United States Patent [19]

Wolf et al.

[11] **3,731,780**

[45] **May 8, 1973**

[54] PRINTING APPARATUS AND CONTROLLING CIRCUIT THEREFOR

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[73] Assignee: **Electrospace Corporation**, Westbury, N.Y.

[22] Filed: **May 10, 1971**

[21] Appl. No.: **141,485**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 806,430, March 12, 1969, abandoned.

[52] **U.S. Cl.**.....**197/49**, 101/93 C, 197/18

[51] **Int. Cl.**.....**B41j 1/32**

[58] **Field of Search**.....197/18, 49; 101/93 C; 340/172.5

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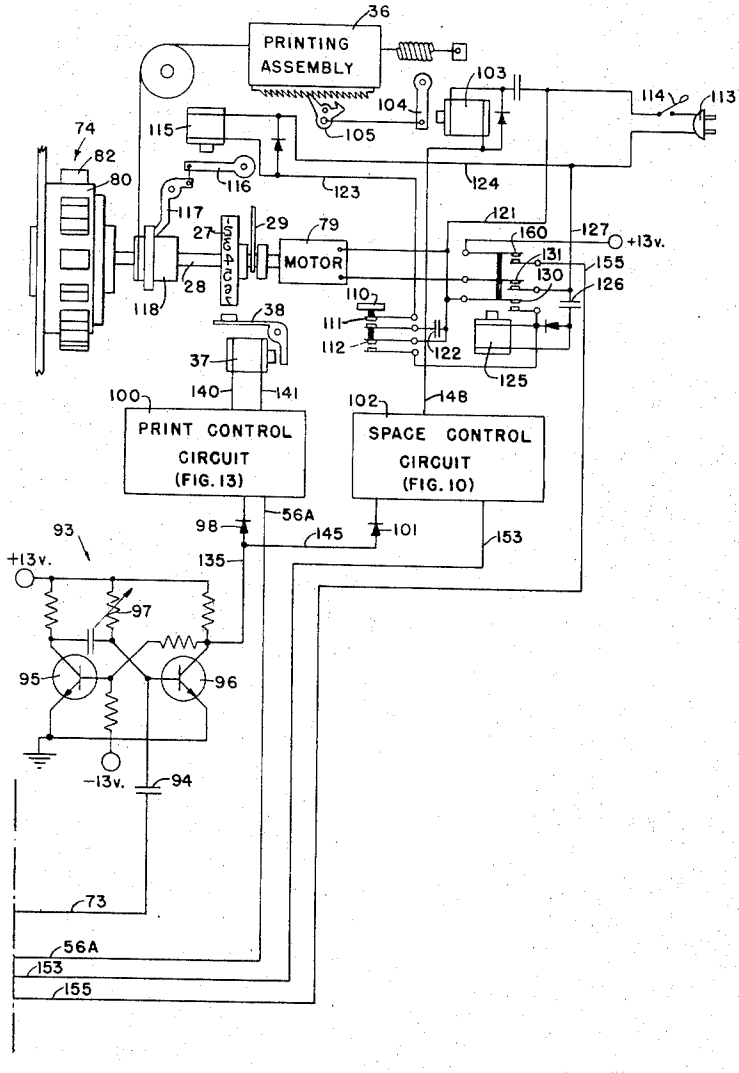
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Primary Examiner—Edgar S. Burr
Attorney—Albert F. Kronman

[57] **ABSTRACT**

A printing apparatus which types characters on a type wheel under control of an electric circuit. The apparatus includes a type wheel, a printing hammer, and a series of timing AND circuits. A spacing mechanism moves the wheel along a record sheet to receive the printed symbols. The characters to be printed are selected by activating one of a series of storage multivibrators connected to the AND circuits and an optical timing device coupled to the type wheel supplies timed pulses to the AND circuits to control the printing operation.

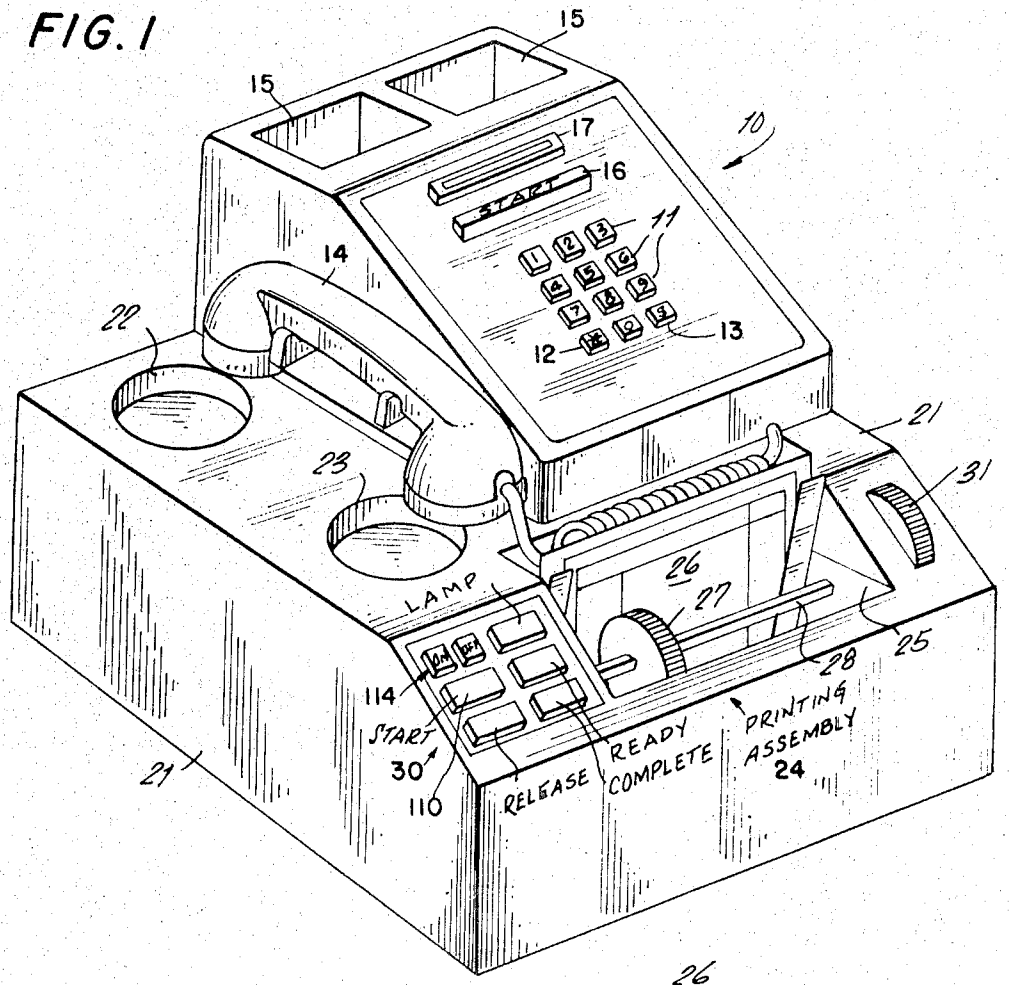
3 Claims, 13 Drawing Figures



Patented May 8, 1973 3,731,780

5 Sheets-Sheet 1

FIG. 1



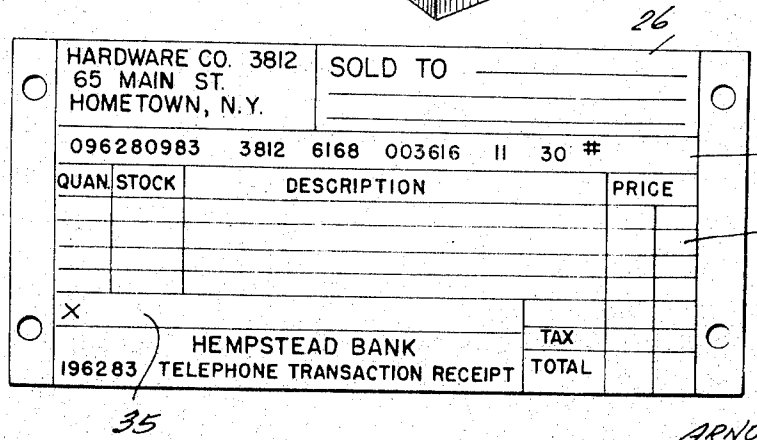


FIG. 2

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FIG. 3

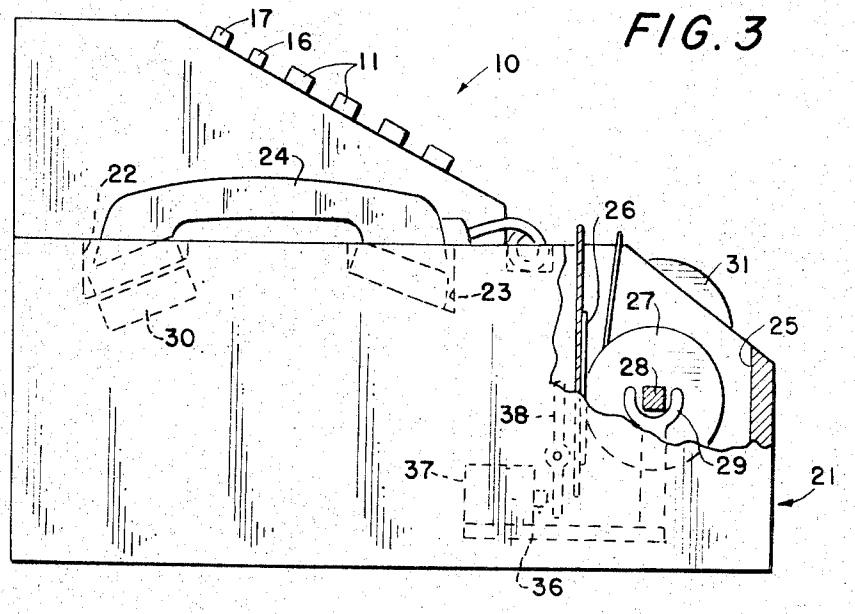


FIG. 11

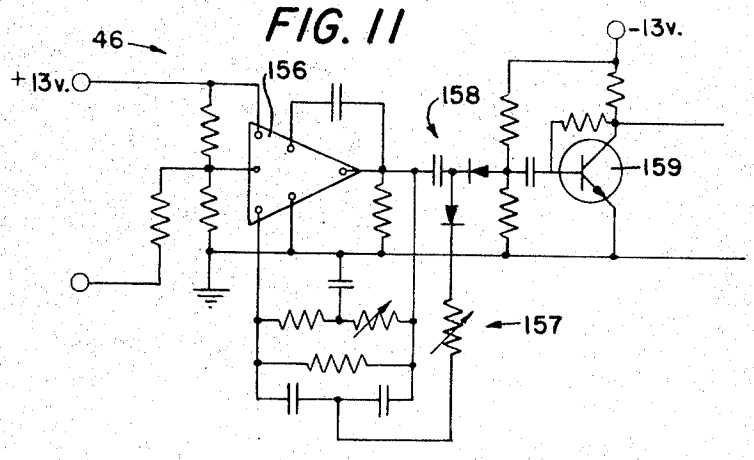
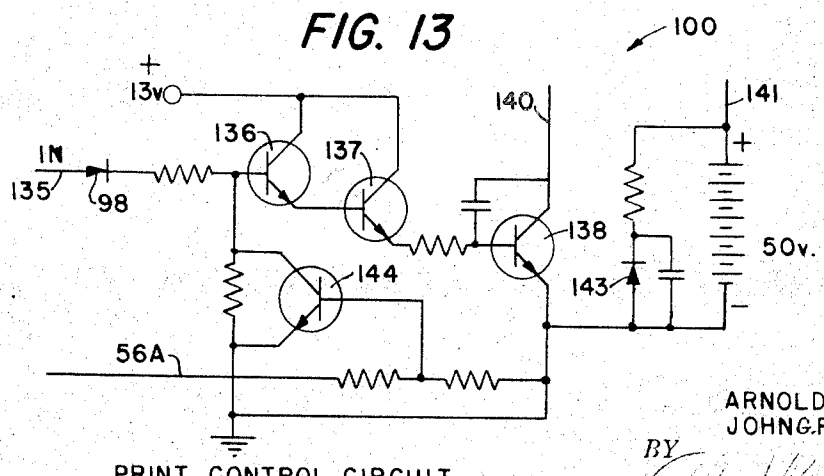


FIG. 13



PRINT CONTROL CIRCUIT

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FIG. 4

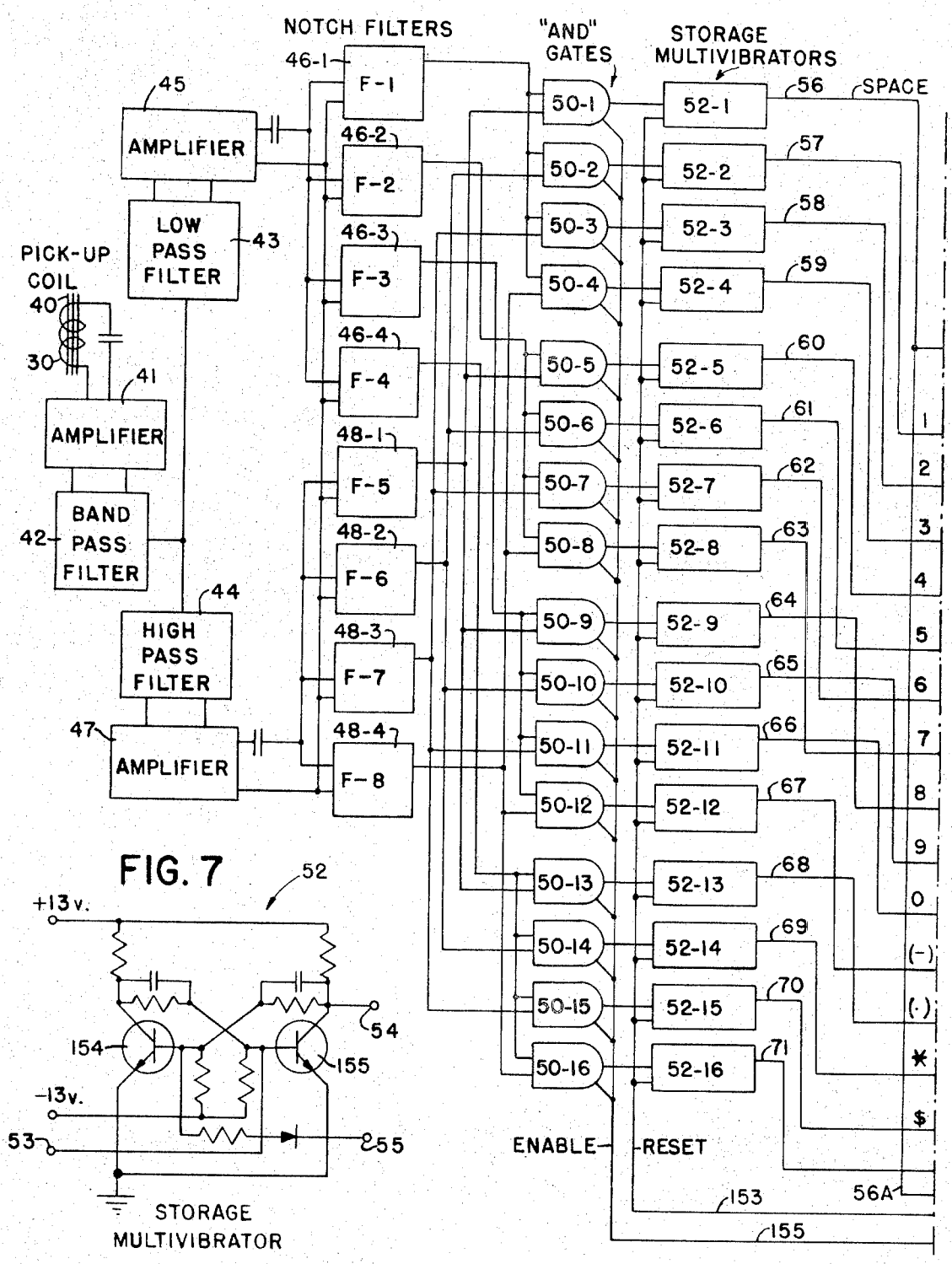

NOTCH FILTERS
"AND" GATES
STORAGE MULTIVIBRATORS
SPACE
PICK-UP COIL
40
30
AMPLIFIER
45
LOW PASS FILTER
43
41
AMPLIFIER
BAND PASS FILTER
42
44
HIGH PASS FILTER
47
AMPLIFIER
46-1
F-1
46-2
F-2
46-3
F-3
46-4
F-4
48-1
F-5
48-2
F-6
48-3
F-7
48-4
F-8
50-1
50-2
50-3
50-4
50-5
50-6
50-7
50-8
50-9
50-10
50-11
50-12
50-13
50-14
50-15
50-16
52-1
52-2
52-3
52-4
52-5
52-6
52-7
52-8
52-9
52-10
52-11
52-12
52-13
52-14
52-15
52-16
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
1
2
3
4
5
6
7
8
9
0
(-)
(.)
*
$
ENABLE
RESET
153
155
56A

FIG. 7

52
+13v.
154
155
54
-13v.
53
55
STORAGE MULTIVIBRATOR

FIG. 5

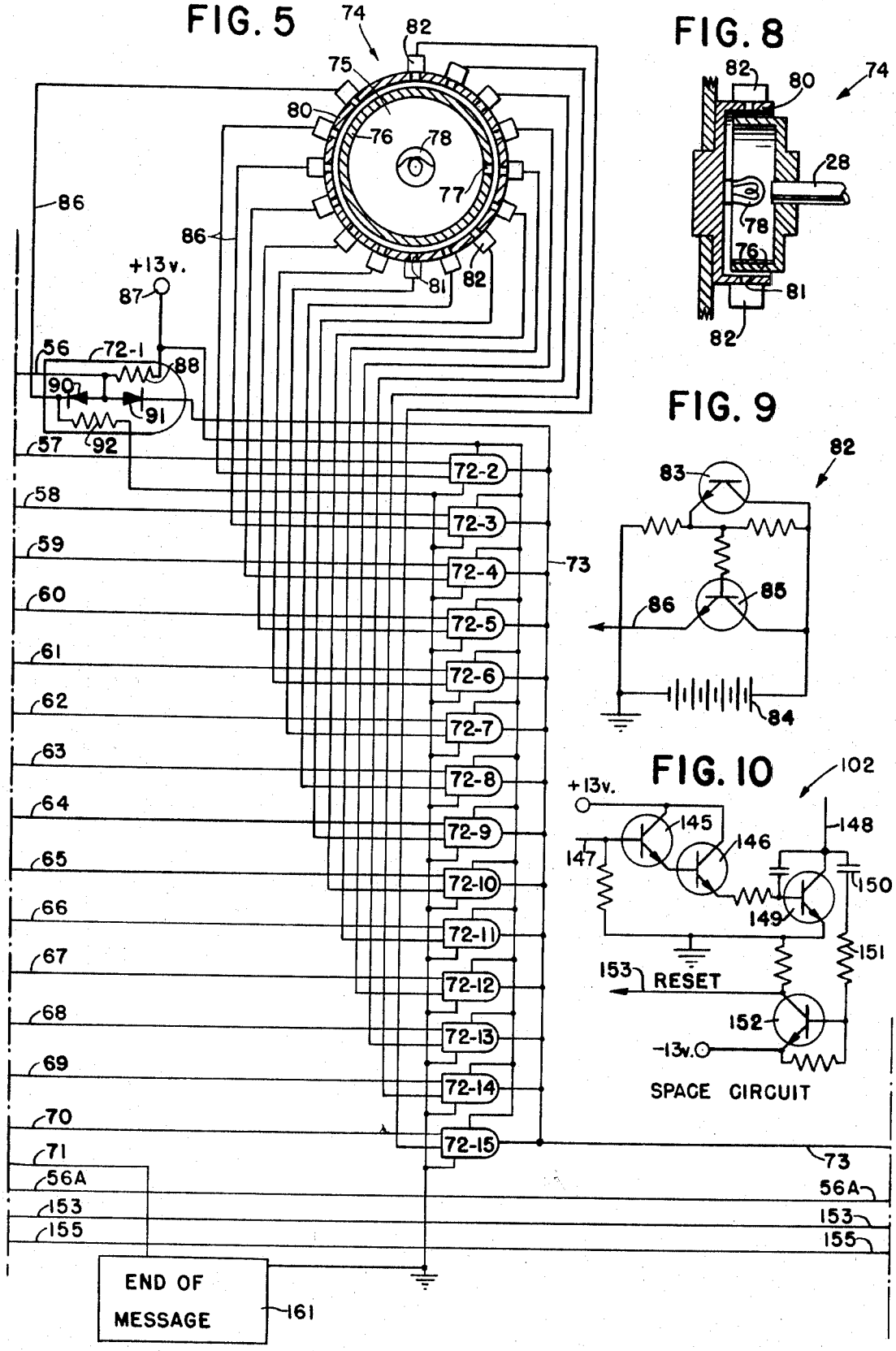


FIG. 8

FIG. 9

FIG. 10

FIG. 6

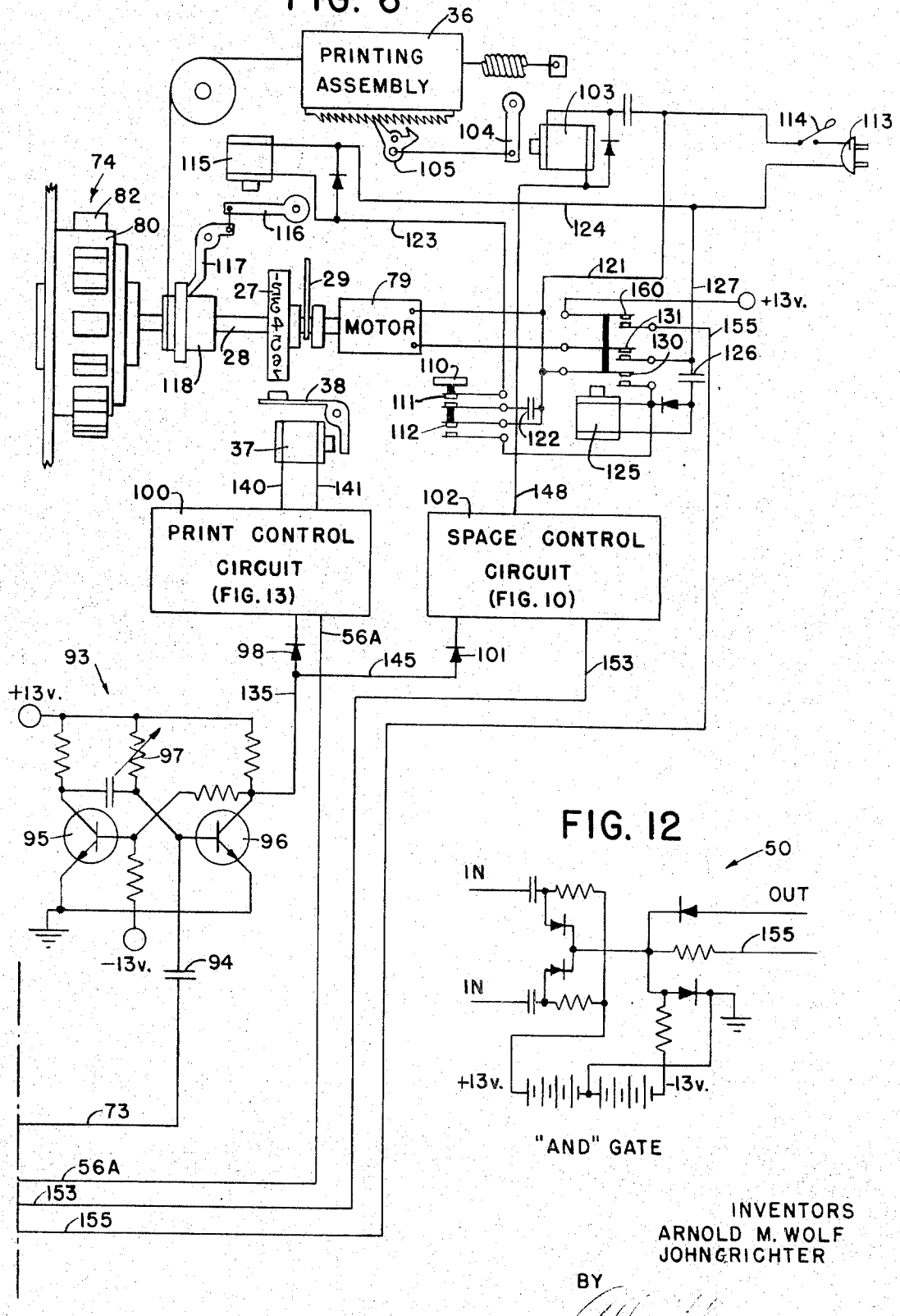


FIG. 12

"AND" GATE

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PRINTING APPARATUS AND CONTROLLING CIRCUIT THEREFOR

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of application, Ser. No. 806,430, filed Mar. 12, 1969, now abandoned.

This invention relates to a printing apparatus which can be used in connection with a telephone receiving set and is controlled by alternating current signals sent over the telephone line. The printing apparatus is small and compact and can be housed in a small container secured to the telephone subscriber set.

Automatic type printing controlled by received electrical signals is old in the art. Generally, the printing devices were modified typewriters and were not very fast. The present invention uses a single type wheel which turns all the time at a constant speed. A small hammer operated by a magnet prints a selected character on the record sheet. The typing action is quite fast because the rotating wheel and the hammer action are the only mechanically moving objects during the typing of a single line.

A feature of the present invention is a tone decoding circuit and a storage circuit used to apply a control voltage to the printing circuit.

Another feature of the invention is a timing means coupled to the rotating type wheel which determines when an operating pulse is applied to the printing magnet.

Another feature of the invention is a plurality of AND circuits which send the operating pulse to the printing apparatus only when the type wheel is in the proper position and when a printing signal has been received.

For a better understanding of the present invention, together with other details and features thereof, reference is made to the following description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is an isometric view of the telephone receiver set combined with the tone decoder and printer.

FIG. 2 is a plan view of a ticket showing the results of the printing action.

FIG. 3 is a side view, with some parts broken away, of the receiver shown in FIG. 1.

FIGS. 4, 5, and 6 when placed side by side, are a schematic diagram of connections showing the entire circuit of the printing control unit.

FIG. 7 is a schematic diagram of connections of one of the storage multivibrators used in FIG. 4.

FIG. 8 is a cross sectional view of the rotating disk used in FIG. 5.

FIG. 9 is a schematic diagram of connections of the photosensitive transducers used in the rotating disk assembly shown in FIGS. 5 and 8.

FIG. 10 is a schematic diagram of connections of the space circuit shown in block form in FIG. 6.

FIG. 11 is a schematic diagram of connections of the notch filter circuit shown in block form in FIG. 4.

FIG. 12 is a schematic diagram of connections of the AND gate shown in FIG. 4.

FIG. 13 is a schematic diagram of connections of the print control circuit shown in block form in FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, a telephone subscriber set 10 is shown having the usual digit buttons 11, control buttons 12 and 13, and a hand set 14. The subscriber set may include storage compartments 15, a start bar 16 and a slot 17 for receiving automatic signalling cards. A base compartment 21 includes a recess 22 for receiving the receiver portion of the hand set and a similar recess 23 for receiving the microphone portion during a recording and printing operation.

The printing assembly 24 is positioned in the base compartment 21 in a well 25, open at the top so that an operator can insert a blank card 26 before the printing operation and then remove the card after the information has been printed thereon. In FIG. 1, a printing wheel 27, on a square or splined shaft 28, is shown in the well. Also, a knurled wheel 31 is indicated for moving a roll of paper behind the card 26 if a carbon copy of the printed matter is desired. To the left of the printing well there are seven control keys 30 which are used to start and stop the operation, to release the card, and to operate other components in the system not connected directly with the printing apparatus.

FIG. 2 shows a typical card 26 used with the telephone banking system. It may contain pre-printed items such as addresses, blank spaces for a buyers number 32 and signature 35, and a place 33 for the printing apparatus to print the price of an article or service.

The side view of the telephone set, FIG. 3, shows the printing wheel 27 on its shaft 28, coupled by an arm 29 to move the print wheel along the shaft during the printing operation. The arm 29 is secured to a base plate 36 which supports an electromagnet 37, and a print hammer 38, behind the card 26. The electrical connections to the magnet and control buttons will be described later when the entire circuit is disclosed.

FIGS. 4, 5, and 6, when placed side-by-side show a schematic diagram of connections of the entire electric circuit, but showing many of the circuit elements in block form. This circuit receives coded tonal pulses from the receiver portion of the telephone headset, decodes the pulses, and then controls the printing mechanism to print a line of digits on the card 26 in the space 25.

A pick-up coil 30 may be wound on an iron core 40 for greater efficiency. Coil 30 is connected to the input terminals of an amplifier 41 and the output terminals of the amplifier are connected to a band pass filter 42 and then to a low pass filter 43 and a high pass filter 44. The output of the low pass filter 43 is applied to another amplifier 45 and then sent to a first group of notch filters 46–1, 46–2, 46–3, and 46–4, each of which is arranged to pass only a narrow band of frequencies. The details of the notch filters are shown in FIG. 11. In a similar manner, the output of the high pass filter 44 is applied to amplifier 47 and then sent to four notch filters 48–1, 48–2, 48–3, and 48–4, each of which passes only a narrow band of frequencies. The eight notch filters are adjusted to pass frequency bands which differ from each other by a substantial amount, these eight frequency signals comprising the coded indicia which control the printing apparatus. Each received signal, at pick-up coil 30, includes two signal waves, one

matching one of the filters **46** and the other matching one of the filters **48**.

The output pulses from filters **46–48** are applied to sixteen AND gates **50–1** through **50–16**, each of these gates having two input connections and operating to deliver an output voltage only when input current pulses are received on both input lines. In addition, all the AND gates **50** are connected to an "enable" conductor **155** and permit operation of the ANd gates only when this conductor is supplied with a positive voltage. The details of this AND circuit are shown in FIG. **12**. It is apparent from the circuit of FIG. **4** that each filter circuit is connected to four gates **50–1** through **50–4**. Each of the gates will be opened only when a combination of two frequencies are received by the pick-up coil **30**. These two frequency waves are separated by the filter circuits and then one and only one of the 16 AND gates **50** is opened.

Adjacent to each gate **50** is a bistable multivibrator forming a series **52–1** through **52–16**. Each of these multivibrators. sometimes called flip-flops, has a "set" terminal **53** (see FIG. **7**), an output terminal **54**, and a reset terminal **55**. Each of the set terminals **53** are connected to a gate **50** so that, when the gate is opened, an operating pulse is transferred to the associated flip-flop and its conductance is transferred to the left side, increasing the potential of the output terminal **54** and applying a positive voltage to the output conductor. Each of the sixteen output terminals is connected to a conductor, **56** through **71**, which supplies its positive voltage pulse to a timing circuit which includes at least **15** AND circuits **72–1** through **72–15**. All the AND circuits **72** have a common output conductor **73** which is coupled to a print control circuit (FIGS. **6** and **13**) and to the hammer magnet **37**. The print control circuit also controls the space circuit and the mechanism which moves the print wheel **27** along its shaft **28**.

Multivibrator **52–1** has its output conductor **56** connected to the space circuit, FIG. **13**, and other control circuits to cause the print mechanism to move one space without printing a character. Multivibrators **52–2** through **52–11** are for printing digit characters from 1 through 9 and 0. The output terminals of these circuits are connected to conductors **57** through **66**, each of which is connected to its AND circuit **72**. Multivibrators **52–12**, **52–13**, **52–14**, and **52–15** control the printing of a dash (-), a period (.), and asterisk (*), and a dollar sign ($) respectively. The output terminals of these circuits are connected to conductors **67**, **68**, **69**, and **70**, all of which run to an AND circuit shown in FIG. **5**.

Timing Circuit

Synchronism between the decoding circuit and the printing wheel is provided by the series of AND circuits **72** and a timing wheel **74**. FIG. **5** shows the timing wheel which includes an inner wheel **75** having a flange **76** with a single hole **77** cut in the flange material. A central lamp **78** provides light which shines through the hole **77** as it is turned by the motor **79** and shaft **28**. An outer flange **80** surrounds flange **76** and is provided with at least 15 holes **81** equally spaced around the flange to let light from lamp **78** shine through in a sequential manner. Covering each hole **81** is a photosensitive circuit **82**, shown in detail in FIG. **9**.

Each of the photosensitive circuits **82** includes a light-to-electric transducer **83** which in this case is a semiconductor unit although other photosensitive units can be used. Transducer **83** is connected to a battery **84** which sends current through the collector and emitter electrodes only when light is incident on the semi-conductor surface. Transducer **83** is directly coupled to a transistor **85** which is biased by a voltage divider to be normally non-conductive. When light activates transducer **83**, it conducts and alters the bias on transistor **85** to make it conductive. The emitter of each transistor **85** is connected to a timing conductor **86** which is connected to one of the input terminals of an AND circuit **72** and, as the disk **76** turns one revolution, all the AND circuits **72–1** through **72–15** are sequentially energized by the application of a positive pulse. If none of the conductors from the storage multivibrators are provided with a positive potential there will be no output pulse on conductor **73**, but if any of the storage conductors has a positive potential, an output pulse will be sent over conductor **73** to the magnet **37** (FIG. **6**) to cause the hammer **38** to print a symbol.

All the AND circuits have the same circuitry, as shown in the detail **72–1**. The storage conductor **56** is connected to a voltage terminal **87** in series with a resistor **88**. Conductor **56** is also connected to the junction of two diodes **90** and **91**. The timing conductor connected to ground in series with a resistor **92**.

The operation of the AND circuit is as follows: When there is no voltage on conductor **56** the junction point between the two diodes is close to ground potential because the current is drained through diode **90** and there is no output current. However, if a voltage is applied to timing conductor **86**, diode **90** is back biased and no current can flow through it. This raises the potential of the junction point and current is sent through the output buffer diode **91** to the output conductor **73**. The hole **77** in rotor **76** is synchronized with the print wheel so that a positive pulse on any one of the storage conductors results in the printing of a character identified with that conductor.

The timed output pulse from the AND circuit is transmitted over conductor **73** to a print timing and shaping circuit **93** (FIG. **6**) in series with a capacitor **94**. Circuit **93** is a mono-stable multivibrator and includes two transistors **95** and **96** with the usual cross connected circuitry. Circuit **93** times the printing action shapes the printing pulse and allows for the inductance of the print magnet **37** and the inertia of the printing hammer **38**. The timing action is made adjustable by varying one of the resistors **97**. A printing control pulse is sent from the collector electrode of transistor **96** through diode **98** to a print control circuit **100**. At the same time, a portion of the same pulse is sent through diode **101** to a space control circuit **102** to operate a magnet **103**, actuate an armature **104**, and turn an escapement pawl **105** to move the printing assembly one space so that the next character may be printed in spaced relationship to the first character.

The starting mechanism includes a start key **110** for manual depression. Two pairs of contacts **111** and **112** are closed when the start button is depressed, one pair **111** connected in series with a power plug **113**, a systems switch **114**, and a magnet **115**. When the magnet **115** receives current it actuates armature **116** and

pawl 117 to release a one-revolution clutch 118. The clutch 118 pulls a cord 120 attached to the printing assembly base and pulls the base 36, the printing wheel 27, and the magnet 37 to the left, ready to start a line of printing. When contacts 111 are closed, a circuit is completed which may be traced from the plug 113, through switch 114, over conductor 121, through capacitor 122 and contacts 111, then over conductor 123, through the winding of magnet 115, and back to the other side of the plug by way of conductor 124. When contacts 111 are broken the circuit is broken and the clutch 118 is normalized.

When contacts 112 are closed, another circuit is completed which may be traced from the plug 113 over conductor 121, contacts 112, relay winding 125, capacitor 126, and back to the plug 113 by way of conductor 127. This current operates the relay and closes contacts 130 and 131. Contacts 130 are holding contacts, connected across contacts 112, and hold the relay in its operated condition after the switch 110 is opened. Contacts 131 are connected directly in series between the plug 113 and a motor 79 which is coupled to shaft 28, print wheel 27, and the timing disk 76. The printing apparatus is now ready to accept signals from the decoding circuits and print characters on the card 26.

Print Control Circuit

The print control circuit 100 is shown in block in FIG. 6 and in detail in FIG. 13. The timed printing signal is received over conductor 135 and is applied to two transistors 136 and 137, coupled together to form a high impedance Darlington circuit. The output of this combination is applied to an amplifier transistor 138 which is connected to conductor 140 and the print magnet winding 37 (FIG. 6). The return conductor 141 is connected in series with a 50 volt power supply 142, shunted by a diode 143 for bypassing inductive transients generated by winding 37.

The print hammer 38 (FIG. 6) is operated once each printing cycle except when a space is called for. During this time the printing input circuit is short circuited to ground by a transistor 144 (FIG. 13) having its emitter connected to ground, its base connected through part of a voltage divider to conductor 56A and the top storage multivibrator 52–1 which is activated each time a space operation is desired. The pulse sent over conductor 56 is applied to the base of transistor 144 making it conductive and short circuiting the input terminals of the printing circuit.

Space Control Circuit

The space control circuit 102 is shown in detail in FIG. 10. The input to this circuit includes two transistors 145 and 146 coupled together to form a high impedance Darlington circuit. The space signal is received over conductor 147 (when a character is printed) and is applied to the base of transistor 145. The result is an output pulse amplified by transistor 149 and sent over conductor 148 to the space magnet 103 which actuates armature 104 and escapement pawl 105 to move the printing assembly one space. A space operation must be made each time a character is printed and for this reason the output pulse of transistor 96 is divided into two portions, one sent over conductor 135 to the print circuit 100 and the other sent over conductor 145 to the space circuit.

A short time interval after the space circuit 102 (FIG. 10) is activated and sends a signal over conductor 148 to move the printing assembly 36, a pulse is transmitted over a delay circuit including a capacitor 150 and a resistor 151. This pulse builds up slowly and, after a few milliseconds, changes the voltage on the base electrode of transistor 152 to make it conductive and send a reset pulse over conductor 153 to all the storage multivibrators 52 and reset or normalize the one which has been actuated. This action completes the space operation.

The detailed circuits shown in FIGS. 7, 9, 10, 11, 12, and 13 indicate the actual wiring of these units as employed in a workable system. There are many variations of these units which may be used and the invention is not dependent upon the details of construction as shown. FIG. 7 shows the details of each of the storage multivibrators 52 to put a positive voltage on a storage conductor 56 through 71 when a printing operation is called for. This circuit includes two transistors 154, 155 with the usual cross connections. In the normal condition, transistor 155 conducts and a zero voltage is applied to its storage conductor. The circuit is activated by applying a negative voltage to terminal 53 to transfer conductance to transistor 154 and raise the voltage on terminal 54 to a positive value. After the printing operation, a negative reset pulse is applied to terminal 55 by way of conductor 153, and the circuit is normalized.

FIG. 11 shows the details of a commercial integrated amplifier 156 used in connection with a double T notch filter 157 and coupled to a diode limiter section 158 and an output amplifier stage which includes transistor 159.

The AND gate 50 shown in detail in FIG. 12 is only one of many similar circuits which can be used to select the proper combination of signal frequencies and transfer two input signals into a single output signal which triggers a multivibrator 52. The construction of this AND circuit is based on the requirement of an enable voltage applied over conductor 155 from contacts 160 and a source of positive voltage. Contacts 160 are closed when relay 125 is activated at the start of the printing cycle. When the AND circuit is operated, conductance is transferred in its associated multivibrator.

AND circuit 50–16 is made operative when signals from F–4 and F–8 are received. This actuates storage multivibrator 52–16 and a positive voltage is applied to conductor 71 which is connected to circuit 161 (FIG. 6). This circuit operates signals and lamps which tell a second operator at a distant position that the message is ended. This portion of the circuit has no bearing on the printing apparatus and will not be described in detail.

Having thus fully described the invention, what is claimed as new and desired to be secured by Letters Patent of the United States, is:

1. In a printing apparatus including a continuously running motor, a rotating type wheel driven by the motor, and a print hammer operated by an electric printing signal to impact the rotating type wheel; the improvement comprising: a rotating disk driven by said motor with holes defining the position of each type character on the type wheel; optical sensing means for

producing a series of timed electrical pulses, one for each passage of each hole in the disk; a series of timing conductors connected to the sensing means; a plurality of storage multivibrators, each activated by a printing signal and each connected to a storage conductor identified by a type character on the type wheel; each of said storage multivibrators adapted to apply a positive voltage to its storage conductor during a revolution of the type wheel; a plurality of AND circuits each having a first input connected to a storage conduct and a second input connected to a timing conductor; and a common output conductor for all the AND circuits coupled to the print hammer for printing a character on a record sheet; and an electrical circuit which disables the printing means during a space operation, said circuit including a short circuiting transistor having its collector and emitter electrodes connected across a pair of input terminals in a print control circuit, the base electrode of said transistor connected to a space control circuit for receiving a current pulse whereby the short circuiting transistor is made conductive each time a space operation occurs and the input terminals of the print control circuit are short circuited.

2. A printing apparatus as claimed in claim 1 wherein a reset pulse is sent to all the storage multivibrators to normalize them after the printing cycle is completed, said reset pulse derived from the space control circuit.

3. A printing apparatus as claimed in claim 1 wherein said reset pulse is delayed a predetermined time interval after the printing operation, said delay produced by a capacitor and a resistor connected between a conductor transmitting the printing pulse and the base of the transistor.

* * * * *