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# United States Patent [19]

**Koopman, Jr. et al.**

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[54] **PSEUDORANDOM COMPOSITION-BASED CRYPTOGRAPHIC AUTHENTICATION PROCESS**

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[22] Filed: **Aug. 22, 1994**

[51] **Int. Cl.**[6] .................... **H04K 1/00**

[52] **U.S. Cl.** .................... **380/28**; 380/42

[58] **Field of Search** .................... 380/28, 42, 4, 380/49

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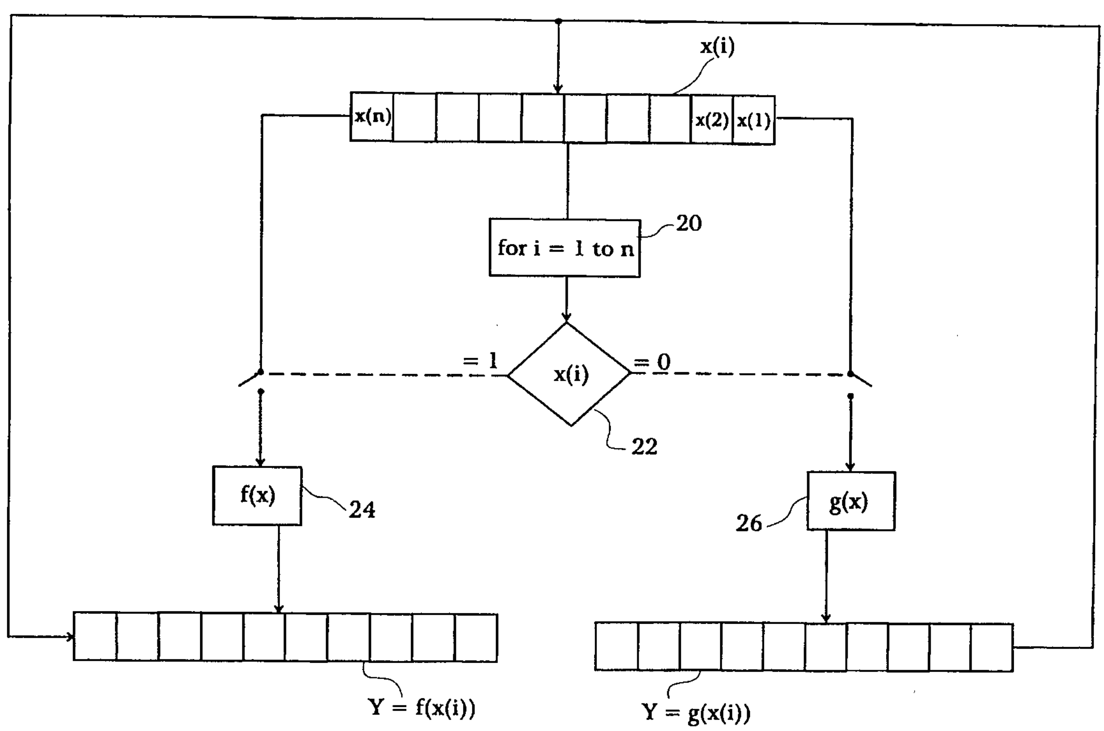
[57] **ABSTRACT**

The pseudorandom process iteratively applies a selected CRC encryption process on the information to be encrypted. The encryption process is selected by testing one of the digits comprising the number to be encrypted. A first encryption process is used if the tested digit is a 1; a second encryption process is used if the tested digit is a 0. The process is repeated a plurality of times, e.g. once for each digit in the number to be encrypted, resulting in a highly encrypted value that is not easily reverse engineered by chosen or known plaintext attack.

**19 Claims, 4 Drawing Sheets**



# FIGURE 1

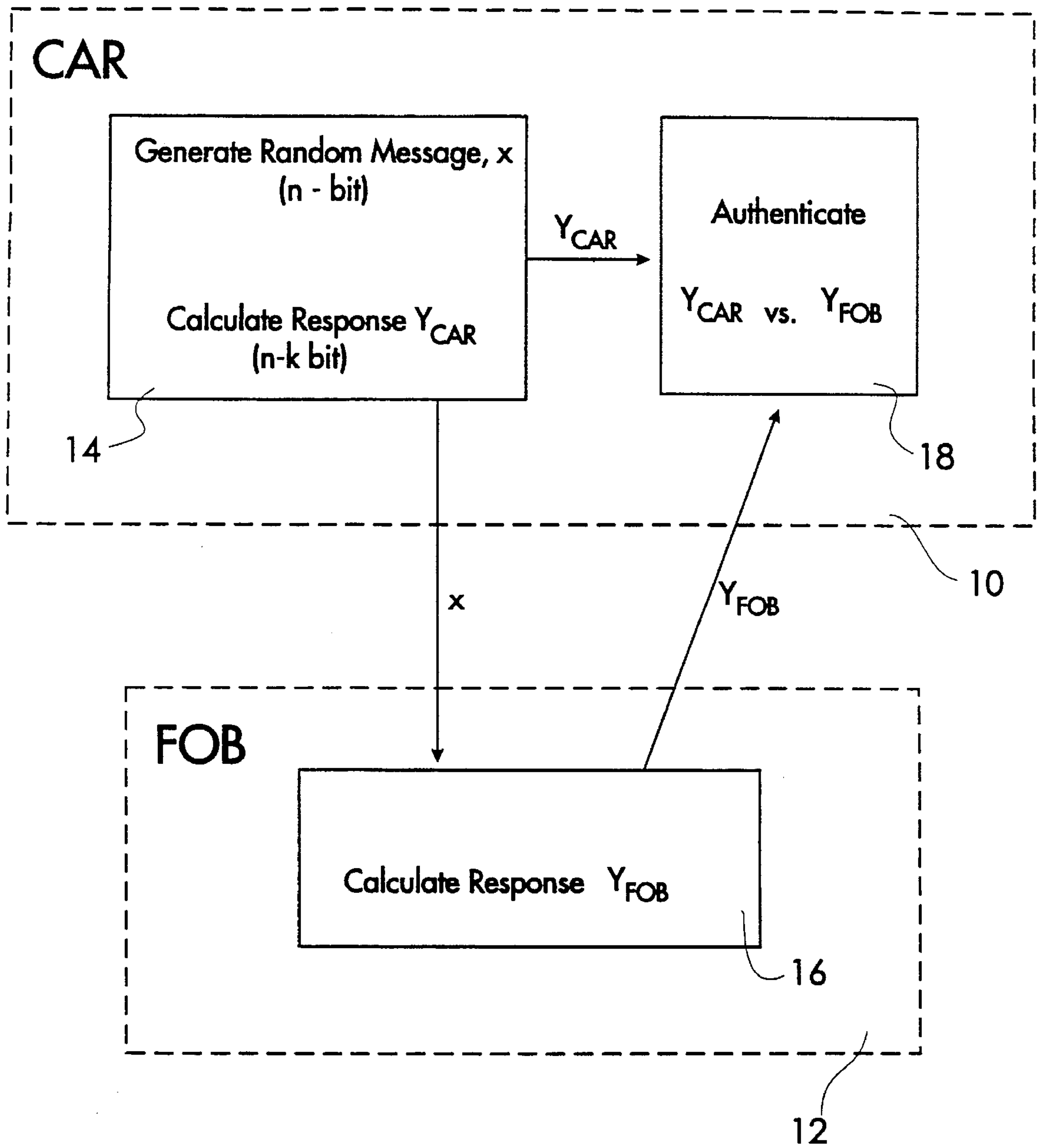
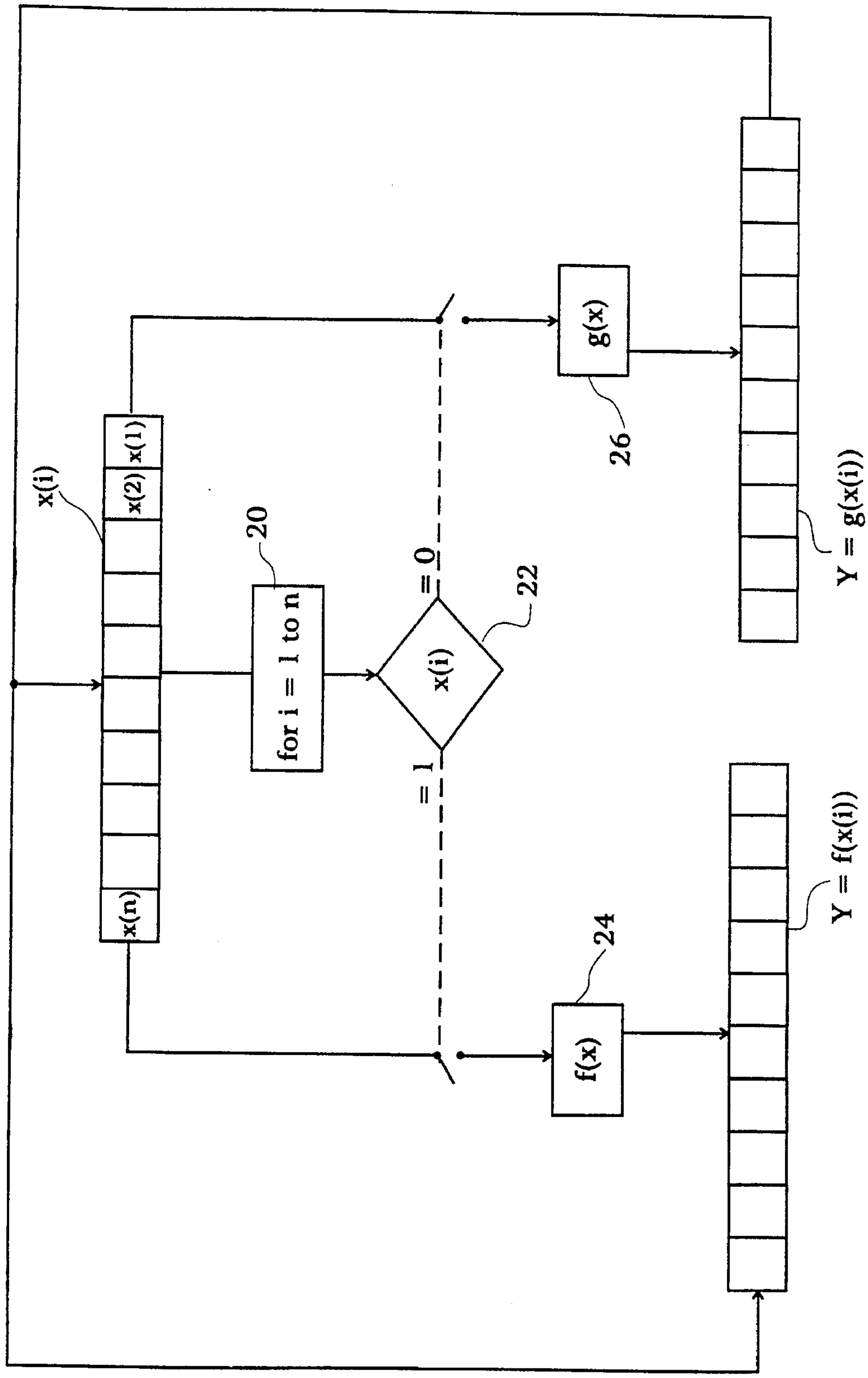

CAR
Generate Random Message, x
(n - bit)
Calculate Response $Y_{CAR}$
(n-k bit)
$Y_{CAR}$
Authenticate
$Y_{CAR}$ vs. $Y_{FOB}$
14
18
10
x
$Y_{FOB}$
FOB
Calculate Response $Y_{FOB}$
16
12

FIGURE 2



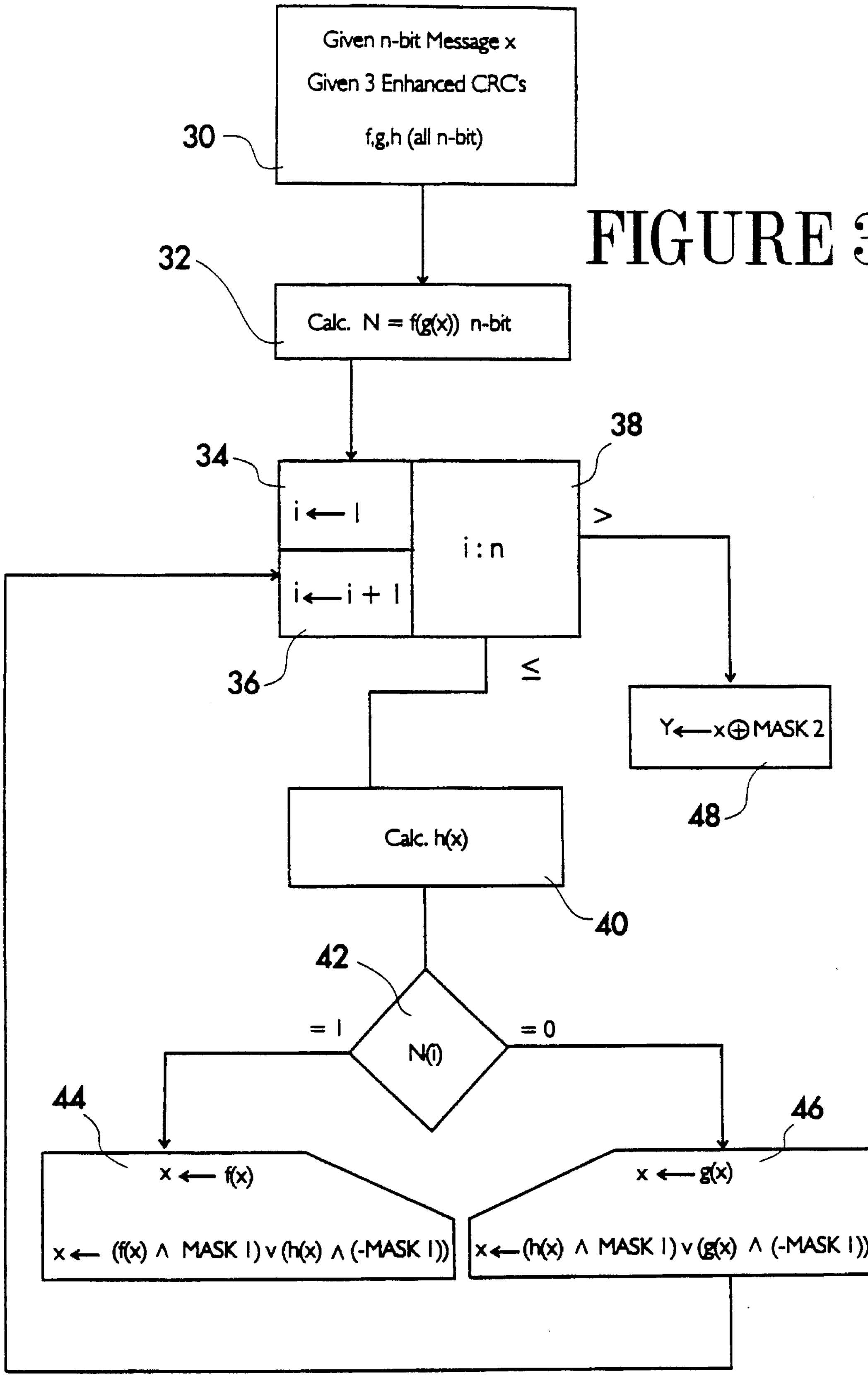

Given n-bit Message x
Given 3 Enhanced CRC's
f,g,h (all n-bit)
30
32
Calc. N = f(g(x)) n-bit
34
38
i ← 1
i : n
i ← i + 1
36
>
≤
Y ← x ⊕ MASK 2
48
Calc. h(x)
40
42
N(i)
= 1
= 0
44
46
x ← f(x)
x ← (f(x) ∧ MASK 1) v (h(x) ∧ (-MASK 1))
x ← g(x)
x ← (h(x) ∧ MASK 1) v (g(x) ∧ (-MASK 1))

FIGURE 3

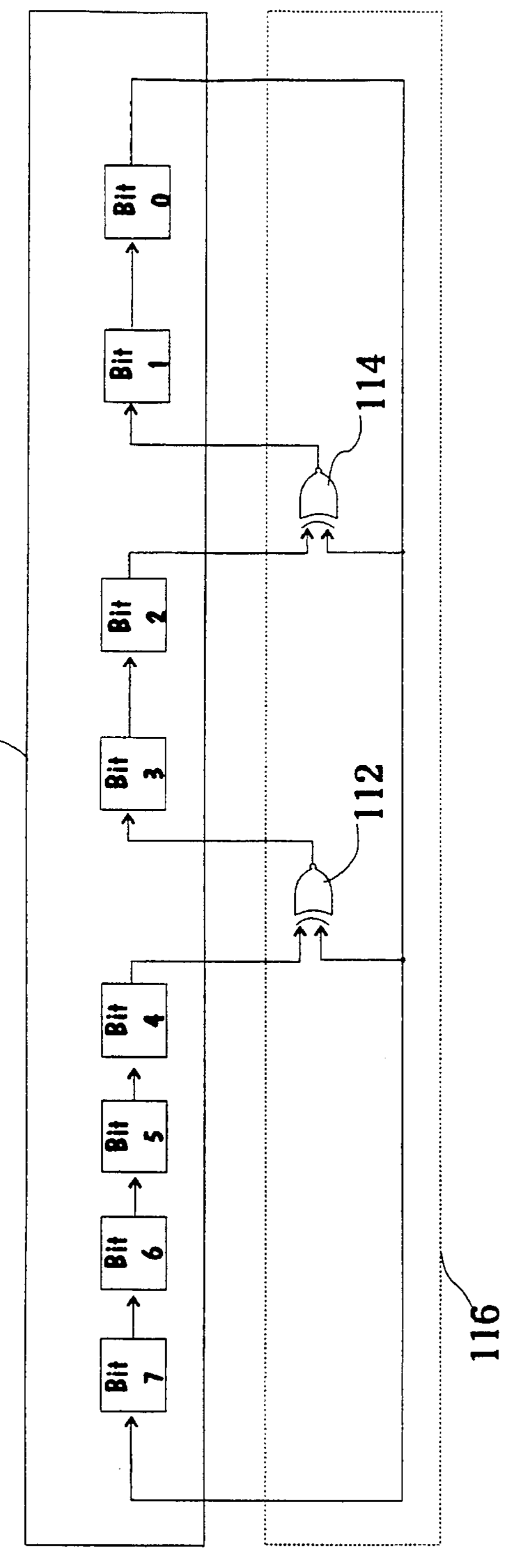



Figure 4

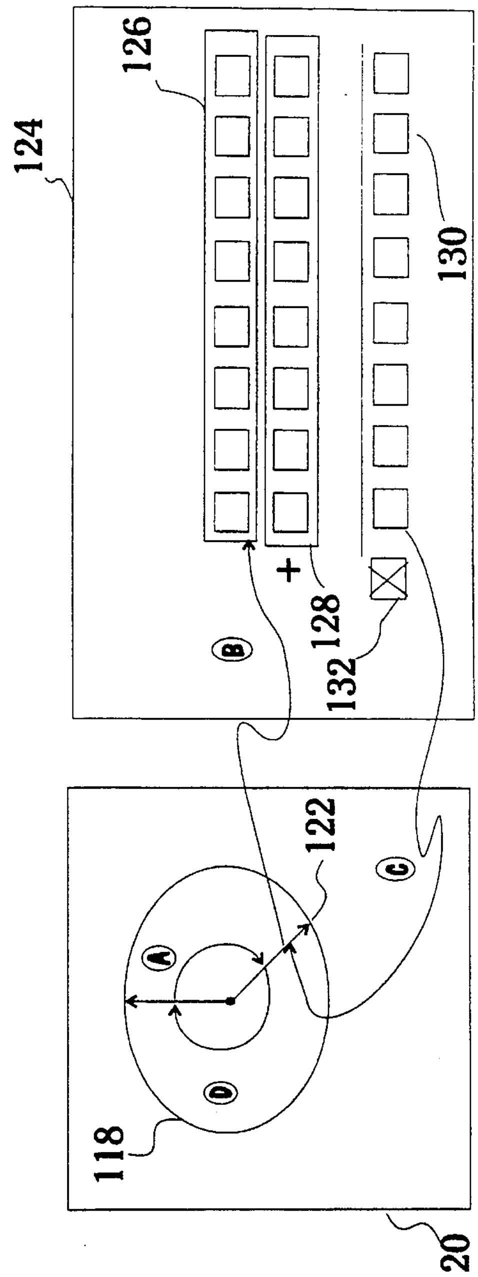



Figure 5

# PSEUDORANDOM COMPOSITION-BASED CRYPTOGRAPHIC AUTHENTICATION PROCESS

## BACKGROUND ANS SUMMARY OF THE INVENTION

The present invention relates generally to cryptography, and in particular to a method of encrypting digital information rendering it more difficult to decipher using computer-assisted techniques. Although the invention is applicable to a wide range of applications, it finds particular utility in an encryption system for keyless entry locks, such as keyless entry locks for automotive applications.

Cyclic redundancy code (CRC) cryptographic authentication processes are currently employed in antitheft systems for vehicles, including keyless entry systems and engine ignition systems. User authentication is a major concern. Present-day systems use RF or infrared transmissions to communicate between the vehicle and the wireless electronic key device, commonly embedded in a key fob. These systems suffer from "playback" attacks, where a would-be thief simply records the transmission of the key Fob and plays it back to gain entry. Cryptographic authentication systems are used to provide some degree of security against such playback attacks.

While cyclic redundancy code cryptographic authentication systems provide a modicum of security, these systems can be broken by computer-assisted techniques. One such technique is the "chosen plaintext" attack, in which a computer generates a sequence of possible access codes and monitors the response of the key fob or lock to each sequence sent. Because computers can do this quite quickly, it is possible using the chosen plaintext attack to rapidly sequence through millions of selectively chosen combinations, until the unlocking combination is found. The chosen plaintext attack works well on conventional cryptographic systems because the attacker knows the identity of each input number tested and simply has to observe the system response to that input. After enough observations are made, the internal workings of the secret cryptographic process can be inferred.

The present invention provides a unique pseudorandom process for immunizing cryptographic system against chosen plaintext attack. The digital information to be encrypted is represented as a set of binary digits. The set of binary digits is then altered by sequentially testing each of a plurality of digits, one digit at a time, to determine if the digit is a 1 or a 0. For each digit so tested, a first encryption process is applied to the set of digits if the tested digit is a 1, and second encryption process is applied to the set of digits if the tested digit is a 0. The power of this technique may be seen by considering what happens when an n-bit number is encrypted. Because each bit may be tested an encryption process selected accordingly, there are $2^n$ possible encryption processes. The encryption process is therefore data dependent, making chosen plaintext attack exponentially less fruitful.

For a more complete understanding of the invention, its objects and advantages, reference may be had to the following specification and to the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating an exemplary authentication interaction between car and Fob, useful in explaining the invention;



FIG. **2** is a flow diagram illustrating the pseudorandom bitwise encryption technique of the invention;

FIG. **3** is a flowchart illustrating a presently preferred embodiment of the invention;

FIG. **4** is a block diagram illustrating an example of a linear feedback shift register (LFSR), useful in understand the principles of the invention; and

FIG. **5** is a schematic diagram illustrating the method by which digital information is encyrpted utilizing processing steps in both the Galois Field and the Integer Ring.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention will be described in the context of a keyless entry system for a vehicle. Accordingly, in FIG. **1** a car is diagrammatically depicted by dashed box **10** and a remote keyless entry key fob device is similarly depicted at **12**. In the illustrated scenario, the car transmits digital information x to fob **12** and fob **12** transmits digital information $Y_{fob}$ to the car **10**. In a typical keyless entry system the two digital information signals are sent using infrared or radio frequency signals. Because these signals are sent via a wireless pathway, they are potentially subject to reception by would-be code breakers. Accordingly, one important aspect of the invention is the encrypting of these signals so that they may not be readily decrypted and used to steal the car.

Digital information message x is generated as a random n-bit number. For example, the random number may be generated using a random number generator which relies on thermal noise or on cosmic background radiation, for example. Both the car and the fob both employ the same mechanism to calculate an encrypted digital information signal Y, which may be an n-bit number or alternatively an n-bit number with certain digits masked off (n-k bits). In FIG. **1** the mechanism used by the car to generate the encrypted digital information $Y_{car}$ is illustrated as the lower portion of block **14**. The counterpart mechanism in the fob is depicted by block **16**, which produces the encrypted digital value $Y_{fob}$. The details of this encryption mechanism are described in connection with FIGS. **2** and **3** below.

The car **10** also includes an authentication block **18** which compares the encrypted information $Y_{car}$ with the encrypted digital information $Y_{fob}$. If these two values match, the interrogation sequence will deem the entry attempt to be authentic and the lock is unlocked. If these values do not match, then the interrogation sequence fails and the lock remains locked.

Before turning to the details of the encryption routine, it is instructive to note that the digital information transmitted from car to fob is a random number. The digital information returned by the fob to the car is an encrypted random number. Hence the would-be thief gains virtually no information by monitoring either of these transmissions.

Referring to FIG. **2**, the presently preferred pseudorandom encryption process is introduced. Specifically, FIG. **2** details the bitwise encryption technique whereby the digital information is altered in a different way depending on whether each digit is a 1 or a 0. Thereafter, in FIG. **3**, the presently preferred pseudorandom encryption scheme is illustrated in detail.

Referring to FIG. **2**, the digital information to be encrypted is represented as a set of binary digits, in this case binary digits x(1) . . . x(10). For purposes of this example, a 10 bit number has been used. Of course, in practice the number may be any number of bits. Each of the individual binary digits or bits has been illustrated separately by boxes designated x(0) . . . x(1) . . . x(10). A looping construct **20** is used which tests, one after another, each successive bit of the digital information N(i). This looping mechanism is designated at **20**. With each pass through the loop, the individual digit represented by the index counter i is tested to see whether it is a 1 or a 0. If the digit is a 1, encryption process f(x) is used, as depicted at **24**. If the digit is a 0, encryption process g(x) is used as depicted at **26**.

Processes f(x) and g(x) operate on the entire set of binary digits representing x. The resultant value Y, whether generated using f(x) or g(x), is fed back to and substituted for the original value x, whereupon the next iteration of the loop continues in the same fashion. In this way, the original digital information value x will be encrypted through a series of n encryption processes, with each individual process being either f(x) or g(x), depending on the digital value of the bit pointed to by the current index counter i. A pseudorandom, data-dependent composition process results. In the case of the 10 bit number illustrated in this example, this process results in $2^{10}=1024$ different encryption processes.

In FIG. **3** a presently preferred encryption process, using the technique of FIG. **2**, is illustrated. The digital information to be encrypted is represented as an n-bit message X, as depicted at block **30**. Block **30** also illustrated that the presently preferred encryption process uses three enhanced cyclic redundancy code processes, designated as functions f, g and h, all n-bit processes. The details of these enhanced cyclic redundancy code processes are explained in FIGS. **4** and **5**. While these processes are presently preferred, it will be understood that other encryption processes may be used instead.

In step **32** the encrypted value n is calculated using two of the three provided functions, namely f and g. Step **32** is a composition process. That is, the result of one function is used as the input to the next function. Thus, in this case, the CRC process g is applied to message x and the result is then fed as input to CRC function f. The resulting value N thus represents a composition-based encryption of message x.

Next, control proceeds to the looping construct depicted by boxes **34**, **36** and **38**. Essentially the looping construct uses an index counter i which is first assigned the value 1 in step **34**. The index counter is compared to N in step **38** to determine the end of looping. Subsequently, the looping construct increments the index counter i by assigning it the value i+1 as indicated in step **36**. The looping construct continues in this fashion until the index counter i=n (the number of bits in the n-bit message x and in the encrypted n-bit value n). The presently preferred looping construct tests the index counter value at step **38** before proceeding to step **40** or to step **48**. If the index counter i is $\leqq$n, control proceeds to step **40**. Otherwise, if index counter i is $\geqq$n, control proceeds to step **48**.

In step **40** the third enhanced CRC function h is used upon message x. This will result in an encrypted value having n bits or digits. This value is used later in the encryption process, as will be illustrated.

At step **42** each digit of the encrypted digital information N is tested to determine if the digit is a 1 or a 0. One digit of value N is tested on each pass through the looping construct. Thus, the first time through the loop the digit N(**1**) is tested; the second pass through the loop N(**2**) is tested, and so forth. If the digit tested is a 1, control branches to step **44**. If the digit tested is a 0, control branches to step **46**.

Steps **44** and **46** are different in that they used different encryption processes. Step **44** uses CRC process f, whereas step **46** uses CRC process g. The control flow through each branch is essentially the same. Taking step **44**, for example, the value x is replaced with the encrypted value f(x). This value is then concatenated with a portion of the encrypted value h(x). Note that h(x) is calculated at step **40** and note that this calculation occurs anew with each iteration of the loop. The presently preferred concatenation involves applying a mask (mask **1**) to values f(x), g(x) and h(x). The mask is applied by Boolean AND operation. The resulting masked values are then combined using a Boolean OR operation and the value x is replaced by the result of this OR operation. Any mask can be used as mask **1**. For example, mask **1** can be a predefined bit pattern, e.g., 0101101010. Alternatively, the mask can be generated by a process. For example, the m high order bits of f(x) may be concatenated with n-m low order bits of h(x), or the l high order bits of h(x) may be concatenated with the n-l low order bits of g(x), depending on whether f(x) or g(x) was used in the loop index (i.e., whether control has branched to step **44** or step **46**.

Once all n loop iterations have been completed, the result Y is generated at step **48**. Y may be simply the value x after the above-described encryption process. Alternatively, a second mask (mask **2**) may be applied to the value x and this new masked value is used as Y. This is illustrated in step **48** where mask **2** is applied to value x using an exclusive OR operation.

Once all n loop iterations have been completed, the resulting Y is transmitted back to the car for authentication. Since the car has the same shared secret information as the fob, the car performs the same operations on the original message x that is sent to the Fob. Authentication amounts to confirming the message received from the fob (Y) matches that produced by the car.

The above-described pseudorandom technique may be implemented using a variety of different encryption processes. In the presently preferred embodiment three processes f, g and h are used. By way of example, the following will now describe a suitable cyclic redundancy code (CRC) process which may be used to implement the invention. The process illustrated here is an enhanced cyclic redundancy code process which has increased resistance to attack by virtue of the non-Galois field operation that is secretly performed at a point in the encryption process known only to the car and to the fob. Of course, the foregoing pseudorandom cryptographic process can be used with other types of encryption processes.

The presently preferred encryption method uses a cyclic redundancy code (CRC) to scramble the bits of a message of digital information. Conventional CRC processes provide comparatively weak encryption. This is because a CRC process can be expressed as a linear operation over a Galois Field, and linear operations are inherently easier to analyze than nonlinear operations. The enhanced CRC process introduces nonlinearities into the CRC process by performing an operation over the Real Field or Integer Ring, in the middle of the CRC process.

As used herein the terms Real Field and Integer Ring are used essentially synonymously. As will be explained, this technique introduces significant complexity, making cryptographic analysis far more difficult. The inclusion of an Integer Ring operation, such as Integer Ring addition, superimposes a supplemental encryption function over and above the basic CRC process. This, in effect, gives two simultaneous levels of encryption or scrambling, essentially for the price of one.

The enhanced CRC process can be implemented to operate on digital information comprising any desired number of bits. For example, in a keyless entry system a 32 bit CRC process (with a secret feedback polynomial) may be used to scramble a 32 bit piece of digital information such as an access code. The CRC process is equivalent to multiplication in a Galois Field GF($2^n$). The CRC can be computed as **32** iterations of a shift and exclusive OR with mask operation.

To illustrate the principle, an 8 bit CRC process will be illustrated. It will, of course, be understood that the invention is not restricted to any bit size number. Referring to FIG. 4, the individual bits residing in register **110** have been designated in the boxes labeled bit **0**-bit **7** consecutively. In general, register **110** is configured to cycle from left to right so that bit **7** shifts right to supply the input to bit **6**, bit **6** to bit **5**, and so forth (with the exception of those bits involved in the exclusive OR operations). As illustrated, bit **0** shifts back to bit **7**, thereby forming a cycle or loop.

In addition to the shift operation, the digital information in register **110** is also subjected to one or more exclusive OR operations. In FIG. 4, exclusive **0**R operations **112** and **114** have been illustrated. Exclusive **0**R operation **112** receives one of its inputs from bit **4** and the other of its inputs from bit **0**. Exclusive OR **112** provides its output to bit **3**. Similarly, exclusive OR **114** receives its inputs from bit **2** and bit **0** and provides its output to bit **1**. The two exclusive OR operations illustrated in FIG. **4** are intended to be merely exemplary, since, in general, any number of exclusive OR operations may be used, ranging from none up to the number of digits in the register (in this case **8**). Also, the exclusive **0**R operations may be positioned between any two adjacent bits, in any combination. Thus, the positioning of exclusive **0**R operations between bits **3** and **4** and between bits **1** and **2** as shown in FIG. **4** is merely an example.

The exclusive OR operations selected for a given encryption may be viewed as a mask wherein the bits of the mask are designated either 1 or 0, depending on whether an exclusive OR operation is present or not present. Thus, in FIG. 4, the mask may be designated generally at **116**.

Table I illustrates the shift register bit patterns for the register and mask combination of FIG. 4. The Table lists at the top an exemplary initial bit pattern (to represent an exemplary byte or word of digital information), followed by the resulting bit patterns for each of 8 successive iterations or cycles.

Table I depicts all of the possible successive bit patterns for the circuit of FIG. 4. Because the exclusive OR gates of FIG. 4 do not correspond to a primitive polynomial, the circuit is not a maximal length feedback shift register. That it is not maxima length is obvious by inspection of Table I. Each separate column of binary numbers represents successive steps of the circuit of FIG. 4. A shift of the last number in a column (equivalently a cycle) produces the number at the top of the column. There are 20 different cycles of length between 2 and 14.

TABLE I

| | | | | | | |
|---|---|---|---|---|---|---|
| 00000001 | 00000011 | 00000101 | 00000111 | 00001001 | 00001011 | 00001101 |
| 10001010 | 10001011 | 10001000 | 10001001 | 10001110 | 10001111 | 10001100 |
| 01000101 | 11001111 | 01000100 | 11001110 | 11000111 | 11001101 | 01000110 |
| 10101000 | 11101101 | 00100010 | 01100111 | 10101001 | 11101100 | 00100011 |
| 01010100 | 11111100 | 00010001 | 10111001 | 11011110 | 01110110 | 10011011 |
| 00101010 | 01111110 | 10000010 | 11010110 | 01101111 | 00111011 | 11000111 |
| 00010101 | 00111111 | 01000001 | 01101011 | 10111101 | 10010111 | 11101001 |
| 10000000 | 10010101 | 10101010 | 10111111 | 11010100 | 11000001 | 11111110 |
| 01000000 | 11000000 | 01010101 | 11010101 | 01101010 | 11101010 | 01111111 |
| 00100000 | 01100000 | 10100000 | 11100000 | 00110101 | 01110101 | 10110101 |
| 00010000 | 00110000 | 01010000 | 01110000 | 10010000 | 10110000 | 11010000 |
| 00001000 | 00011000 | 00101000 | 00111000 | 01001000 | 01011000 | 01101000 |
| 00000100 | 00001100 | 00010100 | 00011100 | 00100100 | 00101100 | 00110100 |
| 00000010 | 00000110 | 00001010 | 00001110 | 00010010 | 00010110 | 00011010 |
| 00001111 | 00010011 | 00010111 | 00011001 | 00011011 | 00011101 | 00100111 |
| 10001101 | 10000011 | 10000001 | 10000110 | 10000111 | 10000100 | 10011001 |
| 11001100 | 11001011 | 11001010 | 01000011 | 11001001 | 01000010 | 11000110 |
| 01100110 | 11101111 | 01100101 | 10101011 | 11101110 | 00100001 | 01100011 |
| 00110011 | 11111101 | 10111000 | 11011111 | 01110111 | 10011010 | 10111011 |
| 10010011 | 11110100 | 01011100 | 11100101 | 10110001 | 01001101 | 11010111 |
| 11000011 | 01111010 | 00101110 | 11111000 | 11010010 | 10101100 | 11100001 |
| 11101011 | 00111101 | | 01111100 | 01101001 | 01010110 | 11111010 |
| 11111111 | 10010100 | | 00111110 | 10111110 | 00101011 | 01111101 |
| 11110101 | 01001010 | | 00011111 | 01011111 | 10011111 | 10110100 |
| 11110000 | 00100101 | | 10000101 | 10100101 | 11000101 | 01011010 |
| 01111000 | 10011000 | | 11001000 | 11011000 | 11101000 | 00101101 |
| 00111100 | 01001100 | | 01100100 | 01101100 | 01110100 | 10011100 |
| 00011110 | 00100110 | | 00110010 | 00110110 | 00111010 | 01001110 |
| 00101001 | 00101111 | 00111001 | 01010001 | 01010011 | 01011011 | |
| 10011110 | 10011101 | 10010110 | 10100010 | 10100011 | 10100111 | |
| 01001111 | 11000100 | 01001011 | | 11011011 | 11011001 | |
| 10101101 | 01100010 | 10101111 | | 11100111 | 11100110 | |
| 11011100 | 00110001 | 11011101 | | 11111001 | 01110011 | |
| 01101110 | 10010010 | 11100100 | | 11110110 | 10110011 | |
| 00110111 | 01001001 | 01110010 | | 01111011 | 11010011 | |
| 10010001 | 10101110 | | | 10110111 | 11100011 | |
| 11000010 | 01010111 | | | 11010001 | 11111011 | |
| 01100001 | 10100001 | | | 11100010 | 11110111 | |
| 10111010 | 11011010 | | | 01110001 | 11110001 | |
| 01011101 | 01101101 | | | 10110010 | 11110010 | |

TABLE I-continued

| | | | |
|---|---|---|---|
| 10100100 | 10111100 | 01011001 | 01111001 |
| 01010010 | 01011110 | 10100110 | 10110110 |

The bitwise shifting and exclusive OR operations provided by the CRC process can be viewed as a multiplication operation between the register and mask in the Galois Field GF($2^n$). This operation is, in effect, a convolution operation in which the register bit pattern representing the digital information to be encrypted is convolved with or folded into the bit pattern of the mask.

Rather than performing the shifting and exclusive OR operations through a full cycle, as demonstrated by Table I, the present invention suspends or temporarily halts the convolution operation after a predetermined number of multiplications or iterations. The number of iterations performed before the CRC convolution process is suspended can be treated as a secret number or key to be used in later decrypting the resultant. In FIG. **5** the CRC convolution process is illustrated diagrammatically by circle **118**. For illustration purposes, one complete cycle of n iterations (n being the number of bits in the register in this example is diagrammatically depicted by a full rotation of 360° within circle **118**. Thus during a first portion of the convolution process depicted by arc A the CRC process proceeds from its starting point at the twelve o'clock position to the suspension point (in this case at the five o'clock position). The point at which suspension occurs is arbitrary,since suspension can occur at any selected point within the full convolution cycle.

While the convolution process is occurring, as depicted by circle **118**, the operations can be considered as taking place in or being represented in the Galois Field, designated generally by region **120**. However, when the suspension point is reached, as at **122**, the Galois Field processes are suspended and further processing occurs in the Integer Ring **124**. While in the Integer Ring the intermediate resultant of previous Galois Field operations (multiplications) are operated on by a Real Field or Integer Ring process. In FIG. **5**, the intermediate resultant value is depicted generally by bit pattern **126**. In the presently preferred embodiment bit pattern **126** is arithmetically added with a predetermined number or bit pattern **128**, with the resulting sum depicted at **130**.

One characteristic of the Integer Ring operation is that a carry operation may or may not occur, depending on the value of the digits being added. That is, if digits 0+0 are added, no carry occurs, whereas if digits 1+1 are added, a carry is generated. Any carry from the most significant digit is ignored, as illustrated at **132**.

After the Integer Ring operation has completed, the resultant sum is transferred back to the Galois Field as indicated by arrow C, whereupon the remainder of the CRC operation is carried out as indicated by arc D.

It will be appreciated that the options for altering the simple CRC process are numerous. The precise point at which the CRC process is suspended and the resultant transferred to the Integer Ring can be after any preselected number of iterations (the preselected number being optionally a secret number or key). In addition, the number or bit pattern **128** added while in the Real Field or Integer Ring can also be any secret number, serving as an additional key. Because carries may occur between bits of the intermediate value during the addition step in the Integer Ring, the process is nonlinear with respect to the Galois Field over which the CRC process is being performed. It will be seen that the process thus described is extremely inexpensive to implement, since it only requires one or a few additional program instructions to accomplish and may be effected in as short as a single clock cycle.

The improved encryption resulting from the above-described process may be used as a new fundamental cryptographic building block which can be combined to form a part of a more complex encryption/decryption process. For example, more than one Integer Ring operation could be performed during the CRC process to further complicate any decryption analysis. Similarly, any single or combination of information-preserving, reversible operations over the Integer Ring (e.g. addition, subtraction) can be used during the CRC. The key to effectiveness is that the Integer Ring operation must produce the possibility of inter-bit arithmetic carries, which are inherently poorly expressed by Galois Field analysis. Similarly any combination of two or more information-preserving, reversible operations over different mathematical structures, such as Groups, Rings or Fields, can be used. The key to effectiveness is that the operation in one mathemtaical structure is inherently poorly represented in one or more of the other structures.

The enhanced CRC process may be implemented in software.

From the foregoing it will be understood that the invention provides an easily implemented, but highly effective technique for encrypting digital information so that chosen plaintext attack cannot be readily used to decrypt the information. While the invention has been described in its presently preferred form, it will be understood that the invention is capable of modification without departing from the spirit of the invention as set forth in the appended claims.

What is claimed is:

**1**. A method of encrypting digital information comprising the steps of:

(a) representing said digital information as a set of binary digits, N:

(b) testing one of the binary digits to determine if the digit is a 1 or a 0;

(c) applying a first encryption process on said digital information if the digit is a 1 or a second encryption process on said digital information if the digit is a 0 to produce an altered set of digital information;

(d) replacing said digital information with said altered set of digital information;

(e) repeating steps (b) through (d) upon testing a second of said binary digits to determine if said second of said binary digits is a 1 or a 0.

**2**. The method of claim **1**, wherein said first encryption process comprises an enhanced CRC process.

**3**. The method of claim **1**, wherein said second encryption process comprises an enhanced CRC process.

**4**. The method of claim **1**, further comprising the step of performing a third encryption process on said set of binary digits prior to said step of testing one of the binary digits.

**5**. The method of claim **1**, wherein said step (e) is performed iteratively over each digit in said set of digits.

**6**. The method of claim **1**, wherein a plurality of binary digits are tested in step (a).

7. The method of claim 4, wherein said third encryption process comprises an enhanced CRC process.

8. A method of encrypting digital information represented by a plurality of binary digits, said method comprising the steps of:

(a) testing a first bit of the plurality of binary digits to determine if the digit is a "1" or a "0";

(b) encrypting the digital information according to a first encryption process if the digit is a "1" or according to a second encryption process if the digit is a "0" to produce an altered set of digital information;

(c) replacing the digital information with said altered set of digital information; and

(d) repeating said steps (a) through (c) upon testing a second one of said binary digits to determine if the digit of said second one of said binary digits is a "1" or a "0".

9. The method of claim 8, wherein said first encryption process comprises an enhanced CRC process.

10. The method of claim 8, wherein said second encryption process comprises an enhanced CRC process.

11. The method of claim 8, further comprising the step of:

performing a third encryption process on the plurality of binary digits prior to said step of testing a first bit of the plurality of binary digits.

12. The method of claim 11, wherein said third encryption process comprises an enhanced CRC process.

13. The method of claim 8, wherein the plurality of binary digits comprises at least three bits, and said step (d) is performed iteratively over each bit of the plurality of binary digits.

14. The method of claim 8, wherein a number of binary digits are tested in step (a).



15. A pseudorandom composition based cryptographic authentication process for encrypting digital information represented as a plurality of binary digits, said pseudorandom composition based cryptographic authentication process comprising the steps of:

(a) testing a first bit of the binary digits to determine if the digit is a 1 or a 0;

(b) encrypting the digital information according to a first encryption process if the digit is a 1 or according to a second encryption process if the digit is a 0 to produce an altered set of digital information, said first and second encryption process comprising an enhanced CRC process;

(c) replacing the digital information with said altered set of digital information; and

(d) repeating said steps (a) through (c) upon testing a second one of said binary digits to determine if the digit of said second one of said binary digits is a 1 or a 0.

16. The method of claim 15, further comprising the step of:

performing a third encryption process on said set of binary digits prior to said step of testing a first bit of the binary digits.

17. The method of claim 16, wherein said third encryption process comprises an enhanced CRC process.

18. The method of claim 15, wherein the plurality of binary digits comprises at least three bits, and said step (d) is performed iteratively over each bit of the plurality of binary digits.

19. The method of claim 15, wherein a number of binary digits are tested in step (a).

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