Aug. 12, 1947. C. R. DOTY 2,425,518

CIPHERING APPARATUS

Filed Jan. 11, 1944 10 Sheets-Sheet 1

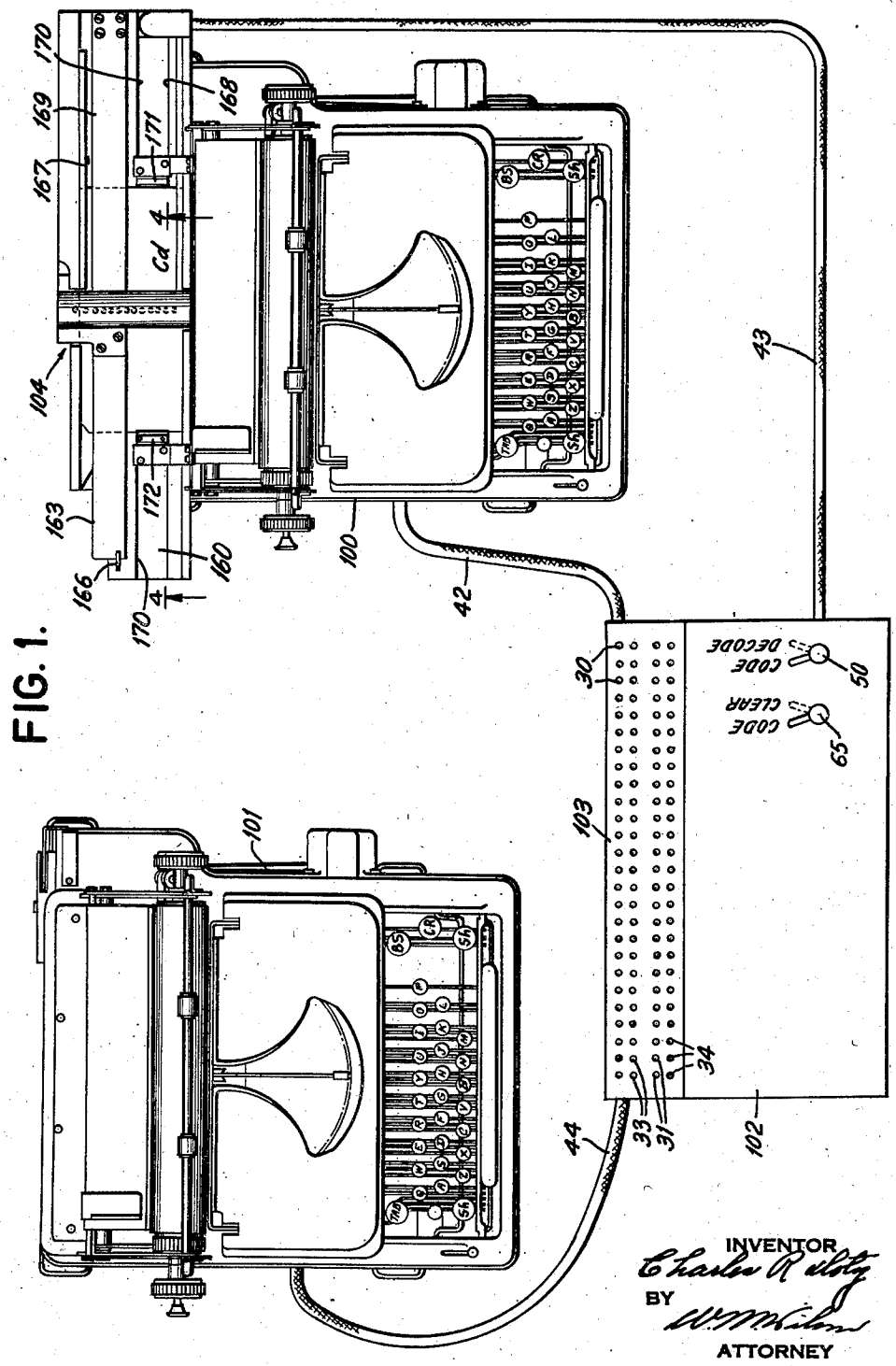

FIG. 1.

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FIG. 2.

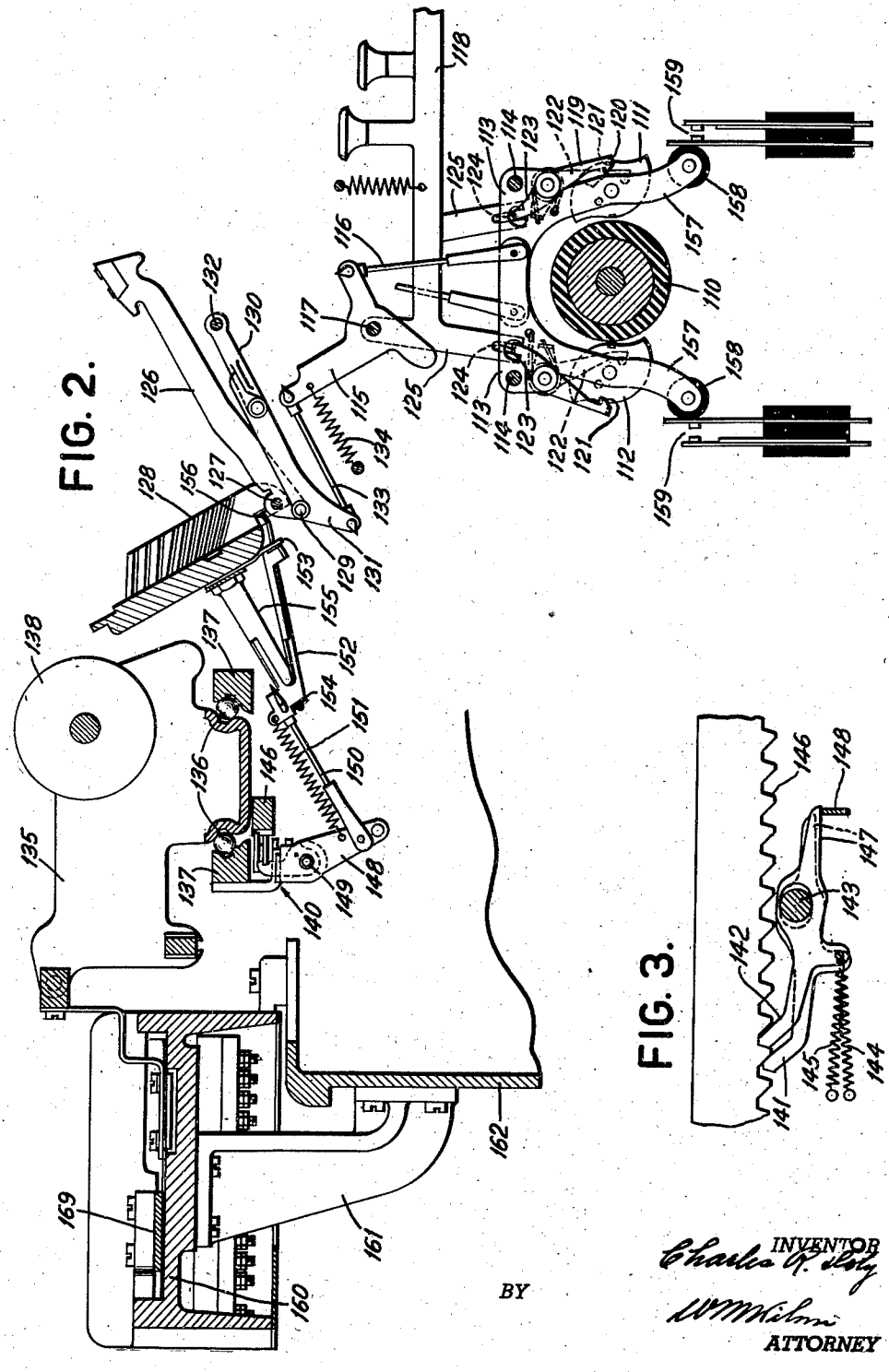

FIG. 3.

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CIPHERING APPARATUS

Filed Jan. 11, 1944 10 Sheets-Sheet 3

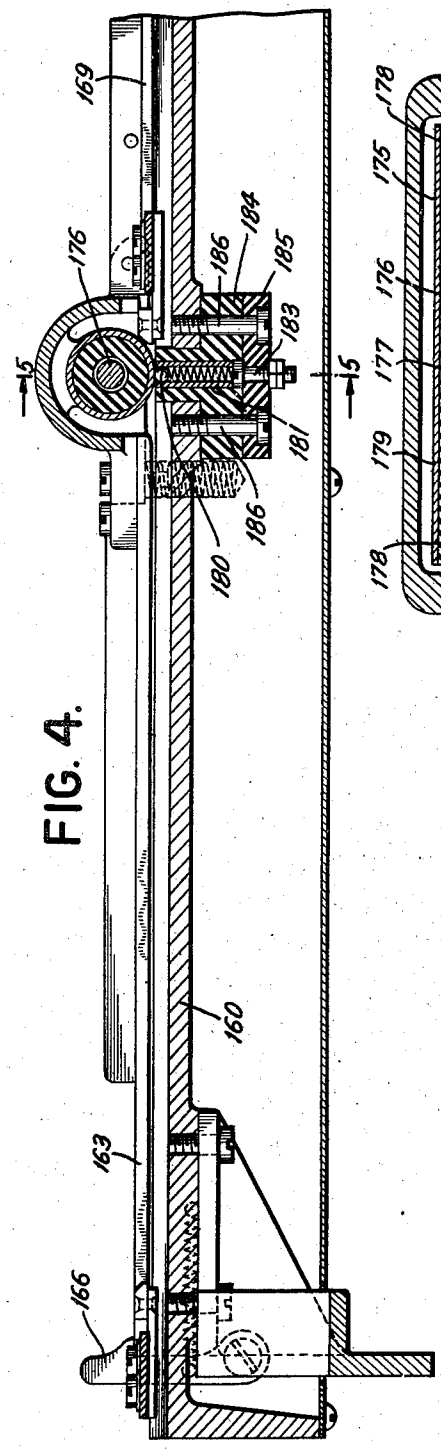

FIG. 4.

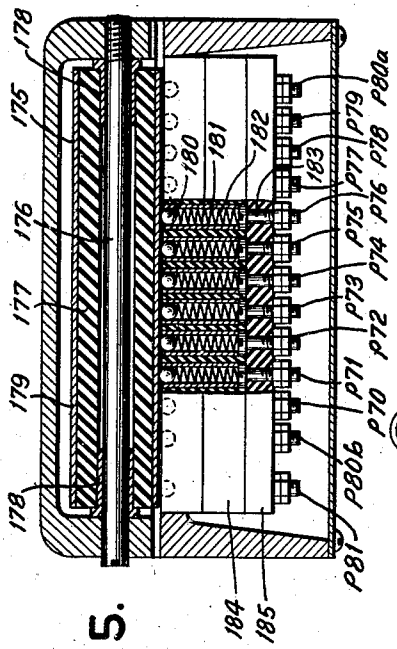

FIG. 5.

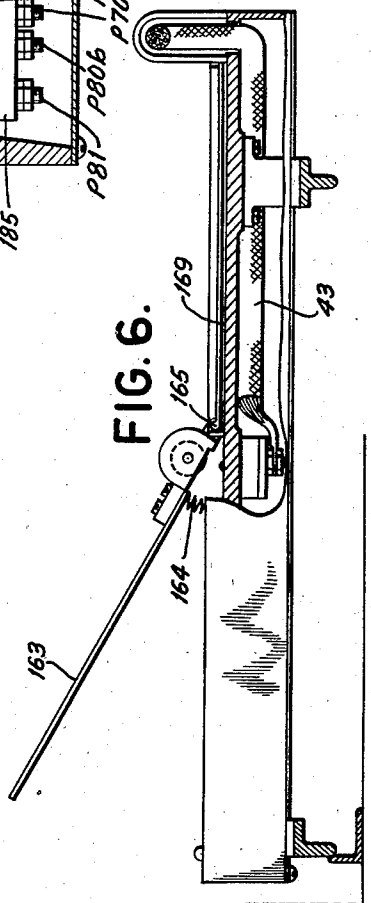

FIG. 6.

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FIG. 7.

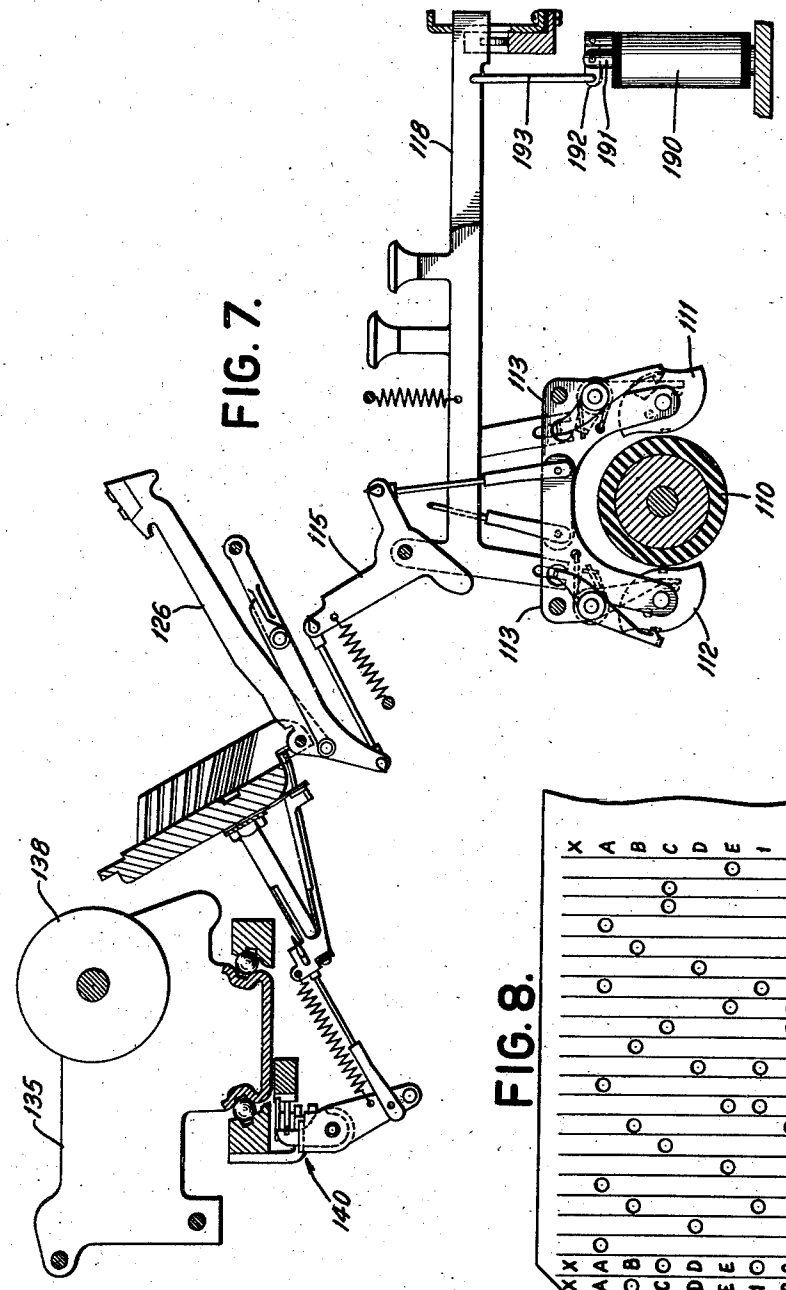

FIG. 8.

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FIG. 9.

	A					B					C					D					E					X
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
A	F	E	D	C	B	K	J	I	H	G	P	O	N	M	L	U	T	S	R	Q	Z	Y	X	W	V	A
B	G	F	E	D	C	L	K	J	I	H	Q	P	O	N	M	V	U	T	S	R	A	Z	Y	X	W	B
C	H	G	F	E	D	M	L	K	J	I	R	Q	P	O	N	W	V	U	T	S	B	A	Z	Y	X	C
D	I	H	G	F	E	N	M	L	K	J	S	R	Q	P	O	X	W	V	U	T	C	B	A	Z	Y	D
E	J	I	H	G	F	O	N	M	L	K	T	S	R	Q	P	Y	X	W	V	U	D	C	B	A	Z	E
F	K	J	I	H	G	P	O	N	M	L	U	T	S	R	Q	Z	Y	X	W	V	E	D	C	B	A	F
G	L	K	J	I	H	Q	P	O	N	M	V	U	T	S	R	A	Z	Y	X	W	F	E	D	C	B	G
H	M	L	K	J	I	R	Q	P	O	N	W	V	U	T	S	B	A	Z	Y	X	G	F	E	D	C	H
I	N	M	L	K	J	S	R	Q	P	O	X	W	V	U	T	C	B	A	Z	Y	H	G	F	E	D	I
J	O	N	M	L	K	T	S	R	Q	P	Y	X	W	V	U	D	C	B	A	Z	I	H	G	F	E	J
K	P	O	N	M	L	U	T	S	R	Q	Z	Y	X	W	Y	E	D	C	B	A	J	I	H	G	F	K
L	Q	P	O	N	M	V	U	T	S	R	A	Z	Y	X	W	F	E	D	C	B	K	J	I	H	G	L
M	R	Q	P	O	N	W	V	U	T	S	B	A	Z	Y	X	G	F	E	D	C	L	K	J	I	H	M
N	S	R	Q	P	O	X	W	V	U	T	C	B	A	Z	Y	H	G	F	E	D	M	L	K	J	I	N
O	T	S	R	Q	P	Y	X	W	V	U	D	C	B	A	Z	I	H	G	F	E	N	M	L	K	J	O
P	U	T	S	R	Q	Z	Y	X	W	V	E	D	C	B	A	J	I	H	G	F	O	N	M	L	K	P
Q	V	U	T	S	R	A	Z	Y	X	W	F	E	D	C	B	K	J	I	H	G	P	O	N	M	L	Q
R	W	V	U	T	S	B	A	Z	Y	X	G	F	E	D	C	L	K	J	I	H	Q	P	O	N	M	R
S	X	W	V	U	T	C	B	A	Z	Y	H	G	F	E	D	M	L	K	J	I	R	Q	P	O	N	S
T	Y	X	W	V	U	D	C	B	A	Z	I	H	G	F	E	N	M	L	K	J	S	R	Q	P	O	T
U	Z	Y	X	W	V	E	D	C	B	A	J	I	H	G	F	O	N	M	L	K	T	S	R	Q	P	U
V	A	Z	Y	X	W	F	E	D	C	B	K	J	I	H	G	P	O	N	M	L	U	T	S	R	Q	V
W	B	A	Z	Y	X	G	F	E	D	C	L	K	J	I	H	Q	P	O	N	M	V	U	T	S	R	W
X	C	B	A	Z	Y	H	G	F	E	D	M	L	K	J	I	R	Q	P	O	N	W	V	U	T	S	X
Y	D	C	B	A	Z	I	H	G	F	E	N	M	L	K	J	S	R	Q	P	O	X	W	V	U	T	Y
Z	E	D	C	B	A	J	I	H	G	F	O	N	M	L	K	T	S	R	Q	P	Y	X	W	V	U	Z

CODE TO	DECODE
A	E
B	D
C	C
D	B
E	A
1	5
2	4
3	3
4	2
5	1

FIG. 10.

FIG. 12.

FIG. 11a.	FIG. 11b.
FIG. 11d.	FIG. 11c.

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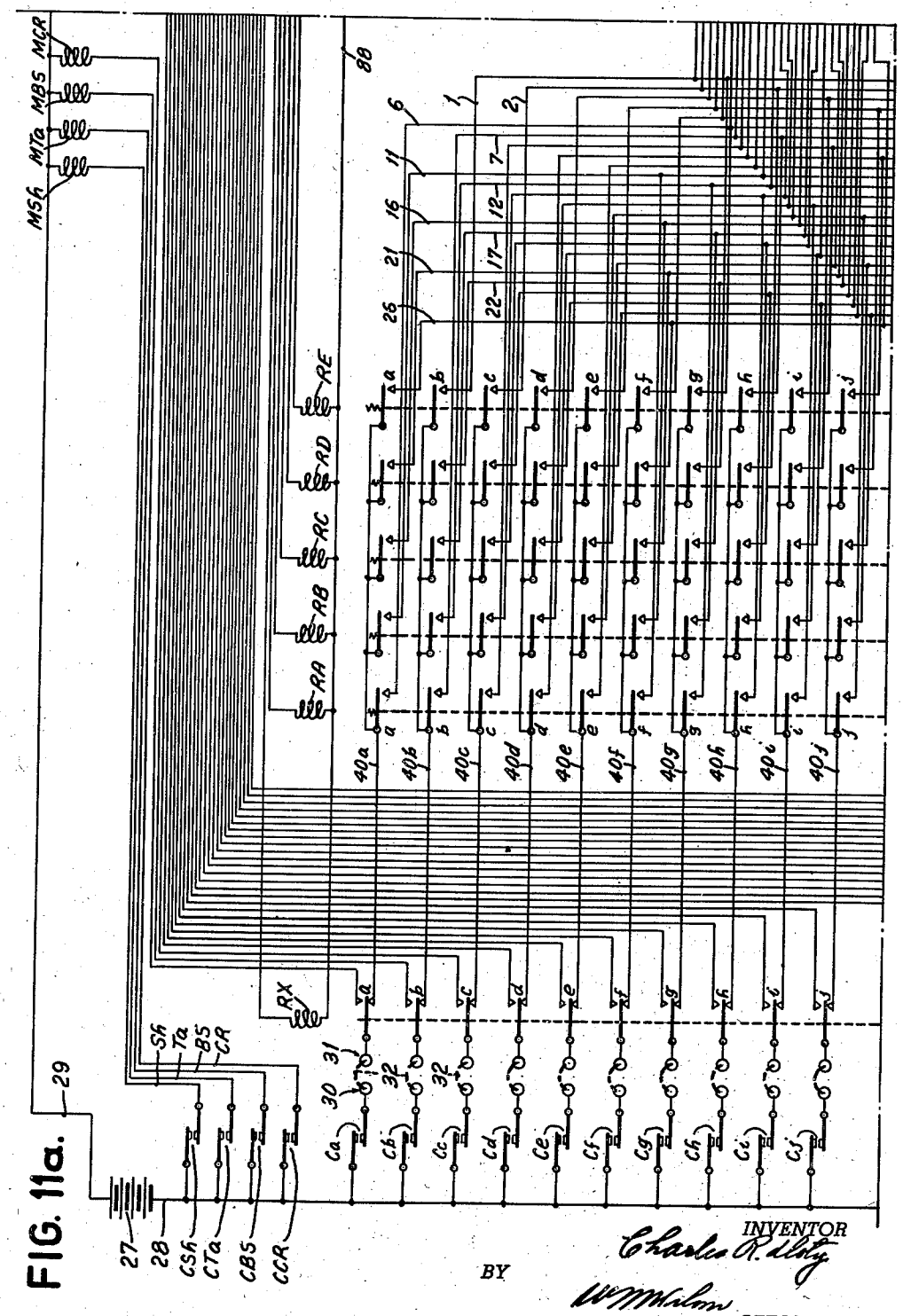

FIG. 11a.

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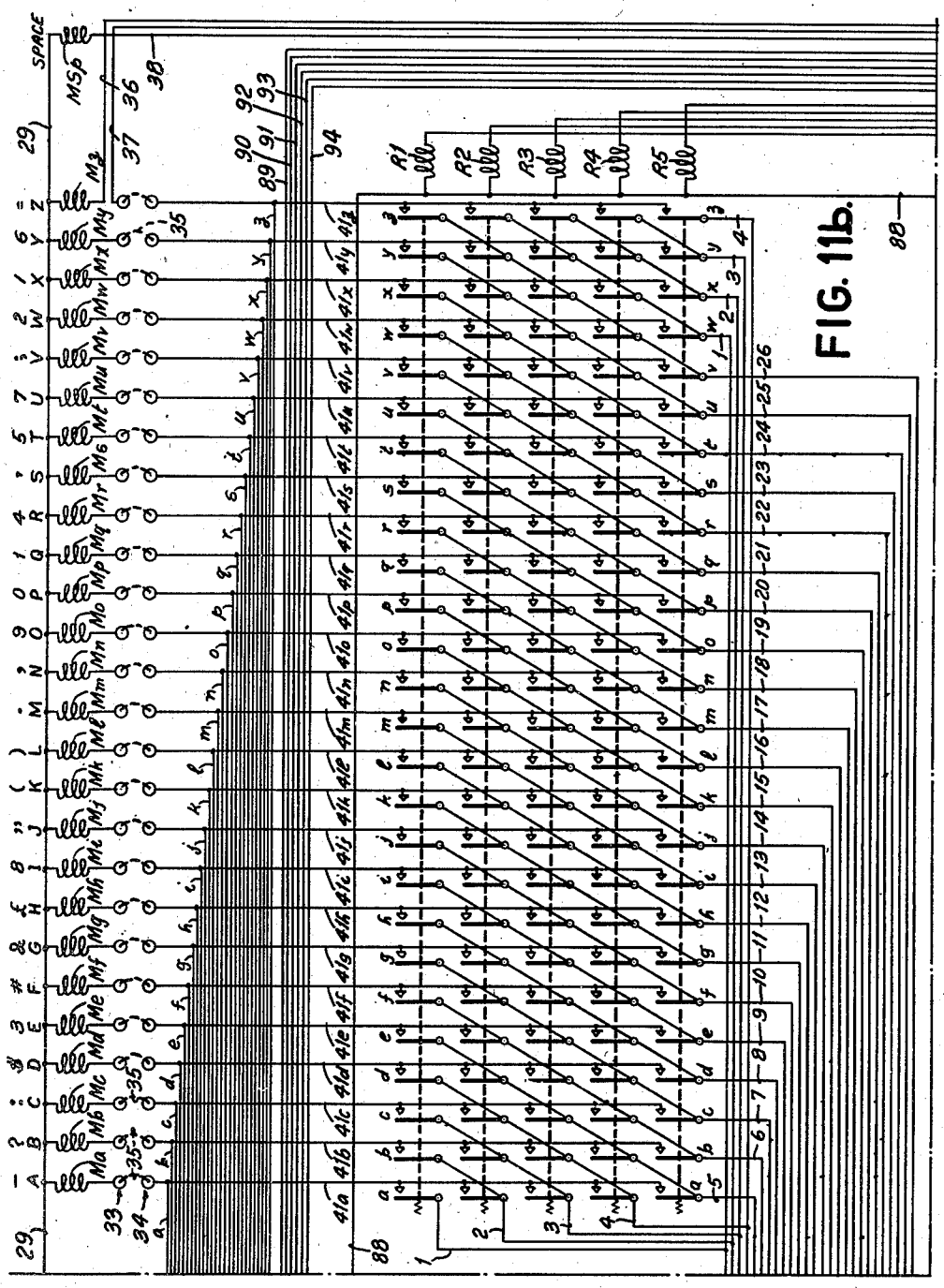

FIG. 11b.

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CIPHERING APPARATUS

Filed Jan. 11, 1944 10 Sheets-Sheet 8

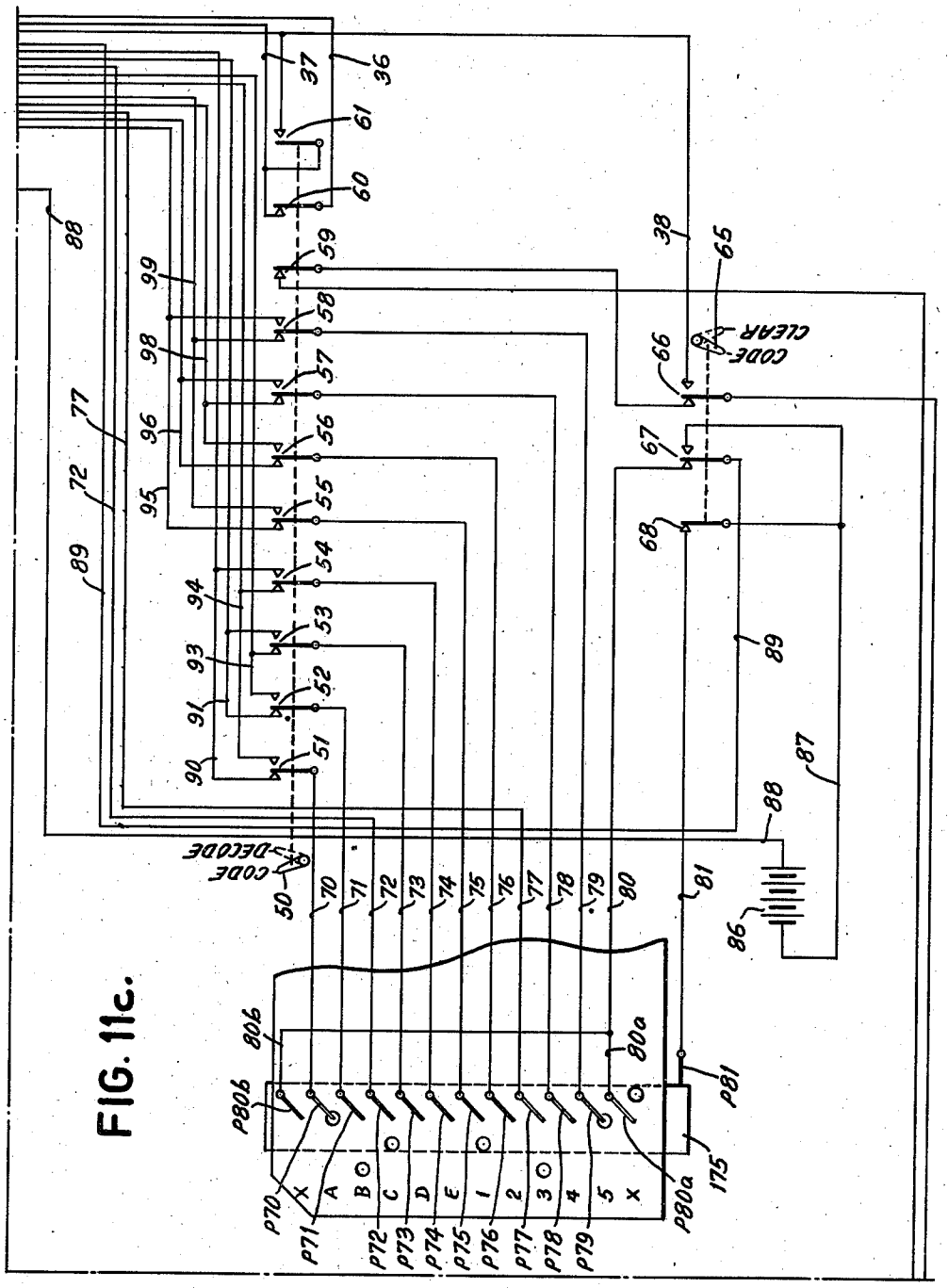

FIG. 11c.

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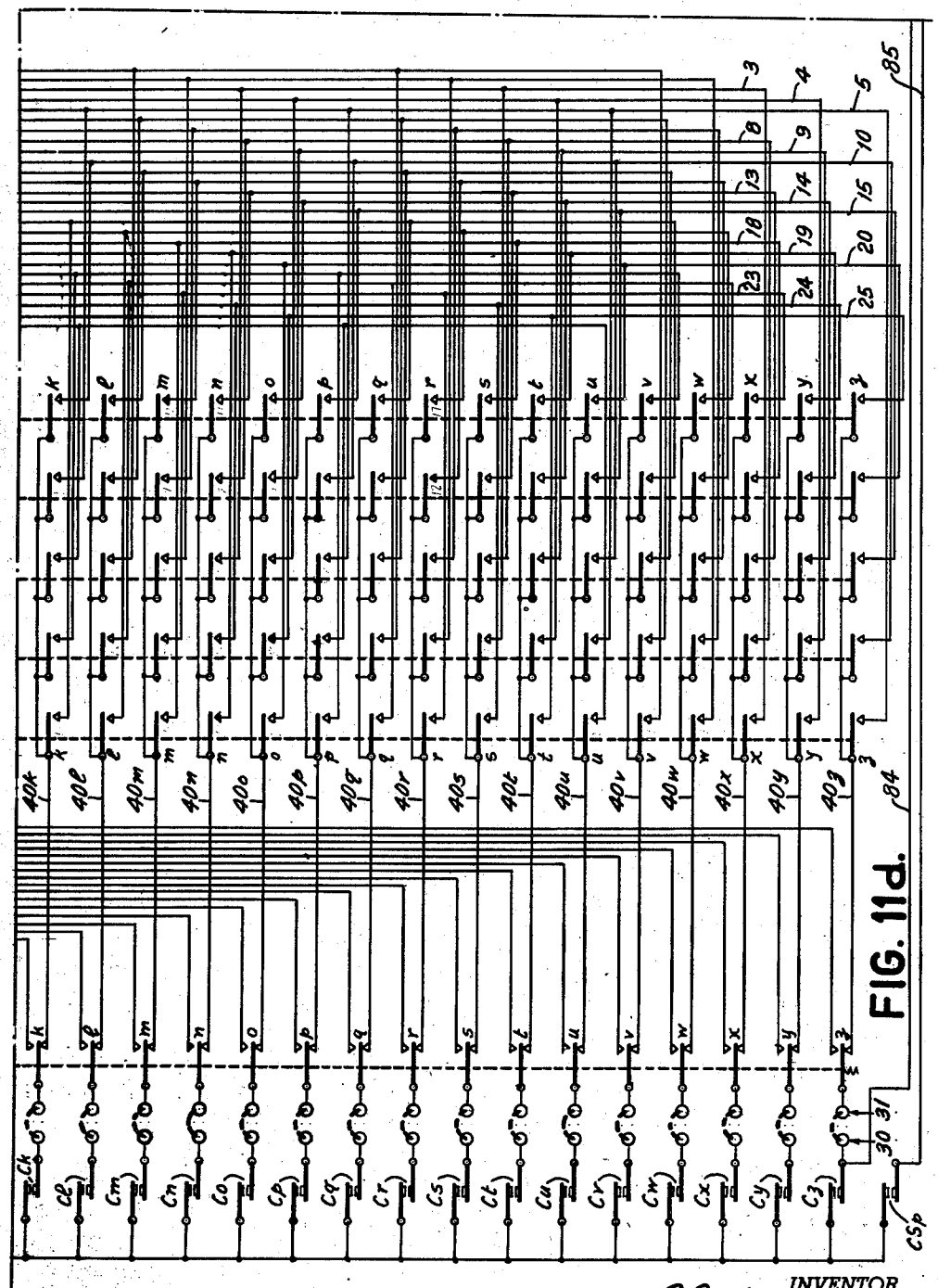

FIG. 11d.

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CIPHERING APPARATUS

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FIG. 13.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
CODE	B	C	A	D	B	A	E	C	B	E	A	D	B	C	E	A	D	B	A	C	C	E
	3	1	5	5	1	4	3	4	2	1	3	1	5	2	2	1	4	4	2	3	5	4
DECODE	D	C	E	B	D	E	A	C	D	A	E	B	D	C	A	E	B	D	E	C	C	A
	3	5	1	1	5	2	3	2	4	5	3	5	1	4	4	5	2	2	4	3	1	2

FIG. 14.

TO ALL CHANNEL U-BOATS

FIG. 15.

B D A Q V	N W O Q Z	Q H K Z X	Z 4 I S N	E O

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Patented Aug. 12, 1947

2,425,518

UNITED STATES PATENT OFFICE

2,425,518

CIPHERING APPARATUS

Charles R. Doty, Yonkers, N. Y., assignor to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application January 11, 1944, Serial No. 517,797

9 Claims. (Cl. 197—4)

1

This invention relates to ciphering and deciphering apparatus and its general object is to provide an improved apparatus for carrying out these operations.

A particular object of the invention is to provide an apparatus of the kind described wherein the permanent parts of the machine constitute a simple arrangement whereby any character can be substituted by any other character, the particular substitution being determined by a control record, such as a perforated card, or its equivalent. Thus, the machine itself gives no clue to the cipher key employed, the key being embodied in a destructible record, which has the further advantage that the key can be made indefinitely long and the choice of its composition is unlimited. In a preferred embodiment, the control record, in the form of a perforated card, can be set into the machine in various positions, each providing a different cipher key. There may be, for example, one hundred control cards in a set and these can be exchanged in succession, say, at the end of each line, or any shorter number of character spaces.

Another object is to provide an apparatus of the kind described which facilitates the correction of errors in a ciphered message. With this object in view the apparatus preferably includes a control machine comprising a typewriter having means associated with its carriage for sensing a control record carrying the cipher key, and a controlled machine operated by the control machine to type a ciphered message according to the prescription of the control record. The sensing of the control record follows the movement of the carriage and the control record has different control designations for each character space position of the carriage. While a certain control record is in place, there is a particular cipher relation between the control machine and the controlled machine for each character space position of the carriage, and the cipher relation for any character position can be restored by returning the carriage to that character position. Thus, an error can be corrected by erasing the erroneous characters on both machines, returning both carriages to the then blank letter space position, and striking the correct key on the control machine.

Still another object is to provide an apparatus of the kind described adapted to be adjusted to plain language condition by the control record.

In accordance with another feature of the invention, means may be provided whereby the cipher key control by the control record can be

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modified to the extent of, for example, factorial twenty-six different alphabets.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is an outline plan view of the entire apparatus.

Fig. 2 is a vertical sectional view through the control machine with parts broken away.

Fig. 3 is a detail view of the escapement mechanism of the control machine.

Fig. 4 is a vertical sectional view of the control record sensing mechanism of the control machine, taken on the line 4—4 of Fig. 1.

Fig. 5 is a vertical section on the line 5—5 of Fig. 4.

Fig. 6 is a small scale front elevational view of the control record sensing mechanism, with parts broken away.

Fig. 7 is a vertical sectional view of the printing mechanism of the controlled machine.

Fig. 8 is a portion of a control card.

Fig. 9 is a diagram showing the relation of the keys of the two machines, for one plugging arrangement.

Fig. 10 is a diagram showing the reciprocal relation of the coding relays to the index point positions of the control record with the code-decode switch in its two different positions.

Figs. 11*a* to 11*d* are four parts of a complete circuit diagram of the apparatus.

Fig. 12 is a diagram of the correct arrangement of Figs. 11*a* to 11*d* to form the complete circuit diagram.

Fig. 13 is a table showing a sequence of perforation combinations for a control record and also their effect on the control relays with the code-decode switch in decode position.

Fig. 14 is a view showing a message to be enciphered.

Fig. 15 is a view showing the same message enciphered.

Before describing the novel features of the invention, the essential parts of the well known machines used in the illustrative embodiment will be briefly reviewed. As shown in Fig. 1, the complete apparatus is composed of three units. At the right is the control machine 100, at the left it the controlled machine 101, and between these is a relay box 102 and plugboard 103. The control machine and the controlled machines are

typewriters and, as shown in the drawing, are similar to the Electromatic typewriter, except for the keyboard. The control machine 100 has, in addition to the standard typewriting mechanism, a control record sensing mechanism 104. It also has key operated switches, to be described presently, connected by the wires of a cable 42 to one row of plugboard sockets 30. The control record sensing mechanism of this machine is also connected by a cable 43 to the relay box 102. The controlled machine has key operating solenoids, to be described presently, connected by the wires of a cable 44 to another row of plug sockets 33.

The control machine

As shown in Fig. 2, the typewriter which constitutes the control machine 100 comprises a power driven roller 110, at the front and back of which are arranged two sets of cams 111 and 112. The cams are journaled upon oppositely arranged bell cranks 113 pivoted upon stationary rods 114. The upper ends of the bell cranks 113 are connected to their related type bar operating levers 115 by links 116. The levers 115 are pivoted upon a stationary rod 117, upon which key bars 118 are also pivoted. The key bars control latch levers 119 having latches 120 engaging lugs 121 on the realted cams 111 and 112, to hold them against the action of spring influenced arms 122, which tend to rotate the individual cams, to throw their eccentric peripheries toward the roller 110. The latch levers 119 are pivoted on the bell cranks 113 and have upwardly extending arms 123 with bent over ends 124 engaging in slots of the downwardly extending arms 125 of their related key bars 118. The type bars, one of which appears at 126 in Fig. 2, are pivotally mounted at 127 upon a basket 128 and are connected at 129 to one part of a toggle mechanism comprising two levers 130 and 131. The lever 130 is mounted on a fixed pivot 132, while the lower end of lever 131 is connected by a link 133 to the type bar operating lever 115. A spring 134 holds the mechanism in the normal position shown. Upon actuation of a key bar, the latch lever releases the related cam, which is rocked against the roller 110 by its spring biased arm 122 and caused to execute one-half revolution, in the course of which it rocks out the bell crank 113 and operates the type bar. This mechanism is all well known, being fully disclosed in a number of patents, such as Thompson Patent No. 1,873,512.

Behind the type bar basket is a carriage 135 mounted by ball bearings 136 upon a stationary guideway 137 and carrying a platen roller 138. The carriage is drawn toward the left (Fig. 1) by a spring of the usual kind (not shown), its movement being controlled by an escapement mechanism shown in small scale at 140 in Fig. 2, and on a larger scale in Fig. 3. The escapement mechanism comprises two dogs 141 and 142 loosely pivoted on a stationary pin 143 and urged by springs 144 and 145 into engagement with a rack bar 146 fixed to the bottom of the carriage 135. As shown in Fig. 3, the dog 141 is slightly longer than the dog 142. The two dogs have tails 147 with which a lever 148 pivoted on a stationary pivot 149 engages alternately to cause the movement of the carriage by successive steps. The lever 148 is connected by a link 150 and spring 151 to a universal frame 152 mounted by springs 153 and 154 upon stationary posts, one of which is shown at 155, the other being directly behind it. The frame 152 has an arcuate striking bar 156 which is struck by the type bars near the end of their printing movement. The resulting movement of the universal frame 152 rocks the lever 148 and releases one or the other of the two dogs 141 and 142 from the rack bar, allowing the latter, and the carriage to which it is attached, to move one column space to the left (Fig. 1). The escapement mechanism just described is fully disclosed in the patent to Crumrine 1,936,466 and the patent to Thompson et al. 1,994,544.

The bell cranks 113 have downwardly extending arms 157 bearing contact operating rollers 158, to close individual, normally open pairs of contacts 159 each time the related key lever is depressed.

The control record sensing mechanism.—This mechanism comprises a table 160 mounted by two brackets, one of which appears at 161 in Fig. 2, to the rear side of the main frame 162 of the typewriter. This table is adapted to support a control card Cd (Fig. 8) similar in form to the cards used in International tabulating machines. Above the table 160 is pivoted a strap 163 which is normally urged upward by a spring 164 but which can be turned downward about its pivot 165 and engaged under a snap hook 166. When the strap 163 is elevated, the control card can be slipped under it from the left and inserted beneath two guide bars 167 and 168 spaced slightly above the bed upon which the card lies. The card is additionally held by a stationary strap 169 anchored by screws at its right end to the table 160 and raised above the bed enough to allow the card to slip under. The bed 160 has a longitudinal groove 170 in which travel two carriage fingers 171 and 172 secured to the rear side of the carriage 135 and adapted to engage the right and left edges of the control card, when the card is placed upon the bed. Thus, as the typewriter carriage moves in either direction, the card is moved by the fingers 171 and 172 upon its bed.

The control card.—The area of the control card (Fig. 8) is subdivided into vertical columns corresponding, respectively, to the character spaces constituting one line of a sheet which is to receive the typewritten record of the message. The vertical columns are subdivided into twelve equally spaced index point positions, individually identified by the column of characters at the left edge of the card. The top and bottom index point positions are both marked X. Between these there is an upper group of five index point positions respectively marked A, B, C, D, E and a lower group of index point positions respectively marked 1, 2, 3, 4, 5. Each column contains either an X perforation or a combination of two perforations, one in the upper group and the other in the lower group of index point positions. The functions of the perforations will be explained in detail later.

At the center of the card sensing table is a roller 175 revolubly mounted upon a stationary shaft 176. This roller comprises a cylinder 177 of insulating material, bushings 178 providing bearing contact with the shaft 176, and a metallic outer cylinder 179. Beneath the roller 175 is a row of contact devices, each comprising a contact ball 180 guided in a metallic tube 181, which is crimped at its upper end to retain the ball against the upward urge of a spring 182. The lower ends of the spring and tube bear upon a binding post 183 in the form of a screw having two nuts thereon for the attachment of individual related wires of the cable 43. The metallic parts described are mounted in insulating members 184 and 185

secured to the bottom of the table 160 by screws 186. There are thirteen contact devices, twelve being positioned to sense, respectively, the twelve index point positions of the columns of the control card, while the thirteenth is positioned for direct contact with the roller 175 beyond the top edge of the control card. The contact devices are individually identified by the reference characters P70, P71, P72, P73, P74, P75, P76, P77, P78, P79, P80*a*, P80*b*, P81. The wires leading off from the binding posts 183 are formed into the cable 43 which runs to the relay box. When the carriage of the typewriter is in its extreme right hand position, the control card is located so that the sensing balls sense the first column, near the left end of the control card. The control card has forty-five columns, the last column at the right being in sensing position when the typewriter carriage is near the left limit of its movement.

The controlled machine.—The controlled machine is like the control machine just described, except that there is no control card sensing mechanism attached to it and the keys are provided with electromagnetic operating means. As shown in Fig. 7, the type bar operating mechanism, carriage and escapement are all similar to those described in connection with Fig. 2. In addition, each key has an individual operating solenoid 190, to the armature 191 of which is pivotally connected a lever 192 having a link connection 193 to the related key bar 118.

The coding relays and plugboard

The box 102 (Fig. 1) contains two groups of gang relays, the first group being RA, RB, RC, RD, RE, and the second group being R1, R2, R3, R4, R5. Each of these relays has twenty-six pairs of contacts respectively identified in the drawing by the twenty-six letters of the alphabet. The *a* contacts of the relays RA—RE are in the horizontal row *a*—*a* and the other contacts of these five relays are in similar horizontal rows identified by the other small letters of the alphabet, respectively. The *a* contacts of the relays R1—R5 are in the vertical row *a*—*a* and the other contacts of these five relays are in similar vertical rows identified by the other small letters of the alphabet, respectively. Interposed between the contacts of the two groups of relays are twenty-six conductors 1, 2, 3, . . . 26. The system, in accordance with which these conductors are connected to the contacts, appears most clearly from the drawings.

In addition to the two groups of relays mentioned, there is a relay RX having twenty-six transfer contacts individually identified by the small letters *a*, *b*, *c*, . . . *z*. A common wire 40*a* connects one side of all the *a* contacts of relays RA, RB, RC, RD, RE to the lower one of the *a* contacts of relay RX. Wires 40*b*, 40*c*, etc., similarly connect the *b*, *c*, etc., contacts of the relays RA—RE to the lower one of the *b*, *c*, etc., contacts of relay RX. The middle springs of the *a*, *b*, *c*, . . . *z* contacts of relay RX are connected to respective plug sockets of the row 31. These plug sockets can be connected in any desired manner by plug wires 32 to individual plug sockets of the row 30. The latter are respectively connected to one side of the pairs of cam operated contacts C*a*, C*b* . . . C*z* (these contacts are identified by reference number 159 in Fig. 2). The other members of these pairs of contacts are connected by a common wire 28 to one side of a battery 27.

The *a* contacts of the group of relays R1 to R5

are connected by a wire 41*a* to a plug socket of the row 34; the *b*, *c*, etc., contacts of said relays are connected by respective wires 41*b*, 41*c*, etc., to other individual plug sockets of the row 34. The latter plug sockets can be connected in any desired manner by plug wires 35 to individual plug sockets of the row 33. The latter plug sockets are respectively connected to the key operating magnets M*a*, M*b*, M*c* . . . M*z* of the controlled typewriter (these magnets are identified by reference number 190 in Fig. 7). The connection of the magnet M*z* extends through wire 36, a switch 60, and wire 37 to the related plug socket of the row 33. The opposite terminals of the magnets M*a*, M*b* . . . M*z* are connected by a common wire 29 to the opposite side of battery 27.

The upper terminals of transfer contacts *a*, *b*, *c*, . . . *z* of relay RX are connected by respective wires *a*, *b*, *c*, . . . *z* directly to wires 41*a*, 41*b* . . . 41*z*. Thus, when the relay RX is energized, the cam contacts C*a*, C*b* . . . C*z* are connected directly to the corresponding magnets M*a*, M*b* . . . M*z*.

The control machine and the controlled machine have a number of functional controls, including the case shift, the tabulator, the back space and the carriage return. At the left of Fig. 11*a* there are shown four pairs of cam contacts, namely, CS*h* controlled by the case shift key S*h* (Fig. 1), CT*a* controlled by the tabulator key TAB, CBS controlled by the back space key BS, and CCR controlled by the carriage return key CR. These contacts are individually connected by wires SH, TA, BS and CR, respectively, to magnets MS*h*, MT*a*, MB*s* and MC*r* operating the case shift key lever, the tabulating key lever, the back space key lever and the carriage return key lever, respectively, of the controlled machine.

The relay box 102 has a switch 50 which can be moved either to "code" or "decode" position (Figs. 1 and 11*c*). This switch operates a plurality of contacts numbered 51, 52, 53, 54, 55, 56, 57, 58, 59, 60 and 61. The middle terminals of the switches 51 to 58 are connected, respectively, by wires 70, 71, 73, 74, 75, 76, 78 and 79, to the binding posts P70, P71, P73, P74, P75, P76, P78 and P79 of the control card sensing mechanism. In the normal position of the transfer switches 51 to 58, the last mentioned wires are connected, respectively, to wires 90, 91, 93, 94, 95, 96, 98 and 99 which lead to relays RA, RB, RD, RE, R1, R2, R4 and R5, respectively. The wires 72 and 77 connect binding posts P72 and P77 directly to relays RC and R3, respectively. In the transferred position of switches 51 to 58 the connections of the wires are switches so that wires 70, 71, 73, 74, 75, 76, 78 and 79 are connected, respectively, to wires 94, 93, 91, 90, 99, 98, 96 and 95. The effect of this transfer is to change the relation of the index point positions of the control card to the relays RA—RE and R1—R5 to establish the reciprocal relation required for decoding.

The relay box 102 also has a switch 65 for changing the apparatus from coding condition to plain text condition, the two positions being indicated in Figs. 1 and 11*c* by the legends "Code" and "Clear." The operation of this switch will be explained later.

Operation

The operation of the apparatus will be described by following through the coding and de-

coding of the portion of a message shown in Fig. 14. It will be assumed that the control card to be used in this operation will be punched with the combinations tabulated in Fig. 13 in the twenty-two columns occupied by the portion of a message shown in Fig. 14. Below the code combinations there is a tabulation of the decode combinations, which are derived from the code combinations in accordance with the table shown in Fig. 10.

It will be assumed, further, that the plugboard is plugged as shown in the circuit diagram. This establishes a code relation in accordance with the table shown in Fig. 9, that is to say, if the combination of perforations in a column of the control card is A—1, the letter A will code into the letter F, while if the combination of perforations is A—2 the letter A will code into the letter E.

Paper is inserted in the control machine and the controlled machine, the latter being preferably ruled vertically as shown in Fig. 15 to provide a separation into groups of five letters each in the usual manner. The ruling eliminates the need for spaces to separate the groups. The control card is inserted into the sensing mechanism at the back of the control machine in the manner previously described, and the carriages of both machines are moved to their right end positions. The switches 50 and 65 are both turned to "code."

Coding.—In the first column position the combination of perforations shown is B—3. The following circuits are established through these perforations: from the negative terminal of battery 86, through wire 87, contacts 68, wire 81, contact P81, roller 175, contact P71, wire 71, contacts 52 in normal position, wire 91, relay RB, wire 88 to the positive terminal of battery 86; also from roller 175, through terminal P77, wire 77, relay R3 and wire 88 to the positive terminal of battery 86. The relays RB and R3 are thereby energized.

The T key of the control machine 100 is operated to print the first letter of the message on the check sheet in this machine. The closure of contacts C*t* by the cam controlled by the key T of the control machine completes a circuit from battery 27, through wire 28, said contacts C*t*, the corresponding socket 30, plug wire 32 and socket 31, the *t* contacts of relay RX in normal position, wire 40*t*, the *t* contacts of relay RB, wire 4, the *b* contacts of relay R3, wire 41*b*, the corresponding socket of row 34, plug wire 35, and socket of row 33, magnet M*b*, and wire 29, to the other terminal of battery 27. Magnet M*b* is energized and operates the B key lever of the controlled machine 101, causing the latter to print the letter B as shown in Fig. 15. As the type bar of each machine is operated, the carriage is allowed to escape to the next column position. In the control machine the control card is also moved one column to the left, breaking the circuits of relays RB and R3 and bringing the sensing balls 180 in index point positions C and 1 into contact with the roller 175. This completes circuits through the relays RC and R1 similar to those previously traced.

The next key struck is the O key. This causes an O to be printed on the paper in the control machine 100 and the contacts Co to be closed, completing a circuit from wire 28, through said contacts, the related plug connections, the *o* contacts of relay RX, wire 40*o*, the *o* contacts of relay RC, wire 4, the *d* contacts of relay R1, wire 41*d*, the plug connections, magnet M*d* and wire 29 to battery 27, energizing said magnet. Thereby the control machine 101 is caused to print the letter D in column 2. The carriages of both machines escape to column 3.

In column 3 of the message there is a space. The space bar of the control machine 100 is operated and spaces the carriage of that machine to column 4. Before this occurs, relays RA and R5 having been energized as a result of the perforations in the A and 5 index point positions of column 3 of the control card, the following circuit is completed by closure of contacts CS*p* of the control machine: from wire 28, through said contacts, wire 85, contacts 66 and 59, wire 84, the plug connections of rows 30 and 31 pertaining to the letter Z, the *z* contacts of relay RX, wire 40*z*, the *a* contacts of relay RA, wire 5, the *a* contacts of relay R5, wire 41*a*, the related plug connections, and magnet M*a* to the return wire 29, energizing said magnet and causing the letter A to be printed in column 3 by the controlled machine.

The operation continues in a similar manner and it will be assumed that on reaching the letter A in the word "channel," the operator erroneously strikes the S key. At this time the control card combination is E1; therefore, the relays RE and R1 are energized. The closure of contacts C*s* completes a circuit from wire 28, through said contacts, the related plug connections, the *s* contacts of relay RX, wire 40*s*, the *s* contacts of relay RE, wire 18, the *r* contacts of relay R1, wire 41*r*, the related plug connections, magnet M*r*, to return wire 29. The operator will notice this error in the check copy, perhaps when the line is finished and proofread before proceeding to the typing of the next line. On noticing the error, the operator erases the erroneous letters S and R on the papers in the two machines and returns the carriage to column 10 position, where the error occurred. This can be done by operating the back space key BS of the control typewriter, which will cause the control machine to back space in the usual manner and will complete an obvious circuit through contacts CBS, wire BS, and magnet MBS, causing the controlled machine 101 to follow the back spacing of the control machine. When the column 10 position is restored, the relays RE and R1 are reenergized by the circuits completed by the combination of perforations in column 10 of the control card. When the operator then strikes the A key, a circuit is completed from wire 28, through contacts C*a*, the related plug connections, the *a* contacts of relay RX, wire 40*a*, the *a* contacts of relay RE, wire 26, the *z* contacts of relay R1, wire 41*z*, the related plug connections, wire 37, contacts 60, wire 36, magnet M*z*, to return wire 29, energizing said magnet and causing the letter Z to be typed by the controlled machine. In column 17, the character to be typed is a hyphen, an upper case character. In this column position the relays RD and R4 are energized. The operator first depresses the case shift key S*h*, causing the type basket of the control machine to drop to upper case position. This closes the contacts CS*h*, completing a circuit from wire 28, through said contacts, wire S*h*, and magnet MS*h* to return wire 29, energizing said magnet and causing the controlled machine to shift to upper case position. The operator then strikes the hyphen key (the A key), a hyphen is printed in column 17 of the control machine, and contacts C*a* are closed to complete a circuit from wire 28,

through said contacts, the related plug connections, the *a* contacts of relay RX, wire **40***a*, the *a* contacts of relay RB, wire **21**, the *r* contacts of relay R4, wire **41***r*, the related plug connections, magnet M*r*, to return wire **29**, energizing said magnet and causing the controlled machine to print the number 4.

Decoding

In decoding the ciphered message shown in Fig. 15, the machines are prepared in the same way as for coding, except that the switch **50** is shifted to "decoding" position. A control card identical to the one used in coding is set up on the card sensing table **160** of the control machine. With the carriage of this machine in its right end position, the contact balls **180** sense the perforations of column **1**. This time, however, due to the change in the position of switch **50** the relay RD is energized instead of relay RB (see the "code-decode" table, Fig. 10). The circuit extends through contact device B**71**, wire **71**, switch **52** in transferred position, wire **93**, and relay RD to return wire **88**. The relay R3 is energized through a circuit extending from contact device P**77** through wire **77**, the same as for coding. When the operator strikes the B key of the control machine, a circuit is extended from wire **28**, through contacts C*b*, the related plug connections, the *b* contacts of relay RX in normal position, wire **40***b*, the *b* contacts of relay RB, wire **22**, the *t* contacts of relay R3, wire **41***t*, the related plug connections, magnet M*t*, and return wire **29** to battery **27**, energizing said magnet. The T type bar of the controlled machine is operated to print the first letter of the message being decoded.

In the third column the relays RE and R**1** are energized. When the A key is depressed, the circuit is extended from wire **28**, contacts C*a*, the related plug connections, the *a* contacts of relay RX in normal position, wire **40***a*, the *a* contacts of relay RE, wire **26**, the *z* contacts of relay R**1**, wire **41***z*, the related plug connections, wire **37**, switch **61**, wire **38**, magnet MS*p* and return wire **29** to battery **27**, energizing said magnet and operating the space bar of the controlled machine.

The other circuits utilized in the decoding operation can be traced out in the same way. It will be observed that the letter Z is ciphered into the same letter as a space, while the letter into which Z is ciphered will decipher into a space.

If it is desired to print any part of the message in clear text, the control card can be perforated in one of the two X index point positions for every column in which clear text is to be printed. This will cause a circuit to be completed, in those columns, through contact device P**80***a* or P**80***b*, wire **80***a*, or **80***b*, wire **80**, switch **67** in normal position, wire **89**, relay RX and return wire **88** to battery **86**. With the contacts of relay RX in transferred position, the closure of any one of contacts C*a*, C*b* . . . C*z* extends a circuit through the related plug connections, the related contacts *a*, *b*, *c*, . . . *z* of relay RX, the related wire *a*, *b*, . . . *z*, and through the plug connections to the solenoid M*a*, M*b* . . . M*z* of the controlled machine, corresponding to the key of the control machine which was operated.

If it is desired to operate the machines continuously in clear text, the switch **65** is shifted to the "clear" position. This opens switch **68**, so that none of the relays RA—RE and R**1**—R5 can be energized. The contacts **67** transfer, connecting battery **86**, through wire **87**, said contacts in transferred position, wire **89**, relay RX and return wire **88** to battery **86**, energizing said relay and establishing the clear text relation of the two machines. The contacts **66** transfer so that, when the space bar is operated, a circuit is extended from wire **28**, through contacts CS*p*, said contacts **66** in transferred position, wire **38**, magnet MS*p* and return wire **29** to battery **27**.

The control cards can be utilized in various ways, to vary the cipher key derived from a single set of cards. For example, instead of leaving one card in for a full line, the cards may be exchanged after printing half a line, or any smaller fraction of a line. Each card can be turned in the plane of the card through 180°, so that the bottom edge becomes the top edge. In this position the upper and lower groups of index point positions are reversed and their control accordingly modified. Furthermore, the card can be turned in another direction to place it face down upon the card table so that the sequence of perforation combinations is run through in reverse order. In the face down position, the card can also be turned through 180° in the plane of the card, to bring the bottom edge to the top. Thus, each card provides four different ciphering sequences.

The control by a single control card can be modified by means of the plug connections, in accordance with factorial twenty-six different alphabets. If the plugging shown in the drawing is changed, the table shown in Fig. 9 will be changed accordingly. In changing the plugging it is only necessary to insure that the connections of sockets **30** to sockets **31** agrees with the connection of sockets **33** to sockets **34**. To facilitate the plugging operation and to prevent errors, the wires **32** and **35** can be sheathed in pairs, with two-pronged plugs at each end. Thus, when the prongs of one plug are plugged into a pair of vertically aligned sockets in the rows **30** and **33**, the wires connected to said prongs can only be connected to a pair of vertically aligned sockets in the rows **31** and **34**, by the two prongs of the plug at the other end of the two wire cable. To insure against connection of a socket in row **30** to a socket in row **34**, the two prongs of each plug can be suitably differentiated by size or shape, in well known manner.

Since the apparatus with the exception of the control cards is merely a means whereby any different cipher relation can be established between the control machine and the controlled machine, the machines themselves give no clue to the cipher key. The latter is determined by the punching of the destructible cards and by the plug connections which can be removed at any time without trace.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. For example, while I have shown in the drawing a controlled typewriter wherein the keys are operated by individual solenoids, any equivalent means for selectively operating the character manifesting devices of the controlled machine may be substituted. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In a ciphering apparatus, a set of key op-

erated switches, a set of character manifesting devices, a set of electrically operable devices, one for each key operated switch, for causing the selective operation of said character manifesting devices, two groups of gang relays, the relays of one group each having contacts connected, respectively, to said electrically operable devices, while the relays of the other group each have contacts connected, respectively, to said key operated switches, each of said contacts having a complementary contact and said complementary contacts of the two groups of relays being interconnected in a combinational arrangement, whereby each key switch can be connected to any one of said electrically operable devices by selective operation of said relays in various pairs, each pair comprising a relay of each group, each one of said key switches being connected to a different one of said electrically operable devices by each paired operation of said relays, and means controlling the operation of said relays comprising a control member having variously positioned control designations thereon, sensing means for said designations comprising a plurality of sensing elements, respectively connected to different ones of said relays, and means for relatively shifting said control member and said sensing means.

2. A ciphering apparatus as described in claim 1, wherein the control designations are located in various positions within two different fields of the control member, the individual sensing elements of said sensing means being adapted to sense related designation positions of the two fields, the sensing elements pertaining to one field being operatively associated, respectively, with the relays of one group and the sensing elements pertaining to the other field being operatively associated, respectively, with the relays of the other group.

3. A ciphering apparatus as described in claim 1, wherein the control designations are located in various positions within two different fields of the control member, the individual sensing elements of said sensing means being adapted to sense related designation positions of the two fields, the sensing elements pertaining to one field being operatively associated, respectively, with the relays of one group and the sensing elements pertaining to the other field being operatively associated, respectively, with the relays of the other group, the fields being symmetrically arranged on the control member, so that the latter can be turned to reverse the relation of the fields to the sensing elements.

4. A ciphering apparatus as described in claim 1, wherein code-decode switch means are provided and adapted to modify the control of said sensing means over said relays, so that the same control designations of the control member will cause a different interconnection between said key switches and said electrically operable devices when said switch means is in decode position than when it is in code position, the interconnection in the decode position being the reciprocal of the interconnection in the code position.

5. A ciphering apparatus of the type wherein a plain text and a cipher text are printed simultaneously by two printing mechanisms, under control of a single keyboard, the plain text being printed one character after another on a record sheet supported by a carriage which moves step-by-step as the characters are printed, characterized by cipher control means movable progressively with the carriage to change the cipher relation between the keyboard and the cipher text printing mechanism as the printing progresses, said cipher control means being movable reversely, with the carriage to any previous position, to restore the cipher relation which existed at said previous position.

6. A cipher apparatus as described in claim 5, wherein said cipher control means comprises a control member having variously positioned control designations thereon, a holding device to position said control member, and a sensing device to sense the designations of said control member, said devices being relatively movable in either direction to establish effective sensing relation between said sensing device and particular designations of said control member.

7. A cipher apparatus as described in claim 1, wherein transfer means are provided to disconnect said key switches from their related contacts of said relays and to connect said key switches directly to their corresponding electrically operated devices, said sensing means having a sensing element to sense a control designation in a special position of the card, said last element being operatively connected to said transfer means so as to transfer the same on sensing of a designation in said special position.

8. In a cipher apparatus of the kind comprising a typewriter having a keyboard, type members controlled thereby, a carriage to support a record sheet, and escapement means for the carriage operated under control of the keys, combined with a second typewriter comprising type members controlled by the same keyboard through variable cipher means adapted to change the individual relations of the keys of said keyboard to the type members of said second typewriter; control means for said cipher means comprising a perforated card, stationary sensing means therefor, and holding means for said card connected to said carriage so as to move said card past said sensing means as said carriage moves, said cipher means having setting means connected to said sensing means and responsive to the sensing of perforations in different positions on said card to vary said cipher means.

9. A ciphering apparatus as described in claim 1, wherein plugging means are included in the connections between the contacts of the relays of one group and said electrically operable devices, and in the connections between the contacts of the relays of the other group and said key operated switches, for varying the effect of said relay controlling means.

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