Sept. 17, 1957 R. A. HIGONNET ET AL 2,806,574

VARIABLE ESCAPEMENT

Filed Aug. 21, 1953 3 Sheets-Sheet 1

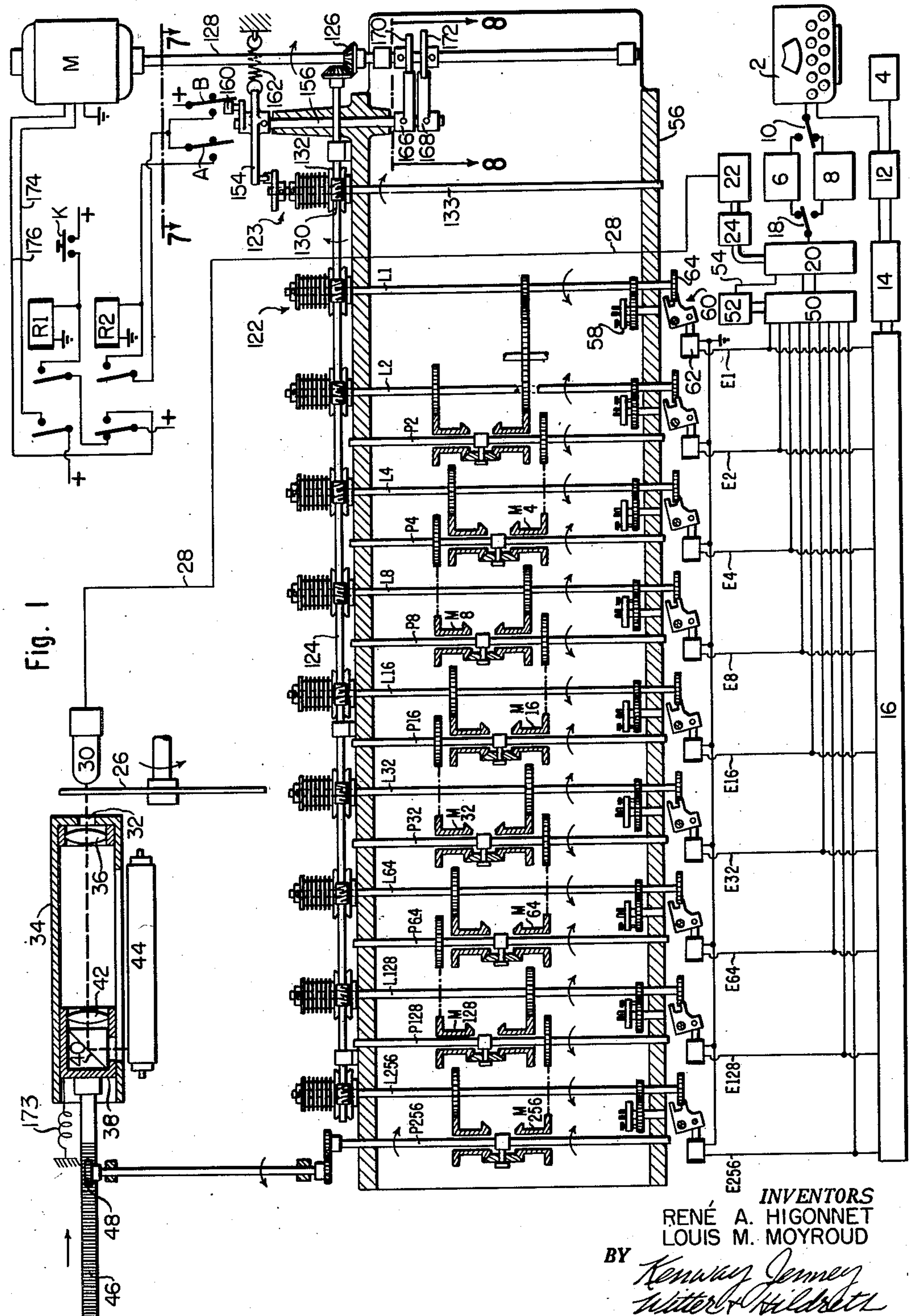

Fig. 1

INVENTORS
RENÉ A. HIGONNET
LOUIS M. MOYROUD
BY Kenway, Jenney, Witter & Hildreth
ATTORNEYS

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VARIABLE ESCAPEMENT

Filed Aug. 21, 1953 3 Sheets-Sheet 2

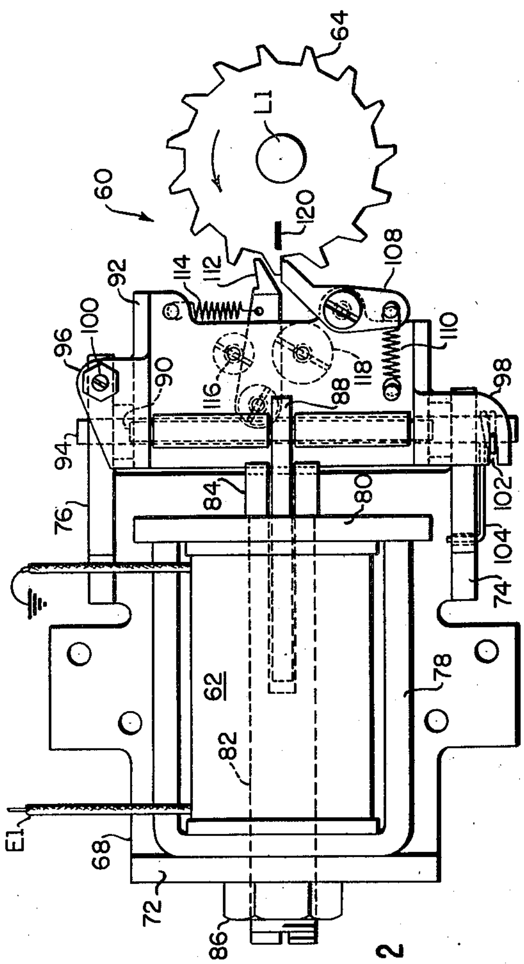

Fig. 2

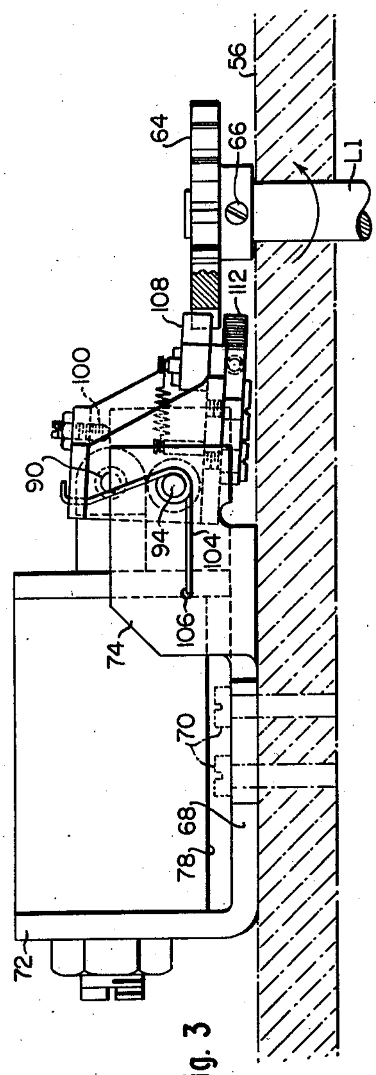

Fig. 3

INVENTORS
RENÉ A. HIGONNET
LOUIS M. MOYROUD

BY Kenway, Jenney, Witter & Hildreth

ATTORNEYS

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VARIABLE ESCAPEMENT

Filed Aug. 21, 1953 3 Sheets-Sheet 3

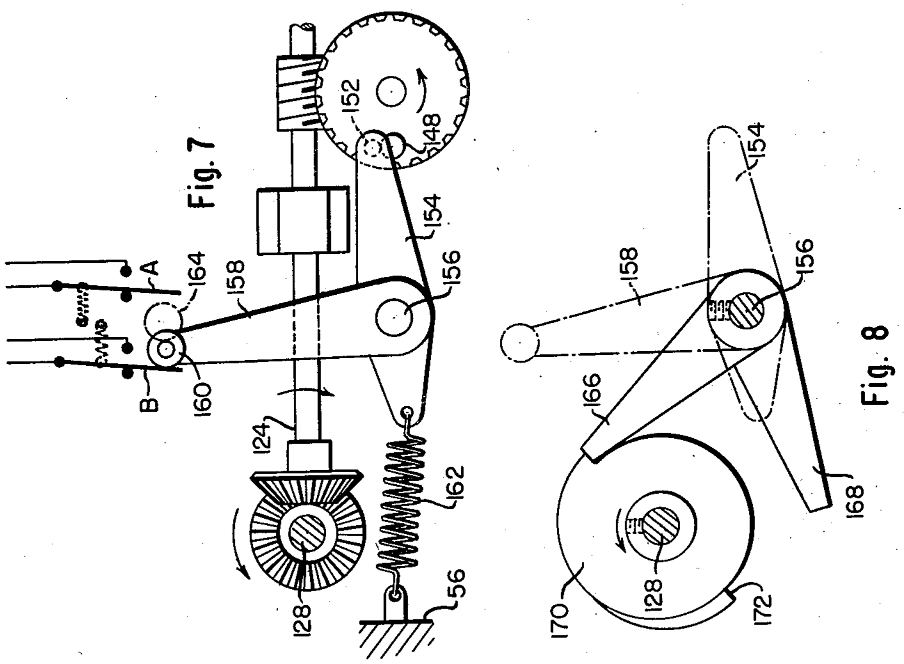

Fig. 7

Fig. 8

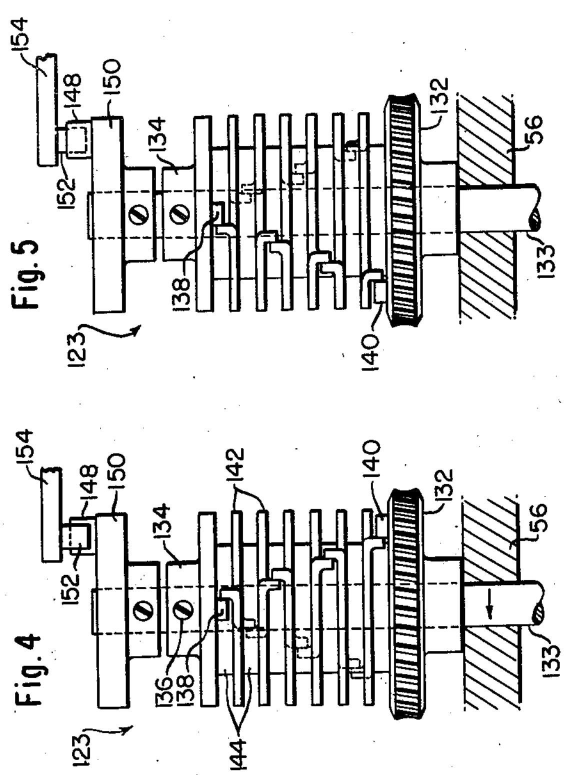

Fig. 5

Fig. 4

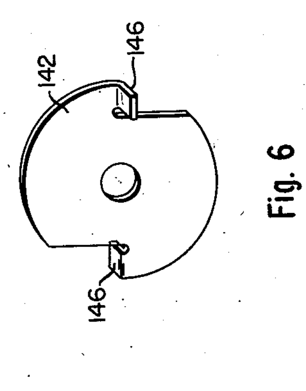

Fig. 6

INVENTORS
RENÉ A. HIGONNET
LOUIS M. MOYROUD
BY Kenway Jenney Witter & Hildreth
ATTORNEYS

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1

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VARIABLE ESCAPEMENT

Rene A. Higonnet and Louis M. Moyroud, Cambridge, Mass., assignors to Graphic Arts Research Foundation, Inc., Cambridge, Mass., a corporation of Delaware

Application August 21, 1953, Serial No. 375,653

11 Claims. (Cl. 197—84)

The present invention relates to variable escapement mechanisms, and more particularly to a resettable differential mechanism for type composing apparatus adapted for variably spacing the characters in a line as they are successively transcribed, the said mechanism responding to input information represented in numerical form.

One object of the present invention is to provide resetting mechanism for each of the additively connected differential stages of such an escapement, whereby each stage may be returned at predetermined intervals (e. g., at the end of each line of type composition) to a fixed, precisely determined position.

Another and related object is to provide novel mechanism for returning the carriage which spaces the characters of type to a precise position corresponding to the margin of a page, the said mechanism operating upon a principle which eliminates the effects of backlash.

A still further object, with reference to type composition, is to provide a variable escapement mechanism having a plurality of input leads which may be energized in selected combinations corresponding to a numerical representation of each desired width of carriage movement. For such purposes, we prefer the binary notation, since this requires only two discrete conditions per digit represented. The said notation is preferably introduced into the composing machine by permutation bars associated with the keys of the keyboard, and is maintained in all of the operations associated with the provision of character and word spaces in the line. Specifically, these operations involve the memory unit or register which stores the selected characters for purposes of justification, the line length accumulator, the justifier, the multiplier units which relate the information pertaining to the relative width values of the characters in any given alphabet to the set width selected for the particular composition, and the character spacing mechanism itself.

With these and other objects in view, a feature of the present invention resides in the novel use of a delayed action clutch in the rewind apparatus of each stage in a series of differentials comprising the variable escapement mechanism. Each stage has an input shaft provided with a clock spring or similar device normally urging the shaft in one direction, and a ratchet escapement mechanism. At the beginning of a line of composition the spring is fully wound. As the line of characters is progressively transcribed, one character at a time, the ratchet mechanisms associated with the input shafts operate in successive selected combinations to unwind the springs. At the end of the line a reversible motor, acting through each delayed action clutch, causes each input shaft to rotate in the reverse direction through an angle equal to the cumulative total of its previous spacing movements, thus rewinding the respective springs and returning each input shaft precisely to its original position. Thus the variable escapement, by moving in reverse, brings the character spacing carriage, which is continuously connected therewith, precisely to its original position corresponding to the margin of a page.

2

According to another feature, the arrangement of the differential mechanisms of the variable escapement provides an appropriate response to the binary form of input, such as is provided by the output of the multiplier unit described in the copending application of Caldwell, Higonnet and Moyroud, Serial No. 295,284, filed June 24, 1952.

The variable escapement mechanism herein described is preferably adapted to move the reflecting element of the optical system described in the copending application of Caldwell, Serial No. 148,901, filed March 10, 1950, now Patent No. 2,670,665. This optical system, through the movements of a mirror or other suitable reflector, directs a beam of successively projected characters to variably spaced positions in a line upon a sensitized sheet or film, as hereinafter more fully described.

The present invention also constitutes an improvement over the variable escapement described in Patent No. 2,636,588. As such, it is well adapted for use in photocomposing machines of the type described in our copending application, Serial No. 70,472, filed January 12, 1949, now Patent No. 2,682,814, and in said application Serial No. 295,284.

Other features of the invention relate to certain features of construction, modes of operation, arrangements and relationships which will be more readily understood from the following description of a preferred embodiment thereof.

In the accompanying drawings,

Fig. 1 is a partially schematic side elevation of the variable escapement showing various associated parts of a photographic composing machine, the latter being represented partly in block form;

Fig. 2 is a front elevation of the ratchet advance mechanism for one stage of the variable escapement,

Fig. 3 is a bottom elevation of the mechanism shown in Fig. 2;

Fig. 4 is a view illustrating the condition of a delayed clutch after the completion of the resetting operation, or immediately prior to the transcription of a new line of characters;

Fig. 5 is a view similar to Fig. 4, illustrating the condition of the clutch in an intermediate resetting position;

Fig. 6 is an oblique view of a single delay wheel of the clutch;

Fig. 7 is a view of the switching mechanism controlling the reversible motor M, taken on line 7—7 of Fig. 1; and

Fig. 8 is a view taken on line 8—8 of Fig. 1 showing the mechanism for stopping the reset power shaft.

Fig. 1 shows the basic elements of a photographic composing machine, with details of construction of the preferred form of variable escapement according to this invention. Preferably, the machine is essentially like that which is described in the above-mentioned application Serial No. 295,284, in that it employs multiplier units in conjunction with the recording and transcribing apparatus, as hereinafter more fully described. In place of the film carriage described in that application, however, we preferably use a sliding prism arrangement like that described in the above-mentioned application Serial No. 148,901. It will be understood, however, that the specific form of machine herein described is used merely for purposes of illustration, and is not intended to imply a limitation of the invention thereto.

The operation of the entire machine will first be generally described before passing to the description of the specific and preferred form of the variable escapement.

The operation of the machine in composing each individual line of type is conveniently described in terms of two distinct, consecutive steps. In the first or "storage" step, the operator types the entire line on a keyboard unit 2, whereby an instantaneous visual copy of the typed matter is preferably produced for purposes of correction. Information relative to the selected characters including their respective widths is also recorded and accumulated in suitable memory and computing devices for later use in controlling the selection of characters to be transcribed, and in the automatic computation of justification space corrections to be inserted or subtracted at appropriate places in the line. In the second or "transcription" step, the stored characters are successively disposed by photographic projection and with the desired spacing upon a sheet or strip of sensitized film. A suitable carriage, hereinafter more fully described, is interposed in the optical projection system and an element thereof is moved by an escapement to provide the necessary spacing.

At the beginning of the "storage" step, the machine operator adjusts a coefficient selector **4** (described more fully in said application Serial No. 295,284) to a position corresponding to the set width of the characters to be composed. At this moment, the keyboard unit **2** is connected with one of two registers **6** or **8** as determined by the positions of switching means schematically illustrated by a set of transfer contacts **10**. The keyboard is provided with a set of permutation bars mechanically engageable with the keying mechanism, whereby each depressed key moves a corresponding combination of the permutation bars, producing upon a set of output leads an electrical representation of information corresponding to the selected character. This information is of the binary form, that is, each output lead has only two possible conditions, energized and unenergized. Preferably, the total number of keyboard output leads is divided into two groups as described in said application Serial No. 295,284. One group represents the so-called "relative width value" of the particular character in binary notation; that is, one lead of the group represents each binary digit. The second group of leads represents information of two types, namely information which serves to distinguish characters of the alphabet having like widths from one another, and information in the nature of instructions pertaining to the transcription of the character, including its selected set width.

As the operator types each character of the line, the foregoing coded information is sent over the output leads to the register **6** or **8** then connected with the keyboard unit **2**, and also to a multiplier unit **12** which is connected with the coefficient selector **4**. This multiplier, as described in the application just mentioned, multiplies the binary number representing the "relative width value" of the character with the selected coefficient, also represented in binary form, thereby producing a product in binary notation which is supplied to an accumulator **14**. The latter accumulates a total representing the actual cumulative widths of the selected characters, together with minimum word spaces, since the "relative width value" of each character has been multiplied by the selected set width in which it is to be projected to form each summand. The total is sent to a justifier **16** which, after the entire line has been typed, computes the desired increments to be added to or subtracted from the successive intercharacter or interword spaces, or both, to cause the line to become flush with both the left and right margins of the page. It will be clear, of course, that the justifier must also take into account the number of word spaces in the line, which number is conveniently supplied to it by means connected with the space bar of the keyboard unit **2**, as shown in the above application.

During the subsequent "transcription" step, means schematically illustrated by transfer contacts **18** connect the register which contains the previously stored information with a reading unit **20**, the latter being adapted to read the information character-by-character, moving automatically from one position to the next in the register under the control of automatic stepping means. A suitable register and reading unit are described in our copending application, Serial No. 770,320, filed August 23, 1947.

Cycling means operating in synchronism with the movements of the reading unit cause projection of the selected characters as they are read from the register one at a time upon the sensitized film and subsequent spacing of the projected characters by corresponding variable amounts as determined by the information contained in the register and in the justifier. Since the projection and spacing operations follow successively upon one another, it is convenient to provide in the reading unit a number of "sensing," or momentary-type contacts adapted to be operatively associated with depressible pins in the register, and holding or repeating relays adapted to be energized on the sensing contacts and to hold through cam-operated contacts associated with the operational timing or cycling mechanism. Such relays are described in said application Serial No. 70,472. In this manner, the information read from the register may be held for a brief period permitting the successive operation first of the projection unit **22** and second of the variable escapement hereinafter to be more fully described.

The projection of the selected characters is preferably performed by a device such as that shown and described in our copending application Serial No. 770,320, mentioned above. The encoded information in the reading unit **20** is sent to a decoder **24** which selects a particular segment of a continuously rotating opaque disk **26**, which segment contains a translucent character to be projected. The decoder is connected with the projection unit **22**, which sends an impulse synchronized with the movement of the disk over a lead **28** to an intermittent flash device **30**. The flash device emits an exceedingly brief impulse of light energy through the disk **26** at the precise moment when the selected character is accurately aligned in a fixed projection position or axis, in front of a window **32** in an optical frame or bench **34**. This frame is similar to that described in the above-mentioned application Serial No. 148,901, and comprises a stationary collimating lens **36** and a movable system **38** comprising a reflector **40** and lens **42**. The collimating lens forms an image of the selected character at infinity, and the parallel rays are collected by the lens **42** and converged after reflection upon the sensitized sheet **44**.

To space the successive characters, the member **38** is moved by means of a rack **46** and pinion **48**, the pinion being driven by the variable escapement mechanism. The escapement is driven in turn by energization of selected combinations of its input leads E1 to E256, which are connected to the justifier **16** and to a multiplier **50** similar in function and operation to the multiplier **12** previously described. The multiplier **50** is connected with the reading unit **20** to receive information corresponding to the "relative width value" of the selected character. It receives information from a coefficient selector **52** pertaining to the selected point set. The latter information, as previously mentioned, is also stored in the register and hence is available at the reading unit **20** from whence it is received by means of a lead **54**.

The variable escapement operates directly from the binary information supplied to it by either the justifier **16** or the multiplier **50**. Thus, it is not required that special provision be made to translate or decode the binary width information prior to its transfer to the escapement. This results in a considerable saving in equipment and hence reduces the cost of manufacture.

We turn next to a specific description of the variable escapement mechanism and its related parts. The device as shown in Fig. 1 is to a degree schematic in arrangement, proportions and details of design, but it will be understood that this is merely to permit a ready understanding of its operation. In actual construction the parts will, of course, be oriented in such suitable manner as may be dictated by considerations well known to those skilled in the mechanical arts.

The various parts of the mechanism are supported between the end walls of a rigid frame **56**. In this frame are journaled a set of eight interconnected differential stages, each stage except the first representing one digit of the binary input. The right-hand differential, which is the single exception, represents both the lowest and next-to-lowest order digits. There is an input shaft **L1** to **L256** for each differential, except for the first which is connected to both of the shafts **L1** and **L2**. There is also an output shaft **P2** to **P256** for each differential, and a carry-over gear **M4** to **M256** by which the motion of the output shaft is transferred to the next higher order differential. Thus for example, the motion of the output shaft **P8** is determined both by the directly applied input rotation of the shaft **L8** and by the carry-over motion imparted by the output shaft **P4** through the gear **M8**.

The gear ratios throughout the mechanism are 1:1 except for the input shaft **L1** connection to the lowest-order differential. The ratios produce a binary series, since the carry-over and direct input rotations are each scaled down in the differentials by a factor of 2.

It will be noted from the example just given that the carry-over gearing from stage to stage is indicated in the drawing as a dot-dash line connecting the output shaft of one stage such as **P4** with an input gear such as **M8** of the succeeding stage. It will be understood that in the actual construction, the gears connected by such lines are in actual engagement.

Each of the input shafts **L1** to **L256** is provided at one end with a clock spring **58** which at all times urges the shaft in the direction indicated by the arrow thereon. Escapement in this direction is controlled by a ratchet wheel and pawl device **60**, details of which are shown in Figs. 2 and 3. A coil **62** connected with an input lead such as **E1** produces a movement corresponding to one tooth of the ratchet wheel **64**, which is rigidly secured to the corresponding shaft **L1** by a set screw **66**. Thus, for each desired space in the line energization of the appropriate combination of leads **E1** to **E256** produces one tooth of angular rotation in each of the corresponding combination of the input shafts **L1** to **L256**.

The various parts of the ratchet advance mechanism are mounted in a rigid bracket **68** secured to the frame **56** by screws **70**. The bracket has an outwardly turned end wall **72** and two outwardly turned upper sidewall portions **74** and **76**. The end wall **72** furnishes support for a magnet assembly including the coil **62**, a U-shaped closure **78** of magnetic material, and an end plate **80** also of magnetic material, the closure and end plate forming an external magnetic path for the coil **62**.

Extending through the magnet is a fixed cylindrical core **82** having an enlarged end portion **84** with a shoulder resting against the plate **80**. The core is threaded at the opposite end to receive a nut **86** by which the magnet assembly is fixedly secured to the end wall **72**. The core **82** has a longitudinal slot extending from one end into the magnet to receive an armature **88**. The armature is pivoted upon a shaft **90** which is in turn supported in a channel-shaped pivot member **92**. The member **92** is supported on a shaft **94** suspended between the side walls **74** and **76** of the bracket **68**. Thus, upon energization the coil **62** draws the armature **88** into the magnet, thus causing the pivot member **92** to rotate in the bracket about the shaft **94**.

The member **92** has flange portions **96** and **98**, the portion **96** having a stop pin **100** to limit rotation of the member **92** in the direction to withdraw the armature **88** from the magnet, and the flange **98** having a slot **102** to engage one end of a torsion spring **104**, the other end of the spring being received into a hole **106** in the side wall **74** of the bracket. The spring **104** urges the pivot member **92** in the direction to cause the pin **100** to bear upon a surface of the side wall **76** when the magnet is unenergized.

When the magnet is in the unenergized condition as

shown in the drawings, the pivot member **92** is in a position to cause a pawl **108** pivoted thereon to come into alignment with the ratchet wheel **64**. A spring **110** urges this pawl into engagement with the wheel. The clock spring **58** (Fig. 1) urges the wheel **64** in the direction indicated by the arrow in Figs. 2 and 3, thus defining what may be termed the "rest" position of the escapement.

Also pivoted upon the member **92** is a second pawl **112** having a spring **114** urging it against a stop provided by a screw **116** threaded into the member **92**. Another stop is provided by a screw **118**.

Upon energization of the coil **62**, the armature **88** pivots the member **92** about the shaft **94**, disengaging the pawl **108** from the wheel **64** and bringing the pawl **112** into position to engage with the next adjacent tooth after rotation of the wheel **64**. It will be noted that the space between the pawls as viewed in Fig. 3 is less than the width of the teeth so that at all times at least one of the pawls is in position to engage therewith.

The clock spring urges the succeeding tooth into engagement with the pawl **112** after a rotation of the wheel which is appreciably less than the angle distended between adjacent teeth. The movement is very rapid, but the correspondingly large momentum of the wheel **64** and shaft **L1** is absorbed by the spring **114** upon contact of the wheel with the pawl **112**.

When the coil **62** is deenergized, the member **92** pivots back to its original position, bringing the pawl **108** into a position where, upon a small additional movement of the wheel **64**, the tooth previously engaged by the pawl **112** comes into contact therewith. It will be appreciated that in this manner, we have provided a mechanism in which the precision of the escapement is insured by absorption of a large part of the momentum of the wheel **64** through the pawl **112**, so that the impact of the teeth upon the pawl **108** is relatively small in spite of the exceedingly fast escapement speeds achieved.

As previously indicated, each of the input shafts **L1** to **L256** is rotated to a predetermined fixed position at the beginning of each line of transcription. This position may be conveniently indicated on the escapement by a mark **120** (Fig. 2) which is placed on the particular tooth of each of the ratchet wheels to be finally engaged by the pawl **108**. During the transcription of a typical line, each of the input shafts will have been rotated by its ratchet means in the direction of the arrow (Fig. 1) through an angle corresponding to a random number of tooth spaces which varies from stage to stage. To reset each stage, we provide at one end of its input shaft a delayed action clutch **122**. In addition to these clutches, we provide one additional clutch **123** of similar construction which forms no part of the character spacing mechanism, but is used exclusively as a control element governing the resetting operation. Figs. 4 and 5 show details of the clutch **123** on an enlarged scale, but it will become apparent that the following description thereof is also applicable, except as otherwise indicated, to the clutches on the input shafts. Extending longitudinally of the machine we provide a shaft **124** which is driven through bevel gearing **126** from a reset power shaft **128**. The shaft **128** is rotated by a reversible motor M. The shaft **124** has a series of worms such as **130** having alternate left and right hand threads, each of the worms being in continuous engagement with a worm gear such as **132** forming one end of the clutch.

Referring to Figs. 4, 5 and 6, it will be noted that the shaft **133** of the control clutch extends through and is supported in the frame **56**. Near the outer end of the shaft is secured a disk **134** by means of a set screw **136**. Near its periphery the disk **134** has a downwardly extending pin **138**. The gear **132** also has an upwardly extending pin **140** secured near its periphery.

Between the pins **138** and **140** are supported a number of delay wheels or disks **142**, each constructed in the shape shown in Fig. 6, and each free to slip in rotation about the shaft 133. The disks are separated by suitable spacers 144 so that the outwardly turned lugs 146 of adjacent disks may come into contact. The pins 138 and 140 are in appropriate positions to come into contact with the end lugs as shown in the drawings. The clutches on the input shafts are similarly constructed, except that they each have one more disk 142, and do not have a disk like the disk 150.

Immediately prior to the "transcription" step, each clutch is in a position corresponding to that shown in Fig. 4. During the transcription of the line, the input shafts L1 to L128 move, under the control of the input signals, in selected combinations, each shaft moving in such a direction that its pin corresponding to the pin 138 in Fig. 4 moves away from the lug of the delay disk with which it is initially engaged. After approximately a full revolution this pin will have moved to a position bearing upon the lug from the opposite direction. For example, if the clutch 123 were connected with an input shaft, the input shaft would escape in the direction indicated by the arrow in Fig. 4. (It will be appreciated that, in fact, the clutch 123 remains in the position shown throughout the "transcription" step.) Further movement after the pin bears upon the lug would cause rotation of the topmost delay disk and would also cause the oppositely turned lug of this latter disk to move out of engagement with its own lower contacting lug until, in turn, this lug becomes engaged and so on. There are enough delay disks 142 on each clutch so that in even the longest line the final lug on the lowermost disk will not engage with the pin corresponding to the pin 140. It will be understood that this latter pin is stationary throughout the "transcription" step, and that the shaft 124 does not rotate. Therefore, during the "transcription" step each input shaft is rotated through its ratchet mechanism without restraint by the delayed action clutch.

At the end of the line of transcription, each of the input stages is reset in two steps which may be conveniently termed the "rewind" step, and the "return" step. At the beginning of the "rewind" step the control clutch 123 and related parts are in the positions shown in Figs. 4, 7 and 8. This clutch, having no associated input ratchet mechanism, does not move during the transcription of the line, and remains in a position such that the gear 132 is urged in the direction indicated by the arrow in Fig. 4, so that it causes a pin 148 projecting from a disk 150 secured to the shaft 133 to bear upon a pin 152 extending from an arm 154, the arm being in turn secured to a shaft 156. The shaft 156 is rotatably journaled in the frame 56 (see Fig. 1). An arm 158 also secured to the shaft 156 holds an insulated contact roller 160 against a pair of normally-closed contacts B, holding them open. An extension of the arm 154 is secured to a spring 162 which is fastened at the other end to the frame. This spring normally urges the roller 160 to the position indicated at 164, but the pin 148 holds it in the position shown in Fig. 7.

While the arm 154 is being so held, a pair of stop arms 166 and 168 rigidly secured with it to the same shaft 156 are held in the positions shown in Fig. 8. The arm 166 engages a stop cam 170. The arm 168 is free of a second stop cam 172. These two cams are secured to the shaft 128 (see also Fig. 1).

As previously explained, the clutches associated with each of the input shafts will have moved during "transcription" from an initial position in which their respective disks 142 appear as shown in Fig. 4, starting at the upper end corresponding to the disk 134, according to the movements of their respective input escapements; but no motion will have reached the gear corresponding to the gear 132 of any of these clutches.

The "rewind" step is initiated, by a circuit hereinafter described, when the motor M begins to turn the shaft 128 in the direction indicated by the arrows in Figs. 1, 7 and 8. Through the bevel gearing 126, this turns the shaft 124 in the direction indicated by the arrow in Fig. 1, and imparts motion to the worm gear 132 and the corresponding gear of each of the input delay clutches 122 in the direction opposite to that of the arrow in Fig. 4.

In the first revolution of the shaft 128, the cam 170 (Fig. 8) throws the arm 166 out of engagement therewith, and rocks the arm 154 toward its neutral position allowing the contacts B to close. (The consequent slight downward movement of the pin 152 is not prevented by the control clutch 123 because of the previously-mentioned movement of the gear 132 in the appropriate direction to allow such motion.)

Continued rotation of the motor M after the above events causes engagement, approximately once per revolution of the gear 132, of this gear with an additional disk 142 until ultimately the disk 134 is engaged. When this occurs, the disks 142 of the clutch 123 will appear as shown in Fig. 5. Once the disk 134 is engaged, the shaft 133 is turned, rotating the pin 148 in the direction of the arrow in Fig. 7 until it bears upon the pin 152 from the side opposite to that shown in the figure. The "rewind" step is terminated thereupon and the motor M stopped by movement of the roller 160 to close a pair of normally-open contacts A. At substantially the same time, the rocking of the arm 154 moves the stop arm 168 into position to engage with the cam 172. This positively stops the motor shaft 128 in a precisely defined position.

At various times during the "rewind" step, that is, while the motor M is rotating, each of the input delay clutches 122 will have become engaged therewith. The motion of the input shaft in each case during "transcription" will have been opposite to that of its worm gear during the "rewind" step. Therefore the clutches of those escapements which operated more frequently in a given "transcription" step will engage earlier than others which operated less frequently. But at the end of the "rewind" step, each input shaft will have been returned to its original position by rotation in reverse through the same total angle through which it turned during the preceding "transcription" step.

To insure accurate resetting of the mechanism with backlash taken up, the cam 172 is set so that when it is engaged by the arm 168 each of the input shafts has advanced to a position in which its pawl 108 rests within the space of the particular tooth on the ratchet wheel marking the initial position of the input shaft. In other words, there is a slight over-travel in each stage on resetting, so that upon subsequent reversed rotation of the motor M, as hereinafter described, the clock spring in each stage will cause a slight motion of the wheel in the normal direction of escapement before the wheel becomes positively engaged by the pawl. It will be appreciated that during this entire "resetting" step the member 38 of the character spacing mechanism is in continuous engagement with the variable escapement, that in consequence the said member overtravels at the margin by a slight distance during the "resetting" step, and that it moves up to the precise initial position for the transcription of a new line when the respective ratchet wheels are allowed to move back against their respective pawls as described. We may also provide, if required, a supplementary spring 173 secured at one end to the frame and at the other end to the member 38 to urge the latter in the direction opposite to that of its movements during transcription. This spring provides a force which is weaker than that of any of the clock springs 58, but strong enough to bring the differentials and transfer or carry-over gears M4 to M256 into positive engagement with the input gears, particularly in the highest order stages of the escapement where backlash is more noticeable. By this means, the backlash within the mechanism is completely taken up.

The "return" step is initiated with the closing of the contacts A, and a circuit hereinafter to be more fully described operates to reverse the motor M, thereby rotating the control clutch **123** in reverse through exactly the same angle by which it rotated in the "rewind" step. This rotation sets all of the clutches back to the position indicated in Fig. 4, but produces no movement in the input shafts of the escapement stages, the latter being held by their respective pawls **108**. In the last revolution of this "return" step, the pin **148** of the control clutch moves in the direction opposite to that of the arrow in Fig. 7, thereby finally opening the contacts B when the pin **148** engages with the pin **152** and moves it to the position indicated in Fig. 7. The rocking of the arm **154** causes the stop arm **166** to engage with the cam **170** to stop the shaft **128** positively in a manner similar to that previously described for the "rewind" step.

The rotation of the motor M is under the control of two relays R1 and R2. These relays are connected with the contacts A and B as shown in Fig. 1. The circuit conditions as shown correspond with those which obtain immediately after the end of the "return" step, that is, at the beginning of a new line of transcription.

When a new line is to be transcribed, the machine operator closes a key K which energizes the relay R1. This relay holds through its normally open contacts in series circuit with normally closed contacts of the relay R2. Energization of the relay R1 closes a second pair of contacts to connect a voltage source with a lead **174**, causing rotation of the motor M in an appropriate direction to perform the "rewind" step of the resetting operation as previously described.

In the initial movement of the roller **160** in the "rewind" step, the contacts B close, but this has no effect upon the circuit. However, at the end of the "rewind" step, the contacts A are closed, thereby causing energization of the relay R2 through the contacts B, now closed. The relay R2 holds through its normally open contacts in series circuit with the contacts B. The holding circuit of the relay R1 is opened by the relay R2 and the potential is thereby removed from the lead **174**. Voltage is immediately applied to a lead **176** through transfer contacts of the relay R2, thereby causing reverse rotation of the motor M. This rotation continues until the contacts B are again opened by the roller **160**. This breaks the holding circuit of the relay circuit R2, after which both relays R1 and R2 remain at rest until the key K is again depressed.

It will be understood that while the present invention has been described with reference to a specific embodiment it is in no way limited thereto, but on the contrary, it encompasses all variations in control circuitry, design, arrangement and relationships of the various parts that will occur to those skilled in this art in the light of the foregoing specification.

Having thus described our invention, we claim:

1. A differential device having two input shafts and an output shaft, driven means connected with the output shaft, means to advance the input shafts in successive selected combinations to produce movements of predetermined variable size in the output shaft, said successive advancements being initiated with each input shaft in a fixed initial position, and resettng means including a delayed action clutch connected with an input shaft and reversible means for driving the clutch to rotate the shaft to said position through an angle equal to its aggregate movement in said succession of advancements and in the opposite direction thereto.

2. A differential device having two input shafts and an output shaft, driven means connected with the output shaft, means to advance the input shafts in successive selected combinations to produce movements of predetermined variable size in the output shaft, said successive advancements being initiated with each input shaft in a fixed initial position, and resetting means including a delayed action, two-way clutch connected with an input shaft, reversible drive means for the clutch, and controls having provision to drive said shaft through the clutch to said position through an angle equal to its aggregate movement in said succession of advancements and in the opposite direction thereto.

3. A variable escapement mechanism comprising a number of stages arranged in a series, each stage comprising a differential device having two input shafts and an output shaft, at least one of said stages having an input shaft connected with the output shaft of the preceding stage in said series, means to advance the input shafts of each of a selected combination of the stages to produce a movement of predetermined size in the output shaft of the final stage, said advancement being initiated with each input shaft in a fixed initial position, and resetting means for each stage to rotate an input shaft independently to said position through an angle equal to its movement in said advancement and in the opposite direction thereto.

4. A variable escapement mechanism comprising a number of stages arranged in a series, each stage comprising a differential device having two input shafts and an output shaft, at least one of said stages having an input shaft connected with the output shaft of the preceding stage in said series, means to advance the input shafts of the stages in successive selected combinations to produce movements of predetermined variable size in the output shaft of the final stage, said successive advancements being initiated with each input shaft in a fixed initial position, and resetting means for each stage to rotate an input shaft independently to said position through an angle equal to its aggregate movement in said succession of advancements and in the opposite direction thereto.

5. In type composing apparatus, the combination of a keyboard having provision for selection of the characters in a line of type, means for transcribing the characters successively upon a sheet, and an escapement mechanism to move the transcribing means relative to the sheet for spacing the characters, said mechanism consisting of a number of stages arranged in a series, each stage comprising a differential device having an individual input shaft, means to advance each input shaft from an initial position in successive selected combinations to produce movements of the escapement corresponding to the widths of said characters, and resetting means for each stage having provision to move its said input shaft after the last character in said line is spaced through an angle equal to its movement in said advancement and in the opposite direction thereto.

6. In type composing apparatus, the combination of a keyboard, a register for storing information corresponding to each of the selected characters in a line of type, said information including a binary representation of the character width, means for transcribing the characters successively upon a sheet, and a variable escapement mechanism to move the transcribing means relative to the sheet to space the characters, said mechanism comprising a number of stages arranged in a binary series, each stage including a differential device having an individual input shaft, and means connected with the register for rotating selected combinations of the input shafts in accordance with the binary values represented.

7. In type composing apparatus, the combination of a keyboard, means actuated by the keyboard to represent the width of each selected character successively in binary form, means for transcribing the key-selected characters successively upon a sheet, and a variable escapement mechanism to move the transcribing means relative to the sheet to space the characters upon the sheet, said mechanism comprising a number of stages arranged in a binary series, each stage including a differential device having an individual input shaft, and means connected with said width representing means for rotating selected combinations of the input shafts in accordance with the binary values represented.

8. In type composing apparatus, the combination of a keyboard having provision for selection of the characters in a line of type, means for transcribing the characters successively upon a sheet, an escapement mechanism to move

the transcribing means relative to the sheet for spacing the characters, said mechanism consisting of a number of stages arranged in a series, each stage comprising a differential device having an individual input shaft, means to advance the input shafts in successive selected combinations to produce movements of the escapement mechanism corresponding to the widths of said characters, each input shaft having a predetermined initial position at the beginning of the line, and resetting means for each stage having provision to move its said input shaft after the last character in said line is spaced through an angle exceeding in magnitude and opposite in direction to its movement in said advancement, and thereafter to return said shaft precisely to its initial position.

9. In type composing apparatus, the combination of a keyboard having provision for selection of the characters in a line of type, means for transcribing the characters successively upon a sheet, a carriage to move the transcribing means relative to the sheet from an initial marginal position for spacing the characters, an escapement mechanism for the carriage, said mechanism consisting of a number of stages arranged in a series, each stage comprising a differential device having an individual input shaft, means to advance the input shafts from an initial position in successive selected combinations to produce movements of the escapement mechanism corresponding to the widths of said characters, resetting means having provision to move each input shaft after the last character in said line is spaced through an angle exceeding in magnitude and opposite in direction to its angular movement in said advancement, and thereafter to return said shaft precisely to its initial position, and a spring urging the carriage to return past its said initial position and thereafter permitting movement to said position upon operation of the resetting means.

10. A differential device having two input shafts and an output shaft, driven means connected with the output shaft, means to advance an input shaft in successive selected steps to produce movement of predetermined size in the output shaft, said successive advancements being initiated with said input shaft in a fixed initial position, and resetting means for said input shaft including a gear, a delayed action two-way clutch connecting said shaft with the gear, means to rotate the gear through a fixed angle to to engage the clutch and cause said shaft to return to said initial position, and means to rotate the gear through an equal and opposite angle after said shaft is returned.

11. A differential device having two input shafts and an output shaft, driven means connected with the output shaft, means to advance an input shaft in successive selected steps to produce movements of predetermined size in the output shaft, said successive advancements being initiated with said input shaft in a fixed initial position, and resetting means for said input shaft including a gear, a delayed action, two-way clutch connecting said shaft with the gear, means to rotate the gear through a fixed angle to engage the clutch and cause said shaft to return to a position beyond said initial position, means to rotate the gear through an equal and opposite angle after said shaft is returned, and ratchet and pawl means to arrest the shaft precisely in said initial position.

References Cited in the file of this patent

UNITED STATES PATENTS

1,084,671	Tallmadge	Jan. 20, 1914
2,411,723	Hausman	Nov. 26, 1946
2,439,470	Jackson	Apr. 13, 1948