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United States Patent [19]

Sudia

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[54] **ENHANCED CRYPTOGRAPHIC SYSTEM AND METHOD WITH KEY ESCROW FEATURE**

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[21] Appl. No.: **803,176**

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Related U.S. Application Data

[60] Division of Ser. No. 272,203, Jul. 8, 1994, abandoned, which is a continuation-in-part of Ser. No. 181,859, Jan. 13, 1994, abandoned.

[51] **Int. Cl.**^{6} **H04L 9/32**

[52] **U.S. Cl.** **380/23**; 380/30

[58] **Field of Search** 380/30, 23

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,200,770	4/1980	Hellman et al. .	
4,218,582	8/1980	Hellman et al. .	
4,405,829	9/1983	Rivest et al. .	
4,868,877	9/1989	Fischer .	
4,995,082	2/1991	Schnorr .	
5,001,752	3/1991	Fischer .	
5,005,200	4/1991	Fischer .	
5,136,643	8/1992	Fischer .	
5,150,411	9/1992	Maurer .	
5,164,988	11/1992	Matyas et al. .	
5,199,070	3/1993	Matsuzaki et al. .	
5,214,700	5/1993	Pinkas et al. .	
5,214,702	5/1993	Fischer .	
5,222,140	6/1993	Beller et al. .	
5,261,002	11/1993	Perlman et al. .	
5,276,737	1/1994	Micali .	
5,313,521	5/1994	Torii et al. .	
5,315,658	5/1994	Micali .	
5,371,794	12/1994	Diffie et al.	380/21
5,396,558	3/1995	Ishiguro et al.	380/25
5,539,828	7/1996	Davis	380/50
5,557,518	9/1996	Rosen	364/408

OTHER PUBLICATIONS

American National Standard X9.30, "Public Key Cryptography Using Irreversible Algorithms for the Financial Services Industry: Part 1: The Digital Signature Algorithm (DSA)" (American Bankers Assn., Washington, D.C., 1993).

American National Standard X9.30, "Public Key Cryptography Using Irreversible Algorithms for the Financial Services Industry: Part 2: The Secure Hash Algorithm (SHA)" (American Bankers Assn., Washington, D.C., 1993).

American National Standard X9.30, "Public Key Cryptography Using Irreversible Algorithms for the Financial Services Industry: Part 3: Certificate Management for DSA" (American Bankers Assn., Washington, D.C., 1993).

Silvio Micali, "Fair Public Key Cryptosystems", Laboratory for Computer Science of the Massachusetts Institute of Technology,. Oct. 13, 1993.

Donn B. Parker, "Crypto and Avoidance of Business Information Anarchy" First Annual AC Conference on Computer and Communication Security, Nov. 3–5, Reston, VA.

(List continued on next page.)

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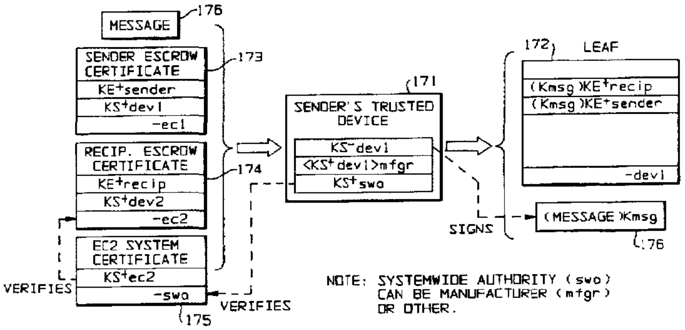
Attorney, Agent, or Firm—Steptoe & Johnson LLP

[57] **ABSTRACT**

A cryptographic system with key escrow feature that uses a method for verifiably splitting user's private encryption keys into components and for sending those components to trusted agents chosen by the particular users is provided. The system uses public key certificate management, enforced by a chip device that also self-certifies. The methods for key escrow and receiving an escrow certificate are applied to register a trusted device with a trusted third party and to receive authorization from that party enabling the device to communicate with other trusted devices. The methods for key escrow also provide assurance that a trusted device will engage in electronic transactions in accordance with predetermined rules.

12 Claims, 25 Drawing Sheets



NOTE: SYSTEMWIDE AUTHORITY (swo) CAN BE MANUFACTURER (mfgr) OR OTHER.

SEND ENCRYPTED MESSAGE WITH MCH (OVERVIEW)

OTHER PUBLICATIONS

CCITT Recommendation X.509, "The Directory—Authentication Framework", International Standards Organization (ISO), Melbourne, Australia 1988.

Dorothy E. Denning, "The Clipper Encryption System", American Scientist, Jul.–Aug., 1993, pp. 319–323.

Martin E. Hellman, "Commercial Encryption", IEEE Network Magazine, Apr. 1987, vol. 1, No. 2, pp. 6–10.

David B. Newman, Jr., Jim K. Omura and Raymond L. Pickholtz, "Public Key Management for Network Security", IEEE Network Magazine, Apr. 1987, vol. 1, No. 2, pp. 11–16.

DIFFIE-HELLMAN AND MICALI ABBREVIATIONS

x	RECIPIENTS PRIVATE KEY (EXPONENT)
x1...n	NUMBERED FRAGMENTS OF PRIVATE KEY
xi	i-th FRAGMENT OF PRIVATE KEY
y	SENDER'S EPHEMERAL PRIVATE KEY (EXPONENT)
a	PUBLIC BASE NUMBER
P	PUBLIC PRIME MODULUS NUMBER
DHx	INTERMEDIATE NUMBER, $= a^{x} \bmod P$
DHy	INTERMEDIATE NUMBER, $= a^{y} \bmod P$
Kdh	DIFFIE-HELLMAN DERIVED MESSAGE KEY
V1...n	MICALI INTERMEDIATE NUMBER, $= a^{xi} \bmod P$

OTHER SYMMETRIC KEY ABBREVIATIONS

k_{msg}	RANDOM OR DERIVED MESSAGE KEY
M	PLAINTEXT MESSAGE
C	CIPHERTEXT MESSAGE

FIG. 1A

FIG. 1B GENERAL ASSYMETRIC KEY NOTATION

	PUBLIC	PRIVATE
SIGNATURE	KS^{+}	KS^{-}
ENCRYPTION	KE^{+}	KE^{-}

FIG. 1C PUBLIC KEY CERTIFICATE NOTATION (EXAMPLE)

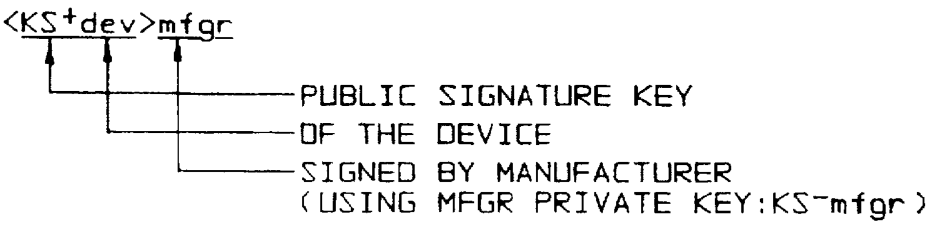

$\langle KS^{+}dev\rangle mfgr$
PUBLIC SIGNATURE KEY
OF THE DEVICE
SIGNED BY MANUFACTURER
(USING MFGR PRIVATE KEY: $KS^{-}mfgr$)

FIG. 1D

PUBLIC KEY ENCRYPTON
NOTATION (EXAMPLE)

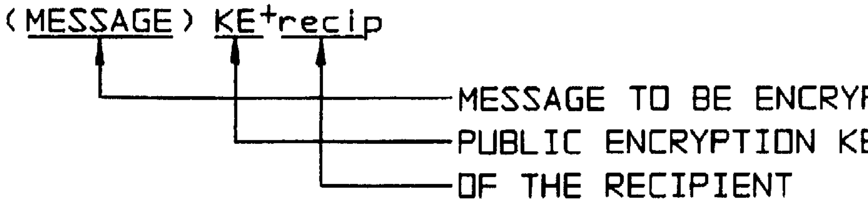


FIG. 1E SUFFIXES USED TO DENOTE KEY OWENERSHIP

box		LAW ENFORCEMENT DECODER BOX
ca	ca1...n	CERTIFYING AUTHORITY (FOR PUBLIC SIGNATURE K
dev		DTRUSTED DEVICE
ea	ea1...n	ESCROW AGENT
ec	ec1...n	ESCROW CENTER
mfgr	mfg1...n	MANUFACTURER OF THE TRUSTED DEVICE
owner		OWNER OF DEVICE (IF OTHER THAN USER)
recip		RECIPIENT OF A MESSAGE
sender		SENDER OF A MESSAGE
swa		SYSTEM-WIDE AUTHORITY
user	user1...n	USER OF THE TRUSTED DEVICE

FIG. 1F

SHORTHAND NOTATION - SIGNING

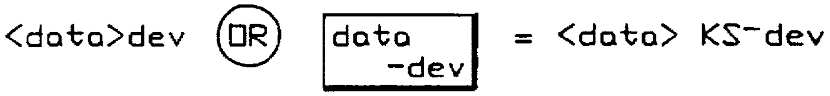


FIG. 1G

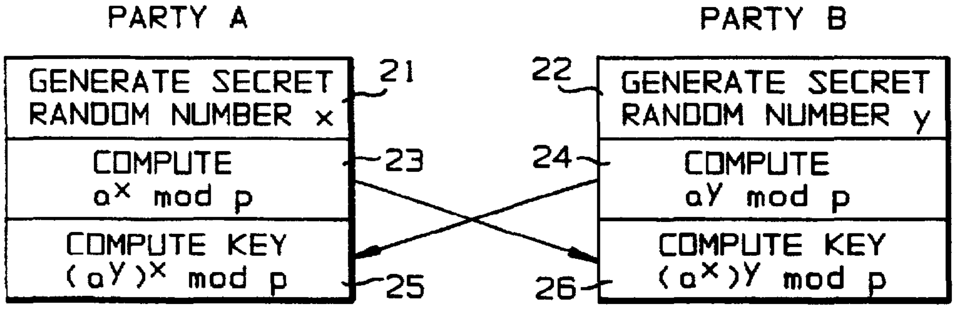
SHORTHAND NOTATION - ENCRYPTION

<data>sender = (data) KE^{+}sender

FIG. 2

INTERACTIVE DIFFIE-HELLMAN KEY DERIVATIVE

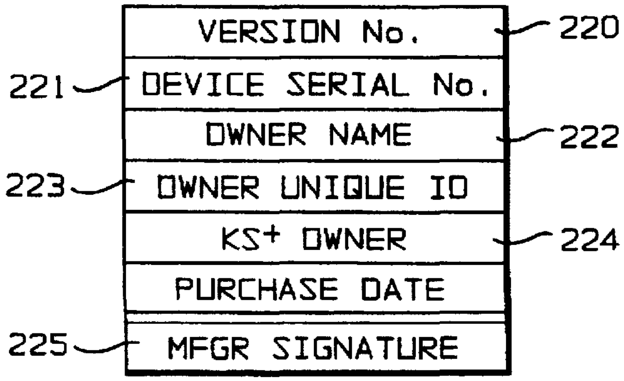
PRIOR AGREEMENT ON (NON-SECRET)
PRIME p AND VALUE a


PARTY A
PARTY B
GENERATE SECRET RANDOM NUMBER x
21
22
GENERATE SECRET RANDOM NUMBER y
COMPUTE a^x mod p
23
24
COMPUTE a^y mod p
COMPUTE KEY $(a^y)^x$ mod p
25
26
COMPUTE KEY $(a^x)^y$ mod p

COMMON KEY a^{xy} mod p KNOWN BY A AND B
BUT NOT DEDUCIBLE BY AN EAVESDROPPER

FIG. 22

DEVICE OWNER'S
CERTIFICATE (EXAMPLE)



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