of the tape 200. The step-by-step rotation of the feed roller 240 feeds the tape 200 so as to present successive columns of the unperforated tape 200 to the punch elements 210.

The operation of the punching mechanism of the tape perforating unit, as well as the operation of the tape feeding mechanism performed in the necessary sequence, is effected upon energization of the tape clutch control magnet 280, shown only in the wiring diagram of Fig. 11. In the Doty patent, complete details are shown of the manner in which such magnet initiates the operation of the tape perforating unit. For understanding the present improvement it is sufficient to know that this initiates the operation of the drive shaft 220, the shaft 241 for feeding the tape and other operating elements of the tape perforating unit to effect the tape punching and feeding operations.

#### Operation

The general operation of the machine will now be given in connection with the circuit diagram of Fig. 11.

It will be assumed that the card carriage of

the record sensing unit has been returned to card column 1 position, at which time latch contacts 35 and floating cam contacts 149 (Fig. 11) are both closed. It will also be assumed that a tape is to be perforated in the combination code to represent the three numbers on the record card C (Fig. 2) represented by coded perforations according to the Hollerith statistical code.

At column 1 position of the card carriage a circuit will be closed from line 300, through contacts 35 and 149, contact roll 91, brush 12 sensing the zero perforation of column 1, coil of the translating relay RO and control relays R12 and R14 to line 301, energizing said relays.

At the same time a circuit is completed from contacts 149 through the tape clutch magnet 280 and cam controlled contacts C1, energizing the clutch magnet. This initiates a cyclic operation of the tape perforator.

RO relay will close the RO2, RO3, RO5 relay contacts and upon closure of C5 cam contacts a circuit will be closed from line 300 through C5 cam contacts, wire 305, thence through the RO2, RO3, RO5 relay contacts to the punch magnet selecting circuits 312, 313 and 315 (assuming that the DC relay is unenergized), from the aforesaid circuits, to the tape punch magnets 290 which condition the tape perforating mechanism for perforating the tape at the 2, 3 and 5 code positions to represent the numeral 0.

However, in the assumed example, column 1 of the master card M has a perforation at the X index point position and concomitantly with the energization of the RO relays a circuit is closed from line 300, through latch contacts 35, floating cam contacts 149, contact roller 50, brush 53 of the master card sensing means, through the DC relay to line 301. A holding circuit is immediately established through the DC1 holding contacts, the AC1 relay contacts now closed, through latch contacts 35, back to line 300. The DC relay opens the DC2 and DC5 contacts so that tape punch magnets 290 for punching at the 2 and 5 code positions are now disconnected and only the circuit 313 for the tape punch magnet 290 for punching at the 3 code position will be completed when cam contacts C5 close. Hence, the tape punch selecting circuits are modified upon the energization of the DC relay. The energization of the tape punch magnet 290 for perforating the tape at the 3 code position will perforate the first column at such position (see Fig. 5), instead of perforating the tape at the 2, 3 and 5 code positions which would represent 0. When such tape is utilized to control a tape-controlled typewriter, for example, the controlling circuits can be devised or arranged to initiate the operation of the platen carriage spacing mechanism, so that a blank space will be provided in this column.

During the first tape perforating cycle and when cam contacts C2 close, a circuit will be closed from line 300, latch contacts 35, escapement control magnet 40 to line 301. Upon energization of the escapement magnet an operation of the above described escapement mechanism of the sensing unit spaces the record card to column 2 and during such operation floating cam contacts 149 open to cause the deenergization of the previously energized translating and control relays. Upon closure of the floating cam contacts 149, when the card carriage comes to rest at card column 2, the RO translating control relay will again be energized under control of the

perforation at the 0 index point position. Since the stick circuit for the DC relay is still maintained, the repeated energization of the RO relay will result in the second perforating of the tape at the 3 code position of column 2 to again represent a space designation. Of course, a second cycle of operation of the tape punch is effected by the energizing circuit for the tape clutch magnet 280 previously described.

Thereafter, the tape is spaced to column 3 and the record card likewise and since a 0 is represented in column 3 of the record card C, the operation just described is repeated, resulting in the designation of a space in the third column of the tape.

After the third column of the record card C has controlled the tape perforating operation, the card carriage is spaced to card column position 4, at which time there is an analysis of the 1 digit representation in card column 4 of the record card C.

A circuit is now closed from line 300 through latch contacts 35, floating cam contacts 149, sensing brush 12 for sensing the 1 perforation through the R1 translating relay, R13 and R14 control relays to line 300. R1 relay then closes its multiple contacts, and since such multiple relay contacts are connected to the 311, 312, 313 and 315 tape punch selecting circuits, tape punch magnets 290, 1, 2, 3 and 5 will be energized to perforate the tape at code positions 1, 2, 3 and 5 to represent in the Baudot code the numeral 1.

The impulse circuit for energizing such tape magnets extends from line 300 through C5 cam contacts, wire 305, through the AC relay coil, thence through the multiple relay contacts closed by the R1 relay, tape punch selecting circuits 311, 312, 313 and 315 to the related tape punch magnets 290 to line 301. Energization of AC relay opens the AC1 relay contacts to break the holding circuit for the DC relay and the DC2 and DC5 relay contacts now come to closed position for setting the tape punch magnets 290 for punching at the 2, 3, 5 code positions when the RO translating relay is subsequently energized.

After perforating card column 4 of the tape under control of the corresponding card column of the card, the tape and card are spaced to the next column and since a perforation is assumed to be at the 2 index point position, the R2 translating relay will close its 1, 2, 5 contacts, selecting tape punch magnets 290 for perforating the tape at code positions 1, 2 and 5 which in the Baudot code represent the numeral 2. Thereafter, the record card and tape both assume the column 6 position and since it is assumed that such column of the card is perforated to represent 0, understanding that at this time the DC5 relay is deenergized, energization of the RO relay will select tape punch magnets for perforating the tape at code positions 2, 3 and 5 which represent a 0.

Summarizing, when the first master card column of any card field is X punched, the tape punch selecting circuits will be conditioned and modified so that for each successive analysis of a 0 representing perforation of the record card C, punch magnets will be selected to designate a space in each corresponding column of the tape until a record card column is reached where a significant digit 1-9 is represented.

Referring to Fig. 2, according to the index point positions 9-1 perforated a correspondingly designated translating relay will be energized and in each instance when a R9-R1 (Fig. 11) relay is

energized, the AC relay coil as previously stated is also energized to break the holding circuit for the DC relay so that intermediate zero or zeros to the right of the column in which the first significant digit appears will be perforated in a tape column to represent 0. When such tape controls a tape-controlled typewriter, the number will be properly recorded.

In the assumed example the second field of the card consisting of card columns 7-12 is perforated to represent 004500 and the corresponding initial column 7 of the master card is also X-punched. The above described operation will be repeated for this field in precisely the same manner, except that the two tape columns at the left will be perforated to represent two spaces instead of two zeros, whereas the two extreme right hand columns of the tape will be perforated to represent 00, required in subsequent recording of the number 4500.

In the assumed example the third card field consisting of columns 13-17 are perforated to represent a 0 in each column. If the initial column of the master card, namely, column 13 is X punched, there will be a suppression of 0 punching in all corresponding columns of the tape and space designations will be substituted therefor.

In the sensing unit now under consideration it is common practice to skip the card to the last column position and circuits which are well known will be effective to set a motor into operation which will restore the carriage to the first column position and concomitantly feed a second card thereon. During such operation, latch contacts 35 open and open the holding circuit of the DC relay in the event that the latter was previously energized. Hence, tape punches for punching a zero representation on the tape can be selectively energized in the event that it is required to select such tape punch magnets for punching 0 in the initial card column of the next card.

While there have been shown and described and pointed out the fundamental novel features of the invention, 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:

1. In a recording machine of the class described, the combination of a tape punching mechanism including punch elements therefor, record controlled means for effecting the selection of tape punch elements to cause punching of columns of said tape to represent numerical data, and automatic means operable for 0 representing record columns at the left of the record column representing a digit 1-9 of highest denominational order to suppress 0 tape punching for corresponding tape columns and to select punch elements representing some arbitrary symbol other than 0.

2. In a recording machine of the class described, the combination of a punching mechanism comprising punch elements for punching numerical data including 0 digit punching, record analyzing means including 0 perforation analyzing means for successively analyzing the record column by column, means under control of said analyzing means to select punch elements and to effect the operation of said punch-

ing mechanism to punch equivalent numerical data column by column, and means operable when a predetermined 0 representing record column or columns is analyzed to prevent the selection of the 0 digit punch elements under control of the 0 perforation analyzing means and to select punch elements which punch a representation of some other arbitrary symbol instead of 0.

3. In a recording machine of the class described, the combination of a tape punching mechanism including punch elements, means for analyzing a perforated record representing digits 0-9, means under control of said analyzing means for effecting the selection of punch elements of said tape punching mechanism to punch columns of a tape to represent numerical data, a supplemental perforated record analyzing means therefor, and means under control of said last named analyzing means for conditioning the punch selecting means to select punch elements for punching said tape to represent some arbitrary symbol other than a 0 when certain columns of said perforated record represent 0 and said supplemental record is perforated.

4. In a recording machine of the class described, the combination of a tape punching mechanism including punch elements, record controlled means for effecting the selection of punch elements to punch columns of said tape to represent numerical data, automatic means for suppressing the selection of punch elements which punch said tape to represent 0 and alternatively select punch elements which punch columns of said tape to represent some arbitrary symbol other than zero corresponding to 0 representing columns of said perforated record at the left of the column representing the first significant digit 1-9, and means operable upon analysis of a digit 1-9 in said significant digit representing column for rendering said last named means ineffective whereby tape columns representing 0 to the right of the column containing the first significant digit are punched to represent intermediate zeros.

5. In a recording machine of the class described, the combination of a tape punching mechanism having tape perforating punches, record controlled means for selecting said punches and for effecting the operation of said tape punching mechanism to punch columns of said tape to represent numerical data represented on the perforated record, and automatic means for suppressing the punching of said tape to represent zero when controlling record columns at the left of the highest denominationally ordered significant digit represent zero and alternatively select punches of said tape punching mechanism to represent "space" so that when the tape controls a tape controlled recording machine a blank paper spacing operation will be effected.

6. In a recording machine of the class described, the combination of a tape punching mechanism including punch elements, means for analyzing a plurality of fields of a perforated record, each field comprising a plurality of columns representing digits 1-9 and 0, said 0 being at one or more columns to the left of the first significant digit 1-9, means under control of said analyzing means for effecting the selection of punch elements of said tape punching mechanism to punch columns of a tape to represent numerical data, means for analyzing a supplemental record to determine presence of a special perforation which designates each selected card field, and automatic means under control of said last named analyzing means for selecting punch elements for punching said

tape to represent some arbitrary symbol other than a zero, when controlling record columns of a selected card field at the left of the first significant digit 1-9 represent a zero, and said supplemental record contains a special perforation for said selected card field.

7. In a recording machine of the class described, the combination of a tape punching mechanism, means for analyzing a perforated record representing digits 1-9 and means for analyzing a record perforation representing 0, means under control of said analyzing means for effecting the operation of said tape punching mechanism to punch columns of a tape to represent numerical data, automatic means under control of said means for analyzing 0 representing perforations for punching said tape to represent "space" when a corresponding controlling column of said perforated record at the left of the record column which represents the first significant digit 1-9 represents a 0, and further means under control of said analyzing means for digits 1-9 for rendering said last named means ineffective for each column at the right of the column which represents the first significant digit 1-9, whereby said tape will be normally punched to represent zero whenever a column of the record representing an intermediate zero is sensed by said zero representing perforation analyzing means.

8. In a recording machine of the class described, the combination of a tape punching mechanism and punch elements therefor, means for analyzing a perforated record representing digits 1-9 in one code including means for analyzing a record perforation representing 0 in the same code, means under control of said analyzing means for effecting the selection of said tape punch elements according to a different code to punch columns of a tape to represent numerical data corresponding to the numerical data on the perforated record, automatic means under control of said 0 analyzing means operable for 0 representing record columns to the left of the column representing the first significant digit 1-9 for selecting punch elements according to said different code to punch said tape to represent an arbitrary symbol other than a zero, and further means under control of said record analyzing means for digits 1-9 for rendering said 0 record analyzing means ineffective to select punch elements to represent said arbitrary symbol for 0 record representing columns at the right of the column representing the first significant digit 1-9, whereby for such zero representing right hand record columns said tape will be punched in corresponding columns to represent an intermediate zero.

9. In a recording machine of the class described, the combination of a punching mechanism including punch elements, electrical record perforation analyzing means including 0 representing perforations analyzing means, a relay energized under control of the 0 analyzing means, means under control of said relay to normally select punch elements representing 0, a supplemental record, means for analyzing said supplemental record for ascertaining the presence of a perforation, and means under control of said supplemental record analyzing means upon ascertaining a perforation for preventing said relay when energized from selecting the 0 representing punch elements and to select instead other punch elements representing an arbitrary symbol.

10. In a recording machine of the class described, the combination of a tape punching mechanism including punch elements, record

analyzing means, means controlled by said analyzing means for selecting said punch elements of said tape punching mechanism and to successively punch columns of numerical data on the tape beginning at the left, corresponding to the columns of numerical data represented on the perforated record, said selecting means including means to normally select the 0 punch element to punch said tape to represent a 0 under control of the 0 record perforation analyzing means, automatic means operable when the first left hand column of a record is analyzed and represents zero to suppress the selection of the 0 punch elements under control of the 0 analyzing means and to select other punch elements representing an arbitrary symbol and to retain such alternative operation for all columns at the left when such zeros precede a significant digit 1-9, and means to render said last named means ineffective when said record analyzing means analyzes perforations which represent the first significant digit 1-9 at the right of such zeros, whereby said tape may be punched to represent intermediate zeros.

11. In a recording machine of the class described, the combination of punching mechanism for including punch elements for punching data representing the digit 1-9 and 0, record analyzing means including 0 representing perforation analyzing means, punch selecting means under control of said analyzing means to select punches of said punching mechanism to punch equivalent numeral data, and means operable when a predetermined 0 representing column of said record is analyzed to render 0 digit punch element selection ineffective under control of the 0 perforation analyzing means and to modify the punch selecting means to select other punch elements representing an arbitrary symbol.

12. In a machine of the class described, a plurality of tape punches, means to select said tape punches in coded combinations to punch data to represent the numeral series 0-9 inclusive, and means for modifying the tape punch selecting means for selecting punches representing 0 to select punches according to said code to represent other data outside of said numeral series.

13. In a tape punching machine, the combination with a cyclically operable record controlled machine including means for analyzing in each cyclic operation of the machine a column of a perforated record representing digits 0-9 of a number, a tape punching machine operable in cycles concurrent with said record controlled machine including punching selecting means controlled by said analyzing means for punching a tape column by column to represent digits 1-9 in successive columns, means for conditioning said tape punching machine for elimination of zero digit tape punching upon analysis of the first zero

representing record column of a field of the record and retaining said condition for one or more columns of tape punching, and automatic means for suppressing the punching of the tape to represent zero when one or more controlling record columns at the left of the first significant digit represent zero and alternatively select punches to punch said tape to represent an arbitrary symbol other than zero.

14. In a tape punching machine, the combination of a cyclically operable record controlled machine including means for analyzing in each cyclic operation of the machine a column of a perforated record representing digits 0-9 of a number, a tape punching machine operable in cycles concurrent with said record controlled machine including punch selecting means controlled by said analyzing means for punching a tape column by column to represent digits 1-9 in successive columns, means for conditioning said tape punching machine for elimination of zero digit punching upon analysis of the first zero representing record column of the record and retaining said condition for one or more columns of tape punching, automatically operable means for suppressing the selection of punches to punch the tape to represent zero when one or more corresponding record columns at the left of the first significant digit represent zero, and alternatively select other punches to punch the tape to represent an arbitrary symbol, and means operable upon analysis of the record column representing said first significant digit to disable said conditioning means to prevent further zero elimination for zero representing columns at the right of said first significant digit.

15. In a punching apparatus, the combination of a cyclically operable record analyzing machine including means for analyzing a record column by column in successive cyclic machine operations, a tape punching machine including punch selecting means controlled thereby to punch a tape in a different code column by column in cyclic operations concurrent with those of the record analyzing machine, a supplemental record in said first named machine having perforations at selected columns corresponding to the designated fields of the record, means controlled by said supplemental record upon occurrence of a perforation for conditioning said tape punching machine for elimination of zero digit tape punching upon analysis of one or more zero representing columns at the left of the first significant digit for a field designated by said perforation, and means for suppressing the selection of punches to punch said tape to represent zero when record columns at the left of the first significant digit represent zero and alternatively select punches which represent an arbitrary symbol in said different code.

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