KEYBOARD PRINTER FOR TYPEWRITING AND RECORDING CHARACTERS ON A MAGNETIC TAPE

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ABSTRACT

Keyboard printer for typewriting characters on paper and recording the same on a magnetic tape. The printer keyboard has capacitive motionless keys. The printer has a rotative equipment including a striking mechanism and a pulse generator and produces one start pulse per rotation cycle of the equipment, character pulses equally distributed in the cycle and one key pulse per cycle corresponding to the capacitive character key actuated by the operator. The code of the struck character is the number of character pulses between the start pulse and the key pulse. This number is counted in the binary code and is recorded on the magnetic tape, using the character pulses as synchronization pulses. Means are provided for actuating the advance mechanism of the tape by signals derived from the character pulses, which avoids the necessity of a motor in the tape recorder.

4 Claims, 5 Drawing Figures
Fig. 5

1) Start pulse
2) Key pulse
3) Character pulse following the key pulse
4) Flipstop 111
5) Flipstop 112

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This invention relates to a typewriter for producing coded characters on a magnetic tape preferably contained in a minicassette of known type. The characters typewritten in coded form on the magnetic tape are struck in plain language by the machine.

The prior art has already disclosed similar information gathering machines used in conjunction with computers as peripheral equipment for the latter. Such machines generally use paper as the information support (punched cards or tapes), the input means being a keyboard of the alphanumeric type or just numeric type, it being possible to check the input data by a plain-language printing on the same support or on a separate support. The present tendency is to use magnetic tape in magazines.

The invention relates to a typewriter for producing plain language on paper and coded characters on a magnetic tape.

The machine according to the invention is derived from the typewriter controlled electrically by means of a keyboard having capacitive keys as described in U.S. Pat. application Ser. No. 63,527 filed Aug. 13, 1970, this machine in turn being derived from the keyboard printing machine for computers as described in U.S. Pat. No. 3,589,494 of June 29, 1971.

The machine according to the invention records character by character and seriatim on a cassetted magnetic tape, i.e., without any device storing more than the character which is being recorded, and provides step-by-step transport of the magnetic tape by simple mechanical means comprising neither a motor, nor a clutch, said means being controlled by signals from the logic circuits provided in the machine.

The typewriter which is controlled electrically by a keyboard having capacitive keys as described in the U.S. patent application mentioned hereinabove, makes use of the signals emitted by the two internal clocks of the machine, said clocks consisting respectively of two phonic wheels, to control the striking of the type characters by a logic circuit or system. It delivers a cycle start pulse, type or character pulses, which are synchronization pulses distributed equally in the cycle, and key pulses at the rate of one per cycle maximum, the delay thereof in relation to the start pulse constituting the code for the actuated key.

The typewriter according to the invention uses the same signals:

firstly, for striking the type characters by means of the above-mentioned logic system;

secondly, to convert the type characters into binary coded signals by means of a second logic system, which takes some of the signals from the first system.

As will be indicated hereinafter in detail, one of the phonic wheels comprises as many teeth as there are characters on the type wheel of the typewriter, and produces the character pulses, while the other phonic wheel has just one tooth and produces the start pulses. Counting the number of character pulses from the time defined by a start pulse, until the next key pulse, the said type character can be identified.

It will therefore be apparent that the main component of the second logic system mentioned above is a conventional counter which counts the pulses it receives in the binary counting system. The bits leaving this counter seriatim actuate the recording head disposed near the magnetic recording tape.

If the number of typewriter characters is not more than 64, the said characters can be coded by a six-bit binary code.

If two pulses are provided before the bits which form the six code elements in order to give the magnetic tape time to cancel out its acceleration, i.e., to acquire a sufficiently constant speed, the second logic system in question must be reset to zero every eight pulses. This zeroizing is obtained, as well be seen hereinafter, by means of a second counter. The latter, advancing at the rate of the character pulses, emits a signal at the eighth pulse to produce the required zeroizing.

The invention will be more readily understood from the following detailed description together with the accompanying drawings wherein:

FIG. 1 is a simplified perspective view of one embodiment of the typewriter according to the invention;

FIG. 2 illustrates the circuit diagrams of the two logic systems, one of them controlling the striking of the typewriter characters and the other the encoding of the same characters into binary numbers;

FIG. 3 illustrates diagrams explaining the operation of the first logic system;

FIG. 4 illustrates diagrams explaining the operation of the second logic system; and

FIG. 5 shows the magnetic tape recording equipment.

Referring to FIG. 1, reference 1 denotes an electric motor which continuously rotates a type wheel 10, a phonic wheel 20 having a single tooth of magnetic material, a phonic wheel 30 the periphery of which has as many teeth of magnetic material as there are keys (type characters and functions) in the machine and the rotor arm 41 of a distributor 40. Motor 1 rotates, for example, at 20 revolutions per second.

Phonic wheel 20 produces one start pulse per revolution in the winding 22 on the magnetic core 23. In the example selected, the start pulses have a frequency of 20 Hz. The phonic wheel 30 produces a given number of character (or function) pulses distributed equally in time during one revolution cycle in the winding 32 on the magnetic core 33. It will be assumed that there are 50 teeth on the phonic wheel 30, 48 corresponding to type characters and 2 to the "carriage return and line feed" and spacing functions; the frequency of the character or function pulses is then 1,000 Hz.

Reference 2 denotes a typewriter platen bearing a sheet of paper 3 and movable longitudinally by a conventional mechanism (not shown).

Reference 50 denotes the flexible printed circuit keyboard rigidly connected to the distributor 40 by the connecting strip 4.

The distributor 40 is a cylinder comprising an annular electrode 42 and a plurality of radial electrodes 43, to 43n. The annular electrode 42 is connected to the winding 32. Each of the radial electrodes 43, to 43n is connected to a type or function key 51, to 51n. The arm 41 bears a metal terminal plate which provides a selective capacitative coupling between the annular electrode and one of the radial electrodes depending upon its position during the cycle.
The keys are formed in two zones on which the operator places the end of his or her finger. Key pulses are obtained at the output of the amplifier 60.

The start pulse from the winding 22 is fed directly to the input 100, of the logic system 100 which controls the striking of the type characters on paper, directly to the input 200, of the logic system 200 which encodes the struck type characters into binary numbers, and indirectly with some delay to the input 200, of the logic system 200 via the terminal 100, of the logic system 100.

The character pulses from the winding 32 are fed directly to the input 100, of the logic system 100, directly to the input 200, of the logic system 200, and indirectly, with some delay and, after they have been "validated," to the input 200, of the logic system 200.

The start pulse occurs very shortly after the last character pulse because of the appropriate offset of the phonic wheels 20 and 30 in relation to one another.

In accordance with the process described in detail in the U.S. Pat. application Ser. N. 63,527 hereinbefore mentioned, the operator’s finger contacting a key 51 k of the keyboard 50 results in a key pulse being fed, after amplification and clipping in 60, to the input 100, of the logic system 100. This key pulse is not applied directly to the logic system 200; it acts on the latter solely by the action that it produces in time on the logic system 100.

As indicated in the U.S. Pat. application Ser. No. 63,527 referred to hereinbefore, a first transistorized amplifier in the logic system 100 produces a printing signal at the output terminal 100 to feed the winding of the striking electromagnet 11. The latter has a plunger acting as a hammer so that the designated character is applied as required to the sheet of paper on the platen 2. A second transistorized amplifier also in the logic system 100 produces a control signal at the output terminal 100 to actuate the drive means which carry out the auxiliary functions of "carriage return and line feed" and "spacing."

The logic system 200 delivers the following signals:

at the terminal 200, coded signals to feed a recording signal generator contained in unit 300. This generator feeds the recording head brought near the magnetic tape which moves intermittently;
at terminal 200, synchronization pulses for the recording signal generator indicated above. These signals are emitted at the rate of the character pulses;
at terminal 200, pulses which are amplified in unit 300 and then feed the winding of a plunger-type electromagnet, one of the ends of the plunger having a hook. The latter receiving a reciprocating movements acts on the teeth of a ratchet wheel which actuates the magnetic tape step-by-step and, via belts, the take-up and feed spools on which the magnetic tape is wound and unwound.

FIG. 2 shows the circuit diagrams of the logic systems 100 and 200.

The logic system 100 has already been described in the aforementioned U.S. Pat. application Ser. No. 63,527. The description will be repeated to facilitate the explanation of the operation of the system 200.

The logic circuit 100 in FIG. 2 has three inputs: 100, to which the start pulses are applied, 100, to which the key pulses are applied and 100, to which the character pulses are applied. Circuit 100 comprises five bistables 101, 102, 103, 111 and 112 of conventional type, six AND gates 104, 105, 106, 114, 116, 117, five delay lines 107, 108, 109, 109, 113 and 115 and three amplifiers 110, 118, 118. The system 100 operates as follows:

When the motor 1 of the typewriter is inoperative, no pulse is applied to the inputs 100, 100, 100, of the system 100 and hence the bistables 101, 102, 103 are in the zero state and the AND gates 104, 105, 106 are closed.

When the typewriter motor 1 is started and the operator is not using the keyboard 50, the system 100 does not come into operation until a start pulse is applied to the terminal 100. The reason for this is that since the AND gate 106 remains closed, the character pulse from the winding 33 (FIG. 1) and applied to the terminal 100, is inoperative. The same applies to the key pulse applied to the input 100, since the AND gate 105 is also closed.

As soon as the first start pulse is applied to the terminal 100, the bistable 101 passes from the zero state to the one state with a certain delay time τ1 due to the presence of the delay line 107. The AND gate 104 directly receives the start pulse at one of its inputs and, at its second input, a voltage applied with a delay τ1 by the bistable 101 when it passes from the zero state to the one state, and therefore remains closed. Since, however, the bistable 101 remains in the one state, the AND gate 104 opens on the second start pulse.

The signal from the AND gate 104 brings the bistable 102 into the one state and the bistable 102 applies a voltage to the first input of the gate 105, this voltage being maintained.

The following start pulses no longer result in any change of the states of the bistables 101 and 102 and consequently the AND gate 105 will pass a key pulse as soon as it is applied to the terminal 100.

When the operator uses the typewriter according to the invention, the capacitive action of his or her finger on a key of the keyboard 50 will produce a key pulse at the terminal 100, and this immediately brings the bistable 103 into the one state, because, as indicated hereinbefore, the AND gate 105 is open, and the bistables 101 and 102 are brought into the zero state with a certain delay τ2 produced by the delay line 108, so that the AND gates 104 and 105 are closed τ2 after the key pulse has passed through the AND gate 105.

The voltage from the bistable 103 as a result of its changeover from the zero state to the one state is applied with a certain delay τ2 due to the presence of the delay line 109, to the first input of the AND gate 106 which thus opens for a character pulse as soon as it appears at the terminal 100.

As it leaves the AND gate 106, the said character pulse actuates the strike electromagnet 11 as a result of the energy delivered by the amplifier 110 and returns the bistable 103 to zero, thus closing the AND gate 106.

As indicated hereinbefore, since the key pulse has returned the logic system 100 to the initial state that it occupied when the typewriter was started, it follows that as long as the operator’s finger has not left the key of the keyboard 50 between two consecutive start pul-
ses, the bistable 102 will not be able to be returned to the one state and the following key pulses produced by the operator holding his or her finger on the same key will have no effect on the strike electromagnet 11.

As soon as the operator's finger leaves the key within the required time, the typewriter will be released and it will be possible for another type character to be printed.

The electromagnet 11 could be controlled directly with the signal from the AND gate 105 without the intervention of the character pulse following the key pulse, but there would then be the occasional risk of producing strike pulses which are out as regards durations, in the event of any appreciable modification of the action of the correct finger during the period of the key pulse.

The delay time \( t_1, t_2, t_3 \) of the delay lines 107, 108, 109 may be of the order of some microseconds. In the system described, the printing operation is effected not by the key pulse but by the character pulse which follows it. The key pulses must therefore be offset by one step.

The application of a finger to a capacitative key associated with a function must not result in the striking electromagnet 11 being triggered. The logic system 100 must therefore enable printing to be inhibited for all the functions, as a result of the AND gate 116, and control the carriage return and line feed, by means of the AND gate 117, the output of which is connected to the amplifier 118, which delivers the energy required for actuating the drive means which carry out the functions.

In the following, it will be assumed that the carriage return and line feed function pulse is situated as the last character pulse \( a \) just before the start pulse \( r \) which follows (line 2, FIG. 3) and the "spacing" function pulse is situated as the first character pulse \( b \) just after the above-mentioned start pulse (line 2, FIG. 3). Since the active pulses are the character pulses following the key pulses, the active function pulses are \( a' \) and \( b' \) in line 3 of FIG. 3.

The start pulse applied to the input 100, simultaneously brings the bistables 111, 112 into the one state. The AND gate 117 is thus opened for the character pulse \( a' \) (line 3, FIG. 3) at the output of the AND gate 106.

The character pulse \( a' \) (line 3, FIG. 3) after a time defined by the delay line 113, returns the bistable 111 to the zero state thus closing the AND gate 117. The signal produced by the bistable 111 being returned to zero and delayed by the delay line 115 allows the AND gate 114 to open for the character pulse \( b' \) which thus returns the bistable 112 to zero, so that the gate 116 is opened.

It will thus be seen that the character pulses leave via the terminal 100, through the amplifier 110, that the "carriage return and line feed" function pulse leaves via the terminal 100, through the amplifier 118 and that the "spacing" pulse which is a pulse existing for both the type characters and for the "spacing" function, leaves via the terminal 100's through the amplifier 118'.

The operation of the logic system 200 will now be described.

The terminal 200, receives the start pulses, the terminal 200, receives the character pulses, the terminal 200, receives the second start pulse and the terminal 200, receives the validated key pulse.

When the typewriter is started, the first start pulse has no action on the logic systems 100 and 200.

The second start pulse, which appears with a certain delay at the terminal 100, of the system 100, is applied to one of the inputs of the OR gate 214, so that the bistable 201 is brought into the one state and the bistables 202, 203 are brought into the zero state while the counter 205 is rezeroized.

The bistable 201 in the one state opens the AND gate 210 for the next start pulse applied the the input 200, and the AND gate 209 for the character pulses applied to the input 200. The bistable 202 in the zero state holds the AND gate 212 closed. The bistable 203 in the zero state holds the AND gate 213 closed.

The six-stage counter 204 counts the character pulses leaving the AND gate until the "validated" key pulse appears at the terminal 100, of the system 100. The bistable 201 is thus rezeroized and closes the AND gates 210 and 209 and opens the AND gate 211. Counter 204 no longer counts and therefore remains stationary on the numerical equivalent of the struck type character.

The next start pulse applied to the input 200, passes through the AND gate 211 and brings the bistable 202 into the one state, thus opening the AND gate 212.

The character pulses of period \( T \) applied to the input 200, and passing through the AND gate 212 are then counted by the counter 205.

The latter emits a signal which:

1. is delayed by \( 2T \) by the line 207 and brings the bistable 203 into the one state, thus opening the AND gate 213.

2. is delayed by \( 8T \) by the line 208 and passes through the OR gate 214 to rezeroize the counter 205 itself, the bistables 202 and 203 and bring the bistable 201 into the one state.

The gate 213 is thus off after having passed six character pulses which are applied as synchronization pulses via the output terminal 200, to the recorder 300. These six pulses are \( C_6, C_5 \ldots C_0 \) (line 2, FIG. 4).

Counter 204 or main counter operates as a binary counter when it is triggered by gate 210 and as a shifting register when it is triggered by said character pulses transmitted by terminal 200, and delay line 206. A counter of this kind is well known in the art. As it is a six-stage counter, six pulses are needed to transfer away its contents. When it operates as a shift register, said six character pulses \( C_6 \) to \( C_0 \) control sequentially the shifting of the counter, a bit 1 or 0 being transferred, for each shift, from the sixth stage of the counter to terminals 200, and 300, Therefore the contents of counter 204 is transferred sequentially to terminals 200, and 300, then to the recorder 300 in which it is stored as a binary coded number. Said number is converted in the recording signal generator 301 in character signals shaped as shown in diagram (h) of FIG. 4 by means of well known circuits (not shown).

Further, the six pulses \( C_6 \) to \( C_0 \), which are applied to the recording signal generator 301 from terminal 300, are used in this generator as synchronization pulses. In-
deed, in this embodiment, data pulses have two different durations and are recorded by RZ (return to zero) technique, and it is well known that, in this technique, synchronization pulses are necessary, because this recording method is not auto-synchronizing, the recording or character pulses being controlled by synchronization pulses by means of well known logical circuits (not shown).

The "one" output of the sixth bistable (weight 5) is connected to the output 200, of the six-stage counter 204, thus the six synchronization pulses C3 to C6 will control the generation of the six recording signals in dependence at all times on the state of the said bistable.

Taking a "long" pulse for the one state and a "short" pulse for the zero state, the sequence of operations is as follows:

Pulse C3 controls the first recording pulse corresponding to the weight five delivered by the counter 204; because the sixth stage of the counter has not yet had its state changed.

The pulse C4 delayed by the line 206 shifts the counter 204 by one stage and hence the sixth stage assumes the state communicated to it by the fifth stage.

The pulse C5 controls the second recording pulse corresponding to the weight four delivered by the counter 204.

The pulse C6 delayed by line 206 shifts the counter 204 by one stage and hence the sixth stage assumes the state of the fourth stage; and so on until the weight zero.

A possible method of recording is shown in the diagrams (h) in FIG. 4. Each clock time $T = 1$ ms is split up into three times $T/3$ each equal to 0.33 ms. The binary number "one" corresponds to a recording current of the time of 2 $T/3$ and the binary number zero corresponds to a recording current of the time $T/3$.

The step-by-step advance of the magnetic tape controlled by the signals taken from the output of the bistable 202 precedes the recording signals by 2 ms, so that the magnetic tape can reach the required speed of movement which may, for example, be between 10 and 20 cm/s.

In the example selected, with 50 type characters per revolution and six code elements it is possible to reduce the mechanical speeds and the frequencies of the recording signals, for example by the following means:

In the connection coming from terminal 206, of the system 200 between the input of the AND gate 209 and the input of the AND gate 212, it is possible to provide a unit 215 (shown in broken lines in FIG. 2) which divides by four the frequency of the pulses that it receives and which is rezeroed by the start pulse. Consequently the two AND gates 212, 213 will be actuated at a rate of 4 ms instead of 1 ms and recording on the magnetic tape will clearly be reduced in speed.

The magnetic tape movement times (line g, FIG. 3) will then be:

$$4T (2 + 6 + 2) = 40 \text{ ms}$$

and the speed of movement will drop from a value within the interval 10–20 cm/s. to a value within the interval
rent character pulses and key pulses when a key is manually operated, said key pulses being timed within a cycle of said shaft according to the operated key, a binary counter for counting character pulses which is "on" by a start pulse and "off" by the next key pulse whereby said counter stores a contents which is a binary number equal to the number of character pulses generated between said start pulse and next key pulse, a magnetic tape recorder, means for transferring sequentially counter contents to said magnetic tape recorder, means for converting said contents into character signals, means for gating a predetermined number of character pulses following said next key pulse which control said transferring means and synchronize storing of said character signals on said magnetic tape.

2. An apparatus for recording character signals on a magnetic tape as set forth in claim 1, wherein said means for gating a predetermined number of character pulses following the said next key pulse comprises an auxiliary counter triggered by the next start pulse following the start pulse starting the binary counter, the said auxiliary counter counting character pulses, a gate transmitting character pulses, such gate being opened during the period between two character pulses having predetermined delays from the said next start pulse.

3. An apparatus for recording character signals on a magnetic tape as set forth in claim 2, wherein the magnetic tape recorder comprises step-by-step advancing means for the tape, said advancing means comprising a plunger electromagnet whose plunger provided with a hook actuates a toothed wheel coupled to a magnetic tape drive wheel, said advancing means being triggered by the said next start pulse and the first synchronization pulse being applied to the said magnetic tape recorder delayed by a predetermined period number so that the said magnetic drive wheel rotates at constant speed after having canceled out its acceleration.

4. A keyboard printer for recording character signals on a magnetic tape comprising means for generating onto a plurality of start and character terminals a start pulse and character pulses, a plurality of manually operated character keys each including first and second electrodes, connections between the first of the said electrodes and said character terminals, an annular electrode, a rotating electrode sequentially and capacitively coupling said annular electrode to each one of a plurality of character electrodes each constituting one of the said character terminals, connections between the second of said electrodes and an output terminal, said key electrodes exhibiting with each other a large capacitance when operator's finger tip is on the key and a small capacitance when operator's finger tip is off the key, whereby cyclical key pulses are produced at a key pulse terminal as long as operator's finger tip is on the corresponding key, means for applying said key pulses to said selective printing means, a binary counter for counting and storing the number of character pulses between the start pulse and the next key pulse, said pulse number determining the character to be recorded, means for triggering said binary counter by said start pulse, means for stopping said binary counter by the next key pulse, a magnetic tape recorder, means for transferring binary counter contents serially to said magnetic tape recorder, means for gating a predetermined number of character pulses following the said next key pulse, such gated character pulses being used for controlling said transferring means and as synchronization pulses within said magnetic tape recorder.