Dec. 16, 1947. H. J. NICHOLS 2,432,787

TAPE PUNCH

Filed Oct. 31, 1944 5 Sheets-Sheet 1

Fig. 1.

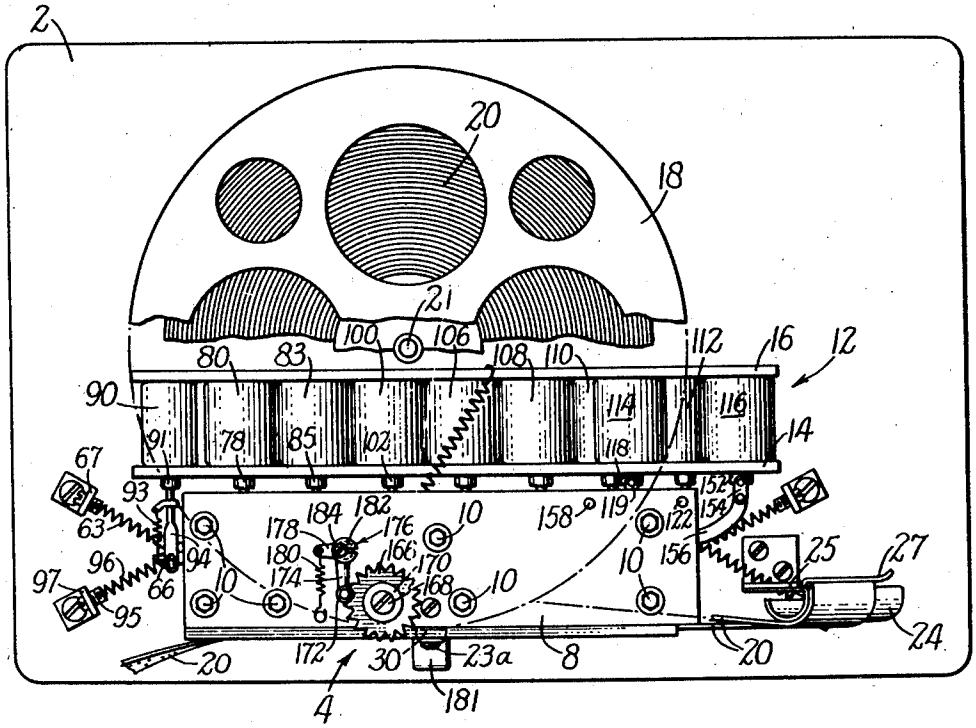
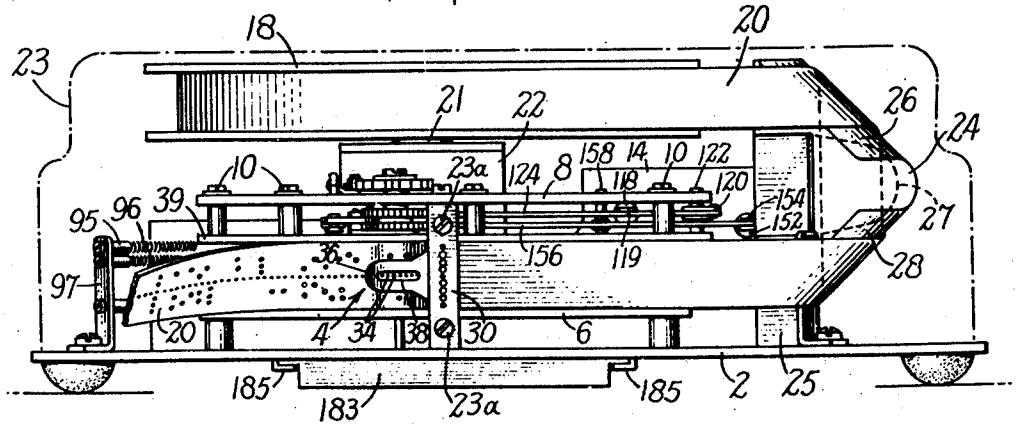


Fig. 2.



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TAPE PUNCH

Filed Oct. 31, 1944 5 Sheets-Sheet 2

Fig. 3.

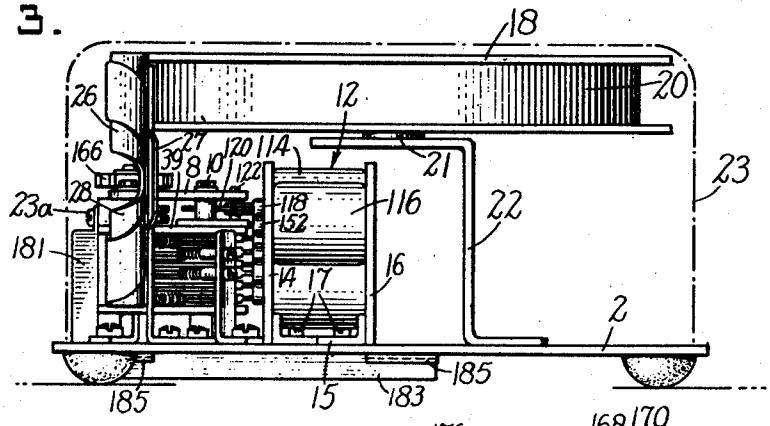


Fig. 4.

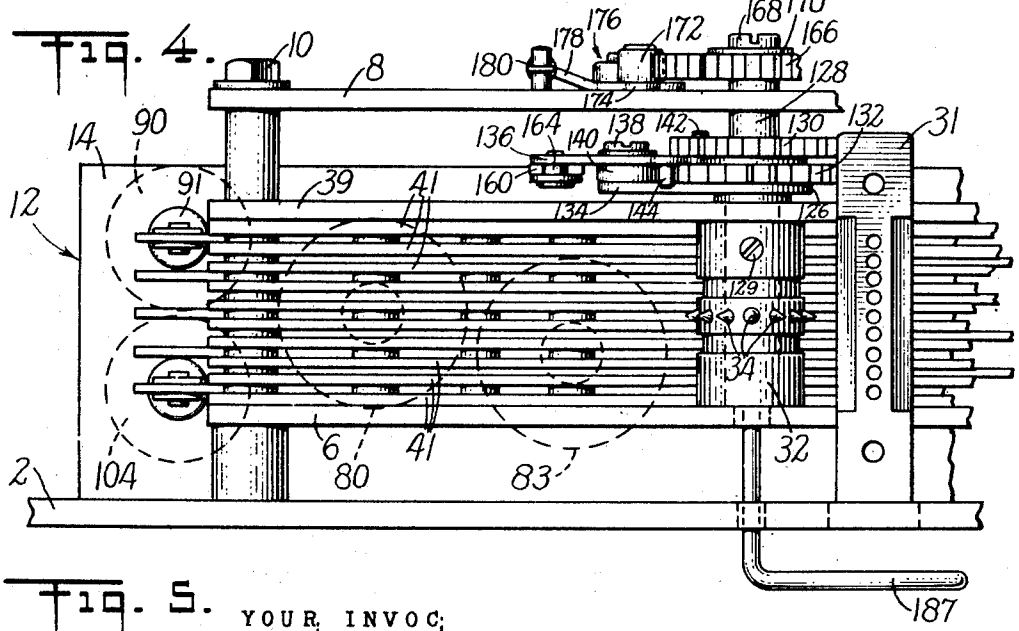


Fig. 5.

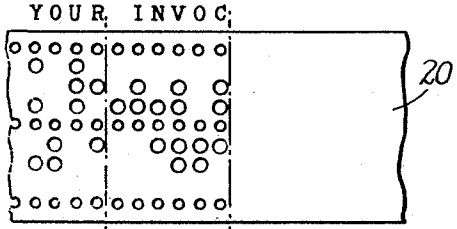
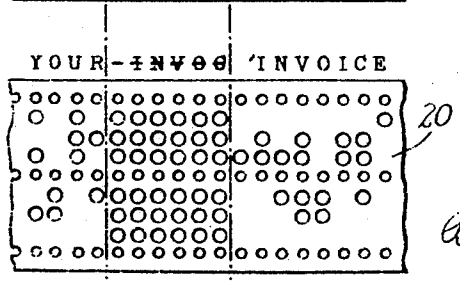


Fig. 6.



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TAPE PUNCH

Filed Oct. 31, 1944 5 Sheets-Sheet 3

Fig. 7.

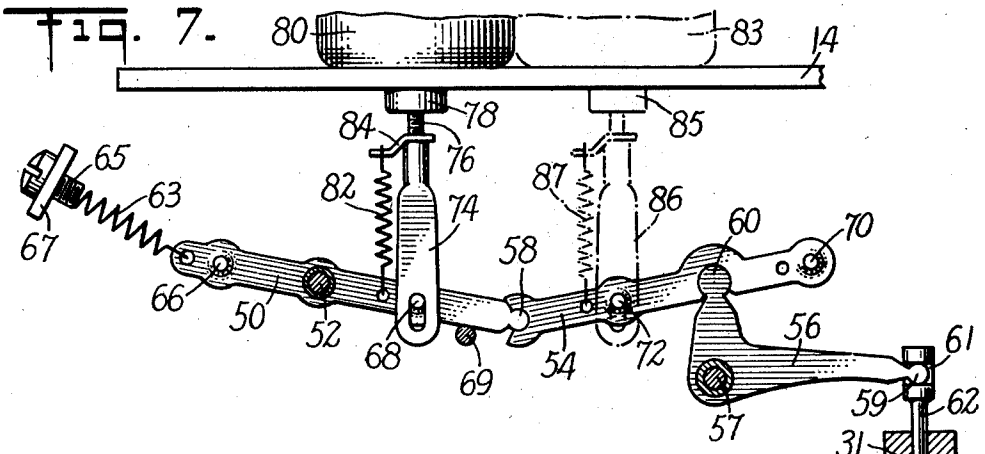


Fig. 8.

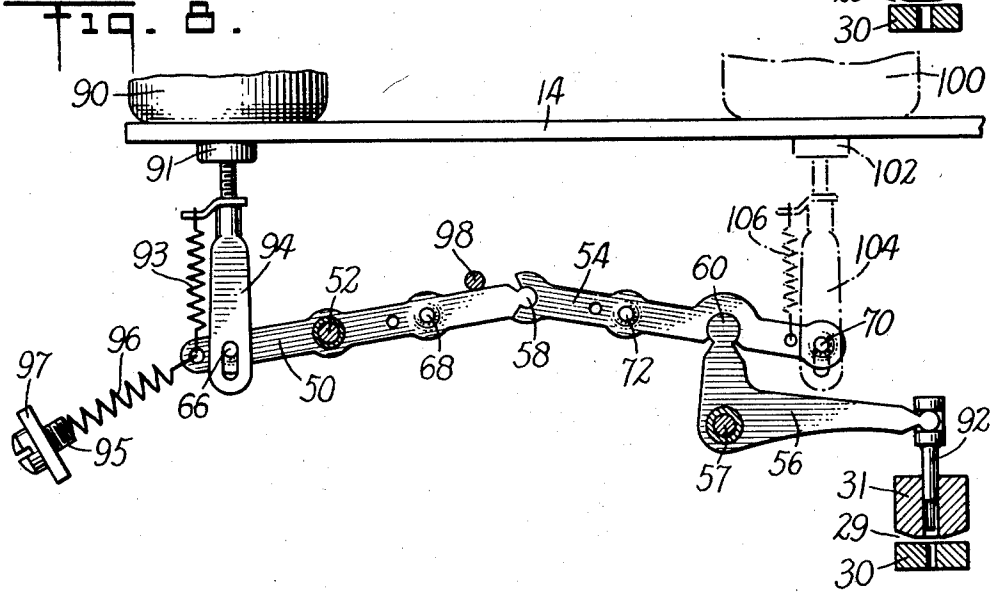
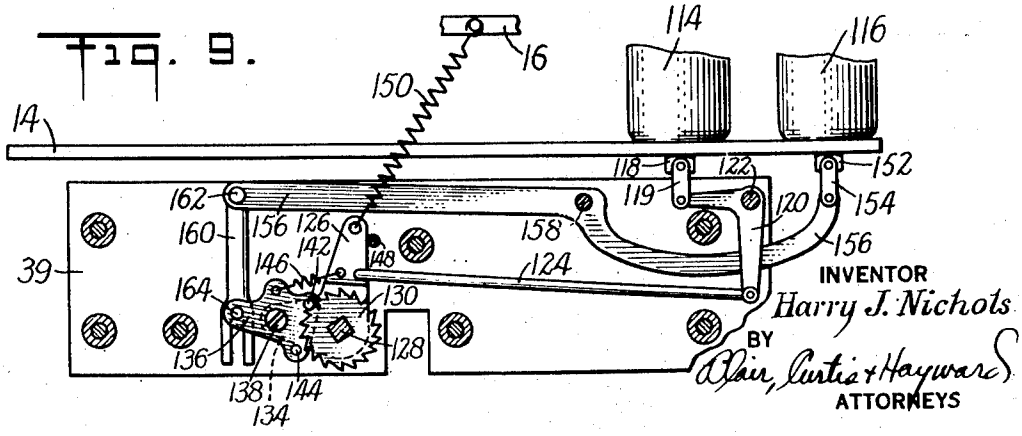


Fig. 9.



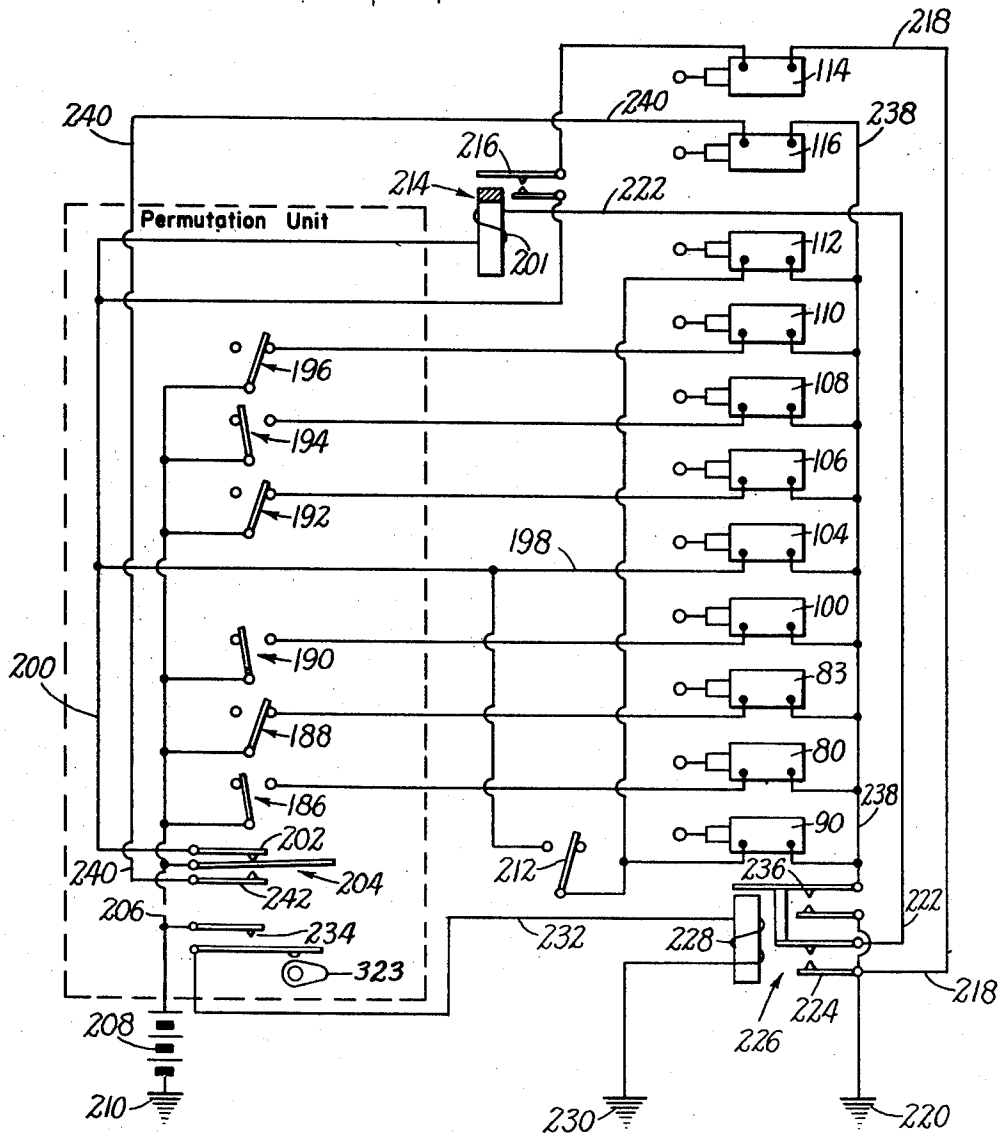
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TAPE PUNCH

Filed Oct. 31, 1944 5 Sheets-Sheet 4

Fig. 10.



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Dec. 16, 1947. H. J. NICHOLS 2,432,787

TAPE PUNCH

Filed Oct. 31, 1944 5 Sheets-Sheet 5

Fig. 11.

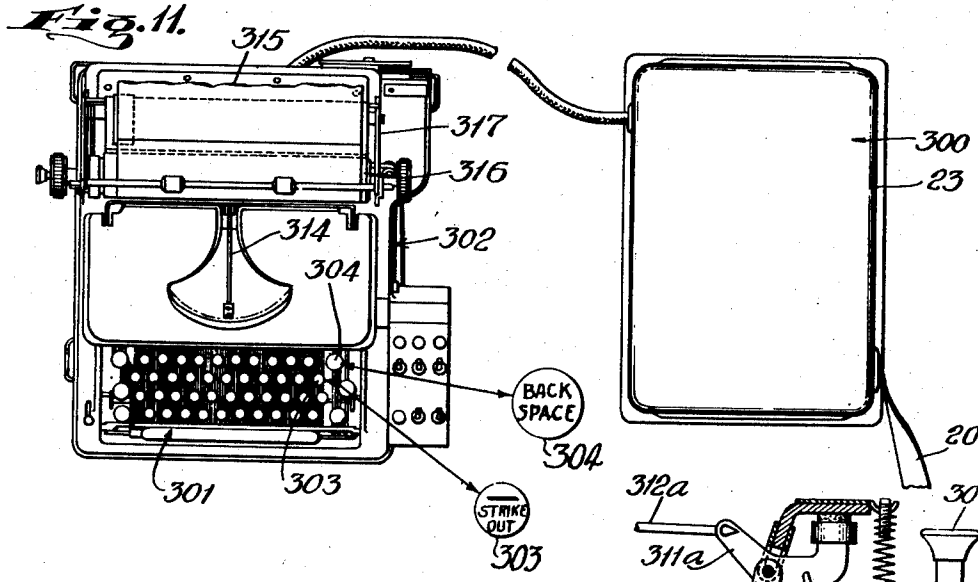


Fig. 13.

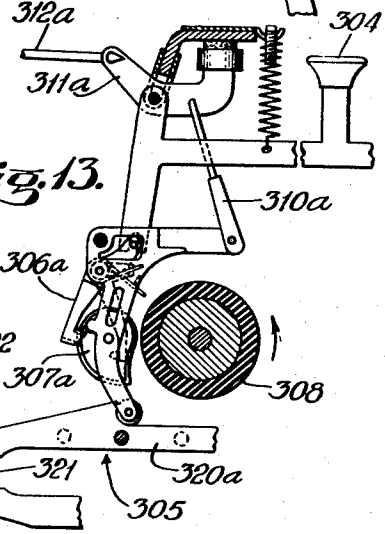
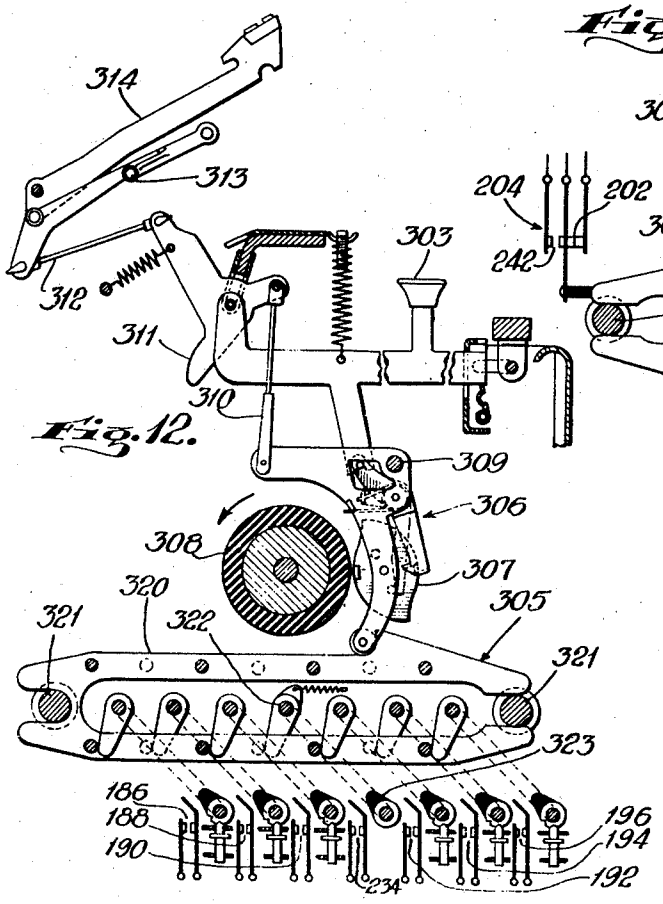


Fig. 12.



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2,432,787

TAPE PUNCH

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Application October 31, 1944, Serial No. 561,179

16 Claims. (Cl. 164—113)

1

This invention relates to recording apparatus and more particularly to recording apparatus of the type wherein character data are recorded in a tape as code designations and by means of a tape punch.

An object of this invention is to provide for the automatic punching of tape to record subject matter in accordance with a code, such as the Baudot code. A further object is to provide a tape punch which is compact and sturdy in construction, and which will stand up under long usage and will operate in accordance with the demands of commercial practice. A further object is to provide apparatus of the above character which may be manufactured economically in mass production and which may be readily adapted for use under a variety of conditions. A further object is to provide a tape punch of the above character which is adapted for control by an independent keyboard, a teleprinter, a typewriter, a tape reader, a code translator, or the like.

A still further object is to provide, in a typewriter controlled tape punch, a new and improved means and a new and improved method for simultaneously correcting errors on the typewritten copy and in the tape.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

In the drawings:

Figure 1 is a top plan view of one embodiment of the invention;

Figure 2 is a front elevation of the embodiment of Figure 1;

Figure 3 is a side elevation from the right-hand side of Figure 2;

Figure 4 is an enlarged view of the lower left-hand portion of Figure 2 with certain parts broken away and removed so as to expose internal parts of the apparatus;

Figures 5 and 6 are views of punched tape demonstrating one feature of the system;

Figures 7 and 8 are partially schematic views of two of the punch units;

Figure 9 is a view of the tape feed construction;

Figure 10 is a wiring diagram of the system;

Fig. 11 is a plan view showing the tape punch of Figs. 1 to 9 inclusive as controlled in its operation by a typewriter;

Fig. 12 is a fragmentary vertical section

2

through the typewriter of Fig. 11 and showing somewhat diagrammatically elements of a permutation unit which are operated as a result of depressing the error strike-out key; and,

Fig. 13 is a view similar to Fig. 12 and showing the back-space key and elements operated thereby.

This tape punch is particularly adapted for remote control by an automatic typewriter, or by the signals produced by a teleprinter, for recording the subject matter being typed or produced thereby. In Fig. 11 of the drawings, the tape punch is indicated generally by the reference numeral **300** and is shown as being controlled in its operation by the keyboard **301** of a well known commercial form of typewriter indicated by the reference numeral **302**. As will appear more fully hereinafter, the record produced by this tape punch is a tape having regularly spaced transverse rows of record holes punched therein, each row representing a character in accordance with the code. The punched tape is primarily a means of storing the subject matter, either temporarily or for an indefinite period, and the tape is available to retype the subject matter or for other use in a tape-controlled signal system. In some systems the tape is normally produced at a slow rate, but it is used at a rapid rate; in other systems the tape is produced at a rapid rate, but may be used at a slow rate. In all of these systems where there is a difference in the normal operating rates of the various units, there is the ever present danger that the speed of the entire system will be reduced to the speed of the slowest unit. The tape punch herein disclosed is suitable for use in any system of this type, and it will operate efficiently at a slow speed or at a fast speed depending upon the operation of the other units in the particular system.

In the illustrative embodiment of the invention the six-unit Baudot code is used and three rows of tape feed holes are provided, there being a row of feed holes near each edge of the tape and at the center of the tape. However, under some conditions of use the two outside rows of feed holes are unnecessary, and then, if desired, the punches producing these feed holes may be used to produce holes for supplemental signaling. Furthermore, another code such as the five-unit Baudot code may be used and the sixth hole may then be used for supplemental signaling. The feed holes and signal holes are punched in rows across the width of the tape, and all of the holes in each row are produced simultaneously by a

transverse row of individually operated punches. This insures accurate alignment of each row of holes, and the various rows of holes are accurately spaced along the tape. In this way the apparatus is adaptable to various modes of operation and even a completed unit may be readily changed from one type of system to another without anything more than minor changes in construction.

One feature of the invention is the provision of means for accurately adjusting the distance between adjacent rows of holes, i. e., the pitch of the rows of feed holes and record holes; illustratively, there are ten rows of holes per linear inch of tape. Another important feature of the invention is the provision of means for striking out erroneous typing, which has been recorded in the tape, by merely following the procedure which is usually followed in striking out errors in the typed copy on an electric typewriter.

The detailed construction of the punch 300 is fully disclosed in Figs. 1 to 9 inclusive. Referring particularly to Figures 1 to 3 of the drawings, a base 2 has rigidly mounted along its front side a punch unit 4 having a lower mounting plate 6 and an upper mounting plate 8 which are parallel and between which are mounted the tape punches and the tape feed mechanism; the entire punch unit is held together and fixed to base 2 by seven vertical bolts 10 extending through the plates. Adjacent punch unit 4 is a solenoid assembly 12 formed by a number of horizontal-axis solenoids held between a pair of parallel vertical plates 14 and 16 which are in turn held to base 2 (see Figure 3) by a bracket 15 and a plurality of set screws 17. Centrally positioned with respect to base 2, partially over the top of the solenoid assembly and the punch unit, is a reel 18 of blank tape 20, the pivotal support being provided by a ball-bearing spindle 21 carried by an angle bracket 22 welded to base 2. As indicated in broken lines in Figures 2 and 3 and in full lines in Fig. 11, the mechanism is enclosed in a cover 23 the details of which are not shown, but which has end walls fixed to base 2 and a top portion hinged at the rear of the machine.

Referring again to Figure 2 the tape is lead to the right from the front side of the reel to a tape guide 24 mounted on a vertical bracket 25 fixed to base 2. The tape passes over a roll turn 26 at the top of tape guide 24 and thence downwardly along the back of the guide where (see Figures 1 and 3) the tape is held against the guide by a tongue 27 integral with the guide. At the bottom of the tape guide the tape passes around a lower roll turn 28 and thence to the left behind a punch block 30 into a punch slot 29 (shown at the right-hand side of Figures 7 and 8) between punch block 30 and a punch guide 31. Punch guide 31 is beveled at its two edges (see also Figure 4) and as shown in Figure 1 the punch block 30 is fixed to the punch guide by a pair of screws 23a. As indicated above, there are six record holes and three feed holes, each of which is produced by a punch, thus there are nine punches carried in punch guide 31 and nine cooperating holes in the punch block 30. The top, bottom, and center punches produce the feed holes and are of the type shown in Figure 8. These punches have reduced ends, and their holes are small, whereas, the record holes are larger and are produced by punches of the type shown in Figure 7. These punches are in groups of three above and below the center punch. The

tape is pulled to the left through the punch slot 29 by a pin barrel 32 and from the pin barrel the tape passes from the machine through a chute. As shown in Figure 2, the tape is held in contact with pin barrel 32 by a spring clip 36 carried by punch block 30 and slotted at 38 to permit the passage of feed pins 34 which engage the feed holes in the center row (see also Figure 4). As will be explained more fully below, the tape is moved intermittently, it being stopped for each punching operation and then started again. However, this intermittent pull and, in fact, any sudden jerk on the tape, is absorbed by tape guide 24 because roll turns 26 and 28 are smooth, and the tape tends to ride outwardly (to the right in Figure 2) when there is a sudden jerk or pull; and then the tape rides back again to the position shown when the pull is relaxed or is steady. Thus, even though the tape is pulled intermittently it is unwound at a steady rate by a relatively steady pull on the reel, and the intermittent pull by the pin barrel does not tear the tape.

Each of the punches is individually operated by a solenoid and lever assembly, the punch being projected to punch the tape by energization of its solenoid and then being retracted and held away from the tape by a tractile spring. Each of the lever assemblies is of the type shown in Figures 7 and 8 and comprises three flat levers all positioned horizontally so that they all operate in a single plane in vertical alignment with the punch. Accordingly (see Figure 4), positioned below plate 8 and parallel thereto is a rigid intermediate plate 39, and between this plate 39 and plate 6 are ten spacer plates 41. Plates 39 and 41 are all held in rigid parallel relationship by bolts 10 and suitable spacer sleeves so that nine narrow parallel spaces are provided for the lever assemblies. The lever assemblies for five of the punches are positioned in their respective spaces at the left of punch block 30 and the other four lever assemblies are positioned to the right. Each lever assembly is in alignment with its punch as well as in alignment with the axis of the solenoid which operates it.

Referring to Figures 7 and 8, each lever assembly comprises a swinging lever 50 pivoted on a fixed pivot pin 52 extending through the adjacent plates 41, a bell crank 56, and a floating lever 54, which is connected only to lever 50 and bell crank 56 by disc and socket joints 58 and 60, respectively. Bell crank 56 is pivoted on a fixed pivot pin 57 and at its right-hand end it is operatively connected to a punch 62, through a slot 61 in the end of the punch and a disc 59 on the end of the bell crank arm. Punch 62 slides in punch guide 31 and when bell crank 56 rocks clockwise, the end of the punch moves from the position shown across the punch slot and into the punch block 30. Levers 50 and 54 form in one sense a toggle-pair, and they provide four points of actuation of equal leverage where solenoid units of equal force may be connected and will produce identical punching actions at the punch. These four points of connection are formed by integral pins each extending on opposite sides of the levers, and are as follows: near the left-hand end of lever 50 pin 66, an equal distance to the right of pivot 52 pin 68, at the right-hand end of floating lever 54 pin 70, and an equal distance to the left of joint 60 pin 72.

The operation of this lever assembly in rocking bell crank 56 clockwise from the position shown through an arc sufficient to project the punch through the tape, is as follows: lever 50

is pivoted at 52, and when swung counterclockwise from the position shown in Figure 7 so as to straighten the toggle, its right-hand end swings through a small arc carrying the left-hand end of floating lever 54 with it; the right-hand portion of floating lever 54 is rockably attached to bell crank 56 which in turn is mounted on the fixed pivot 57. Thus, when the left-hand end of lever 54 is moved from the position shown, the lever 54 is rocked about the joint 60, and at the same time it swings to the right with levers 50 and 54 moving toward alignment, and with bell crank 56 rocking to the right. The movement of the bell crank projects the punch against and through the tape. At the right-hand end of lever 50 is a fixed stop pin 69 against which lever 50 is biased by tension spring 63, carried by adjusting screw 65, which in turn is threaded in a bracket 67 mounted on the base of the machine. Thus, the elements are normally biased toward the position shown. In Figure 7 one of the solenoid operating units is shown in full lines and includes a solenoid 80, and an armature 78 slidably positioned in the solenoid. Armature 78 carries a threaded armature rod 76, to which is adjustably attached a clevis 74, the opposite end of which is slotted to receive lever 50 so that the two sides fit above and below lever 50. The eyes of clevis 74 are elongated, and positioned in these eyes are the two ends of pin 68, which is integral with lever 50. A tractile spring 82 is attached at one end to lever 50 and at the other end to a bracket 84, rigidly mounted on clevis 74.

The elongated eyes in clevis 74 cooperate with pin 68 to provide a lost motion relationship between clevis 74 and the link 50, with spring 82 tending to hold these members in the positions shown. However, when solenoid 80 is energized, armature 78 is given a sudden pull and the first movement of the armature is so rapid that the movement is absorbed by spring 82 and no movement is transmitted immediately to the lever 50. That is, lever 50 tends to remain stationary, and, in fact, it is resiliently held by spring 63. However, as clevis 74 starts to move, spring 82 exerts a strong pull on lever 50, and this is great enough to overcome the inertia of the members as well as the effect of spring 63, so that lever 50 starts to swing with the clevis under the influence of spring 82. The initial movement of lever 50 is relatively slow, and it causes punch 62 to approach the tape and to push the tape against the punch block. While this action is taking place, clevis 74 is moving rapidly and gaining speed, and it soon moves a distance with respect to lever 50 equal to the length of the clevis eyes so that the ends of pin 68 are caught by the opposite ends of the eyes. This results in there being a positive-acting mechanical pull by the clevis on lever 50, so that the movement of armature 78 is transmitted to the punch without any intervening resilient action as is produced by spring 82 during the early part of the movement.

Immediately after this positive-acting relationship is established, the punch is projected through the tape. However, this positive-acting relationship does not exist until the armature and the clevis have been brought up to full speed, and due to the weight of these members considerable kinetic energy has been stored up; this kinetic energy as well as the power of the solenoid is utilized to project the punch through the tape. In this way armature 78 and clevis 74 gather momentum during the first part of their movement while spring 82 transmits only sufficient force to the punch

to move the punch against the tape and to position the tape against the punch block; and, while this is taking place, the various members are being brought up to speed. Then just as the punch is about to pierce the tape the positive-acting relationship is created between the armature and the punch so that the momentum of the armature as well as the instantaneous pull of the solenoid is utilized to perform the actual punching operation. Thus, the solenoid unit does not carry a heavy load until all of the moving members have been brought up to speed and the tape has been positioned against the punch block. In this way, a relatively small solenoid unit accomplishes the punching operation in an efficient and dependable manner. After the punch is projected through the tape, solenoid 80 is deenergized and spring 63 returns the elements to the initial position shown.

As indicated in broken lines, an identical leverage and spring assembly is used to provide the operative connection between the next adjacent solenoid 83 and its punch, the solenoid unit in this case being shown in broken lines and including an armature 85 and a clevis 86. Clevis 86 is connected to floating lever 54 by pin 72, there being a coil spring 87 and the same lost-motion connection as provided between clevis 74 and lever 50. The energization of solenoid 82 imparts the same mechanical action to the linkage assembly as does the energization of solenoid 80 and the tape is punched in the same way. That is, when solenoid 83 is energized, armature 85 and clevis 86 start to move, and spring 87 starts to exert a force upon lever 54 so that levers 54 and 50 start to move toward alignment, and bell crank 56 is rocked clockwise so that the punch moves the tape against the punch block. Thereafter a positive-acting relationship is set up between pin 72 and clevis 86 so that the punch is projected through the tape.

Figure 8 is a showing of the other two possible connections between the operating solenoid units and this leverage assembly. Accordingly, as shown in full lines, a solenoid 90 has its armature 91 operatively connected to punch 92 through a clevis 94 and a pair of levers 50 and 54. Clevis 94 is connected to the left end of lever 50 by pin 66, and a spring 93 corresponds to spring 82 in Figure 7. The members are biased toward the position shown, with the right end of lever 50 held in engagement with a stop pin 98, by a spring 96, carried by an adjusting screw 95, threaded in a fixed bracket 97. With the links in this position, energization of solenoid 90 swings lever 50 clockwise so that levers 50 and 54 move toward alignment, and this movement rocks bell crank 56 clockwise with the same action and force as with the arrangement in Figure 7. That is, the relationship between the members in Figure 8 is such that the energization of solenoid 90 gives an action at the punch which is identical with the action which results from the energization of solenoid 80 in the assembly of Figure 7. At the right-hand side of Figure 8 there is a broken-line showing of a solenoid 100, having an armature 102, a spring 106, and a clevis 104 connected with pin 70 on link 54. Here again, the energization of solenoid 100 produces an action at the punch which is identical with that explained above in connection with the discussion of solenoid 80 and its associated parts.

The four solenoids represented in Figures 7 and 8 are operated individually to produce four of the feed and punch holes discussed above. The other five holes are produced with identical solenoid

units and lever assemblies, there being four solenoids positioned at the right of the punch block and five positioned at the left of the punch block. This particular linkage assembly which is used interchangeably for the various punches is admirably adapted for use in apparatus of this type where compactness and reliable operation are very important, and where interchangeability of parts reduces production costs and simplifies the problems of maintenance.

As shown in broken lines in Figure 4, there is positioned beneath solenoid 90 an additional solenoid 104, which has a linkage assembly like that of solenoid 90. These two solenoids produce the outer row of feed holes which are of reduced size, and as explained above these feed holes may be omitted when preferred by merely disconnecting their solenoids. Referring to Figure 1, the four solenoids 90, 80, 83, and 100 are shown in side-by-side relationship and at the right are positioned the additional punch-operating solenoids 106, 108, 110, and 112. As indicated above, solenoids 106, 108, 110, and 112 are provided with linkage assemblies identical with those shown in Figures 7 and 8.

In addition to the punch-operating solenoids there are two feed solenoids positioned partially over solenoids 110 and 112, these being a forward-feed solenoid 114 and a reverse-feed solenoid 116. The feed mechanism which is operated by solenoids 114 and 116 is shown best in Figure 9. The forward-feed solenoid 114 has an armature 118 which is connected through a link 119 to a bell crank 120, pivoted at 122. Bell crank 120 is connected to one end of a push rod 124, the other end of which is pivotally attached to a feed crank 126. Crank 126 is rockably mounted on the vertical feed shaft 128 (see also Figure 4) which is rotatably mounted in the fixed mounting plates 8, 39, and 6 and which carries the pin barrel 32. Pin barrel 32 is fixed to the shaft by a set screw 129, and the tape-feed movement is transmitted to the shaft and thence to the pin barrel and the tape. Accordingly, shaft 128 carries a forward-feed ratchet wheel 130, and a reverse-feed ratchet wheel 132 which are mounted in spaced relationship on a squared portion of the shaft, the cross section of which is shown in Figure 9. The forward-feed ratchet wheel 130 has teeth with the contour shown in Figure 9 so that clockwise movement may be transmitted through it to the shaft; whereas, the reverse-feed ratchet wheel has similar but oppositely formed teeth so that counterclockwise movement may be transmitted through it to the shaft.

Feed crank 126 is rockably mounted on shaft 128 beneath ratchet wheel 132 (see Figure 4) and it has an integral arm 134 (shown in broken lines in Figure 9) extending to the left which carries a double pawl 136. Pawl 136 is rockably mounted on arm 134 by a screw 138 and is held in spaced relationship by a washer 140 (Figure 4). At the right, pawl 136 extends between ratchet wheels 130 and 132 and it carries an upwardly extending pawl pin 142 which is engageable with teeth of the forward-feed ratchet wheel 130 and a downwardly extending pawl pin 144 which is engageable with the teeth of the reverse-feed ratchet wheel 132. Referring to Figure 9, pawl 136 is biased clockwise about its pivot on screw 138 by a spring 146 attached to feed crank 126 and the pawl. This spring holds pawl pin 142 resiliently against the forward-feed ratchet 130 so that a forward-feed action normally results from rocking movement of the feed crank. Feed crank 126 is biased toward the position shown against a stop pin 148 by a spring 150 attached to the feed crank and the base of the machine.

During operation, forward feed of tape is desired after each punching operation, and to produce this solenoid 114 is momentarily energized; this draws armature 118 into the solenoid and swings bell crank 120 clockwise through a short arc. This acts through push rod 124 to swing feed crank 126 counterclockwise through an arc which is slightly greater than the pitch of one tooth on the feed ratchet wheels. When this occurs, pawl 136 moves downwardly and pawl pin 142 rides over one tooth on the forward-feed ratchet wheel 130. Soon thereafter solenoid 114 is deenergized, releasing its armature and permitting spring 150 to swing feed arm 126 back to the position shown. Pawl pin 142 is held against the forward-feed ratchet wheel by spring 146, and the ratchet wheel is carried along with the feed crank. This advance is equal to the pitch of one tooth on the ratchet wheel, which is also the distance between the pins on pin barrel 32 and is the distance between the rows of holes in the tape. Thus, during normal operation the tape is advanced step-by-step by the intermittent energization of solenoid 114.

The tape is fed step-by-step in a reverse direction by the intermittent energization of the reverse-feed solenoid 116. Solenoid 116 has an armature 152 connected through a link 154 to the right-hand end of an operating lever 156, which is pivoted on a fixed pivot shaft 158 and the left end of which carries a thrust-fork 160 which is attached to lever 156 by a pivot pin 162. The forked lower end of thrust-fork 160 extends along the under side of pawl 136 and engages a headed pin 164 (Figure 4) rigidly mounted on the pawl. The energization of the reverse solenoid 116 (Figure 9) pulls armature 152 into the solenoid and swings lever 156 counterclockwise around its pivot shaft 158. This moves the left-hand end of lever 156 toward the front (toward the bottom of Figure 9) and as a result of this movement, thrust-fork 160 swings pawl 136 counterclockwise about its pivot screw 138 so that pawl pin 142 is disengaged from the forward-feed ratchet wheel 130, and pawl pin 144 is moved into engagement with the reverse-feed ratchet wheel 132. As the stroke continues, the engagement of pawl pin 144 with the reverse-feed ratchet wheel 132 causes reverse-feed movement to be transmitted to ratchet wheel 132 and thus to shaft 128. Immediately, thereafter, solenoid 116 is deenergized, and springs 150 and 146 return the various members to the position shown in Figure 9. It should be noted that the clockwise torque exerted by spring 146 is less than that exerted by spring 150 so that the initial swinging movement caused by thrust-fork 160 swings pawl 136 without moving crank lever 126. However, when solenoid 116 is deenergized and thrust-fork 160 starts moving upwardly, both springs exert their torques, and the members are returned to their initial positions immediately without any further movement being transmitted to the ratchet wheels.

The tape is fed accurately both in its forward movement and in its reverse movement, and accuracy is insured by a jockey-roller arrangement shown best in Figures 1 and 4 and mounted on the top of plate 8. Shaft 128 has a squared upper end which carries a star-wheel 166 held in place by stud bolt 168 and a washer 170. Referring particularly to Figure 1, engaging star-wheel 166 is a jockey-roller 172 carried by an eccentric

pivot arm 174 pivoted at 176 and having a spring arm 178. Attached to spring arm 178 is a spring 180, the other end of which is fixed so that arm 174 with jockey roller 172 is biased counterclockwise, and as a result the jockey roller rides against and in between the teeth of the star-wheel 166. Star-wheel 166 has the same number of teeth as there are pins on pin barrel 32, and there is a fixed angular relationship between the teeth and the pins. Thus, during each forward and reverse-feed operation, the jockey roller rides over one tooth on star-wheel 166, and at the end of the feeding operation, when the respective solenoid is deenergized, the star-wheel will be held in an exact predetermined relationship by the jockey-roll. If the feed operation has been slightly more or slightly less than the distance between the pins on the pin barrel, spring 174 is effective to project the jockey-roller against the star-wheel with sufficient force to turn the star-wheel to the proper position.

As indicated above, arm 174 is pivoted at 176, there being an eccentrically mounted cylindrical bushing 182 which has a reduced cylindrical portion snugly received in a hole through the arm, and an overhanging head which extends over the edges of the arm. Bushing 182 is clamped to plate 8 by a stud bolt 184 extending through a hole which is eccentric with respect to the center of the bushing. The head of bushing 182 is slotted, and when stud bolt 184 is loosened, the bushing may be rotated by a screwdriver or the like about the stud bolt; this rotation moves the bushing and with it, arm 174 and jockey-roller 172. However, the jockey-roller is held into engagement with star-wheel 166 so that the movement of the jockey-roller causes the star-wheel to turn through a short arc and in fact the arrangement of parts is such that a very fine adjustment is obtained of the angular position in which the star-wheel is held by the jockey-roller As indicated above the position of the star-wheel when it is stopped determines the position of the tape during the punching operation, and thus, determines the position of the row of holes, which is produced by the row of punches. In this way, an accurate adjustment is provided for the spacing of the rows of holes.

For proper operation, the spacing between the punches and the pin on the pin barrel where the tape contacts the pin barrel is equal to a specific number times the pitch of the transverse rows of holes in the tape. That is, the tape must be stopped for the punch operation so that a feed hole will be punched in the exact place to be engaged by a pin. This exact spacing between the pins on the pin barrel and the punch is obtained by rotating bushing 182; when the proper adjustment is obtained, stud bolt 184 is tightened so as to maintain the adjustment.

The chips punched from the tape are projected through the punch block into a chip chute shown best in Figures 1 and 3 and indicated at 181. Chip chute 181 is clamped to the punch block at the top by the upper screw 23a holding the punch block in place and at the bottom the chip chute extends through an opening in the base 2 to a chip tray 183 which is movably held by brackets 185 at the four corners of the chip tray. The tray is removed by sliding it forward a distance equal to the width of the brackets and then lowering the tray. Referring to Figure 4, attached to the lower end of the shaft 128, which rotates the pin barrel, is a chip stirrer 187 which is rotated with the pin barrel and moves along the bottom of the tray so as to push the chips away from beneath the chip chute.

In Figure 10 the electrical circuit of the tape punch is shown along with a schematic representation of the keyboard-controlled permutation unit. A plurality of electrical switches which may be considered as operated elements of the permutation unit, are inclosed within a dash-line rectangular appearing at the left of Fig. 10. As will be explained more fully hereinafter, the permutation unit is of well known construction and is indicated generally by the reference numeral 305 in Figs. 12 and 13. In Fig. 10, the punch solenoids as well as the feed solenoids are represented at the right and are connected to the permutation unit at the left. In the permutation unit the permutation switches 186, 188, 190, 192, 194, and 196 are connected respectively to solenoids 80, 83, 100, 106, 108, and 110. Solenoid 104 which produces the center row of feed holes is connected through a lead 198 to a lead 200 which extends to the normally-closed switch unit 202 of a feed-switch assembly 204. The other side of switch unit 202 is connected to the power lead 206 which carries current from a battery 208, the other side of which is grounded at 210. Solenoids 90 and 112 which produce the outer rows of feed holes may also be connected to lead 198 by the closing of a manual switch 212. Thus, when only a single row of feed holes are desired, switch 212 is open as shown, and when three rows are desired, switch 112 is closed.

Lead 200 extends upwardly to the winding 201 of a delayed action feed relay 214 which has a normally-open switch 216; switch 216 is closed after a predetermined delay by the energization of the relay winding 201 and opens again after a predetermined delay upon the deenergization of the winding. Switch 216 is connected at one side to lead 200 and at the other side to the forward-feed solenoid 114, the other side of which is connected through a lead 218 to ground, designated 220. Winding 201 is connected at the right to a lead 222 and thus to one side of a normally-open switch 224, the other side of which is connected to ground 220. Switch 224 is part of a double relay switch 226 which has a winding 228 connected at one side to ground 230 and at the other side through a lead 232 and a cam-operated switch 234 to power lead 206. Relay switch 226 has a second normally-open switch 236 which is connected at one side to ground 220 and at the other side to a lead 238 which is connected to all of the punch solenoids and to the reverse-feed solenoid 116. The other side of solenoid 116 is connected through a lead 240 to a normally-open switch 242 which is part of switch assembly 204; as will be explained below, the center contact carrying blade of switch assembly 204 may be swung down from the position shown in Fig. 10, so as to open switch 202 and to close switch 242.

As shown in Fig. 11 the keyboard 301 of the typewriter 302 comprises the required complement of character and functional keys, including a strike-out key 303 and a back-space key 304. The general construction and operation of the typewriter 302 is well known to those skilled in this art, it having been in commercial use for a number of years and having been disclosed fully in a large number of U. S. patents among which is Patent No. 1,777,055, granted September 30, 1930. Consequently, there is no need to disclose in detail its construction and operation herein, it being sufficient to say that the typewriter 302 is of the power-operated type (see Fig. 12) and

that each time a character key is depressed, a related cam unit 306 is tripped and the double lobe cam element 307 thereof is caused to engage a continuously rotating power roller 308 which rotates the cam for one-half of a revolution and the cam is then latched up again. The rotation of the cam rocks its cam unit counterclockwise about a fixed rod 309; and, through a related link 310, sub-lever 311, link 312, and toggle 313, the rocked cam unit 306 moves a related type bar 314 counterclockwise into printing engagement with a copy sheet 315 (see also Fig. 11) supported by a platen 316 on a carriage 317. The character key shown in Fig. 12 is the strike-out key 303, but it will be apparent that a similar action takes place each time any of the other character keys is depressed. As is also well known to those skilled in this art, each time one of the functional keys is depressed, a cam unit similar to 306 is rocked and, in rocking, effects the functional operation represented by the actuated key. Fig. 13 shows the back-space key 304 and it will be apparent that the depressing of the key 304 trips its related cam unit 306*a* and thereby causes the single lobe cam 307*a* to engage power roller 308 and rock the cam unit 306*a*, and, through the link 310*a*, lever 311*a*, and link 312*a* actuates the back-space mechanism (not shown) of the typewriter. For a complete disclosure of the back-space mechanism see Patent No. 1,873,553, granted August 23, 1932. The link 312*a* is the same as the link 18 of the latter patent.

The permutation unit is of the same general type as is disclosed in my prior Patent No. 2,315,727, granted April 6, 1943, and comprises generally a plurality of permutation slides 320 which are mounted in parallel side-by-side relation on fixed supporting rods 321 and which are, respectively, related to and are actuated by the key-controlled cam units 306, 306*a*. For example, in Fig. 12 when the cam unit 306 is rocked counterclockwise as previously described, its related slide 320 is slid to the right and in so doing selectively actuates the previously referred to permutation switches in accordance with the code designation corresponding to the key actuated. The code designation for the strike-out key 303 comprises a code hole in each of the code positions in the tape. Consequently, when the slide 320 which is related to the key 303 is moved to the right, it closes each of the permutation switches 186, 188, 190, 192, 194, and 196. When the cam unit 306 returns to the inactive position shown, a spring (not shown) returns its related slide to its inactive position.

During the operation resulting from the depressing of each key, its related slide 320 through a rod 322 and cam 323 closes the switch 234 (see also Fig. 10). Each closing of switch 234 energizes solenoid 228 closing switches 224 and 236. The closing of switch 236 energizes each solenoid which is connected at that time at its other side by its associated permutation switch to power lead 206, and the tape is punched so as to produce the corresponding feed and record holes. In Figure 10 switches 188, 192, and 196 of the permutation unit are closed and the center feed hole solenoid 104 is connected. Accordingly, the closing of switch 236 causes solenoids 83, 104, 106, and 110 to be energized.

The closing of switch 224 by the energization of winding 228 energizes winding 201 of relay 214 simultaneously with the energization of the punch solenoids, and due to the slow action of relay 214, switch 216 is closed after a short delay. The closing of switch 216 energizes the forward-feed solenoid 114 so as to swing the feed arm to the feed position; shortly thereafter, switch 216 opens again (as a result of the opening of switch 224), deenergizing solenoid 114 with the result that the tape is fed forward one step. The delay in the closing and reopening of switch 216 is such that the punching operation is completed and the punches are withdrawn before the tape is moved.

The reverse feed of the tape is under the control of the back-space key 304 on the typewriter, or other operating machine, and the tape is fed back one step for every back space stroke of the key. When the back-space key is pressed, the permutation unit sets the code to blank so that no punching of the tape occurs; at the same time, the cam unit 306*a* is actuated as explained above and its related slide 320*a* moves to the left as viewed in Fig. 13 and thereby transfers the switch assembly 204 so as to open switch 202 and close switch 242. As shown in Fig. 10, the opening of switch unit 202 deenergizes the forward-feed circuit and the feed hole punch circuit, and the closing of switch 242 connects solenoid 114 to power lead 206; thus, the closing of switch 226 results only in the energization of solenoid 116. The energization of solenoid 116 feeds the tape back one step whereupon the solenoid is deenergized.

As indicated in Fig. 11, the depressing of the strike-out key 303 effects the printing of a character similar to the dash (—). It is conventional practice for a typist to cancel previously typed characters by back-spacing the typewriter carriage so as to bring the erroneously printed character into printing position and then to strike the dash (—) key or the "X" key so as to thereby strike out the erroneous character. In accordance with the present invention, the depressing of the back-space key 304 back spaces the tape and the carriage simultaneously and the depressing of the strike-out key 303 causes the punching of code holes in all code positions of the tape while the type bar 314 is being operated to print the dash (—). Figs. 5 and 6 indicate how an error in the typewritten matter and in the tape are corrected simultaneously. The characters appearing above the recording fields of the tape in Figs. 5 and 6 indicate the matter that is printed on the sheet 315 of Fig. 1 while the corresponding code designations are being recorded in the tape. In Figure 5 it is assumed that the typist is typing "your invoice" and fails to strike the "i" before the "c." Upon discovering this error, the operator operates the back space key six times to move the carriage of the typewriter back and this operation also operates the reverse feed mechanism so as to reverse the tape. Thereafter the typist strikes the strike-out key six times and this strikes out the typed copy, as indicated in Figure 6, and also causes the tape punch to punch all of the record holes in the tape. The typist then proceeds by spacing once and then typing the correct word "invoice." Later when the tape is read out, the typewriter or teleprinter controlled thereby, types "your invoice" omitting the crossed out part entirely; that is, the tape reader produces no typing or spacing signal in the portion of the tape where all six of the record holes are punched.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter here-

inbefore set forth, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a tape punch for producing transverse rows of code holes in a tape, each row of which represents a signal character, the combination of, a base, a tape reel mounted on said base on a vertical axis and spaced from said base, a punch assembly positioned below and adjacent the periphery of said reel, said punch assembly including a plurality of punches positioned in paral'el vertical alignment and a punch block adapted to cooperate with said punches, tape-engaging means to feed tape from said reel through said tape punch assembly, a leverage assembly comprising a plurality of independent leverage units corresponding in number to the number of said punches and associated respectively with said punches, a solenoid assembly comprising a plurality of solenoid-operating units corresponding in number to the number of said leverage units and connected respectively to said leverage units, and motive means to impart intermittent movement to the tape through said tape-engaging means coordinated in its action with the action of said punches whereby the tape is moved one step after each punching operation.

2. Apparatus as described in claim 1 wherein each of said leverage units includes a pair of interconnected levers each having means forming two connections to which a solenoid may be attached with the action by the solenoid on the punch being substantially identical when connected to any one of said connections.

3. In a tape punch, a leverage assembly comprising, a bell crank having two arms one of which is connected to a punch with the bell crank adapted to be rocked to move the punch to a punch block, a floating lever connected to the other arm of said bell crank at a pivotal axis which is substantially one third of the length of the lever from one end thereof said floating lever having means forming a pair of connections one of which is positioned at the end of the floating lever adjacent the bell crank and the other of which is positioned an equal distance on the other side of said pivotal axis, a pivoted lever longitudinally related to said floating lever in end-to-end relationship and connected to the end of the floating lever furtherest from said pivotal axis, pivotal means providing a fixed pivot for said pivoted lever at a point spaced along said pivoted lever a distance substantially equal to twice the distance between said pivotal axis and each of said connections, and means providing two connections with said pivoted lever at points spaced along said pivoted lever on the opposite sides of said pivotal means distances equal to the distance between said pivotal axis and each of said connections, whereby an operating force will exert an equal operating effect on the punch if applied at any one of said connections.

4. In a leverage assembly for a tape punch the combination of, a pivoted lever having an operating arm portion by which force is transmitted through a joint at its end, said lever including means forming two connections for transmitting force to said lever through lever arms equal to one half the lever arm of said joint, a floating lever connected at one end through said joint to said pivoted lever and having a connecting coupling spaced from said joint a distance equal to the lever arm of said joint, said floating lever including means forming two connections for transmitting force to said floating lever, and means connected to said coupling whereby said coupling provides a moving pivot about which said floating lever rocks.

5. In a tape punch, a tape feed mechanism including, a pin barrel engaged by the tape to transmit feed motion to the tape, a drive shaft upon which said pin barrel is rotatably mounted, a feed arm rockably mounted on said shaft, drive unit to transmit feeding movement to said feed arm including a spring which rocks said feed arm toward one extreme position and a solenoid which is energized to rock the arm toward the other extreme position, a forward-feed ratchet wheel a reverse-feed ratchet wheel, both of said ratchet wheels being mounted upon said shaft to transmit feed movements to said shaft, a double pawl rockably mounted on said feed arm and having a pair of pins adapted respectively to engage said ratchet wheels, spring means biasing said pawl in a direction so that the respective pin engages said forward-feed ratchet wheel, a forward-feed motive means to rock said arm and transmit forward-feed movement to said shaft, and a reverse-feed solenoid assembly having an armature operatively connected to said pawl whereby energization of the solenoid rocks said pawl to disengage the respective pin from the forward-feed ratchet wheel and to engage the other pin with the reverse-feed ratchet wheel and thereafter to transmit a reverse feed movement through said pawl to said reverse-feed ratchet wheel.

6. In a tape punch, the combination of, a forward-feed solenoid to transmit step-by-step forward movement to the tape, a reverse-feed solenoid to transmit step-by-step reverse movement to the tape, a feed direction switch which is normally positioned to close a circuit to said forward-feed solenoid and which may be reversed to open said circuit and to close a circuit to said reverse-feed solenoid, a time-delay relay in the circuit of said forward-feed solenoid having a normally-closed switch which is closed a predetermined time after the energization of the relay, and a master switch impulse-producing mechanism to transmit impulses to the circuits of said solenoids whereby feed impulses are produced depending upon which circuit is at that time closed by said feed direction switch.

7. In a tape punch, a tape-feed mechanism to impart step-by-step movement to the tape comprising, a pair of solenoid assemblies each of which includes a solenoid and an armature which is moved by energization of the solenoid, a rockably mounted feed-arm, a spring biasing said feed-arm toward one extreme of its movement, a leverage assembly connecting one of said armatures to said feed-arm so that upon energization of the respective solenoid said feed-arm is rocked against the action of said spring, a rotatable shaft having its axis coincident with the axis of the rocking movement of said feed-arm, a forward-feed ratchet wheel mounted on said shaft, a pawl rockably mounted on said shaft and having a pair of oppositely extending pawl pins, a spring biasing said pawl so as to engage one of said pins with said forward-feed ratchet wheel, a reverse-feed ratchet wheel mounted on said shaft and adapted to be engaged by the other of said pins upon the rocking of said pawl against the action of the spring, and a reverse-feed assembly connecting said pawl with the armature of the other solenoid assembly so that upon energization of the solenoid first said pawl will be

rocked against the tension of its spring so as to disengage the respective pin from the forward-feed ratchet wheel and to engage the other pin with the reverse-feed ratchet wheel and second a reverse-feed step will be transmitted to said shaft.

8. In a tape-feed mechanism for a tape punch, the combination of, a motive assembly comprising a source of power for forward-feed and reverse-feed step-by-step movements, a drive shaft through which the feed movements are transmitted to the tape, a shaft driving assembly to transmit the reverse-feed movements to said shaft directly and to transmit the forward-feed movements to said shaft with a predetermined time delay between the initiating of each forward-feed movement by the motive assembly and the driving of the shaft, a pin barrel mounted on said shaft to transmit the feed movements to the tape, a star-wheel rigidly mounted on said shaft, a jockey-roller resiliently held against said star-wheel, and adjustable mounting means for said jackey-roller to permit its adjustment tangentially with respect to said star-wheel.

9. Apparatus as described in claim 8 wherein the mounting in said jockey roller comprises, a pivotal means, and an arm carrying said jockey-roller at one end and pivoted at its other end on said pivotal means, said pivotal means comprising an eccentrically mounted bushing which is adjustably secured.

10. In a tape punch, the combination of, a pair of parallel spaced mounting plates, a plurality of solenoids mounted between said plates with their axes normal to said plates, a plurality of armatures positioned respectively in said solenoids and adapted to move axially of the solenoids, a plate assembly providing a plurality of parallel spaced flat spaces corresponding in number with the number of said armatures and aligned respectively with the axes of said armatures, a punch assembly comprising a plurality of punches positioned in parallel spaced relationship corresponding in number to said spaces and positioned respectively in alignment with said spaces, and a plurality of leverage assemblies corresponding in number with said punches and positioned respectively in said spaces, each of said leverage assemblies providing a mechanical connection between its punch and the respective armature.

11. In a tape punch, a punch assembly including a plurality of punches positioned in spaced parallel relationship in substantially vertical alignment, a punch block having holes therethrough to receive said punches, a chip chute mounted on said punch block opposite said punches to conduct the chips from said punches downwardly, a chip tray beneath said chute, a tape feed assembly including a pin barrel rotatably mounted on a vertical axis adjacent said punch block, and a chip stirrer attached to said pin barrel to be rotated upon the rotation of said pin barrel and to move chips within said chip tray from beneath said chip chute.

12. In a tape punch, the combination of, a base, punching means mounted thereon, a reel rotatably mounted on said base and spaced therefrom, a tape guide to receive the tape from said reel and to pass the tape to said punching means, said guide comprising a pair of roll turns serially mounted along the path of the tape and having axes which are positioned substantially in quadrature, a tape punch unit to punch holes in the tape along a line substantially between the edge of the reel and the base, and a pin barrel to pull the tape with a step-by-step movement through the punch unit around guide and from the reel.

13. In apparatus for punching record holes in tape, the combination of, a punch assembly including a plurality of punches which are operable simultaneously to produce signal elements, a forward-feed mechanism to impart a step-by-step movement to the tape, said forward-feed mechanism including a spring assembly which is loaded a predetermined amount and thereafter imparts a feed movement and motive means to load said spring assembly, and means to impart energy simultaneously to said punch assembly and said forward-feed mechanism whereby the punch assembly punches the tape and thereafter the forward-feed mechanism produces a forward-feed movement.

14. Apparatus as described in claim 13 wherein a reverse-feed mechanism is provided which transmits a reverse-feed movement to the tape immediately upon receiving an impulse of energy.

15. Apparatus as described in claim 13 wherein a forward-feed solenoid is provided the energization of which is controlled by a time-delay relay and a reverse-feed solenoid is provided which is energized directly by the actuation of a back-spacing signal means.

16. In recording apparatus, the combination of a typewriter comprising a carriage for holding a work copy and a keyboard including a plurality of character keys operable, respectively, to effect printing of corresponding characters on said copy, an error key operable to effect printing of a significant character which will obliterate previously printed characters when printed over the latter, and a back-space key operable to effect step-by-step backward spacing of said carriage; a tape punch operable when actuated to punch in a tape character-representing code designations according to a predetermined combinational hole code system and including both a forward-spacing means and a backward-spacing means for spacing said tape; a permutation unit actuated in response to the operation of each of said character keys and effecting in each instance operation of said tape punch to punch a code designation representing the corresponding character and to operate said forward-spacing means, and said permutation unit being actuated in response to the operation of said error key to effect operation of said punch to punch in the tape all code positions of said code system and to operate said forward-spacing means; and means responsive to the operation of said back-space key to effect operation of said backward-spacing means of the punch simultaneously with the backward spacing of said carriage.

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