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(72) Inventors BENGT FLORIN and KALEVI LOIMARANTA

(54) IMPROVED CIPHERING MACHINE

(71) We, AB TRANSVERTEX, a Swedish Joint Stock Sompany, of Fittja Industriomrade, Varby, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a ciphering machine for ciphering text in clear produced in binary form by superimposing every text in clear character signal with a variable ciphering signal.

It is previously known to produce these ciphering signals changed constantly for every character by means of a set of toothed wheels with a different number of teeth (preferably a prime number) which are mounted on the same shaft and are in driving connection with respective separately movable toothed wheels having the same number of teeth. At this second set of toothed wheels every tooth represents a binary bit, and the aligning teeth in the entire set of toothed wheels define a character formed by corresponding binary bits. Said second set of toothed wheels, thus, defines as many characters as there are teeth along the wheel circumference. At the beginning, the bits forming said characters are chosen at random. If the toothed wheels of the first set (having a different number of teeth) are stepped simultaneously one tooth at a time, it is obvious that, when the driving toothed wheel with the lowest number of teeth has been stepped through one entire revolution, the teeth then aligning in the driven set of toothed wheels will represent combinations of binary bits, i.e. characters, other than the original ones. The combinations are changed additionally when the drive wheel with the next to lowest number of teeth has completed its cycle, and so on. If, for example, the numbers of teeth of the drive wheels are prime numbers, it is understood that the same combinations (characters) as the original ones will not be obtained unless the set of drive wheels has been stepped a number of steps which is equal to the product of the respective number of teeth on the wheels comprised in the set.

Of the peripherally moving characters one character is selected for every ciphering operation, which character corresponds to a row of aligning teeth, either along one and the same reference line or with a systematic shifting between different lines in order to render unauthorized deciphering still more difficult.

The ciphering character obtained (in form of a signal) is superimposed to the simultaneously stepped character in clear so as to form the ciphered character.

The arrangement described above, however, involves several disadvantages.

From a purely ciphering point of view it shows the restriction that the aforesaid systematic change of characters in the peripheral series of characters for purely practical reasons hardly can be carried out for characters (tooth rows) other than such located relatively closely. Consequently, the possibilities of changing existing in reality between the total of characters located along all of the wheel circumference is utilized only to a small fraction.

According to this invention there is provided in a ciphering machine for ciphering text in clear produced in binary form, by superposing every text-in-clear character signal with a variable ciphering signal, comprising a plurality of electric devices stepped in parallel, said devices each having a different and repetitive operative cycle and forming an array of parallel rows of a different number of bistable flip-flops, the initial states of which are set according to an arbitrary scheme so that the states of flip-flops stepped in parallel define together, in every flip-flop column of said array, a ciphering character, whereby said column characters automatically change their bit composition every time a row of flip-flops

has completed a cycle and starts a new one; the improvements comprising means, responsive to the present contents of a flip-flop column in a pre-selected reference position, to select, at each ciphering moment or step, at least one of the remaining flip-flop columns in the flip-flop array, as determined by said contents, and to transfer the signals corresponding to the states of the selected flip-flops to an adding device for producing said ciphering signal which is to be superposed on the text-in-clear signal.

One embodiment of the invention is described below with reference to the accompanying drawings wherein:

Figure 1 shows a basic diagram for a ciphering machine according to the invention;

Figures 2 and 3 show wiring diagrams for two examples, respectively, of character selectors comprised in the machine; and

Figure 4 shows the wiring diagram for a type of adding circuits also comprised in the machine.

Figure 1 shows in this embodiment four shift registers S_a, S_b, S_c and S_d, each of which comprises a chain of bistable flip-flops, which here are shown merely schematically as blocks.

The number of flip-flops varies from one chain to another. The shift register S_a, for example, which is represented in the Figure by the uppermost row of flip-flops, comprises thirteen flip-flops a1—a13. The shift register S_b representing the second row comprises twelve flip-flops b1—b12, and in an analogous manner the the shift registers S_c and S_d, respectively, formed by the third and fourth row of flip-flops comprise eleven and ten flip-flops c1—c11 and d1—d10, respectively.

In every chain the outlet of the one flip-flop is connected in the usual way to the inlet of the next following flip-flop, in such a manner, that upon stepping the register one step the information in every flip-flop in said chain is shifted forward one step. In the Figure also is shown the last flip-flop in every chain connected to the first flip-flop in the same chain in order to form a closed step cycle.

From the beginning, all of the flip-flops are given, for example by punched cards, conditions preferably chosen at random. For the sake of clearness, however, the arrangement for this feed of information has not been included in the Figure, nor are the usual drive circuits for the shiftings shown.

The registers are intended to be stepped in parallel, i.e. the information bits in the first column k1 of flip-flops a1, b1, c1 and d1 are transferred to the flip-flops a2—d2 of the second column k2, and the contents of the latter is transferred to the flip-flops a3—d3 of the third column, and so forth. Every flip-flop column defines a character, which in this case comprises four bits. Owing to the difference in length of the cycles of the shift registers the bits fed in from the beginning into, for example, the first column k1 will be stepped unchanged to the "last" flip-flop d10 of the register S_d, corresponding to column k10. At a further parallel stepping the shift register S_d starts a new cycle with the beginning in k1 where the original bit in the flip-flop d1 returns, but the remaining bits in k1 are replaced by the bits in the flip-flops a13, b12 and c11, respectively, said bits being originally present in flip-flops a4, b3 and c2 of the registers S_a—S_c. At the next stepping the register S_c starts a new cycle with the beginning in k1, which now in addition to the original bit in the flip-flop c1 includes the new bits from a13, b12 and d10. This cycle is repeated in an analogous manner for the remaining registers S_b and S_a. It is understood that the original combinations do not appear again unless a number of steps equal to the product of the step number of the four shift registers have been stepped.

In the following the arrangement is described which is used for selecting the character, i.e. the bit combination in a column, to be utilized for ciphering a character in clear in the form of a pulse fed simultaneously with the stepping of the shift registers.

For this purpose a number of character selectors are provided, in this case four in number, viz. T1, T2, T3 and T4. Every character selector has four pairs of inlets i1—i4, which are connected in parallel with the corresponding inlets of the other character selectors and adapted to be connected to four pairs of flip-flop outlets of an arbitrary column *via* a switch (system selector) V not described in detail. In the following argumentation the selectors are assumed, as indicated in the Figure, to be connected to the flip-flops a1—d1, respectively, of the column k1 *via* conductor pairs L1—L4.

The outlets U1—U4, respectively, of every character selector T1, T2, T3 and T4 are connected to the one inlet of—in this case two—AND-gates O1 and O5, and O2, O6; O3, O7; and O4, O8, respectively. The other inlet of every gate O1—O8 is connected to the outlet of an adding circuit A1—A8, which like the character selector has four pairs of inlets, each pair being connected to the respective four flip-flop outlet pairs of its column *via* the switch V. In the embodiment shown the switch is assumed so to be set that the adding circuits A1—A8 are connected to the flip-flop columns k2—k9 straight above them in

the Figure. The outlets g1—g8, respectively, of the gates O1—O8 are all connected (but for the sake of clarity shown only for the outlet g8) to a first inlet öv on a final adding circuit SA, to the other inlet k1 of which a binary coded signal in clear is fed in a way not described in detail synchronously with the stepping of the shift registers S1—S4. From the outlet ch of the adding circuit SA then the signal is taken out which is superimposed with the character content of the column in question, i.e. the ciphered signal.

Before describing the mode of operation of the above arrangement, it briefly shall be dealt with the construction of the character selectors T1—T4 and adding circuits A1—A8, with reference to Figures 2—4 showing embodiments of the construction of these arrangements. As appears from Figures 2 and 3 the character selectors T1 and T2 are built up of the same components, i.e. AND-gates G1—G5, but the internal connections are made different in order to give every character selector its own special nature. In Figure 2, thus, the gate pairs G1, G2 and G3, G4 are shown connected in like manner with respect to the respective inlet pairs i1, i2; i3, i4, in that in both of the gate pairs G1, G2; G3, G4 the "0"-conductor in the left-hand inlet pair i1 and i3, respectively, extends to the "1"-inlet on the right-hand gate G2 and G4, respectively, in the pair, and the "1"-conductor in the right-hand inlet i2 and i4, respectively, extends to the "0"-inlet on the left-hand gate G1 and G3, respectively, in the pair. In Figure 3 the relation is the same as regards the left-hand gate pair G1, G2 while at the right-hand gate pair G3, G4 the "0"conductor in the left-hand inlet pair i3 extends to the "0"-inlet on the right-hand gate G4, and the "0"-conductor in the right-hand inlet pair i4 extends to the "0"-inlet on the left-hand gate G3.

By these two basic type connections represented by the left-hand and right-hand gate pair, which may be designated by A and B, the connections of the two remaining character selectors T3 and T4 are obtained in that T3 is built up of a left-hand part of B-type and a right-hand part of A-type, and T4 is built up of a left-hand part B and a right-hand part also of B-type.

A table of the build-up of the four character selectors T1—T4 and the bit combinations (deductable from Figures 2 and 3) at the inlets in i1—i4 causing out-signal from the character selector in question, is shown below.

Character selector	Construction	Bit Combinations			
T1	A+A	1111	1100	0011	0000
T2	A+B	1110	1101	0010	0001
T3	B+A	0111	0100	1000	1011
T4	B+B	0101	0110	1001	1010

Figure 4 shows the build-up of the adding circuits A1—A8 which are of mutually entirely equal nature and built up in a conventional way with unit circuits connected to each other of the type as framed in Figure 4. A more detailed description appears not necessary.

A simple example may illustrate the mode of operation of the ciphering machine described above.

It is assumed that in a certain moment during the continued stepping of the field of columns k1—k9 in column k1 the bits "0 1 0 0" are found in the respective flip-flops a1—d1. This character signal is fed *via* respective conductor pairs L1—L4 to the inlets i1—i4 of all character selectors T1—T4. Hereby only the character selector T3 (according to the Table above) gives an out-signal to associated AND-gates O3 and O7. At the second inlets of these gates—as at the second inlets of all remaining gates—a signal is available by assistance of the adding circuit A3 (A7, respectively) which represents the total of the character bits in column k4 (and column k7). These bits are, for example, assumed to be " 1 1 0 1" (and "0 0 1 1"). The total of these bits then is "1" ("0", respectively). As the out-signal of the character selector opens gate O3 (O7, respectively), this "1"-signal ("0"-signal, respectively) passes through to the inlet on the final adding circuit SA in order there to be superimposed on the text-in-clear signal from the input k1 arriving at the same time. (The "0"-signal possibly can be used as a second superimposing pulse).

At the next stepping of the shift registers a character selector determined by the new bit combination in the flip-flop column k1 will open the passage for a new signal from a corresponding column, and so on. For every new stepping, thus, a "jump" forward or back of the practically always entirely available field of all information in the

flip-flop chains of the different shift registers is obtained. This renders possible a many times greater utilization of the total of character variations in the information field than it is possible at the mechanic designs of ciphering machines.

The fact that in the example shown only four character selectors are required together with the four flip-flops in every column, has its reason in the circumstance that both the character itself and its pole switching are allowed to act upon the character selectors of the embodiment shown.

In like manner as at the known ciphering arrangements operating with binary code, the deciphering is carried out simply by superimposing the ciphered signal pulses with the same series of pulses as used at the ciphering operation. Owing to the special nature of the binary system, the text in clear is restored.

The invention is not restricted to the embodiment described above, but various modifications thereof can be imagined, particularly with respect to the number of shift registers and the relation between their cycles.

The invention in principle is not bound to the use of shift registers, but also other electric arrangements with cyclic operations can be imagined, such as binary counters with associated logic circuits.

The application field of the machine, furthermore, can be widened to a large extent by making the cycles of the electric arrangements in question adjustable.

WHAT WE CLAIM IS:—

1. In a ciphering machine for ciphering text in clear produced in binary form, by superposing every text-in-clear character signal with a variable ciphering signal, comprising a plurality of electric devices stepped in parallel, said devices each having a different and repetitive operative cycle and forming an array of parallel rows of a different number of bistable flip-flops, the initial states of which are set according to an arbitrary scheme so that the states of flip-flops stepped in parallel define together, in every flip-flop column of said array, a ciphering character, whereby said column characters automatically change their bit composition every time a row of flip-flops has completed a cycle and starts a new one; the improvements comprising means, responsive to the present contents of a flip-flop column in a pre-selected reference position, to select, at each ciphering moment or step, at least one of the remaining flip-flop columns in the flip-flop array, as determined by said contents, and to transfer the signals corresponding to the states of the selected flip-flops to an adding device for producing said ciphering signal which is to be superposed on the text-in-clear signal.

2. A machine according to claim 1, wherein the means for selecting at least one certain flip-flop column comprises a plurality of character selectors individually associated with a different one of said remaining flip-flop columns, and each of said character selectors having a plurality of inputs of the same number as that of the flip-flop rows, the inputs of all of said character selectors being connected in parallel to the corresponding outputs of the flip-flops in the column of said reference position, and each of said character selectors having output connected to one input of an AND gate, the second input of which is connected to the output of an adding circuit, said adding circuits having their respective inputs connected with the outputs of the flip-flops in the associated columns such, that for a certain character in said reference position column only one character selector is activated to supply an output signal to its AND gate, at the second input of which the output signal from its adding circuit is always present, for effecting an output signal from said AND gate, representing said ciphering signal.

3. A machine according to claim 2, wherein each of the character selectors comprises a system of AND gates having its respective input connected to the output of the flip-flop of said reference position column in such a manner that an output signal from the gate system is obtained only in response to certain definite characters in said reference column.

4. A machine according to claim 2, wherein a switch is placed between the outputs of the flip-flop columns and the associated adding circuits for enabling shifting of the connections between said flip-flop columns and the character selectors.

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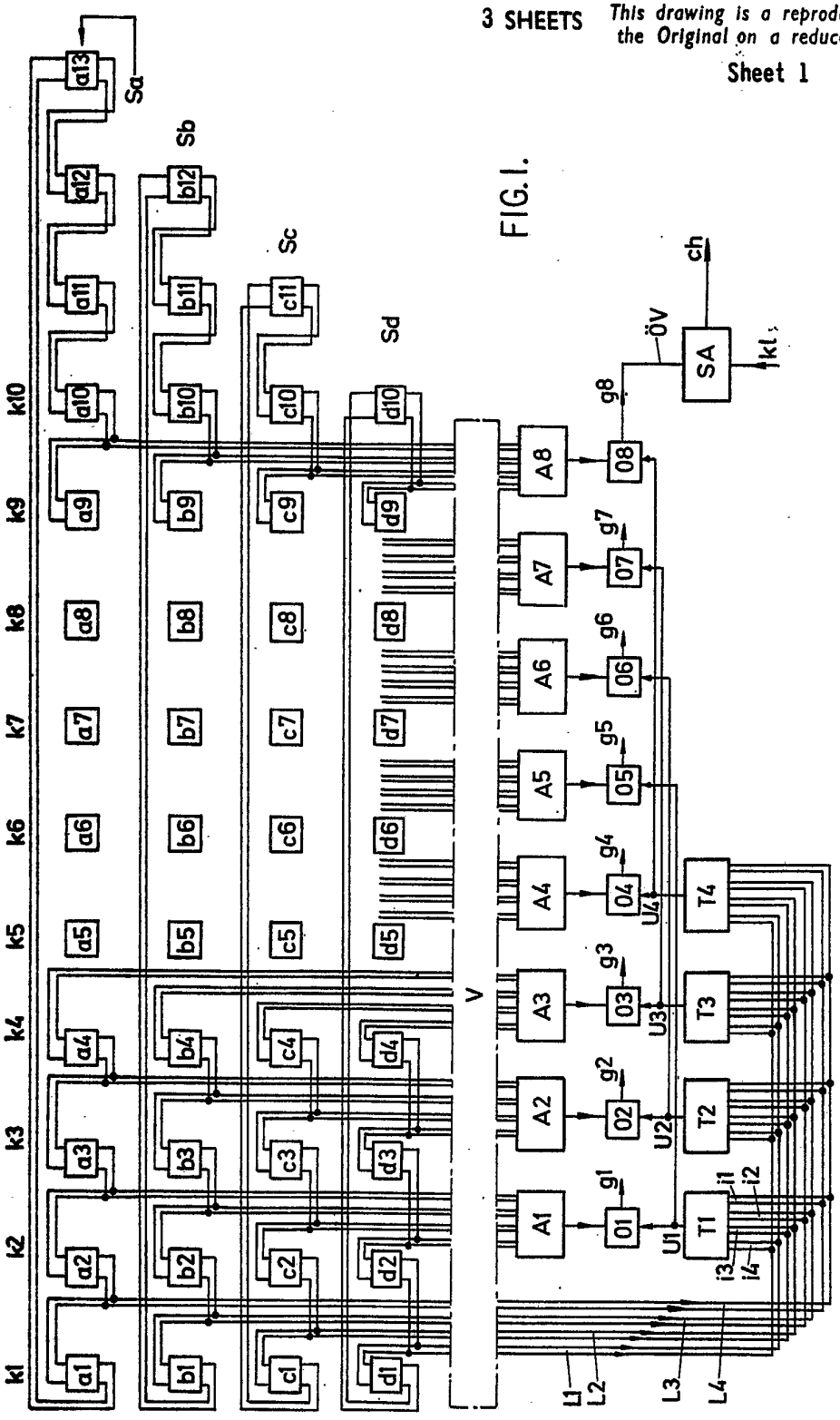
1235571 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG. 1.



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3 SHEETS

FIG.2

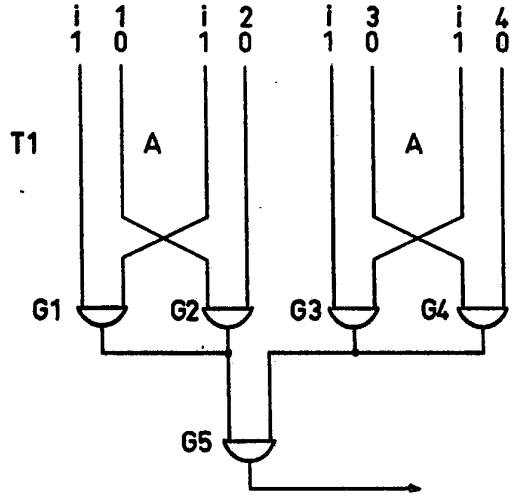
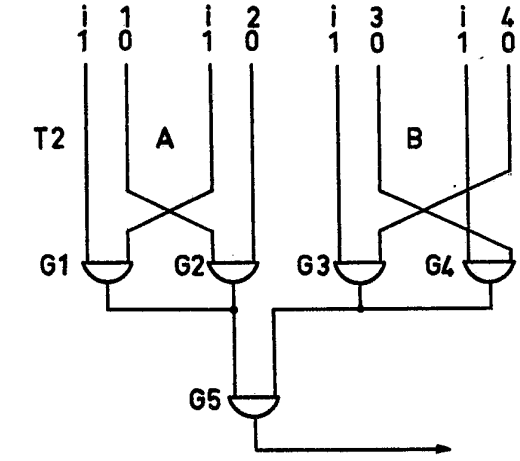


FIG.3



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Sheet 3

FIG. 4