

April 9, 1946.

C. D. LAKE ET AL

2,398,014

RECORD PUNCHING MACHINE

Filed Feb. 15, 1945

9 Sheets-Sheet 1

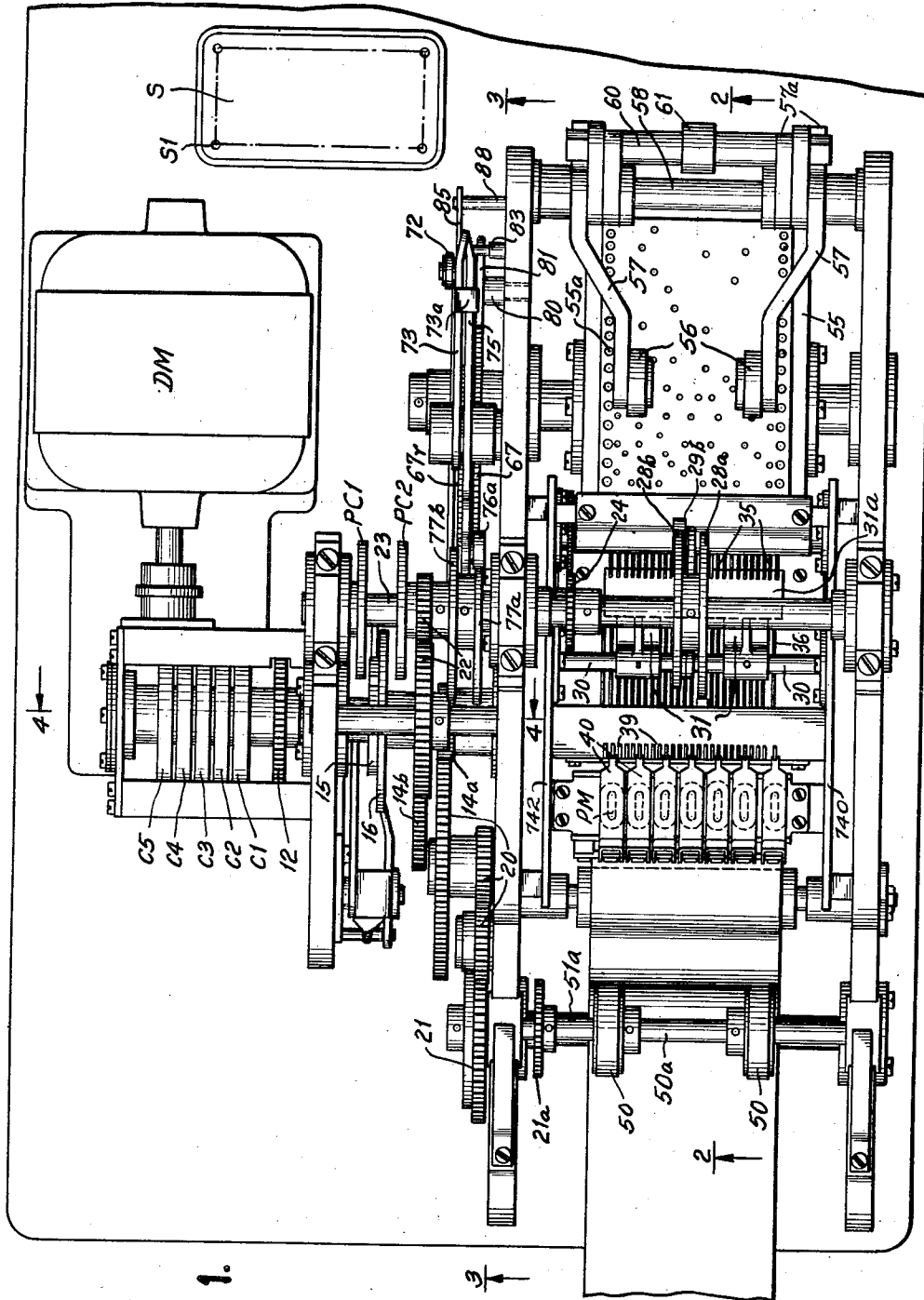


FIG. 1.

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9 Sheets-Sheet 2

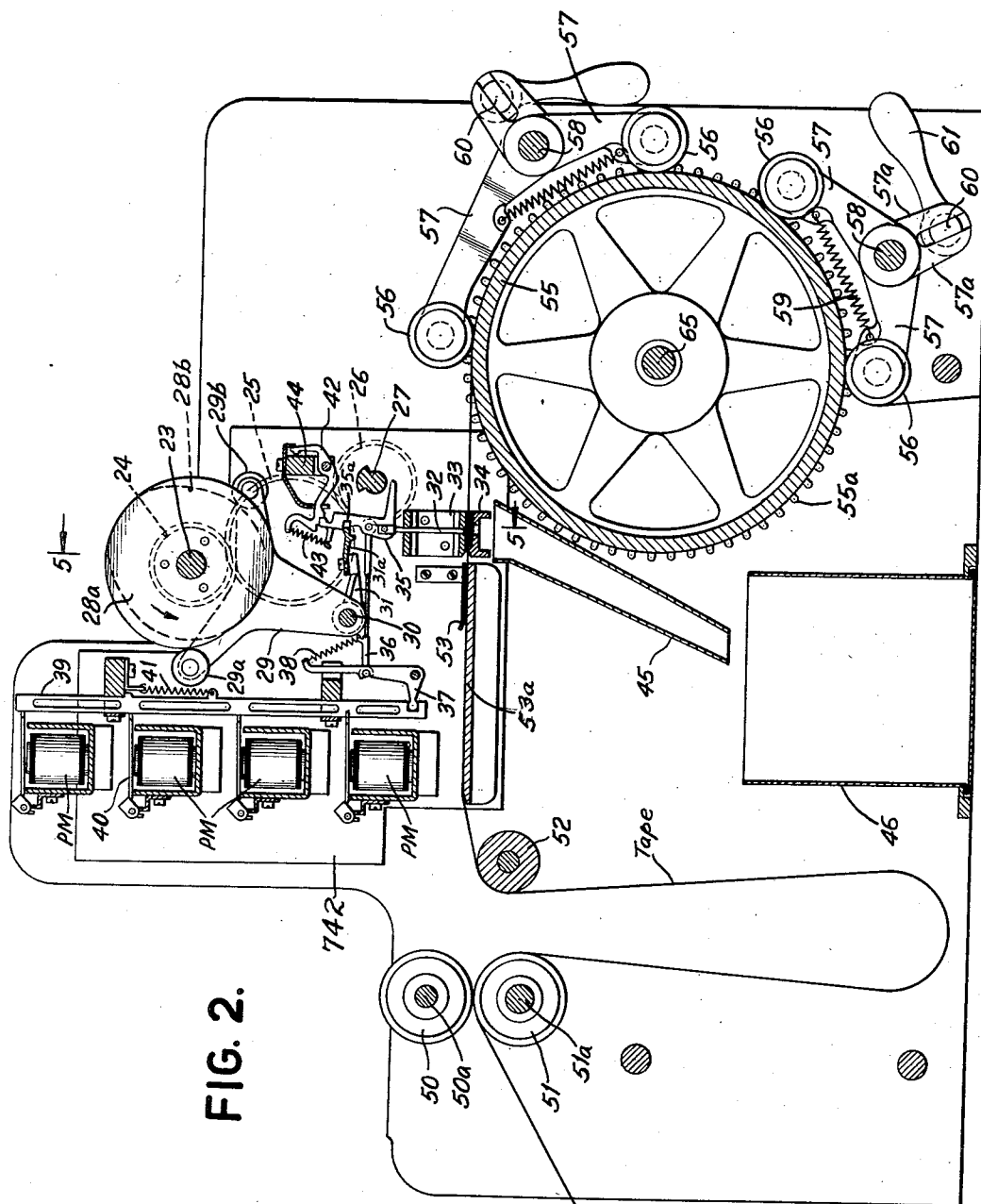


FIG. 2.

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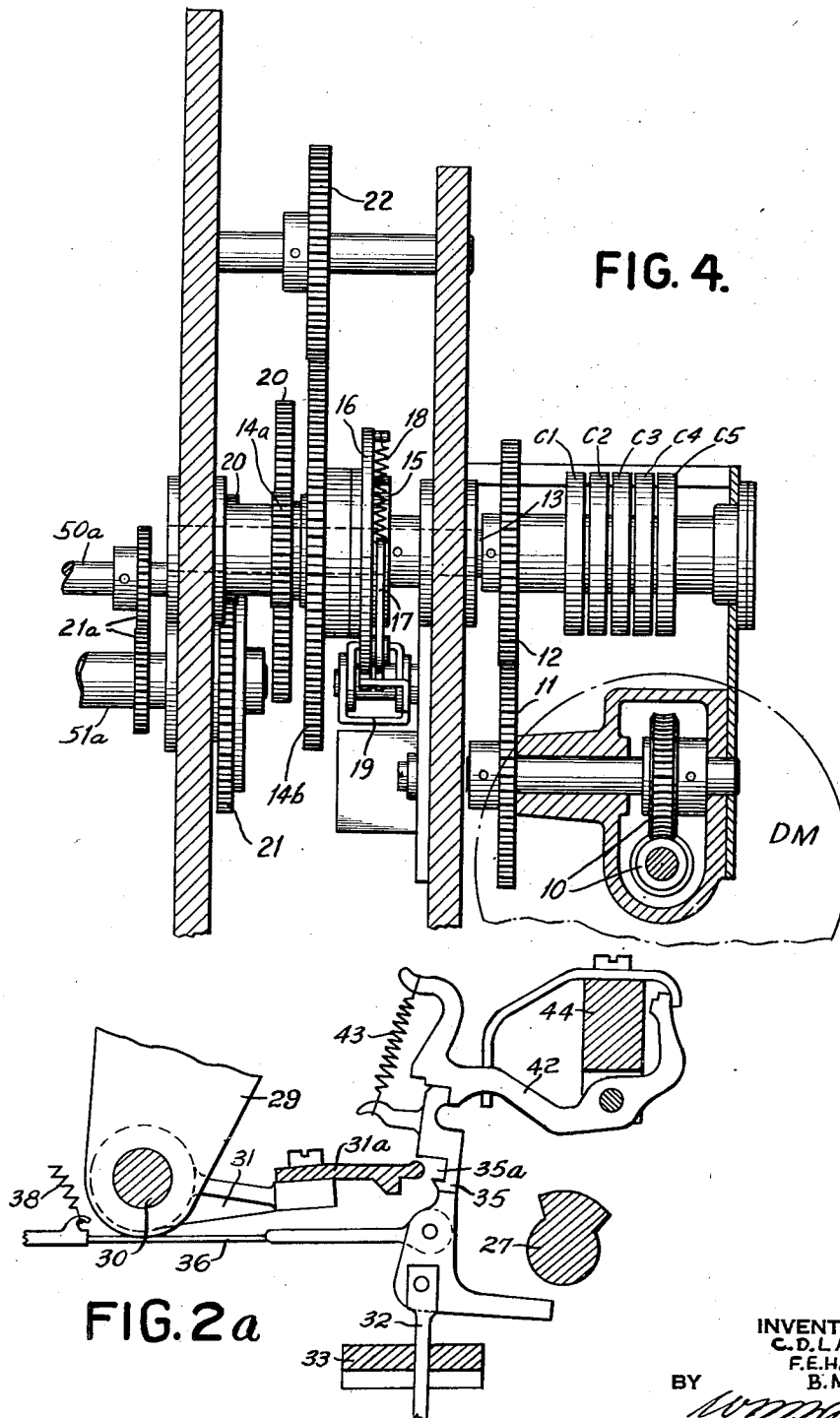
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9 Sheets-Sheet 3



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9 Sheets-Sheet 4



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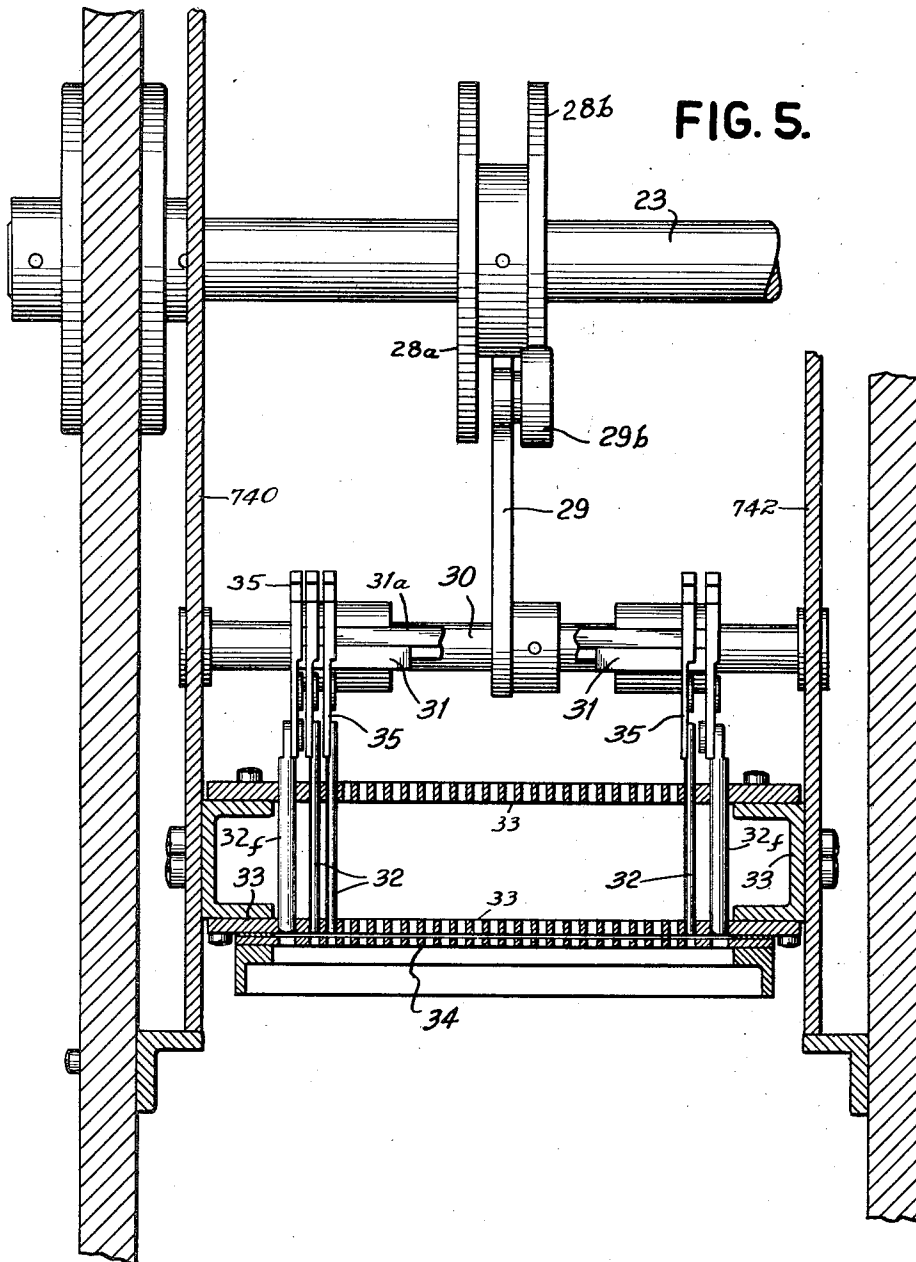
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RECORD PUNCHING MACHINE

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RECORD PUNCHING MACHINE

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9 Sheets-Sheet 6

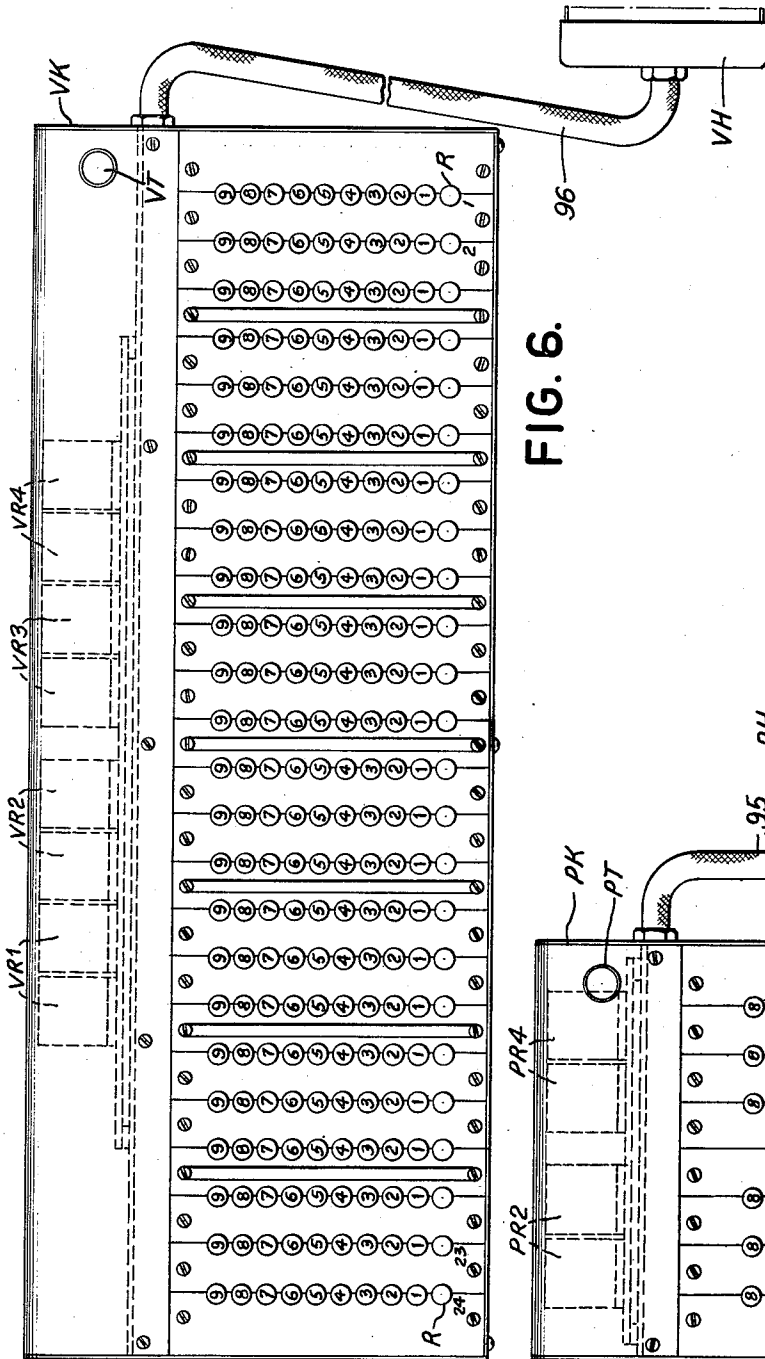


FIG. 6.

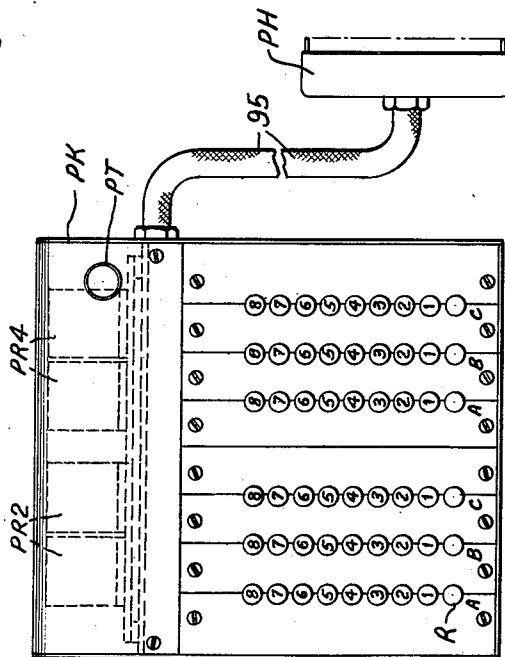


FIG. 7.

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RECORD PUNCHING MACHINE

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9 Sheets-Sheet 7

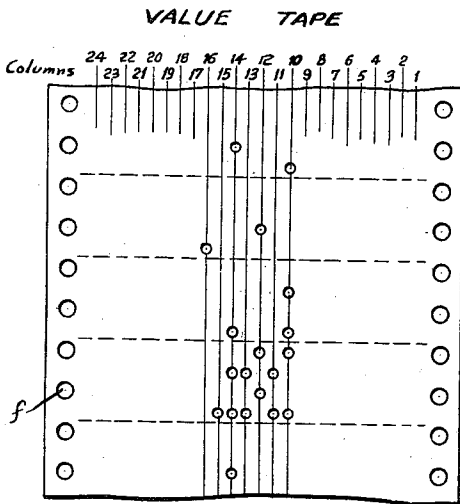


FIG. 8.

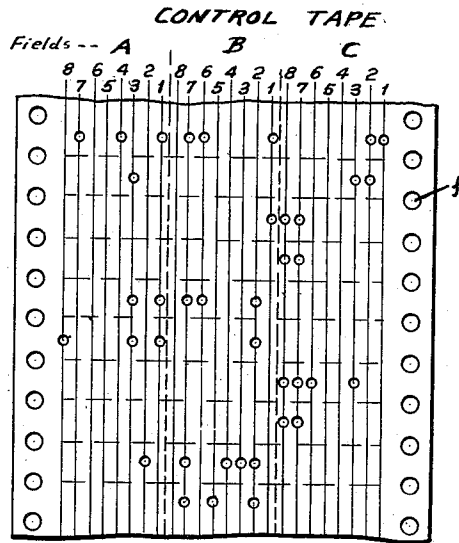


FIG. 9.

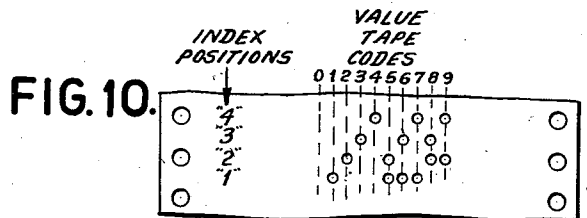
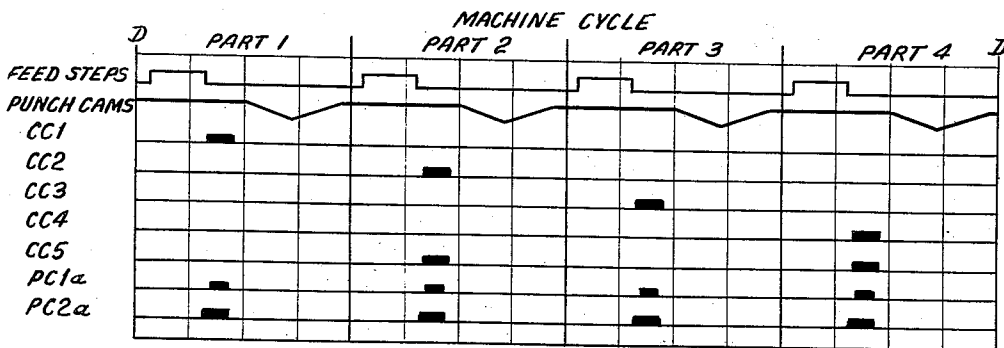


FIG. 11.



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RECORD PUNCHING MACHINE

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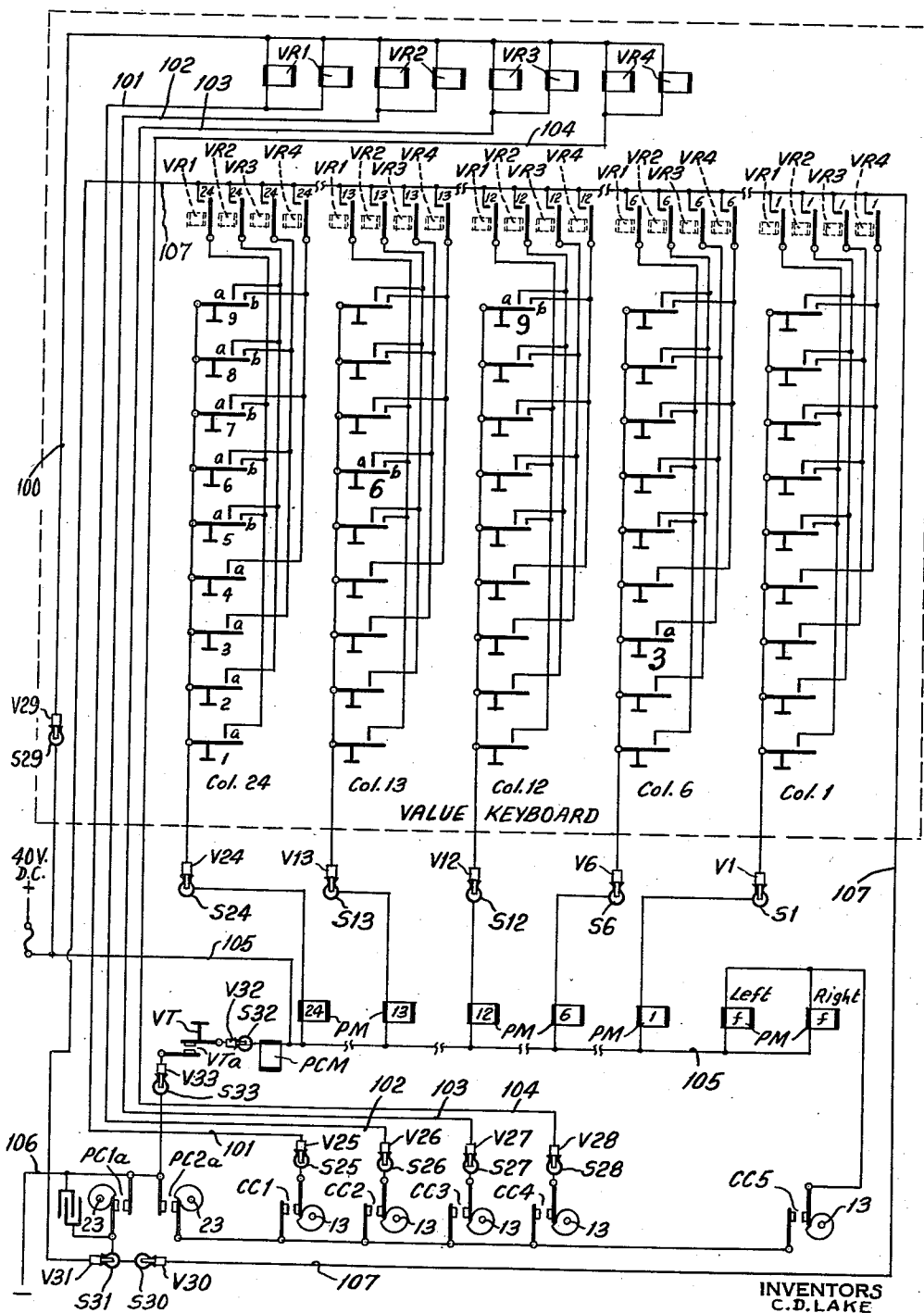


FIG. 12.

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RECORD PUNCHING MACHINE

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9 Sheets-Sheet 9

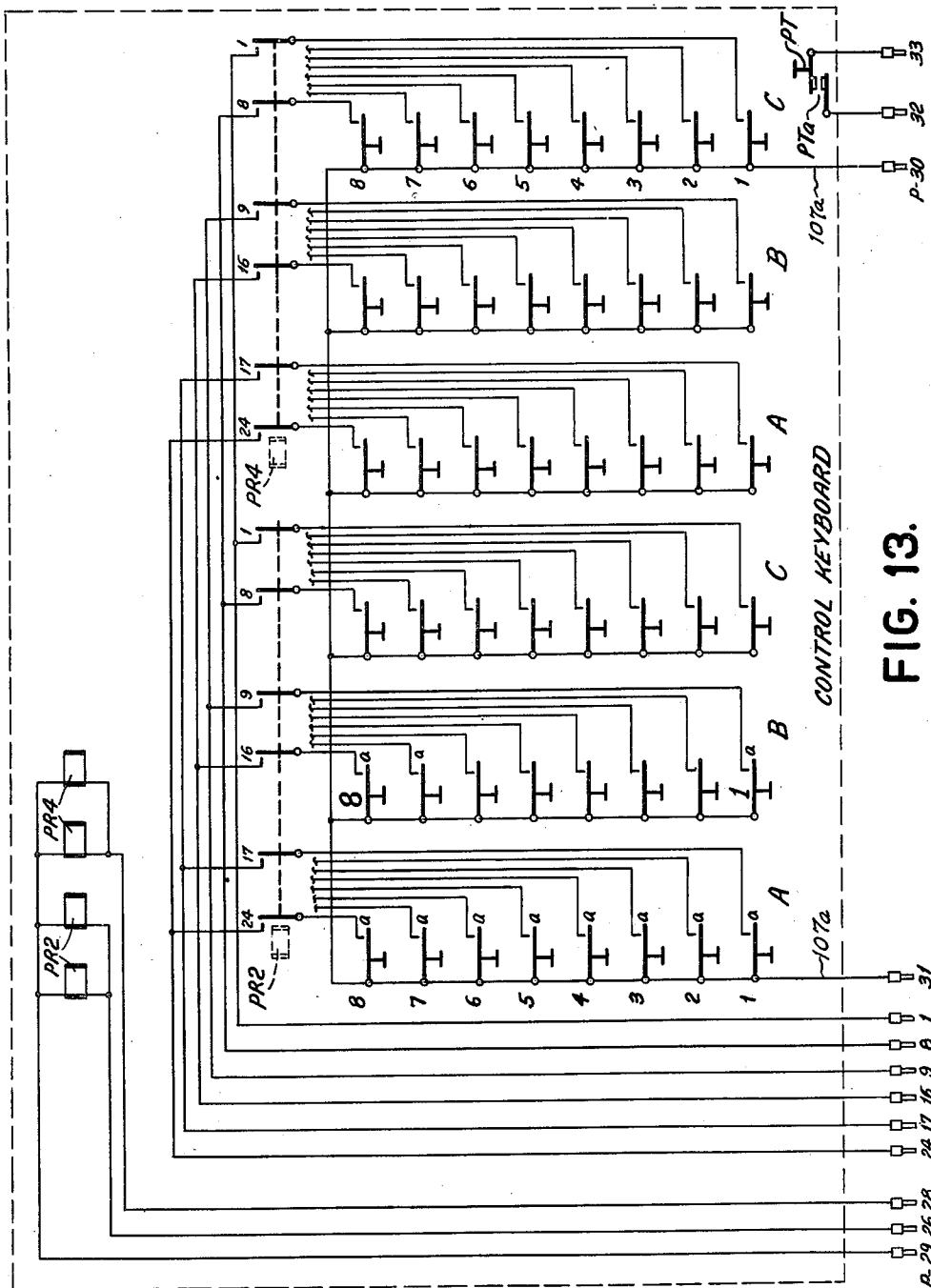


FIG. 13.

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UNITED STATES PATENT OFFICE

2,398,014

RECORD PUNCHING MACHINE

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Application February 15, 1945, Serial No. 578,110

33 Claims. (Cl. 164—113)

This invention relates to apparatus for punching item designations into record material.

The items to be designated may be values or control information. Record mediums bearing value or control item designations are used to control a calculator. The value designations extend in the direction of feed of the record medium through a calculator. Such direction may be referred to, for convenience, as the vertical direction. The control designations extend at right angles to the direction of feed of the record medium through a calculator or in a direction which may be called horizontal. It may be mentioned that in automatic letter writers, the character designations also run in a horizontal direction on the record medium. Value designations are to be recorded here according to a code in which some of the digital values are designated by single perforations and others by combinations of perforations. Such code may be called a combinational value code. The control designations are to be recorded here in accordance with a special code in which control items are represented by single perforations or combinations of perforations and, further, by their location in one or another of a plurality of zones of index positions.

An object of the present invention is to provide novel means for controlling punching apparatus to perforate record material according to different codes of data designations.

An object of the invention is to provide punching apparatus for punching record material according to a code in which the designations run horizontally or, alternatively, according to a code in which the designations run vertically. Specifically, the invention provides a punching apparatus which may be operated to punch a record medium with value designations running vertically or, alternatively, to punch a record medium with control designations running horizontally.

An object of the invention is to provide punching apparatus for punching the perforations, combining to represent a digit in a combinational code, successively.

An object of the invention is to provide punching apparatus with a keyboard or the like for manually selecting digits to be punched in combinational code and with means for thereafter punching perforations combinationally representing the selected digits in succession.

An object of the invention is to provide punching apparatus performing a given machine cycle in which it may punch a selective number of lines of perforations. Specifically, the invention provides a punching machine which in a given cycle

is controlled to punch either four horizontal lines of perforations to represent values according to a combinational code or, alternatively, to punch two horizontal lines of control data designations.

An object of the invention is to provide punching apparatus to punch lines of perforations, entering into data designations, at selective distances apart. Specifically, the invention provides a punching machine for punching two lines of control data designations in the same vertical space of a record medium in which the machine may punch four lines of value data designating perforations, spacing the two lines of control data designations twice as far apart as two successive lines of value data designating perforations.

An object of the invention is to provide punching apparatus in which a concurrent selection of perforations for successive horizontal lines of the record medium controls the successive punching of the lines of the selected perforations. In one aspect, the invention provides a punching apparatus in which control items for successive horizontal lines are selected by setting up a keyboard or the like and in which the two lines of selected control items are punched successively in a machine cycle. In a second aspect, the invention provides a punching apparatus in which the digits of a single amount are selected by setting up a keyboard or the like and in which successive horizontal lines of index positions are perforated, one after another, during a machine cycle to represent the amount in accordance with a chosen code.

An object of the invention is to provide novel keyboard means for controlling punching means.

An object of the invention is to provide keyboard means with elements for selecting data to be punched and also with control means for controlling the mode of operation of the punching means.

An object of the invention is to provide interchangeable keyboards with self-contained controls for selecting different modes of operation of the punching means. Specifically, the invention provides a keyboard for values and a keyboard for control items. Either one of these keyboards may be applied to the punching machine. Upon application of either keyboard to the machine, the controls in the keyboard act to condition the machine for the mode of operation for punching the type of data settable on the applied keyboard.

Another object of the invention is to provide

novel stepping mechanism for a record tape or the like.

The invention also aims at improvements in the punch actuating means.

It is to be understood that in several respects, the invention applies not only to recording by punching but to recording generically.

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.

An example of the use of the invention is in the punching of tapes for a calculator disclosed in application Serial No. 576,892, filed February 8, 1945.

In the drawings:

Fig. 1 is a plan view of the machine, with covers removed and neither keyboard attached.

Fig. 2 is a section along lines 2—2 of Fig. 1.

Fig. 2a shows a portion of Fig. 2 on a magnified scale.

Fig. 3 is a section along lines 3—3 of Fig. 1.

Fig. 4 is a section along lines 4—4 of Fig. 1.

Fig. 5 is a section along lines 5—5 of Fig. 2, and is shown on a magnified scale.

Fig. 6 is a plan view of the value keyboard.

Fig. 7 is a plan view of the control item keyboard.

Fig. 8 shows a fragment of a value record tape prepared by the machine.

Fig. 9 shows a fragment of a control record tape prepared by the machine.

Fig. 10 indicates the code for value designations.

Fig. 11 is a timing chart for the machine.

Fig. 12 shows the circuits relating to the value keyboard and the punching means.

Fig. 13 diagrammatically shows the electrical features of the control item keyboard.

Successive sections of the same roll of tape may be perforated with value and control data. The sections of the tape bearing value data may subsequently be severed from the tape sections punched with control data. If desired, individual sections of the tape bearing value data may then be attached to one another to form a long value tape, and individual sections of the tape bearing control data may also be attached to one another, if desired, to form a long control tape. Alternatively, it may be found more convenient to insert a roll of tape in the machine to receive value perforations and to remove this tape and insert another roll of tape to receive the control perforations. Regardless of whether the same roll of tape or different rolls are used to receive the value and control data, sections of tape punched with value data will be called value tapes, and sections of tape punched with control data will be called control tapes.

Fig. 10 shows a section of the tape punched with the code used for value designations. The arrow indicates the direction in which the tape feeds to the punches. Four successive rows of index positions 1, 2, 3, and 4 constitute a single value record. In accordance with the code used herein, digit 1 is represented by a perforation in the 1 index position of a column of index positions. Digits 2, 3, and 4 are represented by perforating a column in the 2, 3, and 4 index positions, respectively. Digit 5 is represented by perforations in the 1 and 2 index positions of the same column. Digits 6 and 7 are similarly represented by the combination of the 1 perforation

with the 3 and 4 perforations, respectively. Digits 8 and 9 are represented by combinational perforations 2—3 and 2—4, respectively. There are twenty-four columns of index positions, so that a number with as many as twenty-four places may be represented in one value record. It may be mentioned that if any of the places in a number contains zero, the related column of index positions is left blank. To summarize, the code used for the designations on a value tape represents items by the selective, differential disposition of perforations along vertical lines of the value record.

Fig. 8 shows a length of value tape prepared by the machine. The direction in which the tape feeds to the punches is indicated by the arrow. The tape is punched with successive value records, each bearing the designations of one amount. The dotted horizontal lines have been inserted in Fig. 8 to separate the value records but are not actually present on the tape. Nor are the column-defining lines actually present on the tape.

Fig. 9 shows a length of control tape prepared by the present machine. The arrow indicates the direction in which the tape feeds to the punches. The code for control designations punched on the control tape is one in which the designating holes are selectively significant in accordance with their differential horizontal disposition across the tape. The control tape is of the same width as the value tape and it has twenty-four similarly spaced columns of index positions. These columns of the control tape are divided into three fields A, B, and C, each with eight columns. The index positions in each field are known as the 8, 7, 6 . . . 1 positions and may be referred to as the A8 to A1, B8 to B1, and C8 to C1 positions to indicate in which of the fields they are contained. A single horizontal row of these index positions on the control tape constitutes one control record. The column defining lines shown in Fig. 9 are not actually present on the tape as produced. Nor are the dashed lines, separating fields A, B, and C and also separating the index position rows, actually present on the prepared tape. Considering the top row of the tape shown in Fig. 9, it constitutes a single control record bearing control designations A741, B761, and C21. The next row of the control tape is another control record and it bears control designations A3 and C32. Similarly, each of the other horizontal rows of the control tape constitutes a single control record bearing designations of control items. The purposes of the control designations do not bear on the present invention, but it may be pointed out that the designations may represent letters, numerals, symbols, words, machine functions, etc., as desired. For example, the designations represent machine functions in the calculator disclosed in the aforementioned application. Permutations of the eight index points in each of the zones A, B, and C provide for 256 different codal representations in each zone, or a total of 768 for all three zones. For instance, in the top row of the tape shown in Fig. 9, the designation A741 calls for the reading out of an amount from a switch row #1 in the aforementioned calculator, the designation B761 calls for the calculator to perform multiplication, and the designation C21 calls for inversion of the amount as it is read out of the switch row. The designation A3 in the next row calls for the reading out of an amount from a storage register #3, and the designation C32 calls

for inversion of the amount read out of the register. It is seen that the control tape bears items designated by perforations codally significant according to their horizontal, differential disposition on the tape.

Both the value and the control tapes have feed holes *f* at each side. The feed holes in a tape are perforated, during a machine cycle, in every other line of the tape. Comparing the control and value tapes, their feed holes are similarly spaced but their rows of index positions are differently spaced. The index rows on the control tape are twice as far apart as those on the value tape. As will be described in detail later, the machine performs a machine cycle in which four successive steps of feed of the tape occur, each step being the distance between successive lines. When the machine is conditioned for operation on a value tape, it performs four successive punching steps, each following a step of line spacing of the tape. When the machine is conditioned for operation on a control tape, it performs two punching steps, one after the first line space step and the other after the third line space step. Thus, when punching the control tape, the machine skips punching of every other line. There are two keyboards, one used when the value tape is to be punched and the other used when the control tape is to be punched. The value keyboard is settable with a single amount and the punching machine then operated for a cycle to punch the four successive rows of index positions 1, 2, 3, and 4 of a value record, one row after another, in accordance with the selected amount. The control keyboard is settable with the control items for two successive control records, each such record consisting of one row of index positions. The punching machine is then brought into operation for a cycle to punch the two rows of index positions with the designations of the selected control items.

The machine includes a motor DM (Figs. 1 and 4). The motor, through worm gearing 10, rotates a gear 11. Gear 11 meshes with a gear 12 to drive a shaft 13 continuously. One revolution of shaft 13 is taken as the measure of a machine cycle (Fig. 11). Cams C1, C2, C3, C4, and C5 are fixed to shaft 13 for operating cam contacts CC1, CC2, CC3, CC4, and CC5 (Fig. 12). The shaft 13 through a conventional one-revolution clutch drives an assembly including gears 14a and 14b and a driven clutch disk 16. A drive clutch disk 15 is fixed to shaft 13 and formed with a notch 15a (Fig. 3). Driven disk 16 carries a clutch pawl 17. A spring 18 urges the nose of the pawl towards the disk 15, but the pawl is normally latched by the armature 19 of a clutch magnet PCM. Upon energization of the clutch magnet, it unlatches the pawl 17, permitting it to engage the notch 15a in disk 15. Such engagement can occur only at a definite point of the revolution of shaft 13. This point is the beginning of a machine cycle (see Fig. 11) and is denoted by letter D. The clutch pawl, when engaged in notch 15a of disk 15, couples the driven assembly to shaft 13 for rotation thereby. Gear 14a of this assembly serves through gearing 20 to drive a gear 21 which is fixed to a shaft 51a carrying the lower, tape feed rolls 51 (see Fig. 2). Gearing 21a (Fig. 3) is provided between the shaft 51a and upper feed roll shaft 50a. The shaft 50a carries the upper, tape feed rolls 50. The gear ratios are such that the feed rolls make a small fraction of a turn for one revolution of the gear 14a; i. e., in a machine cycle.

The driven clutch assembly also includes the gear 14b which through gearing 22 drives a cam shaft 23. The ratio of gears 14b and 22 is such that shaft 23 makes four revolutions in a machine cycle. Fixed to shaft 23 are two cams PC1 and PC2 for operating cam contacts PC1a and PC2a shown in Fig. 12. Shaft 23 carries a gear 24 (Figs. 1 and 2) which through idler gear 25 drives, in 1:1 ratio, a gear 26. Gear 26 is fixed to a knock-off cam shaft 27.

Fixed to shaft 23 are complementary punch cams 28a and 28b (Figs. 1, 2, and 5). A pair of arms of a rocker 29 carry rollers 29a and 29b engaged with cams 28a and 28b, respectively. The rocker 29 has a third arm which is fixed to a shaft 30 journaled in side plates 740 and 742 of a sub-frame (see Figs. 1 and 5). Also fixed to this shaft is a pair of arms 31 carrying a punch operating plate 31a. During each revolution of shaft 23, cams 28a and 28b effect an oscillation of rocker 29, its shaft 30, and the punch operating plate 31a. There are twenty-six punches 32 (Figs. 2 and 5). The two end punches 32f are of larger diameter than the others and serve for punching the feed holes *f* (Figs. 8, 9, and 10) into the tape. The twenty-four remaining punches serve for punching the data designating holes in the columns of either the value or control item record tape. Punches 32 are guided for vertically slidable movement in a frame 33 and adapted to coact with a die 34 in punching the tape material.

The punches 32 are individually pivoted to levers 35. Each lever has a notch 35a. The upper wall of the notch overlaps the top of plate 31a in all positions of the lever. Hence, upon the upward stroke of plate 31a, it positively returns the lever 35 and connected punch 32 to upper positions. The lower wall of the notch 35a is shorter than the upper wall and, in the retracted position of the lever 35, the lower wall of the notch is out of the path of plate 31a, as best shown in Fig. 2a. However, upon forward, counterclockwise movement of lever 35, its notch 35a receives the tip of plate 31a. Hence, on the subsequent down stroke of the plate 31a, it depresses the lever 35 and connected punch. The forward movement of a lever 35 is effected upon energization of a related punch magnet PM. Each lever 35 is pivotally connected to a link 36 which is in engagement with a lever 37. Springs 38 between levers 37 and links 36 maintain the levers and links interengaged. Each lever 37 is swiveled to vertically slidable bar 39 which is urged upwardly by a spring 41. Each bar 39 is notched to engage the end of the armature 40 of a punch magnet PM. These punch magnets are staggered in position, as may be understood from Figs. 1 and 2 to allow the bars 39 to be arranged closely together side-by-side. Upon energization of a magnet PM, it causes downward movement of the related bar 39. Bar 39 thereupon rocks associated lever 37 counterclockwise. In turn, the lever 37, through link 36, effects similar movement of lever 35. The lever 35 is thus moved to forward position upon energization of the associated magnet PM. The magnet PM is energized only momentarily, but the lever 35 is latched in forward position, in which its notch 35a receives the tip of plate 31a, until the connected punch 32 perforates the tape. The latching means comprises levers 42, one for each lever 35. The latches 42 are pivotally mounted on a cross bar 44 and connected to the levers 35 by springs 43 which urge the levers and latches to

maintain engagement. In the retracted position of a lever 35, its upper end is engaged with the bottom step of the associated latch 42. Upon the forward movement of the lever 35, its upper end moves into engagement with the top step of latch 42 which, thereby, keeps the lever in its forward position. The bar 44 limits the movement of latches 42 so that they cannot follow the downward movement of the levers 35. Upon the down stroke of punch operating plate 31a, it depresses those levers 35 which have been latched in their forward positions and causes the connected punches to perforate the tape. As the down stroke of plate 31a and the levers 35 is completed, the upper ends of the levers move below the upper steps of the latches 42. Springs 43 thereupon return the levers 35 to their retracted, clockwise positions in which they engage the bottom steps of latches 42 and in which their notches 35a release the plate 31a. To insure the return of levers 35 to their retracted positions, the knock-off cam shaft 27 strikes the tails of the levers at the completion of the punching stroke and effects clockwise movement of the levers.

The tape to be punched is led from a supply roll (not shown), between the upper and lower feed rolls 50 and 51 (Fig. 2), then formed with a loop and passed over a guide roller 52. From the guide roller, the tape is led over the support plate 53a and under a guide plate 53 and between the punch guide frame 33 and the die 34. A machine cycle is then initiated, in a manner brought out later in the description of the circuits. During the cycle, two successive pairs of feed holes *f* (Figs. 8, 9, and 10) are punched in the tape. The operator then brings the tape forwardly a sufficient distance to enable the feed holes to be hooked onto feed pins 55a on a feed drum 55 (Fig. 2). Before doing so, the upper pair of pressure rolls 56 are withdrawn from the drum, in a manner described later. The portion of the tape in front of the feed holes is cut off so that the feed holes can be hooked over those pins which appear in Fig. 2 below the upper pressure roll 56 and so that the leading end of the tape may lie flush on the surface of the drum. The pressure rolls are then brought back into operative position, and the upper rolls then hold the leading end of the tape firmly down on the drum. The portion of the tape extending between the feed holes which have been punched and the punch die 34 is then cut away along the margins where feed holes are normally punched. Successive machine cycles are then initiated to punch a length of the tape with feed holes. The stepping of the tape during the punching of the feed holes in the length of tape, behind the portion whose margins have been cut away, is effected by the drum 55 in a manner to be described. In this way, the proper distance between the feed holes and, therefore, between lines of the records to be perforated, is established when the tape is inserted in the machine. The drum 55 will feed the tape under a second pair of pressure rolls 56. Pressure rolls 56 engage the tape to keep it flush on the surface of the drum. The pressure rolls are carried by pairs of levers 57 which are free on rods 58 (see Figs. 1 and 2). The levers 57 are urged, by springs 59, in directions to maintain the pressure of rolls 57 on the tape. The levers 57 have short outer extensions 57a gripping oblong portions of a shaft 60. On the shafts 60 are handles 61 for turning shafts to spread the extensions 57a apart and, thereby, to rock the levers 57 in directions to

withdraw the rolls 56 from the drum 55. This is done when the tape is being threaded on the drum or being removed therefrom. The drum 55 feeds the tape to a take-up spool (not shown).

Figs. 1 and 3 show the means for effecting stepping of the feed drum 55. The drum is fixed to a shaft 65. Fixed to one end of shaft 65 are two ratchet wheels 67 and 67r having their respective ratchet teeth inclined in opposite directions. Adjacent to the ratchet wheels is a feed pawl carrier comprising a lever 68 free on shaft 65. One end of the lever 68 pivotally carries a feed pawl 69, the nose of which is urged by a spring 70 into engagement with ratchet wheel 67. The opposite end of lever 68 is pivotally connected to the lower end of a link 72. Link 72 is pivotally connected at the upper end to an arm 73 free on a shaft 74. Also free on this shaft is an adjacent follower lever 75 which has two spaced rollers 76a and 76b respectively engaging complementary cams 77a and 77b. These cams are fixed to the clutch-driven cam shaft 23 which, as previously explained, makes four revolutions in a machine cycle. There is a bent tab 73a on arm 73 which overlies an upper edge of follower lever 75. A spring 78 connects the outer ends of arm 73 and the follower lever 75 and normally keeps the arm in a position in which its tab 73a is engaged with the upper edge of the follower lever. It is clear that the clockwise movement of the follower lever 75 will act through spring 78 yieldingly to effect similar movement of the arm 73 but, on the other hand, counterclockwise movement of the follower lever will be transmitted positively to arm 73.

A stud 80 is fixed to the machine frame and freely mounts a holding pawl 81 biased by a spring 82 into engagement with ratchet wheel 67. The anchor pin 83 for spring 82 is fixed to the frame, as shown in Fig. 1. Also free on stud 80 is an aligning pawl 84 the nose of which is adapted to engage the teeth of ratchet wheel 67r. The rear arm of pawl 84 pivotally carries a hook 85 which is hooked into the right hand end of the lever 68. A spring 86 connects hook 85 to fixed pin 83 and urges the hook upwardly and, thereby, urges the pawl 84 counterclockwise to maintain its engagement with ratchet 67r. The spring 86, at the same time, normally keeps the hook engaged with a pin 84a on the rear arm of pawl 84 and the hook end in engagement with lever 68. During each revolution of shaft 23, the cams 77a and 77b effect an oscillation of follower lever 75 and a corresponding oscillation of arm 73. Upon the clockwise, yieldingly effected stroke of arm 73, it depresses the link 72 to rock the lever 68 clockwise. The lever 68 pulls down on the hook 85, thereby rocking the aligning pawl 84 out of engagement with ratchet wheel 67r. The shaft 65 of the tape feeding drum 55 is now free to move clockwise, and this action is effected by the pawl 69 which is moving clockwise with the lever 68. The lever 68 continues to pull down on the hook 85 until the hook meets a fixed pin 88 and is cammed counterclockwise, thereby releasing itself from the lever 68. Meanwhile, the feed pawl 69 has moved the drum clockwise for one step plus a slight overthrow to insure the passage of the top of a tooth past the nose of detent 81. Upon release of hook 85 from lever 68, spring 86 returns the hook 85 to its upper position, thereby rocking the aligning pawl 84 into coaction with ratchet wheel 67r. Pawl 84 returns the drum the amount of the overthrow as it seats itself in a ratchet notch of the wheel 67r. This overthrow return may occur

while the feed pawl 69 still is engaged with ratchet wheel 87 owing to the yielding of spring 78. Upon the return stroke of the lever 68, it cams the lower end of hook 85 aside and re-seats itself on the hook. The feed step is such as to move the tape the distance between two successive rows of index positions on the value tape VT (Figs. 8 and 10) or half the distance between two successive rows of index positions on the control tape CT (Fig. 9).

As previously explained, the control tape (Fig. 9) is punched in accordance with a code whereby index positions 8 to 1 in each of zones A, B, and C of a horizontal row selectively are punched to represent control items. The index positions are referred to as the A8 to A1, B8 to B1, and C8 to C1 positions. One or more control items may be punched into each zone of a row. The control item may be represented by one or a combination of perforations. Thus, in the top row, in zone A, perforations in positions 7, 4, and 1 combinationally represent a control item A741; in the next row, a perforation in position 3 of zone A represents item A3; and in the third row, in field C, perforations in positions 8 and 7 represent items C8 and C7, respectively. The items for two successive rows of the control tape may be selected and the two rows punched, one after another, during an ensuing machine cycle. The keyboard on which the desired control items may be set up is shown in Fig. 7, where it is designated PK. There are two sets of key columns A, B, and C. The left hand set is operated to select items to be punched in one row of the control tape and the right hand set is operated to select items to be punched in the next row of the control tape. In each set, the A key column is used to select items for zone A, the B column for zone B, and the C column for zone C. Each key column has keys 1 to 8 corresponding to index positions 1 to 8 of the related zone, and a release key R. Upon depression of a numbered key, it closes key contacts, shown only in Fig. 13, and is latched in depressed position by known means (not shown). The latched key is released only upon depression of the release key R in the same column.

After the keys of both sets have been depressed, a machine cycle is initiated by depression of a start key PT. During the cycle, the items selected by the left hand set of keys are punched into one row of the control tape and then the items selected by the right hand set are punched into the next row of the control tape. Assume, for instance, that the two lower rows shown in Fig. 9 are a pair of rows punched during the same cycle. The lowermost row is the leading row and its items are selected by the left hand set of key columns. The items in the row above are selected by the right hand set of key columns. During the ensuing cycle, the lowermost row is punched according to the selected items and then the row above is punched according to the items selected therefor. During a next cycle, the third row from the bottom will be punched with items selected by the left hand set of keys and then the fourth row from the bottom will be punched with items selected by the right hand set of keys. This order of selection and punching will be maintained as long as control items are punched under control of the keyboard PK. It will be seen, for example, that the second row from the top in Fig. 9 will be punched under control of the left hand set of keys and then the top row will be punched in the same cycle under control of the right hand set of keys. The second row from the

top bears control items A3 and C32 which are selected by depressing key 3 in column A and keys 3 and 2 in column C of the left hand set of keys. The top row bears control items A741, B761, and C21. These items are selected by depressing keys 7, 4, and 1 of column A, keys 7, 6 and 1 of column B, and keys 2 and 1 of column C of the right hand set. A cycle is then initiated by depressing the button PT and, during the cycle, the second row from the top and the top row are punched, in succession, with the selected items.

Mounted inside the housing of the keyboard PK are two twin-coil relay magnets PR2 and PR4. The relay magnets, start button contacts, and the key contacts are connected in a manner shown in Fig. 13 to plug wires. The plug wires are gathered in a cable 95 (Fig. 7) which terminates in a plug head PH. To associate the control keyboard with the punching unit, the plug head PH is plugged into a gang-socket receptacle S (Fig. 1).

The value keyboard is shown in Fig. 6 and designated VK. It has twenty-four columns of keys, one for each column of the tape. Each column includes keys 1 to 9 for selecting digital values 1 to 9 to be punched in code into a value record. As previously explained, a value record is composed of four successive index position rows 1, 2, 3, and 4 (Figs. 8 and 10). After the values to be punched into a record have been selected, the start key VT is depressed, closing related contacts shown in Fig. 12, to initiate a machine cycle. During the cycle, the index rows 1, 2, 3, and 4 will be punched successively with the perforations for designating the selected values. Upon depression of a numbered key, it closes key contacts shown only in Fig. 12 and is latched in depressed position by known means (not shown). There is also a release key R in each column. A latched number key is released by the depression of another numbered key or of the release key in the same column. There are four relay magnets VR1, VR2, VR3, and VR4 mounted inside the keyboard. The relay magnets, start button contacts, and key contacts are connected in a manner shown in Fig. 12 to plug wires which are gathered in a cable 96. The cable terminates in a plug head VH which may be plugged into the receptacle S (Fig. 1).

Circuits connecting the punch unit to the value keyboard

When values are to be punched, the value keyboard VK (Fig. 6) is connected to the punch unit by inserting the plug head VH into receptacle S (Fig. 1). Fig. 12 shows the pertinent circuits. The key contacts are the same for each column and, therefore, it is sufficient to show five columns of the key contacts. The relay magnets VR1, VR2, VR3, and VR4 relate to index position rows 1, 2, 3, and 4 (Fig. 10), respectively. Each of these magnets, when energized, closes a relay contact in each of the twenty-four columns of key contacts. The relay contacts are numbered to correspond to the related columns. Thus, for column 24, the relays VR1, VR2, VR3, and VR4 operate their respective contacts "24."

Each key for selecting a value represented by a single perforation operates only one key contact, while each key which selects a value represented by a combinational pair of perforations operates a pair of key contacts. The key contacts are connected to the relay contacts in accordance with the code. Considering column 24, for ex-

ample, the 1 key operates its contact *a* which is wired to contact "24" of relay magnet VR1. This accords with the requirement that the digit 1 be represented by a perforation in the 1 index position of a column. As another example, the digit 9 is represented by perforations in index positions 2 and 4 of a column; hence, key 9 operates two contacts *a* and *b* wired to relay contacts of relay magnets VR2 and VR4, respectively.

The plug tips in plug head VH are designated in Fig. 12 by numbers preceded by letter V. The companion plug sockets in receptacle S (Fig. 1) are similarly numbered in Fig. 12 but preceded by letter S. There are twenty-four plug tips V1 to V24 for the key contact columns 1 to 24. These are received by plug sockets S1 to S24 which are wired to punch magnets PM (also see Figs. 1 and 2) for tape columns 1 to 24. The relay magnets VR1 to VR4 are wired at the common sides to a plug wire 100 which has a plug tip V29 inserted in socket S29. Socket S29 is connected to the plus side 105 of a 40 V. D. C. line. The relay magnets are individually connected to plug wires 101, 102, 103, and 104 which have plug tips V25, V26, V27, and V28. These are engaged in sockets S25, S26, S27, and S28 wired to the cam contacts CC1, CC2, CC3, and CC4. The common sides of the relay contacts of relays VR1, 2, 3, and 4 are connected to a wire 107 one end of which has a plug tip V30 and the opposite end a plug tip V31. These are engaged in plug sockets S30 and S31 connected to each other and wired via cam contacts PC1a to the minus side 106 of the voltage line.

The motor DM (see Figs. 1 and 4) is in a conventional motor circuit which is not shown. When the tape punching apparatus is to operate, the motor circuit is closed, and the motor will run continuously until the motor circuit is reopened. While the motor is running, it continuously operates the cam contacts CC1, CC2, CC3, CC4, and CC5 (also see Figs. 1 and 4). Only when a machine cycle takes place do the cam contacts PC1a and PC2a operate. The timing of the cam contacts in a machine cycle is shown in Fig. 11. The cycle is divided into four equal parts 1, 2, 3, and 4 in each of which the clutch-driven shaft 23 (Figs. 1, 2, and 3) makes one revolution. In each revolution of shaft 23, the drum 55 will be advanced one step in a manner previously described, so as to feed the tape one line space. A feed step occurs early in each of parts 1, 2, 3, and 4 of the machine cycle. The first feed step, in part 1, brings index position row 1 of a value record to the punching position. The 2d, 3d, and 4th feed steps, in parts 2, 3, and 4, bring the index position rows 2, 3, and 4 successively to the punching position. Thus, in a machine cycle, a length of tape defining a value record is fed to punching position, in four equal steps.

For purposes of further explanation, assume that digits 6, 9, and 3 are to be designated in columns 13, 12, and 6 of a value record. The keys 6, 9, and 3 in key columns 13, 12, and 6 are depressed. The start button VT is then depressed. Upon depression of the start button, it closes its contacts VTa to establish a circuit from the plus side 105 of the voltage line through clutch magnet PCM, to socket S32 and coacting plug tip V32, thence via contacts VTa to plug tip V33 and coacting socket S33, and thence to the minus side 106 of the voltage line.

Upon energization of clutch magnet PCM, it brings the cam shaft 23 into operation for four revolutions during a machine cycle, as previously

described. During part 1 of the cycle, the drum 55 is fed one step to advance the 1 index position row of a value record, to be prepared, to the punching position. Thereafter in part 1, cam contacts CC1 and PC2a close establishing a circuit through code relay VR1, as follows: from the plus side 105 of the voltage supply line, via socket S29, coacting plug tip V29, and the wire 100 through relay VR1; thence by way of wire 101, plug connection V25—S25, and the cam contacts CC1 and PC2a to the minus side 106 of the voltage line.

Code relay VR1, being energized, closes its twenty-four relay contacts, one in each key column, to prepare for the punching of the 1 positions, in the various columns of the value record, under control of the key contacts. In column 13, key 6 has been depressed. The code for value 6 is 1—3. Hence, in part 1 of the machine cycle, column 13 will be punched in the 1 position. The punch magnet circuit is timed by cam contacts PC1a and extends from the plus side 105 of the voltage line through punch magnet PM for tape column 13, thence via plug connection S13—V13, the common of the key contacts of keyboard column 13, the now-closed *b* contact of the 6 key in this column, through contact "13" of relay VR1 to wire 107. The circuit is completed via plug connection V30—S30 or V31—S31 through cam contacts PC1a to the minus side 106 of the voltage line.

In the manner previously explained, the energization of the punch magnet PM brings about operation of the related column punch 32 (see Fig. 2). Accordingly, for the assumed example, the "1" perforation of the codal designation for digit 6 is made in column 13, during part 1 of the machine cycle.

Early in part 2 of the machine cycle, a feed step occurs, bringing index row 2 of the value record to the punches. Cam contacts CC2 and PC2a then close, completing the circuit of code relay VR2, from the plus side 105, via plug connection S29—V29 through relay VR2, to wire 102, plug connection V26—S26, and cam contacts CC2 and PC2a to minus side 106. Relay VR2 closes its 24 relay contacts, one in each key column.

Column 12 of the value record is to be punched with a 9 value designation, as previously assumed. Hence, the 9 key in column 12 has been depressed. Upon closure of cam contacts PC1a, a circuit is established through magnet PM—12 to cause the "2" perforation of designation 2—4 for digit 9 to be punched in tape column 12. This circuit extends from plus side 105 through magnet PM—12, plug connection S12—V12, contact "a" of the "9" key contacts in key column 12, now-closed contact "12" of relay VR2, wire 107, plug connection V30—S30 or V31—S31, and cam contacts PC1a, to the minus side 106. As a result of energization of magnet PM—12 during part 2 of the machine cycle, a perforation is made in index position 2 of column 12 of the value record.

During part 2, at the same time as cam contact CC2 closed, the cam contact CC5 also closed. A circuit is thereupon established from the plus side 105 through the left and right punch magnets PM—*f*, through cam contacts CC5 and PC2a, to the minus side 106. These punch magnets cause a pair of feed holes *f* (Figs. 8, 9, and 10) to be punched in the left and right hand margins of the tape and in horizontal alignment with the 2 index row of the value record.

Early in part 3, a feed step occurs, bringing

index row 3 to punching position. Code relay VR3 is then energized by a circuit from plus side 105 via S29—V29, relay VR3, wire 103, V27—S27, and CC3 and PC2a to minus side 106.

In the assumed example, key 3 of column 6 and key 6 of column 13 have been operated. Circuits make upon closure of PC1a through magnets PM—6 and PM—13, causing perforations to be made in positions 3 of columns 6 and 13. The perforation 3 in column 6 represents the selected digit 3. The perforation 3 in column 13 combines with the previously made perforation 1 in the same column to represent selected digit 6. The circuit for magnet PM—6 is from plus side 105 through magnet PM—6, S6—V6, key contact 3a of key column 6, contact "6" of relay VR3, wire 107, V30—S30 or V31—S31, and PC1a, to the minus side 106. The circuit for magnet PM—13 is from plus side 105 through magnet PM—13, S13—V13, key contact 6a of key column 13, contact "13" of relay VR3, and, as in the preceding circuit, via PC1a to the minus side 106.

Early in part 4 of the cycle, a feed step occurs, positioning index row 4 at the punches. Code relay VR4 is energized by a circuit from plus side 105 via S29—V29, relay VR4, wire 104, V28—S28, CC4 and PC2a, to the minus side 106.

In the selected example, the key 9 in column 12 has been depressed. During part 2 of the cycle, a perforation 2 was made in column 12. During current part 4, a perforation 4 will be made in this column. Perforations 2 and 4 combinationally represent digit 9. The circuit for magnet PM—12 is from the plus side 105 through magnet PM—12, S12—V12, key contact 9b of column 12, contact "12" of relay VR4, wire 107 and, as before, via PC1a to the minus side 106. Also, during part 2, cam contacts CC5 close for the second time in the cycle. A circuit such as made in part 2 therefore is completed through magnets PM—f. Hence, a pair of feed holes are punched along the margins of index row 4 of the value record.

To summarize, when the value keyboard is plugged into the punch unit, the four code relays VR1, VR2, VR3, and VR4 are plug-connected to cam contacts CC1, CC2, CC3, and CC4. Hence, these code relays VR1, 2, 3, and 4 will be energized respectively in parts 1, 2, 3, and 4 of a machine cycle. The code relays condition the punch magnet circuits to be energized selectively in accordance with the selection of values made by the digit keys of the value keyboard. Accordingly, punching may occur in each of the four parts of a machine cycle. There will be four feed steps, each of which may be followed by the punching of one or more columns of the value record. Perforations which combinationally represent a digit are punched sequentially in the same column of the value record, one perforation being punched during one part of the cycle and the other perforation in a later part of the cycle.

Circuits relating to the control keyboard

When the tape is to be punched with control items, the plug head PH (Fig. 7) is plugged into the gang-socket receptacle S (Fig. 1).

Fig. 13 shows the wiring of the control keyboard. The plugs in plug head PH are designated by numbers preceded by letter P. These plugs are received by the correspondingly numbered plug sockets S shown in Fig. 12.

The columns of key contacts are alike in construction. Each key, when depressed, closes its "a" contact. The common sides of all the column

contacts are connected to a wire 107a which has plug tips P30 and P31 at opposite ends. These plug tips are inserted in sockets S30 and S31 (Fig. 12). The individual sides of the 24 key contacts in columns A, B, and C of the left hand set of three key columns are separately connected to 24 relay contacts "1" to "24" of relay PR2. The individual sides of the 24 key contacts in columns A, B, and C of the right hand set are similarly connected to contacts "1" to "24" of relay PR4. The function of the relays PR is generally similar to that of relays VR; i. e., when energized, they partially close the punch magnet circuits and, thereby, prepare them to be completed selectively under control of key contacts. The common sides of the relays PR2 and PR4 are connected to plug P29 which is insertable in socket S29 (shown in Fig. 12). The individual sides of the relays PR2 and PR4 are connected to plugs P26 and P28, respectively. These plugs are insertable in sockets S26 and S28 (Fig. 12) which are wired to cam contacts CC2 and CC4. Hence, in part 2 of a machine cycle, relay PR2 will be energized and in part 4, the relay PR4 will be energized by circuits similar to those traced previously for relays VR2 and VR4. It will be noted that the contacts "1" to "24" of each of relays PR2 and PR4 are numbered to correspond to the tape columns for which they prepare punch circuits. That is, contacts "1" to "24" of each of these relays are wired to plugs P1 to P24 (Fig. 13). These plugs are inserted in sockets S1 to S24 (Fig. 12) which are wired to punch magnets PM for tape columns 1 to 24, respectively.

The start button PT (Figs. 7 and 13) of the control keyboard operates contact PTa. The contact is connected at opposite sides to plugs P32 and P33 which are received by sockets S32 and S33 (shown in Fig. 12). Hence, upon depression of the start button PT, the clutch magnet PCM will be energized by a circuit similar to that traced before through start button contact VTa (Fig. 12). A machine cycle will ensue. During part 1 of the cycle, a feed step will occur. But no punching operation can occur during part 1 because there is no connection between the control keyboard and cam contact CC1. During part 2 of the cycle, a second feed step will occur, followed by energization of relay PR2. Contacts "1" to "24" of relay PR2 close and punch magnet circuits are then completed in accordance with the selection of control items made by the left hand set of key columns A, B, and C. For instance, assume that the control item B81 is selected for the leading one of the two item rows to be punched in a cycle. The keys 8 and 1 in column B of the left hand set are depressed. Upon the closure of cam contacts PC1a (Figs. 9 and 12) in part of the cycle, circuits are established from the plus side 105 of the voltage line (Fig. 12) through magnets PM9 and PM16, to sockets S9 and S16 and the related plugs P9 and P16 (Fig. 13); thence from plug P9 via contact "9" of relay PR2 and contact "a" of key 1 in column B of the left hand set, to the plug wire 107a; also from plug P16 via contact "16" of relay PR2 and contact "a" of key 8 in column B of the left hand set to the plug wire 107a. The circuits are completed by way of plug P30 (Fig. 13) and socket S30 (Fig. 12) or plug P31 (Fig. 13) and socket S31 (Fig. 12) and cam contacts PC1a to the minus side 106 of the voltage line. In this manner, the selected item B81 is punched during part 2 of a cycle into a row of the control tape (Fig. 9) under

control of column B of the left hand set of key columns A, B, and C. Other items selected for this row of the tape also will be punched in a similar manner during part 2 of the cycle and under control of the left hand set of key contacts A, B, and C.

In the same way as explained for the value tape, the left and right hand magnets PM—f (Fig. 12) will be energized during part 2 of the cycle, so as to cause the feed holes f to be punched in the tape.

During part 3 of the cycle, the third feed step will occur but there will be no punching because the cam contacts CC3 are not connected to the control keyboard.

During part 4 of the cycle, the fourth feed step will occur. Relay PR4 will be energized shortly after. The contacts "1" to "24" of relay PR4 will close, enabling the key contacts of the right hand set of key columns A, B, and C to be effective for selectively closing the punch circuits. In a manner now understood, the second one of the two item rows to be prepared in the same cycle will be perforated in part 4 with the items selected by the right hand set of key columns. Also, feed holes f will be punched during part 4.

To summarize, when the control keyboard is plugged into the punch unit and a cycle is initiated, four feed steps will occur but only two punching steps may be effected, one punching step following the second feed step and the other punching step following the fourth feed step. The first punching step will be prepared by energization of relay PR2 during part 2 of the cycle and a row of control items will be punched during this part of the cycle under control of the left hand set of key columns A, B, and C. The second punching step will be prepared by relay PR4 during part 4 of the cycle. A second row of control items will be punched in part 4 under control of the right hand set of key columns A, B, and C.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred 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:

1. In combination with perforating means to punch index positions of record material with item designations, means to control the perforating means to punch the record material with a selected item designation within a vertical line of index positions in accordance with one item designating code in which different items may be selectively represented within index positions of such vertical line, and alternatively effective means to control the same perforating means to punch the record material with a selected item designation within a horizontal line of index positions according to a different item designating code in which different items may be selectively represented within index positions of such horizontal line.

2. In combination with perforating means to punch item representations into index positions of record material, means, including an item selecting keyboard and associated control means, for controlling the perforating means to punch selected item representations into vertical col-

umns of index positions according to an item representing code in which different items may be selectively represented within a set of index positions in a vertical column, and other means, including another item selecting keyboard and associated control means, for controlling the perforating means to punch selected item representations into horizontal lines of index positions according to a code in which different items may be selectively represented within a set of index positions in a horizontal line.

3. In combination, a punching unit for punching record material according to either of two codes to represent selected items, a pair of keyboards interchangeably associable with the punching unit, one keyboard including means to select items to be represented according to one code and the other keyboard including means to select items to be represented according to the other code, each keyboard having associated therewith control means supplementing the selecting means of the keyboard and operable to couple the selecting means with the punching unit according to the requirements of the code related to the keyboard, and means for so operating the control means associated with keyboard in use.

4. In combination, a cyclically operable punching unit to punch record material according to any one of a plurality of different codes of item representation, a plurality of item selecting keyboards interchangeably cooperable, only one at a time, with the punching unit, each keyboard relating to a different code, each keyboard including item selecting means and also having associated therewith separate control devices for rendering the punching unit effective to punch the record material according to the code related to the keyboard, and cyclically operating means in the punching unit capable of operating the control devices associated with the keyboard which is in cooperation with the punching unit.

5. In combination with means to punch a column of index positions of a record according to a combinational code of item representation, means to select the item to be represented, and means thereafter effective for controlling the punching means to produce sequentially in the column of index positions the perforations combinationally representing the selected item.

6. In combination with means to punch a column of index positions of a record according to a combinational code of digit representation, a keyboard or the like to select any one of different digits to be represented, and means operated after the digit selection has been made for controlling the punching means to produce sequentially in the column of the record the perforations combinationally representing the selected digit.

7. In combination, means to punch record material with item representations in accordance with a combinational code by which a combination of perforations in different index positions represents a desired item, mechanism to feed the record material so as to present the index positions successively to the punching means, means to select an item to be represented, and means controlled thereby for operating the punching means to punch index positions brought one after another to the punching means with the perforations combinationally representing the selected item.

8. In combination with means to produce item representing perforations in a plurality of zones of index positions in a line of index positions on

a record according to a code in which different items are represented by different combinations of perforations in different ones of the zones of index positions, means to select the items to be represented in the different zones of index positions along said line, and means thereafter operated to control the punching means to punch each set of index positions with a combination of perforations representing the item selected for the zone.

9. In combination with means to produce item representing perforations in a plurality of zones of index positions in a line of index positions on a record according to a code in which items are distinguished by the zone in which they are located and selectively represented in the zone by different combinations of perforations, a keyboard or the like settable according to a plurality of items to be represented in the different zones, and means operated after said items have been selected by the keyboard for controlling the punching means to punch the combinational perforation representations of the selected items in the zones of index positions.

10. A cyclically operable punching apparatus comprising punching means to produce item representations in record material, a keyboard or the like having a plurality of sets of item selectors concurrently selecting a plurality of items to be represented, a plurality of controls, each upon operation rendering a related set of item selectors effective to control the punching means to produce the perforations representing items selected by said set, and cyclically operating means for operating said controls in succession.

11. A cyclically operable punching apparatus comprising punches to produce item representations in record material, electrical devices for controlling operation of the punches, a keyboard or the like having item selectors and contacts controlled thereby, relay means for bringing said contacts into circuit with the electrical devices so as to operate the devices according to the selected items, and cyclically operating means for operating the relay means.

12. In combination with punching means to produce item representations in record material, a keyboard having item selecting means and containing control means operable to place the punching means under control of the item selecting means so as to punch the selected item representations into the record material, and cyclically operating means for operating the control means.

13. Apparatus comprising a punch unit with punches to perforate record material with item representations, electrical devices to control operation of the punches, and cyclically operating contact means, in combination with a keyboard containing item selecting keys, contacts operated thereby, and control relay means energized under control of said contact means to bring the key contacts into circuit with the electrical devices for controlling operation of the punches to perforate the record material with selected item representations.

14. In combination, a punching unit including punches and electrical devices for rendering the punches selectively effective to perforate record material for representing selected items, a keyboard with item selecting means and contact means operated thereby, relay means and contacts operated thereby for bringing the contact means into circuit with the electrical devices to control operation of the devices according to the

selected items, and means in the punching unit for bringing about operation of the electrical devices.

15. In combination, a cyclically operable punching unit to punch representations of items into record material, said punching unit including punches and magnets for selectively rendering the punches effective, a keyboard containing item selecting keys, key contacts operated thereby, relay means, and relay contacts operated thereby and cooperable with the key contacts, cyclical means in the punching unit for rendering the relay means effective, and cyclical means in the punching unit for then completing the circuits of the magnets by way of the relay contacts and the selected key contacts so as to render the punches effective in accordance with the selected items.

16. In combination, punching means to punch record material in index positions disposed in horizontal and vertical lines, means to feed the record material line by line to the punching means, a pair of alternative selecting means selectively effective to control the punching means according to desired items, means cooperatively relating one of the item selecting means to the punching means to control the punching means to punch a plurality of index positions concurrently in a horizontal line of the medium to represent desired items, and means cooperatively relating the other item selecting means to control the punching means to punch a plurality of index positions, in a vertical line, sequentially to represent desired items.

17. In combination, a punching unit for punching record material to represent items according to any one of different codes, said unit including punches and electrical devices for selectively rendering the punches effective, a plurality of keyboards respectively relating to the different codes, each keyboard including manual elements to select items to be represented and contact means operated by the elements, and each keyboard also having associated therewith relay means and relay contacts operated thereby for bringing the contact means into circuits of the electrical devices so as to control operation of these devices according to the selected item or items and the code relating to the keyboard.

18. Apparatus comprising a punching unit including punches to perforate record material with item representations, electrical devices to control operation of the punches, timing contact means, and an accessible electrical outlet with a gang of terminals respectively wired to the electrical devices and said contact means, in combination with a keyboard containing item selecting keys, key contacts operated thereby, relay means for switching said contacts into circuit with the electrical devices so as to cause operation of the devices according to the selected items, and an electrical connector including a gang of terminals wired to the key contacts and the relay means and freely engageable with the terminals in said outlet to connect the key contacts to the electrical devices and the relay means to the timing contact means for interrelated operation.

19. In a cyclically operating machine, punches to punch item representations into record material during a plurality of steps in a given cycle, electrical devices for controlling operation of the punches, item selecting means for controlling the electrical devices to cause selected item representations to be punched, a plurality of relays

for bringing the electrical devices and item selecting means into cooperation for a selective number of steps in the cycle, and cyclically operating means for operating said relays successively at different steps in the cycle.

20. In a cyclically operating machine, drive means, driven means, a one-revolution clutch for clutching the driven means to the drive means for a cycle of operation, feeding means operated by the driven means a number of times in a cycle to bring a number of lines of index positions on record material successively to a punching position, a line of punches at said positions, means operated by the driven means said number of times in the cycle for operating selected punches, punch selecting circuits including item selecting contacts, relay means for rendering the punch selecting circuits effective, and means operated by the driven means for operating the relay means a selective number of times in the cycle.

21. In combination with a punching unit including means operable for a variable number of punch steps in a cycle to perforate record material in each punch step with item representing perforations, a plurality of keyboards selectively cooperable with the punching unit, each keyboard including item selectors, and selective control means associated with each keyboard and effective when the keyboard is in cooperation with the punching unit for rendering the punching means effective to be controlled by the item selectors for a selective number of punch steps in the cycle to perforate the record material with perforations representing the selected items.

22. In combination with a punching unit including punching means to punch record material with item representing perforations and feeding means to feed one line of the record material at a time to the punching means, a plurality of keyboards selectively cooperable with the punching unit and settable according to items to be represented, each keyboard containing control means for rendering the punching means effective according to the keyboard setting to punch item representing perforations into lines, of the record material, selective distances apart.

23. In combination with a punching unit including punching means to punch item representing perforations into lines of index positions on record material, means to present one line of index positions after another to the punching means, a plurality of keyboards selectively cooperable with the punching unit, each keyboard settable according to items to be represented by perforations in a plurality of lines of the record material, one of these keyboards also containing control means for rendering the punching means effective to punch every line of the record material with perforations according to the items selected by the keyboard setting, and another of the keyboards also containing control means for rendering the punching means effective to punch alternate lines of the record material with perforations according to the items selected by the setting of this keyboard.

24. In a machine for punching record material according to either of two codes, one of which represents items by combinations of perforations in different index positions of a column of the material and the other of which represents items by combinations of perforations in different index positions along a line at right angles to the column; punching means, mechanism for feeding the record material to the punching means,

means to select an item to be represented according to the first-named code, means to select an item to be represented according to the second-named code, means associated with the first-named selecting means for rendering the punching means effective under control of this selecting means to punch the perforations combinationally representing a selected item in different index positions along said column, and means associated with the second-named selecting means for rendering the punching means effective under control of this selecting means to punch the perforations combinationally representing a selected item in different index positions along said line.

25. In combination, a line of punches, means to feed record material, one line at a time, to the line of punches, means to select an item which is to be represented by perforations in a plurality of different lines of the record material, means to select an item which is to be represented by one or more perforations in a single line of the record material, and means effective when the first-named selecting means is in operation for controlling the punches to punch the perforations, representing the selected item, sequentially in a plurality of lines of the record means, and means effective when the second-named selecting means is in operation for controlling the punches to punch one or more perforations concurrently along a single line of the record material to represent the selected item.

26. In a machine utilizing a record tape or the like, mechanism to feed the tape step by step and comprising a feed shaft rigidly carrying a pair of ratchet wheels with respectively opposing teeth, a feed pawl to coact with one of the ratchet wheels, an alining pawl for coacting with the other ratchet wheel, a reciprocable driver connected to the feed pawl and effective within its forward stroke to cause the feed pawl to turn the shaft through one feed step plus an overthrow, means operated by the driver during the turning of the shaft by the feed pawl for withdrawing the alining pawl from its associated ratchet, and means effective at completion of the turning of the shaft by the feed pawl for returning the alining pawl into coaction with its associated ratchet to return the shaft by the amount of said overthrow.

27. In a machine such as described or the like, stepping mechanism comprising a driven element, a pair of ratchets fixed to the element and respectively provided with oppositely inclined teeth, a driving pawl for engaging one ratchet, an alining pawl for engaging the other ratchet, a reciprocable driver so operatively connected to both pawls that upon the forward stroke of the driver the alining pawl is withdrawn from its ratchet while the driving pawl is actuating its ratchet to advance the driven element one step plus an overthrow distance, and means effective upon completion of this actuation of the element by the driving pawl for engaging the alining pawl with its ratchet to effect return of the element through the overthrow distance.

28. Apparatus comprising a sheet-perforating punch, a reciprocating arm, an interponent connected to the punch to occupy either a rear position or a forward position and having a surface which, in the forward position only, is engaged by said arm upon an operating stroke thereof, whereupon said arm drives the interponent in a direction to effect the punching stroke of the punch, the interponent also having a surface

which, in the rear position of the interponent, is engaged by the arm upon its return stroke, whereupon the arm drives the interponent in a return direction so as to effect restoration of the punch, and means to shift the interponent from its rear to its forward position prior to a punching operation and to allow the interponent to return to its rear position after the punching stroke.

29. Apparatus comprising a sheet-perforating punch, a reciprocating actuator element, an interponent element pivoted to the punch to occupy either a rear position or a forward position, said elements having portions which, in the forward position of the interponent element and upon an operating stroke of the actuator element, interlock to so couple the interponent element to the actuator element as to enable the actuator element to act upon the interponent element to effect the punching stroke of the punch, said interlocking portions, in the rear position of the interponent element and upon the return stroke of the actuator element, remaining partially coupled in such manner as to enable the actuator element to effect positive restoration of the interponent element and punch, and means to shift the interponent element to forward position prior to an operating stroke of the actuator element and to allow the interponent element to return to rear position prior to the following return stroke of the actuator element.

30. Apparatus comprising a sheet-perforating punch, a power-operated actuator, an interponent connected to the punch to occupy either an idle position or an active position and engaged, when in active position, by the actuator to produce a punching stroke of the punch, means for shifting the interponent from its idle to its active position preparatory to punching operation, and a power-operated knock-off, synchronized with the actuator, for acting on the interponent, at the completion of the punching operation, to restore the interponent positively to its idle position.

31. Apparatus including a sheet-perforating

punch, a reciprocating arm, an interponent pivoted to the punch so as to occupy either a rear or a forward position and acted on, when in forward position, by the arm to effect a punching stroke of the punch, means to shift the interponent from the idle to the forward position preparatory to punching operation, a knock-off cam for acting on the interponent, at the completion of a punching operation, to restore the interponent to idle position, and means for actuating the arm and knock-off cam in coordinated timing relationship.

32. Apparatus comprising a sheet-perforating punch, an interponent associated with the punch and depressible to effect a punching stroke of the punch, said interponent being so mounted as to occupy either a rear position or a forward position, an actuator for depressing the interponent, when in forward position, to effect the punching stroke, means for shifting the interponent to its forward position preparatory to a punching operation, a latch provided with a step for engaging a portion of the interponent, when shifted to forward position, to retain the interponent in the forward position during the performance of the major portion of the punching stroke, said interponent withdrawing from said step of the latch as the punching stroke is being completed so as to allow the interponent to return to its rear position.

33. Apparatus as defined in claim 32, said latch being rockably mounted for limited movement, a spring connecting the interponent to the latch to compel the latch to follow and maintain engagement with the interponent for the major portion of the punching stroke, and a positive knock-off for acting on the interponent, at the completion of the punching stroke and after it has withdrawn from the latch, to restore the interponent to its rear position.

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